Exam Preparatory Manual for Undergraduates

Forensic Medicine and Toxicology

(Theory and Practical)

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(In accordance with syllabus prescribed by MCI)

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Exam Preparatory Manual for Undergraduates: Forensic Medicine and Toxicology (Theory and Practical)

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Preface

Writing a book on forensic medicine is my lifetime ambition. The basic aim of taking up this subject is to bring a reasonable standard of uniform medicolegal services throughout the country, a good ethical practice of medicine and also to bring life to the outdated term "Medical Etiquette".

Working on this project of writing a book was a slow and studious process, and I started doing it very soon after I completed my postgraduation. I also wanted to be sure that my book should not be just an addition in the series of books in forensic medicine. I wanted to come out with a book which is student friendly, short, precise, covers all the aspects of the subject, theory and practical and to help the students to face the examinations with confidence and also learn the basic skills, thus able to apply them throughout their lifetime. All my dreams came true when M/s Jaypee Brothers Medical Publishers (P) Ltd joined hands with me and gave me the opportunity to write this excellent student-friendly textbook.

Only doctors who possess the basic degree of MBBS are called medical experts in the court of law, so allopathic physicians apart from the basic duty of curing patients of their ailments have yet another important responsibility, which is to fight for social justice by enlightening the court by the truth based on strong scientific proof. To be frank, only by the knowledge of this subject of forensic medicine and, of course, pathology, emergency medicine and surgery, we, the allopathic physicians, stand distinct in the huge crowd of doctors, but only a very few of us recognize this fact.

Even though plenty of forensic medicine experts are available in the country, yet nearly 90% of the medicolegal workload of the country is still being carried out by the doctors who do not possess a postgraduate degree in forensic medicine. Ultimately, they have to depend upon the knowledge gained by them in the 2nd year of their MBBS course.

This book is entitled *Exam Preparatory Manual for Undergraduates: Forensic Medicine and Toxicology (Theory and Practical)* and is prepared in accordance with the syllabus prescribed by the Medical Council of India (MCI). All the chapters in this book are carefully written for easy understanding. All the chapters are presented in question-and-answer format, to help the students understand how the questions would be asked in examinations and what they are expected to write as answer for each question.

Even though the book is in a question-and-answer format, it carries all the points which a standard textbook is expected to contain. Questions are in the form of topics/headings and answers in the form of explanations; thus, students can study only this book, which would be more than enough for the undergraduate medical students and they would be rewarded back with excellent marks in their examinations.

For the welfare of the students, the important set of practical exercises are also discussed; thus, the students can also prepare well for their practical examinations. This book will serve all the needs of the students for theory, practical and viva-voce examinations.

Apart from the medical students, this book will also be useful for the investigation team, judiciary and other branches of students who need to have knowledge of forensic medicine such as the students of criminology, criminal justice and forensic science.

V Dekal

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Contents

Section I:

Medical Jurisprudence

CHAPTER 1

Introduction and Scope of Forensic Medicine

Keywords: Forensic medicine, medical jurisprudence, medical ethics, medical etiquette.

1. What is forensic medicine?

- Forensic medicine or legal medicine is also called as state medicine.
- Forensic medicine is a branch of medical science which deals with the application of medical knowledge to help or aid in the administration of justice.
- The word "forensic" originates from the Greek which means "open forum" — a public debating place (court of law).
- It is a branch of medical science which Bridges between the law and medicine. In short, the subject deals with the **medical aspects of the law**.

Forensic medicine can be broadly divided into:

- *Clinical forensic medicine:* It deals with the examination of the living individuals, such as cases of sexual offences, wound certificate, age estimation, etc.
- *Forensic pathology:* It deals with interpretation of autopsy findings in the medicolegal investigation of death (forensic thanatology — Study of death).

2. Define medical jurisprudence.

- **Juris:** Law; Prudentia: Knowledge.
- Medical jurisprudence deals with the legal responsibilities of the physician with reference to those arising from physician-patient relationship, such as medical negligence, consent, rights and duties of doctors, serious professional misconduct, etc. (in short, it deals with the **legal aspects of practice of medicine**).
- Medical jurisprudence deals with the laws which govern the practice of medicine, hence any violation of the said law relating to medical practice will attract penal action and punishment against the doctor as per the provisions of the Indian Penal Code.

3. Define medical ethics and etiquette.

- **Medical ethics** deal with the moral principle which should guide the members of the medical profession in their dealings with each other, their patients and the state.
- **Medical etiquette** deals with the conventional laws of courtesy observed between the members of the medical profession.

4. What is the scope of forensic medicine?

- Forensic medicine deals almost entirely with crimes against human beings. In present days, almost all the offences against the human body require medical opinion in order to deliver an impeccable justice in the court of law. The primary interest is to provide the source of information about medical science to confine the needs of the law.
- Forensic medicine is mostly an exercise of common sense combined with the application of knowledge and experience acquired in other branches of medicine.

- Forensic medicine involves:
  (i) Observation of facts,
  (ii) Collection of evidence,
  (iii) Interpretation of the scene of crime and
  (iv) Reconstruction of the events based on medicolegal examination.
- In all cases of crime involving human body, e.g. homicide, suicide, assault, sexual offences, traffic accidents, poisoning, etc., the help of the medical officer is sought by the investigative agency. In all such cases, the doctor will be required to appear in the court as an expert witness and depose evidence.
- In some cases, as in cases of sudden death, the authorities will have to depend completely on the medical witness in establishing the cause of death.

5. *What are the circumstances a doctor may be called to the court?*

- A doctor may be called to the court to testify:
  (i) As an ordinary witness who saw something happen.
  (ii) As a medical practitioner who treated the patient.
  (iii) As an expert witness to give opinion on matters of science.

CHAPTER 2

The Indian Legal System

Keywords: Inquest, magistrate inquest, coroner's court, evidence, witness, medical witness, criminal courts in india, dying declaration, compos mentis, dying deposition, summons, conduct-money, perjury, hostile witness, leading question, court procedure.

INTRODUCTION

The legal system in India is governed by:

Indian Penal Code (IPC) formed in the year 1860:

- It deals with substantial criminal laws of India. It defines various offences and prescribes punishment for all offences.

Criminal Procedure Code (CrPC) formed in the year 1973:

- It stipulates the duties of the police/enquiry officer, in their dealings with the offender during interrogation and in the investigation of death.

Indian Evidence Act (IEA) formed in 1872:

- It deals with laws of evidence and applies to any court whether civil or criminal.

Case laws:

- Legal principles derived from judicial decisions. It is different from statutory laws enacted by the legislature; but accepted as precedence in similar types of cases in future.

1. Define inquest? What are the various types of inquest? Describe the procedure of police inquest? What is magistrate inquest and when magistrate inquest is conducted.

Inquest: (In: In; Quasitus: To seek)

- Inquest is defined as preliminary legal inquiry into the cause, manner and circumstances of any unnatural, sudden and suspicious death.

Types of inquest

- There are basically four types of inquest prevalent throughout the world and they are:
  (i) Police inquest
  (ii) Magistrate inquest
  (iii) Coroner's inquest
  (iv) Medical examiner system of inquest.
- In India, there are only two types of inquest (police inquest and magistrate inquest).
- Section 174 CrPC deals with police inquest and section 176 CrPC deals with magistrate inquest.

Police inquest

- This is the commonest type of inquest conducted in India.
- The officer in-charge of a police station, not below the rank of sub-inspector (called the investigation officer of that particular case), on receipt of information of a death, informs the executive magistrate and proceeds to the place where the dead body is found.
- Conducts the inquest in the presence of two reliable witnesses, who should be respectable persons of the society (panchas). He comes to a conclusion of the apparent cause of death, as judged by him and prepares a report called the inquest report (panchnama).

Table 2.1 Difference between Coroner's court and Magistrate court

Coroner's court	Magistrate court
Court of inquiry	Court of trial
Can summon a witness, issue warrant and impose fine	Do
Court of inquiry and hence cannot award any punishment	Court of trial and hence punishment is awarded after trial

- If death is purely due to disease (natural death), he may handover the body to the relatives of the deceased to bury the body according to their religious customs. If death is unnatural or if he suspects some foul play or the cause of death is not known, he sends the body to the nearest authorized autopsy center for postmortem examination, along with a copy of the inquest report.

Magistrate inquest

It is the inquest conducted by the executive magistrate appointed by the state government. The Executive magistrates are of people of the revenue department not below the rank of Tahsildar, District Revenue Officer (DRO), Revenue Divisional Officer (RDO), PA to collector or the district collector can all act as executive magistrates. The executive magistrate conducts inquest in the following situations:

(i) Dowry deaths
(ii) Death in police custody
(iii) Death during police interrogation
(iv) Death due to police firing
(v) Death in a psychiatric hospital/mental asylum
(vi) Exhumation
(vii) In any case of death, the magistrate may/can conduct an inquest instead of or in addition to the police inquest (Section 176 CrPC).

Coroner's inquest

- Coroner is a person qualified either in medicine or law or both, appointed by the Govt.
- He conducts the inquest in all unnatural and suspicious deaths.
- He is empowered to summon any person for enquiry.
- Coroner's court is a court of enquiry, but he is not empowered to conduct a trial.
- This type of inquest is done in United Kingdom and some states of the USA.
- This type of inquest was practiced in many parts of India during the British period; it is no more in practice in India and was lastly withdrawn from Bombay in the year 1999. Refer Table 2.1 for difference between coroner's court and magistrate court.

Medical examiner system of inquest

- This is the type of inquest prevalent in most states of the USA and also in many advanced countries. A medical examiner (forensic expert) is appointed to perform the functions of coroner.
- On receipt of information of a death, the medical examiner visits the scene of crime and conducts the inquest. Thus, he is able to gather first-hand evidence which is interpreted in proper perspective owing to his knowledge of medical science and he himself conducts the autopsy on the body and hence, better corroboration of evidences and thus better administration of justice.
- This is said to be the most superior type of inquest.

2. What are the various criminal courts of India? What are the powers of various courts?

"Refer Fig. 2.1, and Tables 2.2 and 2.3."

Juvenile justice board

- The aim is to provide care, protection, development and rehabilitation of the delinquent juveniles.
- The Juvenile Justice (Care and Protection of Children) Act, 2000.
- As per the act a 'juvenile' means a person who has not completed 18 year of age.
- Juvenile in conflict with the law' means: A juvenile who is alleged to have committed an offence.

- A juvenile cannot be retained in a place where there are no provisions for rehabilitation.
- Juvenile courts are preceded by 1st class women magistrates.

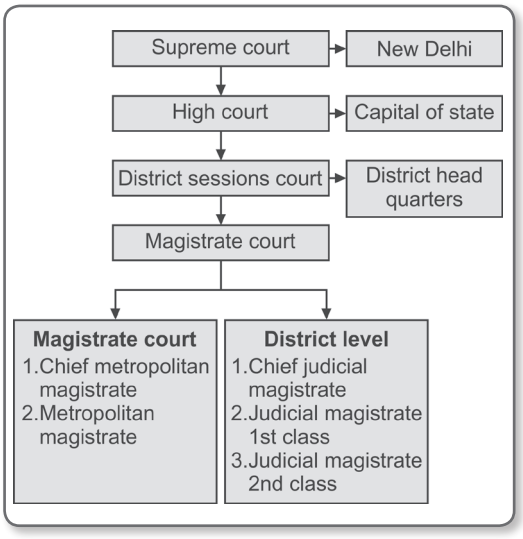


Fig. 2.1 Criminal courts in India

3. What is a cognizable offence?

- An offence means any act or omission punishable by the law.
- Cognizable offence is an offence for which the police officer can arrest an individual without a warrant from the magistrate, e.g. rape, murder, dacoity, etc.
- In these cases, the arrested person is sent to the doctor by the police for examination.
- In a non-cognizable offence, the individual may go direct to the doctor, or file an affidavit in court and then the magistrate sends the person to the doctor for examination. (Section 41 CrPC)

4. What is an evidence? What are the types of evidences?

- Evidence means and includes all the statements which the court permits or requires to be made before it by the witnesses, in relation to the matter of fact under inquiry.
- For the evidence to be accepted by the courts, it must be properly identified as to what it is, where it was found and how it is related to the crime.

Table 2.2 Criminal courts of India

Court	Location	Powers
Supreme court	New Delhi	Highest judicial tribunal of the country. Can pass any sentence Usually considers only appeals from the high court
High court	State capital	Highest judicial tribunal of the state. Can pass any sentence Usually considers only appeals from the lower courts
Session court (district sessions court)	District head quarters	Highest judicial tribunal of the district Can pass any sentence but death sentence has to be confirmed by the high court

Table 2.3 Magistrate courts

Court	Location	Powers
Chief metropolitan magistrate Chief judicial magistrate	Metropolitan areas District (not being a Metropolitan area)	Can pass a sentence of imprisonment up to 7 years: Fine without limit
Metropolitan magistrate Judicial magistrate of first class	Metropolitan area subdivision of a district	Can pass a sentence of imprisonment upto 3 years: Fine up to Rs. 5,000/-
Judicial magistrate of second class	Taluk level	Can pass a sentence of imprisonment upto 1 year: Fine up to Rs. 1,000/-

Chain of custody

- It is a method to verify the actual possession of an object from the time it was first identified, until it is offered as evidence in the court.

Types of evidences

i. ***Direct evidence***

- The witness testifies directly of his own knowledge as to the facts in dispute; only those witnesses who have first-hand knowledge can give direct evidence in the court of law—First-hand knowledge rule.

ii. ***Circumstantial evidence: (presumptive evidence)***

- The circumstances tend to prove the ultimate fact in issue; it is the evidence derived from circumstances as distinguished from direct and positive proof.

iii. ***Substantial evidence***

- The evidence which a reasonable prudent man will accept as adequate for arriving at the decision in that case.

iv. ***Corroborative evidence***

- The evidence that concurs with another. Generally, the eye witness is considered as positive evidence and the medical witness or the expert witness is only corroborative in nature.

v. ***Hearsay evidence***

- Any statement made by a person other than the actual witness who has the firsthand knowledge of the fact or crime. It is the evidence of a third person, what was told to him by someone else. Such an evidence cannot be cross-examined as they are not actual witness.

5. What are the ways in which evidence can be presented in the court?
What is documentary evidence? Give examples of documentary evidence.
Describe: Dying declaration; compos mentis; dying deposition.

- Evidence could be oral or documentary.

Oral evidence

- In all cases, oral-evidence must be direct; it must be the evidence of a person who saw, heard or perceived. Hence oral evidence is given more preference in the court of law. Oral evidence is the best type of evidence because it is subjected to cross-examination.

Exceptions to oral evidence

- Dying declaration
- Expert opinion expressed in a treatise (textbooks, journals, peer reviews)
- Evidence of a doctor recorded in a lower court
- Evidence of a witness given in a previous judicial proceedings, etc.

Documentary evidence

- Document means any matter expressed by means of letters, figures or marks.
- Documentary evidence includes all the documents produced for the inspection of the court.

Examples

- Medical leave certificate, medicolegal reports like: Age certificate, sexual offences certificate, dying declaration, postmortem certificate, etc.

Medical evidence

- When any case is presented to a doctor for examination, he gives his opinion in the form of a certificate which includes the findings observed by him and his opinion based on the observations; hence, all the evidences of any expert are given in the form of a document.
- The investigation team investigates the case on the basis of his opinion and in all situations, the doctor must come to the court, and testify under oath, cross-examined by the defense, for his evidence to be accepted as a proof in the court of law.

Dying declaration: (Section 32 IEA)

- It is the statement oral or written made by a person who is about to die, as a result of some unlawful act. The statement should relate to the cause of his death, or to the circumstances which have resulted in his present condition.
- Dying declarations are admissible in the court, and may provide useful information to the court and may help to obtain justice. In case of death of such a person, the dying declaration is as such accepted as evidence in the court without any cross-examination.
- It is believed that any individual who is about to die will speak only the truth, but in the

present days, due to the change in the attitude of the human beings, these types of declarations have lost their values in the courts of law.
- If the individual survives after making such declaration, they are accepted as evidences, but only as corroborative evidence; and the individual has to come to the court, reproduce those statements under oath, get cross-examined by the defense before they are accepted as concrete evidences by the court.

Duty of a doctor while recording dying declaration
- Upon admission in to the hospital, in such cases, the doctor should immediately inform the judicial magistrate about the condition of the patient for the purpose of recording the dying declaration.
- Dying declarations are usually recorded by the judicial magistrates; in the absence of the magistrate or when there could be a relative time delay for him to arrive then, it can be recorded by the police officer or any individual who is present by the side. Even the doctor himself can record such declarations when no one else is present or when there is no time to wait.

Compos mentis
- Before recording the statement and also throughout the recording till the end, the doctor should certify that the person is conscious and his mental faculties are normal.
- The doctor who certifies compos mentis cannot record the declaration even under emergency. Some other doctor can record it, if it is so much urgent.
- If the individual dies or becomes unconscious before completing his declaration, then the process of recording is stopped at that stage and signed by the doctor and by the person who was recording it and handed over to the court in a sealed cover.
- No additions or deletions or any alterations should be made in the statement.

Dying deposition
- This is superior to dying declaration and recorded only by the magistrate; while recording the deposition, the accused and his lawyer are allowed to be present. The statements made by the victim are then and there cross-examined by the defense, and hence carries equal value as that of a trial conducted in the court. This is not practiced in India.

6. Who is a witness? What are the types of witnesses? Who is an expert witness?

Witness: Sections 118 to 134 of IEA deals with witnesses
- Witnesses are individuals who testify under oath what he knows about the issue under dispute. All persons are competent to testify unless they are prevented from doing so.
- Hence, there is no age limit to be a witness, but the individual who gives evidence should have enough mental maturity to understand the court questions and answer them logically, or else it becomes easy for the defense to disqualify such witnesses. Hence, it is always preferable that the age of the witness is more than 12 years.
- People suffering from insanity and those under the influence of any drug or intoxication are prevented to be witnesses in the court of law.

Types of witnesses

Common witness
- Any individual who was present nearby or comes to know about any crime and has seen, heard or perceived any information regarding it, can be a common witness; and it is the social responsibility of every citizen to inform the police regarding any crime and also come forward to the court to give evidence regarding what he knows about that particular incident or crime.
- The common witness is not permitted to volunteer any statement in the court of law and is bound to answer only what is being asked to him.

First hand knowledge rule
- The common witness must possess the first hand information regarding the matter under dispute.

Expert witness
- Expert witness is a person who has been trained or skilled in technical or scientific subject, and is capable of drawing inferences, opinions and conclusions from the facts observed by him or noticed by others; Example: Doctor, firearm expert, fingerprint expert, chemical examiner, etc.

- An expert witness is expected to help the court to arrive at the near truth, by his special knowledge and skill.
- He is called to the court to clarify certain doubts, on that particular specialty and hence should restrict himself in clearing the doubts logically and scientifically; his answers must be direct wherever possible as he is there to help the court with his special knowledge.
- As far as possible he should not volunteer any statement; at the same time, never hesitate to volunteer a statement, if he feels that there is a chance of miscarriage of justice due to failure of the court to elicit a particular issue.

7. Write short notes on summons.

Summons: Is also known as subpoena.
(Sub: Under; Poena: Penalty); Sections 61 to 69 of CrPC deal with summons.

- Summons is a document compelling the attendance of a witness in a court of law under penalty, on a particular day, time and place, for the purpose of giving evidence.
- The witness is also required to bring with him any document under his control, which he is bound by the law to produce as evidence.
- Summons is issued to the witness by the court and usually served through the police.
- If the witness is a government servant, summons is sent to the head of the office where he is working and served through him to the witness.
- Usually, three copies are served and the witness signs in one copy and sends it to the court through the police who serves the summons, as an acknowledgement that he has received.
- The person who has received a summons is bound to attend the court at the prescribed time and date without fail.
- If he is unable to obey the summons due to unavoidable and acceptable reasons, he has to intimate the court well in advance, about his inability to attend the court.
- If a person receives two summonses from different courts on the same day; he has to give priority to criminal courts over the civil court.
- If both the summonses are from criminal court, then priority is to be given to the higher court; if both the courts are of equal status, then he has to attend the court from which he received the summons first and inform the other court, that he may be summoned later.

8. What is conduct money?

- The expert witness is paid money to meet his expenses for coming to the court from his residence and back; it is usually paid along with the summons or in the court after giving evidence. If the doctor feels it insufficient, he can ask the court to get it enhanced; however, no such money is paid in criminal cases as it is considered as a responsibility of the expert toward the state.

9. What is perjury? Who is a hostile witness? What are leading questions and their importance in the trial?

Perjury

- Section 191 IPC defines perjury as "willfully giving and/or fabricating false evidence under the oath." Perjury is breaking the oath and the witness is liable to be prosecuted under section 193 IPC (imprisonment which may extend upto 7 years).

Hostile witness

- After making a particular statement in the court, the witness contradicts his own statement, and hence is supposed to have some interest or motive to conceal part of the truth or gives completely false evidence, and then he is declared hostile by the court.
- When the witness is declared hostile, then he can be cross-examined by the side by which he has been called, i.e. leading questions are permitted even in examination-in-chief.

Leading question

- The question which suggests an answer or caries a hidden answer inside is a leading question.
- Example: In case of an injury:
  - Direct question: Which weapon will cause the injury?
  - Leading question: Can the injury be caused by a single-edged knife?

Importance of Leading questions:

- Leading questions are allowed only in cross-examination, since the aim of the prosecution is to prove the crime, whereas the aim of the defense is to weaken the witnesses.
- Leading questions are not allowed in the examination-in-chief; but allowed when the witness turns hostile as per section 154 of IEA.

10. What is the procedure of trial in the court?

Conduct of a doctor in the witness box:

- In any criminal trial, it is the duty of the prosecution to prove the crime beyond any reasonable doubt.
- After the witness enters the witness box, they have to take oath before recording the evidence.

Oath taking

- "I swear in the name of God that the evidence I shall give to the court shall be the truth, the whole truth and nothing but the truth".
- After the witness takes the oath, recording of evidence commences.

i. ***Examination-in chief***

- Done by the side who has called him, usually by prosecution.
- The witness is allowed to reproduce all the facts concerned with the case, which are known to him. Then the prosecution is allowed to put forth any questions necessary to prove the crime. They are permitted to ask only direct questions.

ii. ***Cross-examination***

- It is done by the defense counsel to elicit points in his favor. The defense raises doubts and it is the duty of the prosecution to clarify those doubts logically. The defense is allowed to ask leading questions.
- Usually after the cross-examination, the presiding officer puts forth his questions to the witness. But if the defense has introduced any new issues, then a re-examination is permitted.

Re-examination

- By the prosecution to get more clarity, on the said matter and to rectify deviations, if any. (Not in all cases).

Re-cross examination

- When a re-examination is allowed, then a re-cross-examination is also permitted to cross the new points introduced if any by the prosecution.

Court Questions

- At the end of the recording, the court questions are asked by the presiding officer (judge) to clarify his mind regarding the whole presentation of evidence.

Conduct of a doctor in the court

- Attend the court in time, neatly dressed and always with the white coat.
- Respect the court, approximate both hands together near the chest and bend forward as a token of respect before entering the court and also after entering the witness box.
- Go to the court well-prepared and do not forget to take all the necessary documents relating to that particular case.
- Be frank and clear on the subject matter; speak audibly and clearly.
- Use simple language and avoid technical terms as far as possible.
- Give reasonable time in between for the stenographer to type your statement.
- Give direct answers whereever possible.
- If you don't know the answer to a particular question, be frank to admit it.
- Never volunteer a statement; but, do not hesitate to volunteer a statement if you feel that there is a danger of justice being miscarried, owing to the court's failure to elicit an important issue.
- In medical science, it is always difficult to separate fact from opinion; hence, the doctor attending the court as a scientific witness, has to express his opinion arising out of the facts observed by him.

In cases of medical negligence

- It is hard to criticize a colleague, but never conceal what you know to be true. Since, the court or the complainant does not possess any knowledge on medical science; whereas, the medical man has enough medical knowledge to defend himself; the very purpose of our evidence is to help the court in deciding what's right or wrong based on medical opinion and hence never hide anything which you saw or know.

- There is no perfect witness, but efforts must be made by everyone to be a perfect witness.
- Our evidence should in no way be inferior to anyone else and thus a reasonable standard has to be there, which can be achieved only by strong knowledge on medical science.
- Many a times, you may have to wait for a long time for your evidence to be recorded, but never lose patience. Wait for your turn and present the case clearly and nicely, thus win the respect of the court and I am sure that when you go to the same court next time, the judge will make every effort to record your evidence first.
- Due to the bitter experiences in the past, the doctor may feel hesitant to go to the court and many a times there may not be even a single question raised by the defense; but do not care for those things in your mind, develop a positive thought inside you; feel it is our duty as a citizen to attend the court and give evidence whenever we are summoned, and be proud that since we have this special knowledge of medical science, we are being called by the court to assist it with our special knowledge.
- A medical witness by his honest, unbiased and straightforward opinion can win the confidence of both the prosecution and as well as the defense.

CHAPTER 3

Medical Ethics and the Law

Keywords: Medical ethics, etiquette, Hippocratic Oath, Indian medical council, state medical council, professional misconduct, dichotomy, covering, penal erasure, red cross emblem, professional secrecy, privileged communication, euthanasia, malingering.

INTRODUCTION

- **Medical ethics** deals with the moral principles which should guide the members of the medical profession in their dealings with each other, their patients and toward the state.
- **Medical etiquette** deals with the conventional laws of courtesy observed between the members of the medical profession.
- The word ethics is derived from Greek term "ethikos" which stands for rules of conduct that govern the natural deposition in human beings.
- Ethics is self-imposed code of conduct assumed voluntarily by the medical profession.
- Code of ethics retains the moral guidelines and cannot run contrary to the society and the ethical codes must always be in conformity with the law of the land.
- Code of ethics is different from the law, since non-adherence to the prevailing ethical standards may not be considered as an offence by the law and hence any doctor, who violates the ethical codes, cannot be punished by the law rather will attract an action for the infamous conduct by the medical council.
- Ethics reflects the conduct, character and attitude of a doctor; whereas, negligence is related to the competence, knowledge and skill of a doctor.
- Ethical violation is professional misconduct and the state medical council takes action.
- The first basic code of medical ethics is universally known as "Hippocratic Oath" (around 500 BC). Hippocrates was the Father of Western Medicine lived in Greece.
- At the time of registration of a medical graduate has to sign a declaration which is the modern version of **Hippocratic Oath** and is called as the Declaration of Geneva (1948).

The Declaration of Geneva (1948): Modern Version of Hippocratic Oath

- I solemnly pledge to consecrate my life to the service of humanity.
- I will give my teachers the respect and gratitude which is their due.
- I will practice my profession with conscience and dignity.
- The health of my patients will be my first consideration.
- I will respect the secrets which are confined in me, even after the patient dies.
- I will maintain by all means and power, the honor and the noble traditions of the medical profession.
- I will consider my colleagues as my brothers.
- I will not permit considerations of religion, nationality, race, party politics or social

standings to intervene between my duty and my patients.
- I will maintain at most respect for human life from the time of conception.
- Even under threat I will not use my medical knowledge contrary to the laws of humanity.
- I make these promises solemnly, freely and upon my honor.

1. What is the constitution and functions of Indian medical council?
- Indian Medical Council was formed under the Indian Medical Council Act 1956.

Constitution of the indian medical council
- One member from each state, nominated by the central government in consultation with their respective state government.
- One member from each university, to be elected from amongst the members of medical faculty, by members of its senate.
- One member from each state medical council, selected from amongst the registered medical practitioners of the state.
- Seven members are to be elected from amongst themselves, enrolled in any SMC.
- Eight members nominated by the central government.
- The president and vice-president are elected from amongst the members of the council.
- Executive committee constituted from amongst the members, comprising of the president, vice-president and 7 to 10 other members.
- The council appoints a registrar and secretary for its day to day functions.
- The term of office will be 5 years from the time of assuming charge.

Functions of the indian medical council

i. **Maintenance of medical register:** Maintains a register containing the names, address and qualification of medical practitioners who have registered with any state medical council. The IMC has no direct role toward this function of maintenance of register.

ii. **Medical education:** It regulates the standards of undergraduate and postgraduate medical education. This is one of the most important functions of the Indian Medical Council. The IMC maintains a uniform standard of medical education throughout the country. There are many medical colleges and universities in India and the teaching pattern and exam pattern varies from university to university, but the syllabus and number of years of study and period of hours of training at different levels and different subjects are maintained at a uniform standard by the Medical Council of India. It prescribes minimum standard of education for undergraduate, postgraduate and super specialty courses.

iii. **Recognition of medical degrees:** All the medical degrees awarded inside as well as outside India are regulated and are to be recognized by the council, if the individual is practicing medicine in India. The medical council maintains three schedules (Table 3.1).

iv. **Appellate tribunal:** Appeals against any disciplinary action taken by the SMC.

v. **Disciplinary control:** The council prescribes minimum standards of professional conduct, ethics and etiquette amongst its members. The council periodically issues warning notice (warning notice is a list of offences which are considered as infamous conduct).

2. What is the constitution and functions of State Medical Council?

State medical council
- State Medical Council consists of members elected by the registered medical practitioners of the respective state and members nominated by the state government.

Table 3.1 Schedule of medical degrees

First Schedule	Second Schedule	Third Schedule Part A	Third Schedule Part B
Medical degrees offered by different Universities in India, which are recognized by the council	Medical degrees offered by different universities outside India, which are recognized by the council	Medical degrees conferred by Indian universities, which are not mentioned in the 1st schedule	Standard medical qualifications of foreign countries, which are not mentioned in 2nd schedule

- The president and the vice-president are elected amongst themselves; a registrar is nominated to carry out the day to day works of the council.

Functions of SMC

1. **Maintenance of medical register:** This is one of the most important functions of any state medical council.
- Every medical graduate, upon passing his final year exams, has to get his name temporarily registered in the SMC to pursue his internship; upon completion of one year internship he has to get permanently registered himself in the respective SMC and a permanent registration number is allotted to him.
- He needs to specify the registration number wherever necessary. A doctor cannot start his medical practice before he gets himself permanently registered in any SMC.

2. **Disciplinary action and control:** Disciplinary action is purely the function of the SMC. Enquiry and action for any infamous conduct are carried out by the State Medical Council only.
3. **Issue warning notice periodically:** Warning notice is a list of offences which comprises of infamous conduct; it is not a complete list and not intended to be complete also.

3. What is infamous conduct? What are the acts which amount to professional misconduct? Write short notes on dichotomy; covering.

Definition

- Infamous conduct is any act done by a registered medical practioner which is considered disgraceful and dishonorable by his professional colleagues of good repute.
- There are various acts of a doctor labeled as infamous conduct and are listed in the warning notice. Some of those acts which amount to professional misconduct are:
  i. Abortion
  ii. Adultery
  iii. Alcoholism
  iv. Addiction
  v. Advertising
  vi. Association
  vii. **Dichotomy:** "**Fee splitting"** getting commission/monetary benefits for referring a patient to another doctor, investigation, prescribing drugs of a particular company or sending prescription to a particular retail shop, etc.
  viii. **Covering:** Assisting/associating with unqualified people to carry out the work of a doctor.
  ix. Violation of any of the provisions of the acts which govern the medical profession which is in force from time to time.
  x. **Issuing false certificates:** Issuing false certificate in any regard is an infamous conduct.
    - It is in common practice to issue medical certificates to people working in government and private sectors; issuing false medical certificates without valid grounds amounts to professional misconduct.
      – As far as possible issue medical certificate only when you have treated the patient.
      – At any one time do not issue sickness certificate for more than 15 days.
      – When you have treated the person as outpatient, specify in the certificate itself that you have treated him as outpatient only.
      – Do not issue certificates to unknown persons; be sure that the individual comes in person and signs in front of you in the prescribed place in the leave certificate.
      – Death certificate: Efforts should be made to examine the dead body physically before issuing the certificate; do not attempt to issue the certificate by going through the old treatment records, statement from the relatives or hearsay information; also issue death certificate to the individuals for whom you were the only treating doctor in the recent past.
  xi. Notification of birth, death, infectious diseases, etc. in interest of the community and public, the doctor is bound to notify these to the concerned authorities. Failure to no-

tify such diseases amounts to professional misconduct.

xii. Withholding information about notifiable diseases to public authorities; It is the duty of the doctor toward the community/state to inform the authorities about any notifiable diseases he comes across.

xiii. Refusal to treatment on religious or social grounds.

xiv. Disclosure of professional secrecy: Never disclose the secrets of your patients to anyone, even to the close relatives without the consent of the patient.

4. What is professional secrecy; when it can be revealed? Explain privileged communication with suitable examples.

- The doctor in the course of the treatment of his patients will come to know certain information about the patient. The doctor is obliged to keep all the information provided by the patient about his condition or any information he comes to know concerning the patient as secret; and he should not divulge the information about the patient to anyone **without the consent** of the patient. He should not divulge such information to anyone **even after the death** of the patient.
- However, there exists no professional secrecy when a person subjects himself voluntarily for examination as in cases of insurance or examination for issuing driving license and also in medicolegal cases. The doctor is bound to reveal all information regarding the patient to the concerned authorities in such circumstances. The consent for divulging the information is implied as he subjects himself voluntarily for such examination. Also, it becomes the duty as a physician to reveal all the findings of the examination in such circumstances.
- Breach of professional secrecy is infamous conduct except, when it is required by the law to be revealed. The only exception is privileged communication.

Privileged communication

- It is a statement made bonafide upon any subject matter by a doctor to the concerned authorities, due to his duty to protect the interests of the community or of the state.
- To be privileged, the communication must be made only to a person having interest in it, or in reference of which he has a duty.
- The doctor should first persuade the patient to obtain his consent before notifying the proper authority. The doctrine of privileged communication fails, if the information is revealed to more than one person.

Examples

i. Infectious diseases:

- A patient suffering from communicable disease like gastroenteritis, enteric fever, etc. working in a common eating place like hotel; In these situations, the patient should be persuaded to stay away from the job till he becomes non-infectious; if the patient refuses, then the doctor can inform the employer about illness of the patient.
- A teacher or children's nurse suffering from tuberculosis or other easily contactable infectious diseases: The patient is advised that she is unfit for the job till you become non-infectious; if the patient does not obey and continues to do the same work; now the doctor can inform the employer (Parents of the child) about the disease condition of the patient and not to employ her till she becomes non-infectious.

ii. A person suffering from venereal disease (syphilis or gonorrhea) is about to marry. First the patient is advised to postpone the marriage or use condoms to prevent the spread of the disease to his partner, till he becomes non-infectious; if he refuses to obey the advice then the doctor can make a privileged communication to the concerned person.

iii. Servant and employees:

- An engine driver, bus driver or ship's employee suffering from epilepsy, high blood pressure, drug addiction or color blindness. The doctor should advice them to quit the job, if the patient fails to obey; then the doctor can inform the concerned authorities in the interest of the community.

5. What is procedure of initiation of charge of infamous conduct against a doctor? What are the punishments that could be given? What is professional death sentence?

- Infamous conduct is an ethical violation and hence no legal action can be taken against a doctor for such conduct, unless his act falls

into any of the punishable provisions of the penal code.

- Only the patient or the legal relatives of the patient can initiate an action for the infamous conduct committed by the doctor in the State Medical Council.
- On receipt of the information of the complaint against a doctor, the executive committee analyses such a complaint and if it finds there is prima facie evidence, then the SMC sends intimation to the concerned doctor, asking for explanation regarding the alleged complaint.
- The reply of the doctor if found satisfactory, then the petition of the complainant is dismissed at that stage itself; if the council is not satisfied with the explanation given by the doctor and feels that the doctor is guilty of committing an infamous conduct, then the SMC forms an executive committee, from amongst its members consisting of 5, 7, or 9 members depending as the situation warrants.
- The executive committee summons the doctor for a personal enquiry, where the doctor is asked to be present before the committee on a particular date and time with the relevant documents to prove his innocence.
- The doctor may appear in person or can also send a representative, with authorization to represent him for the enquiry. The complainant is also summoned to be present during the phase of the enquiry.
- The complaint is first read and the doctor is given chance to defend himself against the complaint with necessary relevant documents if any; after hearing the statement of both the parties, the executive committee takes the action after following the due process of the law. Depending on the outcomen the doctor is either found guilty or innocent; if he is found guilty, there are three types of punishments meted out to the doctor.
  (i) Warning: For simple and minor issues, where the doctor is warned not to repeat such acts, and a severe punishment will be awarded if he continues to involve himself in such a type of infamous acts.
  (ii) Temporary erasure: The name of the doctor may be temporarily removed from the medical register, for a variable period which may extend from 2 months to 5 years. Upon completion of the suspension, his name will be re-instated.
  (iii) Permanent erasure: (**Penal erasure**): It is otherwise called as "**professional death sentence.**" The name of the doctor may be permanently removed from the medical register. His degree is withdrawn and is not allowed to practice medicine profession anymore.
  This type of permanent erasure may also be done when the doctor dies, or if he is convicted by the court of law for any serious offences committed by him like rape, murder, etc.

6. What is warning and what is a warning notice?

Warning and warning notice

- Most students often confuse with the terms warning and warning notice.

Warning

- Warning is the minimum punishment for a doctor who is proved to have committed an infamous conduct. That is, giving a warning to the doctor with an advice not to get involved in any such misconduct in future and if he indulges himself in such repeated misconducts it would attract a more severe punishment like temporary erasure.

Warning notice

- Warning notice is not related to any punishment; it is a list of offences which are considered as professional misconduct and any doctor committing any of those acts listed in warning notice will attract a charge of infamous conduct and subsequent enquiry and appropriate punishment by the state medical council will be undertaken.
- The list is not complete and not intended to be complete; any new type of infamous acts are done by a doctor in future, then those professional misconducts would be added in the subsequent warning notice.

7. Mention a few important acts which govern the medical profession?

- An act is a body of law, which lays down certain guidelines for carrying out some activity and also prescribes punishment if that activity is not carried out in accordance with the law.

- The doctor practicing medicine should be aware of the important acts which are in force. Some of those acts which are related to medical profession are:
  - The Indian Medical Councils Act 1956.
  - The Drugs and Cosmetics Act 1940; the Drugs and Cosmetics Rules 1945.
  - The Drugs and Magic Remedies (objectionable advertisement) Act 1954.
  - Narcotic Drugs and Psychotropic Substances (NDPS) Act 1985.
  - Birth and Death Registration Act 1969.
  - Medical Termination of Pregnancy (MTP) Act 1971.
  - Pre-conception and Pre-natal diagnostic techniques (Prohibition of sex selection) Act 1994.
  - The Mental Health Act 1987.
  - The Consumer Protection Act 1986.
  - The Transplantation of Human Organs Act 1994 (THOA).

8. What is the status of using Red Cross emblem by doctors?

Red cross emblem

- Section 12 of the Geneva Convention Act, prohibits the use of the Red Cross and allied emblems, for any purpose without approval by the Government of India.
- Section 13 lays down penalty of ₹ 500 for unauthorized use of such emblems and also forfeits the goods upon which the emblem is used.

9. What is euthanasia? What is active and passive euthanasia? What is the legal status of euthanasia in India?

- The word "euthanasia" was derived from the Greek word which means 'good death.'
- Euthanasia is mercy killing, assisted suicide or aid in dying.

Definition

- Euthanasia refers to infliction of a painless form of death on an individual suffering from severe, incurable diseases, resulting in intractable pain and suffering to the patient.
- Various forms of euthanasia:
  (i) Voluntary: The patient gives consent to end his sufferings.
  (ii) Non-voluntary: The patient is not in a position to give consent, e.g. comatose patients.
  (iii) Involuntary (compulsory): Decision by the society to terminate the life of an individual; it is done against the will and consent of the individual. It is decided by the relatives / health authorities depending on the severity of the case. Example: An individual having a deadly dangerous disease with high-risk of spreading the disease to the society. This is a very rare situation, but these types of new diseases keep on changing from time to time.

Classification of euthanasia

- Active: Inflicting death by an act of commission, e.g. injecting lethal dose of morphine.
- Passive: By an act of omission, e.g. withdrawing life saving supports in comatose patient.
- Pediatric: To the seriously sick or deformed infants, e.g. severe congenital anomalies.
- Geriatric: Seriously sick, bed-ridden aged individuals.
- Battlefield: Severely wounded or handicapped individual in the war field, to end his sufferings and also to prevent him from getting caught and tortured by the enemy.

Legal status of euthanasia in India

- Euthanasia has been alternatively accepted and condemned in India.
- Euthanasia is not legalized in India and hence any doctor practices or helps in euthanasia will be charged of causing murder /manslaughter or abatement of suicide, respectively.
- **Article 21** of the basic Constitution of India gives right to live but not right to die.
- As per the supreme court view: **Passive voluntary euthanasia** can be visualized as a fundamental right protected under **Article 21 of the constitution**, which assures right to privacy; it gives the patient a right to refuse life-saving medical treatment.
- The right to personal liberty includes the freedom to die with dignity.
- Active euthanasia though viewed as a crime, no convictions have been made so far against any individual for commission of such offence in our country, since most of the

cases are not reported or undisclosed and concealed.
- No doctor in any situation can encourage such act, even on humanitarian grounds. Even though it may be the only better option for the patient, it is against the law and it should not be practiced.

10. What is malingering? Name some diseases which are commonly feigned and how will you diagnose such cases?

Malingering: (Shamming).
- Malingering means planned feigning or pretending a disease for the sake of gain.

Reasons
- By soldiers or policemen to evade duties.
- Prisoners to avoid hardwork.
- Businessmen to avoid a business contract.
- Workmen to claim compensation.
- Criminals to avoid legal responsibilities.
- Diseases that are usually feigned are:
  (i) Ophthalmia; (ii) Dyspepsia; (iii) Intestinal (abdominal) colic; (iv) Sciatica (back pain); (v) Epilepsy; (vi) Insanity and (vii) Artificial bruise.
- The individual may do some **act of commission** to sham a disease; examples:
  (i) He may injure the nasopharynx with sharp instrument, swallow the blood and regurgitate in front of the doctor to mimic hematemesis.
  (ii) Excessive intake of digitalis may simulate a heart disease.
  (iii) Eating large amount of carrot, produce carotinemia and may simulate jaundice
  (iv) Chronic ingestion of coumarin will induce hemorrhagic diathesis.

Diagnosis
- In most cases detection is easy, but in some cases it may be difficult.
- History is taken from the patient, relatives and friends, and any inconsistencies in the description of the symptoms are noted.
- Usually the signs and symptoms will not confirm (fix into) any known disease.
- Malingering can be diagnosed by keeping the patient under observation and watching him without his knowledge. Rarely an anesthetic may be given to detect malingering.

CHAPTER 4

Medical Negligence

Keywords: Consent, informed consent, rules of consent, loco parentis, professional negligence, Section 304-A IPC, res ipsa loquitur, calculated risk doctrine, novus actus interveniens, vicarious liability, therapeutic misadventure, corporate negligence, products liability, contributory negligence, CPA, Professional indemnity policy, Workmen's Compensation Act.

INTRODUCTION

Negligence

- Diligence means due care and skill; Negligence is the opposite of diligence.
- In negligence, the degree of skill and care exhibited by a doctor while performing the procedure was below the prescribed standard.
- Negligence is defined as "omission to do something which a reasonable man would do or doing something which a prudent reasonable man would not do."

1. Define consent?
What are the types of consent?
What is informed consent?
What is the role of consent in medical practice?

Definition

- Consent is defined as "voluntary agreement, compliance, permission or accepting for the act proposed by another" and is valid only for that specified act or purpose.
- Indian Contracts Act, Section 13 states that "two or more persons are said to consent when they agree upon the same thing in the same sense."
- To be legally valid, the consent given must be intelligent and informed.
- The doctor examining or treating a patient without the consent amounts to the offence of assault.

Types of consent

There are two types of consent: (i) Implied consent, and (ii) Expressed consent.

- Implied consent: The behavior or the act of patient or the individual, itself indicates that he has consented for the act; you can take it for granted that he/she has given the consent. This is applicable only for minor procedure of medical practice like general physical examination, checking the pulse, blood pressure or giving injection, etc.
- Expressed consent: The doctor has to ask for the consent and obtain it before any procedure or treatment. Expressed consent is of two types: (i) Oral consent, and (ii) Written consent.
  - **Oral consent:** It is of equal value as that of written consent, but when a dispute arises between the two parties then it becomes difficult for the doctor to prove that he has obtained a proper consent. Hence, oral consent holds good only for simple procedures like per abdominal

examination, giving IV fluids or testing the blood, etc.

– **Written consent:** It is always better to go for written consent whenever the procedure is a slightly complicated or prolonged procedure like a suturing for an injury, an incision and drainage for an abscess, etc.

Informed written consent (The cornerstone of medical practice):

This is the most superior form of consent in medical practice. Informed consent is called as the "**doctrine of full disclosure.**" The law believes that the patient alone is the best person to care for himself and he has the right to choose what is good or bad for him and what is needed to be done on him to get cured of his disease or the problem he is suffering from.

Informed written consent in medical practice

- A doctor after examining the patient must explain to the patient and/or the relatives:
  (i) What's the disease or problem he is suffering from?
  (ii) What is his proposed treatment plan for that disease or condition?
  (iii) What are the other standard alternate treatments /procedures available for that particular disease or condition?
  (iv) What are the advantages and disadvantages of his proposed treatment; and why he prefers to follow that particular treatment option?
  (v) What are the advantages and disadvantages of the alternative line of treatment?
- The information provided to the patient should be in writing in simple language and in the language in which the patient is familiar. Then allow the patient to choose what type of treatment he needs and to be done for him.
- In important situations like surgery, it is always better to explain all these to the patient and to the close relatives of the patient and get it signed by the patient as well as the legal guardian. Since, if suppose the patient dies, the relatives are the people who are going to file the case if any and hence they should be convinced that the doctor did everything which is good for the patient and death was unavoidable.
- **Informed refusal:** When the doctor feels that a particular type of treatment will be the best for the patient and if the patient does not accept for the proposed treatment plan, there are many chances that it could result in some complications at later time; in spite of explaining all these in detail, the patient still refuses for the doctor's proposed treatment plan, then the doctor has to bring all in writing and get it signed by the patient; this is called as "informed refusal".

Consent in medicolegal cases

- Informed written consent should be obtained in all medicolegal examinations. It should be informed to the individual that, the opinion you are going to arrive after the examination, will be issued in the form of a certificate; which may go in favor of him or against him in the court of law; but, if he refuses to give consent for examination then it will definitely (100%) go against him in the court.

2. What are the rules of obtaining consent? What is loco-parentis?

Rules of obtaining consent

- Consent is a mandatory for every medical examination and treatment.
- Oral consent should be obtained in the presence of disinterested third party.
- Written consent is not necessary in all situations, but when a dispute arises it becomes difficult for the doctor to prove that he obtained a valid consent. Hence, any procedure beyond routine physical examination such as blood transfusion, collection of blood, etc. expressed consent, preferably written consent is necessary.
- In major procedures such as surgery, written informed consent is necessary and is mandatory.
- The doctor should explain the objective of his examination and also inform the patient that he has the right to refuse consent.
- When the person subjects himself voluntarily for examination, such as insurance or for issuing driving license, no consent is necessary and also there exists no professional secrecy.

- **In criminal cases**, the victim cannot be examined without informed consent; but the accused of a crime can be examined using reasonable amount of force without consent, under the request of police not below the rank of sub-inspector (**Section 53 CrPC**).
- As per section 54 CrPC, an accused person can request for medical examination to prove his innocence.
- In cases of drunkenness or under the influence of any drug, the individual may be unconscious or not in a state to understand and give consent. In such situations, the doctor can examine the patient without consent if requested by the investigating officer, withhold the results of examination and hand it over to the authorities after the individual becomes fit to give consent. But if he refuses to handover the report at this stage, it has to be obliged; but not in criminal cases (section 53 CrPC: If he is accused of a crime), the doctor can handover the results without the consent.
- A prisoner can be treated forcefully in the interest of the society. Same way an individual starving himself to death can be treated forcefully without consent, since no individual has the right to die.
- Consent given for committing a crime or illegal act such as criminal abortion is not valid.
- An individual under 18 years cannot give consent to suffer any harm (**Section 87 IPC**).

Section 88 IPC

- An individual above 18 years can give valid consent to suffer any harm which may result from an act, done in good faith, not known or intended to cause death.
- An individual less than 12 years of age cannot give consent to suffer any harm, done in good faith and for his benefit. The consent has to be obtained from the parents or guardian, if they refuse to give consent, the doctor cannot treat the patient even to save the life (Section 89 IPC).
- Consent given by an individual under fear or intoxication or by an insane is invalid.
- In case of emergency, when no relatives are available or no time to wait for their arrival, the doctor can proceed on with the treatment even without consent.
- When a treatment is made compulsory by the law, then no consent is necessary (Example: Vaccination, where the government gives the consent)
- In treatment or surgery, which is expected to involve his sexual capacity or fertility, the consent of both the husband and the wife are necessary.
- An adult individual cannot be detained inside the hospital without his consent, he has to be discharged under 'Against Medical Advice'.
- If any person has consented or given willingness for donation of any organ or body after his death; the consent of the legal heirs is mandatory to harvest the organs, after death of the individual (no individual has any right over his body after his death).

Loco Parentis: (Local parent)

- In an emergency involving children when the parents or guardian is not available, the person in-charge can give consent (e.g. teacher in a school).

Professional Negligence (Medical Malpractice)

3. Define professional negligence. What are the components to be established in a case of negligence against a doctor?

Definition

- Professional negligence is defined as "omission to do something which a reasonable competent man would do or doing something which a prudent reasonable man would not do, either of these results in direct damage or death of the patient."
- Medical negligence arises when the standard of care exhibited by the doctor while doing a procedure or treatment was below the prescribed standard.
- Negligence results either from the doctor's lack of knowledge and skill or failure to excise reasonable degree of care and skills while performing the procedure/act.
- When a patient dies during the treatment due to alleged medical negligence, the doctor is booked under section 304 (A) of IPC

Section 304 (A) IPC

- Whoever causes death of any person by rash and negligent act, not amounting to culpable homicide, shall be punished with imprison-

ment for a term which may extent to 2 years, with or without fine.

Components of a negligence suit

- For the charge of negligence to be established against a doctor, the following components have to be proved beyond any reasonable doubt.
  (i) Existence of a duty of care
  (ii) Dereliction of such duty
  (iii) Damage
  (iv) Direct cause: The resultant damage should be a direct effect of such dereliction. Also, it has to be proved that the resultant damage was reasonably foreseeable (commonly expected).
- Even if it is proved that the doctor was negligent but such an act did not cause any damage to the patient, then the doctor cannot be held liable for any compensation.

Ordinary degree of professional skill is a must:

- The doctor is not expected to give the best available treatment; he is only expected to give the reasonable degree of care. Hence, average degree of professional skill is the minimum requirement from any doctor.
- His act will be compared with that of another doctor possessing the same qualification and practicing medicine under the same circumstances. The care given by a doctor in a rural set up cannot be compared with that of a doctor practicing medicine at a corporate hospital in a city.

Error in judgment either in diagnosis or treatment is not negligence:

- The doctor cannot be held liable for the error in investigations and if his treatment was based on the results.
- If he has treated the patient presuming a diagnosis and later found by investigations that his diagnosis was wrong, even then the doctor cannot be held liable but he has to clarify clearly what was the basis on which he arrived at that diagnosis.

4. What is novus actus interveniens?

- An unrelated act intervening: This arises rarely when some new unrelated act interferes; Example: Some accidental injuries sustained in the course of the treatment by a doctor which added to the damage/precipitated death. In these circumstances, the doctor can prove that death was due to unrelated act which happened in between.

5. Write short notes on Res ipsa loquitur:

- **Res ipsa loquitur** means "the evidence speaks for itself".
- In any case of negligence, the burden of proof rests on the patient and he has to prove by evidence and witnesses that the doctor was negligent and the damage has been caused directly by his negligent act.
- In res ipsa loquitur, it is clearly evident that the doctor has committed some negligent act and hence the burden of proof is shifted to the doctor's side and he has to prove his innocence and that the resulted damage was not due to his act.
- Examples: Leaving surgical instruments or any foreign body like gauze or blade inside the abdomen during an abdominal surgery; operating on the wrong limb or operating on a wrong patient, etc. In these circumstances, it is proved that the doctor was negligent; hence, the burden of proof shifts to the doctor's side.

6. What are the defenses available for a doctor in cases of medical negligence?

i. Consent

- It is a very good defence in any charge of negligence, provided it has been obtained following the rules of consent in a proper format.
- Most of the charges of negligence against a doctor are due to failure in obtaining a proper informed written consent. A proper consent saves the doctor in almost 99 % cases of negligence. Since, most of the treating doctors are not much aware of the legal provisions and anyone cannot judge the outcome of the case at that moment of time, and no one can guess which case will go wrong and which patient may file a case at a later time. But doctors should note that consent is a defence only in civil cases.

ii. Contributory negligence

- The doctor was already negligent and the patient also has added to the resultant damage; the doctor has to prove that the patient by his

negligent actions has added to the damages caused. Then the amount of compensation may be reduced.

- *Examples:*
  (i) A doctor has advised the patient to keep the wound clean; come and change the dressing everyday in his clinic; the patient fails to follow the instructions and advice, which resulted in severe infection and in some damage.
  (ii) Failure of the patient to take medicines as advised by the doctor can all be brought forward as a defence, but the doctor has to prove it.

iii. Corporate negligence

- In corporate hospitals, the management is responsible for the negligent act of any individual doctor or paramedical staffs. The case is filed against the hospital in most cases and the hospital has to give the compensation. May be the hospital authorities can recover the amount from the doctor or may terminate his service as they feel correct.

iv. Products liability

- The burden of proof rests on the doctor; he has to prove that the resultant damage was due to faulty machine, instrument or drug.
- Here again, the instrument has to be maintained as per the norms of the manufacturer; faulty handling of the instruments, not servicing the instrument at the proper interval of time or not checking the functional status of the instrument before commencing the procedure are duties of the doctor. If the damage is due to faulty usage of the machine, then the manufacturer will not be held liable for the resultant damage.

v. Therapeutic misadventure: (Medical maloccurance)

- This is a very good defence for the doctor, if he has excised reasonable degree of skill and care while doing that procedure or a line of treatment.
- This is applicable in situations where the treatment procedure carries inherent risk of complications. The doctor was reasonably good and has taken proper care and precautions while giving treatment, and in spite of doing everything correctly, unfortunately the patient suffers some damage or dies.
- This is mainly due to individual variation in response of different patients to different procedures or drugs, which is totally unexpected.
- Here again, the burden of proof rests on the doctor and he has to prove that he had followed standard guidelines and taken enough precautions to avoid the expected adverse effects, and in spite of this the death or damage had resulted.
- Examples:
  a. Breaking of a needle while giving intramuscular injection.
  b. Damage to recurrent laryngeal nerve during thyroidectomy.
  c. When a seriously ill patient is under treatment of a doctor and later the patient dies, it is enough if the doctor brings forth evidences to prove that he had taken all necessary measures to save the life of the patient, but death was inevitable.

vi. Calculated risk doctrine

- Every medical procedure, how small it may be has got some inherent risk, hence the percentage of the expected risk is important in any case of negligence and again the same has to be well-informed to the patient at the time of obtaining the consent. If the risk percentage/the expected mortality rate is high, then the doctor can defend himself that death was inevitable.

vii. Vicarious liability: (Respondent Superior) "let the master answer."

- For any act done by the employee, the employer is responsible. The chief doctor is responsible for the entire negligence act done by his assistants and paramedical staffs.
- This doctrine can be enforced only in cases of civil negligence involving monitory compensations.

7. What are the steps to be taken by a doctor to prevent medical negligence?

- Always take valid consent, how small the procedure may be.
- Employ fully qualified staffs and associates.
- Attend the patient in time; in cases of emergencies, treatment has to be done even if the patient does not pay the fees at that moment.

- Update your knowledge as far as possible, especially on the commonest issues and on those types of cases which you are seeing frequently.
- Maintain accurate and complete medical records about all the patients, for a minimum period of three years; general practitioners at the periphery can atleast make a note of all the patients in the diary, which is difficult to be manipulated at a later date and hence the court will have better belief on the doctor.
- Reasonable degree of care and skill is a must, atleast be thorough in what you do.
- Do not criticize another doctor, even though the other doctor may be wrong or may not have been right.
- Guard against therapeutic hazards: Even if you don't do good to the patient, be sure you don't harm him and cause any damage due to improper treatment procedures.

8. What is Consumer Protection Act 1986: CPA /COPRA? Short notes: Three tiers of consumer forum;

- The aim of the act is to provide better protection of the interests of the consumer and speedy justice to the consumers.
- Doctors are also covered under the Act (Supreme court judgment, 13th November 1995) as the doctor provides a service to the patient and for which he is being paid. Government hospitals and those who provide free treatment to all the patients at all times, are not covered under this act.
- Consumer Dispute Redressal Forums are established at 3 levels (**tiers**):
  1. District Consumer Disputes Redressal Forum: Compensations upto ₹ 20 lakhs.
  2. State Consumer Disputes Redressal Forum: ₹ 20 lakhs to 1 crore.
  3. National Consumer Disputes Redressal Forum: More than ₹ 1 crore.

The complaint can be lodged in the consumer court, in a white paper, with relevant documents to support the allegation and the amount of compensation he is claiming.

- No court fee is charged in such cases and once the cases are taken up compensations if any are awarded within a reasonable period of time.
- Either of the parties can go for an appeal to the next level forum, if they are not convinced.

9. What is professional indemnity policy?

- The doctors can insure their professional practice by way of taking professional indemnity policy. In the event of compensation if any to be paid in medical negligence cases, the insurance company which provides the service will pay the compensations to the patient.
- The professional indemnity service is also provided by the respective Indian Medical Association at the state level branches.
- Depending on their clinical setup and the types of patients they handle, the doctors can take policies upto their convenience and necessity, and make their own options in payment of premium money.
- In such cases, the case itself is taken over by the insurance company and the compensation is also paid by them directly to the patient, within the limits of their insurance amount.
- Hence, it is advisable that every doctor should protect his practice by taking a professional insurance cover before they start up their medical practice, since no one can say when things may go wrong and at what moment of time litigations may arise during their professional practice.

10. Write short notes on workmen compensation act (1923).

- This act provides for the payment of compensation to the employee for the injuries sustained by accident, in the course of his work or employment at his work place.
- If the workman dies, then the dependents are entitled to receive the compensation.
- If he contracts any diseases, as an occupational disease related to that particular employment, it is deemed to be an injury by accident for the purpose of compensation.
- The amount of compensation depends upon whether the injury has caused death, permanent total disablement or permanent partial disablement.

- Any medical sequence which connects the disability or death with the event at work is legally adequate for awarding compensation.
- The workman is not eligible for compensation if at the time of sustaining the injuries he was under the influence of alcohol or drugs.
- In all industrial diseases and injuries, medical evidence is mandatory; hence the doctor must keep all relevant treatment records and is also bound to opine the relationship between the injury and death or acceleration of a pre-existing natural disease by the injury.
- The medical certificate issued in all such cases must be accurate and without any influence or ambiguity.

Section II:

Personal Identity

CHAPTER 5

Identification

Keywords: Identity, corpus delicti, race, cephalic index, age, medicolegal importance of age, gustafson's method, sex, Barr bodies, Davidson's body, intersex, stature, bite marks, forensic odontology, dactylography, cheiloscopy, dermatoglyphics, superimposition, tattoo marks, scars, biological trace evidences—hair, blood and semen.

Forensic science laboratory, analytical toxicology, polygraph, narcoanalysis, brain mapping, DNA profile, truth serum, word association, hypnosis.

INTRODUCTION

- **Identification** is defined as the determination of individuality of a person based on certain physical characteristics; (i.e.) fixation of the personality.
- Identification of an individual may be complete or partial.
- Complete (absolute) identification: The absolute fixation of individuality of a person.
- Incomplete (partial) identification: Ascertainment of only some facts about the identity of an individual; while others remain still unknown. Adding on the data will help in establishment of absolute identity at later stage of time.
- Identification of the living is usually carried out by the police; but in the identification of the dead, the doctor has a great role to play.
- Many a times medical men are called for elucidation of disputed facts in the process of fixing the identification.

1. What are the medicolegal aspects of identity?

- The question of identity may arise, both in civil and criminal cases.
- Absolute identity is required in civil courts in cases of: (i) insurance, (ii) inheritance claims, (iii) pension, (iv) marriage, (v) disputed sex, (vi) passport, (vii) missing persons, etc.
- Identity is an essential component in many criminal cases like:
  - (i) Absolute identification of both the accused and the victim is mandatory in cases of assault, rape, murder, etc.
  - (ii) Interchange of newborn in hospital
  - (iii) Impersonation (One person going in the place of other)
  - (iv) In deaths due to fire, explosion, travel accidents and other mishaps (mass disasters)
  - (v) When an unknown dead body is found somewhere
  - (vi) In decomposed or mutilated bodies and skeletal remains.

2. What is corpus delicti?

- Corpus delicti refers to the body of offence or the essence of crime; corpus delicti refers to the fact of any criminal offence.
- Example: In cases of Murder: Corpus delicti is the fact that a person died due to some unlawful act. It includes positive identification

of the dead body of the victim and the other facts which are conclusive of death due to foul play; such as a bullet or broken knife found in the body or at the scene of crime and which is responsible for death. It also includes any trace evidences present in the scene of crime, like blood stains, hair, etc.

- Accurate identification of the dead body and proof of corpus delicti is mandatory before a sentence is passed in homicidal deaths.
- There are recorded cases where unclaimed dead bodies, decomposed bodies, portions of a dead body or bones are brought to the doctor to support a false charge. However, there are circumstances where punishment is awarded even when the body is not found or is not identified.

3. What are the various data useful for identification?

(i) Race
(ii) Religion
(iii) Sex
(iv) Age
(v) General development and stature
(vi) Complexion and other features
(vii) External peculiarities such as: Moles, birth marks, deformities, malformation, scars, tattoo marks, occupational marks, etc.
(viii) Anthropometric measurements
(ix) Fingerprints (dactylography)
(x) Footprints (dermatoglyphics)
(xi) Lip prints (cheiloscopy)
(xii) Teeth
(xiii) Cloths and personal articles (pocket contents, jewels, etc.)
(xiv) DNA profile.

In the living: In addition to the above, the following data are also useful:

(i) Hand writing
(ii) Speech and voice
(iii) Gait, tricks, manner and habits
(iv) Memory and education.

4. What are the three major races of human population? How to find out the race? What is cephalic index?

Race

- Human beings are broadly divided into three broad races namely, caucasoid, negroid and mangoloid. The features of race are well evident in the skull and it is based on the cephalic index.

Cephalic Index (CI)

- $\text{Cephalic index} = \frac{\text{Maximum breath of the skull}}{\text{Maximum length of the skull}} \times 100$
- The length (frontal eminence to occipital protuberance) and the breath (bi-parietal) are measured using osteometric board.
- The race of an individual can be identified by calculating the cephalic index. Based on the cephalic index, the skulls are grouped into three major categories of races (Tables 5.1 and 5.2).

5. Write application of religion in fixing the identification.

- Some of the features may help in finding out the religion of an individual.

Table 5.1 Cephalic index and race

Type of skull	Cephalic index	Race
Dolico-cephalic (long headed)	70 to 75	Negroes & pure Aryans
Mesati-cephalic (medium head)	75 to 80	Europeans
Brachy-cephalic (short headed)	80 to 85	Mongolians

Table 5.2 Other features useful to find out the race

Features	Indians	Europeans	Negroes
Complexion (limited value)	Brown	Fair	Black
Eyes	Dark eyes, a few have brown eyes	Blue or gray eyes	Black
Hair	Black, thin and wavy hair	Fair, light brown or reddish hair	Black, wooly hair (arranged in tight spirals)

- Muslim males are circumcised and the females wear full covered black dress.
- Hindu males may have some religious markings on the forehead depending on the customs of their sub-division. Hindu married females may have vermillion mark on their forehead.
- All these are of less value in finding out the religion and hence the religion of a person has less value in determination of identity of an individual.

6. What are the various factors/data useful to determine sex of an individual?
What is sex chromatin; Barr bodies; Davidson's bodies?

Sex plays a major role in establishing the identification, as all the individual fall into any one of the two sexes.

Determination of sex becomes necessary in cases relating to legal heir disputes, marriage, divorce, legitimacy, impotence, rape, etc.

Sex of a person can be determined from:

i. Physical morphology
ii. Microscopic study of sex chromatin
iii. Gonadal biopsy (Tables 5.3, 5.4 and 5.5).

Sex Chromatin

- The demonstration of Barr bodies and Davidson's bodies are used in sex determination.
- Out of 46 chromosomes present in each cell of our body, 44 (22 pairs) are autosomes and 2 (1 pair) are sex chromosomes.
- In males, the patterns of sex chromosomes are XY and in females it is XX.
- In 1949, Barr and Bertram noticed a nodule in the nuclei of some cells of female cats.
- Later, investigations revealed that this nodule was found in a percentage of all normal women's cells (chromatin positive).

Barr bodies

- Microscopically, this nodule is seen as a condensed material toward the nuclear membrane inside the nucleus of the cell. This is called the **sex chromatin** or **Barr body**.
- The Barr bodies are best demonstrated in the cells of **buccal mucosa**, skin and cartilages.
- In the buccal smear, sex chromatin is demonstrable as a small Plano convex mass, lying near the nuclear membrane inside the

Table 5.3 Presumptive evidence of sex

Features	Male	Female
General Built	Muscular, strong and stout	Less muscular, delicate and slender
Scalp hair	Short and coarse	Long and fine
Eye brows	Coarse and thick	Fine and thin
Beard and mustache	Present	Absent
Pubic hair	Coarse, and thick extends upward with apex at umbilicus	Thin, fine, does not extend upward. Triangular in distribution

Table 5.4 Highly probable evidence of sex

Features	Male	Female
Breast	Not developed, nipple and areola small	Well-developed after puberty
Distribution of SC fat	Absent	Present
Vagina & Cervix	Absent	Present
Penis	Present	Absent

Table 5.5 Positive evidence of sex

Features	Male	Female
Ovaries, fallopian tubes and uterus	Absent	Present
Scrotum with testis, prostrate and seminal vesicle	Present	Absent

nucleus (Intranuclear inclusion bodies); which are present in 20 to 30% in female cells and only in 0 to 4% of male cells.

Davidson body

- In neutrophilic leukocytes (WBC), the sex chromatin is often present in the form of nuclear lobes, resembling a drumstick. This is known as Davidson's Body.
- To differentiate sex by demonstration of Davidson's bodies, the peripheral smear must show these bodies in atleast 6% cells, to identify the individual as female.

Gonadal Biopsy

- Confirmatory method of determining the sex is by Gonadal biopsy. In all the cases of disputes in sexual identity, biopsy from the primary gonads is called for.

7. What is concealed sex?

- Criminals may try to conceal their sex to avoid detection by the police by wearing costume of the opposite sex.
- Simple undressing may be rewarding in many cases, other investigations may be necessary in some cases to reach a satisfactory conclusion in the identification of sex.

8. What is intersex? How do we classify intersex? Write short notes on Klinefelter's syndrome and Turner's syndrome.
What is true hermaphroditism? What is male and female pseudohermaphroditism?

Intersex

- Intersex is due to disorders of sexual differentiation.
- Whole of the world population will fall into either of the two sexes, there are individuals who are neither male nor female and they are categorized as intersex.
- Intersex is an intermingling of sexual characters of both the sexes in a single individual to a varying degree including physical forms, reproductive organs and sex behaviors.
- Sexual differentiation is a sequential and ordered process. Chromosomal sex, established at the moment of fertilization determines the gonadal sex, which in turn causes the development of phenotypic sex. Defects in any of the stages of sex differentiation process results in intersex.

Classification of Intersex

1. Disorders of chromosomal sex:
   (i) Klinefelter's syndrome in males, and
   (ii) Turners syndrome in females.
2. Disorders of gonadal sex:
   (i) Pure gonadal dysgenesis
   (ii) Gonadal agenesis (absent testis syndrome).
3. Disorders of phenotypic sex (hermaphroditism)
   (i) True hermaphroditism
   (ii) Pseudohermaphroditism: Male and female.

1. Disorders of chromosomal sex:

(i) **Klinefelter's syndrome**:
- It is male hypogonadism and the chromosomal pattern is 47 XXY; the incidence is 1 in 850 male live births. It is the commonest cause of hypogonadism in males.
- The characteristic features include eunuch body habits and behaviors, abnormally long legs and upper limbs.
- Small atrophic testis often associated with small penis, lack of some secondary sexual characteristics such as deep voice, beard, mustache and male pattern of distribution of pubic hair.
- Gynecomastia is a usual finding, associated with varying degree of mental retardation.
- It is the principle cause of male infertility.

(ii) **Turner's syndrome:**
- Female hypogonadism and the chromosomal pattern is 45 XO.
- Most common sex chromosomal abnormality in females.
- The characteristic features are short stature, low posterior hairline, webbing of neck, broad chest with widely spaced nipples, cubitus valgus, pigmented naevi, and peripheral lymph edema.
- Coarctation of aorta is a common finding.
- It is the most important cause of primary amenorrhea.

2. Disorders of gonadal sex:

(i) Pure gonadal dysgenesis: There is defective and improper development of gonads.

(ii) Gonadal agenesis: (Absent testis syndrome). In this condition, there is complete absence of both the testis.

3. Disorders of phenotypic sex:

Hermaphroditism: Means coexistence of sexual characteristics of both males and females, to a varying degree in the same individual.

(i) True hermaphroditism:

- True hermaphroditism implies the presence of both ovaries and testis in the same individual.
- It is extremely rare. In some cases, there may be a testis on one side and an ovary on the other side. Whereas in some cases, there may be combined ovarian and testicular tissue known as ovotestis; karyotype is 46 XX in 50 % of cases, and 46 XY in 25 % of cases.

(ii) Pseudohermaphroditism: In females and males.

- Female pseudohermaphroditism
  - In this, the chromosomal sex pattern is 46 XX in all cases.
  - The development of gonads (ovaries) and internal genitalia are normal.
  - Only the external genitalia are ambiguous or virilized.
  - The basis of this disorder is excessive and inappropriate exposure to androgenic steroids during early fetal life.
- Male pseudohermaphroditism:
  - In this, the chromosomal sex pattern is 46 XY in all cases.
  - But the external genitalia are either ambiguous or of completely feminine.
  - Commonest cause is defective virilization of male embryo, which usually results from genetically determined defects in androgen synthesis or activity or both.

9. How to determine the sex in the dead/decomposed/skeletal remains? What is Krogman's accuracy?

In a decomposed body

- Make a search for the cervix, fallopian tubes and ovaries.
- Uterus is the last internal organ to putrefy in a female and prostrate in males.
- When the primary sex organs are totally unidentifiable, one has to look for sexual characteristics in the skeleton.

Sex from skeletal remain

- For a trained forensic pathologist, it seldom poses a problem to determine the sex from skeletal remains.
- The accuracy of estimating the sex from skeletal remains depends upon the number of bones available.

Krogman's degree of accuracy

- When the entire skeleton is available, the accuracy is 100%.
- When pelvis alone is available, it is 95%; from skull alone, it is 90%.
- When both pelvis and skull are available, the accuracy is 98%
- Sex differentiating features are prominent only after puberty.
- The pelvis is the best suited bone for determining the sex even before attainment of puberty, since pelvic bone in females is designed for delivery of a fetus.
- Greater sciatic notch is small, narrow, deep and V shaped in males and large, wide, shallow and U shaped in females. (Sciatic notch index = Width of the sciatic notch/depth × 100).
- Pre-auricular sulcus present near the attachment of anterior sacro-illiac ligament. In female pelvis, this will be broad, deep and frequently seen.
- Sex differences in the morphology of skull and mandible are quite reliable.
- Long bones, sternum and ribs were all tried for determination of sex; but, they are used only when skull, pelvis and mandible are not available.
- **Medullary index:** Sex of a long bone can be determined by the medullary index. Sex differentiating features are identifiable only on the ends of the long bones and are useful only when the whole intact long bone is available. When a fragment of bone or only the shaft is available, then medullary index is useful in determining the sex.

$$\text{Medullary Index} = \frac{\text{Diameter of the medulla}}{\text{Diameter of the whole bone}} \times 100$$

- Study of the measurements of various body parts is called **anthropometry** and is useful in establishing the identity.

10. What is stature? How do we estimate the stature of an individual from long bones?

- Estimation of stature or height of a person is subject to variations during life due to muscular relaxation and elasticity of inter-vertebral discs, but still is valuable.
- Height of an individual is mainly based on genetic factors and nutritional status.
- Growth of the long bones determines the height of an individual, which is by appearance and fusion of various secondary ossification centers of the long bones, which in turn, are directly proportional to the nutritional status of the individual.
- All the bones fuse by about 18 to 21 years of age and hence the height of an individual does not increase after 21 years; and the height decreases after 35 years due to degenerative changes in the bones.
- In the examination of skeletal remains, stature of an individual is estimated using the length of the long bones; the length of the long bones is measured using Hepburn's osteometric board.

Stature: The approximate height of an individual will be:

2 × length of an arm + 30 cm + 4 cm.
2 × length from vertex to symphysis pubis.
8 × height of the skull with the mandible.

11. How do we estimate the age of an individual? Write application of radiology in identification/age estimation.
Write application of eruption of teeth in estimation of age.
What is mixed dentition?

- Estimation of age of an individual is based on:
  (i) General physical development.
  (ii) Teeth (eruption of deciduous and permanent teeth).
  (iii) Appearance and fusion of various secondary ossification centers of the bones.
  (iv) Secondary sexual characteristics
  (v) Age-related changes (degenerative changes, after 25 years of age).
- **Age in intrauterine life:** It is assessed by the developmental morphology, appearance of primary ossification centers in the bones and germination of teeth.
- The intra-uterine age of a fetus is calculated by applying the Rule of Hasse:
  - **Hasee's Rule:** This is a method to determine the age of the fetus in the intrauterine life. Length of the fetus (crown-heel length) is measured; if the length is less 25 cm, then the square root gives the approximate age of the fetus in months; when the length is more than 25 cm, then the length divided by 5, which gives the approximate age of fetus in months. Example: If length is 9 cm, then the age is 3 months; if length for 35 cm, age is 7 months.

Age in children and adults under 25 years:

- This is the crucial period of age, where the court refers the individual to the doctor for the estimation of age; even if there are reliable records like birth certificate, school certificate, or any other documents which specifies the correct age, the court relies on the opinion of the doctor for estimation of age based on medical facts.

The various data useful to estimate the age below 25 years are:

- Physical examination and secondary sexual characteristics.
- Dental examination: Eruption and completion of root formation.
- Radiological examination: Appearance and Fusion of various secondary ossification centers.

Physical Examination and Secondary Sexual Characteristics

- The external appearance including the height, general built, etc. will indicate the approximate age of an individual. In addition to this, presence or absence of secondary sexual characters like, beard and mustache in males, development of breast in females, axillary and pubic hair in both the sexes are helpful in estimation of age of the individual (Table 5.6).

Table 5.6 Growth of hair in male and female

Features	Male	Female
Pubic hair	13 – 15 years	13 – 14 years
Axillary hair	14 – 16 years	14 – 15 years
Beard & mush	15 – 17 years	Absent
Hair on other parts	17 – 20 years	Sparse
Graying of hair	Scalp: 40 years (not reliable) pubic hair: 55 years (reliable)	Scalp: 40 years Pubic hair: 55 years
Baldness	After 40 years (not reliable)	Rare

Dentition

- Every individual has two sets of teeth in his /her life time. They are temporary teeth and permanent teeth.
- Temporary teeth or deciduous teeth or milk teeth are 20 in number.
- Permanent teeth 32 in number. Those teeth which erupt in the place of temporary teeth are called "successive teeth" (20 in number) and all the three the permanent molars which erupt behind the successive teeth are called '**super added teeth**" (12 in number).
- The eruption of both temporary and permanent teeth follows a chronological order, this is useful for estimation of age of an individual; root formation gets completed after 2 to 3 years of eruption of the teeth in the oral cavity.
- At birth, there are 44 germ teeth present inside the jaw of a full-term baby (20 + 24).
- These germ teeth develop and erupt outside into the oral cavity, and then the root formation takes place.
- By 3 years, there are totally 20 teeth, all are temporary.
- By 6 to 7 years: There are 24 teeth (20 temporary and 4 permanent).
- From 6 to 12 years total number of teeth remains as 24 (mixed dentition).
- Mixed dentition: The period of time when both temporary teeth and permanent teeth are present inside the oral cavity, i.e. from the eruption of 1st permanent molar to the time of eruption of last permanent canine (6 to 12 years).
- By the end of 12 years, the total number of teeth remains 24, but all are permanent.
- By 14 years there are 28 teeth.
- Third molar erupts by 17 to 25 years (wide range) and not useful in estimation of age. It may not erupt at all or may get impacted, depending upon the length of the mandible.
- The root formation takes 2 more years after the eruption of the teeth in the oral cavity and is 3 years for the 3rd molar for completion of formation of the root. Hence, while examination of radiological picture of teeth for age estimation, the root of the last erupted teeth and the crown of the next to erupt teeth is considered to arrive at a more accurate age.

Radiological Examination

- Estimation of age is based on the appearance and fusion of various secondary ossification centers in the body.
- The bones of human body develop from a number of ossification centers.
- At 11–12th week of intrauterine life, there are 806 centers of ossification.
- At birth, there are about 450 centers.
- The adult human skeleton carries only 206 bones.
- After birth, the growth of the bone is by formation of various secondary ossification centers. The bone growth gets completed by fusion of the shaft with the ossification center.
- The appearance and fusion of various secondary ossification centers have a sequence and time period; this chronological sequence is used for determination of age.

Please Note: The appearance and fusion of various ossification centers are discussed in practical exercise — You need to write the tables in exams.

Age in adults over 25 years

- After 25 years, the estimation of age becomes more uncertain. It is difficult to achieve an accuracy of even 5 years.
- The closure of skull sutures is considered reasonably reliable upto 45 years.
- The changes occurring on the articular surface of symphysis pubis are considered as a reliable index for ageing beyond 25 years of age. But this indicator cannot be used for age estimation in living individuals.

12. Write short notes on forensic odontology.

- It is a branch of dental medicine applicable in resolving issues pertaining to law.
- It is a separate super specialty in advanced countries; in India, this branch is attached to oral medicine department. The applicability is for identification, comparison and examination of bite marks.
- As like fingerprints, the teeth pattern of any individual is unique; no two individual may have the same teeth pattern and hence useful when previous records are available and helps to fix or exclude a subject by comparison of both the data.
- Useful in identification, especially in mass disasters; when the antemortem records are available. This can be easily compared to fix the absolute identity.
- In criminal cases, the pattern can be compared with that of the accused person, thus helps to conclude or exclude a particular individual.

13. What are the methods of charting of teeth?

- There are various methods of charting teeth these are (i) Universal system, (ii) Palmar notation, (iii) Haderup system and (iv) FDI system. Among these, Palmer's notation and FDI system are conventionally followed.
- **Palmer's notation:** The oral cavity is divided into four quadrants; right and left are marked. Each tooth is given a number from 1 to 8, starting from the incisors to the 3rd molar. For temporary teeth, it is marked as "T" and for permanent teeth as "P" above the respective teeth.

Right Left

8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8

FDI (Federation Dentaire Internationale) system:

- It is similar to Palmer's notation but one number is added in front of the tooth number, which indicates the quadrant in which the tooth is located. Each tooth is identified by a two digit number in which the proximal digit indicates the quadrant and the distal digit indicates the actual tooth. While numbering the permanent teeth, the quadrants 1, 2, 3, 4 are used for designating right upper, left upper, left lower and right lower quadrants, respectively. Whereas 5, 6, 7, 8 are used for the corresponding temporary teeth.

Dental charting:

- Various data taken into consideration for the purpose of dental charting are:
  - (i) Extractions of teeth (fresh or old)
  - (ii) Tooth filling
  - (iii) Missing tooth
  - (iv) Artificial teeth (implanted or metal tooth – gold tooth)
  - (v) Broken tooth
  - (vi) Crowned tooth
  - (vii) Pathological conditions and congenital defects
  - (viii) Artificial dentures are also used for identification.

Permanent Teeth

18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38

Temporary Teeth

			55	54	53	52	51	61	62	63	64	65			
			85	84	83	82	81	71	72	73	74	75			

14. Writes short notes on bite marks.

- Bite marks can be present on a living individual, dead body or any remnants of food, etc.
- Human bite marks are elucidated by using a hand lens to examine the bite mark.
- Since the teeth pattern is individualistic, bite marks present on the victim or the accused in cases of serious crimes like murder or sexual assault are useful for identification.
- A bite mark cast is prepared from the surface of the bite mark and compared with that of the subject, thus helps to include or exclude a particular individual.
- Bite marks on remnant food materials such as on an apple or cheese can also be used to fix the identity.
- Bite marks may also give a clue to the motive of the offence by the site over which it is present. Example: Over the breast and thighs in cases of sexual assault.
- While examining bite in dead bodies, the bite marks are dissected and bruising of the underlying tissues can be made out. The extent of bruising also gives an idea about the intensity of the bite.

15. What is Gustafson's method?

- It is a method useful for estimating the age of an individual after 25 years, by the degenerative changes occurring in the teeth; it is used only for dead individuals and not for the living. Only attrition can be made out in living individuals, which is a least reliable data.
- The various criteria taken into consideration are: (APSRTC)
  1. *Attrition:* Wear and tear seen over the occlusal surface.
  2. *Paradentosis:* The gum margins become retracted and there is loosening of teeth.
- *Secondary dentin:* Deposition of dentin (secondarily) within the pulp cavity.
- *Root resorption:* Root resorption due to ageing and tooth may fall off at varying ages.
- *Transparency of root:* It is the transparency of the dentin at the root level.
- *Cementum apposition:* Apposition of cementum at and around the root of the teeth.
- Among the above said criteria, the transparency of the root is most reliable indicator for the estimation of age. In addition to this, the incremental lines on cross section of the teeth are also used for estimating the age of an individual.

16. What is the medicolegal importance of various age groups?

- Within about a week of fertilization, the ovum gets impregnated in the uterus and it is termed as embryo.
- 3 lunar months (12 weeks): Pregnancy can be terminated under the decision of one doctor alone (MTP Act 1971)
- 20 Weeks: The opinion of two doctors is necessary for termination of pregnancy.
- 210 Days (7 calendar months): The fetus becomes viable; viability is the ability of a fetus to have a separate existence of its own out of the mother's womb.
- Ten lunar months: Full-term fetus.

1 year:

- Upto 1 year of age after birth, the baby is called as an "infant"; killing of the baby upto this age amounts to infanticide (section 318 IPC).

5 years:

- Above this age, a child becomes responsible for his act leading to wreckage of a train (according to Indian Railway Act).

7 years: (Minimum age of criminal responsibility):

- Below this age a child is not criminally responsible (Section 82 IPC).

7 to 12 years:

- A Child is criminally responsible, if the child has attained sufficient mental maturity to understand the nature and consequences of his act (section 83 IPC).

10 years:

- Kidnapping a child with the intention of taking dishonestly any movable property (section 369 IPC).

12 years:

(i) Age of criminal liability; every individual above 12 years is criminally responsible for all the acts committed by him.

(ii) Consent can be given for simple procedures which are not known to cause any harm.

14 years:
- Below this age, a person (child) cannot be employed into any work and will amount to child labor: According to Indian Factories Act.

15 years:
i. Below the age of 15 years, sexual intercourse with a woman, even if she is his own wife, amounts to rape.
ii. A person above this age can be employed in a factory like an adult.

16 years:
- A female can give valid consent for sexual intercourse.

18 Years:
i. Majority: Upto 18 years, an individual is considered as a juvenile.
ii. Kidnapping: Taking away an individual of less than 18 years from the legal guardian amounts to the offence of kidnapping.
iii. Marriage: Minimum permissible age of marriage for girls, as per the Hindu marriage act.
iv. Consent: A person above this age can give valid consent to suffer any harm done in good faith; e.g. Consent for surgery, blood donation, organ donation, etc.
v. Vote: Age for voting and for obtaining driving license.
vi. Will: A person can make a valid will (Testamentary Capacity), if he is mentally sound (Compos Mentis).

21 years:
- A person who is under the guidance of the court attains majority.
- Minimum age of marriage for boys.
- Upto this age, a juvenile offender can stay in a borstals school.
- Importing a girl below this age from outside the country for the purpose of forcing or seducing her to illicit intercourse amounts to kidnapping.

25 years: Minimum age for contesting in elections.

35 years: Minimum age for appointment as President/vice-president of India or Governor of a state.

60 years: Senior citizen, age of retirement.

17. Write short notes on dactylography: (Galton System).
What is poroscopy?
What are the types of fingerprints that could be present in the scene of crime?
- Dactylography is a system of identification of an individual based on fingerprints.
- This system was first discovered by Sir William J Herschel, he introduced this system in Hoogly District of Bengal in 1877.
- It was later systematically put into practice in 1892 by Sir Francis Galton, an English anthropologist.
- The 1st case where fingerprinting was used for identification was in Argentina in the year 1892.

Principle:
- The skin covering the ball of the thumb and other fingers is made up of characteristic epidermal ridges.
- These ridges are present both in the dermis and epidermis.
- The arrangement and distribution of these ridges are formed during intrauterine life and remain constant and persist throughout the lifetime.
- Fingerprints are highly individualistic. They are not similar even in monozygotic twins.

Classification: There are 4 types of fingerprints:
1. Loops (Radial or ulnar)—most common, about 67%.
2. Whorls (Concentric or spiral)—25%.
3. Arches (plain or tented)—6 – 7%.
4. Composites (Central pocket loops, double loops or accidentals)—1 – 2%.

- Identification is based on:
  - Counting the ridges between the core and delta, where core is the central portion and the peripheral components are called the delta region.
  - Minute details of the ridges like ridge ending, bifurcation, spur formation, dots, lake formation, broken ridge, short ridge, etc. are compared with the existing available database of the fingerprints.
  - 16 to 20 points of similarity are necessary to establish positive identity.
  - Now a computed automatic system (soft ware) is used, where it analyses nearly

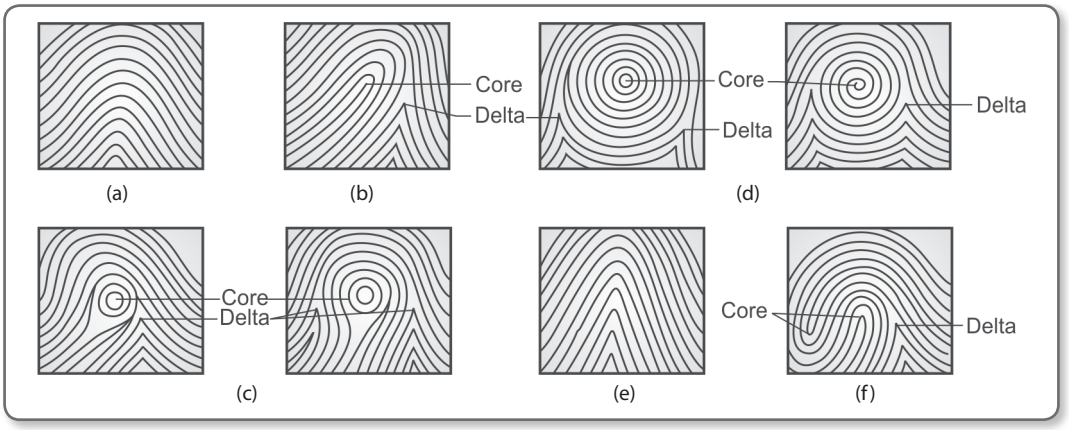


Fig. 5.1 Primary finger print types based on ridge-patterns — (a) arch, (b) loop, (c) whorl, (d) pocket loop, (e) tented arch, (f) composite (twin loop)

100 points of comparison and it takes very less time to confirm or rule out a suspect (Fig. 5.1).

Poroscopy:

- Papillary ridges of the epidermis are studied with minute pores, which contain sweat glands through which sweat exudes out.
- The number, size, shape and the site of a pore in a given length of a ridge vary from person to person and are unique for an individual.
- This method was introduced by Edmond Locard.
- Combination of dactylography and poroscopy helps to fix better accuracy of identity.

Fingerprints in decomposed bodies:

- In advanced putrefaction and cases of drowning, the skin is frequently found loose like a glove, which can be removed, preserved in formalin and used for taking impressions.
- If epidermis is lost due to decomposition, still prints can be obtained from the dermis.

Removal of fingerprints:

- Criminals may attempt to mutilate the fingerprint pattern by inflicting injuries or burns on the bulb of their fingers but there still exist definite delineation unless the true skin is destroyed. The injuries or burns produce a new different pattern which is unique to that particular individual.
- In mummified bodies where the tip of the finger is shrunken, formalin is injected into the tip of the finger to restore its original size and shape. Then the fingerprints are obtained.

Fingerprints at the scene of crime:

- There are three types of prints left over/ obtained from the crime scene and they are:
  - (i) Visible prints:
    - Prints which are contaminated with blood, paint, dirt, dyes, etc. These prints are recorded by photography with suitable light and filters.
  - (ii) Plastic prints:
    - These are impressions made on a soft substance like soap, cheese, wax, clay, etc.
  - (iii) Latent prints:
    - Impressions due to deposition of sebaceous and sweat gland secretions. These are made visible by suitable reagent powders and recorded by a process called "**lifting.**"

18. What is dermatoglyphics?

- Study of footprints is called dermatoglyphics.
- Impressions of human feet on various substrates have been studied and found to be quite reliable and individualistic.
- Dermatoglyphics (the ridge pattern) if clearly visible is a positive factor for identification.
- In the absence of ridge pattern (prints on soil, sand, etc.), measurement of length and width of foot toes and toe pads, arch pattern, the angle of inclination are used for comparison.

19. What is cheiloscopy?

- Cheiloscopy is the study of lip prints; the furrows and grooves present on human lips are analyzed for a positive identification.
- The patterns of the furrows are unique and individualistic and are useful for identification.
- Lip print of a suspect can be obtained from wine glasses or other utensils.
- They are classified into 4 types:
  i. Linear ii. Bifurcate
  iii. Reticular iv. Undetermined
- Identification is based on analyzing the different appearances in a given length of the print.

20. What is a scar?
What are the medicolegal importances of scar?

- Scar is an acquired defect on the skin, widely accepted as a marker of identification.
- Scar is the result of repair mechanism to an injury involving the epidermis. It is covered by epithelium and is devoid of pigmentation, sweat glands and hair follicles.
- The size, shape and location of a scar can aid in positive identification.
- Peculiar scars like surgical scars, keloid formations (Fig. 5.2) scars from burns and injuries, contracture due to acid burns, are reliable features to fix the identity of a person.

Fig. 5.2 Scar with Keloid formation – Multiple linear scars with keloid formation

Medicolegal importance of scars:

- The nature of injury and the causative agent can be identified.
- The age of a scar correlates with the time of infliction of the injury.
- Scar forming injuries on the head and face will amount to grievous hurt.
- Scars around a joint resulting in permanent restriction of movements also amount to grievous hurt.
- Scars on the abdomen due to caesarian section or linea albicantes are indicative of delivery.

21. Write short notes on tattoo marks.
What is the medicolegal importance of tattoo marks?

- **Tattoo marks** are designs or patterns imprinted on the skin surface by multiple small punctured wounds with the help of needles dipped in coloring material (dye).
- The commonly used dyes are:
  (i) Carbon (black), cinnabar
  (ii) Vermillion (red)
  (iii) Ochre (brown)
  (iv) Chromic oxide (green)
  (v) Prussian blue (blue).
- The permanent nature of the tattoo mark depends on the type of dye used and the depth of penetration into the skin.
- Stable pigments such as carbon (black) or Prussian blue, impregnated into the deeper layers of skin last for a longer period of time.
- **Latent tattoo marks** can be revealed or made visible by use of ultraviolet light.
- Faint or disappeared tattoo marks can be made out by histological study of the regional lymph nodes.
- In decomposed bodies, they are made visible by treating the area with 3% hydrogen peroxide. When the epidermis is lost, the tattoo can be well-appreciated as they are present on the dermis also.
- Tattoo marks can be removed by surgical method or use of laser beams, without leaving any permanent mark.
- A tattoo mark can be altered or superimposed over another subsequently, for the purpose of concealment of identity.

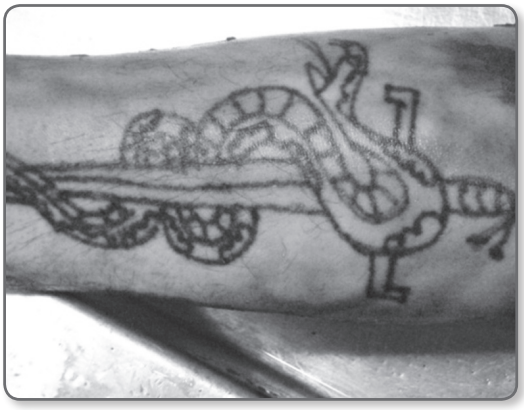


Fig. 5.3 Tattoo mark – Design indicating the mental makeup of the individual

Fig. 5.4 Tattoo mark – The names could be of persons closely associated with him, also indicates the language; a case of superficial burns, tattoo are preserved (not always in burns)

Complications of tattoo mark:

- Septic inflammation
- Erysipelas
- Abscess
- Gangrene
- Syphilis and AIDS.

Removal of tattoo mark (Erasure):

Tattoo mark can be erased by the following methods:

- Application of carbon dioxide snow
- Application of caustic substances, e.g. mixture of papain in glycerin, zinc chloride, and tannic acid.
- Surgical method: Complete excision and skin grafting.
- Electrolysis
- Laser beam.

Medicolegal importance:

- Tattoo marks are especially useful in decomposed bodies.
- Apart from identification, tattoo marks also provide additional information regarding: 1) race, 2) religion, 3) nationality, 4) language, 5) mental makeup (Fig. 5.2), 6) social status, 7) sex behaviors, etc.
- The name tattooed could be that of him or of a person associated or related to him.
- Drug addicts often imprint tattoos over areas of multiple injection mark, in order to conceal them.

Fig. 5.5 Tattoo mark – Very useful in identification of decomposed bodies; the symbol indicates he could be Hindu and a devotional individual

22. Write short note on superimposition of skull.

- Superimposition is a technique applied to determine whether the skull is that of the person in the photograph or not.
- An unknown skull with mandible and a photo of the missing person are required to perform superimposition.
- All the soft tissues attached to the skull are removed.
- The skull along with the mandible is fixed in a stand.
- The photograph is enlarged to "life size."

- The skull is adjusted to the same inclination and orientation as in the photograph.
- The negative of the photograph and the skull are superimposed over one another, by aligning the characteristic points in the negative.
- The anatomical landmarks are compared for a positive match.
- Recently, a computer graphic superimposition technique utilizing a laser scanner and indigenous computer software has been developed in India, which is being successfully employed in practice, which has got greater accuracy of matching.
- Performa based methodical approach can greatly improve the results and minimize errors.

In superimposition, negative results are of more significance rather than a positive match. Since, the possibility of two individuals having the same morphologically similar skull pattern is possible. But in case of a mismatch, it can be conclusively said that the skull does not belong to the person in the photograph.

23. Write short note on medicolegal importance of eyes.

- It is useful for the purpose of identification, e.g. artificial eyes, color of iris, squint, cataract, etc.
- In certain poisoning cases, findings in the eye play an important role. For example:
  (i) Dilated Pupil: Datura, atropine, cannabis, cocaine, alcohol, etc.
  (ii) Contracted Pupil: Opium, phenol, OPC compounds, pilocarpine, barbiturates, etc.
- **Arcus senilis:** It is a circular, gray opaque ring like appearance surrounding the margins of the cornea. It is seen in old age individuals.
- **Mercuria lentis:** Accumulation of mercury vapors on the anterior lens capsule in chronic mercury poisoning.

24. What are trace evidences?
What is Locard's principle of exchange?
Short notes: (i) Hair as trace evidence.
(ii) Medicolegal importance of hair?

- Trace evidences are materials or substances which connect the crime scene with the perpetrator of the crime. They are most important in any crime scene investigations. There are basically four biological trace evidences, namely: Hair, blood, semen and other body fluids.

Locard's principle of exchange:

- It states that "when two objects come into contact with each other, there is always transfer of some material between them." This is helpful in crime investigations, especially in sexual offences.
- Any person during the commission of a crime will almost always leave something and take away something from the scene of crime. This is the theory of interchange.
- It is a well-settled hypothesis that there is almost zero percentage of chances to commit a crime without any exchange of material. But there exists limitations of science in finding out those transferred materials.

Hair as trace evidence:

- Hair is one of the very important biological trace evidences which could be present in the scene of crime, either in the process of struggle or the hair falling off by itself.
- The average rate of hair fall per day is 50 to 100/day. Hence, there are chances that when a person just moves his hair with the hand or when the victim tries to hold the hair of the assailant, the hair may fall of by itself and also the victim may tightly hold the hair and forcefully pulled off. But it is very unfortunate that due to poor knowledge of the investigation team, it's always missed.
- In the examination of hair recovered from the scene of crime as trace evidence, efforts must be made to answer some important questions regarding it.
  (i) Whether they are actually hair or some other fiber.
  – Hair consists of a root (or pulp) and a shaft; whereas fibers do not contain a root or pulp. Hair consists of: (a) Cuticle, (b) Cortex and (c) Medulla, which can be made out by microscopic examination.
  (ii) If it is hair, whether they are of human or animal origin, which can be concluded by morphology and microscopy.
  – It should also be compared with the hair of common types of animals present in that area, which could have gained access into the scene, if they are animal hair.

– Human hair will be fine and thin, cortex is thick, well-striated and 4 to 10 times as broad as medulla; whereas animal hair is coarse and thick, cortex is thin less than twice as broad as that of medulla.

(iii) If found to be human hair, then from which part of the body it is derived from?

– Hair from the scalp will be thin and wavy; whereas axillary and pubic hairs are curly, thick and coarse.

(iv) Sex of the person can also be determined from the hair, by the demonstration of Barr bodies.

(v) Age of the individual could be grossly assessed from the hair.

– Hair root of the children will dissolve readily in a solution of caustic potash, but that of the older people resist such treatment; this is due to the presence of abundant keratin in the old aged people.

(vi) Blood groups (ABO) of the individual can be determined from a single hair of any part of the body by modified absorption-elution technique with 100% accuracy.

(vii) Hair has to be examined for evidence of dyeing, bleaching, disease or poisons like arsenic.

(viii) Is the hair identical with that of the victim or the suspect?
This can be made out by careful comparison under a comparison microscope.

(ix) Did it fall naturally or was it forcibly removed?

Made out by the ruptured root sheath since considerable force is required to pluck out a healthy hair from scalp and still higher force is required to pull out a hair from other parts of the body.

Medicolegal importance of hair:

- Used for identification in cases of assaults and accidents.
- It plays an important role in identification of the offender in sexual offence cases.
- In cases of injury to the hair, nature of weapon can be made out by microscopic examination of the severed end of the hair.
- Singeing of hair helps to differentiate burns from scalds and also in the interpretation of firearm injuries (contact range and close range).
- Time since death can be estimated from the length of hair on face, as the average rate of hair growth on the face is 0.4 mm/day.
- Age of a person can be determined from hair growth on different parts of the body (secondary sexual characteristics and graying of hair).
- Sex can be differentiated from distribution of hair on different parts of the body, texture and identification of Barr bodies.
- In chronic heavy metal poisoning, traces of the metal get deposited on the hair and can be detected by chemical analysis, especially arsenic.

25. Write short notes on (i) blood as trace evidence. (ii) Precipitin test.

The following questions are to be answered, by subjecting the blood stains present in the crime scene to physical and chemical examination:

i. Whether the stain is blood or not:
(a) Benzidine test (b) Phenolphthalein test (**Kastle-Meyer Test**)

- These chemical tests are based upon the presence of the enzyme peroxidase present in the red blood cells.
- Haemin crystal test (Teichmann's test) and Hemochromogen crystal test (**Takayama test**) are also useful to identify blood stains.
- Electrophoresis and immune-electrophoresis can positively identify blood stains.
- Spectrometry is most useful and reliable test for detection of blood stains, even with less than 0.1 ml of blood and especially useful for old stains.
- Confirmation is by subjecting the sample to microscopic examination of red blood cells (not useful for old stains)

ii. If it is blood, then **whether human or animal origin**: Can be confirmed by serological testing of blood (Precipitin test) and by microscopy.

Precipitin test:

- Human serum containing proteins is injected into an animal like horses (H type) and rabbits (R type), the animals are sensitized against these proteins and antibodies to human blood develop in the animal.
- When human serum is brought into contact with the serum extracted from these sensi-

tized animals, it reacts with the proteins of human serum and forms a precipitate. This is a confirmatory test for identifying the human origin of any biological substance.

iii. Note the color, shape, size and direction of the stain.

iv. Whether the blood is of **arterial or venous origin:**

- Arterial blood is bright red and venous blood is dark red in color.
- There will be spurting blood if it is of arterial origin, whereas venous blood stains will be circular, due to dribbling perpendicularly onto the surface.

v. Age of the stain:

- Fresh stain looks bright red in color, which turns reddish brown in 24 hours. After 24 hours, it turns dark brown and then finally turns black when the duration is longer.

vi. Whether antemortem or postmortem in nature:

- Antemortem bleeding causes coagulation and the clot can be taken out en mass and the area after removal of the clot retains the impression of the fibrinous network owing to the process of clot formation.
- Postmortem bleeding occurs without proper coagulation and the clot will be brittle and easily friable due to absence of fibrinous network.

26. Write short notes on seminal stains:.

- **Physical examination:** Seminal stains on white fabric appear yellow with borders appearing darker than the center. When examined under ultraviolet light seminal stains exhibit strong bluish white fluorescence.
- Chemical examination: **Florence test** and Barberio's Test: These tests will demonstrate the presence of choline and spermin crystals respectively. These can be detected by thin layer chromatography (TLC).
- Acid phosphatase test: The normal amount of acid phosphatase in the seminal fluid is 350 bodansky units. The acid phosphatase test can be done for all old stains and in the vaginal washings in cases of rape (can be detected even after 36 hours). This is a specific test for detection of seminal stains. However, confirmation of seminal stain is by demonstration of the presence of spermatozoa, under microscopy.

27. What are the basic facilities required for a forensic science laboratory?

- This is a very vast area of analysis, which needs a coordination of work by a number of experts from various fields of science, mainly:
- Biophysics, biochemistry, histochemistry, microbiology, analytical toxicology, etc.
- Any material evidence must be analyzed as to what it is? From where it was recovered? And how it is related to or involved in the crime. A chain of custody is maintained at every step of transfer of evidence.
- A basic analytical center or laboratory should consist of facilities to analyze:
  - (i) Biological trace evidences:
    Blood: Grouping, detection of stains, analysis of the source, DNA, etc.
    Semen, hair and saliva.
  - (ii) Analytical toxicology: Detection and estimation of various poisons including drugs and medicines. This is done by using various instruments and methods like automated solvent extractor, chromatography: UV spectrometry, gas spectrometry and mass spectrometry.
  - (iii) Computed automated system for: Fingerprinting and superimposition
  - (iv) Hand writing comparison experts.
  - (v) Firearms: Ballistics experts.
- A doctor is not expected to know the functions and techniques involved in each division, but he is bound to know the basics of all the branches and their modes of operation.
- Those which are related to medical science are discussed briefly:

28. Write short notes on polygraph (lie detector)

- Polygraph makes a continuous record of pulse, blood pressure, respiration and electro-dermal reactive changes in response to particular stimuli in the form of questions.
- It is based on the principle that when an individual tells a lie, there is fear in his mind that he could be detected and by the emotions caused by the fear there is stimu-

lation of the sympathetic nervous system and results in certain physiological changes, some of which can be easily recorded.
- In pretest interview the questions are framed with the mutual consent of the subject and the examiner, that they are adequate to serve the purpose of the particular examination.
- The questions are framed in such a manner that the individual is easily able to understand it and give 'yes' or 'no' as the answer.
- Relevant and irrelevant questions are mixed up; and control questions are inserted to reduce the natural nervousness.
- A question is asked every 20–25 seconds and the polygraph chart recorded in 3–4 minutes.
- Usually, the same test is repeated twice or thrice to check for any possible error.
- An experienced and competent polygraph examiner can detect truth or lie in about 80 to 90% of cases. A few errors do occur in deceptive subjects.
- Offenders, suspects, complainant, witnesses and informants are examined by this method, to test the truth of their statement.

29. What is narcoanalysis?
What is truth serum?
- Based on the principle that at a point close to unconsciousness, an individual will be mentally incapable of resistance to questions, and is incapable of inventing the falsehood that he has used to conceal his guilt.
- The methods used are:
  (i) Injectable scopolamine 0.5 mg SC, followed by 0.25 mg every 20 minutes, for an average of 3 to 6 injections, until the subject reaches proper stage of questioning.
  (ii) Sodium amytal or sodium pentothal 2.5 to 5% IV, at 1 mg/minute, until proper stage is induced.
  (iii) Injectable sodium seconal 0.1 g, 15 mg morphine sulfate and 0.5 mg scopolamine IV.
- A large number of false negative results are common in this method.

Word association:
- Change in the reaction time of the subject's reply to word stimuli, either visual or auditory or by stereotype of answers are used.
- **Hypnosis** is the other method used for lie detection.

30. Write short notes on brain mapping: (brain fingerprinting).
- It is based on the information stored in the brain and cognitive brain response; they are not affected by emotional responses and hence said to be more accurate than polygraph.
- The basis is that the suspect's reaction to the details of an event or activity will reflect if he had prior knowledge of the event or activity.
- The technique measures the recognition of familiar stimuli by measuring the electrical brain wave response to words, phrases, or pictures that are presented on a computer screen.
- This technique uses multidisciplinary approach involving brain imaging, neurophysiology, computer science and bioinstrumentation.
- An equipment called 'electro cap' is fixed on the suspect's head; and he is questioned about the crime and also shown visuals of the crime scene (victim, weapon, how the crime was committed, etc.); to stimulate his brain and encourage a reaction on computer monitor.
- Apart from verbal replies, another computer records his neuronal impulses emitted (brain waves and chemical response) when the visual is shown.
- The intensity of the brain wave shoots up whenever a question or visual stimuli matches the information stored in the brain.

31. What is forensic DNA typing?
What are the applications of DNA fingerprinting?
- The first application of DNA typing in forensic science was done by Dr Alec Jeffries (USA) in 1985.
- DNA is extracted from a biological sample and processed to generate a pattern for each individual called 'DNA profile'.
- DNA is found in the chromosomes which are present only in the **nucleus** of a cell; the average length of a DNA molecule in a nucleus is 180 cm.

- Mitochondrial DNA: Abundant sample of DNA, but inherited only from the mother (especially useful, when a fallen hair is available at the crime scene, without the root).

Gene and chromosomes:

- A chromosome contains two complementary strands of deoxyribonucleic acid (DNA) each consisting of phosphate, deoxyribose and one of the four bases: Adenine, Thymine, Guanine and Cytosine. They always form pair (A-T and C-G); the two strands are antiparallel and run in opposite direction.

Genetic polymorphism:

- Within a species, one chromosome of a given type is similar to another, but at some place, (loci) there may be some variability; detectable variations occurring at a single genetic locus are called 'alleles'.
- 'Genetic marker' applies to any observable variation at a single genetic locus.
- This may be serological marker ABO blood group or a DNA marker.

The four main types of DNA markers are:

- RFLPs—Restricted Fragment Length Polymorphisms
- VNTRs—Variable Number of Tandem Repeats
- STRs—Short Tandem Repeats
- SNPs—Single Nucleotide Polymorphisms.

Basis of DNA typing:

- Some chromosomal regions contain repeating units of the same type of DNA; the numbers of repeating units vary from individual to individual. Hence, chromosomal regions with short tandem repeating DNA units are used for human identification.

Method:

DNA is isolated from the biological samples. The purified DNA is cut into fragments using restriction enzymes and the pattern is taken.

For example: **GCGC**ATGTT**GCGC**AAGA**GCGC**–Repeated three times

GCGCATTGAATGCAAGTA**GCGC** –Repeated two times

- The restriction enzyme will cut between first G and first C. The result will be fragments either small fragment or large fragment.
- Restriction fragments are negatively charged and can be separated by '**gel electrophoresis**' which separates the DNA based on their sizes.
- The samples of DNA are allowed to run on a slab of electrophoretic gel, across which a positive charged probe is placed; the smaller fragments running faster, thus separating the DNA samples into distinct bands, which are visualized using luminescent dyes.
- Quite large amount of biological material is needed to get reasonable accurate results.
- **PCR** (Polymerase Chain Reaction) technique: This requires only trace amount of DNA and hence useful, when only limited sample is available, as like the crime scene.

Applications of DNA typing:

- Paternity disputes (accounts for 50% cases of DNA typing done in India)
- Maternity resolutions
- Detection of cases of child swapping
- Identification of the culprit in rape cases and gang rapes
- Identification of mutilated remains
- Identification in exhumed bodies and partially burnt bodies.

Section III:

Forensic Pathology

CHAPTER 6

Medicolegal Autopsy

Keywords: Autopsy, aims and objectives of medicolegal autopsy, dissection methods, blood less dissection, preservation of viscera, artefacts, obscure autopsy, embalming.

1. Define autopsy. What are the types of autopsies?

Autopsy is defined as "scientific dissection of the dead body".

There are two types of autopsies in practice:

i. Pathological autopsy;
ii. Medicolegal autopsy.

i. Pathological autopsy: Pathological autopsy is also called as academic or clinical autopsy. It is done by the clinicians who were treating the patient with the association of the clinical pathologist. Consent of the legal heir is mandatory. Pathological autopsy can be done only in cases of natural death where the cause of death is already confirmed. Academic autopsies are done to acquire knowledge which will be useful for the clinician while treating similar patients in future.

ii. Medicolegal Autopsy: Medicolegal autopsy can better be defined as "investigative scientific dissection of a dead body".

- Medicolegal autopsies are done under an authorization of the police (not below the rank of sub-inspector) or the executive magistrate (officers of the revenue department, appointed by the state government, usually not below the rank of Thasildar).
- There is no need for consent of the relatives, since it is done under an authorization and it will be done even if the relatives object for the post-mortem examination. Medicolegal autopsies are done in all unnatural and sudden deaths.
- There are other two types of autopsies which do not involve dissection of the dead body and they are:
  - (i) **Psychological autopsy:** It is a form of counseling for relatives of the deceased who die of suicide. Especially, when there is a history of suicides among their family members.
  - (ii) **Verbal autopsy:** Done in infant deaths for data on infant mortality.

2. What are the aims and objectives of a medicolegal autopsy?

i. To find out the cause of death:

- Finding out the medical cause of death is one of the prime objectives of conducting an autopsy. Certifying the cause of death can be done only by an allopathic physician. He also has to assess whether the death is natural or unnatural.

  Natural death implies that death is purely due to disease and the pathological process of the disease must be demonstrated at autopsy.

  Unnatural death: It can be accidental, suicidal or homicidal.

ii. To estimate the time since death:

- Assess the probable time interval between which death could have occurred, by the changes which take place in a dead body after death.

iii. Documentation:

- One of the most crucial and critical part of conducting a medicolegal autopsy is documentation. The autopsy surgeon should give foremost importance to documentation. A proper documentation as observed by him will aid anyone to arrive at a logical conclusion. But it's very unfortunate that most of the doctors doing autopsy have a very poor documentation style and most of the questions of the cross-examination go unanswered in the courts of law and all these benefits of doubts go to the accused.
- Documentation should be with reference to postmortem changes, the pathological process of any disease and the injuries present on the body.
- All the injuries present on the body must be documented. How small an injury may be, must be documented clearly; since, that could be the only evidence of struggle. Injuries must be documented with reference to the type of injury, exact dimension (size), shape and location of the injury.
- The autopsy surgeon also has to assess the mode of infliction of the injuries; the probable weapon used/involved in causation of the injury and the relative position of the victim and the assailant at the time of infliction of the injuries.

iv. To fix the **identity** of the individual when not known.

v. To preserve relevant tissues and organs for analysis: HPE and chemical analysis.

vi. In **newborn** to find out whether the baby was a dead born, stillborn or live born.

3. *Who is authorized to do medicolegal autopsy? What are the documents produced to the doctor to conduct an autopsy?*

- Medicolegal autopsies can be done only by allopathic physicians. Any doctor with MBBS degree working in an authorized autopsy center can perform medicolegal autopsies.
- **Note**: *In Tamilnadu, there is MD degree in Siddha Forensic Medicine, offered by The Tamilnadu Dr MGR Medical University; but they are not permitted to undertake any medicolegal work including medicolegal autopsies, since they lack the basic MBBS degree.*
- Hence, every allopathic physician should be proud and bear in mind that it's our honorable duty to perform medicolegal autopsies, as well as appear in the court as an expert medical witness and help the court in matters of any dispute in medical science.
- Requisition for conducting medicolegal autopsy is submitted by the investigating officer along with the following documents:
  - (i) Two copies of the request letter to conduct autopsy
  - (ii) Two copies of the history of the case
  - (iii) Two copies of inquest report: Which consists of details regarding the dead body, identification marks, and clothes on the body; injuries present on the body and apparent conclusion regarding the cause of death as judged by them.
  - (iv) One copy of FIR (First Information Report), and
  - (v) One copy of AR (Accident register) copy.
  - (vi) Any other relevant documents like treatment records, investigation reports, hospital case sheets, death certificate, etc.
- The medical officer must carefully go through the inquest report and gain as much information as possible regarding the case before commencing the autopsy.

4. What are the procedures of external and internal examination in an autopsy?
What are the dissection methods to examine the major cavities and organs in an autopsy?
What is blood-less field of dissection? Method of dissection of heart.

External examination:

- Clothes on the body; with special reference to stains and tears.
- Take necessary photographs of the clothing with any stains present on the body.

- Wash the body thoroughly before commencing the autopsy.
- Check the identification marks.
- Look for any discoloration and postmortem changes like postmortem hypostasis, Rigor mortis, putrefaction changes, etc.
- **Document the injuries:** From head to toe, with reference to the type of injury (abrasion, laceration, cut wound, stab wound, etc.), exact dimension and location with reference to prominent anatomical landmarks wherever necessary.
- Take necessary photographs of all the injuries, before commencing the dissection. In present days, this is an easy task as mobile cameras are available with almost every doctor.

Dissection methods:

- Open the head by an incision from one mastoid process to another, along the vertex. Any contusion or bruise on the scalp tissue is noted, documented and photographed (atleast using a mobile camera) and examine the temporalis muscle.
- Look for any fractures on the skull; fissured, comminuted, depressed, or cut fracture.

Open the calvarium: Look for any intracranial hemorrhages:

- ***Extradural hemorrhage:*** Seen on the membranes, as soon as we remove the vault of the skull. It may be a thick film or even a large hematoma, usually present on the same side of the external injury (Coup injury)
- ***Remove the meninges:*** Look for subdural hemorrhage, which appears as a thin or rarely a thick film on the brain surface; wash the brain thoroughly under flowing water, SDH is easily washed out. If still any more hemorrhage present on the surface of the brain is subarachnoid hemorrhage, which cannot be washed off since they lie beneath the arachnoid matter.
- Dissect the arteries of the circle of Willis, for evidence of disease (atheromatous plaques, aneurysm, or spontaneous rupture).
- Brain tissues are then sliced into multiple pieces by linear incisions using a brain knife; any hemorrhages present inside the brain matter are intracerebral hemorrhages.
- Pons and cerebellum are also examined for any abnormality and hemorrhages.
- Open the thoracoabdominal cavity by making an **"I" shaped incision** extending from the chin to the symphysis pubis with a curvilinear deviating either to the right or left near the umbilicus.
- In cases of suspected neck pathology, incision is made from the suprasternal notch to the symphysis pubis and dissection of the neck is done at last after removing the contents of all the three major cavities of the body; **Bloodless dissection of the neck.**
- Disarticulate the sterno-claviclar joint (in individuals aged above 40 years, a saw or rib cutter may be necessary); cut the ribs along the costo-chondral junction; reflect the sternum by releasing all the attachments; release the floor of the tongue, close to the border of the mandible and pull out all the organs en-mass from the tongue to the rectum, after releasing the diaphragm and retro-peritoneal

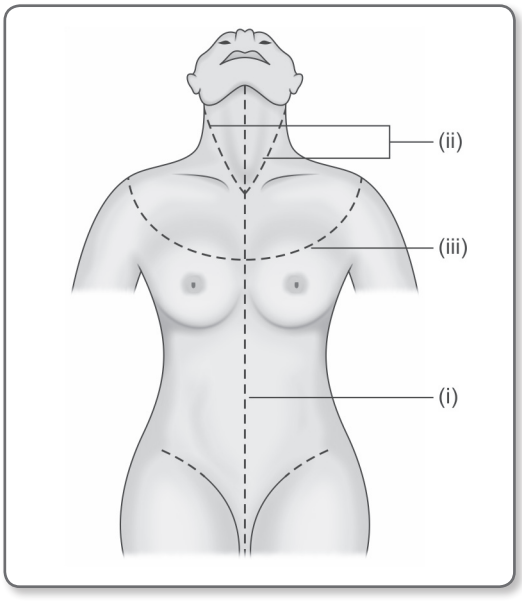


Fig. 6.1 Types of incision for opening the body (trunk) during post-mortem examination. (i) Standard midline incision - straight from below chin to pubis. (ii) V-shaped from mastoids to supra-sternal notch and then straight to pubis, and (iii) Shoulders to manubrium sternii and then straight to pubis

attachments. Then examine and dissect the individual organs separately.

Heart:

- Examine the pericardial fluid and wash the surface of heart thoroughly; the surface of heart is inspected for any evidence of pericarditis (which may appear as white or pale areas of discoloration). Weigh the heart; look for subepicardial petechial-ecchymotic hemorrhages (more on the left ventricle in death due to electrocution, in any asphyxial death) and these petechiae may also be present on the root of aorta.
- Dissection of the heart is along the way of blood flow; identify superior and inferior vena cava; pass the scissors through them and open the right atrium; extend the dissection till the right auricle, to expose the whole of right atrium; examine the valves and cut open the right ventricle along the right border of the heart and come out through the pulmonaries; enter the left atrium through the pulmonary veins, extend the dissection to the left auricle; examine the valves and open the left ventricle along the left border of the heart; examine the endocardium and look for any hemorrhages.
- Thickness of the left ventricle is measured 1 cm below the atrio-ventricular septum.
- ***Dissection of the coronary arteries:*** Identify the right and left coronary ostia; dissect the coronaries by passing a small curved coronary scissors into the lumen of the coronaries through the ostia. Pass the scissors along the entire course of the vessel and their branches; expose the lumen and examine in bright light and check for atheromatous plaques, thickening and narrowing of the lumen of the coronaries; any hemorrhage or clot found inside the lumen is washed thoroughly and examine the underlying lumen surface for plaques and any rupture from the plaques.
- Another way of examining the coronaries is by making serial sections on the epicardial surface, along the course of the vessel at 3 mm intervals.

Lungs:

- Examine the surface after washing the lung; check for petechial hemorrhages on the surface of both the lungs; presence of petechial hemorrhages is a sign of asphyxia; multiple petechio-ecchymotic hemorrhages more on the upper lobes of the lung in cases of aspiration; more concentrated toward the interlobar surfaces in death due to electrocution and sometimes larger areas of sub-pleural hemorrhages (Paultaf's hemorrhages) in drowning.
- It is preferable to dissect along the lumen of trachea and the bronchus, especially in cases of drowning, burns and aspiration; (froth, water and mud particles in drowning, soot particles in burns and stomach contents in aspiration) these must be present on the mucosal surface of larynx, trachea, primary and the secondary bronchioles to confirm it as antemortem findings. Make multiple sections in all the lobes of both lungs to check for macroscopic findings relating to disease or pathology; take bits of tissues for histo-pathological examination whenever necessary.
- ***Esophagus and stomach:*** Pass the scissors into the esophagus from the floor of the tongue, cut open the lumen and examine for any erosions, hemorrhage, discoloration and ulceration (mainly in poisoning and especially in corrosive poisoning). Stomach is first cut out from the lower end of esophagus to the duodenum; stomach opened by passing a scissors along the lesser curvature; the stomach contents are measured and described with reference to the consistency, color and odor of the contents; distinct visible particles if any present must be noted and isolated and sent separately for chemical analysis in a separate container. The stomach along with the other stomach contents can be sent in a separate container.
- ***Liver:*** Surface is examined for evidence of discoloration and nodularity; multiple parallel linear incisions are made and examined layer by layer for any abnormality.
- ***Kidneys:*** Surface of the kidneys examined for petechiae; examine the adrenals for any evidence of hemorrhage and inflammation (especially in anaphylactic deaths). Longitudinal section of the kidneys are made and expose the cut surface; usually the cortex and

medulla are distinctly visible but in cases of degenerative diseases, nephritis and in some poisons (mercury) the cortico-medullary differentiation is poor. Look for any calculi or renal cyst. If there is any visible pathology, preserve the tissues for microscopic examination.

- ***Spleen:*** Examine the size, shape and surface, then make serial sections and look for any visible pathology.
- ***Female genital tract:*** Examine the external surface of the uterus, both anterior and posterior surface; examine the fallopian tubes and ovaries for any obvious pathology. Make a longitudinal incision and examine the uterine cavity and its contents if any (like products of conception, fibroids, endometrium, etc.). If any fetus is present, measure the crown heal length and the circumference of the head. Examine the various ossification centers of sternum, lower end of femur, talus and calcaneum; also examine whether sex differentiation is possible.

5. *What are the methods of reconstruction of the dead body?*

After complete examination, any organs or tissues to be subjected for analysis are retained and all other examined organs and tissues including brain are put back into the thoraco-abdominal cavity, packed with cotton, place the sternum in its position and sutured using strong thread by continuous sutures. The skull cavity is packed with cotton, the cap in laid in its position and sutured by continuous sutures. Then the body is washed, whipped and the legs are tied together and the hands tied together by placing the hands on the abdomen. Then packed by two layer packing material; using polythene sheet and then white cotton cloth. All the body parts should be covered except the face.

Note: If any fetus is present, it is also put back into the abdominal cavity after thorough examination of the fetus. There could be request from the relatives of the deceased to handover the fetus separately, especially when the fetus is near term. But we are not supposed to handover the fetus separately, as we receive requisition to conduct autopsy on one body and we are supposed to handover only one body.

6. *What are the situations where tissues are preserved for HPE and chemical analysis?*

Sending the tissues or organs for analysis:

- ***Histopathology:*** The tissues are preserved using formalin as preservative (10% formaldehyde). Labeled and sent to the pathology lab, with description of autopsy findings concerned with that particular organ.

Chemical analysis: In many situations, the doctor may have to preserve the viscera for chemical analysis; it is mandatory to preserve the viscera in the following situations:

- All cases of poisoning brought dead or treated.
- In all murder cases to detect any poison and alcohol.
- In road traffic accidents to detect alcohol.
- In all cases of magistrate inquest.
- In all suspicious and sudden deaths.

7. What are artefacts? What are the types of artefacts?

- The word artefact is derived from Latin '**arte**'-using art; '**factum**' something made.

Definition:

- Artefacts are changes caused or features introduced in the body and those which are likely to be misinterpreted at autopsy as an antemortem finding are called as artefacts. (The possibilities of misinterpretation of many findings are discussed then and there in the relevant texts).
- These changes could have been introduced in the body before death or at the time of death or after death and they can be therapeutic, agonal or postmortem artefacts.

Therapeutic artefacts:

- These are changes introduced in the body during the attempt to resuscitate the patient in the terminal stage of death. Examples:
  1. Cardiac defibrillators used may produce findings simulating bruising of chest wall
  2. Vigorous cardiopulmonary resuscitations during terminal phase of life may cause fracture of ribs at the costochondral junction.

3. Shape and size of a wound could be altered by surgical intervention during treatment (Kennedy Phenomenon).
4. Any major surgery done for serious injuries may alter the autopsy findings (hence, before autopsy verify relevant medical records and understand what therapeutic procedure has been done).

Agonal artefacts:

- These are changes introduced in the agonal phase of death of a person. Examples:
  1. Aspiration of gastric contents as an agonal terminal event (especially when unconsciousness precedes death and in alcoholism) or during resuscitation measures, or while handling the dead body after death (primary flaccidity allows the contents of stomach to escape into the respiratory tract).
     Careful dissection of the bronchial tree would show, these contents present only upto the level of primary bronchus. Absence of these materials in the bronchioles will help to confirm that these are not antemortem findings.
  2. In cases of injuries when death was so rapid, there may not be visible hemorrhage or extravasation in the surrounding soft tissues to conclude the antemortem nature of injuries; similarly, an individual may collapse and die on the road side and subsequently run over by a vehicle resulting in collection of blood in the cavities, which should not be mistaken as antemortem injuries as the cause of death.

Postmortem artefacts:

- These kinds of artefacts would result due to handling, transportation and storage of dead body like drag marks, cold stiffening, etc.
- Artefacts introduced by predators or deliberate mutilation.
- Decomposition changes like marbling or postmortem purge are likely to be misinterpreted at autopsy, especially when the doctor is less experienced.
- Adopting improper autopsy techniques may result in false interpretation of the findings during autopsy.

8. What is an obscure autopsy/negative autopsy?
What are the commonest causes of negative autopsy?

- After a thorough complete autopsy, chemical examination of all relevant internal organs, necessary histopathological and biochemical analysis, if no definite cause of death could be found or made out, then it is termed as negative autopsy.
- The commonest situations of negative autopsy are:
  1. The most common situation occurs in decomposed bodies. Decomposition is always a challenge to the autopsy surgeons. The outcome percentage also depends upon the magnitude of decomposition.
  2. Many natural causes of death may not leave any specific autopsy findings or will be difficult to elicit at autopsy, especially: vagal inhibition, anaphylaxis, metabolic causes like uremia and cerebral concussion.
  3. In deaths due to some rare poisons: Non-availability of proper detection methods.
  4. Difficulties may also arise in cases of death due to snake bite, electrocution, etc. where the bite marks or the electrical entry wound is not visible.
  5. Inadequate, false or misleading history may sometimes lead to a negative autopsy.
- The incidence of negative autopsy is 2 to 5% of the cases as per many studies, but in India the incidence is much higher due to poor standard of the mortuaries, improper/inadequate training of doctors in conducting autopsies and lack of development in scientific crime detection methods.

9. *What is embalming? What are the methods of preservation of dead body?*

Embalming fluid:

- Embalming is a method of preserving the dead body using chemicals.
- The embalming solution contains 10 % formaldehyde and glycerin. When the body tissues come into contact with the solu-

tion, the proteins are coagulated, tissues are fixed and internal organs are hardened.

- The decomposition process is completely arrested if embalming is done shortly after death; if done sometimes later then the body would be preserved at that stage and further decomposition is arrested.
- Embalming usually does not alter the appearance of the body tissues and organs, but slight difficulty may be encountered while we interpret any disease or injury.
- Due to fixation of the tissues by the embalming fluid, poisonous substances if present cannot be detected during toxicological analysis.
- ***Method of embalming:*** The embalming fluid is injected into the body with the aid of a hand or foot pump and bulb syringe. The solution is pushed inside the body through the cut down of an artery (usually femoral artery). Another cut down is made on the opposite side blood vessel (vein, usually femoral vein) to let out the blood and the excess embalming fluid, either intermittently or continuously. The injected embalming fluid is allowed to stay in the body for a reasonable duration of time to facilitate perfusion into the capillaries and permeation into the organs.
- ***Embalming a body after autopsy:*** All the internal organs are taken out, cut into smaller pieces as possible and soaked into embalming solution for some period of time (30 minutes or more depending upon the time available) and these organs are put back into the thoracoabdominal cavity and covered by cotton dipped in the embalming fluid. The stomach and the intestinal contents are squeezed out before they are put back into the body. The external body surface is embalmed by injecting the solution using syringe. The solution can be injected into the eyeballs and all parts of the face to prevent decomposition as the face is important part to be preserved.
- ***Note:*** When the body has been kept in cold storage, then the body has to be brought back to atmospheric temperature before embalming, if pressure pumps are to be used.

CHAPTER 7

Thanatology (Study of Death)

Keywords: Death, suspended animation, brain death, apnea test, brainstem reflexes, THOA, cadaveric donation, anoxic time, anoxia, somatic death, molecular death, coma, syncope, vagal inhibition, asphyxia, sudden natural death, Winslow's test, Magnus's test, Icard test.

1. Define death.

- Death is defined as the "complete and irreversible cessation of circulation, respiration and brain functions".
- As long as oxygenated blood is maintained to the brainstem, life continues to exist.

2. What is suspended animation?

- Suspended animation is a condition in which the vital functions of the body come down to a minimum level, just compatible with that of life. The person appears apparently dead but life is still present. This is a rare occurrence, usually involuntary and encountered in many cases; the most commonest situations in order of priority are:
  (i) Newborn
  (ii) Electrocution
  (iii) Drowning
  (iv) Hypothermia
  (v) Drugs: Mainly morphine, barbiturates and alcohol.
  (vi) Induced voluntarily by practice (yoga) – Voluntary suspended animation.
- Medicolegally suspended animation is very important as a person under suspended animation can be easily resuscitated by artificial means.
- Suspended animation has to be ruled out to avoid a premature certification of death.
- Especially important in new born, timely resuscitation measures should be attempted before declaring the baby as still born.

3. What is persistent vegetative state?

- Persistent vegetative state occurs in conditions where there are damages to the higher centers of the brain, but the brainstem is intact. The individual breaths spontaneously and a stable circulation is present, but is unaware of self and the environment.
- This condition occurs in diffuse bilateral cerebral hemisphere disturbance, with an intact brainstem.

4. What is brainstem death? What are the tests for brainstem death?

- Brainstem death is a condition in which the patient is irreversibly unconscious and irreversibly apneic (damage to the respiratory center) due to compression/damage to the brainstem.
- The tests include test for brainstem reflexes and apnea test.

Test for Brainstem Functions:

i. Pupillary reflex (afferent 2nd and efferent 3rd cranial nerves)
ii. Corneal reflex (afferent 5th and efferent 7th cranial nerves)

iii. Reflex to grimace (afferent 5th and efferent 7th cranial nerves)
   – Vestibulo-ocular reflex (afferent 8th and efferent 3rd and 6th cranial nerves)
iv. Gag or cough reflex (afferent 9th and efferent 10th cranial nerves)

Apnea Test: The aim of the test is to prove that the patient is incapable of spontaneous breathing and there are no cells alive in the brainstem, which can trigger respiration.

Method: 100% oxygen is given for 10 minutes, followed by 95% oxygen (high oxygen) and 5% carbon dioxide (high CO_2, since brainstem is triggered more by increased levels of CO_2, rather than reduced O_2 levels) and the ventilator is disconnected; if there are any cells alive in the brainstem, then the patient will breathe spontaneously.

5. Transplantation of Human Organs Act 1994 (THOA).
Cadaveric donation: Warm anoxic time/ Beating heart donor.
Harvard's criteria of diagnosing brainstem death.

THOA was passed in 1994 and it deals with the regulation of:

i. Removal and storage of human organs.
ii. Transplantation of human organs for therapeutic purposes.
iii. Prevention of commercial trade in human organs.
   – THOA defines human organ as any part of the human body, which if wholly removed cannot be replicated by the body.
   – The only organ which can be donated during life is kidney.
   – The donor must be above 18 years of age.

Board of Doctors to Certify Brainstem Death:

i. Registered Medical Practitioner (RMP) treating the patient.
ii. RMP in charge of the hospital.
iii. Neurologist/Neurosurgeon nominated from the Panel of Names approved by the appropriate authority (The Director of Medical Services is the appropriate authority).
iv. An independent medical specialist (MD in general medicine) nominated from the panel of names approved by the appropriate authority.
   – None of the member certifying brain stem death should be associated with the transplantation team.

Cadaveric Donation:

- Brainstem death certification by the team of doctors is mandatory for transplantation.
- RMP certifying death should not be a part of the transplantation team.
- Organs are removed when the donor heart is still beating: "***Beating Heart Donor.***"
- Success of transplant depends on the functional status of the donated organs, which again depends on the "***warm anoxic time***" (time interval between cessation of arterial oxygen supply and the refrigeration of isolated organs); and in cadaveric donation, the warm anoxic time is almost reduced to zero.
- Kidneys are removed within 30 to 60 minutes and generally not stored for more than 12 hours.
- The period of viability of other organs is as follows:
  Cornea: 6 hours; Skin: 24 hours; Bone: 48 hours; and Blood vessels: 72 hours, after death.

Diagnosis of Brainstem Death:

British Code or Harvard Criteria:

i. ***Preconditions:***
   (a) Comatose patient on a ventilator
   (b) Positive diagnosis of cause of coma: There should be irreversible/irremediable structural damage to the brain, making the patient unresponsive and comatose.
ii. ***Exclusion:***
   Before the certification of brainstem death (a) hypothermia, (b) coma due to drugs and (c) metabolic and endocrine causes of coma should be ruled out.
iii. ***Tests:***
   (a) Tests for brainstem reflexes, and
   (b) Apnea test.

Types of Transplant

- Homologous donation: Grafting of cells from one part of the body to another in the same patient. Example: Skin grafting, bone grafting, blood vessels, etc.

- Heterologous donation: (live donation) — Blood, bone marrow and other organs from one individual to the other after proper tissue matching and HLA compatibility.

6. What are the stages/types of death?

There are two stages of death: Clinical death and cellular death.

i. ***Somatic or clinical death:*** It is the moment of death; it is the time at which circulation, respiration and brain functions irreversibly cease.

ii. ***Molecular or cellular death:*** Death of the cells and tissues individually, which follows somatic death.

7. What is natural and unnatural death?

According to causative agent, death may be classified as:

- **Natural:** Death is purely due to disease and the pathological process of the disease must be demonstrated at autopsy.
- **Unnatural:** Homicidal, suicidal or accidental.

8. What is the mode of death? What are the three modes of death?
What is anoxia? What are the types of anoxia?
What is syncope? What are the causes of syncope?

- Mode of death depends on which of the three major life supporting system fails first; there are three modes of death and they are: (i) Coma, (ii) Syncope, and (iii) Asphyxia.

Coma:

- Coma is defined as insensibility of the individual due to damage to the brainstem.
  Coma is clinical condition and not a cause of death or diagnosis; it occurs in:
  (i) Compression of brain
  (ii) ***Drugs induced:*** Opium, cocaine, alcohol.
  (iii) ***Metabolic causes:*** Uremia, diabetes.
  (iv) ***Infection:*** Pneumonia, infectious fever, etc.
  (v) ***Others:*** Thrombosis and embolism, epilepsy, hysteria, etc.

Fig. 7.1 Micronodular cirrhosis of liver, a case of chronic alcoholism

Syncope:

- Syncope is sudden stoppage of the function of heart. This is due to vasovagal attack resulting from reflex parasympathetic stimulation.
- In this condition, blood pressure falls suddenly, causing cerebral anemia and rapid unconsciousness.

Causes:

i. ***Anemia:*** Sudden blood loss.

ii. ***Deficient power of heart:*** Myocardial infarction, poisons, fatty degeneration.

iii. ***Vagal inhibition:*** Reflex inhibition of the heart.

iv. Exhausting conditions like dehydration and cholera.

Asphyxia:

- Interference with respiration due to any cause, or lack of oxygen in respired air, due to which the organs and tissues are deprived of oxygen (together with failure to eliminate carbon dioxide) leading to unconsciousness and death.

Anoxia:

- Gordon and his co-workers in 1994 claimed that the only mode of death is anoxia. Let any of three life supporting systems fail first, the end result is tissue anoxia.
- There are four types of anoxia:
  (i) ***Anoxic anoxia:*** Deficient oxygenation in the lungs; from mechanical interference

as in hanging and breathing in a contaminated atmosphere.

(ii) ***Anemic anoxia:*** Due to sudden reduction in blood volume, in this condition the oxygen carrying capacity of the blood is reduced.

(iii) ***Stagnant anoxia:*** Due to impaired circulation, oxygen delivery to the tissues is reduced.

(iv) ***Histotoxic anoxia:*** There is enough oxygen in the blood whereas the tissues are unable to take up or utilize oxygen; for example: Cyanide poisoning.

9. What is sudden death? What are the duties of a doctor in such cases of sudden death? What are the commonest causes of sudden natural death?

Natural Death:

- Death occurring due to some natural disease or pathological condition, old age or debility. Death is not intended or attempted.

Sudden Death:

- Death is said to be sudden or unexpected when a person not known to have been suffering from any disease, injury or poisoning dies within 24 hours after the onset of terminal illness.
- The doctor treating the patient should not issue a death certificate in any case of sudden death, even if he has diagnosed the case as death due to natural cause. This is because some other unknown events could have interfered in causing death of the individual, especially involvement of some poisons (many of the signs and symptoms of such poisoning will mimic a natural disease).
- Hence, if death of a patient occurs within 24 hours after the onset of terminal illness, the case has to be considered as sudden death. All such cases should be made as medicolegal case and all such cases must be referred for autopsy after intimating the concerned police station.
- The association of disease with trauma has to be assessed and may involve compensation benefits for the relatives.
- Situations may arise where trauma per se is not fatal and the pathological lesion found at autopsy may have been compatible with continued life, e.g. chronic heart disease. In these situations, the effects of trauma on the existing disease in causing death have to be assessed and evaluated to arrive at a right decision.
- Most of the sudden and unexpected deaths are due to diseases of the cardiovascular system. Diseases of the CVS account for nearly 40 to 50 % of all sudden deaths.
- The **common causes of sudden natural death** are classified according to the system involved as follows:

1. Cardiovascular system:

- Coronary occlusion: [Atheroma, thrombus, embolism].
- Localization of atheroma: Left anterior descending artery (45 to 64%), right coronary artery (24 to 46%), left circumflex artery (3 to 10%), and left main coronary (0 to 10%)
- Coronary atherosclerosis with thrombosis
- Coronary artery embolism
- Cardiac tamponade
- Angina pectoris
- Rupture of aneurysm and dissecting aortic aneurysm
- Cardiomyopathies: Especially hypertrophic obstructive cardiomyopathy.
- Lesions of conducting system.

Respiratory system

- Air embolism, pulmonary thromboembolism
- Pneumothorax, bronchopneumonia.

Fig. 7.2 Multiple raised atheromatous plaques on the root of aorta

Fig. 7.3 Ruptured plaque on the lumen of left coronary artery, recent thrombus after washing the lumen

Fig. 7.5 TB Lung — Note: Multiple cavities filled with pus

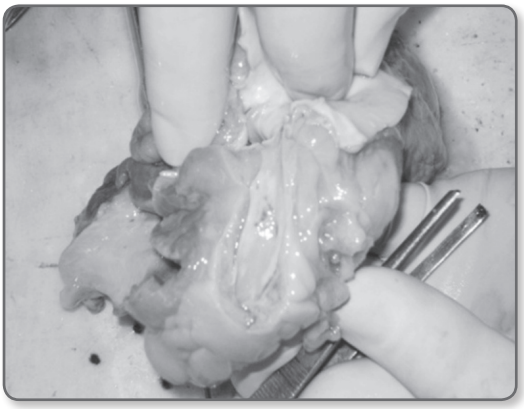


Fig. 7.4 Dissection of the coronary artery

- Status asthmaticus, TB
- Acute edema of glottis
- Foreign body impaction in the airway (aspiration and choking).

CNS

- Intracranial hemorrhage: Cerebral, Cerebellar, pontine hemorrhages.
- Brain tumors, meningitis and encephalitis
- Cerebral thrombosis and embolism
- Status epilepticus
- Rupture of berry aneurysm.

10. Write short notes on vagal inhibition/ syncope.

- Sudden deaths occurring within seconds or minutes due to minor trivial trauma or relatively simple and harmless peripheral stimulation are caused by vagal inhibition.
- Pressure on the baroreceptors situated in the carotid sinuses, carotid sheath and carotid body causes an increase in BP, slowing of the heart rate, leading to dilatation of blood vessels with resultant fall in BP. Afferent impulses from the carotid body pass through the glossopharyngeal nerve to the 10th nucleus in the brainstem, and efferent returns through the vagus nerve.
- Some individuals show marked hypersensitivity to stimulation of the carotid sinuses, characterized by bradycardia and cardiac arrhythmias ranging from ventricular arrhythmia to cardiac arrest.

These types of vagal inhibition (syncope) may occur in:

- Pressure over the neck as in hanging and strangulation.
- Sudden blows to larynx, chest, epigastrium and genital organs.
- Sudden distension of hallow muscular organs, e.g. during attempts at criminal abortion, when some fluid, gas or instruments are passed into the uterus.

11. What are the tests for stoppage of circulation, respiration and brainstem function?

Tests for stoppage of circulation:

i. ***Auscultation:*** Absence of heart and breath sounds.

ii. ***Icard's test:*** 1% alkaline solution of fluorescein is injected subcutaneously, if there is minute capillary circulation then the dye will gradually spread with a greenish hue.

iii. ***Ligature test:*** A ligature is tied around the root of a finger, if there is little amount of circulation present, the finger will become swollen and red, and the proximal part of the ligature will become pale (blanched).

iv. ***Magnus's test:*** A light is placed between webs of the fingers if there is capillary circulation still present there will be a reddish-glow. If there is no circulation, the light will have a yellow and waxy hue.

v. ***Fingernail test:*** When the nail of a finger is pressed firmly, the nail becomes pale; when pressure is released the original red color reappears, if circulation is present.

vi. ***Arterialspurting test:*** A small artery if nicked, the arterial blood will spurt if there is little circulation still present. (This test is usually not attempted).

vii. ***Heat test:*** When heat is applied momentarily over the skin, there will be formation of a blister, with redness and congestion at that place, if there is slightest circulation still present.

viii. ***ECG:*** Continued flat wave in all the leads, for a continuous period of 5 minutes signifies stoppage of heart (isoelectric line).

Tests for Stoppage of Respiration:

i. ***Feather test:*** Feather of a bird is placed in front of the nose, to check whether it moves; if slight respiration is present, the feather will move. This test has got limitations due to influence from external factors.

ii. ***Mirror test:*** A mirror is placed in front of the mouth and if there is slight respiration, then there is deposition of droplets of vapor on the surface of the mirror. (Useful test).

iii. ***Winslow's test:*** A pot containing water or mercury is placed over the chest and a beam of light is focused on it from a fixed source. The reflected image seen on the opposite side is focused on a screen. If there is slightest movement of the chest, there will be gross deflection of the reflected image on the screen.

Tests for stoppage of brain function:

i. Absence of motor and sensory functions
ii. Testing brainstem reflexes
iii. Persistent flat EEG.

CHAPTER 8

Postmortem Changes

Keywords: Postmortem changes, time since death, changes in the eye, tache noir, Kevorkian's sign, algor mortis, postmortem caloricity, livor mortis, contact flattening, primary flaccidity, rigor mortis, cadaveric spasm, heat rigor, cold stiffening, gas stiffening, autolysis, putrefaction, honeycomb liver, marbling, postmortem purge, coagulative putrefaction, Casper's dictum, mummification, adipocere, carbon dating, forensic entomology, presumption of death, presumption of survivorship.

INTRODUCTION

- The changes that take place in the dead body after death are called as **postmortem changes**.
- They are classified into three stages; all these changes commence simultaneously after death, but evident to our eyes only when time advances.
  - (i) **Immediate changes:** Few minutes after death to maximum 30 minutes.
  - (ii) **Early changes:** One hour to 36 hours.
  - (iii) **Late changes:** After 36 hours.

1. What are the immediate changes which take place in a dead body?

- These are changes which take place immediately or at the moment of death and are important for the clinicians to confirm death and issue a death certificate.
  - (i) Complete and irreversible cessation of functions of brain, heart and lungs.
  - (ii) Muscles of the body become flaccid. (primary flaccidity).
  - (iii) Corneal and pupillary reflexes are abolished.
  - (iv) Insensibility and primary flaccidity of the muscles.
    - This is one earliest sign of death and very much concurrent with the moment of death (somatic death), but cannot be considered positive because it is also seen in cases of deep coma, narcosis and suspended animation.
  - (v) Permanent stoppage of circulation:
    - Stoppage of circulation for more than 5 minutes; but in certain conditions, even after stoppage of respiration, heart may continue to beat for more than 10 minutes as in cases of hanging (idiosynchrotic rhythm).

2. What are the early changes after death?

- Changes in the skin
- Changes in the eyes
- Algor mortis (cooling of the body)
- Livor mortis (postmortem hypostasis)
- Rigor mortis (cadaveric rigidity).

3. Describe the changes in the skin and eye after death.

Changes in the skin:

- Skin loses its elasticity immediately after death. Skin which was translucent during life becomes pale and ashy-white.

Changes in the Eyes:

i. ***Pupils:*** Dilated and fixed (no reaction to light), later becomes constricted (with onset of rigor mortis).

ii. ***Cornea:*** Looses its luster, becomes dull, hazy, and finally opaque and wrinkled.

iii. ***Tache Noir Sclerotica:*** A thin film of cell debris and mucus forms two yellow triangles of desiccated discoloration on the sclera each at the side of the iris; which becomes brown and then black, due to continuous exposure to the atmospheric air when the eyelids are open.

iv. ***Intraocular pressure:*** Normal intraocular tension is 14 mm Hg. After death it falls so rapidly that by 1 hour its 3 mm Hg and by 2 hours, the intraocular pressure is nearly zero. Eye balls appear sunken.

v. ***Changes in retina:*** Fragmentation or segmentation of blood columns appears within minutes after death called as "***trucking***" (**Kevorkian sign**). Retina is Pale for the 1st two hours. Then at about 6 hours after death the disc outline is hazy. It becomes totally blurred in 7 to 10 hours. These changes in the retina can be appreciated only by using an ophthalmoscope, and interpreted by an expert ophthalmologist.

vi. ***Chemical changes in vitreous humor:*** Vitreous humor is the only body fluid which is reliable indicator to assess the time since death. There will be a gradual raise in the potassium level after death upto 4 or 5 days.

4. Describe algor mortis (cooling of the body). What is postmortem caloricity?

- There is a constant balance between heat production and heat lost during life. After death heat production is lost, hence the body starts cooling.
- The body loses heat by conduction, convection and radiation.
- Body surface starts losing heat rapidly, but the inner body core temperature does not alter until a gradient is established between the core body temperature and the environmental temperature.
- There is no significant change in the core body temperature upto 2 hours from the time of death. Once the gradient is established, the body starts losing heat at a constant rate.
- The rate of cooling is proportional to the difference in temperature between the body and the surface (Newton's law).
- Temperature is measured by using a chemical thermometer graduated from 1 to 50 degrees centigrade, inserted 10 cm into the rectum. When there is history of suspected sexual assault, then the temperature is measured from the undersurface of the liver by making a slit opening on the upper part of right side of the abdomen (sub-hepatic temperature).
- $$\text{Time Since Death} = \frac{\text{Normal body temp} - \text{Rectal temp/subhepatic temp}}{\text{Rate of fall of Temp/hour}}$$
- Example:
  $$= \frac{37\ (\text{Normal temp}) - 35.5\ (\text{measured})}{1.5\ (\text{constant})}$$
  = 1 Hour.
- Factors affecting the rate of cooling:
  (i) The environmental temperature has a direct proportional effect on cooling of the body.
  (ii) Coverings on or around the body; clothing prevents heat loss from the body.
  (iii) Built of the cadaver:
  - Heat loss is proportional to the surface area of the body; ultimately, the body of children and old people cool rapidly.
  - Fat is a bad conductor of heat; hence females and obese bodies cool slowly.

Postmortem caloricity:

- The increase in body temperature for the first few hours after death is called postmortem caloricity. The mechanism and conditions of this phenomenon are as follows:
  (i) When the heat regulatory mechanism has been severely disturbed before

death. For example: sun stroke and Pontine hemorrhage.

(ii) When there is increased heat production in the muscles of the body before death due to convulsions. For example: Tetanus, strychnine poisoning and epilepsy.

(iii) Excessive bacterial activity during life. For example: Septicemic deaths, cholera and other infections.

5. Describe livor mortis

(Postmortem staining/postmortem lividity/postmortem hypostasis)

- Purplish red discoloration of the skin which takes place on the dependant parts of the body after death is called postmortem staining. After stoppage of circulation, the blood which is fluid in nature, gradually settles down in the toneless capillaries on the dependent parts of the body by 2 to 3 hours after death.
- Those parts of the body which are in actual contact with the surface do not show this staining, as the capillaries are firmly pressed by weight of the body, and this is known as areas of "**contact flattening**" (Fig. 8.1).

Time of appearance:

- Postmortem lividity begins as mottled patches ranging from 1 to 2 cm in diameter in 2 to 3 hours after death. These patches gradually increase in size and coalesce with each other to form a uniform area of staining in 4 to 6 hours.

Fig. 8.1 Postmortem hypostasis — Fixed with areas of contact flattening Time since death (TSD) is 6 to 8 hours.

Table 8.1 Color of PMS and poison

Poison	Color
Carbon monoxide	Cherry red
Cyanide	Bright red
Hydrogen sulfide	Greenish blue
Phosphorus	Brown
Nitrobenzene, potassium chloride	Brownish red
Aniline	Blue or bluish brown

- If the position of the body is altered within a few hours of death, then these patches gradually disappear, and reappear in the new dependent parts.
- Fixation of postmortem staining takes place in 6 to 8 hours, i.e. when we apply pressure on the skin using our thumb, the staining disappears at the point of application of force and that area becomes pale (blanching) and reappears when the pressure is released. Which means postmortem staining is not fixed. If it is fixed, then blanching will not be there when we apply pressure and postmortem staining will remain as such.
- PMS does not disappear and are present as such, but they are masked with the onset of color changes of putrefaction. During putrefaction the skin color changes to greenish black and hence postmortem staining cannot be appreciated.
- PMS may not develop at all, if the body is tossed and turned continuously as seen in fast flowing water in rivers.
- PMS cannot be appreciated well in dark colored individuals.
- PMS may not be appreciated even in fair skinned bodies if they have bled profusely before death or were severely anemic at the time of death.
- PMS has to be differentiated from contusion.

Medicolegal importance

- It is a sign of death.
- It helps in estimating the time since death.
- Indicates the posture of the body at the time of death; it also indicates any alteration/deliberate disturbance in the position of the body after death.

- The color of postmortem staining gives a clue to the poison involved in causing death.

6. Describe rigor mortis? Discuss the conditions altering the appearance of rigor mortis?
What are the conditions which simulate rigor mortis?

Rigor mortis is also called "**cadaveric rigidity**".

- Rigor mortis is a state of stiffening of the body due to rigidity with relative shortening of the muscle fibers. Immediately after death, the muscles go into primary flaccidity and rigor mortis sets in the muscles with passage of time. The muscles go in for secondary relaxation after rigor mortis passes off.
- It indicates the molecular death of the muscles and the muscles do not react to electrical stimulus after rigor mortis has set in.
- Rigor mortis appears in all the muscles of the body, skeletal and smooth muscles; voluntary and involuntary muscles.
- Rigor mortis is a chemical process and is not dependent upon blood supply or nerve supply. It is an internal process within the muscles and hence appears even in an amputated limb.

Mechanism: (ATP depletion)

- The muscle fibers are made of two contractile units namely, actin and myosin filaments. When the muscles are contracted as when walking, lifting some objects or doing any kind of work the actin and myosin filaments come close to each other; later get relaxed. Energy required for this process of relaxation is derived from the ATP and the ATP gets reduced to ADP.
- During life, ATP is constantly synthesized in the body. After death, there is no synthesis of ATP, but the muscles fibers have some amount of ATP in store. As long as there is ATP storage in the muscles, the fibers remain relaxed. Once the stored ATP is exhausted, the muscle fibers go in a far a permanent state of contraction called rigor mortis.

Order of appearance: Proximodistal spread:

- Rigor mortis starts first in the eyelids then it gradually spreads to the muscles of the face, jaw, neck, upper limbs, chest, abdomen and lastly the lower limbs, this is called proximodistal spread of rigor mortis.

Time of appearance: (**Rule of twelve**)

- Starts in 3 to 6 hours
- Takes 12 hours to complete
- Stays for another 12 hours
- Passes off in the next 12 hours.
- Rigor mortis passes off in the same order of appearance.

Conditions altering the onset and duration of rigor mortis

i. ***Age:*** Rigor mortis does not occur in a fetus of less than 7 months of intrauterine age. This is because the myofibrils are formed completely only by seven months of intrauterine life. Thus, helps to find out whether the fetus is viable or not (age of the fetus).
In healthy adult, it develops slowly but well-pronounced and passes off late. Whereas, in children and old, it is feeble and rapid; appears early, stays for a short duration and passes off early.

ii. ***Muscular state at the time of death:*** Onset of rigor mortis is slow and duration is long in cases where muscles are at rest and healthy before death. Appears early and passes of early if the individual dies after great exhaustion.

iii. ***Nature of death:*** In deaths from diseases causing great exhaustion and wasting, the onset is early and duration is short.

iv. ***Atmospheric condition:*** Onset is slow and duration is long in cold winter weather.
Onset is fast and duration is short in hot weather.

Medicolegal importance

- Rigor mortis a sign of death.
- Helps in estimation of time since death; In India, we depend more on rigor mortis to assess the time since death.
- Indicates the position of the body at the time of death (to some extent and not always). For example, an individual dies while sitting on a chair. Sometimes, the body may slip down to the floor during the phase of primary flaccidity.

Conditions simulating rigor mortis: Conditions which look like rigor mortis are:

- Cadaveric spasm.

Table 8.2 Difference between rigor mortis and cadaveric spasm.

Rigor mortis	Cadaveric spasm
Occurs in all the muscles of the body	Occurs only in a group of voluntary muscles
Follows primary flaccidity (starts 3 to 6 hours after death)	Occurs immediately at the time of death
Postmortem finding	Antemortem finding
Helps to estimate the time since death	Not useful to find the time of death
Does not reflect the last act	Reflects the last act of the individual

- ***Heat stiffening:*** Due to coagulation of muscle protein, e.g. death due to burns.
- ***Cold stiffening:*** Due to solidification of subcutaneous fat and water content of the body. For example, bodies subjected to extreme cold temperature, as in high altitudes and when stored in refrigerators in mortuaries.
- ***Gas stiffening:*** Due to gas accumulation under the skin and subcutaneous tissues in the process of putrefaction.

Cadaveric spasm or instantaneous rigor:

- A group of voluntary muscles which were at strenuous work during life (at the time of death) goes into a sudden state of contraction without passing through the stage of primary flaccidity, is called as cadaveric spasm. It is of great medicolegal importance:
- Occurs especially in cases of sudden death, death due to exhaustion and fear, etc.
- It reflects the last action of the individual at the time of death, e.g. firearm in the hands of victims in suicidal gunshot injuries, plants and weeds in the hands of victims in cases of drowning, the weapon in the hands of victims in cut throat injuries, etc.
- Cadaveric spasm cannot be mimicked.
- With the onset of rigor mortis, the whole body goes in for stiffening (cadaveric spasm merges with rigor mortis); when rigor mortis passes off, cadaveric spasm also passes off.

7. Discuss the process of decomposition of a dead body.
State color changes; colliquative putrefaction marbling; honey-comb liver.

Late change: Decomposition of the body.

- It is a process of gradual destruction of body tissues by combined effects of enzymes and destructive action of microorganisms after death.
- It occurs in 2 ways:
  1) **Autolysis**: Enzyme action, and 2) **Putrefaction**: Bacterial action.

Autolysis:

- Cells become permeable after death with release of cytoplasm containing enzymes.
- The proteolytic enzymes cause chemical digestion and disintegration of the organs.
- Autolysis is increased by heat and stopped by freezing.
- Autolysis is an aseptic process which results in maceration of dead fetus in the uterus.
- Auto disintegration occurs in: (i) Brain (liquefaction) (ii) Stomach and GIT (iii) Pancreas.

Putrefaction:

The process of putrefaction is divided into three stages for easy understanding, However, all the changes start occurring from the time of death and are evident to our eyes as time advances.

(i) Color changes
(ii) Production of foul smelling gases
(iii) Liquefaction of tissues.

Color change:

- 1st external sign of decomposition is the Greenish discoloration in the right iliac fossa; which becomes evident in 12–24 hours in summer and 1 to 3 days in winter.
- The color change first occurs in the right iliac fossa because of the presence of caecum, where there are more colonic bacteria and normal bacterial flora of the gut. The bacterial colonies produce hydrogen sulfide, which combines with hemoglobin to form sulfmethemoglobin, which is responsible for the greenish discoloration.
- This color change spreads to the entire abdomen, and extends further to the chest, neck, face and last to the limbs.
- Color gradually changes to dark green then finally black.

- The putrefaction bacteria spread easily in the body fluid and colonize in the venous system. The superficial veins of the limbs, chest, abdomen and neck are stained greenish blue due to hemolysis of red cells and stain the walls of the vessels. This condition is called as "**marbling"** which occurs 36 to 48 hours after death in summer and 2 to 3 days in winter. Marbling has to be differentiated from filigree burns, which is due to lightening. Marbling is well appreciated after the peeling of cuticle, due to rupture of subcutaneous gas blebs (Fig. 8.2).

Evolution of foul smelling gases:

- The main gases are ammonia, carbon dioxide, hydrogen sulfide, phosphorated hydrogen and methane.
- In early stages, these gases are non-inflammable; later on with the formation of enough hydrogen sulfide, the gases become inflammable.
- Due to continued accumulation of gases, there is distention of breast in females, penis and scrotum in males (Fig. 8.3).
- Abdomen gets distended due to accumulation of gases in the intestines. Diaphragm is pushed up compressing the lungs and heart; blood stained frothy fluid exudes from the mouth and nostrils, which is called "***postmortem purge***" (Fig. 8.4) (the secretions present inside the lung parenchyma are pushed out by the increased abdominal pressure). This can be mistaken for antemortem findings of pulmonary edema or drowning.
- Involuntary urination, defecation, seminal ejaculation and delivery of dead fetus occur at this stage.
- Gas bubbles accumulate in all the tissues; subcutaneous tissues become emphysematous.
- Eyes bulge out from their sockets; tongue is forced out between the swollen lips.
- Due to the formation of gas blebs, blisters appear between the epidermis and dermis all over the body.
- Epidermis becomes loosened (skin slippage) producing large, fragile sacs of clear or pink red serous fluid. These blisters gradually enlarge, join together and rupture, exposing large areas of slimy pink dermis.

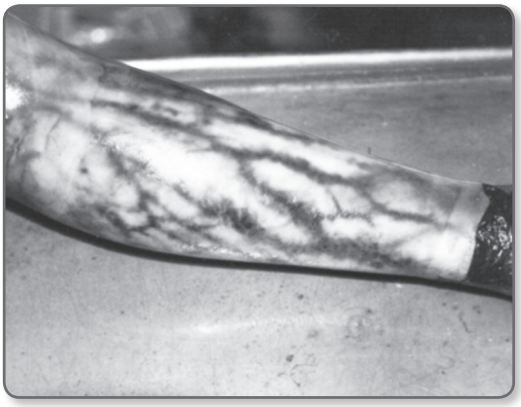


Fig. 8.2 Marbling of veins (36 to 48 hours) in lower limb – well evident after skin slippage, TSD is 2 to 3 days

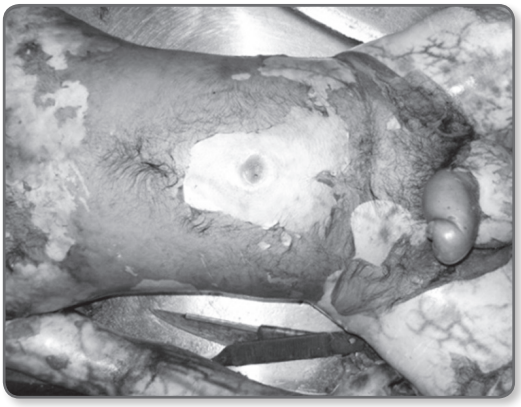


Fig. 8.3 Distension penis and scrotum with peeling of cuticle and marbling, TSD 2 to 3 days

Fig. 8.4 Postmortem purge with distension of face and abdomen, TSD 36 to 48 hours

- By three days, the face becomes discolored, bloated and distorted that identification becomes very difficult.
- The muscles become soft, lose and are converted into a thick semisolid pinkish mass and are gradually separated from the bones by around 2 weeks.
- The cartilages and ligaments are softened in the final stage of decomposition.

Liquefaction of tissues: (Colliquative putrefaction)

- Colliquative putrefaction begins from 5 to 10 days.
- The abdomen bursts and contents of abdomen come out of the cavity.
- The omental, mesentric and peritoneal fat liquefy into a translucent, yellow fluid filling the body cavities between the organs.
- All encapsulated internal organs are converted into bags of putrid fluid and subsequently burst open into the thoracoabdominal cavity.
- The rate of putrefaction of the individual organs depend on the enzyme content, water content and blood supply of the organs. Adrenals and pancreas are the first organs to undergo putrefaction; followed by stomach and intestines; next, the spleen and liver (due to more blood present inside them); then the lungs and later the heart undergoes putrefaction.
- Liver becomes softened and flabby in 24 hours. During the phase of accumulation of gases, multiple blisters appear in the liver, which on cut section appears as yellowish-gray, dendritic figures in the parenchyma in 2 to 3 days; which is called "**foamy**" liver or "**honey-combed**" liver.
- Kidneys and urinary bladder putrefy relatively late.
- Prostrate in males and uterus in females are the last internal organs to undergo putrefaction due to presence of large amount of fibrous tissues.

Skeletonization:

- In an exposed body, flies, maggots, ants, cockroaches, rats, dogs, vultures etc. may reduce the body to skeleton in a few days (Fig. 8.7).
- When the body is in water, it may be attacked by fishes, crabs, etc. and the body is skeletonized within a few days (Fig. 8.6).
- In case of unconfined body buried in a shallow grave, there is moderate delay of putrefaction.
- If deeply buried, due to low temperature and lack of air circulation, the process of putrefaction gets delayed.
- The main factors affecting skeletonization are seasonal and climatic variations, moisture content of the soil, presence and absence of air circulation and pH of soil.
- In India, an unconfined buried body is reduced to skeleton within one year.
- In case of bodies placed in airtight coffins, decomposition may not occur for several decades.

Fig. 8.5 Face distorted, tongue pushed out and bitten between the teeth; skin peeled off and hair easily pulled out; TSD is 3 to 4 days

Fig. 8.6 Body recovered from water; lips eaten by aquatic animals (Postmortem injury)

Fig. 8.7 Fully grown maggots drilling into the skull cavity through the separated sutures; TSD is 5 to 7 days

8. What are the conditions affecting the rate of putrefaction?

Short notes: Casper's dictum

External Factors:

i. Temperature
ii. Moisture
iii. Air
iv. Clothing
v. Manner of burial

i. **Temperature:** Even though putrefaction begins to set in above 10°C, the optimum temperature is between 21 to 38°C; putrefaction is completely is arrested if the temperature is below 0°C and above 48°C.

ii. **Moisture:** Moisture is necessary for putrefaction.
Bodies recovered from water, if left in the air decompose rapidly. Organs which contain water decompose more readily than the dry ones.

iii. **Air:** Free movement of air hastens putrefaction.

iv. **Clothing:** Initially clothings enhances putrefaction by maintaining body temperature. But later on, the clothing delays putrefaction by preventing the access of airborne organisms, flies and insects. Putrefaction is delayed under tight garments (belts, socks, undergarments, boots, etc.) which drive out the blood from that part of the body and thereby prevent the entry of bacterial organisms.

v. **Manner of burial:**
Putrefaction is delayed: (i) When the bodies are buried soon after death; (ii) If buried in dry, sandy soil or in a grave deeper than 2 meters; (iii) In coffined bodies (exclusion of air, water and access for insects); (iv) Salt and lime markedly delay putrefaction.
Putrefaction is rapid: (i) In a body buried in a damp, marshy or shallow grave; (ii) In porous sandy soil, than in soils with excess of clay; (iii) More rapid if changes of decomposition are already present at the time of burial; (iv) In acidic soils even the bones may be destroyed.

Internal factors:

i. **Age:** Bodies of children putrefy early than the old people.
Bodies of new born that have not been fed decompose slowly; if fed before death or if there are any injuries on the body, then the process of decomposition is rapid.

ii. **Sex:** No significant difference in the rate of putrefaction between male and female. But females due to their high fat content may retain the body heat for long time (fat is a bad conductor of heat and hence may prevent the body from cooling) thus favouring the process of putrefaction.

iii. **Condition of the body:** Fat bodies putrefy quickly than lean bodies, due to larger amount of fluid, excess fat and greater retention of heat.

iv. **Cause of death:**

- Putrefaction is rapid in persons dying from Septicemia, peritonitis, inflammatory and septic conditions and asphyxia (abnormal fluidity of blood helps the spread of bacteria).
- Putrefaction is rapid in infection due to *C. welchii* e.g. acute intestinal obstruction, abortion and gas gangrene.
- Putrefaction is delayed if death is due to:
(i) Wasting diseases, anemia and debility (less blood prevents spread of the bacteria), (ii) Poisoning by phenol, zinc chloride, strychnine and chronic heavy metal poisoning (arsenic, lead, mercury).

v. **Mutilation:** Bodies with wounds putrefy rapidly, as it allows easy access of bacteria and

flies. In dismemberment, the limbs putrefy slowly and the trunk putrefies rapidly.
- In advanced putrefaction, no opinion can be given as to the cause of death, except in cases of poisoning, fractures, fire arm injuries, etc.

Putrefaction in water:
Putrefaction is delayed when a body is lying deep in water and covered by clothing.
- Casper Dictum

1 : 2 : 8
Air : water : earth

Rate of putrefaction is low in water than in air; more rapid in warm fresh water than in cold salt water; still lower when buried under the earth.

9. What are the modified forms of putrefaction? Short notes on adipocere and mummification.

i. **Adipocere: (Saponification)**
- This is a modified form of putrefaction.
- The fatty tissues of the body change into a substance similar to soaps, known as adipocere.
- Commonly seen in bodies immersed in water or in damp warm environment.

Mechanism:
- Gradual hydrolysis and hydrogenation of preexisting fats, such as olein, into higher fatty acids, which combine with calcium and ammonium ions to form insoluble soaps.
- These soaps being acidic in nature inhibit the putrefactive bacteria.
- The body fat is converted into palmitic, oleic, stearic and hydroxystearic acid by the fat splitting enzyme lecithinase, produced by Clostridia group of organisms, mainly *Clostridium perfringens*.
- The water required for hydrolysis is obtained mainly from the body tissues.
- If the body is in water, this fluid contributes to the hydrolysis of the subcutaneous fat. Water also helps to remove glycerin which is formed during hydrolysis of fat.
- Both moisture and heat are important for the formation of adipocere.

Properties
- Adipocere has a distinct offensive or sweetish odor. In the early stages, a penetrating ammoniacal odor is noticed.
- Fresh adipocere is soft, moist, whitish, translucent, greasy and resembles pale rancid butter.
- After some years, it becomes dry, hard cracked, yellowish and brittle.
- It is inflammable and burns with a faint yellow flame.
- Floats in water and dissolves in alcohol and ether.

Distribution
- It can occur at any site, where fatty tissue is present.
- First subcutaneous fat gets converted into adipocere. Adipocere change usually partially affects face, buttocks, breast and abdomen. Occasionally the whole body may be affected. The epidermis disappears as the process of adipocere formation advances.
- Initially, it appears as multiple whitish grey rounded outgrowths varying from 1 to 10 cm in diameter. Which join with each other to cover the entire body at a later stage.
- In adipocere, the liver looks prominent and retains its shape.
- The gross features and histological appearance of the organs can sometimes be appreciated.

Time required for adipocere formation
- The minimum time required is 3 weeks in summer.
- Process of stiffening, hardening and swelling of fat occurs over a period of months.
- In most cases, the change is partial and irregular.
- Complete conversion in an adult limb requires at least 3 to 6 months.
- Obese individuals with more fat content and mature new born form adipocere rapidly.
- Non-viable fetus does not show this change.
- Adipocere may persist for years or decades.

Medicolegal Importance
- The morphological features are well preserved and help to establish the identity of the individual.
- Cause of death can be made out as the injuries are usually well preserved.
- Time since death can be assessed based on the stage and extent of adipocere.

ii. **Mummification:**
- It is a modified form of putrefaction which produces dehydration, drying and desicca-

tion, and shriveling of the cadaver. Occurs due to evaporation of water content in the body.
- It begins in exposed parts of the body like face or limbs, and then extends to the entire body including the internal organs.
- Skin is shrunken and contracted, dry, brittle, leathery and rusty brown in color and stretched tightly over the bony prominences such as cheek, chin, ribs, hip and adheres to the bone.
- Mummification may be partial in some cases, with only head or limb being affected.
- Internal organs become black, shrunken, hard, and become a single mass.
- Body loses weight, becomes thin, stiff and brittle.
- Mummified bodies if protected can be preserved for years; mummified bodies are practically odorless.
- Marked dehydration before death favors mummification.
- It takes 3 months to 1 year for the entire body to be mummified.
- Absence of moisture, continuous action of dry warm air is necessary for this process. For example, the mummies in Egypt.
- Mummification of new born may occur if left in a trunk or cupboard.
- Mummification occurs in bodies buried in shallow graves in dry sandy soils.
- Chronic arsenic and antimony poisoning favors the process of mummification.
- Occasionally some parts of the body show mummification and some parts may undergo putrefaction or even adipocere formation (especially when part of the body is in water).

Medicolegal Importance:
- Features are well preserved, and help to establish the identity.
- Cause of death can be made out as the injuries are preserved.
- Time since death can be assessed, based on the extent of mummification.

10. Write short notes on entomology of cadaver.
- Flies lay eggs on the fresh corpse, in the moist areas of the body, e.g. eyelids, nostrils, angle of mouth, etc., soon after death.
- Once skin decomposition begins, eggs are laid down anywhere on the body.
- Larvae and maggots are produced from the eggs in 8 to 12 hours.
- These maggots crawl into the interior of the body and produce powerful proteolytic enzymes and destroy the soft tissues.
- Maggots become pupae in 4 to 5 days. They become adult flies in another 3 to 5 days.

Medicolegal importance:
- To estimate the time since death based on the stage of development of the insect.
- To identify the cause of death, in certain poisoning cases.
- To corroborate the scene of crime, by identifying the species of the insect.

11. What is time since death?
Enumerate the various factors useful in estimating the time since death.
- The time interval between time of death and the time of conducting autopsy is called the time since death (TSD).
- The exact time of death cannot be fixed in any case, but a range of time between which death was presumed to have taken place, can be estimated. It is more of a scientific guess, rather than a precise opinion.
- The longer the postmortem interval, less accurate is the estimated time since death.
- Determination of TSD is an indispensable component of Corpus Delicti.

Estimating the time since death is important as:
- To know when the crime has been committed.
- A starting point for the Police in the investigation of the crime.
- Exclude some subjects and to search for the likely culprit.
- To check on a subject's statement.

To give opinion on time of death:
- Go through all the available history.
- Local physical and environmental factors at the scene of crime (e.g. fire, open windows, environmental temp, etc.)

External examination:
- The body thoroughly examined for:
  (i) Algor mortis (cooling of the body)
  (ii) Livor mortis (postmortem staining)

Table 8.3 Postmortem changes and the approximate TSD (Hot climate)

Postmortem changes		Time in hours
1.	Body warm, transparent cornea	Within 1 hour
2.	Postmortem lividity in patches	2 to 3 hours
3.	Body cold, uniform PMS and fixed; RM in upper parts of body	6 to 8 hours
4.	Rigor mortis all over the body	Around 12 hours
5.	Body cold and stiff, eggs and flies; Greenish discoloration in the right iliac fossa	12 to 24 hours
6.	Rigor mortis passing off and abdominal distension	24 to 36 hours
7.	Greenish discoloration on abdomen and chest, marbling; distension of abdomen and thorax; PM blisters and maggots	36 to 48 hours
8.	Whole body bloated, face unrecognizable; nails and hair easily pulled off; grown maggots/pupae all over body (Fig. 8.5)	3 to 5 days
9.	Colliquative putrefaction, internal organs are reduced to black unrecognizable pultaceous mass; most of the soft tissues disappear; prostrate and non-gravid uterus recognizable	2 weeks
10.	Skeleton exposed bare	1 to 3 months

(iii) Rigor mortis (cadaveric rigidity)
(iv) Decomposition and/or its modifications
(v) Entomology of cadaver (maggots).

On internal examination of the body:

i. ***Stomach emptying time:***

- Stomach starts emptying within 10 minutes
- Bulk of the food is emptied in 2 hours
- Light meal in 2 hours; Medium meal in 3 to 4 hours; and heavy meal in 5 to 6 hours.
- Digestion is delayed in sleep and suspended in coma
- Emotional disturbances cause hypermotility and can result in rapid emptying
- Diet rich in carbohydrate empties faster than proteins, which is faster than fat.
- Head of the meal reaches hepatic flexure in 6 hours; Splenic flexure in 9 to 12 hours; and Pelvic colon in 12 to 18 hours.
- If stomach is full and contains undigested food, the time since death would be approximately 2 to 4 hours.

ii. ***Urinary bladder: Bladder emptying time:***

- Average urine volume of a healthy adult is 1.5 liters/day half of which occurs at night.
- Depending upon the volume of urine in the bladder a rough estimate of time of death can be made out. The rate of formation of urine in an adult is 1 mL/minute; the amount of urine present in the bladder will indicate the approximate time of death, if the previous bladder emptying time is known.
- If the bladder is full it can be said that the individual has lived for a reasonable period of time after going to bed. (Since its customary with most people to evacuate the bladder before going to bed).

Other useful indicators which can be assessed only by laboratory techniques are:

i. ***Cerebrospinal fluid:***

- Lactic acid concentration raises from 15 mg% to 200 mg% in 15 hours
- Non-protein nitrogen shows steady raise 15 mg% to 40 mg% in 15 hours
- Amino acid evenly raises from 1 mg% to 12 mg% in 15 hours.

Depending upon the rate of increase the approximate time of death can be assessed.

ii. ***Blood:***

- Potassium, phosphorus, magnesium increase after death.
- Sodium and chloride—decrease after death
- Other compounds the concentration of which increase after death are: Non-protein nitrogen, amino acid nitrogen, lactic acid and bilirubin.

- Certain enzymes like acid phosphatase, alkaline phosphatase, amylase, lactic dehydrogenase also increase after death.

iii. ***Bone marrow:***

- During life up to 40% of cells are neutrophils
- After death, nuclei begin to swell within 1 hour; becomes round in 4 hours; formation of vacuoles in the cytoplasm, cell outline becomes obscure in about 10 hours.

iv. ***Vitreous humor:***

- Gradual increase in potassium and reduction in sodium occurs for the first 85 hours (3 to 4 days) after death.
- The level of glucose and pyruvic acid decreases and lactic acid increases after death.

v. ***Hair growth:***

- During life, hair grow at the rate of 0.4 mm/day. After death hair and nails stop growing. If the time of last shave is known, then an approximate interval of the time of survival can be made out.

vi. ***Non-scientific data:***

- Examination of scene of crime for time since death: Certain scene markers like newspapers, dates on a postal mail, the degree of coagulation of milk, state of food on a table will indicate the approximate time since death.
- If the body lies on growing grass, underlying grass and vegetations soon dries and turns yellow or brown. This will indicate how long the body was lying at the scene.

vii. ***Carbon dating: (Radioactive carbon)***

- C14 content of the bone is steadily maintained during life.
  After death, radioactivity of C14 gradually weakens with the half life being 5,600 years.
  Radioactive carbon dating is useful only for cases which date back to several centuries; it is not useful for the bones which are less than a century old.

12. What is presumption of death?

- Arises in connection with civil cases.
- A person is presumed to be alive, if there is nothing to suggest the probability of his death within 30 years. But, if proof is produced that the same person is not been heard of for 7 years by his relatives and friends; then death is presumed.

13. What is presumption of survivorship?

- Arises in connection with inheritance of property.
- When two or more persons die in a common disaster. For example, earthquake, plane crash, etc. The question of who survived longer, may arise. The case is decided on facts and evidences available. In the absence of such evidence, age, sex, built, nature and severity of injuries and the mode of death are taken into consideration, in deciding the survivorship.

CHAPTER 9

Violent Asphyxial Deaths

Keywords: Asphyxia, asphyxial triad, hanging, strangulation, throttling, drowning, dry drowning, hydrocution, lynching, burking, bansdola, mugging, garroting, choking, suffocation, smothering, traumatic asphyxia, autoerotic asphyxia.

1. Define asphyxia. What are the causes of mechanical asphyxia?
How do we classify mechanical asphyxial deaths?

- Asphyxia is the interference of respiration due to any cause, i.e. mechanical, environmental or toxic, resulting in failure of intake of oxygen by the tissues together with failure to eliminate carbon dioxide.
- Asphyxia literally means pulselessness. But in forensic context and everywhere in medical science, asphyxia means lack of oxygen.

Causes of asphyxia

- There are various ways which result in asphyxia; they are grouped according to their mode of causation.
  (i) Closure of external orifices: Smothering.
  (ii) Compression of neck: Hanging, strangulation, throttling, bansdola, mugging and autoerotic asphyxia.
  (iii) Occlusion of air passage from within: Gagging, choking and café coronary.
  (iv) Lack of oxygen in the atmosphere, or inhalation of irrespirable gases: Suffocation.
  (v) Restriction of movement of the chest or abdomen: Traumatic asphyxia, burking and overlaying.
  (vi) Prevention of gas exchange in the lung by fluids: Drowning.
  (vii) Inability to utilize oxygen by peripheral tissues: Cyanide poisoning.

Mechanical asphyxia:

Asphyxia due to mechanical force. The causes of mechanical asphyxia are classified into:

i. ***Obstructive causes:*** Smothering, gagging, choking and café coronary.
ii. ***Constrictive causes:*** Hanging, strangulation, throttling, lynching, bansdola, mugging and garroting.
iii. ***Restrictive causes:*** Traumatic asphyxia, burking and overlaying.
iv. ***Replacement causes:*** Drowning.

- ***Chemical asphyxiants:*** Carbon monoxide and cyanide poisoning: Even though these poisons cause death by asphyxia, they are discussed under toxicology and only death due to mechanical asphyxia would be discussed in this chapter.

2. What are the signs of asphyxial deaths?
State classical signs of asphyxia; Asphyxial triad.

Classical signs of asphyxia:

Any way be the causation of asphyxia, it leaves certain signs on the body. They are not specific to asphyxial deaths alone, but invariably present is most cases of asphyxia and are hence called

as the classical signs of asphyxia. They are also commonly referred to as "**asphyxial triad**" and these are:

i. Cyanosis
ii. Congestion of organs (Fig. 9.3)
iii. Petechial Hemorrhages.

Non-specific signs:

- Abnormal fluidity of blood
- Dilatation of right chambers of heart.

Specific sign:

- Specific sign indicates the exact way in which the fatal chains of events were initiated.

Example:

i. Ligature mark on the neck in hanging and ligature strangulation,
ii. Finger nails abrasions on the neck in manual strangulation (throttling),
iii. Fluid in the air passage in drowning,
iv. Food bolus in the larynx in café coronary, etc.

Classical signs of asphyxia:

i. ***Cyanosis***

- The color of oxygenated blood is scarlet red. When the hemoglobin is not fully saturated with oxygen, then it is said to be reduced and the blood assumes a blue color, which is termed as "cyanosis".
- For cyanosis to be evident externally, there should be at least 5 g of reduced hemoglobin per 100 mL of blood. Cyanosis is well-appreciated in the peripheries like fingernails, lips and tongue and hence it is common use to say "peripheral cyanosis."

ii. ***Congestion***

- Collection and stasis of blood due to obstruction of venous return is called as congestion. When the neck is compressed as in hanging, due to defective venous return, there is congestion of the face, as well as in all the internal organs.
- Congestion is associated with tissue swelling, if there is continued venous obstruction. Prolonged congestion leads to edema of the visceral organs.
- When circulation stops completely, the walls of the capillaries become permeable resulting in exudation of fluid from the capillaries into the neighboring tissues leading to edema.

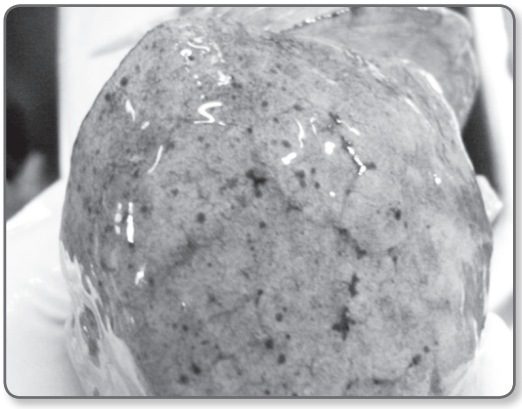


Fig. 9.1 Sub-pleural petechial haemorrhages on lungs

Fig. 9.2 Petechio-ecchymotic haemorrhages on the heart and left auricle

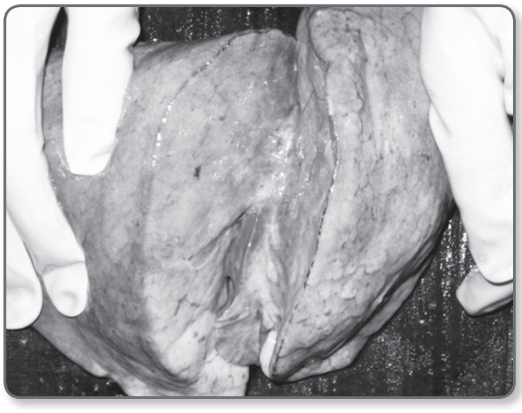


Fig. 9.3 Severe congestion of lungs with petechiae on the inter-lobar surface

iii. ***Petechial hemorrhages***

- Progressive increase in the venous pressure will lead to rupture of post-capillary venules. This leads to escape of blood producing small bleeding points, varying from pinpoint to pinhead size. They are called as petechial hemorrhages.
- They are readily appreciated on the serous membranes such as sclera, conjunctiva, pleura and the pericardium.

3. Define hanging. What are the types of hanging and causes of death in hanging?

Definition:

- **Hanging** is a form of asphyxia caused by suspension of the body by a ligature around the neck. The constricting force being his own body weight.
- Hanging is the preferred method of choice for committing suicide and is said to be a relatively painless form of death. **Hanging is almost always suicidal, unless proved otherwise.**
- ***Note:*** Suicide note is present in many situations and in some female cases, a note regarding the reason for committing suicide and details of individuals who were responsible in forcing her to commit suicide may be hidden inside the inner garments and are recovered during autopsy. If any such documents are recovered, they are handed over to the police with acknowledgement after retaining a copy of those recovered documents.

Types of hanging

I. Depending on the degree of suspension, hanging is divided into:.
   (i) *Complete hanging:* The entire body is suspended and no part of the body touches the ground. Hence, the whole of the body weight acts as the constricting force.
   (ii) *Partial hanging:* The whole body is not suspended and some part of the body is in contact with the ground and the constricting force is only part of the body weight. Example: The feet are in contact with the ground; the individual is in kneeling position or in lying position with only the head hanging out.

II. Depending on the position of the knot, it is divided into typical and atypical hanging.
   (i) *Typical hanging:*
   – The ligature passes symmetrically on both sides of the neck toward the point of suspension and the knot is at the nape of the neck. The head will be flexed and bent forward.
   – The maximum pressure exerted by the ligature is directly opposite to the point of suspension and death is presumed to be purely due to asphyxia, and hence called as typical hanging.
   (ii) *Atypical hanging:*
   – When the knot is at any place other than the nape of the neck, i.e. below the ears, below the chin, behind the mastoid process, etc.
   – The position of the head is tilted toward one side, opposite to the point of suspension.
   – Death may not be due to asphyxia; it could be due to compression of jugular, carotids or trachea only on one side, whereas, on other side blood may continue to flow.

Causes of death in hanging

i. Asphyxia: Due to constriction of the trachea.
ii. Venous congestion: Due to occlusion of jugular veins.
iii. Combined asphyxia and venous congestion: Combination of the above two. Combined asphyxia and venous congestion is the cause of death in 90% cases.
iv. Cerebral Anemia: Due to constriction of carotid and vertebral arteries.
v. Reflux vagal inhibition: When the ligature material rubs over the carotid sheath, there is stimulation of carotid body which leads to reflux vagal inhibition, resulting in sudden stoppage of heart.
vi. Fracture dislocation of cervical vertebra: Occurs only in judicial hanging or hanging accompanied with a long drop (6 to 8 meters) and the knot is below the chin. Here the maximum pressure is exerted on the cervical vertebrae as a result of sudden drop accompanied by the weight of the body. This leads to dislocation and instantaneous fracture at the level of C2, C3 cervical vertebrae, with

corresponding injury to the spinal column. In this condition, death is instantaneous.

Delayed deaths in hanging:

- When hanging attempt is foiled by timely intervention and resuscitation, the hypoxic and ischemic effects to the brain and brainstem will lead to delayed deaths of the individual. In such cases, death is due to:
  (i) Infection
  (ii) Edema of larynx and lungs
  (iii) Hypoxic ischemic encephalopathy
  (iv) Infarction of brain
  (v) Brain abscess
  (vi) Cerebral softening and liquefaction.

4. Describe the postmortem findings in a case of death due to hanging? Add a note on postmortem hanging and lynching.

Postmortem appearance

- All the classical signs of asphyxia namely, peripheral cyanosis, visceral congestion and petechial hemorrhages are present in most of the cases of death due to asphyxia.

Ligature mark:

- The compressing force of the ligature material results in the production of an injury around the neck in the form of a pressure abrasion.
- The ligature leaves a furrow of its own width and pattern. It develops due to the pressure exerted by the ligature material on the skin surface.
- The bed of the ligature mark is pale and dry; pressure exerted by the ligature material pushes the blood from the underneath skin surface and the tissues become pale. Later on with the passage of time, it becomes parchmentized due to the effect of drying.
- The edges are abraded (reddish-brown): Due to the frictional force between the skin and the ligature material. Ecchymosis and congestion of adjacent skin may be seen.
- The pattern of the ligature material often gets imprinted on the skin surface as a pressure abrasion/imprint abrasion (Fig. 9.6).
- The ligature mark is usually situated at the upper border of the neck, above the thyroid cartilage, just below the chin. It runs obliquely upward and backward, symmetrically on both sides of the neck, toward the point of suspension/the knot.
- **Microscopically,** the ligature mark displays the usual characteristics of abrasion, showing desquamation and flattening of cells of the epidermis.
- If death has occurred quickly, evidence of vital reactions at the margins of the ligature mark may be difficult to demonstrate even by microscopy.

Other external findings

- Face is congested, with cyanosis of lips and nail beds.
- Post-mortem staining will be seen over the distal part of both upper and lower limbs

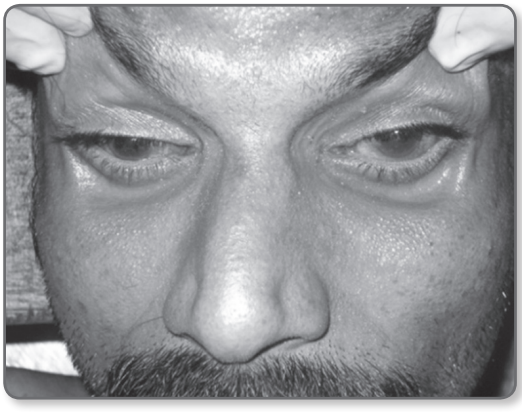


Fig. 9.4 Sub-conjunctival haemorrhages – a case of hanging

Fig. 9.5 Ligature abrasion of hanging – Running obliquely upwards towards the point of suspension

Fig. 9.6 Imprint ligature abrasion – Note: The twisting pattern of the nylon rope imprinted on the skin

Fig. 9.7 Dried salivary stains on the chest and abdomen – Note: The loss of epidermis produced by ants crawling on the dried stains exposing the pale base, indicating the postmortem nature

of the body. This can be appreciated only if the body was in the suspended position for a minimum period of 4 to 6 hours. This type of distribution of postmortem staining is called "***glove and stockings fashion***" of postmortem hypostasis. Petechiae in the lower limbs, if the body is suspended for a long time (8 to 12 hours).

- Neck is elongated and the head is tilted toward one side away from the knot.
- Tongue may be protruded and bitten.
- **Salivary stains** at the angle of mouth: Diagnostic of antemortem hanging and could be present in 40 to 60% cases. When the ligature material rubs over the sub-mandibular salivary glands, there is increased salivary secretion, which could be found dribbled and dried along the angle of mouth of one side, when the head is tilted opposite to the point of suspension (Fig. 9.7).
- In my postgraduate dissertation study and further experience (nearly 1000 cases of hanging), the salivary stains were present in nearly 40% cases. Author has seen many cases where there were ants crawling along a line on the front of chest, after washing the body, we could notice the underlying dried salivary stains could be, dribbled from the angle of mouth. Hence, a careful search for this finding of dried salivary stains will help to confirm a large number of cases as antemortem hanging (Fig. 9.8).

Fig. 9.8 Postmortem ant bite marks – Note: Frequently mistaken for antemortem irregular abrasions

- **Le facies sympathique**: If the knot presses on the cervical sympathetic ganglia, the eye on that side may remain open and the pupil dilated; the eyes on the other side will remain partially open or closed (Fig. 9.3). This is very rare and observed in less than 1% cases, but if present it is also a surest antemortem sign of hanging.

Neck dissection

- Neck is examined after removal of the brain, thoracic and abdominal contents (bloodless field of dissection).
- Superficial incisions of the ligature grooves may show small hemorrhages in the

underlying layers of the skin, caused by direct trauma.
- Extravasation and bruising of the muscles of the neck may be present, especially over the sternocleidomastoid and platysma. The intima of the carotid arteries may show transverse tears (splits) with extravasation of blood in their walls. These changes are due to the traction effect of the body with the ligature material.
- The subcutaneous tissues immediately above and below the ligature mark are congested.
- The tissues underneath the ligature mark are pale and parchment-like.
- The lymph nodes of the neck above and below the ligature mark show evidence of congestion, stasis and hemorrhage. This is also a useful finding of antemortem hanging.

Hyoid bone
- The relevance of fracture of the hyoid bone in hanging is minimal. It only signifies that there was external compression over the hyoid bone.
- Hyoid bone is a highly compressible bone and hence fracture occurs only occasionally; fracture is more common above the age of 40 years as the bone gets calcified in old age and the flexibility is restricted.
- The commonest pattern of fracture is outward fracture (abduction fracture) which is due to antero-posterior compression. The broken piece of bone has an outward angulation.
- Case studies have shown that the incidence of hyoid bone fracture is relatively high when: (i) the ligature material is a hard material like rope or string; (ii) the ligature material should directly compress the hyoid bone, and (iii) the longer the period of suspension of the body, the chances of fracture is increased. From this it is evident that the hyoid bone fracture should not be given much importance, it only indicates that there has been some pressure over the hyoid bone and no information regarding whether death is due to hanging could be made out from the fracture of hyoid bone. But the fracture of hyoid bone is more common in throttling, as there is direct pressure over the hyoid bone. In any fracture, the antemortem nature should be checked; extravasation of blood and if necessary benzidine test and histopathology.

Effects of decomposition on ligature mark:
- In any case, decomposition alters the findings, mainly the external injuries; but though ligature abrasion is a superficial injury fortunately resists putrefaction for a reasonable period of time. During the process of compression of the neck, the blood underneath the ligature abrasion is pushed away from those areas and hence putrefaction is markedly delayed on the ligature abrasion.

Lynching:
- Homicidal hanging of a person by the mob in the public is called as lynching.
- The person who is suspected to be involved in heinous crimes like dacoity, murder, or sexual assault (especially on the white people) is over powered by the mob, and hanged forcefully in the public to raise fear among the public. This was in practice in the ancient period and the aim of committing lynching is to raise fear among the public and as a deterrent to the society in committing such grave crimes.

Postmortem hanging: (Postmortem Suspension)
- Occasionally, after a victim has been murdered by some other means the body may be suspended to simulate suicidal hanging.
- Findings of asphyxia will not be evident and the actual cause of death may be easily made out during autopsy. Postmortem nature of ligature abrasion has to be differentiated and confirmed by the presence of vital reactions and HPE, if necessary.
- When the victim is killed by throttling or ligature strangulation and then suspended; signs of asphyxia will be present and hence difficulties do arise. But a careful observation may reveal fingernail abrasions in throttling and horizontal complete encircling ligature abrasion in cases of ligature strangulation. Also, internal neck dissection (bloodless field) will be highly rewarding and most cases could be solved on the autopsy table itself.

Fibers of ligature material:
- Presence of fibers of ligature material in the hands of the victim indicates that the victim has handled the material either while com-

mitting suicide or by struggle to get rid of the constricting force during the process of death in hanging or strangulation. Absence of such fibers in the hands of the victim indicates that the victim has not touched the material at all, thus indicating postmortem hanging (especially when the material is a rope or clothing).

- In case of postmortem suspension, examination of the upper surface of the branch of the tree or beam (point of suspension) will indicate the direction of traction force. In such situation, the ligature material is first tied around the neck and is pulled from the opposite side to suspend the body. The direction of markings made by the fibers of the ligature material at the point of suspension will be away from the body (anti-clockwise). Whereas, if it is a case of suicidal hanging, the markings will be in a clockwise direction. This finding may occasionally be helpful in postmortem hanging.

5. What is strangulation? Discuss about ligature strangulation.

- It is a form of violent asphyxial death accomplished by application of external force to constrict the neck, either by hands (**manual strangulation/throttling**) or by a ligature material (**ligature strangulation**) or by any other means.
  - There is no suspension of the body in strangulation and hence the constricting force is not the victim's own body weight rather external compression by an assailant.
  - Ligature strangulation is mostly homicidal, occasionally accidental and rarely suicidal (but a person cannot successfully commit suicide by throttling).
- Sometimes, death may occur due to sudden vagal inhibition without leaving any signs of asphyxia on the body.
- Symptoms of **ligature strangulation:**
- There is complete occlusion of air passage due to sudden compression of the neck. Unconsciousness develops very quickly and instant death is common, since the victim is overpowered by the perpetrator and evidence of struggle may or may not be present.
- In incomplete occlusion for a longer duration, there will be intense cyanosis and congestion of the face, bleeding from the mouth, nostrils and ears may be seen.

Causes of death

- Asphyxia
- Cerebral ischemia
- Vagal inhibition: If death is due to vagal inhibition, evidence of asphyxia will not be present on the body.

Postmortem appearance in ligature strangulation

External appearance:

Ligature mark:

- The ligature mark is well-defined and grooved. The intensity and the pattern depend on the amount of force exerted by external compression and the ligature material used.
- It is usually situated at or below the level of the thyroid cartilage.
- It completely encircles the neck, without any discontinuity.

Fig. 9.9 Ligature abrasion of strangulation – Note: The ligature abrasion is horizontal and is present at a lower level on the back of neck and does not merge with the hairline as in case of hanging. The body was recovered after 2 days from the sea shore at a distance 10 km from the place of disposal. Case was brought for autopsy as a case of accidental drowning. Ligature abrasions are relatively resistant to putrefaction

- The direction of the ligature is horizontal or horizontally oblique, with crossing over to the opposite side. In some cases, the ligature material will be encircling the neck several times producing more number of markings and many a times there may be evidence of more than one knot.
- The direction of the ligature mark depends on the relative position of the assailant and the victim at that time of strangulation. (i) It will be horizontally oblique, if the victim was in lying position; (ii) horizontal, when both the victim and the assailant are in standing posture; and (iii) **oblique** if the victim was sitting and the assailant standing behind and also when the victim is dragged from behind.
- The margins of the ligature mark will be reddish, ecchymosed and the base will be pale. With passage of time, the ligature abrasion becomes dry, hard, parchment-like.
- The pressure exerted on the neck by the ligature material produces an imprint abrasion.
- Abrasions and ecchymosis of adjacent skin will be more evident than in hanging.
- If the ligature material is soft and yielding or if it is removed soon after death, then the ligature mark may not be visible over the skin surface. In such situations, a second examination of the neck after several hours may show the presence of a faint pressure abrasion.
- If the ligature material is not present in situ and recovered later, the presence or absence of fibers from the ligature material over the ligature mark can be identified by application of adhesive cello tape and examination under the microscope for comparison.
- Accidental ligature strangulation: A scarf or dupatta may be caught in a moving fan, vehicle, machinery belt, etc. and can result in severe constriction of the neck and produce instantaneous death by ligature strangulation.

Asphyxial signs:

- All the classical signs of asphyxia will be more marked than in hanging.
- Eye balls may be open, prominent and congested with dilated pupils.
- Discharge of blood stained fluid may be seen over the mouth and nostrils.
- Intense congestion of face is usually present and multiple petechial hemorrhages over the forehead are a common finding.
- Tongue will be protruding, bitten by teeth, bruised, swollen and deeply cyanosed.
- Hands may be clenched. While the victim attempts to defend him by inserting his fingers in between the neck and the ligature material, nail scratch marks in the form of linear or crescentic abrasions can be seen over the neck and rarely cadaveric spasm may occur instantaneously at that moment.

Internal appearance:

- Excluding the neck, all the body cavities and visceral organs are examined first in order to get a bloodless neck field. This will also avoid introduction of artefacts in the neck field and the resultant misinterpretations.
- In case of ligature strangulation, evidence of bruising will be present on all the underlying layers of tissues; namely, the subcutaneous layer, muscles of the neck, tracheal rings and also on the posterior pharyngeal wall (Fig. 9.10).
- Since the pressure exerted by the ligature material is over the surface of the thyroid cartilage, fracture of the superior cornua of thyroid cartilage is relatively common in strangulation, with extravasation of blood in the surrounding soft tissues.

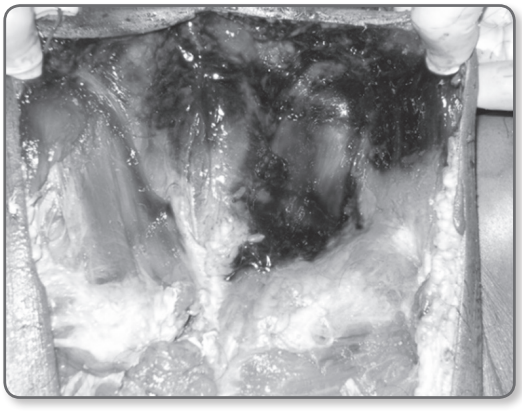


Fig. 9.10 Same case as (Photo 9) Extensive bruising of the neck structures in case of ligature strangulation as the constricting force is from outside

- Other internal organs like larynx and trachea show intense congestion, with frothy mucus and also petechial hemorrhages.
- Lungs show multiple hemorrhagic patches and petechiae over the surface, with marked congestion and emphysematous bullae. Presence of emphysematous bullae associated with congestion and petechiae indicates the agonal struggle of the victim.
- All the other internal organs will be congested and petechiae may be present.
- Involuntary discharge of urine and fecal matter may be seen in many cases.
- Since, ligature abrasion resists decomposition for relative period of time, cases of ligature strangulation can be positively solved even if the bodies are recovered a few days later.

6. How will you differentiate ligature abrasion of hanging from strangulation?

See Table 9.1

7. What is throttling? Discuss the postmortem findings in case of throttling. What are the difficulties encountered by the autopsy surgeon if some soft intervening material is used? Write short notes on throttling.

- Throttling (manual strangulation) is a form of violent asphyxial death, in which the assailant uses his hands to produce compression of the neck of the victim.

Autopsy findings:

- All the classical signs of asphyxia will be markedly evident.
- Petechial hemorrhages on the forehead are a frequent finding, indicative of more severe forms of violent asphyxia than hanging.
- Multiple pressure spots of bruising will be seen over the neck due to assailant gripping the neck with fingers.
- The fingernails of the assailant produce crescentic and linear abrasions on both sides of the neck. The victim also produces certain nail marks by himself during the attempt of struggle to relieve the assailant's hands from causing compression.
- ***Bruises:*** Usually circular, dark red or purple in color 1–2 cm size, resembling the shape of the finger tips. If fingers slide over neck then it can produce elongated bruises.
- ***In case of throttling by one hand:*** There will be bruise mark by thumb on one side and bruise marks of four fingertips on the other side. These bruise marks which are red or purple in the beginning may turn brown later on.

Table 9.1 Difference between ligature mark of hanging and strangulation

Features	Hanging	Strangulation
Level	At or above the level of thyroid cartilage, but mostly slips to the upper end of neck. The mark is usually absent at the back of the neck, as it merges with the hairline	In the middle part of neck, at or below the level of thyroid cartilage. The hairline is usually not involved and the ligature mark is always at a lower level
Direction	Symmetrically oblique, runs toward the point of suspension (Fig. 9.5)	Horizontal or horizontally oblique (Fig. 9.9)
Knot	A point of knot is present at the upper most point of the mark and sometimes the impression of the knot is present on the skin	Knot is not always present, there may be crossing over of the mark, or twisting or sometimes multiple knots
Discontinuity	There is always a length of discontinuity even in cases of noose knots, due to the pulling down effect of the body weight	There is no point of discontinuity (If there is a discontinuity then there can be no effective compression). There is crossing over at any one point or a firm knot is present
Multiplicity	Usually there is no multiplicity, even if present all these marks may not compress the neck and there is a good length of discontinuity at the point of suspension	Many a times there are multiple twist of the ligature material around the neck and all these completely encircle the neck

This way of using one hand is common when the victim is an infant.

- ***When both hands used for throttling:*** Corresponding thumb mark of one hand and four fingers of the other hand will be seen on either side of the neck.

Internal findings: Very important to do a bloodless field of dissection.

- On dissection of neck, evidence of bruising on the underlying subcutaneous soft tissues and neck muscles are seen, which correspond to the pressure abrasions present on the external skin surface (specific finding of death due to throttling).
- Signs of extravasation and bruising will be present over the tracheal rings and also on the posterior pharyngeal wall (as the posterior pharyngeal wall gets compressed over the hard vertebral column).

When some intervening soft material is used between the hands and the neck:

- External signs such as fingernail scratches and pressure abrasion exerted by the bulb of the fingers would be absent. Even then, signs of asphyxia would help to group the death as asphyxial death, followed by dissection of the skin and subcutaneous tissues layer by layer will reveal bruising of underlying layers of skin and bruising of the neck muscles. Also, fracture of hyoid bone and contusion of tracheal rings and posterior pharyngeal wall would be present to confirm death was due to throttling.

Hyoid bone:

- Hyoid bone fracture is relatively more common in throttling. There is inward compression fracture (adduction fracture) and the broken fragment of bone has an inward angulation, with extravasation of blood into the surrounding soft tissues.
- Evidence of struggle in the form of abrasions and bruises may be seen over the mouth, nose, cheeks and forehead, lower jaw, back of shoulders or any other part of the body.
- Sometimes fracture of the ribs and injuries to organs inside the chest and abdomen may be present, when assailant kneels or sits over chest.

8. What are the types of hyoid bone fractures?

- Hyoid bone may get fractured in any case of death due to compression of neck. Fracture of hyoid bone is common in throttling compared to hanging.

i. **Adduction fracture:**

- It occurs in throttling; the broken fragment has an inward angulation due to the force exerted by the fingers of the assailant.

ii. **Abduction fracture:**

- In cases of hanging and ligature strangulation, there is outward angulation fracture (abduction fracture) of the hyoid bone.
- This is due to anteroposterior compression exerted by the ligature material.
- The broken piece of bone has an outward angulation.

Antemortem nature of fracture:

- In any case of hyoid bone fracture, the antemortem nature of the fracture is confirmed by the extravasation of blood at the fractured site and into the surrounding soft tissues.
- It can be confirmed by benzedrine test. Histopathology may also be useful.

9. Write short notes on smothering.

Smothering is closure of the external orifices of respiration, namely the mouth and the nostrils with the help of hands or other objects like pillows, bed sheets and soft materials, etc. resulting in death due to asphyxia. The victim is usually an infant or intoxicated individual.

Autopsy findings:

- If bare hands are used for smothering, an area of paleness around the mouth and the tip of the nose will be present, with scratch abrasions on the nose and mouth. Evidence of nail markings can also be made out around the site of compression.
- These external signs may be absent if soft intervening materials such as a cloth or pillow are used to cause smothering. However, the internal findings of asphyxia will be evident irrespective of the method of smothering.
- All the classical signs of asphyxia like congestion, cyanosis and petechial hemorrhages will be present.
- In addition to these external signs, examination of the oral cavity will reveal bruising and

lacerations on the inner surface of the lips, even if soft intervening materials were used. These injuries are a result of the counter pressure exerted by the teeth. Bleeding gums, bruising of the gingival surface and injury to the tongue are commonly encountered.

10. Write short note on burking.

- Burking is a form of homicidal asphyxial death brought about by combination of smothering and traumatic asphyxia.
- It is named after William Burke and Hare, who used to murder the beggars by this method to supply dead bodies to the department of anatomy in a medical school.
- ***Method:*** In a grossly intoxicated individual, one will sit on the chest and hold the hands tightly by the side, while the other will firmly press over the mouth and nostrils and the result would be rapid asphyxia. Death is due to combined effects of traumatic asphyxia and smothering.

Autopsy findings:

- Signs of asphyxia namely cyanosis, congestion and petechial hemorrhages are present.
- Evidence of smothering mainly, bruising on inner surface of lips with lacerations due to counter pressure offered by the teeth will be evident.
- There may be fracture of ribs caused by the weight of the person sitting on the chest.
- Signs of resistance are minimal and drag marks in the form of abrasions over the back of shoulders and bony prominences may be present.

11. What is mugging?

- Mugging is a homicidal form asphyxia brought about by compression of the neck by the angle of the elbow or the knee, also by the pressure exerted by the foot of the assailant.

12. What is bansdola?

- It is a method of homicide, using bamboo sticks to bring about asphyxia. Two bamboo sticks are placed, one on the front of neck and the other on the back; one end is fixed by tying the two bamboo sticks together and the other end is slowly tightened with a rope, resulting in effective compression of the neck.

13. What is garroting?

- Garroting is homicidal form of asphyxia by applying a ligature around the neck, from behind the victim, when he is unaware.
- Hence, the victim is stunned followed by imminent loss of consciousness due to twisting the material quickly from behind.
- Since the victim is unaware, there is no evidence of any struggle as all the events unfold so quickly.
- By this way, it is possible to overpower even a healthy strong individual and kill him. Unfortunately, in these cases if the material is removed soon after death, then the ligature abrasion is faint that it may not be visible at all. Even then, the internal neck findings will be definitely helpful in finding out the cause of death as homicidal compression of neck.

14. What are the accidental forms of death due to asphyxia?
Write short notes on: Suffocation; café coronary; traumatic asphyxia; sexual asphyxia.

i. **Suffocation:**

- It is a form of asphyxia which is produced by inhalation of irrespirable gases. The common gases involved are hydrogen sulfide, methane, carbon monoxide, carbon dioxide, etc.
- Suffocation can also occur in high altitudes and decompression sickness.
- In suffocation the respired air contains very low concentration of oxygen, resulting in breathlessness and asphyxia.

ii. **Café coronary:**

- It is a misnomer; a grossly intoxicated individual while trying to eat a big bolus of food (meat) tries to speak or laugh and suddenly becomes pale, followed by unconscious and death.
- Due to gross intoxication, there is absence of gag reflux resulting in failure to swallow or cough out the bolus of food and the result is choking.
- It appears as if the person died due to sudden cardiac arrest and hence the name "café coronary."

Autopsy findings:

- The coronaries will be patent; signs of asphyxia will be evident and the bolus of food will be found impacted on the larynx resulting in choking of the respiratory passage.

iii. **Traumatic asphyxia:**

- Asphyxia produced as a result of restriction of movements of the chest and abdomen, as consequence of trauma is called as traumatic asphyxia.
- Examples of such incidence of traumatic asphyxia are:
  - Steering wheel impact in road traffic accidents: The steering wheel may get impacted over the abdomen, resulting in inability of movement of abdomen and chest. There is pronounced congestion above the level of impact and paleness below the level.
  - Stampede: In this, the individual gets trapped in a crowded place or falls down and the crowd of people stamps him, where it becomes improbable for the individual to breath with the weight of these individuals.
  - Fallen masonry: Falling of heavy objects like bricks, concrete slabs and other construction material on the chest and abdomen.
  - Falling of sand/rice bags on an individual.
  - Individual trapped in between two hard objects like heavy vehicles, heavy weight objects or machineries and in cases of collapsed buildings, where the individual gets trapped in between the two hard objects which prevent the movement of chest and abdomen.
  - An intoxicated well built adult over lies on an infant during sleep (**overlaying**)
- In all these circumstances, there is restricted respiratory movement due to external compression on the chest and abdomen.
- Signs of asphyxia will be markedly evident.
- There will be intense congestion mainly above the level of compression, cyanosis and multiple petechial hemorrhages seen both externally and internally.
- Injuries may or may not be noticeable.

iv. **Sexual asphyxia: Auto-erotic asphyxia:**

- It is presumed that the lowering of consciousness due to any cause such as drugs or partial compression of neck results in increased sexual pleasure by prolonging the time orgasm.
- People with perverted sexual behavior (masochist) partially asphyxiate themselves by compression of the neck, usually by hanging to go in for a transient period of unconsciousness to accomplish their aim of increased sexual pleasure by prolonging the time period of erection.

Method:

- In this method, a thick soft material is used as a pad to protect the neck. Then a ligature is applied over the pad, around the neck in the form of running noose, with one free end tied to the limb (elbow, wrist or ankle) after passing through some mechanical device like a pulley.
- The noose can be tightened by extending the arms or legs, and when consciousness is lost, the relaxation of the limb releases the pressure on the neck and the individual regains consciousness after a brief period of time.
- Occasionally the constriction may not get relieved; due to faulty function of the mechanical device or the noose getting entangled. In such a situation, death results due to asphyxia as a result of accidental hanging.
- Death is unintentional as indicated by the scene and the devices used.
- The diagnosis of sexual asphyxia can be made by examination of the scene of crime, which will show the presence of pornographic materials or literature near the body. The dead body may be partly or fully naked with female garments and costumes found nearby.
- The person may blindfold himself or stand in front of a mirror to watch the events. There may be evidence of recent seminal ejaculation.
- Old scars around the neck may be present, as evidence of previous episodes.
- These cases may be misdiagnosed as cases of suicidal hanging. Examination of the scene will reveal evidence of abnormal sexual behavior and evidence of such act practiced previously like grooves in rafter or doors.
- Findings consistent with suicidal hanging will be totally absent.

15. Define drowning. What are the types of drowning?
Discuss the mechanism of death in fresh water and sea water drowning.
What is hydrocution?

Definition:

- **Drowning** is a form of asphyxial death in which there is replacement of air passages by any fluid usually water, resulting in displacement of air from the lungs.
- For drowning to occur, complete submersion of the body is not necessary. If the mouth and nose are submerged, it can cause drowning and result in death.
- A person who does not know swimming when enters into water, sinks in water as the specific gravity of the body is higher than that of water.
- He raises up on to the surface of water due to buoyancy of the body, air trapped inside the clothing and by the struggling movements made by him.
- When the mouth and nose come above the water level, he expire the air from the lungs to inhale fresh air, during this process he inhales more of water than air, and also swallows some amount of water. This process may continue two or three times and he finally sinks into water once he has inhaled enough of water.

Types of drowning:

- Drowning is classified into 3 types:
  (i) Wet drowning.
  (ii) Dry drowning.
  (iii) Hydrocution (Immersion syndrome): Death is due to vagal inhibition.
- With respect to presence or absence of water in the lungs, drowning is divided into **wet drowning** and **dry drowning** respectively.
- **Wet Drowning** is further subdivided into two types, according to the type of water:
  1. fresh water drowning
  2. sea or salt water drowning
- According to the period of survival drowning may be labeled as:
  - Immediate drowning
  - Near drowning: Rescued but died within 24 hours
  - Secondary drowning: Death after 24 hours due to complications of drowning like infections, encephalopathy, hypoxia, etc.

i. **Wet drowning:**

- Water enters into the lungs and the air present in the air passages is displaced. This water mixes with the residual air present in the lungs and forms a fine white froth, which is evident by dissection of the bronchioles during autopsy.

Mechanism of death:

- The mechanism of death in drowning and the patho-physiology involved in the process of drowning depends on whether the medium of drowning is fresh water or salt water.
- Once water enters into the lungs, it gets absorbed into the circulation, resulting in haemodilution. This in turn leads to cardiac overload and acute pulmonary oedema. During this process, there is lysis of the RBCs and release of potassium, leading to ventricular fibrillation. Death may take place in 5 to 8 minutes.

(i) Fresh water drowning:

Water inhalation into the lungs → Blood → Circulatory overload
↓ ↓
Pulmonary edema Hemodilution
↕ ↓
Cardiac overload Hemolysis
(Ventricular fibrillation) ↓
Increased extracellular potassium
leads to cardiac toxicity

(ii) Sea water drowning:

Water inhalation into the lungs ← blood
↓
Hemoconcentration
↓
Massive pulmonary edema

- When water with high salinity (sea water) enters into the lungs, water is imbibed from the circulation into the lungs, resulting in hemoconcentration and death is due to massive pulmonary edema. The individual may survive for 8 to 12 minutes in sea water drowning.

ii. **Dry drowning:**

In this type of drowning, water does not enter into the respiratory passages at all.

- When the person drowns, he may try to withhold his breath to prevent water entering into the lungs which result in intense ***acute laryngeal spasm***.
- This intense laryngeal spasm prevents neither water nor air to enter into the respiratory tract; and the result is death by asphyxia due to drowning.

iii. **Hydrocution/Immersion Syndrome:**

- In some cases, when the cold water strikes over the epigastrium, it may result in vagal inhibition leading to reflex cardiac arrest.
- Even in people who know swimming, while they dive into the water, hyperstimulation of nerve endings all over the body by cold water leads to "hydrocution" and ventricular fibrillation.
- This form of drowning is very difficult to diagnose at autopsy, since the victim knows swimming. There is absence of any signs of asphyxia, no pathological evidence of any fatal disease and the chemical analysis report is negative.
- Arriving at the cause of death is by ruling out, since vagal inhibition does not leave any specific autopsy findings. Hydrocution is one of the causes of negative autopsy.
- Opinion is based on the circumstantial evidences.
- Other causes of death in drowning:
  - Injuries sustained by the victim, by hitting over some hard protruding objects inside the water medium.
  - Shock due to pre-existing heart disease.
  - Exhaustion: Due to prolonged swimming.

16. What are the postmortem findings in a case of death due to drowning?

What are the difficulties encountered when the body is decomposed?

Postmortem findings:

A. Non-specific signs: External:

- The external signs in drowning are:
  1. The clothes and the hair will be wet.
  2. Sand, mud and weed particles will be found adherent over the skin surface and on the clothing.
  3. **Washer women hand:** The skin surface over the palm and soles become wrinkled, soddened and bleached. This is not an antemortem sign of drowning. It indicates the period of immersion of the body in water. Prolonged period of exposure with water increases the intensity of "washer women hand" (Fig. 9.13).
  4. Cutis anserina (**Goose skin**): It is due to contraction of the erector pillori muscle, which leads to puckered appearance of the hair follicle.
  5. Cyanosis, external injuries including broken nails and bleeding from ear can be seen. The injuries may be abrasions, lacerations or contusions and it has to be differentiated from the postmortem injuries caused by aquatic animals.
- In drowning, the body floats over the water surface with face down position and hence postmortem hypostasis will be prominent over the face, front of chest and limbs.

B. Specific signs:

- The presence of fine, tenacious, white or blood-tinged froth around the mouth and nostrils are an important finding in drowning. This froth reappears even if it is wiped off and if pressure is applied over the chest. This is an important antemortem sign of drowning and is called "**the sign of drowning**" (Fig. 9.11).
- ***Mechanism of formation of froth:*** Water enters the lungs and damages the bronchial epithelium and the surfactant, there is residual air present in the bronchioles with all these there are violent respiratory movements by the efforts of the victim for survival; all these result in chirring effect and result in the formation of the fine tenacious froth (Fig. 9.12).
- ***Cadaveric spasm:*** While attempting to save oneself, the individual may tightly grasp the weeds and plants present in the drowning medium. During this process, the individual develops sudden spasm due to development of instantaneous rigor. It indicates that the victim was alive when he entered into the water.

Non-specific internal signs:

- All the internal organs will be congested.
- Edema easily appreciable in lungs.
- The chambers of the heart may contain fluid blood (Fig. 9.2).
- There will be multiple petechial hemorrhages (Tardieu spots) over pleura and pericardium.
- Sand and mud particles can be seen in the nose, mouth or in oropharynx.
- Large quantity of water may be swallowed during the process of drowning, which will be detected in the stomach.

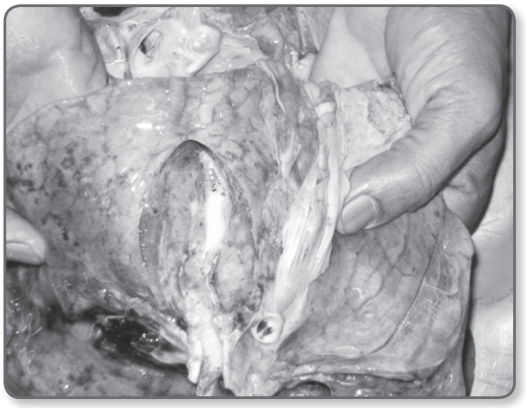


Fig. 9.12 Dissection of the lung in case of drowning – Note: The froth lodged in the bronchial tree

Fig. 9.11 Froth in mouth and nostrils in case of Drowning – Note: The fine gritty mud particles on the surface of the body, a case of sea water drowning. Even if the body is decomposed, these fine mud particles could be made out in the secondary bronchioles, thus may help to give a positive opinion

Fig. 9.13 Washer women's hand in drowning – The intensity indicates prolonged immersion in water

Specific internal signs:

- ***Emphysema aquosum:*** Lungs are heavy and voluminous, water logged with prominent rib indentations on the surface. Multiple petechial hemorrhages on the subpleural surface and the intestinal spaces of the lung and are known as "Paltauf's hemorrhages." Cut-section of the lungs will demonstrate frothy exudation. This lung picture of drowning is called emphysema aquosum.
- Dissection of the bronchial tree: It is always preferable to dissect the lung along the bronchial tree, which shows fine, leathery, tenacious white or blood stained froth in trachea and bronchi upto the terminal bronchiole. Sand, mud or sludge particles may be seen in the trachea, bronchi or primary and secondary bronchioles.

Floatation of the body:

- Floatation in water takes its own time and is mainly dependent on the temperature of the environment, as temperature directly influences the rate of decomposition.
- Once the body sinks under the water, it remains on the undersurface till enough gases accumulate inside the body, then the body comes back to the surface of water and float.
- Floatation of the body usually takes 18 to 24 hours in summer and 24–48 hours in winter.
- Rarely, drowned bodies may get entangled in the aquatic vegetations and may not come to the surface in a few days and may come out to surface after weeks in a bloated stage.
- Bodies drowned in deep lakes at hill stations may not come up to the surface for a long period of time, as the extreme cold temperature markedly delays putrefaction.

Decomposition: A challenge to the autopsy surgeon:

- When the body is fresh, the lung findings are easily appreciated in most cases and hence there exists no difficulty in finding out the cause of death in cases of drowning.
- But, it is unfortunate that many of the victim persons drown when nobody observes them and noticed only when the body comes to the surface of water after a reasonable period of time in a decomposed state.
- All the lung findings may disappear when the body is moderately decomposed. This is due to passive diffusion of water from the lungs into the body and decomposition of the lung parenchyma. Such cases are really a challenge to the forensic pathologist. However, a meticulous dissection of the bronchial tree for search of any minute foreign particles like mud, sand or any other materials which are present suspended in the drowning medium, will help to ascertain the cause of death.

17. What are the laboratory tests used in cases of drowning? Write short notes on diatoms.

Laboratory tests:

(i) Diatoms test; (ii) Gettler's test; (iii) Serum magnesium; (iv) Serum strontium.

- In this, Gelter's test and diatoms tests are important.

(i) **Diatoms:**

- Diatoms are unicellular algae with their cell wall made of silica. It resists acid digestion.
- They are present in all types of water fresh, marine, river and lake water.
- There are more than 15 thousand species of diatoms; they are of different shapes and sizes.
- When an individual dies due to drowning; these diatoms enter the lung, carried into circulation to different parts of the body, including the bone marrow.

Isolation of diatoms from bones:

- When decomposed bodies recovered from water are brought for autopsy, any of the long bones or sternum is isolated and sent to the FSL.
- These bones are subjected to acid digestion and then centrifuged. The sediments are then examined under microscope for diatoms. Diatoms resist acid digestion, as they have a protective silica cell wall.

Medicolegal Importance of diatoms:

- Cause of death can be ascertained when decomposed or partially skeletonized bodies are recovered from water.
- ***Place of drowning:*** Comparison of diatoms present in the body with that of the diatoms

present in the alleged drowning medium helps in concluding the place of drowning. Especially useful in cases of drowning in fast flowing water and in bodies recovered from ditches (diatoms help to find out antemortem drowning and place of drowning).

- While comparing the diatoms, the number, size, shape and percentage of the diatoms are all taken into consideration.
- Diatoms test has got its own limitations of application and hence cannot be considered as a concrete proof of antemortem drowning. However, negative results may sometimes be helpful in ruling out the possibility of drowning.

(ii) **Gettler's test:**

- This test is used to find out the chloride concentration from the right and left ventricular chambers of the heart.
- Normally concentration of chloride will be equal in both right and left side chambers of the heart.
- In case of fresh water drowning, the chloride content will be low in the left ventricle due to hemodilution. In sea water drowning, the chloride concentration will increase by 40% due to hemoconcentration.
- This test is useful to differentiate sea water drowning from fresh water drowning. The significance of this test is highly doubtful and has less practical application.

18. What are the medicolegal aspects encountered in cases of drowning?
What is shallow water drowning?

- Drowning is usually accidental, sometimes suicidal and rarely homicidal.
- But it is not uncommon to kill the person by some other method and submerge the body in water, to simulate death due to suicidal drowning.

Shallow water drowning

- An intoxicated person may fall conscious by the side of a drainage channel and accidentally dip his head into water and death may result due to aspiration . At autopsy, the sewage material may be found in the respiratory tract indicating death due to drowning, this is also called as "shallow water drowning."
- It is always difficult to opine about the manner of death in drowning, as the postmortem findings may be similar in all the cases of accidental, suicidal or homicidal drowning. There may be some signs of resistance in case of homicidal drowning and these signs of struggle will be absent when the victim is unaware. Hence, opining about the manner of death in drowning is much of uncertainty.

CHAPTER 10

Death due to Starvation

Keywords: Starvation, emaciation, brown atrophy of heart, intercurrent infections, article 21.

1. What is starvation?

- Starvation is a condition in which there is deprivation of supply of essential nutrients, either due to inadequate food supply or due to non-intake of food for a long duration.
- Regular and constant supply of food is necessary for the maintenance of nutritional balance of the body.
- Starvation may be acute or chronic. Acute starvation results due to sudden and abrupt stoppage of food and water. Chronic starvation or malnutrition is due to deficient intake of food either quantitatively or qualitatively for a long period of time.

2. What is normal body requirement of a human being?

- An adult requires minimum of 1800 calories of food per day to meet the dietary requirement. There is danger to life when 40% of the body weight is lost.
- Total deprivation water and food causes death in about 10 days. Without intake of food, if water alone is consumed then the individual may survive for 50 to 60 days.

3. What are the signs and symptoms of acute starvation?
What are the postmortem findings in a case of death due to starvation?

Signs and symptoms:

- Acute feeling of hunger in 2 days
- Loss of body fat and emaciation starts appearing from 5th day, with progressive loss of body weight. Breath turns offensive.
- Pulse feeble, blood pressure falls and cardiac atrophy occurs.
- First there is constipation and later diarrhea.
- Temperature is sub-normal; urine scanty and dark in color.
- Skin becomes dry, fissured, pigmented, thin and drawn tight over bony prominences.
- Cheeks sunken; lips dry and cracked; tongue dry and coated.
- Abdomen scaphoid in shape and prominence of ribs with indrawing of intercostal space.
- In chronic starvation, in addition to the above mentioned features, there will be ascitis, edema of the limbs and evidence of intercurrent infections.
- Hair become dry, lusterless and brittle; nails become brittle and ridged.
- The mind is usually clear till the end; some people may develop delirium just before death.

Postmortem findings:

Emaciation and all the external signs of starvation are present.

Internal:

- Loss of body fat and atrophy of muscles.

- Stomach and intestines: Empty, contracted and thinned out.
- Gall bladder: Full and distended with thick, tenacious bile.
- Loss of omental and mesenteric pad of fat.
- All internal organs except the brain are sunken and reduced in size; demineralization of bones and '**brown atrophy**' of heart muscles are evident.

4. What are the factors which modifying the effects of starvation?

- **Age:** Old people withstand starvation better, due to lower food requirement.
- **Sex:** Females combat starvation better, since they have more body fat.
- **State of health:** Healthy people withstand better, due to higher muscle mass in the body.
- **Body fat:** Obese people withstand better.
- **Cold:** Extreme cold aggravates the effects of starvation, since cold accelerates the basal metabolic rate.

5. How do an individual die of starvation? What is the cause of death in starvation?

- In acute starvation, death is due to electrolytes imbalance, dehydration and circulatory failure.
- In partial or chronic starvation death results from loss of immunity and intercurrent infection.

6. What are the medicolegal aspects of starvation?

- **Homicidal starvation:** Victims are usually infants and unwanted children. There is deliberate withholding of food by the parents or caregivers.
- **Suicidal starvation:** It is rare but seen in mentally ill people and prisoners who go on hunger strike as protest. Political groups and other organizations venture on hunger strike to represent their views more strongly and as a mark of protest. However in such situations, they are not allowed to die of starvation. When they extend the starvation to such level which threatens their life, treatment is done on compulsory basis without their consent.
- **The right for food** is not a basic right as per Article 21 of the constitution of India, but guarantees '**right to life and liberty**' of all citizens.
- The supreme court has stated that the chief secretary of a state would be held responsible for all starvation deaths in the state, if reported and proved.

Section IV:

Forensic Traumatology

CHAPTER 11

Injuries and their Medicolegal Considerations

Keywords: Injury, wound, grievous hurt, abrasion, grazes, imprint abrasion, contusion, ectopic bruise, artificial bruise, laceration, cut laceration, fracture, dislocation, incised wound, tailing of wound, cut wound, chop wound, stab wound, Langer's line, defense wound, fabricated wound, hesitation cuts, self-inflicted wounds.

INTRODUCTION

Medical definition of injury:

- Injury or **wound** is the "breach in the natural continuity of any tissue of the living body;"
- Medically all injuries are wounds; these words injury and wound are often used interchangeably.

Legal definition of injury:

- **Section 44 IPC** defines injury as "any harm what so ever illegally caused to any person in body, mind, reputation or property."
- Only bodily injuries are wounds. Hence, all wounds are injuries but all the injuries are not wounds.

Hurt (Section 319 IPC):

- Any bodily pain, disease or infirmity caused to any person is called hurt.

Assault (Section 351 IPC):

- Any offer of threat or attempt to apply force to the body of another in a hostile manner. Execution of such act amounts to 'battering'.

Mechanical Injury

- Injuries caused by application of physical force are called mechanical injuries.
- Character of an injury produced on the body depends upon the following factors:
  (i) Nature and shape of the weapon
  (ii) The amount of force transmitted.
  (iii) The rate of application of force.
  (iv) The nature of the tissues involved.
  (v) The surface area over which energy is delivered.

1. How do we classify injuries?

Injuries are classified in three ways:

(i) Medical classification
(ii) Legal classification
(iii) Medicolegal classification.

(i) **Medical classification of injuries:**

- ***Mechanical injuries:*** Injuries caused by application of physical force.
- ***Chemical injury:*** Corrosive Acids and Alkalis
- ***Thermal injury***,
  Due to Cold: (i) Frost Bite, (ii) Trench Foot, (iii) Immersion Foot.
  Due to Heat: (i) Burns - dry heat. (ii) Scalds - wet heat.
- ***Miscellaneous:***
  (a) Electrical injury
  (b) Radiation injuries
  (c) Fire arm injuries
  (d) Explosive injuries

(ii) **Legal classification of injuries:**
Legally, injuries are classified according to the severity of the injury:

- Simple injury
- Grievous hurt
- Dangerous injury — in living
- Fatal injury — in dead.

iii. **Medicolegal classification of injuries:**
For medicolegal interpretation, injuries are classified as:
- Accidental injuries
- Suicidal injuries
- Homicidal injuries
- Defence injuries
- Fabricated injuries

2. What are simple injuries, grievous hurt and dangerous injuries?

Section: 320 IPC – Grievous hurt:

i. ***Simple injuries:*** Injuries that are neither serious nor dangerous to life are called as simple injuries. For example, abrasions, skin deep laceration on the limbs, etc.

ii. ***Grievous hurt:*** Section 320 IPC gives a list of injuries which constitute grievous hurt. All other injuries which do not fit into any of the clauses of grievous hurt are simple injuries.

Grievous hurt (Section 320 IPC)
- Emasculation
- Permanent privation of sight of either eye
- Permanent privation of hearing of either ear
- Privation of any member or joint
- Permanent destruction of power of any member or joint
- Permanent disfiguration of head or face
- Fracture or dislocation of a bone or tooth
- Any hurt which endangers life, or which causes the victim to be in severe bodily pain, or which prevents the person from following his ordinary pursuits of life for a minimum period of twenty days.

iii. ***Dangerous injury:*** Any injury which causes imminent threat to the life of the individual is a dangerous injury. An endangering injury, is one for which if the individual is not admitted to the hospital and surgical intervention had not been done he could have died.
When the injury leads to death of an individual, then it is called as fatal injury.

Example: Incised wound on the wrist resulting in cut of the radial artery; if surgical intervention is done, there is no threat to the life of the individual. This is an endangering injury. But, if not treated by surgical intervention, profuse bleeding would result in death of the victim in a few minutes to an hour; when death occurs it becomes fatal injury.

3. Classify mechanical injuries.

- Mechanical injuries are classified according to the nature of force involved in production of the injury.

i. **Injuries caused by blunt force**:
- Abrasion
- Contusion
- Laceration
- Fracture and Dislocation

ii. **Injuries caused by sharp-edged weapons**:
- **Incised wound:** Produced by single edged light cutting weapons.
- **Cut/Chop wounds:** Produced by heavy cutting weapons.

iii. **Injuries caused by pointed weapons**: Stab wounds.

iv. **Firearm wounds**: Shot gun and rifled firearm injuries.

Firearm wounds can also be grouped under mechanical injuries, since the projectile which produces the injury on the body is a pointed weapon. Hence, these injuries are also a form of stab injuries.

4. What is an abrasion? What are the types of abrasion?
Write note on healing of an abrasion: Medicolegal importance of abrasions.
What is brush burn and imprint abrasion?

Abrasion (Gravel Rash)

- Destruction of the skin, which involves only the superficial layers of the epidermis.
- They are caused by a lateral rubbing, by a blow or a fall on a rough surface.
- Some pressure and movement of the agent on the surface of the skin is essential to produce an abrasion.
- The damaged layers of the epithelium are heaped up toward one end of the wound, toward the direction of force.

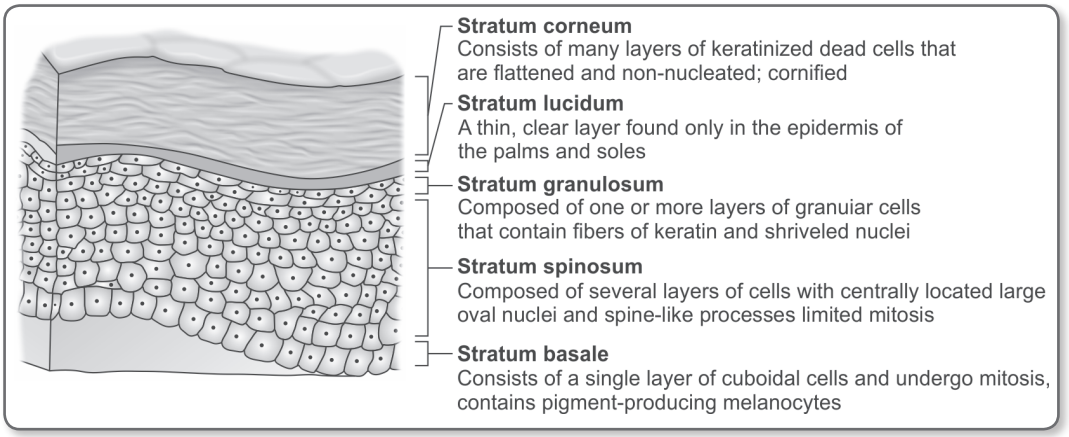


Fig. 11.1 Layers of the epidermis

- The exposed raw surface is covered by exudation of lymph and blood which produces a protective covering called as *"**scab**"*.
- Abrasions are usually simple injuries, as they cause less pain, bleed slightly and heal rapidly without leaving a permanent *scar.*
- Abrasions over a large surface area of the body can cause severe pain and bleeding.

Types of abrasion

- There are mainly four types of abrasions:
  (i) ***Scratch abrasion:***
  - These are linear abrasions caused by a protruding object such as a thorn or nails.
  - There is movement of the body or the weapon which produces linear scratch.
  - These abrasions have a good length but relatively small breath.
  - During the movement of the weapon or the body, the torn up epithelium are carried away toward the end of the wound indicating the direction of force.
  - Linear abrasions can also be caused by sharp weapons, not sharp enough to incise or cut. Example: A running victim is assaulted with a long cutting weapon through the clothing, now there is not enough force transmitted on the body and hence will result in a linear abrasion.

  (ii) ***Grazed abrasion:***
  - Grazes are also called as brush burns or friction burns.
  - Multiple linear abrasions over a larger area of the body is called as grazed abrasion.
  - They are caused by rubbing of the body over a hard surface, usually seen in road traffic accidents; where the individual is dragged over the hard surface of the roads (Fig. 11.2).
  - Due to the uneven surface, the depth of the wound may not be uniform.
  - Grazed abrasions are painful when it involves a large surface area and the depth is more, since the nerve endings are involved.
  - During the rubbing process, there is production of heat between the body and

Fig. 11.2 Grazed abrasion of left thigh, a case of road traffic accident

the road, hence the ends of the wound may look-like as if they are burnt; the wound is hard to touch and hence they are called as "**brush burns**" but they are not thermal injuries, they are mechanical injuries.

(iii) ***Pressure abrasion:***
- They are also called as crushing or friction abrasions.
- These types of abrasions are caused by crushing of the epidermis by compressive blunt force. The skin is crushed by the pressure exerted by the offending object. These types of abrasions are usually associated with bruising of the surrounding areas.
- Example: Ligature abrasion of hanging and strangulation, bite marks, etc.

(iv) ***Impact abrasion:***
- They are also called as "contact or **imprint** abrasions".
- These are abrasions caused by impact of a rough object perpendicular (at right angles) to the skin surface.
- The imprint of the weapon/offending object is left over on the skin.
- Example: Tyre mark in a run over accident, steering wheel impact in collision accidents
- Pressure abrasions and imprint abrasions are grouped under the category of "**patterned abrasions**" as the pattern of the weapon is seen on the skin surface, thus helps to corroborate the weapon responsible for causing the injury.

Atypical abrasions:
- Some authors classify certain abrasions which do not fall into any of the four types such as crescentic abrasions caused by the finger nails, bite marks and tiger skin abrasion (thin linen clothing getting burnt due to heat generated by dragging and adherent on the surface, giving the appearance of tiger skin) as "atypical abrasions" but abrasions caused by the nails are either pressure abrasions (applied at right angles as in throttling) or scratch abrasions (when applied tangentially producing linear scratches); bite marks are imprint or pressure abrasions; and tiger skin abrasion is brush burn (grazes).

Healing of abrasion: Age of an abrasion:
- Abrasion heals from the periphery with generation of new epithelial cells. The age of an abrasion can be assessed by examining the stage of healing of an abrasion.
- The time taken for healing mainly depends on the size, depth and area on the body.
- Abrasions are bright red in color when fresh, due to passage of time the color gradually changes to reddish brown and dark brown, finally becomes black in color in one week.
- From the color of an abrasion, the approximate time of infliction can be assessed.

Medicolegal importance of abrasions:
- Abrasions are the most important medicolegal injury.
- Abrasions are produced at the site of impact and are useful to find out over which area of the body, force was applied.
- Indicates the direction of force: The torn layers of the epithelium are heaped up toward one end of the wound, indicating the direction of application of force/the direction of movement of the body, when hit or dragged over a fixed surface or object.

Table 11.1 Healing of abrasion.

Time	Color
Fresh (less than 12 hours)	Bright red
12 to 24 hours	Bright red scab
2 to 3 days	Reddish brown scab
4 to 5 days	Dark brown scab
5 to 7 days	Black scab firmly adherent onto the base
7 to 10 days	Black scab loosely adherent onto the base; scab could have fallen off in the periphery
10 to 14 days	Scab completely fallen off, exposing the underlying pale dermis
With passage of time	Skin regains the original color, without any scar

- It may be the only sign of a serious internal injury.
- Patterned abrasions help to find out the object causing the injury.
- Example: Imprint of the tyre mark in a run over accident and pattern of the ligature material in case of hanging and strangulation.
- Age of the injury can be assessed which indicates the time of infliction of the injury.
- Relative position of the assailant and the victim can be assessed.
- Motive of the offence can be made out from site of injury; example: injuries over the breast, lips and genitals indicating sexual motive.
- Positive identification of the assailant can be made out; example: from the pattern of bite marks and tissue scrapings from the nail beds of the victim by DNA analysis.
- May give a clue to the place of incident by examination of the wound for dirt, dust, grease, sand or gravel.
- Manner of injury can be assessed (accidental, suicidal, homicidal or fabricated).
- Character and manner of abrasion gives a clue to the cause of death. For example, Crescentic fingernail abrasions on the neck in throttling; pressure abrasion around the mouth and nose in smothering; abrasions on breast, genitals, inner aspect of thigh and around the anus in sexual offences like rape and sodomy.

5. What are the conditions which mimic an abrasion?

- Some of the skin lesions are frequently mistaken as abrasions; by careful examination, these lesions could be easily differentiated.
  (i) Erosions of the skin produced by ants
  (ii) Excoriation of the skin by excreta
  (iii) Pressure sores (decubitus ulcer).

6. How to differentiate antemortem and postmortem abrasions?

- In routine circumstances, it is easy to differentiate antemortem and postmortem

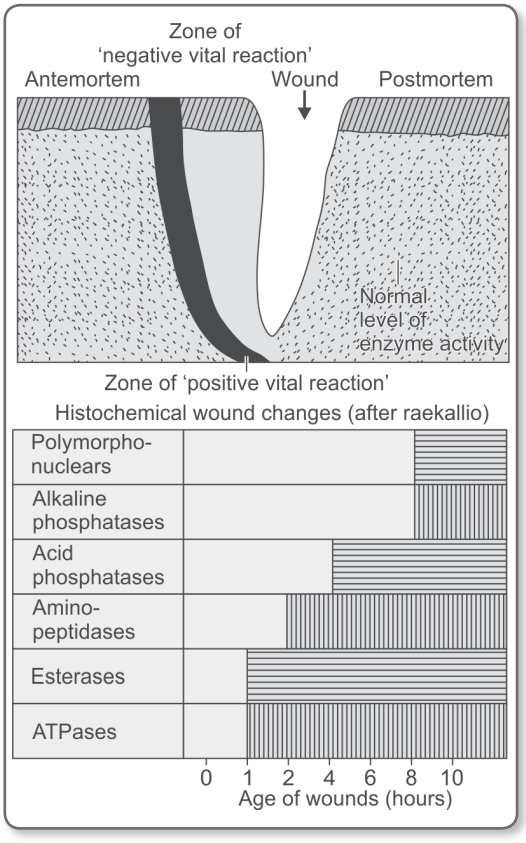


Fig. 11.3 Schematic diagram showing the histochemical estimation of the age of the antemortem skin wounds (after Raekallio)

Table 11.2 Differences between Antemortem and Postmortem Abrasions

Features	Antemortem abrasions	Postmortem abrasions
1. Site	Anywhere on the body	Over bony prominences
2. Oozing of Lymph	Present	Absent
3. Scab formation	Present	Absent
4. Color Changes	Present, if the victim survives some period of time	Absent, mostly yellowish without any change in color
5. Parchmentization	Absent	Present

abrasions just by observation (Fig. 11.4). Difficulties do arise in certain situations especially in decomposed bodies; sometimes it becomes difficult to differentiate abrasions produced just before or just after death even by microscopic examination.

7. Write short notes on contusion.

Contusion/Bruise:

- Contusions are caused by blunt trauma, due to which, there is rupture of blood vessels (arterioles or venules) resulting in extravasation of blood into the surrounding soft tissues.
- Contusions are caused by blunt force such as fist, stone, stick, whip, bar, boot, etc.
- Contusions may develop not only under the skin and subcutaneous tissues, but also in internal organs like lung, brain or muscle.
- Location: Contusions are usually located in the dermis and subcutaneous tissues, often inside the fatty layers (Fig. 11.5).
- Most of the times, there is no destruction of the skin.
- There is a painful swelling, slightly raised above the surface of the skin and crushing or tearing of the subcutaneous tissues.

Types of contusion:

- Superficial contusion or surface bruise.
- Deep bruise.
- Bruise of internal organs.
- Contre coup bruise.
- Ectopic (gravity shifting) bruise (Fig. 11.6).
- Patterned bruise.
- Bruises may be seen in association with abrasion (abraded contusion) or lacerations (contused laceration).
- According to the size of the contusions, pinpoint contusions are called as ***petechiae***; when the size is smaller than a few mm they are called as ***ecchymosis*** and when the size is more than a few cm in diameter they are called as ***hematoma***.

Color changes of a contusion:

- Contusions are red in color when they develop after an impact. The contusions

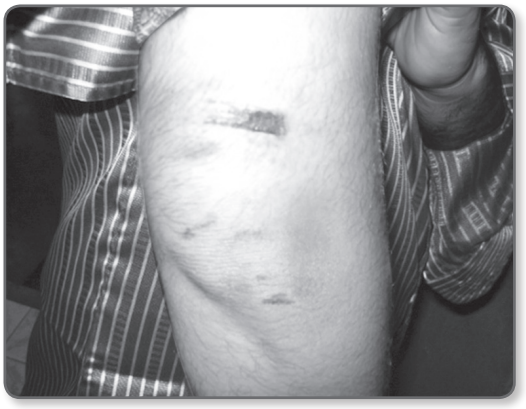


Fig. 11.5 Contusion on lower part of right arm; said to be caused while defending his money from robbers

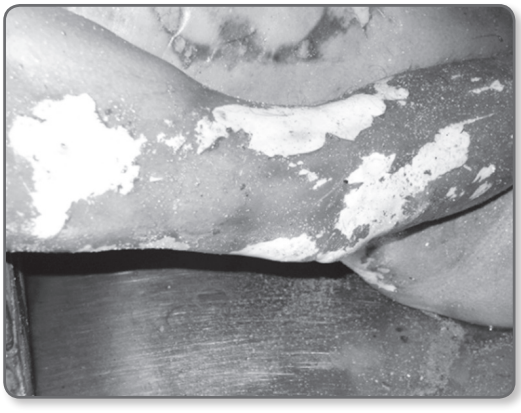


Fig. 11.4 Postmortem abrasion; easily differentiated by the pale base

Fig. 11.6 Ectopic bruise; injury to the base of skull (anterior cranial fossa) resulting in contusion of eyelids

Table 11.3 Healing of a contusion

Time	Color	Pigment responsible
Fresh	Red	Due to extravasation of RBC
1 to 2 days	Reddish blue or blue	Due to deoxygenated blood
3 to 5 days	Reddish brown	Hemosiderin
5 to 7 days	Green	Biliverdin
7 to 10 days	Yellow	Bilirubin
10 to 14 days	Regains original skin color	

slowly resolve in the process of healing; the color changes from time to time before the skin regains its original color; these color changes are used as indicators to assess the time of infliction of the injury.

Medicolegal importance of bruise:

- It is a sign of violence.
- Bruise need not always be simple injuries.
- It is commonly accidental or homicidal, and less commonly self-inflicted.
- Type of the object can sometimes be identified in cases of ***patterned bruise***.
- Time of assault can be assessed by the color changes of the bruise.
- Motive of the offence can be identified from site of bruise.

8. What are the conditions from which contusions have to be differentiated? How to differentiate contusion from congestion and livor mortis?

- Contusions have to be differentiated from
  (i) Postmortem staining
  (ii) Congestion and
  (iii) Lesions produced by plant juices (artificial bruise).

(i) **Contusion and postmortem staining:**
- The difficulty with postmortem staining arises only in dead bodies, especially by 4 to 6 hours after death when the lividity is present in discrete patches before they coalesce with each other to form uniform postmortem staining by 6 to 8 hours.
- It is easy to differentiate by making an incision over the area, postmortem staining will show fluid blood, which oozes out and easily washed off under water. In contusion, there will be extravasation of blood into the layers of tissues and cannot be washed off under water.

(ii) **Contusion and congestion:**
- The difficulty to differentiate with congestion arises both in living and the dead, especially in people with brown or fair complexion.

9. What is a false bruise? How to differentiate a true contusion from false contusion?

- False bruise or bruise like lesions (fabricated) may be produced, by application of irritant substances like chemicals, juices of marking nut or calotropis on the skin to bring a false charge of assault against somebody.

10. What are the factors which determine the appearance of a Bruise?

The production of a bruise is dependent upon a number of factors.

Table 11.4 Differences between bruise and congestion

	Factors	Bruise	Congestion
1.	Causative agent	Mechanical force	Pathological conditions like inflammation, capillary stasis due to hypoxia etc.
2.	Level of the tissue involved	Diffusion of blood at the SC or submucous level with rupture of capillaries	Intravascular phenomenon with engorgement of capillaries (stasis of blood inside the capillaries)
3.	Color	Changes from red to blue, brown, green and yellow	It is all along dusky red without any change
4.	Margin	Diffused (Fig. 11.5)	Well-defined
5.	Dissection	Cut surface stained due to extravasation which is not washable	Bleeding which occurs from the engorged vessels during dissection is washable

Table 11.5 Differences between bruises and bruise-like lesions produced by chemicals or plant juices

	Features	Bruise	False bruise
1.	Shape	Regular	Irregular
2.	Margin	Diffused	Clear & sharply defined
3.	Swelling	Slight	No swelling
4.	Surrounding area of abrasion	May be present	Not present
5.	Small blisters	Not present	May be present
6.	Itching	Not present	Present
7.	Color changes	Occur as the age of the bruise progresses	No color change
8.	Similar lesions	May be present elsewhere in the body	May only be present around the nail beds due to itching
9.	Cause	Mechanical force	Contact with chemicals or plant juice
10.	Extravasation of blood	Present in the subcutaneous tissue	Not present
11.	Chemical test of skin scrapping	Detects nothing	Detects the chemical or the plant juice used

i. Vascularity of the tissues involved
ii. Site on the body:
- Whether the tissues involved are loose or strongly supported; if the tissues are loosely arranged then the bruise appeared is marked, in the event of strongly supported tissues it is less pronounced.

iii. **Age:** Children and old age people bruise easily.
iv. **Sex:** Females bruise more readily, due to less muscle mass and more fat content.
v. **Complexion:** Bruises are more prominent in fair skinned individuals.
vi. **Pathological conditions:**
- When the blood vessels are diseased as in atherosclerosis or conditions like hemophilia, clotting factor deficiencies and blood discrasias, bruising occurs very easily and more marked.

11. What is ectopic contusion?

Gravity shifting contusion: (**Ectopic bruise**)
- Bruise appears in a distant place other than the place of impact of force is called as "ectopic bruise."
- It is due to the shifting of the blood from the ruptured site to the dependent part of the body due to gravity. Hence they are also called as "gravity shifting bruise."
- Examples: (i) Injury to the forehead producing periorbital bruising (lacoon eye or black eye); (ii) injury to the lower part of the thighs result in collection of blood around the knee joint; (iii) injury to the legs, leading to collection of blood around the ankle joint.

12. Write short note on delayed bruising.
- A superficial bruise appears within a short span of time as a dark-red swelling. Whereas a deep bruise may take several hours or even 1 to 2 days to appear. Sometimes, a deeper extravasation of blood may not become externally visible at all. Hence, it is advisable to carry out one more examination after 48 hours, in any case of suspected blunt force injury to check for deep contusions.

13. How to differentiate antemortem and postmortem bruise?
- In antemortem bruise, there is swelling, extravasation, coagulation and infiltration of blood into the tissues; there will be visible color change if the individual has survived for reasonable period of time after the infliction of injury.
- In postmortem bruise, all these signs are absent.

Fig. 11.7 Internal contusion and fracture of femur, with less evidence of external trauma

14. What is a laceration? What are the general features of a laceration?

- **Lacerations** are injuries in which the tissues are crushed/torn as a result of application of blunt force. They involve all the layers of the skin and may also involve the deeper layers like muscles, vessels and nerves. Healing of laceration is by secondary intention with resultant scar formation (Fig. 11.8).
- **General features of a laceration:**
  (i) The shape of laceration is always irregular; the edges of the wound are ragged and undermined.
  (ii) Margins are irregular with areas of abraded contusions surrounding it.

Fig. 11.8 Laceration of right eyebrow and contusion of left eyelid

(iii) The floor of the laceration shows tags of tissue overriding each other to a varying depth. This is called **bridging of tissues —** Diagnostic of laceration.
(iv) There is gross and severe tissue damage in laceration.
(v) Blood lose is usually minimal due to crushing of the lumen of blood vessels.
(vi) Crushing of hair bulbs are seen in lacerations involving the scalp tissue.
(vii) Foreign materials like dust, gravel, sand, etc. may be present in a laceration.
(viii) Healing is by secondary intention with resultant scar formation.

15. What are the types of laceration?

i. **Split laceration:** Also called as "**incised looking laceration.**" These lacerations are present on the areas where there are lesser amount of subcutaneous soft tissues between the skin and the underlying bone. A blunt impact or trauma over such areas will result in splitting of the skin producing injuries which looks-like an incised or cut wound. But these types of injuries can be easily identified as lacerations, by examination of such injuries using a hand lens, which will show the irregular ragged margins.
ii. **Stretch laceration:** Results due to abnormal stretching of the skin as a result of localized pressure and pulling of the skin at site of impact.
iii. **Tear laceration:** As a result of similar mechanism as above coupled with compression of the tissues, under the hard object.
iv. **Avulsion:** Otherwise called shearing laceration, the shearing and grinding force of a heavy object or a vehicle producing separation of the skin from the underlying tissues (like lifting a flap of skin) over a larger area.
v. **Internal laceration:** This may occur with or without any evidence of external injury.
vi. **Crush laceration:** A laceration involving a wider surface area of the body or a limb with extensive laceration of the skin, connective tissues, muscles, tendons, vessels and nerves with compound comminuted fracture of the underlying bones.

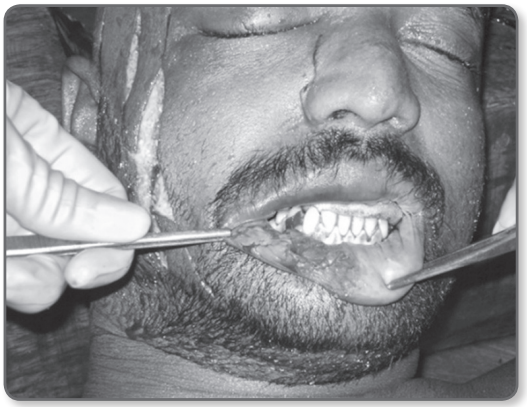


Fig. 11.9 Laceration of inner surface of lips caused by his own teeth when force is applied on the face

Fig. 11.10 Laceration and Incised wound – Margins of the laceration are irregular and bruised, whereas the margins are clean cut in incised wound

16. What is the medicolegal significance of laceration?

- It is a sign of violence.
- The place of occurrence can be identified by the presence of foreign material such as mud, dust, gravel, etc.
- Laceration over the face is considered as a grievous injury, since it produces a permanent scar which amounts to disfiguration of face.
- Lacerations heal by secondary intention with the resultant of scar formation. Large laceration over a joint results in the formation of an extensive scar which restricts the movement of a joint, resulting in permanent disability, thus amounts to grievous hurt.
- Scars so formed may sometimes be helpful in personal identity.
- Lacerations are usually accidental or homicidal and rarely suicidal.
- Age of the injury cannot be determined from lacerations due to extensive variation in the rate of healing of such injures.

17. What are the injuries caused by sharp force? What are the features of an incised wound?

- There are three main types of sharp force injuries:
  (i) Incised wound; (ii) Cut wound and (iii) Stab wound.

Incised wound (Cut, Slash):

- These are wounds produced as a result of slashing or cutting motion with a light cutting weapon such as a knife.
- The primary characteristic of an incised wound is the length of the wound is more than depth of the wound.
- It produces uniform and clear division of the skin and underlying soft tissues.

Features of incised wound

- The margins of the wound are clean cut, regular and well-defined; usually there is no bruising along the margins of the wound.
- Predominantly incised wounds are linear with everted margins, but in areas where skin is loosely applied to the body such as scrotum or axilla, the margins might appear inverted and jagged (with multiple folds).
- The length is the greatest dimension and it does not have any relationship with length of the blade.
- The breath of the wound depends on the extent of gaping of the margins and the elasticity of the skin; the breath of the wound has a relationship with the thickness of the blade.
- The wound will be deeper at the site of commencement and it becomes progressively shallow as the weapon is drawn over the surface of the skin. This is known as "**tailing of the wound**" (Fig. 11.11).

- Tailing of the wound indicates the direction of application of force and the relative position of the assailant and the victim.
- The **shape** of the injury will be fusiform or spindle due to comparatively more retraction of the edges in the center. When inflicted on the convex surface of the body like the occipital region or buttocks, the wound may be crescentic or semilunar in appearance.
- Profuse bleeding is present, as the vessels are clean cut.
- In case of an oblique slash by a sharp edged weapon, beveling of the edges may be present indicating the angle at which the weapon was applied.
- Incised wounds will produce a skin flap when the weapon is struck nearly horizontal to the body.
- In the event of death in such cases, the cause of death is predominantly due to shock and excessive bleeding.
- In case of cut-throat injury, in addition to hemorrhagic shock, death may occur due to asphyxia as a result of aspiration of blood into the respiratory passage.
- In case of homicidal injuries, incised wounds or cut wounds seen on the palmar and dorsal aspects of hands or on the postero-medial aspect of the forearm is indicative of defence injuries (Fig. 11.12).
- Multiple, parallel superficial incised wounds seen over the wrist or neck or elsewhere on accessible parts of the body are hesitation cuts indicative of suicidal tendencies.

Cut wounds:

- Cut wounds are produced by a perpendicular strike, using a heavy cutting weapon such as a chopper or long cutting weapon (Fig. 11.14).
- The resultant injury depends on the weight of the weapon and the force used.
- The injuries are usually severe in nature; it may involve all the layers of tissues like skin, muscles, and also the bones. On the bone, there would be linear fissured fracture or a cut fracture dividing the bone into two; the margins of the cut ends are cleanly divided.

Fig. 11.12 Cut wound of hand — Note the muscles, vessels and bones are cut along the plane of external injury; caused by heavy cutting weapon (defense injury)

Fig. 11.11 Incised wound of the neck with "Tailing"

Fig. 11.13 Multiple incised wounds of the neck

Fig. 11.14 Cut wound of the head — Note: The perpendicular strike by a heavy cutting weapon

Fig. 11.15 Fracture tibia — Externally there is only a small abrasion, but internally there was complete irregular fracture of tibia; note: The extensive bruising of the surrounding soft tissues (antemortem fracture)

- **Chop wounds** are produced by an oblique strike in a tangential manner, using a heavy cutting weapon. A flap may be lifted or the injured part may be severed from the body (Fig. 11.16).

18. How does healing of an incised wound takes place?

- **When fresh:** Bleeding may be still present or fresh soft clot is found loosely adherent onto the base; margins are red, slightly swollen and tender.

Fig. 11.16 Chop wound on the occipital region of scalp — Note: Multiple parallel wounds caused by heavy cutting weapon and force applied in a tangential manner; the underlying brain tissues are cut along the plane of the injury

- **By 12 hours:** The margins are swollen and red; blood and lymph dry up; histologically, there is leukocytic infiltration.
- **By 24 hours:** There is proliferation of connective tissue cells and vascular endothelium.
- **By 36 hours:** There is capillary network formation and fibroblastic infiltration.
- **By 48 hours:** Capillary network is complete and fibroblasts run across the new vessels.
- **By 3–5 days:** Blood vessels are thickened and many new vessels obliterate. Healing of the wound by scar formation starts and advances; and by the end of 6th day the scar formation is complete.
- The scab over the wound falls off or can be taken out easily, leaving a soft, tender, reddish scar, which in the course of weeks or months becomes whitish and firm.
- **Note:** Incised wound produced by **saw-like** movement of the weapon over those parts of the body covered with loose tissue may appear irregular and ragged and give the impression of lacerated wound.

Postmortem incised wound:

- Incised wounds may sometimes be produced on the dead body, which are though rare, may be related with sexual perversion. These incised wounds are made to mutilate

the body particularly the private parts, after forceful sexual intercourse and killing of the victim by any means like injuries or strangulation.
- Sometimes after killing a person, the body is cut into multiple pieces for disposal.
- In cases of murder, the face of the victim is mutilated by multiple incisions to obliterate the feature of identification.

19. How to differentiate suicidal cut throat from homicidal cut throat injury?

See Table 11.6.

20. What are the injuries caused by pointed weapon?
What are the types of stab wound? What are the features of a stab wound?

- Stab wounds are injuries produced with a pointed weapon. The weapon need not always be sharp. It can be a sharp pointed weapon like a knife or only a pointed weapon like the end of an umbrella or a broken branch of tree.
- If weapon is sharp, then less force is needed to thrush the weapon into the body and marginal bruising is less or absent; but when the weapon is pointed and not sharp, then more force is necessary to stab the victim and there is a large abrasion around the wound (Figs 11.17 and 11.18)
- Stab wounds are of two types:
  (i) **Penetrating wounds:** The wound enters the body through one cavity and ends at one point or organ, without producing any wound of exit.
  (ii) **Perforating wounds:** When the weapon enters the body through a cavity and exits out of the body, thus producing two surface wounds (entry wound and exit wound).

Features of a stab wound:

- Breath: The breath of a stab wound usually does not correspond to the thickness of the blade, because of the gapping of the wound margins produced by skin elasticity. But when the edges are approximated, it corresponds to the thickness of the weapon.
- The depth of the wound which corresponds to the length of the track is a guide to the length of the blade inserted into the body.
- The length of the wound has some relationship with the breath of the blade.
- In a stab wound when the force is applied with a thrust, the resulting injury will have a depth which is more than the length of the weapon. This is commonly seen in abdominal wall injuries where the yielding nature of the abdominal wall makes the depth of the injury more than that of the length of the weapon causing it. For example, a 4 inch pocket knife when applied with thrust

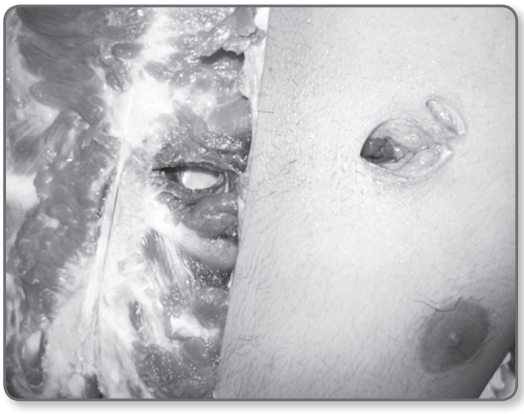


Fig. 11.17 Stab wound of the chest; the wound enters into the thoracic cavity through the intercostal space

Fig. 11.18 Multiple stab wounds on the back of chest and abdomen caused by single edged light cutting weapon, as evident by an acute and a blunt end of all the wounds

Table 11.6 Differences between Suicidal and Homicidal cut throat Injury

	Features	Suicidal cut throat (Fig. 11.19)	Homicidal cut throat
1.	Site	Mostly on the left side and on front of the neck, and partly on right side of neck, in case of right handed person	Mostly in front and partly on either or both sides of the neck
2	Situation	High up on the neck	At a lower level
3.	Direction	From left to right and above downward in a right handed person	Depends on the position of the assailant and the victim. If the assailant was on the right side of the victim, then direction of the wound would be from left to right
4.	Tailing	Present at the right end of the wound in right handed person	May be present on either side depending on the position of the assailant
5.	Hesitation cuts	Present	Absent
6.	Severity of the wound	All the incisions are superficial except one or two wounds which is fatal	Usually all injuries are of equal severity (Fig. 11.20)
7.	Defence cuts	Absent	Present
8.	Signs of struggle	Absent	Present
9.	Secondary wounds	Self-inflicted incised wounds may be present on other accessible parts of the body	Other homicidal wounds, defence cuts, marks of resistance may be present on other parts of the body
10.	Weapon	Held in the hand in case of cadaveric spasm or present nearby	Usually absent. Sometimes after killing the victim, the weapon is placed in the hand of the victim, to simulate suicide
11.	Vessels	Carotid arteries are usually spared because before injuring himself the individual stretches his neck upward, when these arteries shift behind the strenomastoid muscles	The vessels remain vulnerable to injury due to lack of this maneuver
12.	Bleeding	Suicidal injuries on the neck are produced in standing or erect position so, a good amount of blood trickles down in front of chest and abdomen	In most cases, the assailant cuts the neck of the victim in lying position, blood trickles down by the sides of the neck
13.	Foreign materials like hair, etc.	Materials like foreign hair, shirt button etc., will not be present in the hand of the victim	May be present in the hand of the victim, due to the grip in a state of cadaveric spasm
14.	Corresponding cuts on clothes	Absent as the person cautiously removes the clothes to get a clear field to cut the neck	Cuts may be present on clothes as the assailant being in haste is unmindful about the clothes
15.	Circumstance	Closed room bolted from inside or secluded place, which appears undisturbed; the body may be found in front of a mirror	Place of occurrence remains approachable to others which appears disturbed due to struggle with the assailant, latent fingerprint, belongings of assailant may be available in the scene of crime
16.	Suicidal note	May be present	Absent

can produce a stab injury of 6 or 7 inches in depth.
- The lung if punctured, may collapse and be drawn upward and backward when the impact is from the side of the chest, thus giving increased measurements at autopsy.
- The depth and direction of the stab wound depends on the relationship of intra-abdominal organs at the time of assault (whether the victim was standing erect, bent or lying).
- Track of the stab wound indicates direction of the wound.
- Probing is not advisable in living individuals, as it may dislodge some clot or create false passage.
- Depth should be determined by dissecting the track of the wound in layers during operation or autopsy.

Margins
- Margins are inverted. Margins can be everted when the wound is situated over the fatty area such as abdomen or gluteal region; but the margins of exit wound are always everted.
- When a sharp cutting weapon has been thrust, the margins are clean cut without bruising.
- Abrasion or bruising of the margins suggests complete insertion of the blade which produces an imprint abrasion of the hilt or handle. The suspected weapon if available must be examined for compatibility of the shape of the hilt of the handle with that of the abrasion or contusion present on the body.

Shape:
- Usually elliptical in shape, but may vary (like V, square, diamond, cruciate, satellite shapes, etc.).
- The size, shape and configuration of a stab wounds are influenced by a number of endogenous and exogenous factors.
- The elastic tissues of the dermis and the deeper layer of the skin have considerable bearing upon the shape of the wound.

21. What are langer's line?
- The dermal collagen and elastic fibers are arranged in definite pattern and are flowing along imaginary lines present all over the body.
- The pattern of fiber arrangement are the lines of cleavage of the skin and their linear representations on the skin are known as "Langer's line of cleavage."
- These cleavage lines correspond to the creases of the body surface and these are held in tension. When an injury cuts these lines perpendicularly (at right angle), there is wide gapping of the resultant wound.
- A stab wound with long-axis at right angles to the cleavage lines of Langer, will gape open with edges pulled apart.
- A stab that is inflicted parallel to these lines will appear slit-like or wedge-shaped (dimension of blade will fairly match with the injury).

Fig. 11.19 Decapitation of head due to run over by train — Suicidal

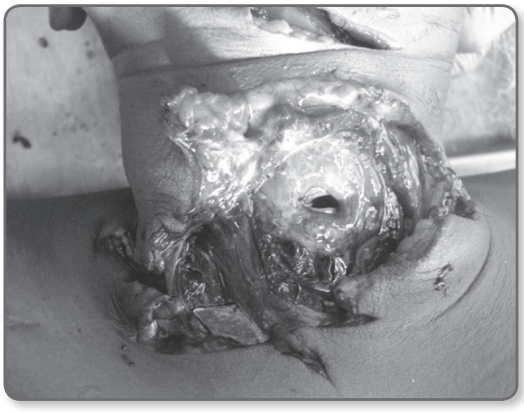


Fig. 11.20 Cut throat injury – Note: The multiple overlapping injuries and puncture wound of trachea

22. Write short notes on defense wounds.

- They are the result of immediate and instinctive reactions of the victim to save himself, either by raising the arm to prevent the attack or by grasping the weapon.
- If the weapon is blunt, abrasions and bruises are produced on the back of forearms, wrist or back of the hands (Fig. 11.21).
- The size and shape depends upon the type and shape of the weapon.
- When sharp weapons were used, the injuries produced will depend upon the mode of application of force.
- In stabbing with a single edged weapon, if the weapon is grasped, a single cut is produced on the palm of the hands or on the creases of the fingers and/or thumb.
- If the weapon is double edged, then cut injuries are produced both on the palmar aspect and the fingers. The cuts may be irregular and ragged, because of the gripping movement of the hand.
- A typical defence wound is seen in the web between the base of the thumb and index finger, when the blade is grasped (Fig. 11.22).
- The presence of defence wounds indicate homicidal nature of the injuries and may be absent if the victim is incapacitated, unconscious, intoxicated or attacked by surprise.

23. What are self-inflicted wounds? How will you diagnose a fabricated wound?

- Self-inflicted wounds are those inflicted by a person on his own body.
- Fabricated wounds (**fictitious, forged or invented wounds**) are inflicted by a person on his own body or by another person with his consent.
- These types of wounds are inflicted:
  (i) To charge an enemy with assault or attempt murder;
  (ii) By the policemen and watchmen acting in collision with robbers to show that they were defending the property;
  (iii) By the prisoners to bring a false charge of torture against the officers;
  (iv) By the recruits of uniformed services to escape hard work;
  (v) By women to bring a false charge of sexual assault or cruelty against them.
- The commonest injuries fabricated are incised wounds; many a times false contusions and sometimes stab wounds and burns. Lacerated wounds and true contusions are least fabricated (Fig. 11.23).
- Self-inflicted incised wounds are usually multiple, superficial, shallow and parallel to each other, present on the accessible parts of the body and do not involve any vital parts like face.

Fig. 11.21 Multiple linear bruises, caused by heavy cutting weapon and force was transmitted through the clothing; a case of murder

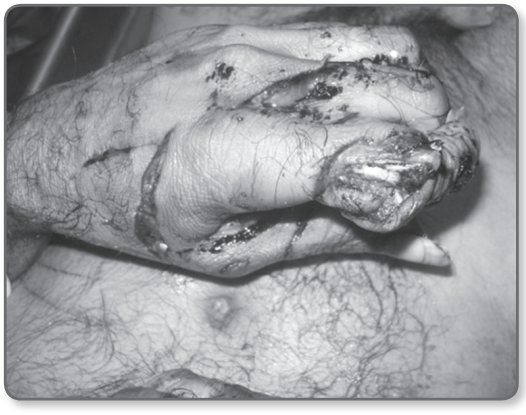


Fig. 11.22 Multiple cut wounds on the back of hand — Defense wounds

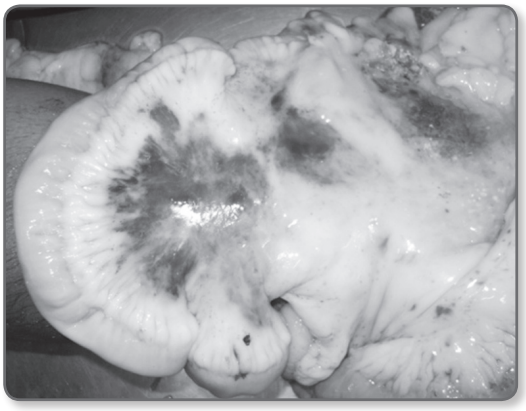


Fig. 11.23 Diffuse bruising of the mesentery due to blunt force injury to the abdomen

- The direction is from behind forward on the top of the head; from above downward on the outer side of upper arm; from below upward on the front of forearms; variable on lower extremities, chest and abdomen.
- Burns are superficial and usually on the left upper arm.
- Clothes are not cut, and if cut are not compatible with the nature of the wounds.
- The history of the assault is usually not compatible with the injuries present on the body.
- Fabricated bruise are also produced using plant juices of Semecarpus anacardium and Calotropis; which can be easily made out by an expert by examination of the margins for the presence of vital reactions, color changes, blister formation and itching.

24. What are hesitation cuts?

- Hesitation cuts are also called ***tentative cuts*** or ***feeler strokes***.
- These are multiple, superficial, horizontal and linear injuries almost parallel to each other. These injuries are never deep.
- The tentative cuts are always superficial because it is the basic instinct of a human to preserve his life, that he cannot inflict painful deep injuries to himself.
- The presence of hesitation cuts indicates the suicidal nature of the injury.
- Commonly present in cut throat injuries on the neck around the main wound, which indicates the half-heartedness and the divided state of mind.
- They are present only on the accessible parts of the body, commonly present on the front of forearm, wrist or elsewhere on the body.
- These types of injuries are also inflicted to annoy or threaten the people close to them.

CHAPTER 12

Regional Injuries

Keywords: Head injury, intracranial hemorrhages, cerebral concussion, lucid interval, skull fracture, pond fracture, fracture ala signature, coup and contre coup injury, cardiac tamponade, whiplash injury, railway spine, primary impact, secondary impact, second impact.

INTRODUCTION

Regional Injuries

- Regional injuries are produced in various parts of the body, either as a result of trauma or violence. Among the regional injuries, the commonly occurring condition is head injury. However injuries to other body parts like injury to the chest including rib fractures, heart and lung injuries, damage to the abdominal visceral organs, pelvic injury, injury to the spinal cord and injuries to the extremities are not uncommon.

1. Define head injury. What are the mechanisms of skull fractures?
What are the various types of skull fractures?

- Head injury includes injury to the scalp (Fig. 12.1), skull and to the brain. Any injury which produces structural and/or functional damage to head and brain are head injuries.
- Injury to the skull could be to the cranial vault or base of the skull.

Skull fractures

- There are two mechanisms by which skull fracture may be caused:
  (i) ***Direct violence:***
  – An object in motion striking the head or a moving head striking a stationary object. Compressions of head under the motor wheel, a stone thrown on the head or a hammer striking the head are examples of direct violence.
  (ii) ***Indirect violence:***
  – Injury to the skull from a force transmitted from elsewhere.
  Examples: Injury to the skull occurring due to fall on the feet or buttock. Here the impact sustained by the feet or buttock is transmitted through the spinal column resulting in injury to the base of the skull (***Ring fracture***).

Fig. 12.1 Extensive scalp contusion and bruising of temporalis muscle

Mechanism of skull fracture:

- There are two mechanisms by which skull fractures are produced.
  - (i) ***Fracture due to local deformation:***
    - When the skull receives a focal impact, the area under the point of impact bends inwards and hence, compensatory bulging occurs at other areas. The contents of skull are virtually incompressible. When the distortion of the bone exceeds the limit of elasticity, then both these intruded and extruded areas may get fractured.
  - (ii) ***Fracture due to general deformation:***
    - When the skull is compressed in between two external objects such as the ground on one side and the wheel of a vehicle on the other side, causing distortion and bulging of the part distal to the point of impact, which may result in fracture.

Types of skull fractures:

i. ***Fissured fracture (Fig. 12.2):***

- These are linear fractures produced by general deformation of the skull.
- These are likely to be caused by forcible contact with a broad hard surface or blows with an agent having a relatively broad striking surface.
- The outer table is capable of rebounding to its normal shape whereas the more brittle inner table gets fractured.
- Fissured fractures do not tend to cross bony buttresses such as glabella, frontal and parietal eminences and occipital protuberances (this is called as "**Puppy's Rule**").

ii. ***Depressed fracture:***

- These fractures are produced by focal application of force. Localized depressed fractures are caused by blows from heavy weapon with a small striking surface. For example, Hammer
- It results in local deformation of the skull and the fractured fragment may sometimes be driven inward into the skull cavity.
- When a hammer is used, the fracture is circular or an arc of a circle, having the same diameter as the striking surface, thus giving a clue to the weapon used.
- Sometimes the fracture radiates in all direction from the center point of application of force. The part of the skull which is struck first shows maximum depression. Then it is called as "depressed comminuted fracture". This is also called as ***"*fracture ala signature (Fig. 12.4)*"*** as the pattern resembles like a signature.

iii. ***Comminuted fracture (Fig. 12.3):*** (Comminuting—Fragmentation)

- It is often a complication of fissured and depressed fracture.
- In a comminuted fracture, there are two or more intersecting lines of fracture, which divide the bone into three or more fragments.
- When there is no displacement of fragments, it resembles a **spider's web** or mosaic pattern. When the force is high, the fragments

Fig. 12.2 Fissured fracture

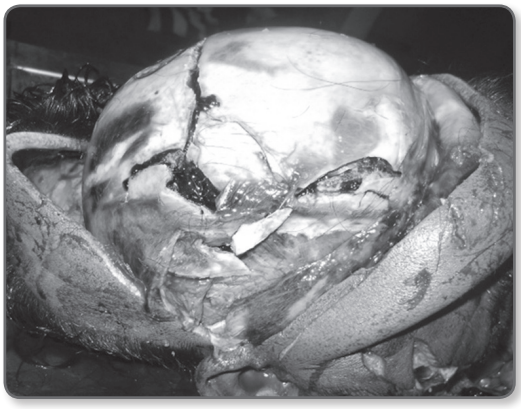


Fig. 12.3 Comminuted fracture

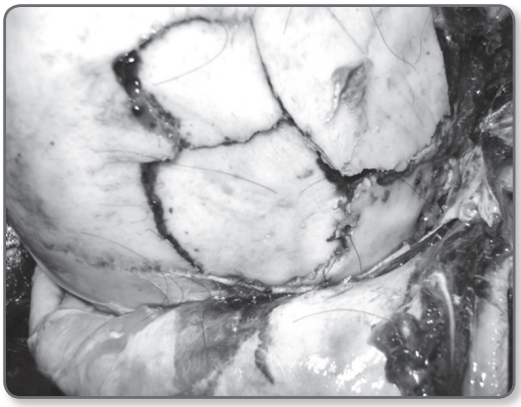


Fig. 12.4 Depressed comminuted fracture

may get displaced and some of the fragments may enter the brain.

- Comminuted fractures are caused by a fall from a height on a hard surface or blows by weapons with large striking surface.

iv. ***Pond or indented fracture:***

- This type of fracture usually occurs only in infants. There is a shallow depressed fracture forming a concave "pond" (dent) like appearance.
- It is more common in the pliable bones of infants; these are caused by obstetric forceps, blow by a blunt object or impact against some hard protruding object.
- Sometimes there is no fracture of inner table but a fissured fracture may occur in the outer table around the periphery of the dent.

v. ***Gutter fracture:***

- In this type of fracture, the full thickness of the bone is not involved, it is only the outer table which is removed as a result of the tangential movement and the glancing effect of the moving object. When a part of bone is removed, it forms a gutter like shape as in a case of a bullet injury.
- Sometimes it is associated with irregular depressed fracture of inner table of skull.

vi. ***Ring fracture or foramen fracture:***

- It is a fissured fracture around the foramen magnum which encircles the base of the skull. It is always due to transmitted force from a distant site of impact.
- The fracture runs about 3 to 5 cm outside the foramen of magnum at the back and sides of skull, due to which the skull is separated from the spinal column.

  Causes:

  - Fall from a height on the feet or buttock; A severe blow to the vertex.
  - A forceful blow on the chin, as in a road traffic accident and fisting.
  - May also be caused by sudden violent turn of the head on spine.

vii. ***Perforating fracture:***

- Caused by firearms and pointed sharp weapons like daggers, knives and axe.
- The weapon passes through both the tables of the skull.
- The size and shape correspond to the cross-section of the weapon.

viii. ***Diastatic or sutural fracture (Fig. 12.5):***

- Fracture on the sutural lines which results in separation of the sutures. It is commonly seen in young and adult individuals, in whom the skull sutures are not fused completely.
- It may be associated with other type of fractures.

ix. ***Fractures of base of the skull:***

- Base of skull fracture may be produced by a force applied directly at the level of base, or due to general deformation of skull.
- It may also occur as an extension of force from the vault and by the force applied to the base through the spinal column or face.

Fig. 12.5 Sutural fracture of coronal suture

- Fractures of the base of skull may be:
  (i) Longitudinal: As in case of front to back or back to front compression, e.g. run over.
  (ii) Transverse fracture due to side-to-side compression, and
  (iii) Ring fracture.
- Fracture of anterior cranial fossa can be indicated by discharge of blood through mouth and nostrils.
- Fracture of the middle cranial fossa diagnosed by loss of blood from mouth and ears. Fracture of petrous temporal bone allows blood and CSF to escape through the ears.
- Fracture of the posterior cranial fossa results in extravasations of blood is behind the mastoid process, or a large hematoma in the soft tissues of back of the neck.

2. What are coup and contrecoup injuries?

- **Coup injury:** It means the injury which is caused at the point or beneath the area of impact and results directly from the impacting force.
- **Contrecoup injury:** Here the resultant injury or damage is produced diagonally opposite to the point of impact.
- A line drawn between the centers of coup and contre coup injury indicates the direction of the force of impact; contre coup injuries are common only on the brain.

Mechanism of contrecoup injury:

- The injury depends upon the acceleration and deceleration force.
- Occurs only when a moving head is struck or suddenly stopped by a stationary object.
- When the individual is in motion, the skull moves forward, the brain which lags behind is also in motion toward the same direction. When the moving head is suddenly stopped, the brain hits over the skull, bounces back and hit over the opposite side of the skull which results in injury at that point. This is called as "contre coup" injury.
- Contre coup injuries will not occur when the head is well-fixed at the time of impact or held immovable and cannot rotate. In other words, for a contre coup injury to occur the head should be in motion and/or free to rotate.
- Contrecoup injuries are due to shearing strain of brain and meninges.

Impact area	Contrecoup lesion
Occipital region	Under surface of frontal lobes and parts of temporal lobe
Parietal region	External surface of frontal and temporal lobe of opposite side

- When both coup and contre coup injuries are present, then the contre coup lesions are more severe than the coup one.
- Contrecoup injuries are rare before the age of three years, as the skull is more flexible.

Medicolegal importance:

- The point of impact can be identified, especially when only contre coup injury is present.
- When both coup and contre coup injuries are present, it should not be mistaken for two different impacts.
- Indicates whether the head was fixed or mobile at the time of impact.

3. What is concussion of brain or commotio cerebri? (cerebral concussion)

- It is a state of temporary unconsciousness due to head injury which is seen immediately after impact, and is always followed by amnesia. It tends to recover spontaneously.
- Concussion most often occurs with acceleration or deceleration injuries, when the head is moving or is freely movable. This is popularly known as 'stunning of the brain'.

Symptoms and signs:

- Patient recovers completely after a brief period of unconsciousness with symptoms of "post-concussion syndrome".
- Recovery from concussion is often followed by complete loss of memory to recent events. (retrograde amnesia).
- This retrograde amnesia is often due to injury to the frontal lobes.
- It has medicolegal significance as it may be associated with post-traumatic automatism.
- In rare circumstances, the patient may die without regaining consciousness when the shock due to concussion is severe.

PM findings:

- May not be rewarding, but some cases may show petechial hemorrhages over cerebral cortex at the junction of gray and white matter.
- Naked eye examination does not reveal any structural damage to the brain; however on microscopy, retraction bulbs may be demonstrated.

4. What are the types of intracranial hemorrhages?
Discuss the features of EDH?
What is lucid interval and how it occurs?

- Intracranial hemorrhages are mainly of four types:
  1. Extradural/epidural hemorrhage
  2. Subdural hemorrhage
  3. Subarachnoid hemorrhage
  4. Intra-cerebral hemorrhage.
- Bleeding over a large area of brain surface, as a thin film is called as hemorrhage. If it is large, well-circumscribed and space occupying, it is called as hematoma.
- According to their situation in relation to the membranes, intracranial hemorrhages are classified as extradural, subdural, subarachnoid and intracerebral hemorrhages.
- Intracerebral hemorrhage may be: Cerebellar, cortical, thalamic, pontine, medullary.

i. **Extradural/Epidural hemorrhage (Fig. 12.6):**

- Bleeding occurs in between inner table of the skull and the dura matter.
- Mostly traumatic in origin and occurs usually on the same side of impact (coup injury).

Causes:

- Impact over the lateral convexity of the head may result in rupture of the middle meningeal artery or any of its branches; less commonly, the posterior meningeal artery.
- EDH is seen in common association with fracture of squamous part of temporal bone.
- The middle meningeal artery is embedded deep in the groove within the skull and remain firmly attached to the dura. Fracture of the skull bones causes stretching of the vessel which leads to rupture of the artery.
- Rupture of anterior branch of middle meningeal artery, usually compresses motor area of the brain of the same side.

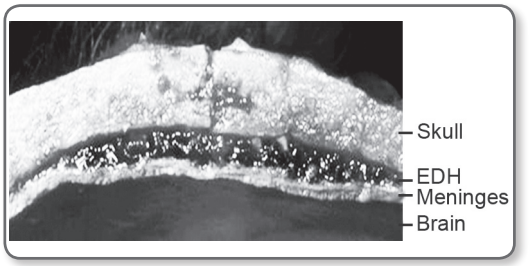


Fig. 12.6 Extradural hemorrhage on both sides of occipital region

- In infants and old age, EDH is not common, as the dura remains tightly adherent to skull.

Salient features of EDH

- The clot will press the brain inward, producing signs and symptoms similar to that of space occupying lesions and increase in intracranial pressure. The clot produces a localized concavity or flattening of external surface of brain.

Clinical features of EDH:

- Following injury, patient loses consciousness due to cerebral concussion.
- After some time, he regains consciousness. Later on, due to continued bleeding, cerebral compression occurs and the patient goes into permanent unconsciousness (coma).
- Death results from respiratory failure due to compression of brainstem.
- Nearly 25–50% of cases may end fatally.

Medicolegal Importance of EDH:

- The period of consciousness between two bouts of unconsciousness is called "**lucid interval**". Early diagnosis by CT scan and surgical intervention by craniotomy and evacuation of the blood clot usually saves the patient. EDH is the only intracranial hemorrhage where the chances of survival by surgical intervention is more, and hence the doctor may be held liable for death of such patients.
- In all cases of head injury, the patient must be kept under observation for a minimum period of 24 hours. A charge of negligence may be filed against the doctor if he fails to keep the patient under observation. Repeat X-ray and CT scan are advisable to confirm no EDH is present before deciding the patient is fit for discharge.

5. Write short notes on subdural hemorrhage.

- Hemorrhage occurring inside the subdural space is subdural hemorrhage.
- Subdural space is the narrow space in between the dura and arachnoid mater; it contains a small amount of fluid, which permits the tough arachnoid to move toward the dura (Fig. 12.7).
- This is the commonest type of intracranial hemorrhage.
- It is invariably traumatic in origin following a blow or fall. SDH may occur even without any fracture of skull or injury to the scalp.
- Subdural hemorrhage is essentially venous or capillary bleeding and not arterial bleeding.

Causes of SDH:

- SDH commonly occurs due to:
  (i) Rupture of bridging veins or communicating veins when brain moves across the dura.
  (ii) Rupture of inferior cerebral veins, entering the sinuses at the base of the skull.
  (iii) Rupture of dural venous sinuses following a blow, or
  (iv) Injury to the cortical veins.
- SDH also occurs due to lacerations or contusions of brain and dura, injury to the old adhesion between the brain and dura; and due to cerebral neoplasm, aneurysm, superior saggital sinus thrombosis or bleeding disorder.
- The volume of blood varies from a few drops or a thin layered effusion to 150 mL or more. Death may occur if the hemorrhage exceeds 50 mL.
- SDH could be acute, sub-acute or chronic:
  (i) ***Acute subdural hemorrhage: (Immediate)***
  – ***Clinical symptoms:*** There may be slight confusion and forgetfulness, but no lucid interval.
  (ii) ***Subacute SDH: (several days to 2–3 weeks)***
  – In subacute, type the brain may or may not be damaged (Fig. 12.8).
  (iii) ***Chronic SDH: (Pachymeningitis Hemorrhagica Interna)***
  – It presents usually 3 to 6 weeks after the injury.
  – It is a frequent incidental finding at autopsy in old persons.
  – The blood collected in subdural space cannot be reabsorbed as dura and arachnoid has no mesothelial lining.
  – By 3–4 weeks the hematoma gets completely encapsulated.
  – Death is very common due to secondary pressure on brainstem.

6. What is subarachnoid hemorrhage?

- The space between the arachnoid and the pia mater is the subarachnoid space.
- It is filled with CSF produced by the choroid plexuses of the lateral and fourth ventricles.
- In all cases of significant brain injury, some degree of SAH is found.

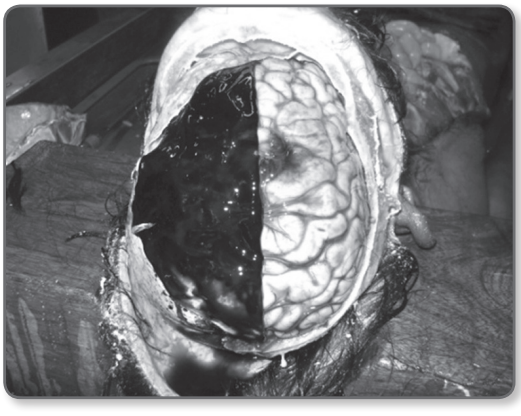


Fig. 12.7 Thick film of subdural hemorrhage on left cerebral hemisphere

Fig. 12.8 SDH and SAH on both cerebral hemispheres; the dura on left side is cut and brain is exposed

- Subarachnoid hemorrhage usually spreads out, rarely forms a hematoma and removed by phagocytosis.

Causes of subarachnoid hemorrhage:

i. ***Nontraumatic:***
- Common in young adults due to rupture of minute developmental aneurysms of the vessels of circle of Willis.
- In elderly subjects, spontaneous rupture of anterior and posterior cerebral arteries.

ii. ***Traumatic causes:***
- Commonly associated with traumatic head injuries.
- Blow over the jaw or on the sides of upper part of the neck may cause rupture of vertebral artery with basal SAH.

Clinical features:
- Diagnostic feature of SAH: Sudden onset of intense headache with stiffness of the neck and photophobia, followed by unconsciousness.
- The diagnosis is confirmed by lumbar puncture which reveals CSF intimately mixed with blood coming out under pressure.

7. What is intracerebral hemorrhage? What is dementia pugilistica?
- This may be found on the surface or in the substance of the brain (Fig. 12.9).
- It occurs most frequently and spontaneously in the elderly and middle aged hypertensives, due to rupture of lenticulostriate artery in the basal ganglia, pons, etc.
- Large areas of hemorrhage may occur at the junction of gray and white matter of the frontal and temporal lobes.
- Causes of ICH other than trauma are arterial thrombosis, fat embolism, cerebral aneurysm; patients under anticoagulant (warfarin) therapy; angioma, brain tumor or metastasis.
- When starts, the hemorrhage may be small but will enlarge due to gradual oozing, leading to edema and softening of brain; ultimately rupture into the ventricle to cause death known as "**delayed traumatic apoplexy.**"

Punch Drunk Syndrome: (Dementia Pugilistica)
- It is a state that occurs in boxers due to the tiny hemorrhages in the brain.

Fig. 12.9 Intracerebral hemorrhage

- The patient suffers from post-traumatic psychosis, loss of memory, tremors, rigidity of the limbs and dysarthria.

8. What is railway spine?
- Railway spine is due to concussion of spinal cord.
- Usually caused by forcible blow over the back or rarely by fall from a height.
- There could be injury to spinal column and it can occur without any evidence of external injury to the spinal column.
- Commonly seen in railway accidents and motor car collisions, hence called as railway spine.

Signs and symptoms:
- Associated with paralysis of upper and lower limbs, with or without involvement of bladder and rectum.
- There may be inability to walk, irritability of temper, loss of sexual power. But, the patient may improve gradually within 48 hours.
- ***Medicolegal importance:*** May involve compensation in civil suits.

9. What is whiplash injury?
- Whip lash injury of spinal cord is due to sudden hyperflexion and hyperextension.
- Usually sustained by an occupant of a car due to sudden stoppage of a high speed vehicle or sudden movement of a resting vehicle, which results in sudden hyperflexion fol-

lowed by hyperextension (or hyperextension followed by hyperflexion) of the head.
- Resulting in fatal contusion or laceration of spinal cord without fracture of spine.

10. Discuss about cardiac tamponade.
- It is the accumulation of blood in the pericardial sac.
- Accumulation of 400–500 mL of blood will be sufficient to cause death.
- Mechanism: Collection of blood in pericardial sac, which prevents ventricular dilatation in diastolic phase, thus compresses the right atrium and venous openings, resulting in progressive failure of circulation, leading to fall in arterial pressure and rise in venous pressure.

Causes:
- Penetrating wounds of heart and great vessels.
- Contusion and laceration of pericardium and heart, by the fractured ends of ribs or sternum.
- Rupture of heart or aorta from indirect force and old myocardial infarction.
- Accidentally occurs during sternal puncture or intracardiac injections in emergency.
- With intact parietal pericardium, cardiac tamponade will be rapid. It will be slow when the parietal pericardium is punctured or lacerated since the blood can escape out.

11. What are the types of transportation injuries?
- Transportation injuries are caused by blunt force with powerful impact, which could result in three types of injuries:
  (i) Primary impact injuries
  (ii) Secondary impact injuries
  (iii) Secondary injuries.

Primary impact injuries:
- These are injuries caused when the vehicle hits the victim (pedestrian).
- It depends on the position of the victim and the part of the vehicle which comes into contact with the pedestrian.
- It bears the design of that part of the vehicle which struck, in the form of an imprint abrasion or a patterned bruise.

Secondary impact injuries:
- These are injuries sustained by the victim after being knocked down by the vehicle. It is due to fall and friction or by the impact on the ground of the individual.
- Injuries may be any blunt impact injuries like abrasions, grazed abrasions, stretch lacerations, etc.

Secondary injuries:
- Injuries sustained as a result of impact between the body and the vehicle for the **second time**.
- The injuries may be run over injuries (crush injuries or internal lacerations and fractures) or avulsions (avulsed lacerations, stretch lacerations or brush burns, etc.).

CHAPTER 13

Forensic Ballistics

Keywords: Ballistics, shot gun, rifled firearm, choking, bore, caliber, cartridge, entry wound, exit wound, scorching, smudging, singeing, stippling, abrasion collar, dirt collar, grease collar, range, contact range, smokeless gunpowder, nitrocellulose, dum dum bullet, souvenir bullet, gunshot residues, dermal nitrate test, neutron activation analysis, atomic absorption spectrometry.

INTRODUCTION

- **Ballistics** is the science which deals with the study of firearms and ammunition.
- The experts who deal with this branch of science are called as "ballistic experts."
- Proximal ballistics: It is the study of firearm and projectiles.
- Intermediate ballistics: Study of motion of the projectile, after being ejected from the firearm till the time it hits the target.
- Terminal ballistics: Study of the damages (effects) caused by the projectile on the human body, and hence called "**wound ballistics**". Doctors are the experts in this area of ballistics.

1. Define a firearm. What is an ammunition?

Firearm:

- It is a mechanical device equipped to create an explosion, which in turn forces out a projectile at high velocity in order to hit the target.

Ammunition:

- It refers to materials used for causing the explosion, along with the projectile. One complete round of ammunition is called the cartridge.

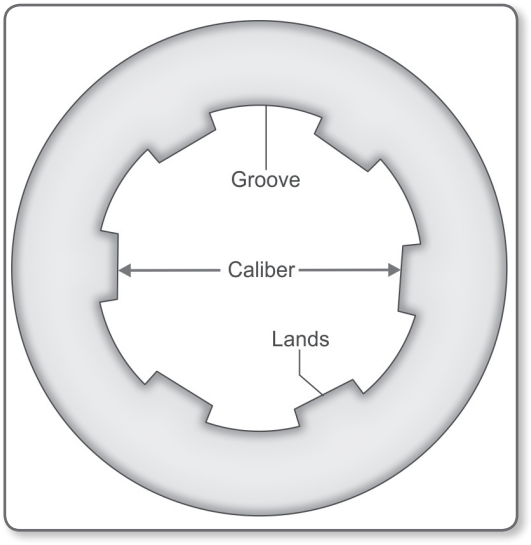


Fig. 13.1 Cross-section of barrel in rifled firearm

General makeup of a firearm/Mechanism

- Any firearm consists of a barrel, a chamber and a triggering mechanism.
- The barrel consists of a hollow metal cylinder of varying length, which is closed at the back (breech end) and open at the front (muzzle end).

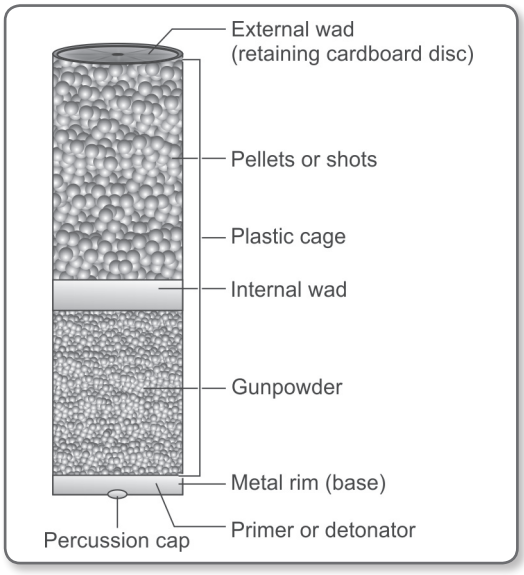


Fig. 13.2 Shotgun cartridge

- The chamber consists of a cabin which can accommodate the cartridge situated at the breech end.
- Trigger and the firing pin initiate the process of firing.

Cartridge:

- It consists of an outer case in which the explosives or chemicals required to ignite the gun powder and the projectile are packed.
- The igniting chemical is the detonator (primer).
- The projectile is either bullets (rifled firearms) and pellets or shots (shot guns).

2. Classify firearms. What is choking? What is a rifled firearm?

- Shot guns
- Rifled firearms
- Air guns or gas operated firearms
- Country made firearms.

Shotgun: These are smooth bored firearm; these may be:

i. Single barreled or double barreled
ii. Breach loader or muzzle loader
iii. Cylindrical or choked.

- **Choking of a firearm:** It is done only in case of shotguns. In this, the terminal portion of the barrel is constricted to prevent the early dispersion of the pellets. Depending upon the degree of choking, it may be quarter choke, half choke or full choke.

Fig. 13.3 Barrel of shotgun (smooth bored) cylindrical gun

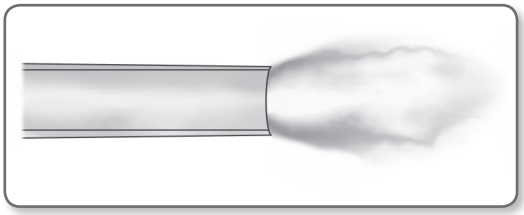


Fig. 13.4 Dispersion of pellets in cylindrical gun

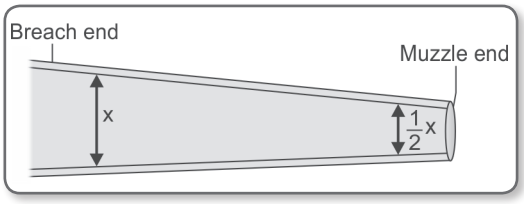


Fig. 13.5 Choking of a shotgun

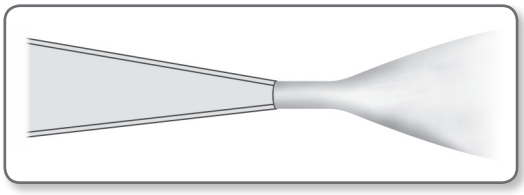


Fig. 13.6 Effects of choking — Prevents early dispersion of pellets

- **Caliber of a shotgun:** It is the number of lead balls of equal size and shape made from and out of one pound of pure lead. When one such ball exactly fits into the inner barrel of the gun, then the number of balls made out of one pound of lead is called the bore of the gun, e.g. if 12 balls are made from one pound of lead and one ball exactly fits into the size of the barrel, then it is designated as twelve bore gun.

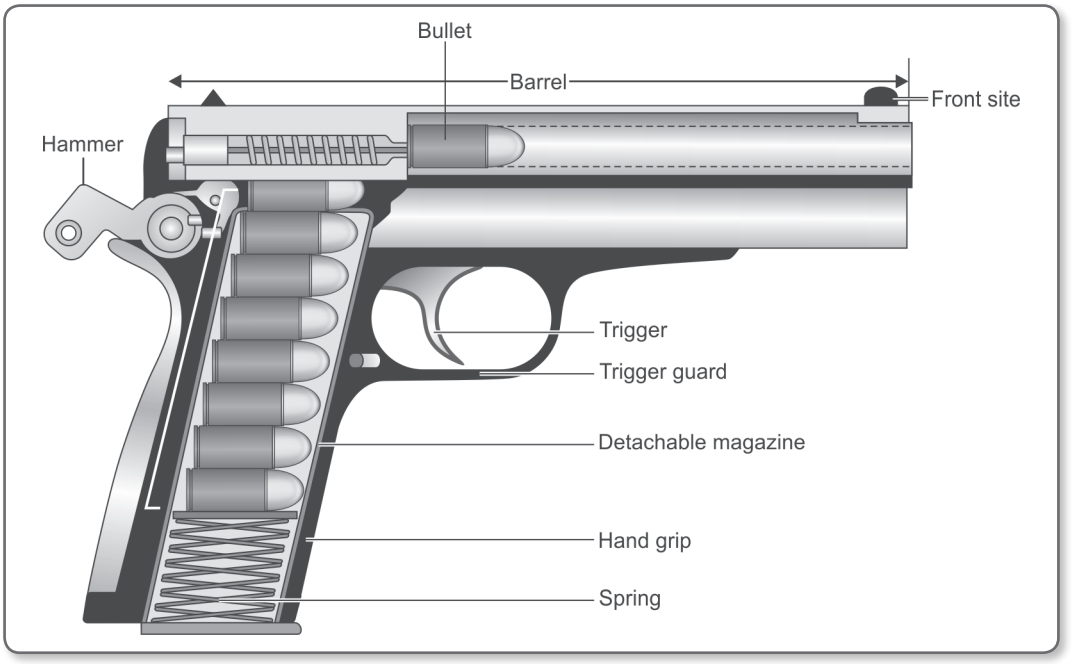


Fig. 13.7 Pistol

- **Rifled firearms:** The barrel of the gun is grooved internally with twisted spiral grooves. This is called as **rifling of a firearm.** The projecting ridges between the grooves are called as lands.
- Rifling gives the bullet a spinning motion, thus increases the power of penetration and prevents wobbling of the bullet when it is traveling in the air.
- Rifled firearms could be:
  (i) High velocity guns: Shoulder arms (machine guns, stun guns, AK-47).
  They can hit the target exactly even if fired from a very long distance. It may be manual, semi-automatic or fully automatic in their makeup.
  (ii) Low velocity guns: Hand guns (revolver and pistol).

3. Discuss the general features of entry wound of a rifled firearm.
Short notes on: Abrasion collar; contusion collar, grease collar; scorching; smudging; stippling; lead ring.

General features of an entry wound:

- When the bullet pierces through the skin: Due to the spinning motion of the bullet, the edges of the wound may be abraded and is called as "**abrasion collar**". Usually it extends upto 0.3 cm around the entry wound.
- In some cases, there may be a contusion in addition to the abrasion. This is called **contusion collar.**
- The diameter of the entry wound together with the abrasion collar gives the approximate diameter of the bullet.
- **Grease collar** or dirt collar (0.7 cm): The barrel of the firearm is cleans using lubricant (grease). When a bullet is fired, the projectile will carry a coating of the grease and while it enters the target, it is whipped off around the entry wound. This is called as "grease collar". It will be absent if firing has taken place through the clothing.
- **Burning (scorching or singeing):** It is due to the effect of the flame or fire which travels along with the projectile, upto a certain distance. When the target is within the range of the distance traveled by the flame, then evidence of burning like scorching of skin, singeing of hair follicles can be appreciated around the entry wound. Evidence of such findings can be made out

in the clothes when firing has taken place through the clothing.

- **Blackening or smudging:** Results from superficial deposit of smoke on the skin surface. Smudging may not be visible to naked eyes when smokeless gunpowder is used. In such cases, infrared or ultraviolet photography will help visualize the smudging.
- **Tattooing (Peppering or stippling):** Results from the grains of gun powder (partially burnt and unburnt) being driven into the skin, each grain acting as a minute missile. The extent of tattooing depends upon the caliber of the weapon, the type of gun powder used and the range of firing. Tattooing may be absent if firing has taken place through the clothing.
- **Lead ring:** It is a line of deposition of the metallic particle around the circumference of the entry wound which can be detected by neutron activation analysis.
- Firearm wounds are generally easily recognized as such, but sometimes wounds caused by red hot pokers or a burning pointed stick may simulate a firearm entry wound.
- Conversely, glancing injuries caused by rifled firearms may be confused with incised wounds or lacerated wounds.
- The shape of the entry wound depends upon the angle of entry of the bullet.

4. What is the range of a firearm injury? How do we find out different ranges of a firearm injury?

Range: The distance traveled by the bullet from the muzzle end of the firearm to the target is the range of a firearm. There are four ranges:

i. ***Contact range:*** The muzzle end is in contact with the body.

ii. ***Close range:*** Within the distance traveled by flame.

iii. ***Near range:*** Within the distance traveled by smoke, unburnt and partially burnt gun powder particles.

iv. ***Distant range:*** Beyond the distance traveled by flame, smoke and gun powder.

i. ***Contact shot:***

- Contact shot over a dense area such as the cranial vault is usually large and cruciate in shape, due to the explosive effect of the gases liberated.
- The imprint of the muzzle of the weapon may be found stamped on the skin.
- Burning, smudging and tattooing are usually absent and in some cases slightly appreciable.
- Contact wounds over thin bones, chest or abdomen are usually circular in shape and are surrounded by abrasion collar and/or contusion collar.
- Hair follicles surrounding the contact wound are singed.
- Muscles and soft tissues along the track of the wound may be cherry red in color due to carbon monoxide.
- Contact shots have a varying size and shape and it will be larger than the size of the bullet due to the explosive effect.
- All the contents of the cartridge, bullet, burnt and partially burnt gunpowder, smoke and fire and are all pushed into body through the entry wound. The exit wound is larger than the size of the entry wound due to the exploding effect of the gases.

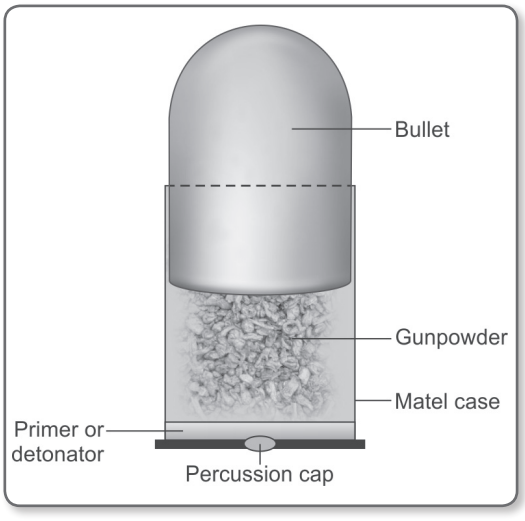


Fig. 13.8 Rifled cartridge

ii. ***Close shot:***

- Close shot is the distance traveled by the flame from the muzzle end. Usually flame travels approximately upto 7.5 cm in case of a revolver or pistol and 15 cm in case of a rifle (shoulder arms—high velocity firearms).
- Wounds are circular; margins are inverted and are surrounded by scorching, smudging and singeing of hair. They are absent if firing has taken place through the clothing but evidence of such findings will be noticed on the clothing.
- Abrasion collar and contusion collar are present; grease collar and tattooing may or may not be present, but will be present on the clothing if firing has taken place through the clothing.

iii. ***Near shot:***

- The distance traveled by smoke, unburnt and partially burnt gun powder particles; usually unburnt gunpowder travels upto 60 cm in revolver and 75 cm in case of a rifle.
- Entry wound is circular or oval in shape, with inverted margins.
- Singeing of hair and scorching are absent.
- Tattooing is seen upto a maximum of 90 cm.
- Abrasion collar and grease collar are present around the entry wound.

iv. ***Distant shot:***

- Beyond the distance traveled by flame, smoke and gun powder.
- Entry wound is circular with inverted margins.
- Scorching, smudging and tattooing are all absent.
- Distant shot suggests a range beyond self-infliction.

5. What are the features of exit wound? What are the differences between entry wound and exit wound?

- Exit wounds vary greatly in size, shape and configuration.
- They are usually larger than their corresponding entry wounds and edges may be everted.
- All the findings if entry wound such as abrasion collar, grease collar, scorching, smudging and tattooing are absent.

Table 13.1 Difference between entry wound and exit wound

Character	Entry wound	Exit wound
Size	Smaller than the diameter of the bullet	Larger
Edges	Inverted	Everted
Abrasion collar and grease collar	Present	Absent
Scorching, smudging and tattooing	May be present	Absent
Bleeding	Less	More
Fat extrusion	Absent	May be present
Atomic absorption spectrometry	Positive	Negative
Cherry red color	May be present	Absent

- Evidence of exploding effect can be noticed in exit wound except when it is supported by hard surface.

6. What is gunpowder? What is its composition?

- This is the principle requirement of the propellant; explodes rapidly and is capable of generating enormous amount of gas, which in turn pushes the projectile at high velocity.
- Usually **black gunpowder** is used and is composed of **potassium nitrate, charcoal and sulfur.**
- In **smokeless** gun powder, **nitroglycerine and nitrocellulose** are used.
- Suicidal gunshot injuries are confirmed by residues of gun powder in the hands.
- Pre-autopsy X-ray of whole body is a must in all cases of gunshot injuries both shot guns and rifled firearms, even if corresponding exit wounds are present.
- The clothing are examined for residues of gun powder around the entry wound.

7. What is dum dum bullet?

- It is a type of bullet in which the jacket does not cover the whole of the base; hence there is a tendency for the core to explode leaving

the jacket inside the barrel which hinders the loading of the next round.

8. What is ricochet bullet?

Ricochet effect of bullet:

- When a bullet is fired from the weapon, it gets deflected from its course by striking an intervening object in its way, before striking the target. This is called "ricochet bullet".
- Medico-legal importance: Culpable homicide not amounting to murder if it is proved that the injury is due to ricochet effect of the bullet. Since, the intention is not to kill the affected victim.

9. What is a tandem bullet?

- Tandem bullet is due to "**piggy back bullet/ phenomenon**".
- Due to faulty ammunition like deposition of rust or due to prolonged non-usage of the firearm, the fired bullet may get struck inside the barrel and when the next round is fired, two bullets come out and enter the target through the same entry wound or two different entry wounds as a result back to back firing of the bullet.

10. What is a souvenir bullet?

- Encapsulation of the bullet inside the body of a victim for a long period.
- The foreign body may get covered within the soft tissues producing slow absorption of the heavy metals, resulting in chronic poisoning.
- This is a rare occurrence.
- The original entrance wound may be seen as a tiny scar in such cases.

11. What is frangible bullet?

- They are bullets designed to fragment upon striking the target, often to the point of total disintegration. They are mostly made up of lead or iron. Chronic heavy metal poisoning in such individuals is common. The object of designing a frangible bullet is to make the recovery and matching with a test bullet difficult. If a bone is penetrated, they are recovered in a deformed state. These bullets do not ricochet inside the body.

12. What is kennedy phenomenon?

- Surgical alteration by suturing and extending the entry/exit wound will create problems in interpretation and evaluation at autopsy.
- This is called as "Kennedy phenomenon". In this condition, it is difficult to differentiate entry and exit wound of a firearm.

13. What are the tests for gunshot residues? Short notes on: Dermal nitrate test; NAA and AAS.

- **Harrison and Gilroy Test:** (**Dermal Nitrate Test**) The principle behind this test is that when a weapon is fired some traces of the gunpowder residues get deposited over the dorsum of the hand close to the index and the thumb fingers. Evidence of presence of gunpowder residues in an individual confirms usage of firearm by him. Dermal nitrate test is performed to find out the presence of antimony, barium and lead.

Neutron Activation Analysis (NAA):

- It is a chemical method to detect even minute traces of elements present in hair, nails, soil, glass pieces, paints, drugs and gunshot residues.
- This test is useful when a comparative sample is available; residues from the suspect's hands are removed by paraffin casting or swabs dipped in 5% nitric acid.
- The atoms of an element present in the specimen are bombarded with neutrons in a nuclear reactor; some of the nuclei of those atoms capture neutrons and they become radioactive. The radioactivity is measured using an analyzer.
- Residues of the primer, antimony and copper are detected by this method.

Atomic Absorption Spectrometry (AAS):

- It is used for measurement of antimony, barium and copper in gunshot residues. This test uses high temperature to vaporize the metallic elements of the primer residues to detect and to measure the quantity.
- NAA and AAS are used to:
  (i) Identify the holes in the clothing, tissues or wood, as whether they were caused by a bullet or not.

(ii) To find out the range of firearm (concentration of antimony and lead around the bullet entry wound).
(iii) Determine the common origin of bullet fragments from different places (in shot gun pellets: By the concentration of antimony, arsenic, copper and silver).
(iv) Find out gunshot residues on the hands, whether the person has fired the gun (presence of lead, antimony and barium in the hands).

14. What are the Primary and Secondary markings on bullets?

When a **Crime bullet** (Exhibit bullet) is recovered, it has to be found out which kind of weapon fired the shot and also the exact weapon from which the bullet was fired. This objective is achieved by checking for primary and secondary markings on the bullet.

Primary markings:

These are class characteristics (primary markings) made on the bullet by the manufacturer; which would be in the diameter, numbering and codes imprinted on the metal case of the bullet.

Such types of primary markings are also present on the gun, which are the primary principles of identification like (i) caliber of the gun, (ii) number and width of the rifling groves, (iii) direction of rifling groves (left or right twist), etc.

These class characteristics of the gun are a result of manufacturer specifications, design and dimensions.

Secondary markings on the bullet:

In all rifled firearm the diameter of the bullet is slightly larger than diameter of the barrel; hence, when the bullet is fired, as it travels through the barrel of the gun, the gun leaves its signature on the bullet and are called the secondary markings on the bullet.

Identification of the bullet is by the caliber, direction of twists of rifling, rate (number) of groves and width of the groves produced on the bullet by the firing gun.

CHAPTER 14

Thermal Injuries

Keywords: Burns, scalds, thermoregulation, hypothermia, heat cramps, sun stroke, frost bite, trench foot, epidermal burns, rule of nine, pugilistic attitude, soot particles, COHb.

INTRODUCTION

Thermal injuries are injuries due to heat and cold:

- Thermal injuries are as a result of the systemic and/or localized effects to excessive heat or cold.
- The factors determining the effects of heat are:
  (i) Temperature (the intensity of heat)
  (ii) The duration of contact of heat on the body.
- **According to Mortiz and Henriques:** The lowest temperature that would produce burns was 44°C and the time required was 5 hours, whereas at 60°C only 3 seconds are required to cause localized burns.

1. Discuss the mechanism of thermoregulation.

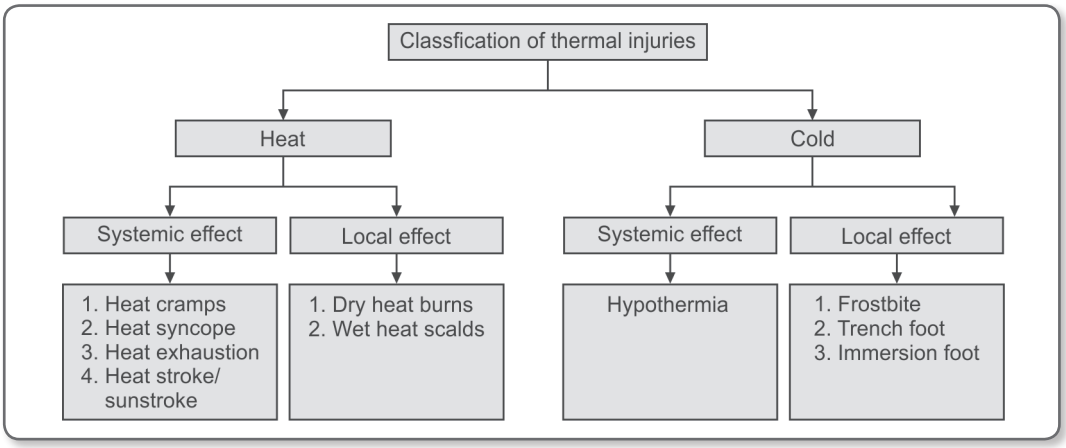
- There is always a delicate balance between heat production and heat loss.
- **Internal body factors:** The amount of heat generated by oxidation of metabolic products. (Internal factor)
- Environmental heat from the sun (External factor) is influenced by:
  (i) Moisture content of the air
  (ii) Wavelength of the light
  (iii) Spectral distribution
  (iv) Absorption by ozone layer
- Heat load results from combination of both internal and environmental factors.
- Whenever, heat load exceeds heat loss, the temperature of the body rises. The dispersion of heat takes place, mainly by sweating and vaporization from the respiratory passages.
- When the body is exposed to high temperature, there is vasodilatation of blood vessels of the skin due to inhibition of sympathetic centers in the posterior hypothalamus. When the environmental temperature increases to a point beyond loss of temperature by convection and radiation, results in sweating.
- Temperature varies in different parts of the body. The inner body temperature always remains constant, except when the individual develops fever.
- The skin temperature rises and falls with the temperature of the surroundings.
- The average body temperature is 98° to 98.6°F when measured orally. It is higher by 1° when measured rectally and lower by 1° when measured under the axilla.

2. Classify thermal injuries.
Discuss the systemic effects of heat.

Thermal injuries are either effects of heat or effects of cold.

Effects of heat:

Generalized effects: Heat stroke, heat cramps and heat exhaustion.



Localized effects: Burns (due to dry heat) and scalds (due to wet heat).

Effects of cold:

Generalized effects: Hypothermia.

Localized effects: Frost bite, trench foot and immersion foot.

Systemic effects of heat:

i. ***Heat cramps:***
- Painful spasm of voluntary muscles, especially extremities and abdominal wall. This is due to loss of water content, sodium and chloride ions from the body as in severe dehydration.

ii. ***Heat exhaustion:***
- This is due to inadequate replacement of water and salts lost in perspiration due to thermal stress.
- Usually occurs after several days of exposure to high temperature. In this condition, body temperature does not exceed 102°F.
- The symptoms are: Tiredness, increased thirst, headache, irritability, subjective feeling of exhaustion and incapacity to work; sweating, fainting and peripheral vascular collapse.

iii. ***Heat syncope: (Heat collapse)***
- It is due to loss of vasomotor tone resulting in peripheral pooling of blood usually in the lower limbs due to dilatation of blood vessels. This in reduction of blood flow to the heart. There is hypotension and reduced blood supply to the brain. Commonly seen in soldiers standing for a long time in parades under hot sun; recovery is usual.

iv. ***Heat stroke: (Sun stroke)***
- It results in absence of sweating, increase in body temperature to 106°F or more.
- Onset is acute or sometimes insidious. The skin is flushed, hot and dry.
- Pulse will be rapid, threading and BP may be normal or reduced.
- The individuals may suffer neuromuscular paralysis.
- Death is commonly due to low BP or disseminated intravascular coagulation (DIC).

3. Discuss about hypothermia.
Write short notes on trench foot and frostbite:

Pathophysiology of hypothermia:
- Temperature of peripheral parts of the body varies from time to time depending on the atmospheric temperature. But the inner core temperature of the body is always maintained constant by thermoregulation and controlled by thyroid hormone, and muscular activity.
- Heat production and heat loss are influenced by the blood flow through the skin and sweating. Clothes covering the body may also play an important role in regulating the body temperature.

Role of skin in thermoregulation:
- When the skin is exposed to cold temperature, there is contraction of blood vessels, resulting in lowering the surface temperature and conservation of body heat. This produces a feeling of chill. Continued exposure

results in injury to the superficial surface as well as loss of body heat.

Thermoregulation by lungs:

- Lungs are one of the major sources of heat exchange.
- During the process of respiration, equilibrium is maintained between the body temperature and the external environment.
- Therefore, continued breathing of cold air results in a massive loss of body heat, which leads to lowering of the inner body core temperature.

Phases of hypothermia

- ***First phase:*** No clinical significance; rectal temperature is between 90° and 98.4°F. Feeling of cold and shivering is present. Responds well to simple resuscitation measures.
- ***Second phase:*** Rectal temperature is between 75° and 90°F. The subject is depressed; there is progressive fall in pulse, BP and respiration. Sense of shivering ceases below 85°F.
- ***Third phase:*** Rectal temperature is below 75°F, temperature regulatory center ceases to function and there occurs progressive cooling; survival is rare at this phase.
- Temperature difference of 10°C between the core body temperature and the atmosphere is enough to cause hypothermia.

Alcohol and Hypothermia:

- In cold atmospheric temperature, consumption of alcohol produces vasodilatation resulting in heat generation which in turn lowers the inner core temperature of the body. It results in consumption of more and more alcohol to keep oneself warm. There will be impairment of judgment and loss of risk sense.

Mechanism of death in hypothermia:

- As the body core temperature falls, there is progressive decrease in the dissociation of oxyhemoglobin, which leads to reduced oxygen supply to the tissues.
- This in turn, depresses the oxidative process in the tissues and results in stagnation of blood leading to tissue hypoxia (stagnant anoxia).
- Death is due to circulatory collapse.

Autopsy findings: Depends on the intensity of cold and the duration of exposure.

External findings:

- Body surface is usually pale, with irregular dusky red patches of frost erythema, particularly on the exposed parts, large joints and extensor surfaces of the body.
- Postmortem staining is usually pink in color; the extremities are cyanosed.

(i) ***Frost bite:***

- Frost bite is localized effect of cold due to impaired local circulation as a result of exposure to freezing temperature (–2° to –8°C). Signs of vital reaction like erythema, swelling and indurations can be seen around the involved surface. Exposure to extreme cold temperature results in sudden vasospasm, ischemia and localized necrosis beyond the line of inflammatory demarcation of the tissues. Occurs in the exposed parts of the body such as ears, nose and extremities like toes and fingers, etc.

(ii) ***Trench foot:***

- Prolonged exposure of the extremities to cold (non-freezing temperature 5° to 8°C) for many hours, leads to **trench foot** or **immersion foot**. Blister formation and localized dry gangrene formation occurs, typically seen in soldiers in winter warfare especially in trenches and in persons exposed to prolonged immersion and exposure to cold sea water.

Internal findings:

- Internal findings are predominantly due to avascular necrosis. Subcutaneous tissues are relatively avascular and blood if present is often bright red in color.
- *GIT:* Multiple patches of acute sub-mucosal hemorrhages may be seen in the stomach and duodenum (appears dark red due to presence of altered blood). If the individual survives, the mucosa over the hemorrhages may slough out leaving shallow ulcers.
- *Brain:* Shows perivascular hemorrhage in the 3rd ventricle with chromatolysis of ganglion cells.
- *Pancreas:* There is variable degree of fat necrosis in the pancreas, ranging from small patches to extensive non-hemorrhagic pancreatitis. This leads to high serum amylase levels, often with fatty necrosis of the adjacent mesentery.

- Multiple visceral infarcts caused by ischemia and evidence of venous thrombosis may be found.

4. What is burns? Classify burns.

- It is a condition due to local effect of dry heat, either due to direct contact with flame or any heated object like wire, hot metals or heated glass.
- In household accidents, burns develop as result of explosion of cooking stoves or gas cylinders resulting in ignition of the clothes worn by the victim. Depending on the intensity of spread either part or whole of the garments catches fire.
- Upon contact with the skin surface, the flame produces burns involving the epidermis, dermis and the deeper structures. Depending on the duration of contact and the extent of involvement, burn injuries are classified into three degrees. First degree burns (involving only the epidermis), second degree burns (involving upto the dermis) and third degree burns (involvement of deeper layers of tissues).

Classification of burns:

Epidermal burns

- This type of burns involves the only the epidermis and are superficial in nature. It results in reddening (erythema and blistering without involvement of the dermis) of the skin.
- Followed by capillary dilatation and transudation of fluid into the tissues resulting in swelling.
- The blisters contain fluid rich in albumin and are covered by white avascular epidermis surrounded by a zone of hyperemia.
- These blisters may resorb and the layers of dermis are peeled off exposing dark red dermis, replaced by growth from the periphery.
- Blisters are painful because of involvement of nerve endings and usually heal without leaving a permanent scar.

Dermoepidermal burns

- Burns involves the whole thickness of the skin including hair follicles, sweat glands and sebaceous glands.
- Extremely painful as they affect the sensory nerve endings.
- Heals with resultant scar formation (Figs 14.1 and 14.2).

Deep burns

- Destruction of deeper tissues, varying from damage to the subcutaneous soft tissues, muscles, bones, etc.
- The burnt areas may be completely charred
- They are relatively painless, as the nerve endings are completely destroyed (Fig. 14.3).

Prognosis: Depends upon the extent of body surface involved, rather than the degree of burns. First degree burns involving a larger area of body surface is more fatal than a third degree burns with focal involvement.

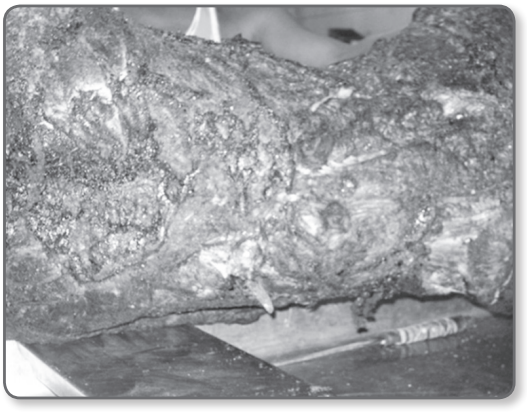


Fig. 14.1 Dermoepidermal burns with extensive charring

Fig. 14.2 Infected dermo-epidermal burns with sloughing

Fig. 14.3 Deep burns with secondary infection

5. What is rule of nine?

This is a method used to calculate the extent of body surface involved in burns. It is useful in assessing the prognosis of the patient. The body surface is divided into 11 parts and each part given a score of 9% (Fig. 14.4).

- Burns involving 50% or above is invariably fatal and 30% is sufficient to cause death.

Rule of palm:

In cases where the distribution of burns is scattered, the percentage is calculated with the presumption that the surface area of a person's palm is taken as 1% of the total body surface.

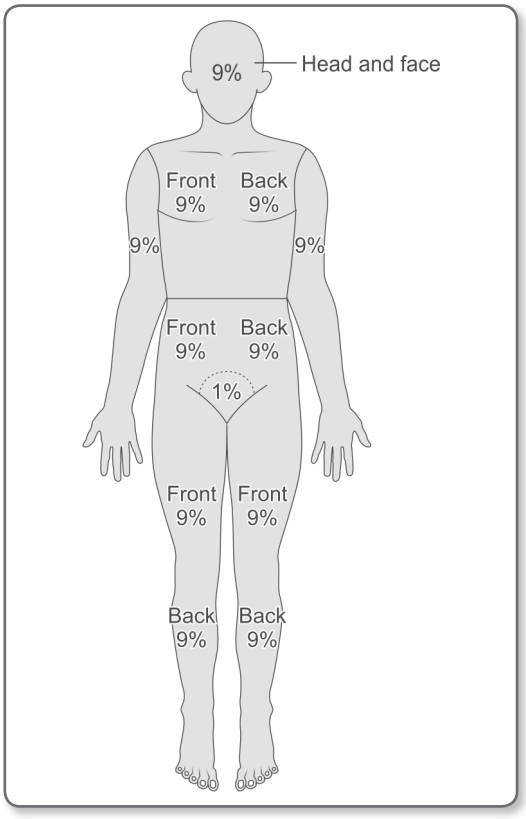


Fig. 14.4 Rule of nine (useful to assess the surface area of body burns)

Table 14.1 Rule of nine

Part of the body	Percentage
Head and face	9%
Right upper limb	9%
Left upper limb	9%
Front of chest	9%
Front of abdomen	9%
Back of chest	9%
Back of abdomen	9%
Front of right lower limb	9%
Front of left lower limb	9%
Back of right lower limb	9%
Back of left lower limb	9%
Genitalia	1%
Total	100%

6. What are the causes of death in burns?

Causes of death in burns:

Immediate causes of death:

- Suffocation: Due to inhalation of smoke, CO and other irrespirable gases.
- Primary neurogenic shock: Death within a few hours.
- Secondary shock due to hypovolemia within 24 to 48 hours. It is usually associated with renal failure due to hypoperfusion resulting in acute tubular necrosis.
- Death due to accidental injuries.

Delayed causes of death:

- *Toxemia:* It is due to absorption of toxic products from the surface of the body, generated during the process of burning.
- *Infections:* Prolonged exposure of the burnt skin surface to microorganisms may favor

the development of infections; these infections affect other vital systems and lead to meningitis, bronchopneumonia, pericarditis, etc. and death due to septicemia.
- Few individuals may develop complications like Curling's ulcer (duodenal ulcer) due to prolonged bed rest.

7. How do we find out the age of burns injury?

Age of the burns can be accessed from the external appearance like:
- Erythema (redness) : Which occurs immediately
- Vesication : 2 to 3 hours
- Exudates begin to dry : 24 to 48 hours (dry brown crest)
- If infected: Pus is formed in 2 to 3 days; superficial slough separates out by 4–6 days; deeper slough separates out within 2 weeks. Then granulation tissue begins to cover the raw areas; scar is formed after several weeks or months.

8. What are the postmortem findings in death due to burns?
What is pugilistic attitude?

- **Examinations of clothes:** For evidence of burns and for the presence of any characteristic smell, like that of kerosene, petrol or any other combustible substances should be looked for. Clothes which are in close contact with the body get damaged completely. Synthetic materials like terelene, nylon may be found closely adherent onto the skin surface.
- Skin surface covered by tight clothing like undergarments are usually spared from damage, if exposure to fire is for a short duration.

External findings:
- If the body is fully burnt all the surface of the skin might have been damaged. If some unburnt skin is present adjacent to the damaged areas, vital reactions in the form of reddish borders adjoining the burnt areas can be seen. The epidermis may be burnt completely exposing the underlying dermis which is usually pink in color, indicating the antemortem nature of the burns.
- Scalp hair and body hair are found burnt and singed.
- Blood tinged froth may be seen around the mouth and nostril, due to development of pulmonary edema. This is due to the irritation produced by inhalation of hot air.

Pugilistic attitude:

(Universal flexion / boxers attitude)
- When the body is exposed to prolonged and sustained heat, it results in contraction of the muscle fibers due to coagulation of muscle proteins. This produces flexion of all the joints which simulate the position of boxer. This is called as "**pugilistic attitude**". This is not antemortem sign of burns; a dead body thrown into fire will show this change.

Heat ruptures:
- This is seen in fleshy areas like calf muscles, thighs, etc. when there is sustained exposure of the body to fire. This can be differentiated from laceration or incised wounds by the absence of blood clots, intact blood vessels and absence of inflammatory infiltrations, as heat ruptures are postmortem in nature.

Internal findings:
- Blood is usually cherry red if death has occurred due to inhalation of carbon monoxide.
- Mucosa of the stomach and duodenum are frequently hyperemic and may show ulcers.

Heat hematomas:

These are areas of collection of blood clots inside the cranial cavity. It is usually seen over the frontal and occipital regions. The size of the hematoma corresponds to the external damage and charring effect to the skull.

Respiratory passage:

Soot particles: These are the deposition of burnt carbon particles which are found adherent to the edematous mucosal surface of the respiratory passage. Demonstration of soot particles over the mucosal surface of the respiratory passage upto the secondary bronchioles are diagnostic of antemortem burns.

9. What are the medicolegal considerations involved in cases of death due to burns?
What are the signs of antemortem burns?

(i) Identity of the deceased: Identity of the deceased in cases of burns throws a big chal-

lenge to the investigators. Remnants of clothing, other articles, X-ray of the entire body and dental pattern may help in establishing the identity.

(ii) Whether burns are **antemortem or postmortem:** The points in favor of antemortem burns are the following:

- Cutaneous reaction to heat or flame:
  - Presence of vital reactions (red flare/red line) on the intact skin adjacent the burnt area.
  - Blister formation: These blisters contain a serous fluid of albumin and chlorides; base is inflamed and red with erythematous borders. Postmortem blisters contain traces of albumin and chlorides and more of gas; the base is dry, hard and yellow.
- Presence of smoke and **soot particles** in the respiratory passage.
  - Evidence of injury to the respiratory tract by fumes and hot gases: Inhalation of hot fumes causes acute laryngeal edema resulting in sudden asphyxiation.
- Elevated levels of **carboxy hemoglobin**: Incomplete combustion of any organic matter leads to production of carbon monoxide. CO has got high affinity to Hb resulting in increased levels of COHb.
  - More than 10% of Hb saturation with CO, usually indicates that the victim has inhaled CO; however in chain smokers, the normal level itself is 8–10%.
  - Presence of elevated levels of other toxic gases in the blood like HCN, ammonia, NO, CO_2 and H_2S are also indicative of antemortem burns.

(iv) Histological evidence: Histochemical reaction shows presence of non-specific esterase (within 45 minutes), Leucine amino peptidase (within 2 hours), Increase in reaction of alkaline phosphatase (within 3 hours) and leukocytic infiltration and staining for DNA and RNA (within 6 hours) is indicative of antemortem burns.

10. How to assess the manner of death in burns?

Suicidal:

- Not uncommon.
- Suicide by burning in domestic environment is much more common among females.
- Usually some inflammable material like kerosene is used.
- At times, superficial burns may be inflicted over the accessible parts of the body to make a false accusation against the enemy.

Accidental:

- Majority of cases occur when the victim is trapped in the burning building or vehicles.
- Some accidents do occur in the kitchen, while cooking.
- Children, epileptics, old people and grossly intoxicated individuals are the usual victims.

Homicidal:

- Though not common, incidences of homicidal burns are reported worldwide.
- Killing the victim by some other means and then burn the body to simulate accidental/suicidal burns is also regular phenomenon. Postmortem nature of burns injury and finding out the real cause of death like throttling will help solve such cases easily.

11. What is scald? What are the features of scalds injury? How will you differentiate burns from scalds?

Scalds:

- These are injuries caused by moist heat. Hot liquids of temperature above 60°C cause scalds.
- The protection offered by the skin and the short duration of contact of the hot liquids prevents inward conduction of heat into the deeper layers, and hence generally only the superficial layers of the skin are involved in scalds.
- However, the extent of scalds greatly depends on the latent heat (heat retention capacity) of any liquid. Scalds produced by sticky viscous liquids are very high due to the high degree of penetration of heat; for example, hot tar, syrups, oil, etc. Injuries caused by these liquids are comparatively deeper than the one caused by hot water.

General features of scald injury:

- The liquid responsible for scalding may be seen on the clothing and the body; smell of the liquid may be present. Scalding usually occurs through the intact clothing and the degree of scalds depends upon the permeability of the liquid.

Table 14.2 Difference between burns and scalds

Features	Burns	Scalds
Source	Dry heat	Wet heat
Clothing	Burnt	Not affected
Singeing of hair	Present	Absent
Charring and blackening of tissues	Present	Absent
Nature of injury	At and above the level of contact	At and below the level of contact, gradually reducing
Soot particles in respiratory tract	Present	Absent
Carboxyhemoglobin	May be present in blood	Absent
Fatality	Usually fatal	Less fatal

- Injury is usually limited to the areas of contact and more severe at the point of initial contact. Scalding is severe at the point of initial contact and at places where the liquid has come into contact with the body for a longer duration. As the liquid runs down, the degree of scalding progressively diminishes.
- Redness appears at once and blistering (vesication) takes place within a few minutes.
- Vesicles are abundant along the course of the running liquid; there is usually a demarcated edge, corresponding to the limit of contact of the liquid.
- The blisters have a hyperemic zone surrounding them.
- Reddening and swelling over the surface can be made out in the floor of the blisters.
- If the skin over the blisters is removed, the floor appears reddish with serosanguinous discharge.
- Postmortem blisters contain gas with scanty fluid, which has a less proteins and chloride content. All the antemortem reactions like redness and swelling are absent.
- Features of injuries caused by dry heat, like burning of clothes, singeing of hair, deposition of carbon particles on the burnt skin surface and respiratory passage, and charring of tissues are absent in scalds.

12. What is respiratory burns?
What are the circumstances of scalds injury?

Respiratory burns:

- This condition is produced by exposure of the respiratory passage to super heated steam or vapors.
- Steam or hot air may be inhaled, causing thermal injury to the respiratory tract. During this, there is excessive production of thick tenacious mucus plugs and edema of the mucus membranes, resulting in obstruction of the airway. This produces death by asphyxia.
- Exposure of skin over the face to super heated steam can produce soddening of the skin, which becomes dirty white in color.

Circumstances of scalds:

- Usually accidental due to splashing of fluid.
- Children may upset the vessels containing hot liquids or may accidentally fall into the vessels containing hot liquids. They may sometimes suck the spouts of the kettles containing hot milk or water, resulting in severe scalds of the mouth and throat.
- Boiling water may be thrown with the intention to injure or annoy any individual.
- Deliberate scalds using hot fluid are common in child abuse.
- Suicidal scalding is rare because they are extremely painful and moreover do not guarantee death.

CHAPTER 15

Electrical and Lightning Injuries

Keywords: Electrocution, joule burns, ventricular fibrillation, lightning, filigree burns, entry wound, exit wound, flash burns, spark burns.

INTRODUCTION

Electrocution

- Deaths due to electrocution are relatively common in domestic and industrial settings. It is mainly due to carelessness or improper knowledge about electrical appliances and electricity. Death due to electrocution is most commonly accidental.
- Injuries produced on the body depend upon:
  - (i) **Kind of electric current:** Both direct current (DC) and alternate current (AC) can produce deleterious effects. Alternate current is 5 to 6 times more dangerous than direct current of the same voltage, since AC results in titanic stimulation which induces muscle spasm and does not allow the patient to release contact of current.
  - (ii) **The amount of current:** Electrocution is rare below 100 volts. Domestic supply is between 220 and 240 volts in the form of alternating current at 50 cycles per second.
  - (iii) **Path of the current inside the body:** When current flows through the heart or brain, death is imminent. Severity is directly proportional to the duration of flow. Current takes the easiest path inside the body and not the shortest path.
- **Mode of electrocution:** For electric shock to occur, there must be contact of the body with both positive and negative pole or alternatively, the earth; when earthing of the body is poor (when the individual stands on a wooden platform), fatal electrocution is uncommon, he may experience only a shock and he can get himself released from the contact source.
- The effects of electricity depend upon the resistance offered by the body.

1. What is electric burns injury?
What is Joule burn?

- The injury produced on the body is due to resistance offered by the body tissues. Electrical burn injuries are usually present at the point of entry and also at the point of exit. They are absent when the hands and feet were wet. Since wetness allows the current to flow easily into the body, as the resistance offered by the body tissues is greatly reduced by wetness.

Joule burn (Fig. 15.1):

- Round or oval shallow craters of 1 to 3 cm in diameter. The floor looks pale, depressed and sometimes burnt, hard to touch, usually extending into the underlying deep tissues to some extent; surrounded by an elevated hyperemic margins which are visible

Fig. 15.1 Joule burn — Electrical entry wound

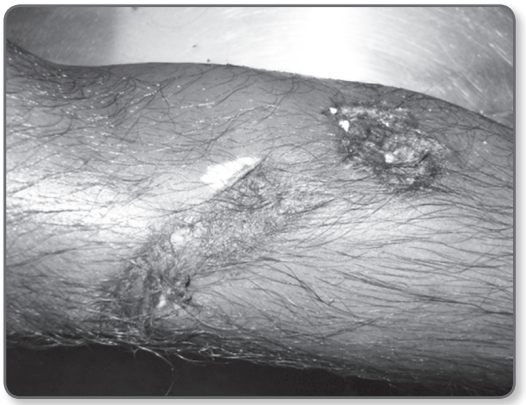


Fig. 15.2 Electrical burn injury (Entry wound) caused by bare wire with large surface area

after thorough washing and viewed with hand lens in good light. The extent of tissue involvement can be made out easily by dissection. If hair are present at the point of contact, it appears burnt and singed. When the period of contact, is prolonged, charring and blackening are also seen.

- This characteristic appearance will not be seen in any other types of injuries. The exit wound is almost similar to the entry wound in appearance but less hard; blackening and singeing of hair are usually absent at the point of exit.
- When a larger area of the body comes in contact with a broad bare wire, then long and linear injuries are produced. In such cases, the clothing also catches fire and whole body may catch burnt in a short span of time. These cases may be presented as case of death due to burns (Fig. 15.2).
- Difficulty arises only when the entry and exit wounds are absent.

2. What is the mechanism of death in electrocution?

- When current enters the body through the point of contact, it travels along the body. When it passes through the heart, it produces conduction defects, leading to increase in the heart rate. This leads to ventricular tachycardia and death may ensure in a short span of time due to ventricular fibrillation. When the passage of current is through the brain, death may result due to paralysis of respiratory center.
- Passage of current for a short duration may not result in death of the individuals; however, the patient may develop a stage of suspended animation which simulates death. Strict caution is required in declaring death in such situation to avoid any premature certification of death. Timely resuscitation measures will help in reviving this condition.

3. What is flash burn/spark burn?

- It occurs in high voltage electricity. Direct contact is not required in such instances. When there is a gap between the source of electricity and the body, the intense heat results in flash-over and produces thermal burns. Usually there will be deposition of trace metallic particles over the burnt surface, which is transferred from the metallic wire.

4. What are the postmortem findings in a case of death due to electrocution?

External autopsy findings:

- Entry wound in the form of Joule burn and exit wound are usually present (Fig. 15.3), except when the contact surface is wet.

Internal findings:

- ***Heart:*** Multiple sub-epicardial and sub-endocardial petechial hemorrhages in the heart more on the left ventricle and also on the root

Fig. 15.3 Electrical exit wound

of aorta are seen. In doubtful circumstances, bits from left ventricle can be subjected for histopathological examination. This reveals elongation of the myocardial fibers, with movement of nucleus toward the periphery of the cell, as current flows through the heart and compensatory vacuolization on the opposite end of the cell due to sudden movement of the nucleus toward the direction of current flow (Figs 15.4 and 15.5).

- ***Lungs:*** Multiple sub-pleural petechial hemorrhages on the surface of both lungs, more concentrated on the inter-lobar surface (pleura offers some resistance when current travels from one lobe to another).
- All the internal organs will be congested.
- ***Note:*** When entry and exit wounds are present on the body, cause of death can be opined without any ambiguity. In the absence of visible external findings, opinion about death due to electrocution can be construed, based on the internal findings of the heart, lungs and histo-pathological observations. An attempt to visit the scene of occurrence will also help in forming a clear opinion about the cause of death in such cases.

INTRODUCTION TO LIGHTNING

- Lightning is a phenomenon which occurs due to generation of very high voltage current from the clouds which is transmitted to the earth through a medium like trees, or high raised buildings or tall metallic poles. The transmission of electricity from the clouds to the earth is called as lightning stroke.
- Lightning chooses the easiest but not the shortest route and hence it sometimes takes a wandering, zigzag path.
- The lightning stroke has a potential of 1000 million volts, and when it passes through the body, results in lethal electrocution.

Fig. 15.4 Subepicardial hemorrhage in case of electrocution

Fig. 15.5 Subendocardial petechiae-ecchymotic hemorrhages on left ventricle in a case of death due to electrocution where entry wound was absent (as hands were said to be wet)

- Lightning differs from electrocution only in degree of electric current. Skin and dry clothes are relatively bad conductors than wet skin and wet clothes. The effects of lightning are similar to that of electrocution but the severity is high. The body and clothing may be completely burnt. Linear burns of 3 to 30 cm length and 0.6 to 2.5 cm in breath can be seen, usually in moist areas of the body.
- The external appearance in case of death due to lightning is the presence of filigree burns (Arborescent burns).

5. What are filigree burns or lichtenberg figures?

- It is otherwise called as arborescent burns.
- It is a superficial, thin, irregular, tortuous marking on the skin. They resemble the branching pattern of a tree or fern leaf.
- This is usually mistaken for the marbling appearance found on decomposed bodies. Filigree burns are brownish black in color as compared to the bluish green discoloration in marbling. Difficulty may arise in differentiating marbling appearance from filigree burns especially when the body is recovered after a few days.

6. What are surface burns?

- These are burns produced due to heating up of metallic objects worn or carried by the individual; when lightning strikes the body, these metallic objects generate enormous heat and produce surface burns on the body. Sometimes, the object becomes magnetized which can be ascertained by pocket compass.

7. What are other associated effects of lightning?

- Clothes may be torn and burnt.
- Shoes may burst open.
- Rupture of tympanic membrane often present.
- Burns injuries may extend deep into subcutaneous tissues, muscles or bones.
- Petechial hemorrhages may be seen in spinal cord and brain. On HPE, chromatolysis and fragmentation of axons can be made out.

Section V:

Sexual Jurisprudence

CHAPTER 16

Virginity

Keywords: Virginity, labia majora, labia minora, fourchette, rugosity, virgin, false virgin, defloration, carunculae hymenales, carunculae myrtiformis.

INTRODUCTION

- For proper medicolegal examination and certification in cases relating to virginity, pregnancy, delivery, abortion and sexual offences, good knowledge of anatomy of the female genital organs is mandatory and hence, anatomy of the female genital organs is discussed in brief.

Anatomy of Female Genital Organs (Fig. 16.1)

- The labia majora are two elongated folds of skin projecting downward and backward from the mons veneris; they meet together in the front in the anterior commissure and on the back in the posterior commissure (in front of the anus).
- In a virgin, the labia majora are thick, firm, elastic and rounded, and lie in close apposition with each other and thus completely close the vaginal orifice.
- The labia minora are two thin folds of skin, just within the labia majora, not usually visualized externally in a virgin; the lower portion of the labia minora fuse in midline and forms the fourchette; the depression between the fourchette and the vaginal orifice is called the fossa navicularis.
- The labia minora are soft, pink in color and sensitive to touch.

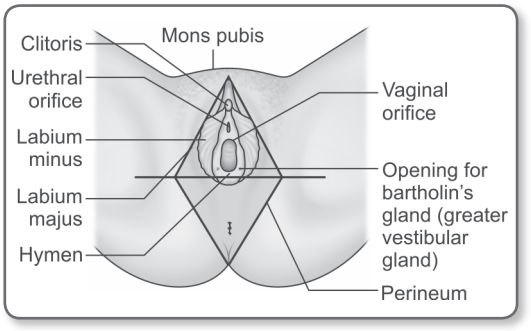


Fig. 16.1 Female external genitalia

- The vaginal canal is a pocket-like structure, triangular in shape about 7.5 cm long; shorter in its anterior wall (6 cm) and longer in its posterior wall (9 cm). The mucosa of the vaginal canal is reddish in color, with multiple folds of rugosity and the walls are well-approximated.
- Frequent sexual intercourse makes the vaginal canal more elongated, upto the posterior fornix, with loss of rugosity; a single intercourse does not alter the parts much except for rupture of the hymen and elongation of the posterior vaginal wall.
- In the women who have undergone full-term pregnancy and delivery, the labia majora will be separated, exposing the labia minora and the vaginal canal.

1. What is virginity?

- Virginity is a state of a female who has not experienced sexual intercourse even once.
- Virginity is otherwise called as "**chastity**" or "**virgo intacta**".
- Defloration means loss of virginity, which means the female has experienced sexual intercourse atleast once.
- The question of virginity may arise in situations like rape, nullity of marriage and divorce.

2. What is hymen?
What are the types of hymen?

Hymen is a thin fold of mucus membrane about 1 mm in thickness and situated at the vaginal outlet; adult hymen consists of folds of membrane having crescentic or annular shape.

In children, the hymen appears as a tight membrane and lies relatively at a higher level in the vaginal canal. It descends to the lower level (normal level) with the formation of series of folds, when the woman attains menarche.

The hymen has a central orifice, which usually does not admit more than the tip of the little finger in a virgin and this opening is for the menstrual flow.

Depending on the size and shape, the hymen is classified into the following types:

Types of Hymen

i. *Semilunar or crescentic:* Semilunar in shape and the opening is placed anteriorly.
ii. *Annular:* The opening is oval or circular and is situated near the center.
iii. *Infantile:* A small linear opening in the middle.
iv. *Cribriform:* Consists of several openings.
v. *Vertical:* Opening is vertical.
vi. *Septate:* Two lateral openings side-by side, separated by a thin strip of tissue.
vii. *Imperforate hymen:* In this type, the hymenal orifice is absent. At the time of attainment of menarche, there will be gradual accumulation of menstrual blood, which makes the hymen bulging with severe lower abdominal pain. In such situations, a small incision is made to create hymenal opening, through which the accumulated menstrual blood is let out.
viii. *Fimbriated or notched:* The edges of the hymenal orifice show multiple small projections in its circumference.

3. What are the principle signs of virginity?

Breasts are hemispherical, firm and rounded. Nipples are small with pinkish areola.

Labia majora appears thick, firm and rounded; fleshy and elastic. Lies in close opposition to each other and hence the labia minora and the vaginal orifice are not visible externally.

Labia minora is soft and small in size; pink in color and sensitive to touch and not visible externally, since it is completely covered by labia majora.

The vagina is narrow and tight; triangular in cross-section. Rugosity is more prominent, its walls can be approximated, the vaginal canal is not roomy and the vaginal orifice remains closed. The orifice admits only the tip of the little finger and is painful. The hymen, posterior commissure, fossa navicularis and fourchette will be intact in virgins.

4. State virginity vs defloration.

See Table 16.1.

Table 16.1 Difference between virgin and deflorated woman

Virgin Woman	Deflorated Woman
Breast:	
Hemispherical	Enlarged
Firm and rounded	Loses firmness and slightly pendulous
Nipples are small and pinkish	Nipples are large and raised
Areola: Pink in color	Areola: Dark brown or black

Contd...

Contd...

Labia majora: 1. Thick and Firm 2. Fleshy, elastic and rounded 3. Lie in opposition to each other and hence labia minora is not visible externally 4. Completely closes the vaginal orifice	1. Lax 2. Not rounded and dark in color 3. Not in opposition with each other and labia minora is exposed outside 4. Gap is present in between the two sides, and the vaginal orifice may be visible externally
Labia minora: 1. Soft and small in size 2. Pink, sensitive to touch and completely covered by labia majora 3. Depression is present in between the fourchette and the vaginal orifice 4. Vaginal orifice remains closed	1. Enlarged 2. Dark or blackened in color and may also show pigmentation 3. Project much outside the labia majora, the depression and folds are lost 4. Vaginal orifice is visible externally
Vagina: 1. Narrow and tight 2. The canal is triangular in cross-section 3. Rugosity is present and sensitive to touch 4. Its walls are approximated, 5. Not capacious	1. Widened and lose 2. The canal is oval or rounded in cross-section 3. Rugosity is decreased/lost and sensitiveness is reduced 4. Walls are not approximated and are separated 5. Roomy and spacious
Vestibule: Admits tip of little finger and painful	Admits more than 2 fingers without pain
Posterior commissure: Intact in virgins	Lose or not prominent due to repeated sexual intercourse in deflorated woman
Fossa navicularis: Closed / intact in virgins	Disappear in deflorated woman
Fourchette: Intact in virgins	Ruptured and old healed tear / scaring may be present
Hymen is intact	Hymen ruptured and only remnants of tags of the hymen may be present along the margins after multiple acts of coitus

5. What are the causes of rupture of hymen?

- Hymen may be ruptured due to:
  1. Sexual intercourse
  2. *Accidental:* Heavy exercise like cycling, gymnastics, etc.
  3. *Masturbation:* Using fingers or foreign body insertion.
  4. *Ulceration:* From diphtheria, repeated fungal infection.
  5. Rarely by uncleanliness, poor personal hygiene and sanitary tampons.
  6. Surgical and Gynecological operations.

There are a number of reasons for rupture of hymen other than sexual intercourse. Ruptured hymen cannot be said as a sign of defloration. The same way, an intact hymen is not a proof of virginity, as the hymen may be elastic and the female is as a false virgin.

6. Who is a false virgin?

False virgin is a female who has experienced sexual intercourse, but retains an intact hymen. In few females, the hymen may remain intact even after multiple acts of coitus; this is due to elastic, thick, tough, fleshy or lose hymen.

7. What are the medicolegal importance of hymen/virginity?
Short notes on:

Carunculae Hymenales: Carunculae Myrtiformis

- Presence of an intact hymen at the time of marriage is considered to be a proof of virginity by the society and the law.
- Presence of an intact hymen is presumed to be a sign of virginity, but is not an absolute proof (false virgin). Similarly, a ruptured hymen may not necessarily be due to an act of coitus.

Medicolegal Importance of Virginity

- Nullity of marriage: (S-12 Hindu Marriage Act)
  If the woman was pregnant at the time of marriage or the male was already married/ impotent, then the marriage is said to be null.
- Divorce: (S-13 Hindu Marriage Act)
  If either of the couple is proved to have committed the offence of adultery, then it is a ground for divorce.

Carunculae Hymenales

Multiple ruptures of hymen with presence of tags of the hymenal tissue on the margins. It is seen in woman habituated to sexual intercourse.

Carunculae Myrtiformis

In this condition, hymen is almost abolished, with remnants of hymenal tissues attached to the margins, as a thick rim of residual tissue. This is seen after pregnancy and delivery.

CHAPTER 17

Impotence, Sterility and Artificial Insemination

Keywords: Impotence, sterility, frigidity, quad, vaginismus, sterilization, artificial insemination, posthumous child, test tube baby, atavism, paternity, legitimacy, surrogate motherhood.

1. Define impotence:

Impotence is the inability to perform or take part in sexual intercourse by a male.

In the act of sexual intercourse, male is the active partner, who has to develop and maintain penile erection sufficient enough to accomplish the act.

2. What is sterility?

Sterility is the inability to procreate by a male or conceive children in a female.

An impotent person may be fertile and capable of procreating; similarly, a potent individual capable of performing intercourse may not be able to fertilize, due to defective production of sperms.

3. What is premature ejaculation?

It is a condition in which, ejaculation of semen occurs before the complete act of coitus, either immediately before or immediately after zpenetration.

4. What is sexual dysfunction?

Any defect either structurally or functionally, which makes the person unable to achieve sexual gratification, is termed as "sexual dysfunction".

A person is said to physiologically impotent at the extremes of age. Same way, after several years of marriage, a male may be impotent toward his wife, but potent toward many other females; this is also a form of psychophysiological impotence.

5. What are the causes of impotence in male? What are the functional causes of impotence?

i. ***Organic causes:*** (Congenital)

- Klinefelter's syndrome and primary testicular failure, mainly cryptorchidism.
- Phimosis, para-phimosis, epispadias, hypospadias, accessory penis and bent nail syndrome.

ii. ***Acquired causes:***

- Partial or complete amputation of penis.
- Prepubertal castration.
- *Local diseases:* Large hydrocele, scrotal filariasis, gonorrhea and carcinoma of the penis.
- *General diseases:* Diabetes, PT and endocrine disorders.

iii. ***Neurological causes:***

- Paralysis of the motor nerves supplying the genitalia, autonomic neuropathy, tumors of cauda equina, lesions in the CNS or spinal cord.
- Hemiparesis or paraplegia: Either due to trauma or cerebrovascular accident (CVA), general paralysis of insane (GPI in tertiary syphilis) and drugs.

iv. ***Functional causes:*** They are predominantly psychogenic in nature.
- First night impotence or bridegroom impotence: Fear, timidity and anxiety are responsible.
- Impotentia Quad Persona: In this condition, a man is impotent toward a particular woman. He is potent with others.
- Sexual aversion disorder: Persistent or recurrent aversion, thus avoid genital sexual contact with a woman.
- Excessive passion and overindulgence.

6. What is Frigidity?
What are the causes of frigidity in a female?

Frigidity
- Sexual unresponsiveness in females is called frigidity: It is similar to that of impotence in males.
- In frigidity, there is inability to initiate or maintain sexual arousal pattern.
- It may be considered as absence of desire for sexual intercourse.
- The true meaning of frigidity means abnormal aversion toward sexual intercourse.

Causes of frigidity:
i. Sedatives or depressant drugs.
ii. Local diseases.
iii. *Systemic Diseases:* Hypothyroidism.
iv. *Physiological causes:* Pre-puberty and menopause state.
v. *Psychological Causes:* Vaginismus.
Frigidity may be temporary or permanent. Temporary frigidity always manifest as female sexual aversion disorder. It may be due to vaginismus.

Vaginismus
- Hyperaesthesia leading to painful spasm of sphincter muscles and levator ani with simultaneous contraction of adductor muscles of the thigh and erector spinae making penetration impossible.

Dyspareunia
- There is severe pain in the lower abdomen and perineum at the time of coitus.
- *Permanent frigidity:* It is invariably psychogenic in nature, which results due to sexual abuse during childhood or traumatic sexual assault in adulthood.

7. Define infertility.
What is absolute and relative infertility?
What are the causes of absolute infertility?

Infertility means incapability of fertilization or reproduction.

Absolute Infertility
- Inability to conceive due to structural or functional defects in the genital organs; which is complete and irreversible.
- *Relative Infertility:* Diminished capacity to produce offspring, which can be rectified.

Causes of absolute infertility in females are:
i. Congenital defects (defect in uterus, cervix or fallopian tubes).
ii. Acquired causes (infection and surgery on uterus).
iii. Hormonal dysfunction.
iv. Chromosomal defect (Turner's syndrome).
v. Local conditions like rectovaginal fistula.
vi. Chronic poisoning (like arsenic and lead).

8. What is sterilization?
What are the medicolegal issues of sterili-zation?
What is "wrongful conception"?
- Sterilization is a procedure which makes a person sterile, without affecting his/her potency or sexual function.

Medicolegal Importance of Sterilization:
- Failure of sterilization in a male may result in the wife becoming pregnant, this leads to suspecting the fidelity of the wife, which in turn leads to situations like divorce, legitimacy of the child and disputed paternity.
- Failure of sterilization is the most common basis for the birth-related actions called "**wrongful conception**" or "wrongful pregnancy" which may bring conflicts in the life between the husband and wife as suspicion of adultery (if husband is sterilized) and if the female has been sterilized then doctor who performed the surgery may have to bear the expenditure cost of the child growth as it is an unwanted child in their family.
- Doctor may be implicated if he/she performs sterilization without proper indication.
- Healthy unmarried individuals and married individuals who do not have any siblings, should not be permanently sterilized even if they volunteer for the same.

9. What is artificial insemination? What are the indications of AI? What are the ethical and legal issues of AI?

- It is a method of assisted reproductive technique, by which healthy semen is deposited into the vagina, cervix or uterus by instruments to bring about pregnancy. There are three types:
  - (i) Artificial Insemination Homologues (AIH)
  - (ii) Artificial Insemination Donor (AID)
  - (iii) Artificial Insemination Homologues Donor (AIHD): ***Pooled semen.***

Indications:

- When the husband is impotent but fertile (AIH, AIHD).
- When the husband is sterile (AID, AIHD).
- Rh incompatibility (AID).
- When the husband is suffering from hereditary diseases (AID).

Guiding Principles: (Ethical issues)

- Informed consent of both spouses has to be obtained after explaining the procedure, its legal implications, etc.
- The identity of the donor and recipient must not be revealed to each other nor do the donors know the result of insemination.
- Donor must be below 40 years, preferably married, not related to either spouse and should have children of their own.
- The donor must be in a good health, both physically and mentally.
- There must be similarity of race, religion and morphological appearance (as much as possible) between the donor and the husband of the recipient.
- It is better and advisable that the physician who performs artificial insemination, avoid delivery of the child.

Legal issues of artificial insemination:

i. Informed written consent of both the spouses donor and recipient. Improper consent would make the doctor face charges.
ii. Legitimacy: In cases of AID, the husband is not the actual father of the child and therefore the child is illegitimate and the child has to be legally adopted.
iii. Inheritance of property: The child born of artificial insemination has to be legally adopted to inherit the property.
iv. Litigation relating to nullity of marriage, divorce may rarely arise.

10. What is legitimacy?

- It is a legal status of a child or a person, born out of lawful wedlock. It includes children born to biological parents only. Persons born during the tenure of legal marriage or within 280 days of dissolution of marriage of the legally wedded couple.
- Legal issues in relation to legitimacy are inheritance of property and use of title (of the husband of the mother) by the child.

11. Who is an illegitimate child?

- Any child which is not born out of lawful wedlock is considered as illegitimate. A child is said to be illegitimate, if it is born out of extramarital relationship or through AID.
- Issues of legitimacy arise when the wife delivers a child when husband is sterile; or born when wife had no access to her husband during the probable period of conception.

12. What is paternity?

- Paternity is the legal status of a child said to be born to a particular father and mother.
- It is decided by paternal likeliness, atavism, blood groups and DNA fingerprinting.

Disputed paternity: Issues of disputed paternity arise in:

- In hospital birth (interchange of newborn by mistake or intentionally).
- In alleged suppositious child.

13. What is atavism?

- It is a condition in which the biological offspring does not resemble its parents, but resembles their grandparents. This is due to the presence of genes (recessive genes) which failed to express in the father but present in the child (Mendel's Law of Mutation).
- Paternal disputes are sorted out by HLA typing (upto 95% accuracy).
- Due to recent advances in DNA analysis, they are concluded with 100% certainty.

14. Who is a posthumous child?

Any child born to a mother, within the period of gestation after the death of the husband, i.e. a child born within 280 days after the death of the biological father is a posthumous child. Legal issues arising out of posthumous child are inheritance of property, legitimacy and compensation.

15. What is a test tube baby?

- **In vitro fertilization** is test tube baby.
- It is a method of facilitating fertilization of the ovum and spermatozoa outside the womb. It is adopted when the uterus is not conducive for the process of fertilization, to occur on its own.
- This is a process by which the ovum are surgically removed from the women, fertilized with the available sperms in a petridish and the resultant embryo is implanted into the womb of the woman, who completes the pregnancy to its full-term.

16. Write short notes on Surrogate motherhood?

- It is a condition in which a woman agrees to bear the child for someone else on contractual basis.

Methods:

- By way of artificial insemination.
- By fertilization of a mature healthy ovum of the wife with husband's sperm and implanting the embryo into the hired woman's (surrogate's) womb.

Types of surrogacy:

i. *Full surrogacy:* Situation where the embryo is provided by the commissioning couple.
ii. *Partial Surrogacy:* When the carrying woman has her own egg fertilized outside and later implanted into the uterus.

Indications for surrogate motherhood:

i. Inability of the wife to conceive or carry the child to term.
ii. Genetic defects or inherited diseases.
iii. Wife does not wish to take time to carry the fetus through.
iv. Wife may suffer from anxiety or labor phobia.

Medicolegal Aspects

- *Consent:* Written informed consent of the deserving couple and the surrogate mother.
- Custody of child is to legal parents.
- For the entire period, surrogate mother has to be given expenses for diet and medicines.
- *Adoption of the child:* After delivery by the surrogate mother, the child has to be legally adopted by the couple to make the child legitimate.

CHAPTER 18

Pregnancy and Delivery

Keywords: Pregnancy, delivery, pseudocyesis, fetus compressus, superfetation, superfecundation, lochia, suppositious child.

INTRODUCTION

Pregnancy

- Pregnancy is a physiological state, which occurs in a woman due to fertilization of the ovum by a spermatozoa and subsequent embedding of the fertilized ovum into the uterine cavity; it occurs during the reproductive age period of the female.
- Fertilization occurs in the isthmus of fallopian tubes and later on the products of conception get impregnated into the uterus.
- Fertilized ovum is called as zygote; after impregnation into the uterus, it is called the embryo; from 9th week till term, it is called as fetus.
- Pregnancy continues normally for 10 lunar months/40 weeks (9 calendar months + 7 days from the day of last menstruation).

Medicolegal aspects of pregnancy:

Criminal cases:

- Pregnancy is considered as a valid ground for reducing capital punishment, when convicted of capital crime (Section: 416 IPC)
- A woman can plead for postponement of trial if she is pregnant.
- When pregnancy is claimed to be the result of rape, kidnapping and seduction, then this pregnancy is helpful to prove the crime and such pregnancies can be legally terminated under MTP Act 1971.
- Pregnancy in an unmarried girl of 16 years or less, and in a married woman of 15 years or less point toward commission of rape.
- Charge of breach of trust is filed if the female becomes pregnant and the man refuses to marry her.
- *Blackmailing:* A pregnant woman may force a man to marry her or pay compensation as she is pregnant and alleges that the pregnancy is due to sexual intercourse with that man.
- *Adultery:* When pregnancy has resulted due to sexual intercourse with a third person.
- Abortion or concealment of birth cases can be brought against a woman who was said to be pregnant.

Civil cases: Pregnancy plays an important role in cases pertaining to nullity of marriage, divorce, inheritance of property, compensation cases, illegitimate child and additional leave facilities.

Diagnosis of pregnancy:

Diagnosis of pregnancy can be made by the following:

i. Presumptive signs
ii. Probable signs
iii. Positive signs.

Presumptive signs of pregnancy:

Amenorrhea, morning sickness (hyperemesis gravidarum), enlargement of breast and appearance of montgomery follicles, pigmentation of skin and chadwick's sign are some of the presumptive signs of pregnancy.

Probable signs of pregnancy:
"Quickening" (coming to life)
- The movement of the fetus is felt by the mother for the first time and is evident by 14 to 20 weeks.
- Enlargement of the abdomen, Hegar's sign, Goodell's sign (softening of cervix), Braxton Hick's sign (intermittent uterine contractions), ballottement, palpation of fetal parts, uterine soufflé and urinary hCG are probable signs of pregnancy.

1. What are the positive signs of pregnancy?
i. *Fetal heart sounds:*
- It can be heard from 18–20 weeks of preg-nancy.
- By 5th month, fetal heart rate is 160/minute, and by 9th month it is 190/minute.
- It is not synchronous with mother's pulse.
- Heart sounds are not heard in dead fetus, excessive liquor, fatty abdomen, and in fetus less than 18 weeks.
- *Funic soufflé:* It is a hissing sound, which is synchronous with fetal pulse.

ii. *X-ray diagnosis:*
- Detection of fetal parts can be made from 16th week of gestation by X-ray examination.
  - Annular shadow for skull
  - Small dots with linear arrangement for vertebral column
  - Series of parallel lines for ribs
  - Linear shadow for limbs.
- Radiological examination will be useful in the diagnosis of twin pregnancy, fetal abnormalities, intrauterine death and hydatiform mole.

iii. *Ultrasonagraphy:* More reliable.
- *By 5 to 6 weeks:* Gestational sac and cardiac activity are made out.
- *By 8 weeks:* Echo from gestational ring/ blighted ovum.
- *By 12 weeks:* Fetal heart beat and heart rate can be recorded.
- *By 14 weeks:* Fetal head and thorax can be identified.

4. *Fetal ECG:* Will show evidence of the cardiac activity of the fetus and is more accurate above 17 weeks of gestation.

2. How is diagnosis of pregnancy in the dead is made?
- During autopsy, pregnancy can be confirmed by the presence of enlarged uterus, presence of embryo/fetus/placental tissue and corpus luteum in an ovary in its progressive or regressive phase (Figs 18.1 and 18.2).

3. What is pseudocyesis?
- Pseudocyesis is also called as spurious pregnancy or false pregnancy or phantom pregnancy.
- It is usually seen in young woman who have an intense desire to bear a child.

Fig. 18.1 Ruptured uterus with fetus in the abdominal cavity — Note: The bruising of the peritoneum

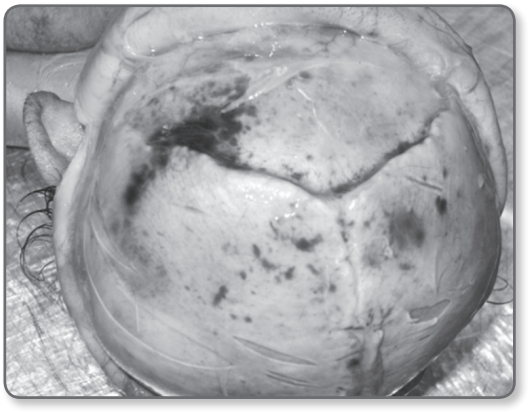


Fig. 18.2 Bruising of scalp with displacement of skull bone – Obstructed labor

- Also common in woman nearing menopause; it is associated with psychic or hormonal disorder.
- Patients with this condition may present with all the subjective symptoms of pregnancy. If not diagnosed in time, the patient may go through full-term of pregnancy and may even have false labor pains of delivery.

4. What is fetus compressus?

- Fetus compressus is also called as Fetus Papyraceous.
- It is a rare form of twin pregnancy, in which the 1st fetus may grow and develop more at the cost of the other. The latter may eventually die, get compressed and gradually get flattened.

5. What is superfetation?

- It is a type of twin pregnancy in which there is fertilization of 2nd Ovum in an already pregnant woman.
- Two fetuses are born either at the same period showing different stages of development. or, first a fully developed fetus is born; then after a period of one to three months, another fetus is born.

6. What is superfecundation?

- It is a type of twin pregnancy in which there is fertilization of two ova in the same ovulation cycle by two separate acts of coitus committed at short intervals. The incidence is 1.5% of all twin pregnancies.
- The two fertilized ova grow simultaneously; one may grow larger at the cost of the other.

Medicolegal aspects of superfetation and superfecundation:

- Adultery, infidelity and disputed paternity, if the biological father of one child is different from that of the other.

7. Define delivery.
What are the medicolegal issues related to delivery?

- Delivery is defined as a process by which there is expulsion or extraction of the child from the uterus, with or without external help. It may be spontaneous or induced.

Medicolegal aspects of delivery:

- The question of delivery arises in situations like:
  - Abortion
  - Infanticide
  - Concealment of birth (Infanticide section 318 IPC)
  - Divorce and nullity of marriage.
  - Delivery is considered as a valid ground for delayed execution of judicial death sentence upto 6 months.

8. What are the signs of recent delivery in living and the dead?
What is lochia? What are the different types of lochia?

General appearance of indisposition:

- The woman looks pale and sick, with shrunken eyes for the first 2 to 3 days.
- Presence of dark colored pigmentation over the lower eyelids.
- Pulse and body temperature are slightly raised.

Changes in the breast:

- Breasts are full and prominent, having a knotty or nodular feeling and tender.
- Nipples: Enlarged, surrounded by darkened areola and Montgomery's tubercles.
- Nipples on squeezing yield milk or colostrums.

Abdominal changes:

- Abdomen is lax, flabby and the skin over the abdomen appears wrinkled.
- Striae gravidarum, linea albicantes and linea nigra are seen due to over stretching of the skin over the abdomen during pregnancy.
- Intermittent painful uterine contractions are felt by the patient for 4 to 5 days (Fig. 18.3).
- The uterus gradually diminishes in size at the rate of 1.5 cm/day.
- On 6th day, the height of the uterus is midway between umbilicus and the pubis; on 14th day, fundus is at the level of pubic symphysis. The uterus comes back to normal position by 9 weeks.

Labia majora and labia minora:

- Swollen, tender, bruising and laceration of the labia may be present.

Fossa navicularis and posterior commisure:

- Shows tears which may extend upto perineum in Primigravida (Fig. 18.4).

Changes in the vagina:

- Vagina is spacious with loss of rugosity and the walls are relaxed.
- May show recent tears which heal by 7th day and the rugae reappear in about 3 weeks.

Changes in the cervix:

- Cervix is soft and patulous.
- Internal Os closes by 24 hrs and the external Os appears soft and admits two fingers.
- After 1 week, the external Os admits one finger with difficulty and it closes by 2nd week.

Lochia:

- It is a discharge from the vagina, which is present for a period of 2 to 3 weeks after delivery. It has peculiar disagreeable odor; it gradually changes in color and consistency. Lochia is of three types depending on its color.
- *Lochia rubra:* It is bright red containing blood clots; it is thick in consistency and is present for the first 4 to 5 days after delivery.
- *Lochia serosa:* During the next 4 to 5 days, the lochia changes in color and appears serous. The consistency becomes gradually thin and pale.
- *Lochia alba:* From the 9th day onwards, the color is yellowish gray which becomes white and turbid and finally disappears in two weeks.
- *Laboratory findings:* Urine shows presence of hCG even after delivery. It can be detected in traces upto two weeks after delivery.

Signs of recent delivery in the dead:

- All external signs and local signs seen in living persons can be made out. In addition to that, on internal examination, the uterine wall appears 4 to 5 cm thickness.
- Uterine cavity is obliterated by apposition of anterior and posterior walls.
- After 6 weeks, thickness of the uterus is about 1 to 2 cm.

On dissection of the uterine cavity:

- The area of the placental attachment shows irregular, nodular, and elevated raw surface of about 15 cm in diameter. It gradually diminishes in size when the uterus contracts. By end of 2nd week, its 3 to 4 cm in diameter and by 6th week, it is 1 to 2 cm in diameter.
- Peritoneum covering the lower part of uterus is arranged in folds (Fig. 18.5).

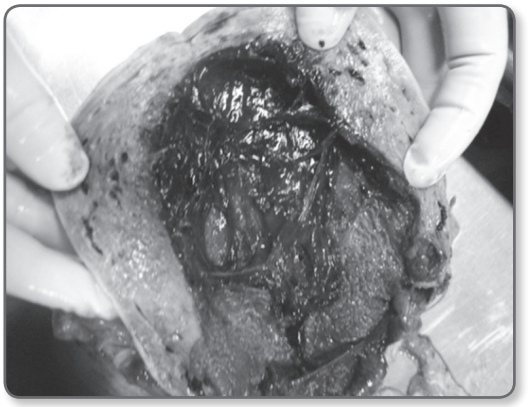


Fig. 18.3 Inner surface of uterus with blood clots and bits of placenta

Fig. 18.4 Extensive caput — a sign of prolonged/obstructed labor

Fig. 18.5 Perineum tear — sign of recent delivery

Fig. 18.6 Bruising of vaginal canal – sign of recent delivery (Prolonged labor)

- Bladder is hyperemic and sub-mucosal hemorrhages may be present.
- The changes in the labia and vagina are similar to that of in the living (Fig. 18.6).
- Perineum shows old tears and healed scars.

9. What are the signs of remote delivery in living and the dead?

- Externally abdomen lax and flabby.
- Lineae albicantes present in all the cases and striae gravidarum may be seen in some cases.

Breast:

- Breast will be soft and pendulous. Nipples are larger, darker and appear raised.
- Areola is dark with Montgomery's tubercles.
- On palpation, the breasts are nodular in consistency and in some multipara, striae may be present on the surface of the breasts.

External genitalia:

- Labia majora is dark and are not in close apposition with each other.
- Labia minora is pigmented, dark and protrude out through the gap in between the two sides of labia majora.
- Fourchette and posterior commissure may show lacerations.
- *Vagina:* Looks capacious, dilated and the walls appear relaxed.
- *Hymen:* Absent and represented by carunculae myritiformis.

10. Who is a supposititious child?

- A woman presents a child, as she is said to have delivered the child; but the fact is that she has not delivered any such child.
- Examination of the female for signs of recent delivery and DNA analysis will be helpful to sort out the issue.
- Legal issues:
  - Inheritance of property.
  - Blackmailing a male.
  - When a widow claims higher compensation from her husband's employer.
  - Bringing a charge of breach of promise of marriage against a man, who is alleged to be the father of that child.

11. What is abandoning an infant?

- *Section 317 IPC:* Abandoning a child of less than twelve years by the father, mother or caretaker, shall be punished with imprisonment upto 7 years.

12. What is concealment of birth?

- *Section 318 IPC:* Whoever intentionally conceals the birth of a child; either dead born or still born and buries or disposes by other means, shall be punished with imprisonment upto two years.

CHAPTER 19

Abortion and MTP Act 1971

Keywords: Abortion, premature labor, artificial abortion, criminal abortion, cupping, syringing, abortion stick, MTP act, placenta.

1. What is abortion? What is premature labor?

- Abortion is a process by which the products of conception are expelled either spontaneously or by induction, before the viability of the child (28 weeks of gestation).

Legal definition of abortion:

- It is the expulsion of products of conception at any time prior to full-term normal delivery.

Premature labor:

- Delivery of fetus after 28 weeks of pregnancy up to 40th week.
- Depending on the time of termination of pregnancy, it is called as abortion in 1st trimester, miscarriage in 2nd trimester and premature labor in 3rd trimester.

2. How do we classify abortion?
What are the causes of natural abortion?

- Abortion is classified into natural and artificial abortion.
- Natural Abortion could be spontaneous or accidental.
- Artificial abortion is either:
  (i) Legal, justifiable or therapeutic abortion
  (ii) Criminal abortion.

Natural abortion

- Natural abortions usually occur by 2nd or 3rd months of pregnancy and the incidence is about 10% of all pregnancies; the causes may be maternal, placental or fetal.

Causes of natural abortion:

- *Maternal causes:* Acute and chronic infections of genital tract; Rh incompatibility, congenital defects of the uterus; poisons like phosphorus, lead, quinine and mercury; accidental injuries and metabolic disorders like diabetes and thyrotoxicosis.
- *Placental causes:* Acute hydramnios, hydatidiform degeneration of the placenta, placenta previa and other diseases involving decidua or placenta.
- *Fetal causes:* Developmental defects of the fetus, and intra uterine death of the fetus due to various reasons and effects of radiation.

3. Write short notes on criminal abortion?
What are the methods of criminal abortion?
What is abortion stick?

- Unlawful destruction or expulsion of the fetus or products of conception from the mother's womb, when there is no therapeutic indication to do so.
- Usually undertaken by:
  (i) Unmarried girls
  (ii) Widows for remarriage.
  (iii) Married woman when they don't want children at that time.
  (iv) Female infanticide.

Types of abortionists:

- Expert/medically qualified professionals.

- *Semiskilled abortionists:* Midwives, nurses, and chemists.
- *Unskilled abortionists:* Quacks, untrained *dais*.

Methods adopted:

i. Mechanical violence: General or local
ii. Abortificient drugs
iii. Instrumentation

Mechanical violence:

- *General violence:*
  (i) Acts indirectly on the uterus by promoting contraction of pelvic organs and thus causing hemorrhage between the uterus and placental membrane.
  (ii) Application of severe pressure over the abdomen, violent exercise, cupping and application of very hot and cold water baths; application of leeches to pudenda, perineum and inner aspect of thighs.
- *Local violence:* Correction of retroverted uterus bimanually may lead to abortion.

Abortificient drugs:

i. *Ecbolics:* Act directly on the uterus and increase the uterine contractions. Example: Ergot, quinine, $KMnO_4$ tablets, lead pills and strychnine.
ii. *Emmenagogues:* Increases the menstrual bloodflow. Act as abortificient in large doses. Example: Savin, borax, prostaglandins and estrogens.
iii. Drugs which irritate the genitourinary tract and in turn provide reflex uterine contraction. For example, oil of turpentine, cantharides, $KMnO_4$ (through vaginal route).
iv. Drugs which primarily irritate the gastrointestinal tract and reflexly stimulate the uterine contractions: These cause excitation of uterus to contract "in sympathy" with the violent contraction of the stomach, intestines and the colon. For example, emetics (tartaric acid), purgatives (castor oil), croton oil, phenolphthalein and magnesium sulfate ($MgSO_4$).
v. Drugs which are primarily toxic to other systems: Inorganic metallic irritants (lead, copper, antimony, mercury and arsenic) and organic irritants (bark of plumbago rosea, juice of calotropis, unripe fruit of papaya and pineapple).

Instruments:

- Those causing rupture of the membranes: Uterine sound, catheter, pencil, hairpin, knitting needle, stick and fingers.

Those causing dilatation of the cervix:

- Bark of slippery elm; it is hygroscopic which absorbs the cervical and vaginal secretions to swell resulting in dilation of the cervix.

Instrumentation by unskilled abortionists:

- Soft pieces of wood of different sizes with 3 mm thickness are passed into the cervical canal and are left in situ. It absorbs moisture and vaginal secretions, and swells up and thus dilates the cervical canal.
- Disadvantages: Unhygienic method and thus increase the chances of infection; it may also get lodged in bladder as a foreign body if improperly inserted and chances of perforation of the cervix or uterus is high.

Abortion stick:

- Thin bamboo stick or stem of calotropis plant, 12 to 18 cm long; one end wrapped with cotton wool or rag, whose greater part is soaked with juice of marking nut, calotropis or a paste made of arsenic oxide, Sulfide or red lead, and is inserted into the uterus. This irritates the uterus and results in detachment of placenta from the uterus.
- *Air insufflations:* Air is instilled into the vagina by means of syringes or pumps, which results in separation of the placenta from its attachments. Air embolism is a commonest complication.
- *Electricity:* Positive pole is applied over the cervix and the negative pole over sacrum or lumbar vessels. Then current is passed, which leads to uterine contraction and thus brings about abortion.
- *Pastes:* Paste containing iodine, thymol or mercury is injected from a collapsible tube with uterine applicator into the uterus.
- *Cupping:* It is a method in which a cup is placed over the lower abdomen and vaccum is created inside, which in turn produces detachment of the placenta leading to abortion.
- *Syringing:* Enema syringe with a hard bulb is used to inject fluid into the uterus. Higginson's syringe is usually used; the suction valve is placed in a bowl of fluid and

pressure is applied on the bulb. A mixture of air and fluid is forced into uterine cavity at high pressure; the fluid detaches parts of amniotic sac and placenta from the uterine walls. The uterus contracts causing hemorrhage and thus leads to abortion. It can be administered by patient herself or by an abortionist.

4. What are the causes of death in criminal abortion?

i. *Immediate/Rapid death:* Hemorrhage, perforation, vasovagal shock and fat/air embolism.
ii. *Delayed death:* Generalized peritonitis, complication of local infection, tetanus, septicemia and toxemia.
iii. Remote causes of death: Jaundice and renal suppression, bacterial endocarditis, pneumonia, pulmonary embolism, emphysema and meningitis; sometimes, death is also due to the poisonous effect of the drugs used to procure abortion.

5. What are the complications of criminal abortion?

- Endotoxemia, septic shock and death.
- Fatal hemorrhages.
- Necrosis of cervical canal.
- Delayed air embolism.

6. What are the signs of recent abortion? What are the postmortem findings in a case of abortion?

Local examination:

- Undergarments show some staining with blood and occasionally with liquid abortificient agent which is used.
- Labia majora and minora appear congested and may show some injuries.
- Posterior commissure, fourchette and vaginal wall are congested with reduced rugosity.
- Vagina shows presence of blood clots.
- *Cervix:* Congested and os shows abrasion and tears; cervix remains dilated for a few days after abortion.
- The woman remains indisposed for 1 to 2 days with slight increase in body temperature.
- Serum and urine of the woman remain positive for hCG tests upto about 7 to 10 days.
- Evidence about the method used to procure abortion may be present.
- Discharge of milk or colostrums on squeezing the breast.

Postmortem findings:

External findings:

- Undergarments may be blood stained or show clots and stains.
- Body may look extremely pale and PMS not prominent due to loss of blood before death.
- Pigmentation of breast and abdomen may be present.
- *Breasts:* Enlarged with dark areola, Montgomery's tubercles and large raised nipples.
- Abdominal wall is lax with linea nigra and occasionally striae gravidarum.
- If cupping is done to induce abortion, then a circular mark may be noticed on the wall of lower abdomen.
- Labia majora appears laxed; labia minora is pigmented, injured and may be stained with blood. Injuries on fourchette and posterior commissure are commonly seen.

Internal examination:

- Uterus, ovary and vagina are dissected enmass for detailed examination.
- Injury to the intra-abdominal organs may be present.
- *Vagina:* Vaginal wall may show perforations near the fornix; the walls may be stained according to the chemical used with excoriation of epithelium.
- *Uterus:* Enlarged, soft and congested with prominent surface vessels; on cut section, the walls will be thickened; cavity may contain the products of conception in full or some remnants of products of consumption. There may be presence of blood clot, hairpin, nail or root of a plant inside the uterine cavity.
- Both the internal and external os are congested and distorted with injuries.
- *Ovaries:* Either of the ovaries will show presence of an active corpus luteum.
- *Lungs:* Evidence of air/fat embolism may be seen with marked congestion.
  If general anesthetic agents like ether were used, smell of ether will be present.
  In cases of death due to hemorrhage, the lungs will appear pale.

7. What are the medicolegal importances of placenta?

- From the size and weight, the period of gestation can be made out.
- It is mere presence (even in pieces) along with blood clots, confirms abortion or delivery.
- Chemical examination of placenta can detect the type of systemic abortificient used.

8. What is amniotic fluid embolism?

- It mostly occurs during the phase of active labor and rarely in 1st or 2nd trimester abortions following trauma and amniocentesis.
- The amniotic fluid enters the maternal venous circulation and results in pulmonary microvascular obstruction and results in severe vasospasm of pulmonary vasculature and hypoxia; usually death occurs in the 1st hour.
- If death is not immediate, then disseminated intravascular coagulation and fibrin deposition occurs in most internal organs.
- Diagnosis is by demonstration of fetal squamous cells, meconium, lanugo hair, fat globules, chorionic and amniotic cells in the lung by HPE.

9. Discuss about medical termination of pregnancy: MTP Act 1971.

- Medical termination of pregnancy is guided by MTP act 34 of 1971.
- It came into force from 1st April 1972 in India except in Jammu and Kashmir.
- The act imposes certain restrictions and aims at liberalizing the termination of pregnancy in order to avoid illegal abortion by untrained abortionists.
- It lays down conditions under which pregnancies can be terminated.

Conditions under which pregnancy can be terminated:

i. *Therapeutic:* Where continuation of pregnancy has a threat to the life of the mother.
ii. *Eugenic:* Where continuation of pregnancy may lead to the birth of congenitally defective children.
iii. *Social grounds:* Where pregnancy is terminated to limit the size of the family in socially and economically underprivileged family.
iv. *Humanitarian:* When pregnancy is due to rape.

Persons authorized to perform MTP:

1. Registered medical practitioner who has conducted or assisted minimum 25 abortions in authorized centers.
2. RMP with diploma or master degree in obstetrics and gynecology.

When can termination be done:

- MTP can be done only upto 12 weeks (3 months) of gestation.
- If any female goes to a doctor and tells that she doesn't want the child and if the gestation period is less than 3 months, then the doctor can very well go on with the induction of abortion (***abortion on demand***).
- If the period of pregnancy is more than 12 weeks (3 months) and less than 20 weeks (5 months) then opinion of two doctors is necessary for termination of such pregnancies. (it is because sex determination becomes possible after 12 to 16 weeks USG, and hence there is always a chance of sex selection in abortion after 3 months and hence the opinion of two doctors is taken to do MTP between 3 to 5 months).
- After 5 months of gestation, MTP should not be done and any doctor who indulges in such practice is said to have committed criminal abortion and is liable for the act.
- But during any period of gestation, if continuation of pregnancy has got an imminent threat to the life of the mother, then MTP can be done to save the life of the mother, even by the opinion of a single doctor alone.

Where termination should be performed:

- Government, semi-government or private hospitals approved for this purpose.

Consent for MTP:

- Written informed consent is necessary and consent of the guardian is required when age of the female is less than 18 years of age.
- Consent of the husband is not necessary, even if the female is married.

Maintain records:

- Records containing all the details of the patient on whom MTP was conducted.
- All forms filled for the procedure of conduction of MTP must be kept confidential and are not to be kept open.

- The consent form filled up by the patient together with the certified opinion of the doctor along with the intimation of termination of pregnancy should be kept in a sealed envelope and marked "SECRET" and then sent to chief medical officer of the state or head of the hospital and kept safe in the medical records department.

10. What are the sections of IPC relating to abortion?

Section 312 IPC:

- Voluntarily causing criminal abortion with the consent of the woman. Both the woman and the abortionist are liable for imprisonment upto 3 years, with or without fine. If the woman is quick with the child, the imprisonment may extend upto 7 years.

Section 313 IPC:

- When abortion is caused without the consent of the woman, the punishment extends upto 10 years.

Section 314 IPC:

- If a pregnant woman dies, from an act intended to cause miscarriage, the punishment shall not be less than 10 years and fine upto 2 lakhs.

Section 315 IPC:

- A person doing an act intended to prevent the child from being born alive or to cause death of the child, is liable for imprisonment upto 10 years.

Section 316 IPC:

- Causing death of a quick unborn child by any act, amounts to culpable homicide. The punishment may extend upto 10 years.

Section 317 IPC: (Abandoning an infant):

- Abandoning a child of less than twelve years by the father, mother or caretaker, shall be punished with imprisonment upto 7 years.

Section 318 IPC: (Concealment of birth):

- Whoever intentionally conceals the birth of a child; either dead born or still born and buries or disposes by other means, shall be punished with imprisonment upto 2 years.

CHAPTER 20

Infant Deaths

Keywords: Infanticide, dead born, still born, live born, viability, Rule of Hasse, hydrostatic test, maceration, Spalding's sign, SIDS, battered baby.

INTRODUCTION

- **Infanticide** is defined as killing a child under the age of one year.
- Only the mother of the child can be charged of the offence of Infanticide, as she has the bound duty of protecting and taking care of the child, once she has delivered a child.
- In India, there is no distinction between infanticide and murder of any individual.
- Other terms commonly used in medical science are:
  Feticide: The killing of the fetus at any time prior to birth.
  Filicide: The killing of a child by its parents.
  Neonaticide: The killing of a child within 24 hrs of birth.

Fig. 20.1 A case of infanticide with bruising of the nostrils — Smothering

Legal Questions to be Answered in Infanticide (Figs 20.1 and 20.2)

- Whether the fetus have attained maturity/viability or not?
- Whether the child was dead born/still born/live born?
- If live born, then how long did the child survive and what was the cause of death?

1. What is dead born?
What are the signs of maceration?

- Dead born is a child which had already died inside the uterus and shows the following signs:
  - Signs of maceration and rigor mortis at birth (rigor mortis only in viable fetus, as the myofibrils are developed only after 7 months of intrauterine life)

Maceration:

- This is aseptic autolysis and occurs when the child remains in the uterus for about 3 to 4 days immersed in liquor amni after death, but should be devoid of air.
- The earliest sign of maceration is skin slippage and seen in 12 hours after death inside the uterus.
- Maceration can be demonstrated by purple skin, air blebs, flexible bones and abnormal

Fig. 20.2 Same case as Fig. 20.1: 1, stab wound on the chest entering into the liver — Note: The blood collected in the peritoneal cavity

mobility of joints, soft viscera, and rarely mummification.
- Loss of alignment and overriding of skull bones of the cranial vault due to shrinkage of the brain after death. This is called **Spalding's sign** and it is seen 48 hours after death of the foetus inside the uterus, which is due to loss of intracranial tension.

2. What is still born? What are the causes of still birth?
- A stillborn child is one, which is born after 28th week of pregnancy but did not show any signs of life, after it has been completely expelled from the vaginal canal.
- The child was alive inside uterus, but did not come to life at all and is considered to be due to defects in the birth process.
- The incidence is about 5% and is seen more frequently in immature male children.
- Prolonged labor, which is shown by presence of caput succedaneum and severe molding of head, and negative hydrostatic test are indicative of still birth.
- In these cases, the body is sterile and decomposition occurs only by aseptic autolysis.

Common causes of stillbirth:
- Prematurity.
- Anoxia and birth trauma.
- Placental abnormalities and toxemia of pregnancy.
- Erythroblastosis fetalis and congenital defects of the fetus.

3. What is viability?
- Viability is the physical ability of a fetus to lead a separate existence of its own, outside the womb of the mother, by virtue of a certain degree of development.
- A child is said to be viable after 210 days of intrauterine life. However, the minimum period of viability is 180 days (6 months).

4. What is live birth? What are the signs of live born?
Short notes: Hydrostatic test; Rule of Hasse.
- **Live born** child is one which is born alive and showed signs of life after it has been completely delivered out of the mother. Causing death of such a child is regarded as infanticide (homicide).
- The law presumes that every newborn child found dead was born dead, till the contrary is proved.
- In civil cases, any sign of life such as hearing of a cry, movement of limbs or even feeble respiration, after complete birth of the child is accepted as proof of live birth.
- Whereas, in criminal cases, live birth has to be demonstrated by postmortem examination.

Signs of live birth (Fig. 20.3):

Postmortem examination:
- Assessment of intrauterine age of the fetus by **Rule of Hasse**. Crown-heal length of the fetus is measured and if the length is less than 25 cm, then the square root of the length will give the approximate age of the fetus in months. If the length is more than 25 cm, then it is divided by 5, which will give the gestational age of the fetus. For example, if the length is 16 cm, then the age of the fetus is 4 months and if the length is 35 cm, the age of the fetus is 7 months.
- *Shape of chest:* Before respiration, the chest is flat and its circumference is 1 to 2 cm less than the abdomen at the level of umbilicus;

after respiration, the chest becomes arched and the circumference of chest is 1 to 2 cm more than that of abdomen.

- Abdominal cavity is opened first to check the level of diaphragm.
  Position of diaphragm: Diaphragm is found at the level of 4th or 5th rib before respiration; after respiration, the diaphragm is pushed downwards to the level of 6th or 7th ribs. (Decomposition alters the finding).

Lungs:

- *Volume:* Fully respired lungs fill the whole of the thoracic cavity and the margins of the lungs overlapping on the pericardium of the heart; whereas unrespired lung appears collapsed towards the hilum.
- *Margins:* Margins are usually sharp before respiration, but becomes rounded after the first respiration, even if feeble respiration has taken place; presence of bullae suggests some form of obstruction and evidence of respiration.
- *Consistency:* Lungs are dense, firm and non-crepitant like liver before respiration. It becomes soft, spongy, elastic and crepitant if respiration takes place.
- *Weight:*
  - Fodere's test: The average weight of the lungs before respiration is 30 to 40 g and it becomes 60 to 70 g after respiration due to increase in blood flow.
  - Ploquet's test: After respiration, due to increased blood flow in the lung, their weight gets doubled from 1/70 of body weight to 1/35 of body weight.

Hydrostatic test:

- Hydrostatic test is done to find out whether the lung has respired or not.
- *Principle:* Before respiration, the lungs are of same consistency as that of liver and do not float in water. After respiration, the specific gravity of lung is decreased which makes the lungs to float in water.
- *Procedure:* A ligature is applied to dissect the entire lung and is placed on water. If the entire lung floats, then each lung is cut into 12 to 20 pieces and then placed on water; a small piece of liver is kept as control. (if liver floats, it indicates decomposition has set in and the test is invalid) (Fig. 20.4).
- If the lung pieces still float, then they are squeezed under water to see if any bubbles escape. Then, the lung bits are wrapped in piece of cloth and squeezed to remove the residual air. The squeezed lung pieces are again put in water. If the pieces still float, it indicates that active respiration has taken place. If they sink, it indicates that respiration has not taken place (Fig. 20.5).
- If some pieces sinks and some floats, then it indicates feeble respiration has taken place.

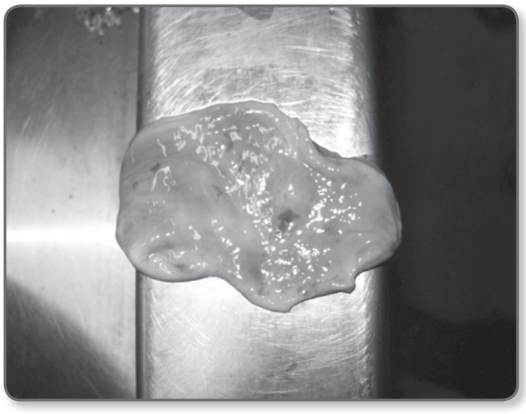


Fig. 20.3 Milk in the stomach — a sign of live birth

Fig. 20.4 Hydrostatic test — Whole lung floating in water

Fig. 20.5 Hydrostatic test — Bits of lung floating in water with liver as control which sinks in water (Positive test)

- *Respired lung may sink:* False negative results may occur in pneumonia, atelectasis and obstruction by alveolar duct membrane.
- *Unrespired lung may float:* False positive results may occur in decomposition and artificial respiration.

Medicolegal aspects of live birth:

- Death could be due to an act of omission, e.g. failure to give feeds, not protecting the baby with proper coverings, etc., or by an act of commission like throttling, strangulation, foreign body in the larynx and trachea, poisoning or even injuries (usually concealed puncture wounds)
- A detailed postmortem examination will demonstrate the exact cause of death; it also helps to assess the exact intrauterine age of the fetus by demonstration of the various ossification centers like sternum, lower end of femur, calcaneum and talus.

5. Write short notes on battered baby syndrome.

- The other synonyms for this condition are: **Caffey's syndrome**, child abuse or maltreatment syndrome.
- Battered child is one who receives repetitive non-accidental physical injuries, usually inflicted by the parents or guardian.
- In addition to these injuries, there may be deprivation of nutrition, care and affection.
- The classical features are obvious discrepancy between the nature of injuries and the explanation offered by the parents. There will be unexplained delay between the time of sustaining such injuries and seeking medical attention.
- There is constant repetition of injuries, often progressive from minor to major injuries.
- Children of low socioeconomic group, broken families, illegitimate and unwanted children are the usual victims.
- There is often a history of financial and emotional problems in the parents.
- Many of the fathers have criminal records and mothers have social and psychiatric deviations.

Manifestations:

- Relatively more in male children and the age group is 2 to 5 years.
- Child may reflect fear and despair.
- Bruises around the wrist, forearm, thighs and ankles, which are due to rough handling and violent swinging of the child.
- Buttocks may show burns often with cigars and whip marks.
- Face and lips bruised and frenulum of tongue may be torn.
- Circular bruises of 1 to 2 cm in diameter, due to poking of adult fingers on the chest, abdomen and thighs. These are called as **six penny bruises** (Fig. 20.6).

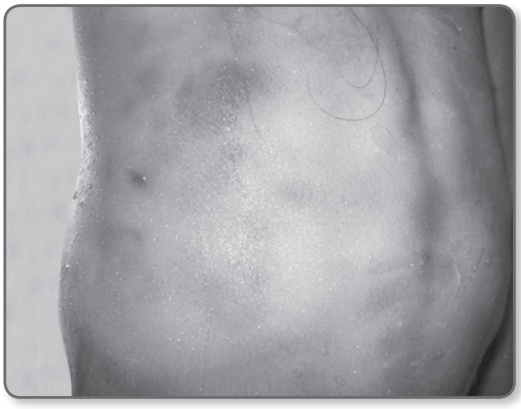


Fig. 20.6 Battered baby — Note: The multiple bruises on chest and abdomen (Six penny bruises)

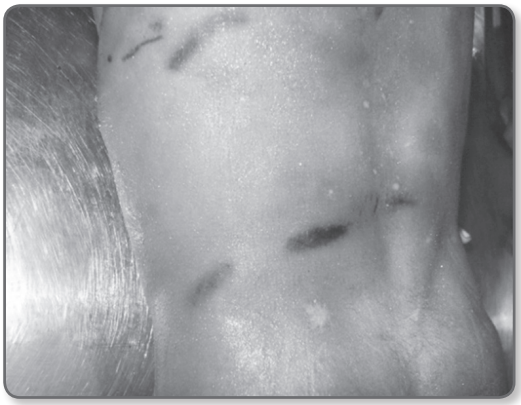


Fig. 20.7 Linear bruise caused by whipping with blunt weapon like a stick (Battered baby)

Fig. 20.8 Same case as Fig. 20.7, showing the diffuse bruising of the underlying subcutaneous tissues and muscles

- Multiple rib fractures may be seen; limb fractures (fresh and old unhealed) mostly in regions of epiphysis of growing bones with periosteal separations.
- Crack fractures of skull associated with intracranial hemorrhages.
- Evidence of multiple external injuries of varying degrees under different stages of healing can be noticed (Figs 20.7 and 20.8).
- Rarely these children may die of these injuries and brought for autopsy with fabricated history of sustaining these injuries accidentally. The autopsy surgeon must be aware of the probability of these conditions and help the investigation team as well as the court appropriately so that the culprits do not escape from the law.

6. What is shaken baby syndrome?

- Is a variant of battered baby syndrome and is serious form of child abuse.
- It results from extreme rotational movements, cranial acceleration and deceleration injuries produced by violent shaking.

Clinical features:

- They are popularly known as 'whiplash shaken baby syndrome'. It is characterized by retinal hemorrhage, subdural hematoma (SDH) and/or subarachnoid hemmorrhage (SAH). There may be little or no evidence of external injuries.
- Shaking itself may cause serious and fatal injuries; there may also be other forms of head trauma, including impact injuries by throwing the child on the walls "Shaken slam syndrome" or "Shaken impact syndrome".
- The victims need not be babies alone, the age of the affected individuals may vary extensively.
- Intractable crying of the baby may lead to tension and frustration for the parents or guardians resulting in aversion towards the victim.
- The caretakers are of abusive behavior and have unrealistic expectation of their children. Many of them may expect their needs to be met with by the children.

Investigations:

- CT scan is the choice and may reveal SDH, mass effects and diffuse axonal injuries (DAI).
- The mortality rate is 15 to 30%
- *Autopsy findings:* External examination may show injuries which corresponds to violent shaking of the child. Internally, SDH, SAH, cerebral edema, intracranial or retinal hemorrhages, and multiple fractures of skull, long bones and ribs are seen.

7. What is cinderella syndrome?

- Sometimes in a family, a single child is chosen to receive the battering (commonly

the youngest or the eldest) and repeatedly thrashed, while the other children are spared.

8. What is Munchausen syndrome by proxy?

- This is a type of child abuse, involving the mother.
- It consists of repeated pretentions of illness or repeated infliction of minor injuries.
- The child is brought to the hospital for induced signs and symptoms with fictitious injuries.
- The child is frequently admitted into the hospital for medical evaluation of any non-existent conditions.

Example:

- The mother may prick her fingers and add the blood drop to the urine of the child and take the sample to the doctor with complains of hematuria by the child;
- The child is repeatedly smothered to unconsciousness, then resuscitated and taken to the hospital.

9. What is the etiology of SIDS?

Sudden infant death syndrome: (SIDS, Crib deaths, Cot deaths)

- It is sudden death of an infant which cannot be explained and the cause of death in such cases remains a mystery, even after a complete autopsy and analysis of clinical history and death scene investigation.
- The incidence is 2 to 3 per 1,000 live births; with male preponderance.
- Most common age is 2 weeks to 2 years; maximum in between 3 to 7 months.
- Twins are at greater risk.
- Commonly occurs at nights and usually there is a history of running nose or coryza.

Autopsy findings:

- Blood stained froth in the mouth, evidence of laryngitis, trachea-bronchitis or congenital heart disease.
- Multiple petechial hemorrhages are often found on the heart, lungs and thymus.
- *Etiology:* The hypothesis of SIDS include:
  - Prone sleeping position.
  - Prolonged sleep apnea.
  - Hypotonic babies, whose neck position reduces airway lumen due to obliteration of the air passages.
  - Dust, mite and cow's milk allergy and anaphylaxis of unknown origin.
  - Calcium and selenium deficiency.
  - Viremia.

CHAPTER 21

Sexual Offences and Paraphilias

Keywords: Sexual offence, section 375, 376, 377 IPC, unnatural offence, perversions, rape, adultery, incest, sodomy, habitual passive agent, lesbianism, buccal coitus, bestiality, necrophilia, necrophagia, pederasty, indecent assault, fetichism, transvestism, sadism, masochism, voyeurism, peeping tom, frotteurism, troilism, exhibitionism.

INTRODUCTION

Sexual Offences

- Both law and customs permits only heterosexual intercourse (penile–vaginal) between a man and his wife.
- Sexual offence is defined as "any form of sexual intercourse/abuse which deviates from the normal heterosexual penile-vaginal intercourse of a man with his own wife". Any act which deviates from this form of sexual intercourse is consequently contrary to law.

1. Classification of sexual offences.

Sexual offences are broadly classified as:

- *Natural sexual offences:* Rape, adultery and incest
- *Unnatural sexual offences:* Sodomy, lesbianism, buccal coitus and bestiality
- *Sexual perversions/deviation/paraphilias:*
  Fetechism and transvestism
  Sadism and masochism
  Exhibitionism and voyeurism
  Pedophilia and frotteurism
  Necrophilia and necrophagia
  Nymphomania and satyriasis, etc.

2. Define Rape?

Section 375 IPC defines rape as:

- Unlawful sexual intercourse by a man with a woman
  - Against her will
  - Without her consent
  - With her consent, when her consent is obtained by:
    - Force or fear
    - Putting her or any person in whom she is interested, in fear of bodily hurt or death
    - When he knows that he is not her husband, and that her consent has been given because she believes that he is the man to whom she is lawfully wedded
  - With or without her consent:
    - When she is of unsound mind, due to mental disease, defect or intoxication
    - When she is under 16 years of age (**Statutory rape**).

Exception: Sexual intercourse of a man with his own wife is not rape, if she is above 15 years.

Even if she is his own wife and she is less than 15 years of age, it amounts to rape.

- To constitute an offence of rape, complete sexual intercourse is not necessary and mere penile penetration is sufficient.

3. What is the punishment for rape?

Section 376 IPC: Prescribes punishment for rape.

- ***Subsection 1:*** Imprisonment for a term of at least 7 years which may extend to 10 years, with or without fine; unless the victim is his own wife and is not less than 12 years of age, in which case, the maximum sentence is 2 years of imprisonment.
- ***Subsection 2:*** Punishment is extended up to 10 years when the offence committed is of:
  (i) Custodial rape.
  (ii) Institutional rape.
  (iii) Rape on a pregnant woman.
  (iv) Rape on a woman less than 12 years of age.
  (v) Victim of gang rape.

Section 376–A: A husband who has sexual intercourse with his own wife, who is living separately while divorce proceedings are pending in the court, can be punished with a maximum of 2 years imprisonment, with or without fine.

Section 376–B, C, and D: A public servant, superintendent or member of the management or staff of any of the institutions, who has sexual intercourse with any inmates of such an institution even with consent, such sexual intercourse not amounting to rape, can be punished with imprisonment for a maximum period of 5 years, with or without fine.

4. Write the scheme of examination of an alleged victim of rape?

There are two main responsibilities for a doctor in the examination of an alleged victim of rape:

i. *Medical responsibilities:* To treat the patient for the complications arising due to the alleged offence, giving appropriate counseling and rehabilitation measures.
ii. *Legal responsibilities:* Thorough and complete examination along with collection of trace evidences to establish the offence of Rape and facilitate proper delivery of justice to the victim.

Fig. 21.1 Multiple abrasions and contusions of the breast – a case of rape and murder

Note: The scheme of examination and certification of both the victim and the accused are discussed under the practical heading.

Evidence of rape

- Marks of violence on victim and the accused.
- Marks of violence about the genitals.
- Presence of stains of blood and/or semen on the clothes and body of the victim.
- Presence of seminal matter in the vagina.
- Pregnancy or existence of STD in both the parties.

5. What is adultery?

Consented extramarital sexual relationship is considered as adultery. Section 497 and 498 IPC deals with adultery.

Section 497 IPC

- "Whoever has sexual intercourse with a person whom he knows or has reasons to believe to be the wife of another man; such sexual intercourse not amounting to rape, is guilty of the offence of adultery and liable for punishment of imprisonment for 2 years.

Section 498 IPC

- Enticing or detaining a married woman, with criminal intention.
- Charge of adultery can be filed only against the adulterous man, and he should know or have reasons to believe that she is lawfully wedded to another man.

- If proved, then it is a ground for divorce for the husband of the adulterous woman.

6. What is incest?

- Consented natural sexual intercourse between a man and a woman, who are prevented by the society to get married.
- Incest is not an offence in India, since marriage between close blood relatives is an accepted practice in India.
- Sexual contact within the same nuclear family is not accepted by any religious customs.

7. What are the unnatural sexual offences? Short notes on sodomy:

Unnatural sexual offences:

i. Sodomy.
ii. Lesbianism.
iii. Buccal coitus.
iv. Bestiality.

Section 377 IPC

- Whoever voluntarily has carnal intercourse against the order of nature with any man, woman or animal shall be punished with imprisonment for life, or with imprisonment of either description for a term which may extend to 10 years, and shall also be liable for fine.

Sodomy:

- **Sodomy** denotes male homosexuality and involves penile-anal intercourse.
- Anal intercourse with a female is called **buggery.**
- The offender is the active agent; the other partner is the passive agent.
- If the passive agent is a child, the practice is known as **pederasty.**
- Habitual passive agents are called **Catamites**, (fairies, gays or queens)
- In India, **Hijras** (castrated males) and **Zenanas** (male transvestites) are the habitual passive agents of sodomy.

Local examination: The findings of examination are totally different on an individual who is not used to an act of sodomy and a habitual passive agent.

Victim not used to sodomy:

- Pain and tenderness are always present.
- Lubricant used and loose pubic hair in and around the anus.
- Perianal abrasions and bruising are always present; sometimes with anal laceration.
- Fresh/dried stains of semen and blood may be recoverable.
- Digital examination is painful and does not allow more than two fingers.

Habitual passive agent:

- Blood stains are usually not present.
- Lubricant and loose foreign pubic hair may or may not be present.
- Perianal hair is shaved and local hygiene scrupulously maintained.
- Thickening and keratinization of the perianal skin due to constant friction.
- No pain or tenderness during examination.
- Lateral buttock traction test is positive (funnel shaped depression of the anus)
- *Anus:* Dilated, patulous and loss of rugosity of mucous membrane. Fresh and old fissures and/or sinuses (tunneling) is a common finding.
- *Rectum:* Prolapsed mucosa, with thickening and disappearance of radial folds.
- Evidence of STD (Condylomata, chancre and gonorrheal discharge) may be evident.
- *Digital examination:* Allows 3 to 4 fingers easily and pain is highly improbable.

8. What is lesbianism?

- Lesbianism denotes female homosexuality; it is also called as **tribadism or sapphism.**
- Typically, it involves mutual masturbation and occasionally an active-passive relationship, by biclitoral/digital/lingual, vaginal stimulation, or the use of vibrators or artificial phalluses (**dildoes**).
- Active lesbian is known as **Butch** or **Dyke**, the usual passive agent is called **Femme**.
- Habitually active lesbians have a strong aversion to normal sexual behavior.
- Whereas the passive agent is not so, and in fact, frequently bisexual.

Medicolegal aspects:

- Lesbianism is extremely difficult to prove: Traces of fresh and dried saliva and/or mucosal cells can be detected on/around the external genitalia, or

- Injuries are present if there has been forcible introduction of a grossly disproportionate artificial phallus.

9. What is Sin of Gomorrah?

Buccal coitus:

- Buccal-penile intercourse is called **fellatio**; the partner who performs the act is called the **Fellator;** and on whom it is performed is the **Fellatee.**
- Buccal-vaginal stimulation is referred to as **cunnilingus.**

Medicolegal aspects:

The only material evidence of commission of the offence would be:

i. Spermatozoa of the fellatee in the buccal cavity of the fellator, or
ii. Fresh or dried saliva and/or mucosal cells on the penis of the fellatee, or vulva of the subject of cunnilingus.

10. Write short notes on bestiality.

- Sexual intercourse with a lower animal is called as bestiality and it is a crime throughout the world.
- The animal usually selected are cows, bitches, female sheep/goat/donkey and large birds in males and bulls, horses, dogs, male sheep/goat/donkeys by the females.

Medicolegal aspects

- Difficult to prove unless the accused is caught during the act.
- Young adult male, usually mentally challenged are the affected people.
- Injuries inflicted by the animal, hair/feathers and/or blood stains of the animal on the clothing or on the individual may be present.

11. What are sexual paraphilias?

Short notes: All perversions:

- Achievement of sexual gratification by means other than sexual intercourse; they are called as sexual deviations, perversions or paraphilias.
- These form a group of psychosexual disorders, which involves involuntary, repetitive, unusual acts, on which sexual arousal and orgasm are dependent.

i. ***Fetishism***

- Sexual focus is on relatively indestructible objects intimately associated with human body.
- Males are the affected ones; attraction is mainly on the clothes and articles which were in close intimation with the female body. For example, panties, petticoat, handkerchief, etc.
- Orgasm is obtained usually by masturbation.

ii. ***Transvestism***

- Crossdressing or eonism; dressing in the opposite sex, for the purpose of arousal and as an adjunct in sexual intercourse or masturbation.

iii. ***Sadism***

- Males are the affected; sexual arousal and orgasm linked to active infliction of injuries or torture of the sexual partner.

iv. ***Masochism***

- Females are the usually affected; sexual excitement linked with passive experience of physical or emotional humiliation or torture.
- There arises no problem when a sadistic male and a masochist female go hand-in-hand.

v. ***Lust Murder***

- Is an extreme form of sadism, where the sadistic male may pass a ligature around the neck of the female and strangle her (may also be a part of masochistic activity) during the act of sexual intercourse; at the moment of attainment of orgasm, he may tighten the ligature and hold it tight for some reasonable period of time and the woman may die due to ligature strangulation, this is called as lust murder. There is no intension to kill, but death is due to accidental strangulation.

vi. ***Exhibitionism***

- Exhibitionism involves repeated acts of exposing one's genitals to a female, who may even be a stranger or unsuspected person.

vii. ***Voyeurism***

- Perversion with desire to observe the genitals or other private parts of the female, while they are bathing, or go still perverted and like to watch them urinating or defecating and orgasm is obtained by masturbation.

viii. ***Peeping Tom***

- Watching people engaged in sexual activity without their knowledge.

ix. ***Troilism***

- Extreme form of peeping tom, where the pervert gets sexual gratification by inducing his wife to sexual intercourse with another person and like to witness the same.

x. ***Frotteurism***

- Practiced by a male pervert in a crowded place to drive sexual gratification by rubbing his private parts against a female's body.

xi. ***Necrophilia***

- Sexual arousal and orgasm can be attained by intercourse with a corpse.
  Mortuary workers are the usual sufferers, as they have the access; people addicted to alcohol and who are impotent may involve in these types of activities.

Necrophagia

- Is an extreme form of necrophilia where in sexual gratification is attained by tearing out the genitals or other part of body of a corpse and eating them.
- Necrophilia and necrophagia are punishable under section 297 IPC.

Section 297 IPC:

- Whoever with the intention of offering any indignity to any human corpse, shall be punished with imprisonment of either description for a term which may extend to one year, or with fine, or both.

xii. ***Pedophilia***

- Preferential sexual activity with children. Indulging the children in sexual activity by touching their private parts, kissing, hugging and make the children touch and fondle on their private parts; they make the children indulge in buccal coitus also.

xiii. ***Satyriasis***

- Excessive sexual desire among males. These subjects are liable to commit sexual offences.

xiv. ***Nymphomania***

- Excessive sexual desire among woman; they may indulge in sex with multiple sex partners and when the access to sex is restricted, they may indulge in lesbianism.

12. What is an indecent assault?

- Indecent assault generally means sex-linked misbehavior towards a person of opposite sex or the same sex.
- Any offence committed towards a female with the intention or knowledge to outrage the modesty of the female.
- ***Section 509 IPC:*** Whoever, intending to insult the modesty of a woman, utters any word, makes any sound or gesture, or exhibits any object shall be punished with imprisonment which may extend to one year.

13. What is auto-erotic asphyxias/sexual asphyxia?

This topic is discussed in Asphyxial death.

Section VI:

Forensic Psychiatry

CHAPTER 22

Psychiatry and Mental Health Act 1987

Keywords: Psychiatry, mental illness, insanity defence, delirium, delusion, illusion, hallucination, impulse, obsession, fugue, phobia, psychosis, sociopath, neurosis, somnombulism, somnalentia, hypnosis, mental retardation, epileptic psychosis, lactational psychosis, GPI, delirium tremens, feigned insanity, restraint of an insane, testamentary capacity, criminal responsibility, McNaughten's rule, Curren's rule, Durham's rule, irresistible impulse test.

INTRODUCTION

Forensic Psychiatry

Psychiatry is a branch of medical science which deals with diagnosis, treatment and rehabilitation measure of the mentally ill people.

Forensic psychiatry:

- Is a subspecialty of psychiatry which deals with the application of knowledge of psychiatry in legal issues.
- In general, it represents interference between law and psychiatry.
- The term "insanity" is loosely used to refer any mental disorder or mental illness.
- However, it is commonly used in legal context such as "insanity defense".
- The IPC employs the term "unsoundness of mind" while referring to insanity.

1. Define mental illness?

- Mental illness is a sociological concept accordingly a "**mentally ill person** may be designated as that member of the community who is unable to look after himself or manage his own affairs or is dangerous to himself or to others".

2. What is legal insanity?

- The mental illness may be of such gravity that it becomes advisable in the interest of the patient or the community to segregate such an individual and deprive him of his liberty and rights as a citizen.

3. What is reception order?

- It is an order issued by the court for admission and detention of a mentally ill person in a psychiatric hospital or nursing home.

4. What is delirium and when does it occur?

Delirium is a disorders of consciousness.

- There is disturbance of consciousness and orientation is impaired.
- Thought content is irrelevant or inconsistent
- In the early stage, the patient is restless, uneasy and sleepless.
- Later, he loses self-control, becomes exited and talks furiously.
- Delusions and hallucinations may be present at this stage; and he becomes impulsive and may commit any crime, for which he is not liable.
- Usually occurs in **physical disease.**

Example: Continuous high fever, mental stress or drug intoxication.

5. What is delusion? What are different types of delusions?

Delusion is a disorder of thought.

- False belief in something which is not a fact; and continues to persists even after the falsity is clearly demonstrated.

Types of delusions:

- *Delusion of grandeur or exaltation:* He is actually poor but thinks he rich.
- *Delusion of persecution:* Usually co-exists with delusion of grandeur; the individual thinks that because he is rich and got lot of money, people closely associated with him (wife or children) are trying steal his money and also believes they are even trying to kill him or poison him to take away his imaginary property and money.
- *Delusion of reference:* He feels that whatever he hears or comes across, he is being referred to.
- *Delusion of influence:* He believes that all his actions are influenced by some external agency; he receives imaginary commands and obeys them (like telepathy).
- *Delusion of infidelity:* The male is the sufferer; he suspects the fidelity of his wife, even though she is not like that in reality and is gem of a female; they are usually addicted to alcohol and may also be impotent.
- *Delusion of self reproach:* He accuses himself for all the bad and mishaps in his life.
- *Nihilistic delusion:* He does not believe in the worldly existence at all.
- *Hypochondriacal delusion:* The individual is relatively healthy, but thinks that he suffers from a number of diseases, goes from doctor to doctor with cluster of imaginary complaints.
- *Erotomaniacal delusion:* Females are the usual sufferers; usually people at a lower level develop some imaginary intimate affection towards one of a higher level and starts believing that they are also reciprocating.

6. What is hallucination? What are the types of hallucinations?

Hallucination is a disorder of perception in which there is false sense perception without any external object or stimuli to produce it. This is purely imaginary and may affect any or all of the special senses. Depending on the various special senses, it may be:

- *Visual hallucination:* He sees something when actually nothing is present there.
- *Auditory hallucination:* He hears some imaginary sounds, which do not exist.
- *Olfactory hallucination:* He perceives some smell, when no such odor is present.
- *Gustatory hallucination:* He feels some taste, when nothing is there in the mouth.
- *Tactile hallucination:* He feels some insects are crawling over his body, which are actually not there. This type of hallucination is also called "***Magnan's symptom***" (2 marks) or "***Formication***". It commonly occurs as withdrawal symptom of chronic cocaine poisoning and are referred to as "***cocaine bugs***".
- *Psychomotor hallucination:* He feels that some part of the body, usually the limbs are getting elongated, goes away from his body, performs some activity and comes back.

7. What is an illusion?

- Illusion is misinterpretation of a real existing stimulus or object.
- *Example:* Seeing a rope he may mistake it as a snake; the weight of the blanket may be mistaken as that of the weight of a collapsed building, etc.

8. What is an impulse? What are the types of impulses?

- Impulse is defined as sudden irresistible desire/force compelling a person to the conscious performance of some act for which there is no motive or forethought.
- Every individual may have impulsive behavior at any one time due to emotional imbalance. But, a sane person is capable of controlling his impulse but an insane person cannot control the impulses.

Types of impulse:

i. *Kleptomania:* Irresistible desire to steal articles of little value.
ii. *Pyromania:* Irresistible desire to set fire.
iii. *Mutilomania:* Irresistible desire to mutilate lower animals (pet animals).

iv. *Dipsomania:* Irresistible desire to drink alcohol in excess amount.
v. *Sexual impulse:* Irresistible desire to engage in some form of sexual activity.
vi. *Suicidal impulse:* Irresistible desire to commit suicide.
vii. *Homicidal impulse:* Irresistible desire to kill someone.

9. What is an obsession?
- Obsession is a disorder of the content of thought.
- A single idea, thought or emotion is constantly entertained by a person which he himself recognizes as irrational, but persists in spite of all efforts to drive it from his mind.
- Any attempt to resist makes them appear more insistent, and yielding is the inevitable outcome.
- It is a ***borderline*** between sanity and insanity.
- Usually occurs in neurotic people, who are very well able to discharge their ordinary responsibilities of life.

10. What is fugue state?
- It is a state of altered awareness during which an individual forgets part or whole of his life, leaves home and wanders away; he has a state of complete amnesia for the period.
- Occurs commonly in hysteria and also in depressive illness and schizophrenia.

11. What is phobia? What are the types?
- An excessive or irrational fear of a particular object or situation.
  (i) Claustrophobia: Fear of staying in a closed place.
  (ii) Nyctophobia: Fear of darkness.
  (iii) Agoraphobia: Fear of open space.
  (iv) Acrophobia: Fear of height.
  (v) Mysophobia: Fear of dirt.
  (vi) Hydrophobia: Fear of water.

12. Who is a psychopath?
- Psychopath is also known as sociopath.
- A person who is neither insane nor mentally defective, but fails to conform to normal standards of behavior.
- Psychopaths have abnormal personality and persistently behave in an antisocial or disruptive manner.
- There is failure of maturation of the personality and the individual retains a child-like selfishness.
- There is no abnormality of thought, mood or intelligence.
- It is not a ground for insanity defense but may provide a plea of diminished responsibility.

13. What is a psychopathic disorder?
- It's a persistent disorder or disability of mind, which results in abnormally aggressive or seriously irresponsible conduct on the part of the person.

14. What is psychoses?
- Characterized by a withdrawal from reality, and living in a world of fantasy.
- Mental illness supervenes upon a normally developed mental faculty.
- There is disorientation in the personality and progressive loss of contact with reality.

15. What is neurosis?
- The patient suffers from emotional and intellectual disorders, but does not lose touch with reality.
- Neurosis is commonly seen in anxiety, depression or hysteria.
- The effect may be mild or may cause considerable disturbance.

16. What is affective disorder?
- Affect means emotion, feeling or mood.

Affective disorder:
- Psychiatric disorder in which the chief feature is a relatively prolonged affective change of an abnormal degree; it consists of two phases namely, Mania (elevation) and Melancholia (depression), hence also called as bipolar disorders.

17. What is lucid interval of insanity?
- Period of sanity in between two bouts of insanity.

Table 22.1 Difference between lucid interval of insanity and lucid interval of head injury:

Insanity	Head injury
History of insanity is present	History of head injury is present and usually occurs in extradural hemorrhage
Predisposing symptoms of insanity present	Predisposing symptoms of cerebral concussion is present
Following symptoms of insanity present	Symptoms of cerebral irritation and brain compression are present
Occurrence is frequent	Occurs only once, and then the person undergoes permanent unconsciousness and death follows

- All the symptoms of insanity disappear and the person is completely normal.
- He can make a valid will during this period and is legally responsible for all his acts.

Difference between lucid interval of insanity and lucid interval of head injury is given in Table 22.1.

18. What are the causes of insanity?

i. *Hereditary:* Huntington's chorea, family idiocy, etc.
ii. *Environmental:* Faulty parental attitude and lack of mental hygiene.
iii. *Psychogenic:* Unsuccessfully repressed mental conflict.
iv. *Precipitating:* Financial worries, frustrations and disappointment in sexual affairs, death of close relative, etc.
v. *Organic causes:* Head injury, atherosclerosis, senile degeneration, myxedema, pernicious anemia, etc.

- International classification of diseases (ICD) 10th Edition. 1992, classifies psychiatric diseases for the purpose of treatment and Chapter F deals with psychiatric disorders.

19. Classification of insanity. (WHO, 1965)

- WHO classification of psychiatric diseases is simple and also widely accepted even today, especially for legal issues.

i. **Organic psychoses:** Senile and presenile dementia, associated with disease, tumors, and endocrine, metabolic and nutritional disorders.

- *Functional:* Schizophrenia and affective disorders.

ii. **Neuroses:**
  - Anxiety neurosis
  - Hysterical neurosis
  - Phobic neurosis
  - Obsessive compulsive neurosis
  - Depressive neurosis.

iii. Personality disorders (psychopath)
iv. Sexual deviations
v. Drug dependence (drug induced)
vi. Mental subnormality (amentia)
  - In mental subnormality (***mental retardation***), there is defective development of mental maturity and intelligent quotient of an individual is taken into consideration.
    (i) *Idiocy:* IQ 0 to 20 and Mental is 3 years.
    (ii) *Imbecility:* IQ 20 to 50 and mental age is 7 years.
    (iii) *Moron or feeble mindedness:* IQ 50 to 75 and mental age is 12 years.

20. What is the relationship of alcoholism and psychosis?
What is delirium tremens?

Alcohol is a CNS depressant and prolonged consumption of large quantities leads to psychiatric problems. Some of the important conditions related to alcohol are:

Alcoholic Blackouts: These are episodes of amnesia which occur after a sudden heavy alcoholic drink and the individual has a complete amnesia of the sequence of events which occur during this phase.

Delirium tremens:

- Delirium tremens is a withdrawal symptom of chronic alcoholism; occurs 2 to 3 days after the last drink and may persist for three

weeks; it is a consequence of sudden abstinence in a chronic drunkard.
- Injuries, infection and shock may be precipitating factors.
- The patient becomes sleepless, restless and irritable; then develops disorders of perception and coarse muscular tremors of the peripheries, mainly face, tongue and hand.
- He is prone to commit some offences during this phase, especially assault, sexual offences, suicide or murder.
- He is totally exempted from the law for any of the offences committed during this period, since delirium tremens is a psychotic condition.

Alcoholic hallucinosis:
- The patient may suffer from different types of hallucinations and may also develop illusions due to chronic alcoholism.

Korsakov's psychosis:
- Characterized by loss of memory for recent events both retrograde and anterograde amnesia; the individual remains responsive and alert despite the severe memory loss and learning impairment.

Wernicke's encephalopathy:
- The physical components of Korsakov's psychosis consists of opthalmoplegia, ataxia and peripheral neuritis and is known as Wernicke's encephalopathy.
- Delusions of infidelity and delusions of jealousy may develop due to the effects of chronic alcoholism.

21. What is GPI? (general paralysis of insane)
- Usually associated with menigovascular syphilis and tabes dorsalis.
- Chronic psycho-organic syndrome characterized by tempermental and personality changes, leading to paralysis and dementia.
- Memory is impaired and retarded thought are present.

22. What are effects of epilepsy on psychosis?
- Epilepsy is usually not associated with psychiatric symptoms; but 10% of patients suffering from epilepsy may have associated psychiatric problems; and may occur at any of the three phases:

(i) *Pre-epileptic confusional state:* A state of confusion and irritability occurring just prior to the epileptic fits.
(ii) *Post-epileptic automatism:* Occurs immediately after the epileptic fits and the individual may commit any offence like assault or theft after the epileptic phase and usually same type of act is done repeatedly, after every attack of fits.
(iii) *Epileptic equilent or masked epilepsy:* The epileptic fits phase may be completely replaced by some criminal act; the individual may even commit murder. This is also called as psychomotor epilepsy or psychic epilepsy.

23. Effects of pregnancy, child birth and psychosis?
- Psychosis may occur any time from the beginning of pregnancy to the end of lactation: Delusions are common and dislike or hatred towards the husband may occur and the Patient may develop suicidal tendencies.
- Post-partum psychosis may take a great variety of forms: The commonest being Mania and the women may commit infanticide.

24. What is lactational psychosis?
May occur after six weeks of confinement.
- Characterized by mental confusion, hallucinations and depression.
- Delusion of persecution may develop, which may lead to suicide and infanticide.

25. How to diagnose insanity?
- Insanity is usually a slowly developing disease and the people close to the patient who are present around the individual can very well make out the difference if observed carefully. It may take two to ten years for the development of full blown psychosis.
- But in a less percentage of cases, it may be sudden in onset; especially in emotionally instable individuals who have some traumatic episode of events in their life, like sudden loss of someone who were very close and on whom they were much dependent in life.
- In typical cases, the diagnosis is easy, but in early stages and in borderline cases, the correct diagnosis becomes very difficult.

- The objectives of clinical examination are to form an opinion about the patient's mind and the degree of responsibility.

Preliminary particulars:

- *Family history:* Psychosis, chorea, epilepsy, etc.
- *Personal history:* Previous mental illness and treatment, environmental factors, emotional conflict and anxiety, drugs, frustrations in life, love, etc.

Physical examination:

- Manner of dress and walk.
- Examine for deformities and organic diseases which may lead to psychosis.
- Pulse and temperature (may be increased).
- Tongue: Furred and coated.
- Skin: Dry and Wrinkled.

Mental condition:

- *Talk:* Mutism, distraction and irrelevant talk.
- *Speech:* Incoherent, slurred and stammering of speech.
- *Writing:* Flight of ideas, insulting language, meaningless and unintelligible.
- *Behavior:* Lazy, impulsive, stereotypy and echopraxia.
- *Mood:* Highly variable mood; emotion, euphoria, joy, anger, apathy, irritable, etc.
- *Memory:* Impaired and amnesia usually present.
- *Sleep:* Insomnia, hyposomnia, somnambulism, somnolentia.
- *Walk and gait:* Staggering gait.
- *Sex behaviour:* Abstinence or perverted.
- *Attention:* Focusing the attention to a particular object or incident is very difficult and concentration power is very much lowered or even absent.
- Thought process and thought content are irelevant and inconsistent.
- *Investigations:* Blood, urine, CSF, X-ray, EEG: But the results of the investigations may not show any diagnostic feature of abnormality.

26. What are the methods of observation and certification of insanity?

- No certificate of mental illness is to be issued by a single examination; minimum three examinations on different day and different times, before a certification of insanity is issued.
- The patient is admitted and kept under observation for 10 days in the first slot, if no clear opinion could be arrived in ten days, then it can be extended to another 10 days to a maximum of 30 days.
- The patient is observed when he is unaware that he is being observed; nowadays, hidden cameras are used for continuous secret observation.
- No single feature is diagnostic, but many of the following findings are useful to arrive at a conclusion of insanity.

27. How to differentiate true insanity from feigned insanity?

The difference between true insanity and feigned insanity is illustrated in Table 22.2.

28. Write short notes on the Mental Health ACT 1987:

The Mental Health Act 1987:

- Replaced Indian Lunacy Act 1912: The basic of the Lunacy Act was to prevent ourselves from the mentally ill people. Due to the advancements in the field of psychiatry, the basic aim of the Mental Health Act is to preserve the rights of the mentally ill people.
- MHA is divided into 10 chapters consisting of 98 sections: Chapter 1 deals with definitions.
  - (i) Psychiatric hospital or nursing home means:
    Is a hospital for the mentally ill maintained by the government or private authority with facilities of outpatient treatment and registered with appropriate licensing authority.
    Admitting a mentally ill person to a general nursing home is an offence.
  - (ii) sychiatrist means:
    A RMP with postgraduate or diploma degree in Psychiatry recognized by the MCI (MD in Psychiatry or DPM)
  - (iii) Mentally ill person:
    A person who is in need of treatment for any mental disorder other than mental retardation.

Table 22.2 Difference between true insanity and feigned insanity

True insanity	Feigned insanity
Onset: Gradual	Usually sudden, after committing an offence
Motive: 100% no motive	Obvious motive (diagnostic)
Predisposing factors of insanity are present	No predisposing factors; absent
Signs and symptoms: Uniform irrespective of whether he is being observed or not	Signs and symptoms: Present only when observed by someone
The symptoms are uniform and fall into any one of diagnosable psychiatric illness	The symptoms are varying and will not fall into any diagnosable psychiatric illness
Physical signs of insanity are present: Face will have the classical feature called vacant look (without any expression)	Physical signs of insanity are absent: Changing facial expressions
Filthy behavior and worst hygiene	Hygiene and filthy behaviors are not to that extent as these cannot be mimicked
Can withstand hunger, insomnia and exertion for a very long period of time	Cannot withstand hunger, insomnia and exertion and hence becomes exhausted soon
Does not mind frequent examinations	Resists frequent examinations for fear of being detected

- Guidelines for admission and discharge of an insane person and various methods of restraint of insane are prescribed in the Mental health Act 1987.

29. What are the various methods of restraint of the insane?
What are the methods of admission into a psychiatric hospital?

i. ***Immediate restraint:***

- Anyone who is present nearby can restrain a mentally ill person if:
  - (i) He is dangerous to himself or to others, or
  - (ii) He is likely to injure himself or others, or
  - (iii) He wastefully spends his money.
  - (iv) Persons suffering from delirium due to disease, and
  - (v) Delirium tremens.

ii. ***Methods of admission of a patient in psychiatric hospital:***

A. *Admission on voluntary basis:*

- The patient himself or his relatives approaches the hospital for admission; such application has to be supported by medical certificate from two doctors (psychiatrists) and one of them should preferably be a government doctor.
- If the hospital has enough facilities, even without such medical certificate admission can be made after examining by two psychiatrists from their hospital itself.
- When he is admitted on voluntary basis, if request for discharge is made, then he has to be discharged within 24 hours of such request, even if he is not fully cured of the problem.
- For a patient to get admitted into the hospital on voluntary basis, there has to be "Insight".
- **Insight** is the ability of the individual to recognize that he is having some mental problem and because of that he is unable to adapt to the required standards of life; thus seeks the help of someone (usually psychiatrist) to get cured of his illness.

B. *Admission under special circumstances:*

(i) Reception order on application:

- The relatives can make an application to the magistrate along with two medical certificates and get a reception order for admission; when such individual applies for discharge, then he will be discharged only after information to the magistrate and he has to wait for the period of time for completion of the process to get discharged.

(ii) Reception order on production of mentally ill person before the Magistrate:
- A wandering psychiatric patient can be produced in front of the magistrate by the police of that jurisdiction and obtain a reception order for detention and admission of such patients. When some relative of such an individual comes forward after a period and requests for discharge, he cannot be discharged if he is not fully cured.

(iii) Admission after judicial inquisition:
- When a person accused of a crime, takes a defend on the grounds of insanity, then the magistrate issues a reception order for detention, observation and certification of mental illness.

(iv) Admission of mentally ill prisoner:
- When a person, convicted of a crime, is found/proved to be insane, then he cannot be imprisoned; he has to be admitted and treated in a psychiatric hospital under the reception order of the magistrate; when such an individual is cured of his mental illness, then the doctor informs the magistrate and he may be discharged or imprisoned under the orders of the court.

(v) Admission of an escaped mentally ill person:
- When a mentally ill person escapes from the hospital, on production of the individual in the court, he can be admitted again on obtaining a reception order.

30. What are all the civil responsibilities of an insane?
Write short notes on testamentary capacity.

i. *Management of property and affairs:*
- The insanity is of such a degree as to make him incapable of managing his property and affairs; then the court may appoint a manager (when he is unable manage the property) or a guardian (when he is unable manage the property and as well as his own affairs) depending on the condition of the patient, on opinion of two psychiatrists.

ii. *Consent:*
- Consent given by an insane person is not a valid consent.

iii. *Contract:*
- An insane person cannot sign a contract and is invalid; if any of the partner was proved to be insane at the time of signing a contract, then the contract goes invalid, but if he has signed in the period of lucid interval, then it becomes a valid contract.

iv. *Marriage:*
- If anyone of the parties was proved to be insane at the time of marriage, the marriage is declared as null or void (invalid marriage). But anyone of the parties became insane after marriage then it can be a ground for divorce by the other party, provided he/she has made enough efforts to treat the mental illness for a reasonable period of time.

v. *Competency as witness:*
- An insane person is not competent to be a witness in the court of law, unless he is in the period of lucid interval.

vi. *Testamentary capacity:*
- It is the mental ability of a person to make a valid will.

The requirements are:
- A written, properly signed and witnessed document.
- The testator must be a major and of sound disposing mind (compos mentis) and it should be certified by a doctor.
- Force, undue influence or dishonest representation of facts, should not have been applied by others.
- None of the witnesses should be beneficiaries of such a will.
- Bedridden and aphasic individuals are not prevented from making a will; provided they understand what the property they have got, to whom they are giving and why they are giving to them.

Holographic will: (2 Marks)
- It is a will which is written by the testator in his/her own hand writing.
- Many a times, doctors are called upon to witness the execution of the will of a sick, and the doctor should check whether the individual is in compos mentis (sound disposing mind).

31. What is somnambulism?

- Sleep walking.
- During sleep, the individual may leave the bed and walk out of the house; he is not asleep but in a state of dissociated consciousness, in a hallucinatory state.
- His mental faculties are partially active and are so concentrated towards one particular idea (that he may solve a difficult problem, which he was unable to do after working for hours on it to solve the issue).
- He may commit any crime or suicide, or meet with an accident, but rarely injures himself.
- There is no recollection of the events, but in some cases the events of one episode are remembered and consequently repeated in the next time.
- Such people are usually well-adjusted in life, socially well-behaved and are not aggressive.
- They are not criminally liable for any offence committed during this phase.

32. What is somnolentia?

- Semi-somnolence: (sleep drunkenness) It's midway between sleep and awake.
- When a person is in the phase of deep sleep and suddenly aroused, especially when he in a dream at that time (deep sleep pattern), he has a confused state of mind and may commit any crime during this period.
- They are not criminally liable for their act during this phase, as they are in a confused state of mind.

33. What are the effects of hypnotism and mesmerism in psychiatry?

- Hypnotism is a sleep-like condition induced by artificial means.
- The individual during the hypnotic trance, may perform some act suggested by the hypnotist, but does not remember them afterwards.
- Medical hypnosis is safe and is used for treatment of many psychiatric conditions.
- Usually the hypnotized individual cannot be made to do some immoral activities.
- An individual doing a crime under this phase is criminally liable, since even though he is under hypnotism, he will be able to regulate his conduct to the needs of the law and can prevent himself form doing such crimes.
- It's said that the brain of a hypnotized person is under the control of the hypnotist and hence ***doctrine of diminished responsibility*** may be applied if such a person commits any grave crime under the influence of hypnotism.

34. What are the criminal responsibilities of an insane?
What is McNaughten's rule?

- The law presumes that every individual is sane and is responsible for his actions.
- The law also presumes that for every criminal act there must be criminal intents.
- Every crime has two components, a criminal mind and the physical component execution of the crime. Criminal mind (mens rea) and actus reus (the actual physical act doing the crime).

Mc Naughten's Rule: The **right** or **wrong** test.

- An accused person is not legally responsible, if it is **clearly proved** that:
  (i) At the time of committing the crime.
  (ii) He was suffering from such a defect of reason.
  (iii) Due to disease of the mind that he did not know the nature and quality of his act he has done,
  (iv) What he was doing was wrong and contrary to the law?

Section 84 IPC:

- Nothing is an offence which is done by a person, who at the time of doing it, by reason of unsoundness of mind, is incapable of knowing the nature of the act, or that what he is doing is either wrong or contrary to law.

35. Name some advancements in psychiatry taken place in advanced countries?

i. ***Durham's rule:***

- An accused person is not criminally responsible, if his unlawful act is the product of mental disease (mental disorder) and mental defect (mental retardation)

ii. ***Curren's rule:***

- An accused person is not criminally responsible, if at the time of committing the act,

he did not have the capacity to regulate his conduct to the requirements of the law, as a result of mental disease or mental defect.

iii. ***The irresistible impulse test:*** (The new Hampshire doctrine)

- An accused person is not criminally responsible, even if he knows the nature and quality of his act and knows that it is wrong if he is incapable of restraining himself from committing the act, because the free agency of his will has been destroyed by mental disease.
- In this test whether the impulse was strong (and irresistible) or the offender is weak (not resisting the impulse voluntarily) is the question for which the psychiatrist or the law does not have any proper answer, and hence this test is never used alone and is always used along with the 'right or wrong test'.

iv. **The American law institute test:**

- A person is not criminally liable, if at the time of such conduct, he lacks adequate capacity either to appreciate the criminality of the conduct or to adjust his conduct to the requirements of the law, as a result of mental disease of defect.

v. **The Federal rule (USA):**

- An accused person is not criminally responsible, if at the time of commission of the act which constitutes an offence, as result of severe mental disease or defect, the defendant was unable to appreciate the nature, quality or wrongfulness of his act.

Section VII:

Medical Toxicology

CHAPTER 23

General Considerations

Keywords: Toxicology, poison, toxinology, poison information center, stabilization, evaluation, poison elimination, emesis, gastric lavage, activated charcoal, antidotes, chelating agents, duties of doctor in poisoning, autopsy on poisoning cases.

INTRODUCTION

Definitions

- **Toxicology** is the science which deals with properties, action, toxicity, fatal dose, detection, estimation and treatment of poisons.
- **Forensic toxicology** deals with the medicolegal aspects of harmful effects of any poison on the human body.
- **Poison** is any substance (solid, liquid or gas) which if introduced into the human body or brought into contact with, will produce ill effect or death by its constitutional or local effect or both.
- **Clinical toxicology** deals with diseases caused by, or associated with abnormal exposure to chemical substances.
- **Toxinology** refers to toxins produced by living organisms which are dangerous to man. Example: Poisonous plants, venoms of snakes, spiders, bees, etc.

1. Write short notes on poison information centers?

- The 1st PIC was established in Netherlands in 1949.
- Telephone answering service was introduced in Leeds, London in 1961.
- In 1963, a National Poison Information center was established at Guys's Hospital, London. In the same year, PIC was opened in Chicago, USA.
- Today more than 75 certified centers are there in USA alone. An intricate computerized information resource system (POISINDEX) is used, which covers more than 80,000 poisonous products.
- In India the National Poison Information Centre was established at AIIMS, New Delhi, in December 1994. Now, National Institute for Occupational Health, Ahmedabad, MMC Chennai, Industrial Toxicity Research Centre at Lucknow and Amrita Institute of Medical Sciences, Cochin has got well-established WHO approved poison information centers.
- The WHO has released its software (INTOX) which is used in India.

2. What are the characteristics of an Ideal homicidal poison?

- An ideal homicidal poison should be:
  (i) Cheap, (ii) Easily available, (iii) Colorless, odorless and tasteless, (iv) Capable of being administered easily with food, drink or medicine, without producing any obvious (color) change to arise suspicion, (v) Highly toxic, (vi) Signs and symptoms should mimic some natural disease, (vii) Effects must be delayed for sufficient long time for the accused to escape suspicion; (viii) Should not produce

any specific postmortem change, (ix) Should not be detected by chemical analysis or tests.

- Organic compound of fluorine (used as rodenticide) and thallium satisfy several of the above criteria. Arsenic and aconite are commonly used as homicidal poisons.

3. What are the characteristics of an Ideal suicidal poison?

- An ideal suicidal poison should be:
  (i) Cheap, (ii) Easily available, (iii) Highly toxic, (iv) Tasteless or of pleasant taste, (v) Capable of being easily taken with food or drink, and (vi) Capable of producing painless death.
- Opium and Barbiturates satisfy several of the above criteria.
  Organophosphorus compounds and endrin are commonly used suicidal poisons.

4. What is the general management of a poisoning case?
What is an antidote? What is the mechanism of action of various antidotes?
Short notes on: Activated charcoal; gastric lavage; coma cocktail; universal antidote.

The general lines of management of any poisoning case are:

i. Stabilization
ii. Evaluation
iii. Decontamination
iv. Poison elimination
v. Antidote administration
vi. Nursing and psychiatric care.

i. Stabilization and evaluation

- When the retention of CO_2 ($PaCO_2$ > 45 mm Hg) or hypoxia (PaO_2 < 70 mm Hg) are indications for assisted ventilation.

Coma cocktail

When a patient is in coma and the nature of the poison is unknown, then coma cocktail is used, which consists of:

- Dextrose—100 mL of 50% solution IV.
- Thiamine—100 mg IV.
- Naloxone—2 mg IV.

Since, hypoglycemia and morphine are said to be the commonest causes of coma.

ii. Decontamination

There are various methods of decontamination: (i) Emesis; (ii) Gastric lavage; (iii) Catharsis; (iv) Activated charcoal: (v) Whole bowel irrigation.

- Decontamination can be done by any of these methods—forced emesis, gastric lavage and activated charcoal are commonly being used.

(i) Emesis:

- Forced emesis can be done and useful, within 2 hours of poison ingestion.
- Concentrated solutions of sodium chloride, soapy water or lime water are generally used.
- Emesis can also be induced mechanically, by inserting the finger into the pharynx.
- Syrup of ipecacuanha (ipecae) is much preferred; 30 mL for adults and 15 mL for children, followed by 250 mL to 500 mL of water.
- Patient must be in sitting position; if vomiting does not occur within 30 minutes then repeat the same dose once again.

Indications for emesis by using ipecae:

- Conscious and alert patients who have ingested poison not more than 4 to 6 hours earlier.

Contraindication:

- Relative contraindications:
  - Very young children, pregnancy, heart disease, bleeding disorders and cardiac poisons.
- Absolute contraindications:
  - Convulsion, impaired gag reflex, coma, foreign body ingestion and corrosive poisons.

(ii) Gastric lavage:

- Indicated for ingested poisons, useful and effective within 2 to 4 hours (max 6–8 hours):

Contraindications:

- *Relative:* Comatose patients, convulsions, pregnancy and children.
- *Absolute:* Corrosive poisons, convulsants, petroleum products and sharp objects.
- Boas tube (stomach wash tube) or Ryles tube (for children) are used (Table 23.1).

(iii) Activated charcoal:

- It is a fine, black, odorless, tasteless powder made from burning wood, coconut shell, bone, sucrose or rice starch,

Table 23.1 Solutions used for gastric lavage

Poison	Solutions
Most poisons—known or unknown	Water or saline
Oxidizable poisons (alkaloids and salicylates)	Potassium permanganate—($KMnO_4$) (1:5000 or 1:10000 solution)
Cyanides	Sodium thiosulfate 25%
Carbolic acid	Castor oil and warm water
Oxalates	Calcium gluconate
Iron	Desferrioxamine (2 g in 1 liter of water)

followed by treatment with an activating agent (steam, CO_2)
- The resultant particles are very small, but have an extremely larger surface area of adhesion; each gram works out to a surface area of 1000 square meters.
- Super activated charcoal which adheres to more surface area is available in the US.

Mode of action:
- Decrease the absorption of various poisons by adsorbing to them on their surface.
- *Dose:* 1 gm/kg body weight; usually 100 gm in adults and 10 to 30 g in children.
- *Procedure:* Add 4 to 8 times the quantity of water to the calculated dose of activated charcoal, and mix to produce a slurry solution, and given to patient after emesis or lavage.

Disadvantages:
- Unpleasant taste
- Provocation of vomiting
- Constipation/diarrhea
- Pulmonary aspiration
- Sometimes, causes intestinal obstruction; especially with multiple doses.

Contraindications:
- Absent bowel sounds or proven ileus
- Small bowel obstruction
- Caustic ingestion
- Ingestion of petroleum distilleries.

iii. Elimination of absorbed poison
- Forced diuresis is commonly employed method for elimination of absorbed poisons.
- Extracorporeal techniques like hemodialysis, hemoperfusion, peritoneal dialysis, hemofiltration, plasmapheresis, plasma perfusion, and cardiopulmonary bypass are also in use to eliminate the poison.

iv. Antidote administration
- **Antidotes** are substances which directly counteract the action of a poison; there are various modes of action of antidotes:

Universal Antidote:
- When the nature of the poison is not known or a mixture of poisons is suspected then universal antidote can be used, which consists of: (i) Activated charcoal, (ii) Magnesium oxide and (iii) Tannic acid. Of course the use of such universal antidote is not in use nowadays.

Table 23.2 Mechanism of action of antidotes

Mechanism	Example
Inert complex formation	Chelating agents for heavy metals
Accelerated detoxification	Thiosulfate for cyanide
Reduced toxic conversion	Ethanol inhibits metabolism of methanol
Receptor site competition	Naloxone for opiates
Receptor site blockade	Atropine for organophosphates
Toxic effect bypass	100% oxygen for cyanide poisoning

5. What is the Indian status on drugs and poisons?

There are various Acts in force with regard to poisons and drugs; the most important of these are:

(i) The Poisons Act, 1919
(ii) The Drugs and Cosmetics Act, 1940
(iii) The Drugs and Cosmetics Rules, 1945.

The drug and cosmetics act 1945 divides (groups) the drugs into various schedules:

- Schedule **C**: Biological products, sera, vaccines, etc.
- Schedule **E**: Poisonous substances under ayurveda, siddha, and unnani systems.
- Schedule **G**: Hormonal preparations, anti-histamines & anti-cancer drugs.
- Schedule **H**: Barbiturates, amphetamines, reserpine, ergot and some sulfonamides.
- Schedule **L**: List of prescription drugs.

The other acts in relation to the poisons and drugs are:

- The Pharmacy Act, 1948. The Drugs Control Act, 1950.
- The Drugs and Magic Remedies (Objectionable Advertisement) Act, 1954.
- The Narcotic Drugs and Psychotropic Substances Act, 1985.

Section 328 IPC:

- Whoever administers to any person any poison, or any stupefying, intoxicating or unwholesome drugs with the intent to cause hurt to such persons, shall be punished with imprisonment upto 10 years, and shall also be liable for fine.

6. Write short notes on chelating agents?

- Chelating agents are a group of chemical substances, which are used as antidotes in heavy metal poisoning.
- The heavy metals combine with the sulfadryl group of mitochondrial enzyme system, and thereby interfere with the cellular respiration.
- Chelating agents have a greater affinity for the metals, compared to the endogenous enzyme systems. They strongly bind with the heavy metals and form inert complexes.
- The complex agents formed with the metal are relatively more water soluble and the complex is excreted through urine.
- The commonest used chelating agents are:
  (i) BAL (British Anti-lewisite) or dimercaprol; dimercaptopropanol.
  (ii) EDTA (Ethylene diaminetetra acetic acid)
  (iii) Penicillamine (Oral chelating agent)
  (iv) DMSA, succimer (3-dimercaptosuccinic acid)
  (v) DMPS (2,3-dimercaptopropane I-sulfonate)

7. What are the duties of a doctor in suspected cases of poisoning?

- Medical duties stand first in the order of priority in any case of poisoning; the doctor must make all necessary efforts to save the life of the patient.
- Follow the general lines of management like stabilization, evaluation, decontamination, antidote administration and nursing care appropriately. The specific antidotes to be administered are discussed in detail under all the poisons.

Legal duties:

- Doctors in government hospitals have to inform every case of poisoning to the police.
- Doctors working in private hospitals need not inform the police if it is a case of accidental or suicidal poisoning. But if the patient dies, the doctor should not issue a death certificate and has to inform the police and refer the body for postmortem examination.
- All cases of homicidal poisoning (definite or suspected) either in government or private hospitals must be reported to the police (section 39 CrPC). Failure to do so will make him liable under section 176 IPC.
- When the police require some information regarding the cases of poisoning, which is accidental, suicidal or homicidal, the doctor must divulge all the information. There is no professional secrecy in this matter (175 CrPC), if any information is withheld or wrong information is provided, the doctor is culpable under 202 and 193 IPC respectively.
- Every effort must be made by the doctor to collect and preserve evidences suggestive of poisoning. Deliberate omission to do so, will attract punishment under section 201 IPC.

- Collect vomitus, feces, stomach washings, contaminated food, etc. and dispatch the same to FSL for chemical analysis, in event of death of the patient along with the body itself.
- If the patient is conscious, but on the verge of death, arrange for dying declaration.
- Detailed written records must be made with respect to every case and should be kept under safe custody by the doctor.
- When poisoning has resulted from a common eating place, the doctor is bound to inform the public authorities, failure to do so, will attract action against him for infamous conduct.

8. What are the procedures of postmortem examination in a case of poisoning?

- Stains of vomitus on the clothing must be collected, preserved and sent to FSL.
- Evidence of corrosion, discoloration, sloughing especially around the mouth may be present, if the poison has been ingested.
- Presence of jaundice (yellowish discoloration of skin, nails, conjunctiva and internal organs) indicates hepatotoxic poison, or poisons causing hemolytic anemia.
- *Odor:* Any peculiar smell must be noted, which may not be perceptible at autopsy due to the odor inside the mortuary (inspite of it, some of the poisons will have peculiar odor) (Table 23.4).
- *Color of postmortem lividity:* May give a clue to the poison involved (Table 23.3).
- *Putrefaction changes:* Arsenic and organophosphates are said to delay putrefaction.
- *Injection marks:* Especially in snakebite, morphine and insulin poisoning, bits of skin from the sight of injection are taken with adjoining intact skin, divided into two parts and one part to the FSL and the other for HPE (especially in snakebite).

Internal examination:

- *Odor:* Some poisons have a peculiar smell, on opening the thoracoabdominal cavity; stomach contents should be examined for the color, volume, consistency and any visible particulate matters.
- Evidence of inflammation on the esophagus, stomach and duodenum in ingested poison.
- The odor could give a clue to the poison involved.

The State of Other Organs:

- Kidneys may show degenerative changes or even necrosis.
- Sub-pleural petechial hemorrhages on the lungs if asphyxia has resulted.
- Heart may show subepicardial petechiae and subendocardial petechio-ecchymotic hemorrhages in cases of cardiac poisons.
- Confirmation is by subjecting the viscera for chemical analysis by forwarding the viscera to the Forensic Science Laboratory.

9. What are the circumstances when viscera are sent for chemical analysis?
What are the viscera preserved in various poisoning cases?

- In many situations, the doctor may have to preserve the viscera for chemical analysis; it is mandatory to preserve the viscera in the following situations:
  (i) All cases of poisoning brought dead or treated.
  (ii) In all murder cases to detect any poison and alcohol.

Table 23.3 Color of PM staining

Carbon monoxide	Cherry red
Cyanide	Bright red
Hydrogen sulfide	Greenish blue
Phosphorus	Brown
Nitrobenzene, potassium chloride	Brownish red
Aniline	Blue, bluish brown

Table 23.4 Odor of various poisons

Odor	Substance
Acetone (apple like)	Chloroform, ethanol, isopropanol, lacquer
Acrid (pear like)	Chloral hydrate, paraldehyde
Bitter almond	Cyanide
Burnt rope	Cannabis (Marijuana)
Hospital smell (disinfectant)	Carbolic acid (phenol), creosote
Garlicky	Arsenic, phosphorus, selenium, thallium
Mothballs	Naphthalene, camphor
Musty (fishy)	Aluminum phosphide, zinc phosphide
Rotten egg	Carbon disulfide, hydrogen sulfide
Shoe polish	Nitrobenzene
Vinegar	Acetic acid
Wintergreen	Methyl salicylates
Kerosene-like odor	Organophosphorus, petrol, kerosene

(iii) In road traffic accidents to detect alcohol.
(iv) In all cases of magistrate inquest.
(v) In all suspicious and sudden deaths.

Routine viscera to be preserved for chemical analysis:

- Routinely five bottles are sent for analysis and is sufficient in cases where the poison is suspected to be ingested. When the mode of administration is not by ingestion, then additional viscera has to be preserved depending on the mode of exposure.
- **Bottle No. 1:** Stomach with its contents.
  Inference: The poison was ingested.
- **Bottle No. 2:** Upper 30 cm of the duodenum with its contents.
  Inference: Poison has moved to the intestines due to active peristalsis, i.e. administered when alive.
- **Bottle No. 3:** 500 g of liver and half of each kidney.
  Inference: Absorbed poison is carried to liver for metabolism and kidneys for excretion.
- **Bottle No. 4:** 100 mL of blood with sodium fluoride as preservative.

Additional viscera in special circumstances (Table 23.5):

Table 23.5 Additional viscera in special circumstances of poisoning

Viscera	Poison
Brain	Volatile and anesthetic poisons
CSF and brain	Alcohol
Heart	Cardiac poisons (aconite, digitalis, etc.)
Spinal cord	Nervous poisons (strychnine)
Bile	Morphine and salicylates poisoning
Hair, nail and long bones	Heavy metal poisoning (arsenic)
Skin and subcutaneous tissues	Injected poisons, drugs and venoms
Blood with liquid paraffin on the top	Volatile poisons, mainly CO and sewer gas

Inference: Poison absorbed into circulation.

- **Bottle No. 5:** 100 mL of the preservative used (saturated solution of sodium chloride is used as a preservative in most cases).
  Inference: To confirm that the preservative is not contaminated and the poison if any detected has not been introduced from the preservative used.
- These five bottles are sealed, labeled and sent to the Forensic Science Laboratory in any case of suspected poisoning through the police constable in charge of the body.
- To be safe and to maintain the chain of custody, it is always preferable to handover the viscera to the police constable along with the body. Many a times the police may not take the viscera on the same day due to number reasons from their side. But to avoid suspicion on our side, it is better to handover the viscera on the same day along with the body itself. We cannot have possession of the viscera after handing over the body and a charge of manipulation may be raised against the doctor at later stage.
- In addition to the routine viscera, some other additional tissues may have to be preserved for specific poisons.

10. How do we classify poisons?

(CINCAM)

i. *Corrosives:* Acids and alkalies.
ii. *Irritants:* Organic and inorganic irritants; plants, animals and mechanical irritants.
iii. *Nervous Poisons:*
   - Cerebral (central: Inebriants, depressants and deleriant poisons).
   - Spinal poisons: Strychnine.
   - Peripheral nerve poison: Gelsemium.

iv. *Cardiac Poisons:* Aconite, digitalis, nicotine.
v. *Asphyxiants:* Carbon monoxide, cyanides.
vi. *Miscellaneous:* Food poisoning: botulism.
vii. *Pesticides:* A separate group of compounds useful for agricultural purpose and are used as common suicidal poisons in India, due to the easy accessibility.

CHAPTER 24

Agricultural Poisons

Keywords: Organophosphorus, insecticide, alkyl phosphates, aryl phosphates, muscarinic action, nicotinic action, acetylcholine, SLUDGE, intermediate syndrome, delayed symptoms, TLC, p-nitrophenol test, atropine, pralidoxime, kerosene odor.

INTRODUCTION

- Agricultural poisons are insecticides, rodenticides, herbicides or fungicides.
- Organophosphorus compounds are the most popular and widely used insecticides in India and they form the most important group of suicidal poisons in India.
- Organophosphorus compounds are of two groups:
  1. Alkyl phosphates:
     – HETP, TEPP (Tetron), OMPA, dimefox, isopestox, malathion, sulfotep, demeton, tichlorfon.
  2. Aryl phosphates:
     – Parathion (Folidol), paraoxon, methyl parathion (metacide), chlorthion, diazinon (diazinon; Tik 20).

1. What are toxicokinetics, mechanism of action, clinical features, diagnosis and management of OPC poisoning?
Short notes on: Signs and symptoms of OPC; treatment of OPC poisoning.

Toxicokinetics:

- Organophosphorus compounds are absorbed through all the portals of entry, through the skin, conjunctiva, inhalation, through gastrointestinal tract, through injection and well-absorbed even when poured into the nose or ears.

Mode of action:

- Organophosphates are powerful inhibitors of acetylcholinesterase which is responsible for hydrolyzing acetylcholine to choline and acetic acid. As a result, there is continued accumulation of acetylcholine, eventually leading to paralysis of the nerves or muscle.

Clinical features:

i. *Cholinergic excess:* Due to accumulation of acetylcholine.

- **Muscarinic effect**: Hollow organ parasympathetic manifestations.
  Bronchoconstriction with dyspnea, cough, pulmonary edema, vomiting, diarrhea, abdominal cramps, increased salivation, lacrimation and sweating, bradycardia, hypotension, miosis and urinary retention.
  The symptoms can be remembered using acronym "**SLUDGE**" denoting Salivation, Lacrimation, Urination, Defecation, Gastrointestinal cramps and Emesis.
- **Nicotinic effects**: Due to autonomic ganglion and somatic motor effects, resulting in fasciculation, weakness, hypertension, tachycardia and paralysis.

ii. *CNS effects:*

- Restlessness, headache, tremors, drowsiness, delirium, slurred speech, ataxia and convulsions. Death is usually due to respiratory failure (paralysis of respiratory centre).

Other useful signs:

- Characteristic kerosene odor is often present in the vicinity of the patient, since the solvent used are some petroleum derivatives like aromax.
- Pinpoint pupil (miosis) is a characteristic feature.
- Ocular exposure can result in systemic toxicity. It causes persistent miosis, inspite of appropriate systemic therapy. Topical atropine (or scopolamine) instillation may be necessary.
- Respiratory failure is the commonest cause of death, but other causes like hypoxia due to seizures, hypothermia, renal failure and hepatic failure may also contribute in causing death.

Diagnosis:

i. *Depression of cholinesterase activity:*

- RBC cholinesterase level of less than 50% is indicative of organophosphorus toxicity.
- Depression of plasma cholinesterase level to less than 50% is a less reliable indicator of organophosphorus toxicity.
- For the purpose of estimation of cholinesterase levels, blood should be collected in heparinized tubes or alternatively the samples can be frozen.

ii. *Thin layer chromatography (TLC)*

iii. *P-nitrophenol test:*

- P-nitrophenol is a metabolite of organophosphates and is excreted in urine.
- 10 mL of urine is steam distilled and the distillate is collected. Add 2 pellets of sodium hydroxide to the distillate and heat on a water bath for 10 minutes. Production of yellow color indicates the presence of p-nitrophenol.

Treatment:

i. *Decontamination:*

- In case of skin involvement, the patient is stripped and washed thoroughly with soap and water.
- If there is ocular exposure, copious eye irrigation with saline, Ringer's solution or water.
- In case of ingestion, stomach wash is done. Activated charcoal is beneficial.

ii. *Antidote administration:*

- ***Atropine:***
  - Atropine is a competitive inhibitor of acetylcholine at the muscarinic postsynaptic membrane and CNS, and will block the muscarinic effects of OPC. Atropine acts only at postsynaptic muscarinic receptors and has no effect on muscle weakness and paralysis.
  - *Dose:* 1 to 2 mL IV or IM (0.5 mg/kg in children) every 15 minutes, till the endpoint is reached, as indicated by drying of bronchial secretions and pupillary dilatation. Once the endpoint is reached, then the dose is adjusted to maintain the effects for 24 hours.
- ***Pralidoxime:***
  - This is a nucleophilic oxime which helps to **rejuvenate** (regenerate) acetylcholinesterase at the muscarinic, nicotinic and CNS sites.
  - Dose: 1 to 2 g IV given over 30 minutes; repeated after one hour and subsequently after 6 hours to 12 hours, for 24 to 48 hours. Maximum 12 g in 24 hours.

Supportive measures:

- IV fluids to compensate fluid loss.
- Oxygenation/Intubation/Positive pressure ventilation.
- Parasympathomimetics, phenothiazines, antihistamines and opiates are contraindicated.

Prevention of further exposure and complications:

- After the recovery, the person should not be exposed to organophosphates for atleast a few weeks, since he is likely to suffer serious harm from a dose normally harmless and result in complications like intermediate or delayed syndromes. These are due to the alterations in the body chemistry.

2. What are the delayed symptoms of OPC poisoning?

i. Intermediate syndrome:

- Occurs 1 to 4 days after poisoning, due to long-lasting cholinesterase inhibition and muscle necrosis.
- The main features include muscle weakness and paralysis, weakness of flexor muscles of the neck and proximal limb muscles, and acute respiratory paresis.

- This intermediate syndrome may be due to inadequate treatment of the acute episode, involving subadequate administration of oximes or inadequate assisted ventilation.
- Management of this intermediate syndrome is by supportive measures, since it does not respond to oximes or atropine.

ii. Delayed syndrome:

- Occurs after 1 to 4 weeks after poisoning, due to nerve demyelination; characterized by flaccid weakness and atrophy of distal limb muscles or spasticity and ataxia. This syndrome also does not respond to oximes and atropine.

iii. Chronic poisoning:

- Usually occurs as an occupational hazard in agriculturalists engaged in pesticide spraying.
- Route of exposure is inhalation or skin contamination. Chronic poisoning manifests as:
  - *Polyneuropathy:* Paresthesia, muscle cramps, weakness and gait disorders.
  - *CNS effects:* Drowsiness, confusion, irritability, anxiety and psychiatric manifestations.

3. What are the postmortem findings in case of OPC poisoning?

Autopsy findings:

- Characteristic odor of kerosene or garlicky odor.
- Froth at mouth and nostrils.
- Cyanosis of extremities.
- Contracted pupil.

Internal findings:

- Congestion of GI tract and visceral congestion.
- Pulmonary and cerebral edema.
- If the body is attached by insects, they may die of poisoning. OPC delays putrefaction and hence can be detected even in decomposed bodies.

Forensic significance:

- Acute insecticide poisoning is a global problem and deaths due to OPC account for a large number of deaths throughout the world.
- Since insecticides are easily available and cheap, suicidal poisoning is very common.

4. What is endrin? What is "Plant Penicillin"?

- Endrin is a cyclodiene insecticide that belongs to chlorinated hydrocarbons (organochlorines).
- It is soluble in aromatic hydrocarbon, insoluble in water and melts at 245° C.
- Endrin is also called as "**plant penicillin**" because of its broad spectrum activity against various insect pests.
- It is commonly used as sprays mixed with petroleum hydrocarbons like aromax and hence smells like kerosene.
- Poisoning is by occupational or accidental exposure.

5. What is paraquat lung?

Endrin and Paraquat are Organochlorine group of insecticides. Paraquat is dipyridylium compounds used as herbicide and weed killer.

When ingested only 10% is absorbed and the rest is excreted unchanged in faeces. After absorption highest concentration of paraquat is seen in the lungs and kidneys.

Lung symptoms include cough, haemoptysis, dysponea due to pulmonary oedema, haemorrhage in the lung parenchyma and fibrosis.

PM findings:

Damage to the pneumocytes with vacuolization, desquamation and necrosis of lung parenchyma are seen; a hyline membrane is often appreciated by microscopy. Diffuse pulmonary oedema and haemorrhages are usually present.

CHAPTER 25

Corrosive Poisons

Keywords: Corrosive, necrosis, sulfuric acid, vitriolage, nitric acid, xanthoprotein reaction, hydrochloric acid, carbolism, carboluria, ochronosis, oxaluria, ink remover, hypocalcemia, acconcher's hand, Trousseau's sign, Chevostek's sign, ammonia.

INTRODUCTION

- Corrosive is any substance which corrodes, causes burning, erosion and necrosis.
- Both acids and alkalies are corrosive in nature; acids are mineral acids (inorganic) and organic acids. Alkalies are less corrosive than acids.
- *Acids:* Acids are hydrogen containing substances that on dissociation in water produce hydrogen ions. They are potent desiccants and when come into contact with the body produce coagulation necrosis of the tissues.
- *On ingestion:* Esophagus is less vulnerable to damage compared with the stomach; because esophagus is lined by squamous epithelium, which are relatively resistant to acids and also the acid travels down faster into the stomach due to gravity. Whereas, the columnar epithelium of the stomach is more resistant to alkalies.
- **Mineral acids** have local corrosive action and usually no remote action after absorption; since, they dissociate into their respective ions, which are normal constituents of plasma.
- Whereas **organic acids** have less local corrosive effect and have pronounced remote systemic effect after absorption.

1. What is sulfuric acid? What are the clinical features, diagnosis, management and autopsy findings of sulfuric acid poisoning?

Sulfuric acid:

- It is a highly corrosive mineral acid and is also called as "**oil of vitriol**"
- Heavy, oily, colorless, odorless, non-fuming liquid and is hygroscopic in nature.
- **Hygroscopic** means has greater affinity for water, reacts violently, giving off intense heat.
- Usual fatal dose is 20 to 30 mL of concentrated sulfuric acid; produces coagulation necrosis.

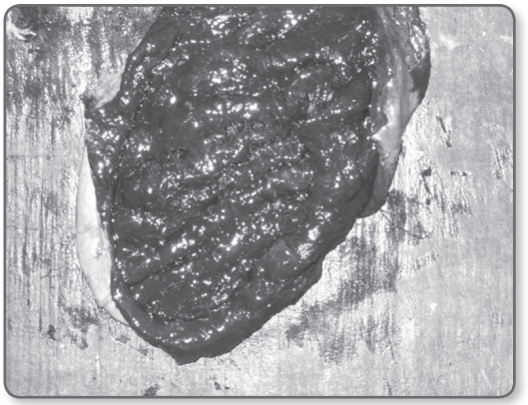


Fig. 25.1 Sulfuric acid poisoning stomach — Note: The corrosion and necrosis of the mucosa

Uses of sulfuric acid:

i. Industrial chemical (concentration is 95–98%).
ii. Storage batteries (concentration is 30–35%)
iii. Domestic use as drain cleaners (concentration is 8–10%).

Clinical features:

- Burning pain from mouth to stomach.
- Intense thirst, drinking water provokes vomiting.
- Vomitus is brownish black in color (due to altered blood).
- Teeth chalky white in color (Fig. 25.2); tongue swollen and black in color, with constant drooling of saliva from the mouth.
- Usually acid spillage around the mouth, hence corrosion of face is present.
- Perforation of stomach is more common with sulfuric acid ingestion, with resultant chemical peritonitis.
- If the patient recovers, there are long-term sequelae, such as stricture formation, pyloric obstruction and stenosis (hour glass deformity of the stomach).
- Contact with the eyes results in conjunctivitis, corneal edema, necrosis and blindness.

Diagnosis:

- *Litmus test:* Saliva can be tested with litmus paper to find out acid or alkali ingestion.
- Fresh stains on the clothing can be tested by adding a few drops of sodium carbonate, results in production of effervescence (bubbles).

Treatment:

- Intense laryngeal spasm is treated with 100% oxygen and cricothyroidectomy.
- No attempt to neutralize the ingested acid, since it results in exothermic reaction with liberation of excessive heat and easy chances of perforation of stomach.
- Water or milk (demulcent) can be given to dilute the acid.
- Remove all contaminated clothes, and exposed skin is washed with saline.
- Eye contact, by prolonged irrigation with water.
- Use of oral feeds, activated charcoal and induced vomiting are contraindicated.
- Steroids are helpful to delay stricture formation but may increase the chance of perforation.
- Powerful analgesics, such as morphine is helpful.
- Flexible fiberoptic endoscopy is done to assess the damage; if 2nd or 3rd degree burns and necroses are present, then esophagogastrectomy may have to be done.
- If perforation is present, an emergency laparotomy is mandatory; perforation closure done.

Autopsy findings:

- Corroded areas of skin and mucus membrane; tongue, gums and lips are swollen and black in color; teeth are chalky white in color.
- Stomach inflammation (Fig. 25.3), erosion, necrosis, hemorrhage and blackening of the

Fig. 25.2 Chalky white teeth in sulfuric acid poisoning

Fig. 25.3 GIT in sulfuric acid poisoning — Note: The stomach and upper GI tract being corroded

Fig. 25.4 Kerosene poisoning — Diffuse submucosal hemorrhages in stomach

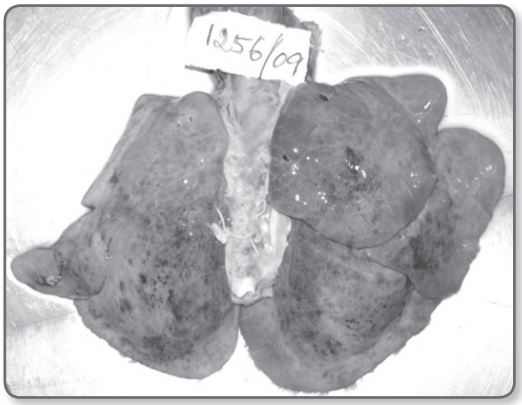


Fig. 25.5 Lung in kerosene poisoning – Petechio-ecchymotic haemorrhages more concentrated on the upper lobe; the child died of aspiration pneumonitis

mucosa are present and perforation are also common—"**wet blotting paper appearance of stomach**" (Fig. 21.1).

- In addition to routine viscera, corroded skin can also be sent for analysis and also for HPE.

Usually, the results are negative and opinion is finalized on the basis of autopsy findings (the classical stomach picture is not present in any other type of poison).

2. What is vitriolage?

- Throwing of acid on a person is called as vitriolage. It is mainly thrown on the face, to disfigure the individual; there is an obvious motive of revenge or jealousy.
- Sulfuric acid is commonly used for this purpose, any other acid or any other corrosives can also used for this purpose. They may fill the acid into the egg shell after carefully evacuating the contents of the egg through a small opening and seal the shell after filling with the acid, hence can be carried in the hand without suspicion and throw on the victim from an accessible distance. Acid is also carried inside small bottles for this purpose of vitriolage.
- When face is involved, there is permanent disfiguration, eye contact with the acid results in blindness and both amount to grievous hurt (Section 320 IPC).
- Treatment: Wash the areas of contact with water; eyes when involved are irrigated with plenty of water; antiseptic and local anesthetic ointments can be used. Morphine can be given to control pain.

3. Write short notes on nitric acid poisoning? What is xanthoprotein reaction?

- Nitric acid is also known as "**aqua fortis**".
- Nitric acid is yellowish fuming liquid, with acrid pungent odor.
- *Uses:* Electroplating, manufacture of fertilizers and metal refinery.

Mode of action: Xanthoprotein reaction.

- Nitric acid is a powerful oxidizing agent that reacts with organic matter and produces trinitrophenol, liberating nitrogen monoxide and the tissues are stained yellow in color and this is called as "***xanthoprotein reaction".***
- It is less corrosive than sulfuric acid, but leaves back a yellow color.

Clinical features:

- More severe eructation and abdominal distension due to gas formation.
- Perforation of the stomach is less common.
- Inhalation of the fumes produces coughing, rhinorrhea, lacrimation and dyspnea.

Treatment:

- Similar to sulfuric acid poisoning; respiratory distress is severe and needs special attention (Fig. 25.6).

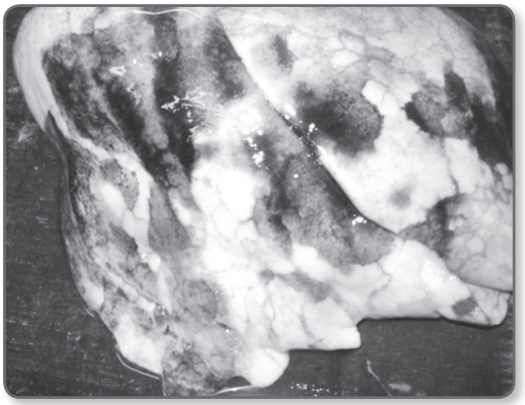


Fig. 25.6 Lung – Inhalation of sulfuric acid; note: There alternative areas of bleeding (Corrosion and rupture of arteries) and pale lung parenchyma – A treated case died after 20 days of poisoning near the recovery period; CT could not pick up the lung finding and the patient suddenly collapsed after a heavy bout of haemoptysis.

Autopsy findings:

- Stains on the clothes, corroded areas on the skin, mucus membrane and teeth appear yellow in color, which is diagnostic of nitric acid poisoning.

4. Write short notes on hydrochloric acid?

- HCl is called as sprit of salts; it is a colorless fuming liquid, which may acquire a yellow color on exposure to air.

Uses:

- Bleaching agent, dying industry, metal refinery, flux for soldering, and metal and drain cleaner.

All the features are same as for sulfuric acid, except:

- Corrosion less severe and appear grayish and not black.
- All the symptoms are less severe compared to sulfuric acid.
- Respiratory complications are more pronounced than corrosive effects due to the fuming effect and needs special attention.

5. What are the properties, uses, clinical features, diagnosis and treatment of carbolic acid poisoning?
Short notes on: Carbolism; carboluria; phenol marasmus.

- Carbolic acid is hydroxybenzene (phenol).
- Physical properties. Colorless, needle-like crystals, and turn into pink color and liquefy when exposed to air.
- Commercial phenol is brownish in color which contains impurities like cresol, and used as 5% solution (becomes white in color on dilution with water) for household disinfection purpose which has a typical hospital odor.

Uses:

- Introduced in the 19th century and was popular disinfectant for both hospital and domestic purposes, but lost importance of use in the operation theaters due to invention of safer antiseptics like cetrimide, chlorhexidine, cresol and povidine iodide.
- Still in use as floor and toilet cleaner in hospitals and homes. (Antiseptic and disinfectant).
- *Preservative:* For commonly used injections like glucagon, pethidine, neostigmine, etc.
- Manufacturing of plastics.
- *Medical use:* 'Face peel' in plastic surgery and neurolysis of spasticity (phenol is injected into the neuromuscular junction).
- *Fatal Dose:* 10 to 30 g; 25 to 50 mL of household phenol may prove fatal.
- *Absorption:* Phenol is rapidly absorbed through intact skin, lungs and GI tract (dilution increases absorption).
- *Mode of action:* Mild corrosive action locally and after absorption results in CNS depression, metabolic acidosis and renal damage.

Clinical features:

Acute poisoning with phenol is known as "**carbolism**".

- Locally it has a mild corrosive effect; hardening and grayish white discoloration of the skin is present on exposure; there may be burning pain, followed by tingling, numbness and anesthesia (the white escher on the skin may fall away in a few days and look brown).

Systemic features:

- *GIT:* Burning pain, vomiting and the stomach mucosa turns into whitish, hard and rubbery in consistency, and hence stomach wash is very well indicated (only corrosive where stomach wash can be done).

- *CNS:* Vertigo, convulsions and coma (pupils usually constricted).
- *RS:* Slow labored breathing, progressing to respiratory failure.
- *Metabolic:* Hypothermia with cold clammy skin and metabolic acidosis.
- *Hepatorenal:* Phenol is metabolized in the liver and the metabolites hydroguinone and pyrocatechol are excreted in urine; urine turns green on exposure to air due to these metabolites and this condition is called "**carboluria**"; oligurea is present and progressing on to acute renal and hepatic failure.

Chronic poisoning: (Phenol marasmus)

- This was common in olden days, in medical professional when phenol was routinely used as skin disinfectant. Chronic exposure to phenol results in phenol marasmus characterized by anorexia, weight loss, vertigo, dark colored urine and pigmentation of skin and sclera (**ochronosis**).

Diagnosis:

- Typical odor in the vicinity of the patient.
- *Bedside test:* Collect urine in a transparent container and expose to sunlight, gradual color change from brown to green.
- Add 1 mL of 10% ferric chloride solution to 10 mL of urine, a purple or blue color develops and persists even after heating, this indicates phenol poisoning.

Treatment:

- Decontamination with copious amount of water, if there is skin contact.
- Stomach wash with sodium or magnesium sulfate.
- Activated charcoal and other supportive measures.

Autopsy findings:

- Distinct odor around mouth and stomach contents.
- Stomach mucosa is grayish white in color, swollen, hard and leathery; if death is delayed, the color may change to brown.

6. What are the systemic effects of oxalic acid poisoning?
Short notes: Acconcher's hand; Chevostek's sign; oxaluria; ink remover.

- Oxalic acid is also called as "Salts of Sorrel"; it reacts with calcium in the plasma and precipitates insoluble **calcium oxalate** and gets accumulated in the liver, heart, lungs and kidneys. All the effects are due to **hypocalcemia** leading to tetany;
  (i) **Acconcher's hand** due to tonic muscular spasm and cramps of the muscles of the upper limb (carpopedal spasm).
  (ii) **Trousseau's sign** is often positive, when pressure is applied on the nerves and vessels of upper arm, there is sudden spasm of the muscles.
  (iii) **Chvostek's sign:** When the facial nerve is tapped, there is spasm of facial muscles.
- The excretion of oxalate crystals in urine is called as **oxaluria.**
- Diagnosis is by demonstration of oxalate crystals in the urine as monohydrates (needle-like or prism-shaped crystals) or dihydrates (tent or envelope-shaped crystals).

Ink remover:

- Criminals use oxalic acid for altering the signature or even by anyone to change the contents of the documents (tampering of records) and produce fake documents, but which can be detected by analysis at FSL.

7. What is shock lung? (Formic acid)

- In formic acid poisoning, there is coagulative necrosis and corrosion of the GI mucosa.
- There is damage to the clotting factors which lead to hemolysis and renal failure.
- Formic acid inhibits aerobic respiration and results in diminution of ATP.
- Aspiration pneumonitis and respiratory distress leads to '**shock lung**'.

8. What are the uses, clinical features, treatment and postmortem findings of alkalies?

Alkalies:

- Commonly encountered alkalies are ammonia (ammonium hydroxide), carbonates (of sodium, potassium and calcium) and sodium hypochlorite.
- Most of these alkalies appear as white powders or colorless solutions; ammonia gas is colorless with a pungent choking odor.

Uses:

- *Ammonium hydroxide:* Used in paints, dirt remover and as refrigerant.

- *Sodium hydroxide (caustic soda):* Drain cleaner and oven cleaner.
- *Potassium hydroxide (caustic potash):* Drain cleaner and hearing aid batteries.
- *Sodium carbonate (washing soda):* Household cleaner and detergent.
- *Sodium hypochlorite:* Household bleach.
- *Usual fatal dose:* 10 to 15 g; 15 to 20 mL for ammonia.

Mode of Action:

- Locally, alkalies produce liquefaction necrosis and saponification of fats; ulcer formation is common and takes several weeks to heal; esophagus is more vulnerable than stomach.

Clinical features:

- Corrosion of GIT with grayish discoloration; dysphagia, vomiting and hematemesis.
- Abdominal pain and diarrhea.
- *Skin:* Grayish, soapy, necrotic areas without charring.
- Eye involvement causes serious ophthalmologic emergencies.
- Ammonia inhalation results in respiratory problems.

Treatment:

- *Inhalation of ammonia:* Needs endotracheal intubation or tracheostomy and oxygen.
- *When alkalies are ingested:* Dilution with milk or water.
- Emesis, gastric lavage, catharsis and activated charcoal are contraindicated.
- Early surgical intervention and use of intraluminal stent in the esophagus is also recommended (esophageal perforation could be missed at latter stage).
- If gastric necrosis is found, then an exploratory laparotomy followed by gastric resection and esophagectomy is done.
- Corticosteroids for prevention of stricture formation (but increases the chance of perforation and infections).
- Prophylactic antibiotics not necessary, unless there is perforation.
- *Injuries to eyes and skin:* Should be irrigated with plenty of water; topical steroids and antibiotics are helpful.

Autopsy findings:

- Characteristic odor (especially in ammonia).
- Brownish or grayish discoloration of the skin and mucosa.
- Corrosion and inflammatory edema; slimness of the mucosa of esophagus and stomach.
- Congestion of respiratory tract and pulmonary edema (ammonia inhalation).

CHAPTER 26

Metallic and Inorganic Irritants

Keywords: Arsenic, aldrich-mees lines, black foot disease, raindrop pigmentation, plumbism, burtonian lines, punctate basophilia, basophilic stippling, lead palsy, Hydrargyrism, Danbury's tremors, hatter's shake, acrodynia, mercuria lentis, iron, copper sulfate, thallium triad, metal fume fever, white phosphorus, phossy jaw, smoky stool syndrome, phosphine.

1. How do we classify irritants?

Irritants can be classified as:

i. *Heavy metals:* Arsenic, lead, mercury, copper, thallium and iron.

ii. *Inorganic irritants:* Phosphorus, aluminum phosphide, iodine and chlorine.

iii. *Organic iritants:* Plants, animals and mechanical irritants.
   - *Plants: Abrus precatorius, Calotropis, Semecarpus anacardium, Ricinus communis, Croton tiglium and Capsicum annum.*
   - *Animals:* Snakes, scorpion, cantharides and bees and wasp stings.

2. What are the environmental sulfides of Arsenic?

- Arsenic is a naturally occurring element widely distributed in the earth's crust.
- Arsenic combines with oxygen, chlorine and sulfur to form **inorganic** arsenic compounds.
- In animals and plants, it combines with carbon and hydrogen to form **organic** arsenic compound.
- **Inorganic** arsenic compounds are mainly used to preserve wood.
- **Organic** arsenic compounds are used as pesticides, primarily on cotton plants.

Environmental sulfide of arsenic:

(i) **Realgar:** Yellow (As_2S_2).

(ii) **Orpiment:** Red (As_2S_3).
   - On heating of these ores, arsenic sublimes and oxidizes to form arsenic trioxide (As_2O_3) fine granular white powder also known as white arsenic.

(iii) **Copper arsenite (**Scheele's green).

(iv) **Copper acetoarsenite** (Paris green or Emerald green).

(v) **Arsine gas:** Arsine gas (AsH_3), formed by the hydrolysis of metal arsenide and by the reduction of metals of arsenic compounds in acidic solutions.

3. What are the medicinal uses of arsenicals? What is the usual level of exposure in humans?

Medicinal uses:

- *Fowler's solution:* (1% potassium arsenite) used for psoriasis; hepatic angiosarcoma is commonest complication.
- Regular, long-term arsenic exposure, results in cutaneous carcinomas as well as internal malignancies including bronchogenic carcinoma and hepatocellular carcinoma.

Human exposure

- Average 20 μg/day from food and water.

- Background air is less than 0.1 μg/m^3.
- Drinking water usually less that 5 μg/L.
- Food is usually less that 10 μg/day.

4. How arsenic is metabolized and distributed in the human body?

Metabolism:

- As^{3+} (Arsenite) is metabolized into methyl-arsenite (in liver).
- Dimethylarsenite (readily eliminated in urine).
- Half-life is 3 to 5 days; excretion is mainly through urine and also through skin in sweat.

Distribution:

- Bound to red blood cells.
- Distributes to liver, lungs and spleen.
- Binds to sulfhydryl group of mitochondrial enzymes especially, pyruvate oxidase and gets concentrated in the hair and fingernails (Mees' lines).

5. What are the types of arsenic poisoning? Write short notes on: Acute arsenic poisoning.

i. Acute Poisoning: (a) Fulminant and (b) Gastroenteritis type.
ii. Inhalation of arsine gas.
iii. Subacute.
iv. Chronic poisoning.

Mode of action:

- Locally acts as an irritant to the gastric and mucus membrane.
- *Remote:* Arsenic acts as a depressant of nervous system, heart and respiration.

Mechanism of action:

- Arsenic combines with the sulfadryl group of mitochondrial enzyme system, mainly pyruvate kinase and thereby, interferes with the cellular respiration.
- It gets deposited in bones, hair and nails.

Toxicity depends on:

- Compound ingested and its physical form (soluble or insoluble).
- Stomach empty or full: Actions start within 10 minutes when the stomach is empty and more than half an hour, if full.
- Inherent tolerance of the patient to arsenic is also an important factor in the development of symptoms; on an average, tolerance of arsenic trioxide is 70 to 180 mg.
- Fatal period is 12 to 48 hours of ingestion.

Acute poisoning:

i. Narcotic form of acute poisoning (**fulminant poisoning**):
- Rare and occurs when massive dose is taken in empty stomach.
- There are no symptoms of gastroenteritis, CNS symptoms predominate.
- Delirium, tenderness of muscles and convulsion leading to complete paralysis of muscles, followed by coma and death.

ii. Signs and symptoms of acute poisoning: (**Gastro-enteritis type**).
- Occur within 30 minutes of exposure.
- Metallic taste and slight garlicky odor to the breath.
- Xerostomia (dry mouth) and dysphasia.
- Burning pain in stomach and throat; intense thirst and salivation.
- Tongue is coated with thick white fur.
- Nausea and projectile vomiting (characteristic symptom).
- Heart burn, with colicky abdominal pain and distention.
- Profuse diarrhea, usually rice water stools (mimic cholera) and in some cases mixed with blood; tenesmus and anal pain are present.
- Urine output is suppressed and urination is painful.
- Non-cardiogenic pulmonary edema develops.
- *Cardiac manifestations:* Acute cardiomyopathy and sub-endocardial hemorrhages (decreased cardiac output due to hypovolemia and due to the direct toxic effect of arsenic on cardiac muscles).
- *ECG changes:* Prolonged QT interval and non-specific ST-T changes.

iii. Inhalation of arsine gas:
- Instantaneous development of symptoms of formication, frothy sputum and pulmonary edema.

Cause of death:

- *Acute arsenic poisoning:* Irreversible circulatory insufficiency.
- *Chronic arsenic poisoning:* Failure of heart muscle.

6. What is the treatment for arsenic poisoning?

Treatment:

Acute arsenic poisoning:

Non-specific measures:

- Gastric lavage to remove residual arsenic from the stomach using 1% sodium thisulfate solution. Recently 2, 3-dimercaptosuccinic acid orally have been tried useful.
- Activated charcoal/$MgSO_4$ to decrease further intestinal absorption
- Intravenous fluids to maintain intravascular volume and prevent circulatory collapse.
- The vital organs must be monitored and specific measures are to be taken.
- Hemodialysis is useful to remove arsenic in the presence of renal failure.
- Narcotic analgesics can be given to combat pain.

Specific therapy:

- *Antidote:* **Freshly prepared hydrated ferric oxide** is given which converts arsenic to ferric arsenite.
- British anti-lewisite (**BAL, dimercaprol**) is given which reverses the hematologic effects of arsenic, it does not appear to reverse the neurologic effects caused by chronic poisoning. Therefore, before any treatment with dimercaprol is started in chronic poisoning cases, the benefits must be weighed against the side-effects.
- *Tests:* Reinsch and Marsh Berzelus tests are done.

7. What is subacute form of arsenic poisoning?

- Symptoms of neuritis are more pronounced.
- Liver shows fatty degeneration resulting in jaundice.
- Pigmentation of skin and rashes may appear.
- Muscular weakness ending in paralysis; convulsion and delirium may be present.

8. What are the effects of arsenic on pregnancy?

- Inorganic arsenic cross placenta and causes intrauterine death.
- In 3rd trimester: Premature labor, pulmonary hemorrhage and hyaline membrane disease occurs that may lead to death of the fetus due to respiratory distress.

9. Write short notes on chronic arsenic poisoning. What is Aldrich Mee's line and black foot disease?

Chronic toxicity:

After ingestion:

- 2 to 4 weeks after ingestion: Incorporated into hair, nails and skin.
- 4 weeks after ingestion: Localize in the bone, where it substitutes phosphate.
- Arsenic is associated with causing cancer of the lung, skin, liver, kidney and bladder.

Chronic exposure: (usually through drinking water)

- Skin cancer (recognized 100 years ago).
- Garlic odor on breath and excessive perspiration.
- Muscle tenderness and weakness.
- Skin pigmentation and paresthesia in hands and feet.
- Subendocardial hemorrhage in the left ventricle of heart.
- Hyperkeratosis (wart-like lesion) of the palms and soles.
- Symmetrical sensori motor polyoneuropathy, often resembling Guillain-Barre syndrome.

Rain drop pigmentation

- Hyperpigmentation of skin of the face or extremities, with classical picture of "dew drops on a dusty road" brownish in color, which resembles **Addison 's disease**.

Blackfoot disease

- Due to chronic exposure to arsenic, there is peripheral vascular disease resulting in **Gangrene of feet** is known as "blackfoot disease".

Aldrich Mee's lines

- Nails become brittle with Transverse whitish striate (lines) of 1 to 2 mm in breath on the fingernails is called as "Mee's lines".

10. What are the effects of chronic exposure to arsine gas?

Chronic exposure to arsine gas manifests as:

- Acute hemolytic anemia, jaundice and striking chills.
- Non-cardiogenic pulmonary edema with bilateral basal crepitation.
- Hemoglobinuria, urine appears black in color.
- Heart failure, delirium and coma.

- Arsine dust causes pulmonary edema, corneal ulcer and conjunctivitis.

11. What are the methods of diagnosis of arsenic poisoning?

- Definitive diagnosis of arsenic poisoning is difficult because of natural presence of trace amounts of arsenic in the body.
- Clinical manifestations simulate many other diseases: Acute poisoning simulates cholera and chronic poisoning simulates Addison's disease, Guillain Barre syndrome and black foot disease as gangrene of foot.

Laboratory diagnosis:

- *Urine test:* Monomethylarsine and dimethylarsine).
- Arsenic in urine more than 100 to 200 mg/24 hours is regarded as indicative of exposure to a potentially toxic amount of arsenic (be sure that the patient has not consumed shellfish for at least 3 days before collection of the sample).
- Coproporphyrin test is positive; gastric contents are useful in acute ingestion.

Blood test:

- Anemia and leukopenia (Acute hemolytic anemia is the rule with arsine exposure).
- Blood arsenic concentrations should not exceed 50 mcg/liter.
- *LFT:* Increased serum alkaline phosphatase and bilirubin.

Chronic arsenic ingestion:

- Body tissues, nails and hair are useful in diagnosis.

Methods:

- Colorimetry, polarography, atomic absorption spectroscopy and neutron activation analysis.
- Hair and nail samples containing >3 ppm or 100 mg or arsenic per 100 g of specimen are diagnostic of arsenic poisoning.
- **Napoleon Bonaparte** was determined to have died of arsenic poisoning after 140 years of his death (Weirder, 1999).

12. What are the postmortem findings of arsenic poisoning?

External:

- Pinched face with sunken eyes.
- Cyanosis of lips and finger nails, associated with jaundice if liver is involved.

Internal:

- Stomach and mucosa are inflamed.
- **Red velvety appearance** is the classical picture of stomach in acute arsenic poisoning; with scattered sub-mucosal hemorrhages on the surface of the mucosa.
- Stomach contents are black, green or dark brown in color; intestine shows inflammation.
- *Heart:* Subendocardial hemorrhage on the left ventricle.
- *Lungs:* Deeply congested, edematous and subpleural petechial hemorrhage.
- *Liver and spleen:* Enlarged, congested and fatty infiltration.
- *Kidney:* Enlarged, congested, fatty infiltration and cloudy swelling of the kidneys.
- *Rectum:* Inflammatory changes are present.

13. What are the medicolegal issues related to arsenic poisoning?

- Arsenic is an ideal homicidal poison.

Advantages:

- Tasteless and odorless; effects are not immediate.
- Acute poisoning mimic cholera and chronic poisoning mimic Addison's disease.
- Successful homicidal cases have been reported and the individual is killed without any suspicion.

Disadvantages:

- Delays putrefaction; detected even if the body is decomposed; even after many years, arsenic can be detected from the nails, hair and bones.

Medicolegal significance:

- Rarely suicidal.
- *Accidental:* Consumption of more sea foods and also by mistake for baking soda.
- *In exhumed bodies:* If nails, hair and bones contain more arsenic than that of the soil present around the body, indicates poisoning by arsenic.
- WHO recommended level of arsenic in water should be less than 5 mg/100 mL.

Other criminal uses:

- Cattle poisoning, abortificient and as aphrodisiac.

14. How will you differentiate cholera from arsenic poisoning?

Table 26.1 shows the difference between acute arsenic poisoning and cholera.

Table 26.1 Difference between acute arsenic poisoning and cholera

Trait	Arsenic	Cholera
Throat pain	Before vomiting	After vomiting
Purging	After vomiting	Before vomiting
Stools	Rice water, later bloody	Rice water
Tenesmus	Present	Absent
Vomitus	Mucus, bile and blood	Watery
Voice	Not affected	Rough and whistling
Conjunctiva	Inflamed	Not
Analysis	Arsenic	*Vibrio cholera*

Lead

15. What are the properties and toxic compounds of lead?

Properties:

- Lead is a versatile metal; its softness and low melting point make lead very easy to handle
- Its high resistance to corrosion makes it ideal for weatherproofing buildings and for equipment used in the manufacture of acids.
- It is a heavy steel gray metal; metallic form and all salts are poisonous.

Toxic forms are:

i. Lead acetate (sugar of lead).
ii. Lead carbonate (safeda).
iii. Lead monoxide (litharge).
iv. Lead tetroxide (red lead, sindur, vermillion).
v. Lead sulfide.

16. What is the mechanism of action of lead?

- Lead interacts with sulfadryl group of enzymes and interferes with hemsynthesis and cytochrome production, thus leads to hemolysis.
- Acute poisoning is not common and clinically shows metallic taste, burning pain in mouth and abdomen, thirst, vomiting, circulatory collapse, etc.
- Characteristic finding is cerebellar ataxia in children.

17. Write short notes on plumbism.

- Chronic lead poisoning is called as **Plumbism** or saturnism.
- Poisoning occurs due to inhalation of lead dust and fumes in factories, from drinking water stored in lead vessels, food contaminated with lead oleate present in tin-lined food packets.
- Other ways are absorption from sindur or accidental poisoning in children due to ingestion of toys painted with lead paint.

Signs and symptoms

- Lead affects almost all the systems of the body.
  - (i) *Facial pallor:* Earliest symptom, seen around the mouth; present in almost 90% of cases.
  - (ii) Anemia with punctate basophilia, reticulocytosis and basophilic stippling of RBC.
  - (iii) *Lead lines:* Called '**Burtonian line**' which is seen on the gums; due to sub-epithelial deposits of lead granules near caries tooth; this is due to the formation of lead sulfide.
  - (iv) *Lead palsy:* Presents with tremors, numbness, hyperesthesia and cramps occur; there may be wrist drop, or foot drop.
  - (v) *Lead encephalopathy:* Present in most cases of chronic poisoning, common in children; characterized by headache, insomnia, visual disturbances, irritability and delirium.
  - (vi) *Colic and constipation:* This is a late symptom and occurs at night.
  - (vii) *CVS:* Vascular constriction and arteriolar degeneration.
  - (viii) Renal involvement leading to hypertension and interstitial nephritis.
  - (ix) Reproductive system leading to menstrual irregularities and infertility.
  - (x) *Lead osteopathy:* Deposition of lead in growing ends of long bones.

Diagnosis:

- Serum Lead > 0.1 mg/100 mL; Urinary Lead > 0.25 mg/100 mL.

Treatment:

- In severe poisoning with encephalopathy:

BAL: 4 mg/kg 4 hourly, till blood lead level falls to < 40 mcgm%.
Calcium sodium EDTA: 75 g/kg/day IV.
Then, followed by D-penicillamine.

- Severe poisoning but no encephalopathy:
  BAL: 12 mg/kg/day.
  EDTA: 50 mg/kg/day.
  Continue oral chelation till blood level is <15 mcgm%.
- *Moderate poisoning:* EDTA therapy followed with oral chelation.
- *Mild poisoning:* D-penicillamine therapy.
- *Supportive:* Thiamine, calcium gluconate, $MgSO_4$, and calcium disodium versenate.

18. What are the postmortem findings and medicolegal significance of lead?

Postmortem findings:

- Blue line on the gums.
- Fatty degeneration of muscles.
- Ulcerative and hemorrhagic changes in stomach and intestines.
- Liver and kidneys are contracted.
- Brain looks pale with PAS positive material in perivascular spaces.
- Bone marrow shows hyperplasia of leukoblasts and erythroblasts.

Medicolegal Aspects:

Cause of death:

- In chronic poisoning, death occurs due to gastroenteritis and shock, malnutrition, intercurrent infection or hepatic failure, etc.

Circumstances of poisoning:

i. Chronic poisoning is more common and is an industrial hazard.
ii. Abortificient: Lead oleate.
iii. Cattle poison: Red lead.
iv. Firearm injuries: Death due to lead poisoning from imbedded missiles.

Mercury

19. What are the signs and symptoms of mercury poisoning?

- After inhalation, mercury is readily absorbed into circulation through the alveolar membranes and rapidly converted into mercuric ions; absorbed through skin also.
- *Kidneys:* Tubular necrosis; CNS: Acts mainly on the cerebellum and corpus callosum.

20. What is mercurialism?

- SC or IM injections of mercury result in abscess formation with ulceration, exuding tiny droplets of mercury.
- Intravenous injection causes '**mercurialism**' characterized by thrombophlebitis, granuloma formation and pulmonary embolism; repeated hemoptysis is characteristic feature.

21. Write short notes on hydrargyrism?

- Chronic poisoning with mercury is called as "**hydrargyrism**".
- Inhalation is the usual mode of contact.

Danbury's tremors:

- Due to chronic inhalation of mercury vapors, there is coarse tremors that begins in the hands, intentional type, interspersed with jerky movements is Danbury's tremors, this is also called as **Glass Blower's tremors**.
- These coarse tremors later on progress to lips, tongue, arms and legs and is called as "**Hatter's shake**".
- Tremors gradually become severe and interfere with all normal daily activities, like shaving, holding a glass, etc. and the advanced condition is called '**concussion mercurialis**' where literally no activity is possible.
- Gingivitis, increased salivation, halitosis, blue lines on the gums (similar to plumbism).

Mercurial erythrism:

- Cluster of psychiatric symptoms, including abnormal shyness, loss of self-confidence, depression, irritability, amnesia, progressing to delirium and hallucinations. Maniac depressive psychosis (**mad hatter**).
- **Acrodynia** is "pink disease" seen mainly in children.
- Renal involvement results in membranous glomerulonephritis, with hyaline casts and fatty casts in urine.

Mercuria lentis:

- Deposition of mercuric vapors on the anterior lens capsule of the eye. Characterized by brown reflex and fine punctate opacities.

22. How the diagnosis of mercury poisoning is done?

- *X-ray:* Progressive movement of mercury by X-ray at regular intervals.

- *Blood mercury level:* Flameless Atomic Absorption Spectrometry (AAS).
- Urine mercury level
- *Hair analysis:* Cold vapors AAS.

Iron

23. Write short notes on iron poisoning?

- Iron is an essential element, deficiency state results in anemia.
- In some individuals due to inborn error, normal dietary requirement may lead to toxicity due to accumulation. Example: Hemochromatosis (**Bronze diabetes**).
- Various iron salts are used for therapeutic purpose to treat anemia; most instances of iron poisoning are due to over dosage.
- *Usual fatal dose:* 200 to 250 mg of elemental iron per kg body weight.
- Iron poisoning results when serum iron level exceeds the total iron binding capacity (TIBC), resulting in free circulating iron in the bloodstream.

Clinical features:

- *Stage I:* (30 minutes to 6 hours): Vomiting, diarrhea, abdominal pain, pallor, lethargy, metabolic acidosis, leukocytosis and hypoglycemia.
- *Stage II:* (6 hours to 24 hours): Hypotension and severe metabolic acidosis.
- *Stage III:* (24 to 48 hours): Multiple organ failure involving GIT, hepatorenal, CNS, CVS with metabolic coagulopathies, hypoglycemia, convulsions, disorientation, coma and death due to hepatic failure.
- *Stage IV:* Recovery is often associated with late complications such as gastric scarring and pyloric obstruction.

Diagnosis:

i. X-ray
ii. Serum iron level: 150 mg/100 mL; beyond 500 mg/100 mL indicates serious toxicity.
iii. Chelation challenging test: Desferrioxamine 25 mg/kg (maximum 1 g) is given IM; if TIBC has exceeded then excess iron is chelated and the compound excreted is pinkish (vin rose) in color; negative result does not rule out iron toxicity.
iv. Quantitative desferrioxamine color test: Confirmatory test.

Treatment:

i. Stomach wash with normal saline.
ii. Magnesium hydroxide (1%) solution given orally may reduce absorption, by precipitating the formation of ferrous hydroxide.
iii. Correction of hypovolemia and metabolic acidosis.
iv. Chelation therapy: Desferrioxamine 1 g IM; followed by 500 mg every 4th hourly for 2 doses, and finally 500 mg every 12th hourly upto a maximum of 6 g in 24 hours. It can also be given as IV infusion normal saline, glucose water or Ringer's lactate.
v. Liver transplant may be required in fulminant hepatic failure.

Autopsy findings:

- Hemorrhagic necrosis of GI mucosa; gastric contents may appear bluish green.
- Hepatic and renal necrosis.

Forensic significance:

- Acute accidental poisoning due to therapeutic over dosage is frequently reported in children.

Copper

24. Write short notes on copper sulfate poisoning.

- Copper is a brown colored metal, several salts of copper are poisonous; copper sulfate is blue colored salt.

Clinical features:

Acute poisoning:

- Myalgia, abdominal pain, vomiting, diarrhea, acidosis, pancreatitis, hemolysis, jaundice, renal failure, delirium, seizures and coma.

Chronic poisoning:

- Chronic inhalation of copper sulfate spray used as insecticide causes 'vineyard sprayer's lung disease' characterized by histocytic granulomatous lung; liver damage is also common.
- Chronic contact in swimming pools causes greenish discoloration of hair.
- Chronic copper toxicity is the hallmark of 'Wilson's disease'—an autosomal recessive genetic disorder due to deficiency of ceruloplasmin.

Diagnosis:

- Serum ceruloplasmin level less than 35 mg% at 24 hours, indicates severe toxicity.
- ***Blood copper level:*** Elevated more than 1.5 mg/100 mL indicates severe toxicity.

Treatment:

i. Induced emesis is contraindicated.
ii. Stomach wash using potassium ferrocyanide converts copper into cupric ferrocyanide.
iii. Administration of **egg white or milk** orally, helps in detoxifying copper.
iv. Hemodialysis is useful in early stages.
v. Severe cases need chelation with dimercaprol 2.5 mg/kg, 4th hourly; followed by oral penicillamine.

Autopsy findings:

- Greenish blue discoloration of GI mucosa.
- Jaundice, hepatic and renal necrosis.

Thallium

25. Write short notes on thallium poisoning. What is thallium triad?

- Thallium is a soft, pliable metal, acquiring notorious reputation as an ideal homicidal poison.
- Absorption occurs through inhalation, ingestion and through intact skin.
- Usual fatal dose is 12 to 15 mg/kg.

Acute poisoning:

- Abdominal pain, gastroenteritis with hematemesis, tachycardia, confusion and headache; hallucination, convulsion, retrobulbar neuritis and ophthalmoplegia.
- Death results from respiratory failure; there is usually bone marrow depression.
- A characteristic dark pigment band is often noticed in the scalp hair in about 3 to 4 days.

Chronic poisoning:

- Alopecia is diagnostic of chronic poisoning; begins in 10 days, and may lead to total loss of scalp hair within a month; lateral half of eyebrows are also peculiarly affected.
- *Skin rash:* Papulomacular rash often assumes a 'butterfly' shape distribution on the face.
- Dystrophy of nails 'Mees stripes'.
- Painful ascending peripheral sensory motor neuropathy; more pronounced in lower limbs.
- Ataxia and other cranial nerve palsies: Optic neuropathy, tremors and encephalopathy; psychotic behavior may also be present.
- *CVS and blood:* Hypertension, cardiomyopathy, ECG changes and thrombocytopenia.
- *Miscellaneous:* Autonomic dysfunction, testicular toxicity, hypokalemia and renal failure.

Thallium triad:

- If symptoms of alopecia, skin rash, painful peripheral neuropathy, lethargy and mental confusion are present, one should suspect chronic thallium poisoning.
- Symptoms mimic Gullian Barre syndrome, acute porphyria, psychosis and thiamine deficiency.

Diagnosis:

- X-ray: Opacities in GIT and liver.
- Tests for contrast sensitivity and color vision in early stages.
- Abnormal ECG and delayed peripheral nerve conduction.
- *Microscopy of hair:* Reveals black pigmentation of hair roots.

Treatment:

- *Stomach wash:* Using potassium ferric ferrocyanide (Prussian blue).
- Activated charcoal may be useful.
- Forced diuresis in conjugation with potassium chloride.
- Hemodialysis and hemoperfusion.
- Chelation therapy not much useful (previous days done with dithiocarb).
- Oral hygiene to prevent stomatitis.
- Physiotherapy to prevent muscle contracture.

Autopsy findings:

- Alopecia and stomatitis.
- Fatty degeneration of heart ('tabby cat striations' on the ventricles).
- Fatty degeneration of liver and renal damage.
- Pulmonary and cerebral edema with degeneration of nerve cells and axons.

Forensic significance:

- Accidental and occupational exposure is common.
- There is increase in the use of thallium as a homicidal poison.

26. What is metal fume fever?

- *Synonyms:* Brass chills, Brazier disease, Foundry fever, Monday fever, smelter's shake, Welder's ague.

Occupations affected:

- Welding, galvanizing, smelting, metal refining, electroplating, alloy making, ship breaking.

Metals involved:

- Caused by inhalation of fumes produced when these metals are heated above their melting point; zinc, copper, magnesium, iron, chromium, cadmium, nickel, manganese, mercury, cobalt, lead, antimony, selenium, beryllium, vanadium, silver and aluminum.

Clinical presentation:

- Resembles flu-like illness; beginning 4 to 6 hours after exposure to the fumes.
- Characterized by chills, fever, myalgia, cough, thirst, sweating, fatigue, dyspnea, leukocytosis; cyanosis and reduced pulmonary tests.
- Resolution of symptoms occurs in 36 hours after withdrawing from the source of exposure.

Treatment:

- Symptomatic; Chelation therapy may be required in chronic recurrent cases.

Prevention:

- Implementation of proper automatic engineering control.
- Good ventilation and exhaust ventilation.
- Use of fume extractors.

Related syndromes:

- Condition closely resembling metal fume fever is 'polymer fume fever' that results from inhalation of gases produced by burning of polytetrafluoroethylene.

Phosphorus

27. What are the two varieties of phosphorus and uses of phosphorus?

- There are two main varieties of phosphorus White and red phosphorus.

Yellow or white phosphorus:

- Yellowish, waxy, crystalline solid with garlicky odor.
- On exposure to air, it oxidizes into white fumes of phosphorus pentoxide, and hence stored under water. It is highly combustible and ignites into flames at 34° C.
- It is luminescent in dark (phosphorescence).

Red phosphorus:

- Reddish, amorphous, odorless substance; it is insoluble and is harmless.

Uses:

- It was widely used in the manufacture of friction matches; but due to its chronic toxicity replaced by potassium chlorate and antimony sulfide. The igniting surface of the match box is coated with powdered glass and red phosphorus.
- *Fireworks:* Important ingredient in manufacture of fireworks (crackers) in India.
- *Military use:* Yellow phosphorus is an important ingredient in tracer bullets, smoke screams and air-sea rescue flares.
- Insecticide and rodenticide, and as fertilizers.
- Many pastes and powders used for killing cockroaches and rats (zinc phosphide).
- *Usual fatal dose:* 60 mg (1 mg/kg body weight).

28. What is the mode of action and symptoms of acute phosphorus poisoning?

Mode of action:

- Phosphorus is a protoplasmic poison and is a potent hepatotoxic.
- In large doses, cause shock and cardiovascular collapse.
- Locally it produces severe irritation of skin and mucosa.
- Absorption is enhanced by administering in an oily vehicle.

Clinical features:

Fulminant poisoning:

- Massive dose of 1 to 2 g results in fulminant poisoning; peripheral vascular collapse and death occurs in 12 to 24 hours.

Acute poisoning:

Symptoms of acute poisoning are divided into three stages:

- 1st Stage (upto 3 days): Severe burning pain, vomiting, diarrhea, abdominal pain and breath smells garlic; vomitus and stools are

luminescent in dark; and eliminate faint fumes (**Smoky stool syndrome**).
- 2nd Stage (upto several days after the symptoms of 1st stage subside): Essentially symptomless.
- 3rd Stage: Due to systemic effects; there is return of GI symptoms with increased severity; hepatomegaly, pruritis and jaundice, progressing to olive green hue; finally leading hepatic encephalopathy, stupor and coma; at this stage, there is mousy odor in the breath (**foetor hepaticus**). Renal damage, oliguria, hematuria, albuminuria and acute renal failure.
- Dermal contact results in acute painful corrosion.

Diagnosis:
- Garlicky odor in breath and vomitus.
- Fuming and luminous vomitus and stools.
- Hepatic and renal failure.

29. What is phossy jaw?

Due to long-term occupational inhalation of phosphorus fumes, there is sequestration, necrosis and osteomyelitis of the jaw (usually lower jaw) and occurs in place of an extracted carries tooth. This is called as "**phossy jaw**" or "**glass jaw**".

30. What is the treatment of phosphorus poisoning?

Treatment:

Acute poisoning:
- *Gastric lavage:* Using potassium permanganate (1:5000 solution); copper sulfate can also be used (converts phosphorus into non-toxic copper phosphide)
- Milk or oily food is contra-indicated (as it enhances absorption of phosphorus)
- Vitamin K (65 mg) slow IV drip, to combat hypoprothrombinaemia.
- Whole blood or frozen plasma transfusion for coagulation defects
- Steroids to combat shock
- Dermal burns with is treated with 1% copper sulfate solution.

Chronic poisoning:
- Remove the patient from the source of exposure.
- Dental treatment, symptomatic treatment and follow up care.

31. What are the characteristic autopsy findings in phosphorus?
- Garlicky odor in the vicinity of the mouth and gastric contents.
- Jaundice and subcutaneous hemorrhages (bleeding points).
- Luminous gastric contents.
- Enlarged fatty liver; as time passes on, acute yellow atrophy of the liver may be present.
- Viscera preserved in saturated saline and not alcohol (luminance is lost if preserved in alcohol).

Forensic significance:
- Accidental poisoning is quite common in children.
- Suicidal poisoning is less common; rat poisons containing phosphorus are used for suicide.
- Homicidal poisoning: Formerly, many murders have been successfully accomplished by mixing phosphorus with any beverage like beer, rum, soup and jam.

32. Write short notes on aluminium phosphide poisoning.
- Aluminum phosphide is marketed in India under many trade names (alphos, celphos, chemfume, quickphos, etc.) and available as green tablets of 3 g each, mixed with urea and ammonium carbonate in airtight containers of ten or twenty tablets.

Uses:
- Grain preservative: On exposure to air, phosphine is released, when fumigated phosphine evaporates leaving no residues on the leaves.
  - Usual fatal dose: 1 to 3 tablets (3 to 9 g).

Mode of action:
- On exposure to air, phosphine is liberated, which causes multi-organ failure.

Clinical features:
- Metallic taste, vomiting, garlicky or fishy odor in breath, burning pain, intense thirst and diarrhea.
- In severe cases, CVS manifestations occur leading to hypotension, ECG changes and heart block.

- Coma precedes death, respiratory distress, cyanosis and cold clammy skin are present.
- Aluminum phosphide poisoning mortality is as high as 90 to 100%.

Diagnosis:

- Garlicky or fishy odor in breath.
- LFT often abnormal; ECG shows ST-T wave changes.
- *Silver nitrate test:* A filter paper is impregnated with 1% silver nitrate and the patient is asked to breathe through it for 5 to 10 minutes; blackening indicates presence of phosphine in breath (silver nitrate is reduced to silver); similar reaction occurs to H_2S also.

Treatment:

- Circulatory shock treated with IV fluids and dopamine.
- Respiratory distress with 100% oxygen, intubation or assisted ventilation.
- Metabolic acidosis with sodium carbonate.
- Magnesium sulfate therapy: Beneficial for cardiac arrhythmias.
- Intense thirst is present, but do not give water orally, since aluminum phosphide present in the stomach combines with water and releases phosphine again.

Autopsy findings:

- *Stomach:* Sub-mucosal hemorrhages with mucosal shedding and garlicky odor.
- *Heart:* Myocarditis and fibrillar necrosis; lungs: Pulmonary edema and ARDS.

Forensic significance:

- No case of death due to aluminum phosphide was recorded in India, before 1980; today it has emerged as one of the leading cause of suicidal and accidental deaths.

33. How do you treat barium poisoning?

- Barium poisoning is treated by stomach wash using magnesium sulfate and sodium sulfate IV.

CHAPTER 27

Organic Irritant Poisons

Keywords: *Abrus precatorius*, toxalbumin, glucoside, SUI, cattle poison, semicarpus, artificial bruise, calotropis, ricin, hemolytic, croton, capsicum, neem, lily, eucalyptus, purging nut, cobra, neurotoxic venom, viper, hemotoxic venom, krait, sea snakes, myotoxic, scorpion sting, cantharides, aphrodisiac.

INTRODUCTION

Organic irritants comprise plant and animal irritants.

Plant irritants:

- There are a wide variety of plant irritants; only *Abrus precatoroius, Calotropis, Ricinus communis,* croton, semicarpus, *capsicum,* Glorry lily, neem, eucalyptus, jatropha and ginseng will be discussed.
- Animal irritants include snakes, scorpion and cantharides.

1. What is *Abrus precatorius*? What are clinical features of poisoning? What are its criminal uses? What is SUI?

- *Abrus precatorius* is called as jequirity, rosary bead, Indian liquorice (Fig. 27.1).

Characteristics:

- Slender, climbing vine, with compound leaves, small pinkish flower and seed pods containing 4 to 6 seeds of 1 cm in circumference; the seeds are scarlet red in color with a black spot on one side.

Active principles:

- Abrin (toxalbumin), abrine (amino acid), abralin (glucoside) and abric acid.

Fig. 27.1 Abrus precatorius

Clinical features:

- Hemorrhagic gastritis and cardiac manifestations similar to viperine snake bite (cardiac arrhythmias and convulsions) leading to death.
- *Usual fatal dose:* 60 to 120 mg (1 to 2 seeds) "**super toxic**".
- *Treatment:* Decontamination and supportive measures.

Autopsy findings:

- Sub-mucosal hemorrhages on stomach mucosa and congestion of the internal organs.

If injected:

- Local signs of inflammation, edema and necrosis are present, which mimic "**viperine snake bite**".

Medicolegal significance:

- Accidental poisoning common in children, as they are attracted toward the color.

"Sui" poison:

- Seeds are crushed and added with pastes of arsenic, lead and calotropis and made into injecting needles and used to kill the enemy from a distance by blowing using a bamboo stick; also used to kill cattle by this method, death of the cattle will appear to be due to viperine snake bite.

2. What is calotropis? What are active ingredients, clinical features and criminal use of calotropis?

- Calotropis is madar. It is a tall shrub with yellowish white bark, oblong thick leaves, with purplish or white flowers; stem and leaves when incised yield a whitish, milky acrid juice.
- Calotropis Gigantea (Fig. 27.2) (purple flowers); Calo-tropis procera (white flowers).

Active principles:

- All parts of the plant are poisonous and contain the active principles in the milky juice. There are four main active ingredients present in the milky juice: (i) Calotropin, (ii) calotoxin, (iii) calactin and (iv) uscharin.

Clinical features:

- When the juice is ingested, there is burning sensation in throat and abdomen. Vomiting, diarrhea and abdominal pain followed by mydriasis, convulsion and delirium.
- Skin contact produces inflammation and vesication.
- Eye contact produces severe conjunctivitis.

Treatment:

- Gastric lavage.
- Demulcents.
- IV fluids.
- Diazepam for convulsions.
- Skin and eyes are irrigated with saline water.

Medicolegal significance:

- Juice is used as an abortificient; the stem is used as "**abortion stick**".
- Accidental poisoning due to quackery.
- Juice is given orally for female infanticide.
- Used as cattle poison.
- Artificial bruise (false bruise) on skin and conjunctivitis.

3. Write short notes on *Ricinus communis*? What is toxalbumin/phytotoxin?

- *Ricinus communis* (Fig. 27.3) is **castor or mole bean.**
- Long shrub with greenish red leaves; fruits are borne in clusters, with soft spined brown capsule containing 2 or 3 mottled grayish brown seeds, with linear stripes on the surface.

Fig. 27.2 Calotropis gigantia plant with flowers

Fig. 27.3 Ricinus communis (Castor plant)

Active principle:
- Seeds yield a pale yellow oil with faint acrid odor.
- Pressed cake retains the toxic principle; ricin a toxalbumin which causes hemolysis and is a super toxic, even superior to cobra venom and hence also called "terrorist weapon".

Toxalbumin: (Phytotoxin)
- Toxalbumin is a toxic protein, which acts like a bacterial toxin; it causes agglutination and lysis of RBC and has antigenic properties.
- *Action:* Ricin blocks the protein synthesis through the inhibition of RNA polymerase.
- *Uses:* Castor oil is used as a purgative and also used as a lubricant.

Clinical features:
- Vomiting, diarrhea, abdominal pain.
- Hypotension and dehydration.
- Fever with chills.
- Hemolysis and renal failure.
- *Usual fatal dose:* 1 mg/kg; 5 to 10 seeds.

Treatment:
- Decontamination (gastric lavage and activated charcoal).
- Correct fluid and electrolyte imbalance.
- Supportive measures.

Autopsy findings:
- GI congestion and erosion with marked renal congestion.

Medicolegal Aspects:
- Accidental ingestion in children and rarely homicidal.
- Over dosage of castor oil causes severe diarrhea.

4. Write short notes on *Croton tiglium* (Fig. 27.4)?
- Evergreen tree with smooth ash colored bark; ovate-lanceolate leaves with small flowers; oblong three lobed fruits containing oval, dark brown seeds (looks-like castor seeds but are slightly larger in size, darker and the linear striations are not so marked). Oil extracted from the seed is highly toxic.
- *Active principles:* Croton (toxalbumin) and crotonoside (glycoside).
- *Clinical features:* Similar to castor seeds; skin contact produces inflammation.
- *Usual fatal dose:* 1 to 2 mL of oil; 5 to 6 seeds.
- *Treatment:* Same like castor.

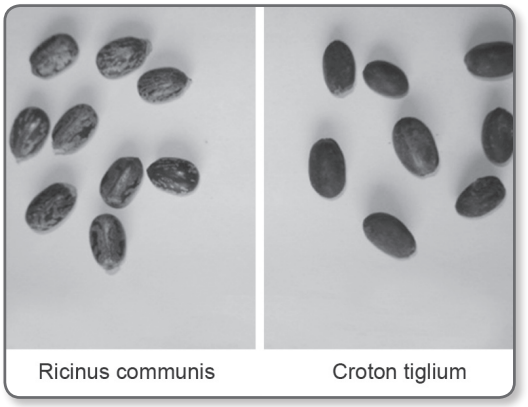


Fig. 27.4 Ricinus and Croton seeds

Medicolegal Aspects:
- Oil is used as an abortificient; accidental ingestion mistaken for castor oil.

5. What is marking nut? What are the criminal use?
- ***Semecarpus anacardium*** (Fig. 27.5) is marking nut.
- Tree bearing hard nut like fruits, the acrid blackish juice extracted from the seeds is used by the washer men (dhobis) for marking on the clothes, hence the name marking nut.
- *Active principles:* Semecarpol and Bhilawanol.
- *Uses:* Laundry marker and quackery remedies.

Clinical manifestations:
- Skin contact with the juice results in inflammation and vesication.
- Ingestion causes burning sensation in GIT, the areas of contact are discolored black and may also form vesication; hypotension and delirium also develop due to ingestion.
- *Usual fatal dose:* 10 g.
- *Treatment:* Supportive measures.

Forensic significance:
- Juice is used as an abortificient and accidental poisoning by quackery.
- *Malingering:* **Artificial bruise** and conjunctivitis are produced by juice of marking nut. It is differentiated from true bruise by color changes, itching and vesication. (Refer chapter on Injuries—Contusion).

Fig. 27.5 Semicarpus anacardium (Marking nut)

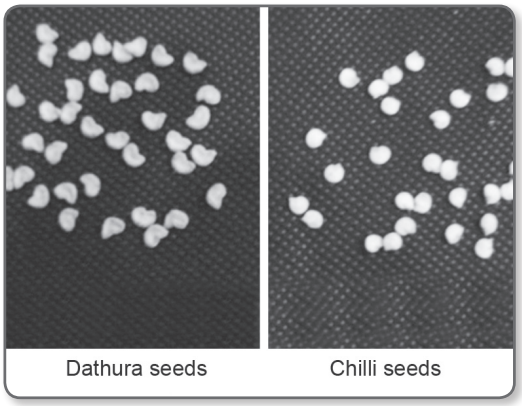


Fig. 27.6 Dathura and chili seeds

6. What is *Capsicum annum*? What are the forensic significance?

- *Capsicum annum* is chilly/red pepper.
- Small herb bearing long tapering fruits, which become red when ripe; possesses a pungent odor and taste. The fruit contains a number of small flat, yellowish seeds which resemble datura seeds.
- Chilly seeds are small, yellow, rounded, smooth and pungent in odor and taste (Fig. 27.6).
- Datura seeds are large, brown, reniform, pitted, odorless and bitter in taste (Fig. 27.6).
- *Active principle:* Capsaicin (alkaloid).

Uses:

- Continental in Indian cuisine, also used in pickles and sauces.
- Carminative and appetite stimulant; as counterirritant in balms.

Clinical features:

- Skin contact results in irritation and reddening.
- Eye contact causes intense burning, lacrimation and reddening.
- Ingestion of large quantities causes burning sensation in the mouth, salivation, abdominal pain, vomiting and diarrhea; sweating is common; urine may turn dark.

Treatment:

- Wash and bath the affected area with vinegar or ice cold water.
- In case of ingestion, give ice cubes to suck and sips of ice cold water.
- Supportive measures.

Forensic significance:

- Workers in pickle manufacturing units often suffer from dermatitis and burning lesions of fingers (Human hand: Vascular and sensory responses of human skin to topical treatment with capsaicin).
- Robbery, assault, rape, etc. can be facilitated easily by throwing chilly powder on the eyes of the victim.
- It can be used for torture or extortion, by forcing chilly powder into rectum or vagina.
- Datura seeds can be mistaken for chilly and eaten, resulting in serious complications.

7. What is glory lily?

- *Gloriosa superba* is climbing lily, superb lily.
- Large herb, climbing plant with terminating leaves in with tendril, long, curling tips. Flowers are large, solitary and long-stalked.

Uses:

- Juice from the leaves is used as a pediculoside (to kill head lice).
- Root is used for folk remedies.
- *Toxic parts:* Leaves and root.
- *Toxic principles:* Root contains colchicine and superbine.

Clinical features:

- Acute poisoning results in severe vomiting, diarrhea, abdominal pain, hypotension and respiratory failure.
- *Treatment:* Decontamination; symptomatic and supportive measures.

8. What is purging nut?

- ***Jatropha curcas*** is purging nut; also known as "**physic nut**".
- Seeds have a powerful purgative action.
- Toxic principles: Ricin and tannic acid.

Clinical features:

- Salivation, abdominal pain, diarrhea, weakness, and muscle twitching.
  Treatment: Supportive therapy.

ANIMAL IRRITANTS

- Snakes, scorpion, cantharides, bees and wasps will be discussed.

9. What are the two important families of poisonous snakes?
How to differentiate poisonous snakes from non-poisonous snakes (Table 27.1)?

- There are thousands of snake species of which more than 200 are venomous species.
- In India, there are more than 200 species of which 50 are poisonous.
- There are two important groups (families) of venomous snakes: Elapidae and viperidae.

i. **Elapidae:**

- Have short permanently erect fangs; this family includes the cobra, king cobra, kraits, coral snakes and the sea snakes.

ii. **Viperidae:**

- Have long and canalized fangs, grooved or hypodermic needles like fangs. This family includes Russell's vipers, saw-scaled (carpet) vipers, pit vipers, green pit vipers (bamboo vipers).
- Venomous snakes of medical importance have a pair of enlarged teeth (the fangs), at the front of their upper jaw. These fangs contain a venom channel (like a hypodermic needle) or groove, along which venom can be introduced deep into the tissues of their natural prey.
- If human beings are bitten, venom is usually injected subcutaneously or intramuscularly.
- Spitting cobras can squeeze the venom out of the tips of their fangs producing a fine spray directed toward the eyes of an aggressor.

10. What are the basic constituents of snake venom and what are the actions on human body?

Snake venoms contain more than 20 different constituents, mainly protein including enzymes and polypeptide toxins. The following venom constituents cause important clinical effects:

i. **Procoagulant enzymes: (Viperidae)**

- These stimulate blood clotting but result in non-coagulation of blood. Venoms such as Russell's viper venom contain several different procoagulants which activate different steps of the clotting cascade. The result is formation of fibrin in the blood stream.
- Most of these components are immediately broken down by the body's own fibrinolytic system.
- Eventually, and sometimes within 30 minutes of the bite, the levels of clotting factors have been so depleted ("**consumption coagulopathy**") that the blood will not clot at all.

ii. **Hemorrhagins: (Zinc metalloproteinases)**

- Damage the endothelial lining of the blood vessel walls causing spontaneous systemic hemorrhage.

iii. **Cytolytic or necrotic toxins:**

- These digestive hydrolases (proteolytic enzymes and phospholipases A) polypeptide

Table 27.1 Difference between venomous snakes and non-venomous snakes

Characteristics	Venomous snakes	Non-venomous snakes
Head	Triangular or diamond-shaped	Smooth and tapered head
Pupils	Elliptical or "cat-like" pupil	Rounded pupil
Fangs	Long and movable fangs	No fangs, have small teeth
Facial pits	Located below the eyes	No facial pits
Bite marks	Two or one puncture wounds	Multiple teeth marks

toxins and other factors increase permeability resulting in local swelling. They may also destroy cell membranes and tissues.

iv. **Hemolytic and myolytic phospholipases A2:**
- These enzymes damage cell membranes, endothelium, skeletal muscle, nerve and red blood cells.

v. **Pre-synaptic neurotoxins:** (Elapidae and some viperidae)
- These are phospholipases A2 that damage nerve endings, initially releasing acetylcholine transmitter, later interfering with release.

vi. **Post-synaptic neurotoxins** (Elapidae):
- These polypeptides compete with acetylcholine for receptors in the neuromuscular junction and lead to curare-like paralysis.

11. What could be the quantity of venom injected in a bite?
- This is very variable, depending on the species and size of the snake, the mechanical efficiency of the bite, whether one or two fangs penetrated the skin and whether there were repeated strikes.
- Although large snakes tend to inject more venom than smaller specimens of the same species, the venom of younger vipers may be richer in some dangerous components, such as those affecting hemostasis.

12. Who are the people commonly bitten by snakes?
- Farmers (rice).
- Plantation workers (rubber, coffee).
- Herdsmen.
- Hunters.
- Snake handlers (Snake charmers, in snake restaurants and traditional Chinese pharmacies).
- Fishermen and fish farmers.
- Sea snake catchers (for sea snake skins, leather).

13. What are the signs and symptoms of a venomous snake bite?

i. **Early symptoms and signs:**
- Following the immediate pain of mechanical penetration of the skin by the snake's fangs, there may be increasing local pain (burning, bursting, throbbing) at the site of the bite, local swelling that gradually extends proximally up the bitten limb and tender, painful enlargement of the regional lymph nodes draining the site of the bite (in the groin—femoral or inguinal, following bites in the lower limb; at the elbow (epitrochlear) or in the axilla following bites in the upper limb).
- Bites by kraits, sea snakes and Philippine cobras may be virtually painless and may cause negligible local swelling. Someone who is sleeping may not even wake up when bitten by a krait and there may be no detectable fang marks or signs of local envenoming.

ii. **Local symptoms and signs in the bitten part (Fig. 27.7)**
- Fang marks.
- Local pain and bleeding.
- Bruising, lymphangitis and lymph node enlargement.
- Inflammation (swelling, redness, heat) and sometimes blistering.
- Local infection, abscess formation and necrosis.

iii. **Generalized (systemic) symptoms and signs**

General:
- Nausea, vomiting, malaise, abdominal pain, weakness, drowsiness, prostration.

Cardiovascular (viperidae)
- Visual disturbances, dizziness, faintness, collapse, shock, hypotension, cardiac arrhythmias, pulmonary edema, conjunctival edema.

Fig. 27.7 Snake bite (Cobra bite)

- **Bleeding and clotting disorders:** Bleeding from recent wounds including fang marks, venepunctures, etc. and from old partly-healed wounds; spontaneous systemic bleeding from gums, epistaxis, hemoptysis, hematemesis, rectal bleeding or melena, hematuria, vaginal bleeding, bleeding into the skin (petechie, purpura, ecchymoses) and mucosa (for example, conjunctivae, intracranial hemorrhage) ; meningism from subarachnoid hemorrhage, lateralizing signs and/or coma from cerebral hemorrhage.

Neurological (Elapidae)

- Drowsiness, paresthesia, abnormalities of taste and smell, "heavy" eyelids, ptosis, external ophthalmoplegia, paralysis of facial muscles and other muscles innervated by the cranial nerves, aphonia, difficulty in swallowing secretions, respiratory and generalized flaccid paralysis.

Skeletal muscle breakdown (sea snakes)

- Generalized pain, stiffness and tenderness of muscles, trismus, myoglobinuria, hyperkalemia, cardiac arrest and acute renal failure.

Renal (Viperidae, sea snakes)

- Loin (lower back) pain, hematuria, hemoglobinuria, myoglobinuria, oliguria/anuria.
- Symptoms and signs of uremia like acidotic breathing, hiccups, nausea, pleuritic chest pain, etc.

Endocrine (acute pituitary/adrenal insufficiency) (Russell's viper)

- *Acute phase:* Shock and hypoglycemia.
- Chronic phase (months to years after the bite): Weakness, loss of secondary sexual hair, amenorrhea, testicular atrophy, hypothyroidism, etc.

14. What are the general lines of management of snake bite (Fig. 27.8)?

The scheme of management should be:

i. First-aid treatment.
ii. Transport to hospital.
iii. Rapid clinical assessment and resuscitation.
iv. Detailed clinical assessment and species diagnosis.
v. Investigations/laboratory tests.
vi. Antivenom treatment and observation of the response to antivenom.

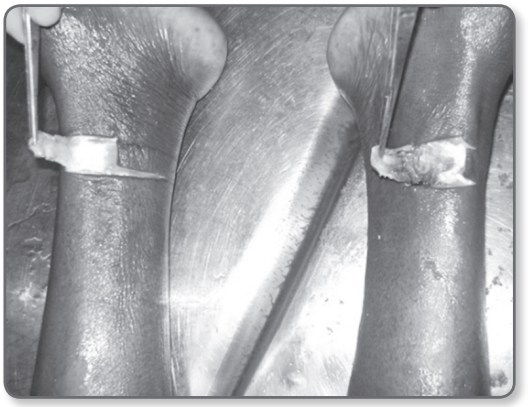


Fig. 27.8 Dissection of the bitten area (and control on the other limb) reveals diffuse bruising of the underlying subcutaneous tissues

vii. Treatment of the bitten part and rehabilitation
viii. Treatment of chronic (late) complications

Aims of first-aid

- Attempt to retard systemic absorption of venom.
- Preserve life and prevent complications before the patient can receive medical care (at a dispensary or hospital).
- Control distressing or dangerous early symptoms of envenoming.
- Arrange the transport for the patient to a place where they can receive medical care.

i. **Recommended first-aid methods**

- Reassure the victim who may be very anxious.
- Immobilize the bitten limb with a splint or sling (any movement or muscular contraction increases absorption of venom into the bloodstream and lymphatics).
- Consider pressure-immobilization for some elapid bites.
- Avoid any interference with the bite wound as this may introduce infection, increase absorption of the venom and increase local bleeding.

a. ***Pressure immobilization method:*** Recommended first-aid for bites by neurotoxic elapid snakes:

– Pressure immobilization is recommended for bites by neurotoxic elapid snakes, including sea snakes but should not be used for viper bites because of the dan-

ger of increasing the local effects of the necrotic venom.

b. ***Tight (arterial) tourniquets are not recommended***

– This method is extremely painful and very dangerous if the tourniquet was left on for too long (more than about 40 minutes), as the limb might be damaged by ischemia, followed by gangrene formation.

ii. **Early clues that a patient has severe envenoming:**

- Snake identified as a very dangerous one.
- Rapid early extension of local swelling from the site of the bite.
- Early tender enlargement of local lymph nodes, indicating spread of venom in the lymphatic system.
- Early systemic symptoms: Collapse (hypotension, shock), nausea, vomiting, diarrhea, severe headache, "heaviness" of the eyelids, inappropriate (pathological) drowsiness or early ptosis/ophthalmoplegia.
- Early spontaneous systemic bleeding.
- Passage of dark brown urine.

iii. **Physical examination**

a. ***Examination of the bitten part***

– The extent of swelling and tenderness to palpation should be recorded. Lymph nodes draining the limb should be palpated for ecchymoses and lymphangitis.

b. ***General examination***

– Measure the blood pressure (sitting up and lying to detect a postural drop indicative of hypovolemia) and heart rate. Examine the skin and mucous membranes for evidence of petechiae, purpura and ecchymosis in the conjunctivae.

c. ***Neurotoxic envenoming***

– To exclude early neurotoxic envenoming, ask the patient to look up and observe whether the upper lids retract fully. Test eye movements for evidence of early external ophthalmoplegia. Check the size and reaction of the pupils.

d. ***Bulbar and respiratory paralysis***

– Can the patient swallow or whether any secretions accumulated in the pharynx, which is the early sign of bulbar paralysis. Ask the patient to take deep breath in and out. "**Paradoxical respiration**" (abdomen expands rather than the chest on attempted inspiration) indicates that the diaphragm is still contracting but that the intercostal muscles and accessory muscles of inspiration are paralysed.

– Do not assume that patients have irreversible brain damage because they are unresponsive to painful stimuli, or have fixed dilated pupils.

– Inability to open the mouth and protrude the tongue in patient.

iv. **Investigations/laboratory tests**

a. ***20 minutes whole blood clotting test (20 WBCT)***

– Place a few mL of fresh sample of venous blood in a small glass vessel, leave undisturbed for 20 minutes at ambient temperature. Tip the vessel once, if the blood is still liquid (unclotted) and runs out, the patient has hypofibrinogenemia (incoagulable blood) as a result of venom-induced consumption coagulopathy.

b. ***Hemoglobin concentration/hematocrit:***

– **A transient increase indicates** Hemoconcentration resulting from a generalized increase in capillary permeability.

c. **Platelet count may be decreased in victims of viper bites.**

d. **White blood cell count**

– An early neutrophil leucocytosis is evidence of systemic envenoming from any species.

e. **Blood film:**

– Fragmented red cells (***"helmet cell"*** schistocytes) are seen when there is microangiopathic hemolysis.

– Plasma/serum may be pinkish or brownish if there is gross hemoglobinemia or myoglobinemia.

f. **Urine examination**

– The urine should be tested by dipsticks for blood/hemoglobin/myoglobins.

15. What is the composition of Anti-venom? What are the indications for anti-venom treatment?

- Anti-venom is the only specific antidote to snake venom. A most important decision

in the management of a snake bite victim is whether or not to give anti-venom.

- **Anti-snake venom** available in India is prepared by hyper-immunizing horses, against the four common poisonous snakes: (i) Common cobra, (ii) common krait, (iii) Russell's viper, (iv) saw scald viper.

Indications for antivenom

- Anti-venom treatment is recommended if and when a patient with proven or suspected snake bite develops one or more of the following signs:

Systemic envenoming:

- *Hemostatic abnormalities:* Spontaneous systemic bleeding or thrombocytopenia.
- *Neurotoxic signs:* Ptosis, external ophthalmoplegia, paralysis. etc.
- *Cardiovascular abnormalities:* Hypotension, shock, cardiac arrhythmia or abnormal ECG.
- *Acute renal failure:* Oliguria/anuria, rising blood creatinine/ urea.
- *Hemoglobin/myoglobin uria:* Dark brown urine, urine dipsticks, other evidence of intravascular hemolysis or generalized rhabdomyolysis (muscles ache and pain, hyperkalemia).

Local envenoming:

- Local swelling involving more than half of the bitten limb.
- Rapid extension of swelling (for example, beyond the wrist or ankle within a few hours of bites on the hands or feet).
- Development of an enlarged tender lymph node draining the bitten limb.

16. What is the dosage schedule of anti-venom injection?

i. Intravenous "push" injection: Reconstituted freeze-dried anti-venom or near liquid anti-venom is given by slow intravenous injection (not more than 2 mL/minute).

ii. Intravenous infusion: Reconstituted freeze-dried or near liquid anti-venom is diluted in approximately 5–10 mL of isotonic fluid per kg body weight (i.e. 250–500 mL of isotonic saline or 5% dextrose in the case of an adult patient) and is infused at a constant rate over a period of about one hour. Snakes inject the same dose of venom into children and adults. Children must therefore be given exactly the same dose of anti-venom as adults.

17. What is anti-venom reaction? How to manage such cases?

i. **Early anaphylactic reactions:**

- Occurs usually within 10–180 minutes of starting anti-venom.

ii. **Pyrogenic (endotoxin) reactions:**

- Usually develop 1–2 hours after the treatment. Symptoms include shaking chills (rigors), fever, vasodilatation and a fall in blood pressure; serum sickness type of late reactions develop 1 to 12 (mean 7) days after treatment.
- Clinical features include fever, nausea, vomiting, diarrhea, itching, recurrent urticaria, arthralgia, myalgia, lymphadenopathy and periarticular swellings.

Management of anti-venom reaction:

i. *At the earliest sign of a reaction:*

- Anti-venom administration must be temporarily suspended. Epinephrine (adrenaline) 0.1% solution (1 in 1,000; 1 mg/ml) is the effective treatment for early anaphylactic reactions.

ii. *Additional treatment:*

- After epinephrine (adrenaline), an anti-H1 antihistamine such as chlorpheniramine maleate (adults 10 mg, children 0.2 mg/kg by intravenous injection over a few minutes).
- Hydrocortisone (adults 100 mg, children 2 mg/kg body weight). The corticosteroid is unlikely to act for several hours, but may prevent recurrent anaphylaxis.

18. What is compartmental syndrome?

Clinical features of a compartmental syndrome

- Disproportionately severe pain.
- Weakness of intracompartmental muscles.
- Pain on passive stretching of intracompartmental muscles.
- Hypoesthesia of areas of skin supplied by nerves running through the compartment.
- Obvious tenseness of the compartment on palpation.

Criteria for fasciotomy in snake-bitten limbs

- After the hemostatic abnormalities have been corrected, when there is clinical evidence of an intracompartmental syndrome, fasciotomy may be necessary.

Rehabilitation

- Conventional physiotherapy in patients with severe local envenoming. The limb should be maintained in a functional position. For example, in the leg, equinus deformity of the ankle should be prevented by application of a back slab.

19. Write short notes on scorpions.

- They are eight legged arthropods and have a hollow sting in the last joint of their tail, which communicates by means of a duct with the poisonous gland.
- The venom is clear colorless **toxalbumin and** can be classified as either neurotoxic or hemotoxic; the toxicity is more than that of snakes but only a very small quantity is injected.
- Venom is a potent autonomic stimulator, releasing massive amounts of catecholamines from the adrenals.
- In majority of cases, the mortality is negligible except in children and rarely in women.

Signs and symptoms:

- Scorpion sting usually has only one hole in the center of the reddened area.
- Symptoms usually localized; but sometimes result in systemic toxicity leading to restlessness, cardiac arrhythmias, paralysis, convulsions, respiratory depression and death, within an hour due to pulmonary edema and peripheral vascular collapse.

Treatment:

- Immobilize the limb; a tourniquet can be applied above the level of the sting.
- Pack the area of sting with ice.
- Local anesthetic is injected at the site; if the sting is left in-situ, then an incision can be made with sterile blade and excise the broken fragment of the sting left inside the body.
- Calcium gluconate IV is of some value to control local swelling.
- Barbiturates can be given to reduce excitement and convulsions, but morphine is not indicated.
- Atropine is of use to control pulmonary edema.

20. What are cantharides? What are the circumstances of poisoning?

- Cantharides are Spanish fly; also called as "**blister beetle**".
- The fly is 2 cm long and 0.6 cm broad.
- The powder of the dried body of the fly is brown in color.
- Active principle is cantharidin. It is readily absorbed through all the surfaces including the skin; locally it acts as an irritant.

Signs and symptoms:

- Contact with the skin produces burning pain and redness followed by vesication in 1 to 2 hours.
- *When ingested:* Causes severe burning pain in the mouth and throat, followed by pain in stomach, nausea, vomiting, severe thirst followed by difficulty in swallowing and speech.
- Urine is scanty and blood-stained.
- Priapism (Painful erection of penis) is a persistent symptom of cantharides poisoning.
- Abortion may occur in a pregnant woman.
- In severe cases, the patient become prostrated, convulsions occur followed by coma and death.
- *Fatal dose:* 15 to 50 g of the powder; fatal period: 24 to 48 hours.

Treatment:

- Stomach wash, demulcents and symptomatic treatment.

CHAPTER 28

Neurotoxic Poisons

Keywords: Somniferous poisons, opium, morphine, naloxone, cocaine, speed balls, body packers, inebriants, ethanol, Macewen's sign, nystagmus, alcoholism, Widmark's formula, methanol, formic acid, barbiturates, automatism, deliriants, datura, cannabis, bhang, hashish, run amok, drug dependence, drug habituation, drug abuse, Nux vomica, strychnine, anterior horn cells, convulsions, tetanus.

1. Classify neurotoxic poisons.

Poisons which act on the nervous system are collectively called as neurotoxic poisons. Based on their effect on the three divisions of the nervous system, the neurotoxic poisons are classified into:

i. Cerebral poisons
ii. Spinal poisons
iii. Peripheral poisons

i. **Cerebral poisons**

Poisons which act on the brain are called as cerebral poisons. Based on their effects on brain function, the cerebral poisons are grouped into:

1. *Somniferous:* Sleep producing substances.
2. *Inebriant:* Producing euphoria (Intoxicates).
3. *Delirient:* Causing excitation.
4. *Pschycotropic:* Mind altering substances.

ii. **Spinal poisons**

Substances altering or affecting the spinal cord functioning.

1. *Excitatory:* Strychnine
2. *Depressant:* Gelsemium

iii. **Peripheral Poison**

Substances interrupting the function of peripheral nerve curare and conium.

2. What is opium? What are the alkaloids derived from opium?

- Opium is a somniferous poison (induces sleep).

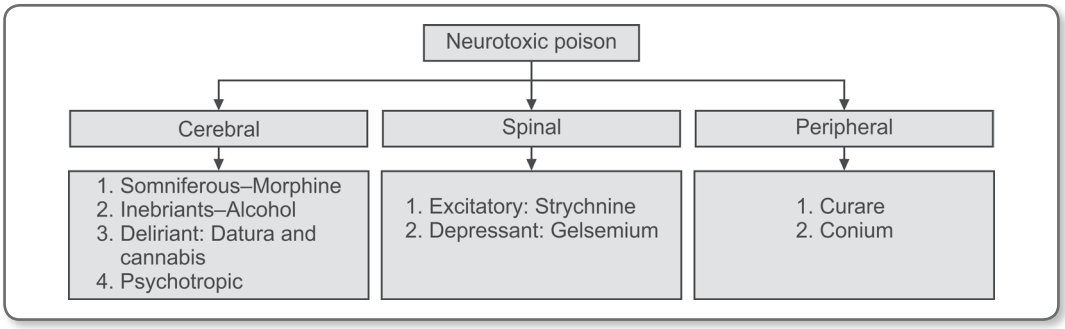


Table 28.1 Natural alkaloids and their action

	Natural Alkaloids	Action
1	Morphine	Analgesic
2	Codeine	Antitussive
3	Thebain	Analgesic
4	Papaverine	Smooth muscle
5	Noscapine	Narcosis

- Opium is the natural source for many drugs which are prescribed mainly to relieve the pain with an additional pleasure of sleep.
- Opium is extracted from the unriped fruit of papaver somniferum which is being cultivated under strict regulations.

Extraction

- Upon incision over the unripe fruit yields a milky white fluid which becomes dark and dry on exposure to a number of alkaloids. On their chemical basis, these alkaloids are divided into two groups:
  (i) Phenanthrene group: 1. Morphine 2. Codeine 3. Thebaine.
  (ii) Benzylisoquinoline group: 1. Papaverine 2. Noscapine [narcoting] (Table 28.1).
- The ripped fruit capsule becomes brown and dry containing the brownish or pale brown fine granular seeds. Seeds are non-poisonous used as condiment in preparation of condimental food.

3. What are opiates and opioids? What are their action and uses?

The naturally occurring opium and the derivatives of opium (semisynthetic) are called as **opiates**. Pure synthetic analogues are called as **opioids** (Tables 28.2 and 28.3).

Table 28.2 Semisynthetic derivatives (Opiates)

1	Apomorphine	Used as emetic
2	Diacetyle morphine (Heroin)	Brown sugar—addiction
3	Buprenorphine (Tidigesic)	Analgesic and preanesthetic medication
4	Pentazocine	Analgesic

Table 28.3 Synthetic derivatives (Opioids)

1	Pathedine (Meperidine)	Analgesic
2	Methadone	Analgesic (Substitution therapy for heroin)
3	Tramadol	Analgesic
4	Loperamide	Antidiarrhea

4. What is the mechanism of action of morphine?

- The effect of opiates and opiods depends upon the receptors in the brain which are recognized as Mu (μ) Kappa (κ) and Delta (δ) primarily and the alkaloids and analogues are having agonistic, antiagonistic and combine agonistic and antiagonistic properties.
- Mu receptor is responsible for euphoria, analgesia, respiratory depression and reduced gastrointestinal mobility.
- Kappa receptor is responsible for CNS depression, miosis and analgesia.
- Delta receptor is responsible for analgesic effect.

5. What is the pharmacokinetics and clinical symptoms of morphine?

Pharmacokinetics:

- *Absorption:* Opiates and opioids are absorbed from gastrointestinal tract, lungs and muscles. They are usually taken orally, parentally and by inhalation.
- *Metabolism:* Mostly in the liver by conjugation with glucuronic acid.
- Excretion is mainly through urine and feces.
- Pharmacodynamically opiates and opiods are known for their **three classical effects**:
  (i) CNS depression
  (ii) Respiratory depression
  (iii) Miosis.

Clinical features

- The three stages of opium toxicity greatly depend upon the amount (dosage) and tolerance (duration) hence may not be classically seen always.
  (i) **Stage of excitement**: A brief period of euphoria due to effects on limbic system.

(ii) **Stage of stupor**: The pleasurable mental excitement soon taken over by anorexia, nausea, vomiting constipation, constricted pupil, loss of sex desire and intense desire to sleep. Progressing to stupor but arousable.

(iii) **Stage of narcosis**: Patient becomes deeply comatose and unarousable, insensible with abolished reflexes.

- Cyanotic face, Cheyne-stoke breath, pinpoint pupil, bradycardia, hypotension, hypothermia, foaming over nose due to pulmonary congestion and edema and death due to **respiratory paralysis** may be preceded by convulsions.

6. What is the treatment of acute morphine poisoning?

i. *Airway:* Clear the airway by removing the froth or particulate matter taken by the individual by snorting or inhalation.
ii. *Breathing:* Adequate ventilatory support.
iii. *Circulation:* Cardiovascular support and monitoring.
iv. *Decontamination:*

- Gastric lavage with cuffed endo-tracheal intubation with potassium permanganate (1:5000) solution till the returning fluid is clear. Since opium derivatives markedly reduce gastric motility, stomach wash should be given even in delayed detection. Since, opium derivatives are resecreted into the bile, stomach wash is indicated even in cases of parental administration.
- Promote fecal excretion by purgatives.

v. **Antidote** administration: **Naloxone** is the specific antidote for opium derivatives. Naloxone is an opioid antagonist that competes with them at the receptor site. Dose is 0.4 mg to 2 mg IV and can be repeated every 10–15 minutes upto 10 mg.
vi. Prevention of respiratory infection by anti-biotics.
vii. Correction of electrolytic imbalance by IV fluids.
viii. General supportive measure.
ix. Psychiatric counseling
x. Periodic evaluation to prevent addiction.

7. What are the postmortem appearances and viscera to be preserved in morphine poisoning?

External:

- Cyanosis of face, lips, earlobes and finger nails.
- Foam cone over nose and mouth.
- Needle puncture marks in classical sites, if administered parentally.

Internal:

- Dark fluid blood, with intense congestion of internal organs.
- Remnants of poison in stomach.
- Respiratory passage and lungs are filled with frothy fluid.

Specimens to be Collected for Toxicological analysis

Routine specimens

i. Stomach: Half stomach with half of its contents.
ii. Intestine: Proximal 100 cm.
iii. Liver: Not less than 500 g.
iv. Kidney: Half of each kidney.
v. Blood: From peripheral vessel 30 mL preserved with sodium fluoride.
vi. Urine: Not less than 30 mL (No preservative).

Special Specimens

i. Gallbladder (Intact)
ii. Half of brain.

8. What are the medicolegal importance of morphine?

- Accidental death is commonly seen among drug addicts.
- Suicide is also common because of painless and pleasurable (divine death) but only to those who have accessibility to the drug.
- Homicide is rare because of bitter taste and dark color. But infanticide is possible by smearing opium over breast.
- It is a powerful drug of addiction.

9. Write short notes on cocaine? What is speed ball? What is Magnan's symptom?

- Cocaine is also known as coke, snow, cadillac or white lady.

- Cocaine is an alkaloid obtained from the leaves of coco-tree *Erythroxylum coca* and *E. novogranatense*, which grows well in South America, India, Indonesia, Java, etc.
- Cocaine is colorless, odorless, crystalline substance, bitter in taste, causes numbness of tongue and mucous membrane.

Common routes of administration:

- Oral, injection, nasal and buccal membranes or by inhalation.
- Cocaine hydrochloride, the water soluble form is typically used for snorting and injection.
- Crude form of free base cocaine is suitable for smoking.

Action:

- Cocaine desensitizes the terminal nerves and causes vasoconstriction at the site of application.
- It stimulates the cortex for a short time, followed by depression. Similar but less marked effect is seen on the spinal cord.

Medicinal uses:

- Formally used as topical anesthetic for corneal and ENT procedures.
- **Brampton's cocktail**: Cocaine was one of the constituents of this mixture, which was popular as a pain reliever in terminal cancer.

Signs and symptoms:

i. ***Stage of early stimulation:***

- Euphoria, excitement, mydriasis, tachycardia, vertigo and nausea.

ii. ***Stage of advanced stimulation:***

- Vomiting, muscle twitching, convulsions, dyspnea, hyperthermia (cocaine fever), hallucination (tactile - cocaine bugs), circulatory and respiratory failure.

iii. ***Stage of depression:***

- Paralysis of muscles, loss of reflexes, coma and death.

Speed balls:

- A combination of cocaine and heroin taken by injection is known as "speed balls".

Cocaine bugs:

- Also known as Magnan's symptom/tactile hallucination/formication.
- It is a withdrawal symptom of chronic cocaine poisoning. Where is a feeling of insects crawling all over the body (tactile hallucination).

10. Write short notes on body packer syndrome?

- This condition is also called as "Mini packer syndrome" or "body stuffing".
- It is a method used to smuggle drugs of abuse (mainly cocaine) across the international borders. The people involved are referred to as "mules".
- The mode of smuggling is by packing the drug (cocaine) in small plastic bags, balloons or condoms of size 2.5 × 1 cm and swallowing them; rectal suppositories or disposable enemas are also used in these methods.
- Retrieval of these drug packets is by self-administration of purgative, followed by defecation.

Acute poisoning:

- Acute poisoning is due to the complication of bursting of the packets during their transit through GIT thus releasing massive amounts of cocaine resulting in rapid collapse and death.

Diagnosis:

- Diagnosis is easy by abdominal X-ray, ultrasound or CT scan; the packets are visualized as radio-opaque shadows on X-ray.

Treatment: (In asymptomatic patients)

- Whole bowel irrigation using polyethylene glycol.
- Alternatively, after waiting for a period of time till the drug reaches the colon; low volume phosphosoda enemas / high volume saline enemas are administered.
- Food intake is not permitted till the drug is taken out.
- Bowel obstruction is to be ruled out before trying to evacuate the drug packets.
- Emptying of rectum by bisacodyl (dulcolax) suppository and metoclopramide 10 mg, 8th hourly for gastric emptying are also useful.

Acute poisoning: Symptomatic people:

- Whole bowel irrigation and activated charcoal.
- Supportive measures like assisted ventilation.
- Benzodiazepines for convulsions.
- *Antidote:* Amyl nitrite inhalation, thiamine 100 mg IV, naloxone 2 mg IV.

- Administration of specific drugs depending on the symptoms.

Complications:

- Intestinal obstruction and rarely, intestinal perforation may occur, which requires surgical intervention.

11. What are inebriants? Which all poisons fall into this category?

- Inebriant refers to any substance which intoxicates, i.e. causes mental confusion, light headedness, disorientation and drowsiness.
- There are several poisons and drugs which fall under this category, they are:
  (i) Alcohol: The most important representative of this group, (ii) Barbiturates, (iii) Chloral hydrate, (iv) Benzodiazepines, (v) Hydrocarbons, (vi) Formaldehyde and (vii) Paraldehyde.

12. What is ethanol? How it is produced? What is proof spirit? What are congeners?

- Ethanol is ethyl alcohol, also referred as grain alcohol.

Physical appearance:

- Clear, colorless liquid with faint fruity odor and sweet burning taste.
- It is both water soluble and fat soluble.

Source:

- Ethanol is produced by **fermentation of sugar with yeast**. The source of sugar could be cereal, vegetable or fruits. Alcoholic beverages are distilled after fermentation.

Proof spirit:

- Refers to a standard mixture of alcohol and water of relative density 12/13 at 51° F, i.e. 49.28% of alcohol by weight or 57.10% by volume.

Congeners:

- They are the by-products of the process of fermentation. All the alcoholic beverages contain several congeners to a varying extent. The odor of the alcoholic beverage is due to the congeners used.
- Vodka is the purest form and contains no congeners and hence virtually odorless. White rum is also relatively pure.

Table 28.4 Concentration of alcohol in various beverages

Beverage	Alcohol content (% by volume)
Light beer	3.5 to 6%
Strong beer	6 to 8%
Natural wine	10 to 15%
Fortified wine	15 to 20%
Whisky, gin, brandy	40 to 45%
Rum	45 to 50%

13. What are the uses of ethanol?

i. Alcoholic Beverages (Table 28.4)

ii. Solvents:

- For after-shave lotions, colognes, mouth wash, perfumes, etc. the alcohol concentration varies from 15 to 80%.

iii. Medicinal use:

- Several anti-histamines, decongestants and cough syrups (2 to 25 %)
- Surgical spirit: Mixture of 90 to 95% of ethanol and 5 to 10% of methanol, is a popular antiseptic.
- Ethanol sponging is effective remedy for hyperthermia.
- Injection of alcohol in close proximity to the nerve or sympathetic ganglia for trigeminal neuralgia.
- Small doses of alcohol is useful in common cold.

iv. Ethanol is the antidote for methanol poisoning.

v. Rectified spirit (90 to 95% ethanol) is used as a preservative.

14. How does ethanol get metabolized in the body? What is the usual fatal dose of ethanol?

Absorption and metabolism:

- 20% is absorbed in the stomach and 80% from the intestines. Peak alcohol concentration in the blood is achieved in 30 to 90 minutes.
- More than 90% is metabolized in the body and 5 to 20% is excreted unchanged by kidneys, lungs and sweat.
- Metabolism is mainly by alcohol dehydrogenase pathway.

- In adults, the average rate of metabolism is 100 to 125 mg/kg/hour. In chronic alcoholics, it is upto 175 mg/kg/hour.
- The blood alcohol level falls at the rate of 15 to 20 mg/100 ml/ hour and is higher (upto 30 mg/100 ml/hour) in chronic alcoholics.

15. What are the effects of ethanol in the body?

i. **Intoxication:**

- Alcohol is a well-known stimulant but is a selective depressant, especially of higher centers. Ethanol primarily depresses the reticular activating system.
- The frontal lobes are sensitive to low concentration of alcohol resulting in mood changes, followed by the occipital lobe leading to visual disturbances and later the cerebellum resulting in loss of coordination.
- The old Roman saying "**In Vino Veritas**" which means "in wine there is truth", i.e. the real personality of an individual will be often revealed when he is intoxicated.

ii. **CNS:**

- Ethanol depresses the CNS. First affects memory and concentration, later there is emotional liability and mood swing. With severe intoxication, there is general impairment of CNS functions, passing on into coma.

iii. **CVS:**

- In moderate doses, ethanol produces tachycardia and vasodilatation, resulting in a feeling of warmth.

iv. **GIT:**

- Ethanol stimulates salivary and gastric secretions, but in high concentration, they are inhibited and mucosa becomes inflamed leading to erosive gastritis.

v. **Genitourinary System:**

- Ethanol induces diuresis by inhibiting ADH. Ethanol is said to be an aphrodisiac, but in chronic alcoholics it slowly leads to impotence.

16. What are the clinical features of ethanol poisoning?

i. **Stage of excitement:**

- Loss of imbibitions, feeling of well-being, talkative, increased self-confidence and fine movements are affected. Blood alcohol 30 to 100 mg%.

ii. **Stage of intoxication:**

- Emotional instability, slurred speech, impaired memory, increased reaction time and muscular in-coordination. BAC 150 to 300 mg%.

iii. **Stage of coma:**

- Unconsciousness, abolished reflexes, subnormal temperature, incontinence of urine and feces. BAC 300 to 450 mg%. Above 500 mg%, the person may go into respiratory failure and death. Death from acute alcohol poisoning is usually rare. The individual goes on for a prolonged sleep coma and may recur spontaneously once the blood alcohol level goes down (16 to 24 hours).

iv. **Hangover:**

- When the individual recovers from coma after a long sleep, he may present with symptoms of acute depression, nausea, abdominal discomfort, irritability, lethargy and severe headache.

McEwan's sign: (Macewan's sign)

- In the comatose stage, the pupils will be constricted. But, on stimulation of the patient (by pinching his face), the pupils dilate and slowly return to the original contracted size. This is called as McEwan's sign and is useful in differentiating alcoholic coma from other coma.
- Fine lateral nystagmus is usually present and is characteristic of alcoholism.

Micturition syncope:

- It is a condition which occurs after heavy beer drinking. When the individual rises from bed in the middle of the night to pass urine, due to the sudden upright posture he loses consciousness during the act of urination.

Munich beer heart:

- It is a condition in which there is cardiac dilatation and hypertrophy due to excessive and prolonged beer drinking.

17. How the diagnosis of ethanol poisoning/ consumption is done?
What is Widmark's formula?

i. Smell of alcohol in breath, slurred speech, muscular incoordination, dilated and

sluggish reacting pupil are helpful in diagnosing alcohol intoxication.

ii. Breath analyzer, urine and blood alcohol concentration are diagnostic.

iii. *Blood:* Skin is cleaned with 1:1000 mercuric chloride and washed with soap and water. 10 ml of blood with 100 mg of sodium fluoride or 30 mg of potassium oxalate as preservative and the sample is shaken thoroughly to prevent loss of alcohol by glycolysis and bacterial action.

Widmark's formula:

- It was evolved by Widmark to find out the amount of alcohol consumed from the blood alcohol or urine alcohol concentration; **a = prc**. Where (a) is the weight of alcohol in grams in the body; (p) is the body weight in kg; (c) is the concentration of alcohol in blood in mg/kg and (r) is the constant, which is 0.6 for man and 0.5 for woman.
- For **urine analysis,** the formula is: **a= ¾ prq**; where is (q) is alcohol concentration mg/kg.

Breath analysis:

- It is based on Henry's law 1:2100. Concentration of alcohol in 1 ml of blood is equal to the concentration of alcohol in 2100 mL of alveolar air.

18. What is alcoholism?
What are the complications of alcoholism?

- Chronic poisoning of ethanol is alcoholism.
- **Alcoholism** is a condition in which an individual consumes large quantities of alcohol over a prolonged period of time. Alcoholism is characterized by pathological desire to consume alcohol and withdrawal symptoms on ceasing alcohol intake.
- Alcohol is quantified in terms of units. One unit contains 8 to 10 mg of alcohol and is equal to 30 mL of spirits.

Complications of alcoholism:

- *CNS:* Alcoholic hallucinosis, Wernicke's encephalopathy and Korsakoff's psychosis.
- *GIT:* Gastritis, periodic diarrhea and an increased incidence of cancers.
- *Liver:* Fatty degeneration of liver, cirrhosis and pancreatitis.
- *CVS:* Cardiomyopathy and hypertension.
- *CNS:* Polyneuropathy.

19. Define drunkenness. How will you certify a case of drunkenness?

- **Drunkenness** is a condition produced in a person who has consumed alcohol in sufficient quantities, so as to lose control over his faculties to such an extent, that he is unable to execute the occupation safely, in which he is engaged at the material time.
- **Note**: Examination and certification of drun-kenness are discussed under practical.

20. What are the signs and symptoms, treatment and postmortem findings of methyl alcohol poisoning?

- Methyl alcohol is called as wood alcohol or methanol. It is a colorless, volatile liquid with a burning taste.

Signs and symptoms:

- Same as ethyl alcohol but inebriation is less prominent and the effects are prolonged.
- Toxicity can result following absorption through skin and respiratory tract.
- Symptoms include nausea, vomiting, pain or severe abdominal cramps, headache, neck stiffness, confusion and vertigo.
- There is marked muscular weakness and depressed cardiac action and hypothermia.
- Acute tubular necrosis in the kidneys.

Visual disturbances

- Photophobia, blurred or misty vision, seeing spots central or peripheral scotomata, decreased light perception, concentric diminution of visual fields for color followed by fairly sudden failure of vision or complete **blindness**.
- This is due to optic neuritis and atrophy of optic nerve due to the effects of formic acid which are the end products of methanol metabolism.
- Fundoscopy reveals hyperemia of optic disc and retinal edema. The retinal ganglion cells and optic disc shows degenerative changes.

Diagnosis:

- An increased osmolol gap accompanied by visual symptoms is suggestive of methanol poisoning.

Metabolism:

- Methanol is oxidized to formaldehyde in the liver, which is 33 times more toxic than

methanol. Formaldehyde is then oxidized to formic acid, which is responsible for metabolic acidosis and visual toxicity.

Elimination:
- About 80% is excreted unchanged from the lungs and 3 to 5% is excreted unchanged through urine.

Analysis:
- Methyl alcohol and formic acid are readily detected from all the organs.

Treatment:
- Gastric lavage using 5% bicarbonate solution and 500 mL is left inside the stomach.
- Activated charcoal is useful.

Antidote:
- **Ethanol** is the antidote and is given as 10% solution in 500 ml infusion and repeated as required till the blood level falls below 25%. Serum ethanol level are frequently checked so as to maintain the level of 100 to 150 mg%
- Hemodialysis is the treatment of choice in severe poisoning.
- Folinic acid or folic acid 50 to 75 mg every four hours is useful in eliminating formic acid.
- Sodium bicarbonate to combat acidosis.
- Blood sugar is frequently monitored.
- Eyes are kept covered to protect from light.

Postmortem appearance:
- Cyanosis is marked.
- Blood could be fluid in nature.
- Skin may be purple in color due to pyridine.
- Stomach and intestines congested, inflamed and small hemorrhages may be present.
- Lungs congested and edematous.
- Brian edematous and may show hemorrhage.
- Liver shows fatty change and sometimes early necrosis.
- Kidneys show tubular degeneration.

21. What are barbiturates? What are the groups of barbiturates?

- Barbiturates are derivatives of barbituric acid.
- Barbiturates were used extensively until banzodiazepines occupied the market.
- Now, have become "museum drugs". Many barbiturates are still available and are still being abused.

There are four classes of barbiturates:

i. *Ultra short acting:* Acts immediately and lasts for about 15 minutes, e.g. thiopentone sodium.
ii. *Short-acting:* Acts within minutes and lasts for about 3 hours. e.g. pentobarbitone.
iii. *Intermediate acting:* Acts within 1–2 hours and lasts for 3–6 hours, e.g. butobarbitone.
iv. *Long-acting:* Acts within 2 hours and lasts for 6–12 hours, e.g. phenobarbitone.

22. What are the signs and symptoms and treatment of barbiturate poisoning? What is automatism?

Acute poisoning
- Taking barbiturates (usually tablets), repeatedly to get sleep out of mental sickness, compels the person to take more and more tablets ultimately resulting in acute toxicity, the individual usually does not remember (forgets) that he has taken the dose and continues to take the drug again and again, this is called "**barbiturate automatism**".

Signs and symptoms:
- Slurred speech, ataxia, lethargy, mental confusion and headache.
- Pupils are first constricted but later dilated due to hypoxia.
- Hypersensitivity reaction, swelling over cheeks, lips, etc.
- Paradoxical excitement (especially in elderly)
- CNS depression, coma and shock.
- Finally death is due to respiratory arrest or cardiovascular collapse.
- Cutaneous bullae (**barbiturate blisters**).

Fatal dose:
- Long-acting barbiturates: 3 to 4 g.
- Intermediate acting: 2 to 3 g.
- Short-acting: 1 to 2 g.

Fatal period:
- 24 to 48 hours. However, patient may be in coma for several days and then die.

When taken with alcohol:
- Can bring about death easily as alcohol potentiates barbiturate action and even a sublethal dose may prove fatal.

Treatment:
- Maintain airway, breathing and circulation.

- Gastric lavage can be done upto 6 to 12 hours.
- Activated charcoal in the usual dose.
- Forced alkaline diuresis is said to be very useful in phenobarbitone poisoning.
- Hemodialysis or hemoperfusion.
- Supportive measures: Oxygen, intubation, assisted ventilation and IV fluid.

23. What is barbiturate addiction?

Chronic poisoning (Addiction)

- Barbiturates are the most addictive drugs.
- They are often used to get a sense of euphoria and relaxation.
- Chronic use is associated with tolerance and hence, a chronic user usually requires 5 times the normal dose to obtain therapeutic effect.
- Abrupt cessation provokes a mild withdrawal reaction characterized by anxiety, headache, tremors and insomnia.

24. How to diagnose barbiturate poisoning? What are the medicolegal aspects? What is truth serum?

- Thin layer chromatography (TLC) for urine, stomach contents, or scene residue.
- Gas chromatography (GC) or high pressure liquid chromatography (HPLC).
- *EEG:* Alpha coma indicates poor prognosis.

Differential diagnosis:

- Other poisoning due to carbon monoxide, meprobamate, etc.

Medicolegal significance:

- Often used by alcoholics and opiate addicts when alcohol or opium is not available.
- *Example:* Emotional tension developed by cocaine is controlled when its intake is combined with barbiturates.
- Addiction is usually due to excessive use of barbiturates to relieve anxiety and depression.
- Death is usually suicidal by over dosage or accidental and rarely homicidal.

Truth serum

- Sodium pentothal is often used to extract truth from criminals and is also called "truth serum". However it actually does not cause people to tell out truth; rather, it just lowers their inhibitions and makes them talkative.

25. Write short notes on chloral hydrate? What is dry wine and mickey finn?

Chloral hydrate

Physical Properties:

- Crystalline, nauseating bitter sweet taste with an aromatic odor.

Action:

- Chloral hydrate in small doses, it acts as an hypnotic; in large doses, it paralyses the vital center of the brain.

Signs and symptoms:

Acute poisoning:

- Burning sensation in throat.
- Nausea and vomiting.
- Drowsiness and unconsciousness.
- Loss of reflexes and muscular relaxation.
- Depression of medullary center, resulting in fall in BP, respiratory rate, convulsions and death with pinpoint pupils.

Chronic poisoning:

- Epigastric pain, nausea, vomiting and gastritis.
- Erythematous rashes.
- Nervous disorders.
- Fatal dose: 5 to 10 g; fatal period: 6 to 24 hours.

Treatment:

- Withdrawal from the drug.
- Gastric lavage.
- Artificial respiration.
- High protein and carbohydrate diet and no fatty food should be given.

Postmortem findings:

- Signs of asphyxia.
- In acute poisoning, the stomach contents have a peculiar smell.
- In chronic poisoning, evidence of fatty degeneration of heart, liver and kidneys.
- It deteriorates rapidly from the body after death and hence viscera should be sent immediately for chemical analysis.

Medicolegal significance:

- Therapeutic over dosage causes hypnotic effects.
- It is rarely used for suicide.
- Not used for homicidal purpose due to the taste and smell.
- "**Dry wine**"—a combination of chloral hydrate and alcohol is used as liquor is some parts of Punjab to induce sleep.

- Chloral hydrate is mixed in some food or drink to make a person suddenly helpless for the purpose of robbery or rape. When mixed with alcohol, it greatly enhances the kick and the person may go in for sudden unconsciousness and is called as "knock-out drops" or **Mickey finn**.

26. What are deliriants?

- Deliriants are drugs which act on the brain and induce altered consciousness, confusion, delusions and agitation.
- Two important drugs of this group are datura and *Cannabis indica*. They are also called as "**stupefying agents**".

27. What are the two varieties of datura plant?

There are two varieties of plants:

i. Datura alba (white flowers) and
ii. Datura niger (purple flowers).

The plant grows all over India in the waste places. Flowers are bell-shaped; fruits are spherical and have sharp spines on the surface (thorn apple) and contain about 500 yellowish brown seeds inside the fruit.

28. What are the active principle and their action of datura seeds? (Fig. 28.1)

- The seeds contain three **alkaloids** as active principles:
  (i) Hyoscine (scopolamine)
  (ii) Hyoscyamine, and
  (iii) Traces of atropine.
- **Alkaloids** are complex substances having nitrogenous base; chemically they behave as alkalies, react with acids to form salts. In plants, they are not uniformly distributed, rather concentrated in certain regions such as root, leaves or fruits.
- Alkaloids atropine, hyoscine and hyoscyamine first stimulate the higher centers of the brain followed by motor neurons; finally causes depression and paralysis, especially the medulla.

Fig. 28.1 Dathura palnt with fruit (Thorn apple) which contains hundreds of seeds – Deliriant poison (together with cannabis is used as stupefying agent)

29. What are the signs and symptoms of datura poisoning?

- When the seeds are ingested, there is bitter taste in the mouth, dryness of mouth, difficulty in swallowing and talking, burning pain in the stomach which is followed by vomiting.
- Voice becomes hoarse; face becomes flushed; pupils are widely dilated, loss of accommodation and photophobia leading to temporary blindness.
- *Kidneys:* Urinary retention and inability to pass urine.
- *Skin:* Becomes hot, dry and scarlatinal rash may appear; pulse is rapid and bounding, but later on weak and irregular.
- *CNS:* Restlessness, agitation, confusion, giddiness and staggering gait.
- Delirium develops and the patient may try to run away from the bed.
- *Carphologia:* Tries to pull imaginary threads from the fingernails.
- Auditory and visual hallucinations and delusions may develop.
- The patient may go into deep sleep or coma and rarely may die of respiratory paralysis.
- *Fatal dose:* 0.6 to 1 g (100 to 125 seeds); fatal period: 24 hours.

30. What is the treatment for datura poisoning?

- Emetics and stomach wash.
- **Injectable physostigmine** 1 mg, repeated hourly, if necessary.
- **Injectable pilocarpine** nitrate 5 mg subcutaneously, repeated every two hours as

required to counteract the action of datura on the brain.
- Delirium is controlled using **barbiturates**, ether or chloroform.

31. What are the circumstances of datura poisoning?
- Either alone or in combination with cannabis, it is used as a **stupefying agent**, by the robbers to facilitate robbery in trains or buses. Datura is mixed with any food or drink for this purpose; the victim falls into deep sleep and wakes up later and finds his belongings being lost.
- Datura is believed to have **aphrodisiac** effect and used as a love filter; it is also used as an **abortificient**.
- The leaves and seeds are mixed with tobacco and ganja and smoked; it may also be mixed with toddy or liquor to increase the intoxication effect.
- Accidental poisoning occurs in children; homicide is very rare.

32. How to differentiate datura seeds from capsicum seeds? (Table 28.5)
- *Test:* **Mydriatic test**: A drop of the sample solution to be tested is put into the eyes of a cat; the pupils dilate if datura is present (effect of atropine).

Table 28.5 Difference between datura seeds and capsicum seeds

Feature	Datura seed	Capsicum seed
Size	Large and stout	Small and thin
Shape	Kidney or bean shaped	Rounded
Color	Brown or yellowish-brown	Pale-yellow
Margins	Laterally compressed convexity	Sharp convex borders
Surface	Numerous depression on the surface	Smooth
Odor and taste	Odorless and bitter	Pungent and burning taste

33. What is *Cannabis indica*?
- Cannabis indica is Indian hemp, hashish, marihuana or ganja.
- The plant grows wildly in India, but the cultivation is banned by the government.
- **Female plant** is tall, grows 4 to 6 meters in height and bushy; **male plant** is short and grows less than 4 meters in height.
- There are many names for cannabis from area to area: Pot, grass, hash, Mary Jone, bhang, hashish, joint, etc.
- Cannabis is the most abused drug in India by the people of low socio-economic group; mostly people habituated to cannabis would like to use it with company.

34. What is the active principal in cannabis and which parts of the plant contain active ingredient?
- The active principle is contained in the resin; cannabinol is the constituent of the resin.
- Cannabinol is inert and gets converted into tetrahydrocannabinol (THC) on burning/heating.
- All parts of the plant contain the resin; the shooting flowers of the female plant (**ganja**) have the highest concentration of cannabinol, next the leaves and then the stem; the seeds do not contain the active ingredient.
- On **incising the stem,** it yields a brown thick resin called **hashish.**
- Hashish is said to be the purest form and contains maximum concentration of the active ingredient, about 40%.

35. What are the various forms of preparations of cannabis?

i. **Bhang:** Prepared from the dried leaves and flowers in the form a decoction and is consumed by mixing with any food or betel. Bhang is directly mixed to prepare sweets (**majoon**). It increases appetite and sexual desire. Bhang is the mildest form of intoxication.

ii. **Ganja:** The shooting flower top of the female plant is ganja. This is the commonly abused of all forms of cannabis. It is dark green in color; it is mixed with tobacco and smoked, in cigars or pipes (hukka). On burning cann-

binol gets converted into THC and has a characteristic odor (**burnt rope odor**) in the vicinity of an individual who has smoked ganja.

iii. **Charas or hashish:** It is the resin (dope or shit) exuded from the stem; brown in color and smoked with tobacco in pipes.

36. What are the signs and symptoms of cannabis intoxication?

- Appear immediately and last for 2 hours if smoked; appear in half an hour and last for several hours if ingested.
- Euphoria, disorientation, impaired memory, disturbed thought process and lapse of attention in the initial stages. The individual starts laughing for silly jokes; this is classically observed when the person consumes on rare occasions. But on continued smoking for long period, the individual detaches from the family members.
- Irrelevant thought process, decreased concentration, disorientation and sleepiness.
- Impaired judgment, altered sexual desire and failure to meet the responsibilities.
- Death is extremely rare, the individual passes of into sleep and wakes up late.
- *Fatal dose:* Charas 2 g and ganja 8 g/kg body weight.

37. What are the complications of chronic cannabis abuse?
What is "Run amok"?

- Using the drug in small dose for long period does not cause much harm. If large doses are consumed for a prolonged period, tolerance and psychological dependence develops and sometimes, there may be degeneration of CNS and symptoms of insanity.
- Reduces serum testosterone levels and reduced sperm count associated with gynecomastia.
- Rarely the individual may develop symptoms of insanity (**hashish psychosis**).

Run amok:

- Develops in an individual who chronically abuses cannabis or rarely in an individual who consumes a high-dose of ganja.
- There is development of psychiatric disturbances marked by a period of depression followed by violent impulsive behaviors.
- He may run here and there, he is impulsive in behavior; the individual may commit suicide (suicidal impulse) by inflicting injuries or may jump from a height. He may attempt to kill individuals with whom he has real or imaginary enemity (homicidal impulse) and surrender himself to the police or he may kill himself.

Medicolegal significance:

- Circumstances of poisoning are usually accidental due to over indulgence.
- There is no physical dependence for cannabis and there is only psychological dependence to the drug.
- Prolonged consumption leads to psychiatric disturbances ranging from depression to hashish and paranoid psychosis.
- It is the most widely abused drug of low socio-economic population.

Drug Dependence

38. Define: Drug dependence, abuse, psychological dependence, drug addiction and habituation.

i. **Drug:**

- A drug is any substance, other than those required for the maintenance of normal health, that when taken into the living organism may modify one or more of its functions.

ii. **Drug dependence:**

- It is a state of dependence on a drug which arises out of a maladaptive pattern of substance use, leading to cluster of behavioral, cognitive and physiological symptoms that develop after repeated intake.

iii. **Substance abuse:**

- It is a persistent excessive desire to use a drug, inconsistent with or unrelated to acceptable medical practice.

iv. **Substance intoxication:**

- It involves unwanted physiological, psychological or sexual effects that cause maladaptive behavior.

- ***Example:*** (i) An individual bribes a nurse of a hospital and manages to get morphine from the hospital—substance abuse; (ii) he takes in morphine and experiences the effects of the drug like euphoria and feeling of well being—substance intoxication; (iii) he continues to visit the hospital demanding higher doses of morphine—drug dependence.

v. **Physiological dependence:**

- It is the alteration in neural system which is manifested by tolerance due to repeated doses of the drug and there is appearance of withdrawal symptoms when the drug is discontinued.

vi. **Psychological dependence:**

- It is a condition in which the individual believes that optimal state of well-being is achieved only through the intake of the drug.
- ***Example:*** (i) An individual takes in heroin and wishes to take it again—psychological dependence; (ii) he now is a regular heroin abuser and experiences withdrawal symptoms when he discontinues the use of heroine—physical dependence.

vii. **Drug addiction:**

- It is a chronic disorder characterized by compulsive use of a drug resulting in physical and psychological dependence; associated with social harm and individual continues to use the drug inspite of these harm.

viii. **Drug habituation:**

- It s a condition resulting from the repeated consumption of a drug and there is psychological or emotional dependency on the drug, but there are no withdrawal symptoms on discontinuation of the drug.
- ***Example:*** (i) An individual breaks up with his wife because of his constant use of cocaine but still continues to use it—drug addiction; (ii) he shouts at his wife for not bringing bed coffee on time—drug habituation.

39. What are the differences between drug dependence and habituation? (Table 28.6)

Table 28.6 Difference between drug dependence and habituation

Drug dependence	Drug habituation
Compulsion to take the drug	No compulsion
Increase in the dose	No increase in dose
Physical and psychological dependence	Some degree of psychological dependence
Withdrawal symptoms present	No withdrawal symptoms

40. What are the common drugs of addiction? (Table 28.7)

Table 28.7 Drugs of addiction

Group	Drugs
Opiates	Heroin, morphine, codeine, methadone and pethidine
Stimulants	Cocaine and amphetamine
Hallucinogens	LSD, marijuana, mescaline and psilocybin
Depressants	Barbiturates, gluthemide, paraldehyde and methprylon
Miscellaneous	Propoxyphene, pentazocine, amitriptyline, cough syrups, etc.

41. What are withdrawal symptoms?

- A group of symptoms produced upon sudden stoppage of a drug of addiction are called **withdrawal symptoms.**
- These symptoms occur 6 to 8 hours after stoppage or sometimes may be delayed and last for 10 to 21 days. There are 3 stages of symptoms of withdrawal:

i. **Early symptoms:**

- Chillness, cold, uneasiness, yawning and rhinorrhea.

ii. **Second stage:**

- Labored and sharp respirations, goose skin, lacrimation, gross tremors and anorexia.

iii. **Third stage:**

- Prolonged sleep, fever, hypertension, pain and cramps of muscles especially calf and abdomen muscles.

- Withdrawal symptoms in new born of addicted mothers: Occur within 1 to 56 hours of delivery and present with symptoms of hyperactivity, convulsions and twitching.

42. What is drug dependence? What are the types of drug dependence?

Drug dependence:

- It is a state of dependence on a drug which arises out of a maladaptive pattern of substance use, leading to cluster of behavioral, cognitive and physiological symptoms that develop after repeated intake.

Types of drug dependence:

- Morphine type
- Barbiturate type
- Cocaine type
- Cannabis type
- Amphetamine type
- Psychedelics: Hallucinogenic drugs: LSD (Ergot) and solvent abuse.

i. **Morphine:**

- Addiction to morphine, heroin, opium and methadone.
- Overpowering desire or need to continue the drug.
- *Mode of abuse:* IV, IM and sniffing.
- Tolerance occurs very early within 48 to 72 hours and physical dependence.
- *Cross-tolerance:* Morphine and pethidine have a high degree of cross-tolerance.

Withdrawal symptoms:

- *Early:* Dilated pupils, yawning, rhinorrhea, myalgia, cramps, lacrimation and anorexia.
- *Moderate:* Restlessness, insomnia, hypertension and tachycardia.
- *Severe:* Vomiting, diarrhea, hyperactive bowel syndrome and hypotension.
- *Causes of death:* Rapid death due to cardiac arrest, arrhythmia and ventricular fibrillation.

ii. **Barbiturate:**

- Physical dependence, tolerance and cross-tolerance.
- Withdrawal symptoms develop within 2 to 3 days.
- *Early:* Tremors, hyperreflexes, diaphoresis, irritability, restlessness, anxiety, tinnitus, nausea and vomiting.
- *Late:* profuse diaphoresis, marked disorientation, hallucination, agitation, tremors and hyperthermia.
- *Purple hearts tablet:* Combination of barbiturate and amphetamine.

iii. **Cocaine type:**

- Psychological dependence and absence of tolerance.
- Withdrawal symptoms are mild (cocaine bugs – tactile hallucination).
- Paranoid psychosis, depression and mental dysfunction.
- *Crack:* Heating cocaine with bicarbonate and is more potent.

(iv) Cannabis type:

- Psychological dependence and no physical dependence.
- No tolerance and no withdrawal symptoms.

(v) Amphetamine type:

- Psychological dependence.
- Tolerance is present but no withdrawal symptoms.
- Severe hyper-excitement, hallucinations and psychoses develop due to prolonged use.
- Hyperpyrexia, hypertension and cerebral hemorrhages may also occur.

43. Write short notes on spinal poisons/ strychnine?

- Strychnine is a powerful alkaloid, present in the seeds of strychnos nux vomica growing in the jungles of India. Fruits are orange, round and hard, and bear 3 to 5 seeds.
- Strychnine seeds are flat, circular disc shaped, 6 mm in thickness and 2.5 cm in diameter; the seeds are light brown in color and are convex on one side and concave on the other (Fig. 28.2).
- The seeds contain strychnine and brucine as active ingredients. Strychnine is many times more poisonous than brucine.
- Strychnine seeds are used as rodenticide to kill stray dogs.

Action:

- Acts on the **anterior horn cells of the spinal cord** and depresses the inhibitory synaptic potentials of the spinal cord. Widespread inhibition of the spinal cord results in release excitation and convulsions resembling tetanus.

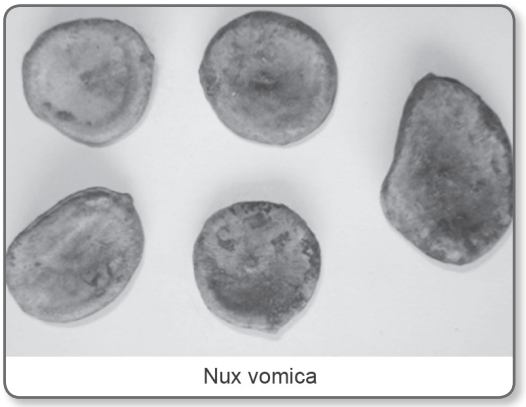


Fig. 28.2 Strychnine Nux vomica seeds (Spinal poison)

Signs and symptoms:

- When the seed is swallowed as a whole, it does not cause any symptoms; if crushed and swallowed, the symptoms start in an hour.
- Bitter taste in the mouth, restlessness, difficulty in swallowing.
- Increased rigidity of muscles, muscular twitching followed by convulsions.
- Convulsions affect all the muscles at a time. Convulsion lasts for half minute to two minutes; repeated after 5 to 15 minutes; in between the convulsions, the muscles remain relaxed.
- The patient is unable to breath as the diaphragm and the thoracic muscles are fully contracted. Hypoxia causes medullary paralysis and death.
- Consciousness is not lost and the mind is clear till the death.
- *Fatal dose:* 50 mg (one crushed seed); fatal period: Few hours.

Treatment:

- Convulsions are controlled by: (i) Diazepam or phenobarbitone; when they are ineffective (ii) succinyl choline, curare or pancuronium; in between convulsions either may be given.
- Short acting barbiturates like pentobarbital sodium and sodium amytal are antidotes for strychnine.
- Stomach wash with warm water and dilute potassium permanganate; activated charcoal to absorb strychnine (tannic acid may be used when charcoal is not available).
- Increasing acidity of urine will increase excretion of strychnine.

Postmortem findings:

- Signs of asphyxia will be present; rigor mortis appears early; hemorhhages may be found inside the muscles and stomach.
- **Test:** Suspected solution is injected into the dorsal lymph sac of a frog, will produce convulsions if strychnine is present.

Forensic significance:

- Homicide is common, as it resembles death due to **tetanus** and may go undetected.
- Suicide is rare due to the potentially dreadful death.
- Accidental by children and over dosage of medicines in folk remedies.
- Used as cattle poison and also as arrow poison.
- Used as an aphrodisiac.
- Strychnine is said to delay putrefaction.

CHAPTER 29

Cardiac Poisons

Keywords: Nicotine, *Nerium odorum*, *Cerebera thevetia*, digoxin, aconite, hippus.

1. Name some important cardiac poisons?

- Poisons which are primarily cardiotoxic and acts directly on the heart are:
  (i) *Nicotiana tabacum* (Tobacco),
  (ii) *Digitalis purpurea*,
  (iii) *Aconite* (Monk's hood),
  (iv) *Nerium odorum* (white oleander),
  (v) *Cerbera thevetia* (yellow oleander) and
  (vi) *Cerbera odollam* and quinine.

2. Write short notes on nicotine?

Nicotiana tabacum (Tobacco)

- The plant is widely cultivated throughout the world for preparation of tobacco.
- It is a shrub with blue flowers; the leaves contain the active principal nicotine which is volatile and bitter in taste.
- Tobacco is smoked, sniffed and also chewed; nicotine is a CNS stimulant.

Absorption:

- Each cigarette contains about 15 to 20 mg of nicotine, of which 1 to 2 mg is absorbed through the alveoli during smoking.
- Nicotine is rapidly absorbed through mucus membranes, lungs and skin.
- 80 to 90% of the absorbed nicotine is metabolized in liver and excreted through kidneys.

Chronic poisoning:

- Chronic tobacco users usually get addicted to nicotine; symptoms include dyspnea, wheezing, tremors, insomnia, anxiety, palpitation, headache, irregular heart beat and angina pain; these individuals have increased chances of bronchitis, oral cancer, lung cancer and chronic heart diseases.

Withdrawal symptoms:

- Intense urge to smoke, headache, anxiety, impaired concentration and memory, muscle cramps and sleep disturbances are usually present.
- Nicotine replacement therapy (NRT) by chewing gum, electric cigars, nasal spray and inhalers are used during the withdrawal phase; it may take a few weeks to completely get adopted.
- *Fatal dose:* 50 to 100 mg of nicotine; 15 to 30 g of tobacco.

Postmortem findings:

- Signs of asphyxia, brown froth in moth and nostrils, patchy hemorrhages on stomach mucosa and pulmonary edema may be noticed; fragments of tobacco may be present in the stomach, if ingested.

Forensic significance:

- Tobacco is the commonest abused drug worldwide.
- Most cases of death are due to accidental over dosage, either consumption of large doses or heavy smoking.
- Rarely tobacco is used for **malingering**; Tobacco is soaked in water and held beneath the axilla the whole night by a bandage;

symptoms of poisoning occur in the morning. The axillary areas are stained with tobacco and the odor of tobacco can be perceived on the skin.

3. What is digitalis?

- *Digitalis purpurea* is a cardiotoxic poisonous plant; active principals are digitalin, digoxin, digitoxin and many more glycosides, they are more concentrated in the leaves and seeds.

Signs and symptoms:

- *GIT:* Nausea, vomiting, anorexia and diarrhea.
- *Visual:* Photophobia, diplopia and blurring of vision. Skin: Urticaria.
- *CNS:* Headache, fatigue, anxiety, depression, confusion, disorientation, drowsiness and sometimes delirium and hallucinations.
- *Cardiac:* Arrhythmias, tachycardia, ventricular fibrillation, atrial flutter, SV and AV block. Death occurs due to cardiovascular collapse.
- *Fatal dose:* 5 mg of digitoxin; 10 mg digoxin; 15 to 30 mg of digitalin and leaves 2 g.
- *Fatal period:* Few hours to one day, depending on the dose.

Treatment:

- Stomach wash with tannic acid. Bowel evacuation followed by activated charcoal.
- Digoxin specific fragment (**FAB**) therapy.
- In the absence of FAB, injection **lignocaine and propranolol** are given.
- Other supportive treatment include: Potassium salts to reduce extrasystole and arrhythmias; bradycardia with atropine and trisodium EDTA to lower serum calcium.

4. Write about aconite?
What is hippus?

- *Aconitum ferox* is an herb with purple flowers widely grown in the foothills of Himalayas. The root contains the active principal aconitine (**monk's hood**, devil's helmet)
- (Fig. 29.1) The dry root is conical and tapering, and shows scars of broken rootlets.

Signs and symptoms:

- Tingling and numbness on contact with the skin, mouth and throat when swallowed.
- Nausea, salivation and vomiting.

Fig. 29.1 Aconitine root (Cardiac poison)

- Muscular weakness, headache, giddiness, profuse sweating and convulsions are present.
- *CVS:* Hypotension, arrhythmias and AV block; first there is tachycardia, later on due to AV block, there is bradycardia. Death is due to cardiac arrest.

Hippus:

- Alternative constriction and dilatation of the pupil (spasmodic pupil) is called as "hippus"; but the pupils remain dilated at later stage. There is dim vision and diplopia.
- *Fatal dose:* 1 g of the root; 2 to 5 mg of aconitine.
- *Fatal period:* 2 to 6 hours.

Treatment:

- Gastric lavage with warm water and weak solution of potassium iodide or tannic acid; atropine 1 mg may be useful; rest are all symptomatic management.

Postmortem appearance:

- Not characteristic, except for signs of asphyxia.
- Stomach and duodenum shows congestion and ecchymosis.
- *Heart:* Subepicardial petechial-ecchymotic hemorrhage on the left ventricle and other regions of the heart is a frequent finding.

Circumstances of poisoning:

- Accidental poisoning by eating the roots mistaking for horseradish root.
- *Homicide:* Aconite is said to be ideal homicidal poisons, as it difficult to detect by

chemical analysis and symptoms resemble a natural disease (cardiac arrest)
- Occasionally aconite is mixed with liquor to enhance the kick.
- Used as an abortificient; and is a constituent of many folk remedies, mainly ayurveda.
- Aconite is a cattle poison and is also used as an arrow poison.

5. What are oleander? What are the types?

Types:

i. *Nerium odorum* is white oleander (Fig. 29.2).
ii. *Cerebera thevetia* is yellow oleander.

Nerium odorum is White oleander.

- *Nerium odorum* is an ornamental shrub widely grown all over India; it bears flowers in terminal clusters; flowers are white or pink in color. Leaves are narrow, lanceolate and dark green in color. Seeds are long, narrow and cylindrical of 5 to 10 cm long.
- All parts of the plant are poisonous, particularly leaves, root and stem; active principal are **nerin** and **oleandrin**.

Cerebera thevetia is yellow oleander (pila kaner)

- It is large, bushy ornamental shrub, grows to 6 to a feet in height; leaves are oblong; flowers are tubular and yellow in color. Fruits are green and globular in shape; 3 to 5 seeds are present inside the fruit and they are vaguely heart-shaped.
- All parts of the plant are poisonous and exude milky white juice; the seeds and leaves are more toxic contains **glycosides thevetin, thevetoxin** and **nerifolin** as active ingredients.

6. What are the signs and symptoms and treatment of oleander poisoning?

Signs and symptoms:

- Numbness in the mouth, burning sensation and dryness in the mouth and throat.

Fig. 29.2 Oleander (Cardiac poison)

- Nausea, vomiting and diarrhea.
- Difficulty in swallowing, abdominal pain and diarrhea.
- Headache, giddiness, loss of muscular power and fainting.
- Pulse is rapid, weak and irregular; fall in BP, hypotension, heart block and collapse.
- Ventricular fibrillation, hypotension, AV block and death due to cardiac failure.
- Pupils are dilated, drowsiness, muscular twitching and spasms.
- Death is due to peripheral circulatory failure.
- *Fatal dose:* 15 to 20 g; 5 to 15 leaves; seeds: 5 to 8; fatal period: 24 hours.

Treatment:

- Stomach wash; ECG monitoring.
- IV sodium molar solution and 5% dextrose to combat shock.
- Atropine 1 mg, adrenaline 0.2 mL and noradrenaline 2 mg IV or infusion.

Circumstances of poisoning:

- Commonly used as a suicidal poison. Homicide is rare.
- Used as an abortificient and as a cattle poison.

CHAPTER 30

Asphyxiants

Keywords: Asphyxiants, carbon monoxide, carboxy hemoglobin, cherry red discoloration, cyanide, cyanmethemoglobin, cytochrome oxidase, nitrites, war gases, simple asphyxiants, tear gases.

1. What is the mechanism of action, signs and symptoms and treatment of carbon mono-xide poisoning?

- Carbon monoxide (CO) is chemical asphyxiants; CO combines with hemoglobin and forms carboxyhemoglobin (CO-Hb).
- Hemoglobin has 2,100 times more affinity to CO than oxygen and hence, hemoglobin readily combines with CO, even if oxygen is present.
- Combustion of any carbon particle results in the formation of carbon dioxide; but when there is incomplete combustion, it results in the production of carbon monoxide.
- In any combustion process, there cannot be complete combustion and hence, in all such situations, there is liberation of carbon monoxide also, to some extent; there are more chances of formation of CO when there is wetness on the carbon particle (trees, plants and wood).

Sources:

- Coal gas, smoke from fire, fumes from defective heating appliances, fumes of internal combustion engines, cigarette smoking, motor car exhaust, etc.

Properties of CO:

- CO is a colorless, odorless and tasteless nonirritant gas; it is lighter than air, insoluble in water and burns with a blue flame.

Mechanism of action:

- CO is absorbed across the alveoli, readily combines with hemoglobin displacing oxygen and forms CO-Hb; reduces oxygen content of the blood and results in anemic anoxia and produces rapid death.
- CO is a cellular toxin; it inhibits electron transport by inhibiting cytochrome A and cytochrome p450 enzyme systems and thus interferes with cellular respiration.
- *Elimination:* CO is eliminated through lungs; about one percent is converted to carbon dioxide.

Signs and symptoms (Table 30.1):

- CO directly damages the CNS causing headache and monoplegia or hemiplegia.

Table 30.1 Signs and symptoms of CO poisoning

CO%	Symptoms produced
0–10%	No symptoms
10–20%	Headache and shortness of breath
20–30%	Headache, shortness of breath, nausea and dizziness
30–40%	Severe headache, fatigue and vomiting
40–50%	Mental confusion, increased heart rate and respiratory rate
50–60%	Passing out, seizures and coma
60–70%	Rapidly fatal

- Impairment of higher intellectual functions.
- Cerebellar changes and personality changes
- Parkinsonism.
- Subcutaneous bullae common in the regions of calves, buttocks, wrists and knees.

Treatment:

- Remove from the source of exposure and expose to fresh air.
- 100% oxygen therapy through tight fitting mask or by using endotracheal tube.
- Hyperbaric oxygen (HBO) is the antidote, but should be used with caution as there are serious risks like gas embolism, visual defects, pulmonary edema and convulsions.
- Complete rest and prophylactic antibiotics.
- Treat cerebral edema by giving steroids, mannitol and fluid restriction.

2. What are the postmortem findings and circumstances of CO poisoning?

Postmortem appearance:

- Cherry red discoloration of the skin, mucous membrane, conjunctivae, nail bed, blood and internal organs.
- Cutaneous blisters on the skin of calf, buttock, wrist and knees.
- Lungs are congested with pink colored blood in the alveoli; pulmonary edema.
- Heart may show areas of focal necrosis on the myocardium.
- Brain is edematous; bilateral symmetrical necrosis and cavitation of basal ganglia may be seen; hemorrhages in the meninges and cortex may also be present.

Circumstances of acute CO poisoning:

- Accidental is the commonest mode of death due to CO poisoning; an individual trapped inside the burning house or due to automobile exhaust, etc.
- Homicide and suicide are rare in occurrence.
- Since, CO is nonirritant and pleasant gas, the individual is totally unaware that he is inhaling CO and hence, he may not get away from that place and soon becomes unconscious and death is ensured.

3. What are the circumstances of chronic CO poisoning?

- Chronic poisoning results from inhalation of relatively higher concentration of CO (below 20%) in respired air, commonly encountered as an occupational hazard, especially in individuals working in automobile and smelting industries (Table 30.2).
- Symptoms of chronic poisoning are headache, confusion, weakness, paresthesias, hypertension, hyperthermia and palpitations.

4. What are the specimen to be preserved and tests for detection of CO?

Specimens:

Note:

- Liquid paraffin should be added to the top of the sample of blood, to prevent evaporation of carbon monoxide.

100 mL of blood with sodium fluoride as preservative.

- If blood is not available then spleen or muscles can be used as sample.
- In badly burnt bodies, the body fluids or bone marrow can be used as specimen.
- Other methods of detection in the laboratory are nondispersive infrared spectrophotometry and gas chromatography.

Test for detection of CO:

1. Add 2 drops of sample blood to 15 mL of water in a test tube and seen through light, it will appear pink if carbon monoxide is present.
2. *Kunkel's test:* If tannic acid is mixed with the sample, it gives a cherry red color.
3. Spectroscopic examination of blood reveals bands of carboxyhemoglobin.

Note:

- In smokers, the concentration of CO at all times is 6 to 8% (less than 4% in nonsmokers)

5. What are symptoms of CO_2 poisoning?

Table 30.2 Concentration of **Carbon dioxide** (CO_2) in air and symptoms

Conc. of CO_2 in air	Symptoms
1%	Drowsiness
3%	Mild narcosis, reduced hearing, increased BP and heart rate
5%	Headache, confusion, dizziness and shortness of breath
8%	Profuse sweating, muscular tremors, dimmed vision and unconsciousness

6. What are the properties, uses and sources of hydrocyanic acid?

Properties:

- Cyanide exists in the form of gas (hydrogen cyanide), liquid (hydrocyanic acid or prussic acid) and solid (salts of cyanide as potassium cyanide, sodium cyanide, etc.)
- Hydrogen cyanide has a bitter almonds odor, which is not perceived by 40% (mostly males) of the world population, inherited as sex-linked recessive trait.

Uses:

- *Industrial:* Electroplating, photography, rubber and plastic industries.
- *Agricultural:* Rodenticide and insecticide.
- *Therapeutic:* Cancer (amygdalin), antihypertensive (sodium nitroprusside)

Sources:

- *Plants:* A wide variety of plants (almonds, apricot, apple, peach, cherry, plum, etc.) possess cyanogenic glycosides; on hydrolysis of these glycosides in the GI tract, hydrocyanic acid is released.
- Burning plastics, silk, wool, cigarettes, etc. results in liberation of cyanide.

7. What is the mechanism of action, signs and symptoms and treatment of HCN?

Action:

- Cyanide inhibits cytochrome oxidase and carbonic anhydrase enzyme systems, thus interferes with the cellular respiration; it blocks the final step of oxidative phosphorylation and prevents formation of ATP.
- There is formation of **cyanmethemoglobin** and the blood is bright red in color. Oxygen will be available in the blood, but the tissues are unable to utilize oxygen, since cytochrome oxidase is necessary for uptake of oxygen by the tissues.
- Color of reduced blood is blue, normal blood is red in color. Color of oxygenated blood is scarlet red; in cyanide, it is bright red (more pronounced) and in CO, it is cherry red (most pronounced).

Signs and symptoms:

- The most rapidly acting poison and hence used by terrorists to commit suicide.
- When inhaled in gaseous form, action is instantaneous. When consumed as a salt, the symptoms are proportional to the dose; when a massive dose is ingested, there is sudden loss of consciousness and immediate death due to respiratory arrest; sometimes the symptoms are delayed for a few minutes.
- *CNS:* Headache, vertigo, perspiration, anxiety, confusion, drowsiness, convulsions, coma and death.
- *GIT:* Bitter burning taste, numbness, nausea and rarely vomiting.
- *RS:* Smell of bitter almonds in breath, tachyapnea, later slowing of respiration.
- *CVS:* Tachycardia, hypotension and collapse.
- *Skin:* Perspiration and subcutaneous bullae; pupils are dilated and there is acidosis.
- *Fatal dose:* 50 to 60 mg of acid; 200 to 300 mg of salt; concentration of 1:500 in air.
- *Fatal period:* Immediate by inhalation; half an hour with salts.

Treatment of cyanide poisoning:

- The principal of treatment is to reverse cyanide-cytochrome combination.
- Treatment should be started immediately and stomach wash at later stage even if ingested.
  - (i) **Amyl nitrite inhalation** for 15 to 30 minutes and repeated if necessary,
  - (ii) **Sodium Nitrite** 0.3 mg in 10 mL distilled water by slow IV injection. There is formation of methemoglobin which competes with cytochrome oxidase for cyanide ions, thus protecting cytochrome oxidase.
  - (iii) **Sodium thiosulfate** 25 g as 15% solution by slow IV over a period of 3 minutes; it converts cyanide into nontoxic thiocyanate. All these are repeated when necessary.

Other treatment measures:

- Hydroxocobalamine 4 to 5 g by slow IV as infusion. It detoxifies cyanide by giving a hydroxyl group, binds a cyanyl group from the cyanide; forming nontoxic cyanocobalamine, which is excreted in urine.
- Dicobalt EDTA acts by chelating cyanide to form harmless compound and is excreted in urine.

- Gastric lavage using 1:5000 potassium permanganate.
- Ventilation with 100% oxygen.
- Methemoglobin more than 50% is an indication for exchange transfusion.

8. What are the postmortem findings and forensic significance of cyanide?

Postmortem appearance:

- Postmortem staining and blood will be bright red in color.
- All the signs of asphyxia are present.
- Jaws may be tightly closed and blood-stained froth may be present in mouth and nostrils, and will be also present inside the bronchial tree.
- Cranial cavity is opened first, as the smell of bitter almonds may be perceived better in the brain.

Forensic significance:

- Usually suicidal by those who have the access to the salts like people engaged in gold industry or laboratories. Sometimes, accidental or the fumes could be inhaled.
- *Homicide:* Cases are reported from time to time, where deaths have been successfully accomplished by administration of cyanide salts.
- Viscera should be preserved in tight containers, as it is lost during storage.

9. Write short notes on war gases?

- These are a group of chemical substances which are harmful to human beings and are mostly used in war times.
- Irritant gases, simple asphyxiants and tear gases are used to control riots in emergency situations by the authorities to disperse the crowd of people.

i. ***Vesicants:***

- Volatile liquids mainly mustard gas and lewisite are used as vesicants (Blistering gases)
- Mustard gas causes irritation of the eyes, nose and respiratory passages; they also produce nausea, vomiting and abdominal pain. It can penetrate the clothing and thus produce intense itching, redness, vesication and ulceration.
- *Treatment:* Wash the affected area with plenty of water; eyes are irrigated with sodium bicarbonate solution; if necessary bronchoalveolar lavage (BAL) is given.

ii. ***Tear gases or lachrymators:***

- These substances produce severe irritation of the eyes and produce copious amount of tears.
- Chloracetophenone (CAP), ethyl iodoacetate (KSK) and bromobenzyl cyanide (BBC) are used as tear gases.
- They are fired in artillery shells or pen guns, the vapors produced causes severe irritation of the eyes and results in production of excessive tears, followed by spasm of the eyelids and temporary blindness. These gases also irritate the air passages; continued exposure is associated with nausea and vomiting and may also cause skin blisters.

Treatment:

- All the effects are transitory and are reversible on removal from the source of exposure.
- The patient is removed to fresh air; eyes are washed with normal saline or boric acid; sodium bicarbonate is applied to the affected areas of skin and blisters.

iii. **Respiratory irritants or simple asphyxiants:**

- Chlorine and Phosgene (gases) and chloropicrin and diphosgene (liquids) are released in gas shells. Chlorine has mild toxicity; phosgene and chloropicrin have more potent toxic effects.
- *Action:* These gases when inhaled produces cough, dyspnea, a feeling of tightness of chest and shortness of breath. They also produce irritation of the eyes, headache, nausea, vomiting, restlessness and the patient may sometimes collapse.
- Death may result in 48 hours due to acute pulmonary edema.
- *Treatment:* Eyes are washed with boric acid solution; adrenaline and oxygen inhalation are given. Antitussives and antibiotics may also be necessary and beneficial.

iv. ***Nasal irritants or sternutators:***

- Organic compounds arsenic used as nasal irritants and are fired using artillery shells.
- They are composed of diphenylchlorarsine (DA), diphenylaminechlorarsine (DM) and diphenylcyanarsine (CD).

- The vapors cause irritation of the nasal mucosa and sinuses, resulting in sneezing, severe headache and nose pain; they also produce nausea, excessive salivation, vomiting and prostration.
- Diphenylamine chlorarsine (DM) is called as "sickness gas" and acts specifically on the vomiting center in the brain.
- *Treatment:* Remove from the source of exposure and symptomatic treatment.

v. ***Nerve gases:***

- They are colorless and odorless volatile liquids, resembling phosphate esters in action.
- They are well-absorbed through skin, conjunctivae, lungs and GIT.
- They inactivate cholinesterase and acetylcholine, resulting in nerve block.

Medicolegal significance of war gases:

- Apart from usage of various types of these gases in wars depending on the necessity, vesicants and tear gases are used to control riots in the public. Rarely some cases may end up in fatality.

CHAPTER 31

Miscellaneous Poisons

Keywords: Food poisoning, toxins, mushroom, botulism, marine food, food allergy, ptomaines.

1. Define food poisoning: What are the common causes of food poisoning?

Definition:

- WHO defines food poisoning as "Diseases usually either infectious or toxic in nature caused by agents that enter the body through ingestion of food".
- It includes all illness which results from ingestion of food containing bacterial or non-bacterial products.

Causes of food poisoning:

- Bacteria and their toxins
- Poisons of vegetable origin
- Poisons of animal origin
- Chemicals.

2. Write short notes on bacterial food poisoning? What is botulism?

i. ***Infectious type:***

- Symptoms of poisoning are produced by multiplication of the pathogenic organisms inside the human body transferred from the food. Example: *Salmonella*, *Vibrio*, etc.
- Commonly results in symptoms of gastroenteritis (vomiting and diarrhea).

ii. ***Toxin type:*** Ingestion of food in which poisonous substance have been formed due to bacterial proliferation.

- Example: Exotoxins of staphylococci and botulinum; meat, fish, egg, milk, canned, preserved meats and imperfectly or uncooked food.
- These exotoxins resist boiling and disintegration by intestinal *enzymes*.
- Produces diarrhea, nausea, abdominal cramps and vomiting.

Diagnosis:

- Diagnosis of bacterial food poisoning is by the history, clinical symptoms and isolation of the organisms from the remnants of food materials consumed by the patient.

Treatment:

- Stomach wash and purgatives, IV fluids, antibiotics and other supportive measures.

iii. ***Botulism:***

- Is food poisoning with *Clostridium Botulinum*.
- There are no symptoms of gastroenteritis.
- *Clostridium botulinum* does not grow in the body, but produce a potent neurotoxin which is absorbed through the alimentary canal; these toxin are destroyed by heating at 100°C for 10 minutes.
- The toxin inhibits acetylcholine, there by blocking nerve impulses at the myoneural junction, resulting in paralysis of nerve endings.

Signs and symptoms:

- Incubation period is 12 to 36 hours, sometimes prolonged up to 72 hours.

- Initially nausea, vomiting and abdominal pain may be present but are not severe.
- Later on, there are symptoms sore throat, difficulty in accommodation, diplopia; respiratory insufficiency and urinary retention; progressing onto descending bilateral symmetrical motor paralysis.
- Patient is conscious till death; death is preceded by delirium and coma.

Differential diagnosis:

- Botulism has to be differentiated from encephalitis, Gullian Barré syndrome, tetanus and elapid snake bite.
- Botulism toxin is one of the most potent toxin affecting human body and the mortality rate is as high as 25%. After death, if liver and kidneys are subjected to histopathological examination, they may reveal thrombosis formation.
- *Diagnosis:* Is made out from the history, clinical symptoms, demonstration of toxin in the blood, vomitus and feces of the patient and by demonstration of bacillus and toxins in the remnant food materials.

Treatment:

- Gastric lavage, purgatives and whole bowel irrigation.
- Activated charcoal.
- Botulinum antitoxin slow infusion in normal saline.
- Botulism immune globulin (BIG) daily till the patient recovers completely.
- Adequate respiration measures.

3. What is food allergy?

- It is due to some intrinsic abnormalities in the immune system of the body; they are nto due to poisonous food materials.
- Some individuals may have hypersensitivity to certain proteins; example: fish, meat, milk, egg or to some vegetables like brinjal.
- The symptoms developed are relatively harmless like urticaria, rashes, asthmatic attacks, or symptoms of gastroenteritis like nausea, vomiting and diarrhea.

4. What are ptomaines?

- Ptomaines are alkaloid bodies formed as a result of bacterial decomposition of proteins. When these ptomaines are formed in dead bodies, they are called as "cadaveric alkaloids".
- Those alkaloids which are secreted by living cells during metabolism are called "leucomaines".
- Ptomaines are not bacterial poisons and are not derived from the bacteria; they are only formed from the decomposition of proteins.
- These are detectable only when the food is decomposed and disagreeable to be eaten.
- Most of these ptomaines formed are nontoxic, except a few namely, neurine and mydalein. They have mild toxic effect resembling atropine only when injected into the animal body and not when ingested. These ptomains do not cause any food poisoning.

5. Write short notes on mushroom poisoning.

- Mushrooms are grown widely in moist woody areas. Some species are nonpoisonous and are used as food; while *Amanita phalloides* and *Amanita muscaria* are well-known poisonous mushrooms. Poisonous mushrooms have bitter acid taste and contain some alkaloids as the poisonous ingredient.
- *Amanita phalloides* contains phalloidin which is a powerful inhibitor of cellular protein synthesis; *Amanita muscaria* contains muscarin which stimulates the parasympathetic postganglionic nerve fibers.

Signs and symptoms:

- The toxic alkaloids act both as irritant and neurotic poisons. Some cases may present predominantly with symptoms of irritation, some may present with neurotic symptoms and rarely mixed symptoms in some patients.
- First there are symtoms of irritation up to 12 hours; there is constriction of throat, burning pain in the stomach, nausea, vomiting and diarrhea; followed by sweating, slow pulse, bradycardia, labored respiration and collapse.
- Neurotic symptoms are headache, giddiness, delirium, muscle twitching and cramps, convulsions and coma.
- *Fatal dose:* 2 to 3 mushrooms; fatal period: one day.

Treatment:

- Stomach wash with potassium permanganate, atropine, fluid replacement and hemodialysis; rest are symptomatic treatment.

Postmortem findings:

- Inflammation of GIT and remnants of mushroom particles may be present inside the stomach. Sometimes fatty degeneration of liver, kidneys and heart may be present. Signs of asphyxia may be evident.
- Poisoning is usually accidental and rarely homicidal or suicidal.

6. Write short notes on fish and marine animals poisoning?
Write short notes on Ciguatera; Tetrodon; jelly fish poisoning.

- Marine fish are inherently poisonous, mainly ciguatera poisoning and tetradon poisoning.
- Poisoning could result from bacterial growth in partially decomposed fish.
- By eating some types of sea fish which are by themselves poisonous to humans, like cat fish, lion fish, dragon fish (potent neurotoxin).

i. ***Ciguatera poisoning:***

- It affects the GIT and nervous system; produces symptoms are abdominal pain, nausea, vomiting, diarrhea, numbness of tongue and lips; death due to respiratory paralysis.

ii. ***Tetrodon poisoning:***

- Globe fish, balloon fish and blowfish.
- It affect GIT and nervous system; causes neurotoxicity and muscle paralysis.

iii. ***Shell fish poisoning:***

- Affects the nervous system, causes muscle paralysis, blurred vision, low BP, unable to breath and results in death.

iv. ***Venomous fish:***

- Some sea fish have extremely sharp spine equipped with large poisonous sacs; cooking does not destroy the poison; it may cause punctures with swelling which bleed readily.

v. ***Box jelly fish:***

- This is the world's most venomous animal; it has dermal, neurotic and cardiotoxic poison.

Section VIII:

Practical

EXERCISE 1

Age Estimation by Dentition

PRACTICAL EXAMINATION

Introduction

The pattern of practical examination and the total marks differ for various universities. But all the universities adopt a standard set of exercises for practical exams. It may be in the form of major exercise with viva, short cases and spotters or in the form of OSPE (objective structured practical examination).

The common and most important sets of exercises and spotters would be discussed to help the students prepare for their practical examinations.

Age estimation

Whenever a conflict of age arises in the procedure of investigation, the help of the medical expert is sought for to determine the age of the individual. Each age has got a medicolegal importance and therefore, determination of age plays a crucial role in both civil and criminal cases. As far as possible, the age estimated should fall within a range of two years (up to 21 to 25 years) and the estimated age should be helpful for the court.

Example:

A victim of sexual offence is referred for age estimation, her alleged age is 16 years; after the radiological examination if the estimated age falls between 15 to 17 years; this age estimated by the medical expert is of no use to the court, rather weaken the case by giving a benefit of doubt that she can be less than 16 years also. Here the court wants to know whether she is above 16 years of age and whether she is less than 18 years or not. Hence, caution should be taken by the expert before arriving at the final opinion regarding the age.

To estimate the age of an individual, the following data are taken into consideration:

1. General physical development: Height, weight, chest and abdominal measurements.
2. Teeth eruption and completion of root calcification.
3. Radiological examination of all the joints (more reliable).
4. Secondary sexual characteristics.
5. Closure of skull sutures and degenerative changes (after 25 years).

Age Estimation by Dentition

The eruption of teeth both temporary and permanent has a chronological order and is used for age estimation.

- At birth, there are 44 germ tooth present inside the jaw of a full term baby (20 + 24)
- By 3 years there are totally 20 teeth; all are temporary.
- By 6 to 7 years: There are 24 teeth (20 temporary + 4 permanent)
- From 6 to 12 years total number of teeth remains as 24 (mixed dentition).

From the germ tooth, the crown is formed and then erupts outside in the oral cavity; after the eruption of the teeth, the root formation takes place. In case of permanent teeth, the root calcification gets completed after 2 years of eruption of the respective teeth and it is 3 years for the 3rd molar tooth. While examining X-rays or OPG, the root of the last erupted tooth and the crown of the next to erupt tooth are taken into consideration to determine the age of an individual. There is wide variation in the eruption of 3rd molar and hence, not useful for age estimation.

The age of eruption of various teeth is given in Tables 1 and 2.

Charting of teeth:

FDI (Federation Dentaire Internationale) system:

- Each tooth is identified by a two digit number in which, the proximal digit indicates the quadrant and the distal digit indicates the actual tooth. While numbering the permanent teeth 1, 2, 3, 4 are used for designating right upper, left upper, left lower and right lower quadrants, respectively. Whereas 5, 6, 7, 8 are used for the corresponding temporary teeth.

Permanent teeth

18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38

Temporary teeth

			55	54	53	52	51	61	62	63	64	65			
			85	84	83	82	81	71	72	73	74	75			

Table 1 Eruption of temporary teeth

Teeth	Age of Eruption	Average age (for remembering easily)
Central Incisor—Lower	6–8 months	6 months
Upper	7–9 months	7 months
Lateral Incisor—Upper	7–9 months	8 months
Lower	7–9 months	9 months
1st Molar	12–14 months (1 year)	12 months (1 year)
Canine	17–18 months (1½ years)	18 months (1½ years)
2nd Molar	24–30 months (2 to 2½ years)	2 to 2½ years

Table 2 Eruption of permanent teeth

Teeth	Age of Eruption (years)	Average age (years)
1st Molar	6–7	6
Central incisor	7–8	7
Lateral incisor	8–9	8
1st Premolar	9–10	9
2nd Premolar	10–11	10
Canine	11–12	11
2nd Molar	12–14	12–14
3rd Molar	17–25	17–25

SAMPLE EXERCISE 1

A dental charting or living individuals or OPG or mandibles wound be provided and asked to estimate the age of the individual from the eruption status of the teeth.

		16	**55**	14	**53**	12	11	21	22	**63**	24	**65**	26		
		46	**85**	44	**83**	42	41	31	32	**73**	34	**75**	36		

Interference: The 1st permanent molar, central and lateral incisors and 1st premolar teeth have erupted. 2nd temporary molars and temporary canines are still present in the oral cavity. While calculating the age, the last erupted tooth and the next to erupt tooth are taken into consideration. 1st premolar erupted and 2nd premolar has not erupted, hence the age is above 9 years and below 11 years.

Fig. 1.1 OPG: 1st Permanent molar, central and lateral incisors have erupted; 1st premolar has erupted only in right lower quadrant. All temporary canines have fallen off (not normal)

SAMPLE EXERCISE 2

		16	15	14	13	12	11	21	22	**63**	24	25	26		
		46	45	44	**83**	42	41	31	32	**73**	34	35	36		

Permanent canine has erupted in upper right quadrant and all other canines are temporary. All the other teeth are permanent in the oral cavity. The age is 10 to 12 years; since the eruption of canine has started we can even say 11 to 12 years. It is preferable to opine within a range of 2 years, as there are wide variations in the eruption of tooth and any age estimated by dental examination has to be confirmed by radiological examination.

I have seen babies with 2 and 4 teeth present at birth and 8 to 12 teeth by 6 months. Both tooth formation and bone development are directly dependent on genetic and the nutritional status of the individual. Age estimation by dentition is always used as corroborative finding. However it is very useful to narrow down the estimated age in the period of mixed dentition (6 to 12 years).

EXERCISE 2

Age Estimation by Radiology

Age Estimation by Radiology

- Estimation of age is based on the appearance and fusion of various secondary ossification centers in the body.
- The bones of human body develop from a number of ossification centers.
- At 11–12th week of intrauterine life, there are 806 centers of ossification.
- At birth, there are about 450 centers; whereas the adult human skeleton carries only 206 bones.
- After birth, the growth of the bone takes place by formation of various secondary ossification centers. The bone growth gets completed by fusion of the ossification center with the shaft of the respective bones.
- The appearance and fusion of various secondary ossification centers have a sequence and time period; this chronological sequence is used for determination of age.
- On radiological examination of the various joints, the age of the individual is estimated by examining the status of various ossification centers.

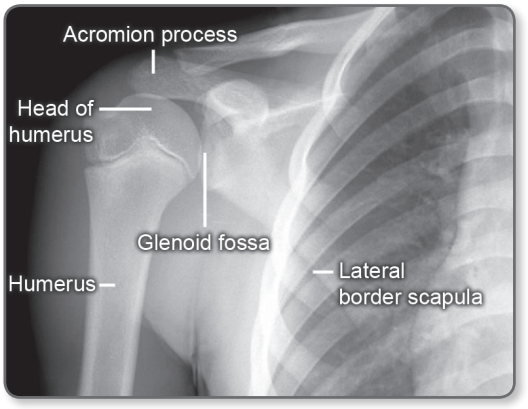


Fig. 2.1 Shoulder Joint: Head, greater tubercle and lesser tubercle have appeared and conjoint fusion has taken place (5 years) but not fused with the shaft; centre for corocoid process and tip of acromion has not appeared – Age more than 5 years and less than 11 years

Table 2.1 Appearance and fusion of various ossification centers of the body

Ossification center	Appearance	Fusion
Shoulder Joint:		
Head	1 Year	
Greater tubercle	3 Years	18–19 Years
Lesser tubercle	5 Years	
Coracoid process	10–11 Years	16 Years
Acromion process	14–15 Years	17–18 Years
Medial end of clavicle	18–19 Years	20–22 Years
Articular facets of ribs		25 Years

Table 2.2 Elbow joint

Elbow Joint	Appearance	Fusion
Capitulum	1 Year	14–16 Years
Medial epicondyle	6–7 Years	14–16 Years
Trochlea	9–11 Years	14–16 Years
Lateral epicondyle	11 Years	14–16 Years
Upper end of radius	5 Years	16–17 Years
Olecranon process of ulna	9 Years	16–17 Years

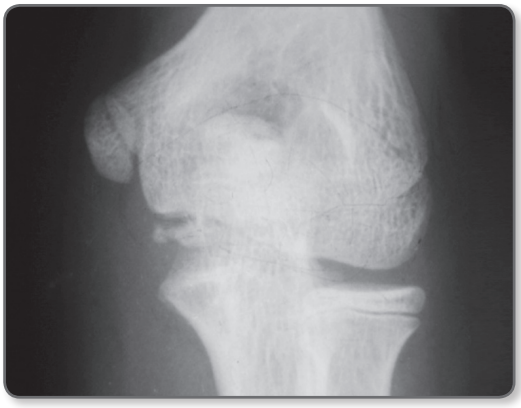


Fig. 2.2 Elbow Joint: Center for capitulum, medial epicondyle, trochlea and upper end of radius appeared but not fused; center for lateral epicondyle not yet appeared — Age is more than 9 years and less than 11 years

Fig. 2.3 Elbow joint: All the centers including lateral epicondyle has appeared but none of them have fused — Age is more than 11 years and less than 16 years

Fig. 2.4 Elbow joint flexed lateral view: Upper end of ulna (Olecranon) is visible only in a flexed lateral view x-ray; the centre has appeared and not fused (Age more than 9 years and less than 16 years; but has to be correlated by viewing other centers in AP view)

Table 2.3 Wrist joint

Wrist joint	Appearance	Fusion
Lower end of radius	2 Years	18–19 Years
Lower end of ulna	5–6 Years	17–18 Years
Capitate	2 Months	
Hamate	2 Years	
Triquetral	3 Years	
Lunate	4 Years	
Trapezium	6 Years	
Trapezoid	4–5 Years	
Scaphoid	4–5 Years	
Pisiform	10–12 Years	
Base of 1st metacarpal	2–3 Years	15–17 Years

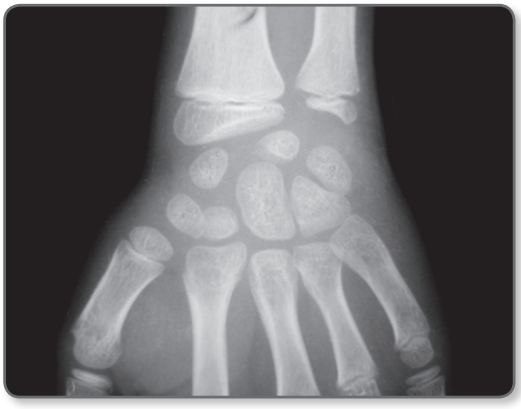


Fig. 2.5 Wrist joint: Center for lower end of radius and ulna appeared, pisiform bone has not appeared; other carpal bones except capitate and hamate have not attained the full size; base of 1st metacarpal not fused — Age is more than 6 years and less than 12 years

Fig. 2.6 Wrist joint: All the carpal bones have appeared (Pisiform seen as overlapping shadow on trapezoid) but base of 1st metacarpal and lower end of radius and ulna not fused – Age is more than 10 years and less than 15 years

Fig. 2.7 Wrist joint: All the carpal bones appeared, base of 1st metacarpal fused but lower end of radius and ulna not fused — Age is more than 15 years and less than 18 years

Table 2.4 Hip joint

Hip joint	Appearance	Fusion
Ischiopubic ramus		6th Year
Triradiate cartilage		13–15 Years
Ischial tuberosity	16 Years	20–22 Years
Iliac crest	14 Years	20–21 Years
Head of femur	1 Year	17–18 Years
Greater trochanter	4 Years	17–18 Years
Lesser trochanter	12–14 Years	17–18 Years

Fig. 2.8 Hip Joint: Center for head of femur appeared, center for greater and lesser trochanter not appeared; triradiate cartilage not obliterated — Age is more than 1 year and less than 4 years

Fig. 2.9 Pelvis: Center for head, greater and lesser trochanter of femur appeared but not fused; triradiate cartilage not obliterated — Age is more than 11 years and less than 15 years

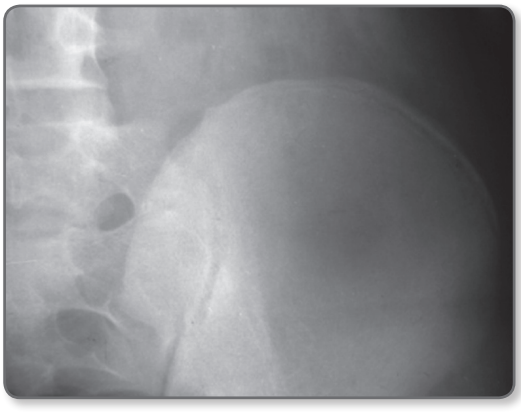


Fig. 2.10 Pelvis: Center for crest of ileum appeared but not fused — Age is more than 14 years and less than 20 (Note: Fusion of femur and center for ischial tuberosity has to be considered to narrow the range)

Fig. 2.11 Ischial tuberosity appeared but not fused; all the centers of femur appeared and fused with the shaft — Age is more than 17 years and less than 22 years (Note: Fusion status of crest of ileum has to be considered — In this case crest of ileum has fused and hence the age is more than 18 years and less than 22 years)

Table 2.5 Other important centers

Other important centers	Appearance	Fusion
Basisphenoid fuses with the basiocciput		18–20 Years
Calcaneum	5th IU/Month	
Talus	7th IU/Month	
Lower end of femur	9th IU/Month	18–19 Years
Upper end of tibia	At Birth	18–19 Years
Upper end of fibula	4 Years	18–19 Years
Lower end of tibia	1 Year	16–17 Years
Lower end of fibula	1 Year	16–17 Years

IU: Intrauterine

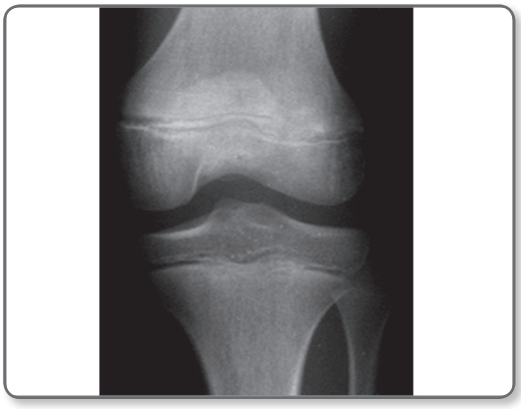


Fig. 2.12 Knee joint: Center for lower end of femur and upper end of tibia appeared but not fused — Age is less than 18 years

Fig. 2.13 Ankle joint: Lower end of tibia and fibula have fused (recent fusion; note: The line of fusion) — Age is more than 16 years

Table 2.6 Centers of sternum

Sternum		
1st Segment	5th IU/Month	Old Age
2nd Segment	5th IU/Month	14–25 Years
3rd and 4th segments	7th IU/Month	14–25 Years
5th Segment	10 Months (At Birth)	14 Years
Last segment	3 Years	40 Years

IU: Intrauterine

Students should by heart the table so that he can directly find out the age of any X-ray given to them. For exams point of view, they must know atleast the four main joints shoulder, elbow, wrist and hip joints.

Sample Exercise:

X-ray of all the joints is given as photographs and determination of age is discussed.

VIVA Questions: (Both for dental and radiological examination)

1. Gustafson's method.
2. *Consent:* When any excise is given X-rays, dental examination, wound certificate, drunkenness or sexual offence certificate, everyone should be thorough with consent. Every student is expected to know the definition, types, rules and application of consent for medical practice and medicolegal cases. Consent is discussed in detail in theory, refer Chapter 4.
3. Medicolegal importance of various age groups; mainly age 7, 12, 14, 16 and 18 years. Discussed in Chapter 5.

EXERCISE 3

Skeletal Remains

Examination of Skeletal Remains

A cluster of bones could be brought for examination; the doctor should examine each bone separately and gain as much knowledge about the individual bone, document all the findings separately and then give a collective opinion. All the bones should be examined for features of sex and age. Some other information could be gained depending on the individual bones, e.g. skull for race and long bones for stature. Undergraduate students must be able to examine Skull, Mandible, Pelvis and Femur.

Age estimation from skull is started from the base and then the vault is examined for suture closure: The basisphenoid fuses with the basiocciput by 18 to 20 years. Then, the teeth are ex-

Table 3.1 Sex differentiation in skullssss

Features	Male	Female
General appearance	Larger, rough with more prominent muscular markings in the temporal and occipital areas	Smaller and smooth
Capacity	1500 cc	1400 cc
Frontal eminence	Sloping	Vertical
Parietal eminence	Less pronounced	More pronounced
Occipital protuberance	Prominent	Less prominent or absent
Glabella	More prominent	Less prominent and smooth
Supraorbital ridges	More prominent	Less prominent or absent
Frontonasal junction	Distinct angulation	Smooth curved
Orbits	Square shaped, placed relatively low on face, margins are rounded	Rounded, higher on face, margins are sharp
Cheek bones	Heavy, broad and laterally arched	Light, small and compressed
Zygomatic arch	More prominent	Less prominent
Mastoid process	Large and rounded	Small and pointed
Digastrics groove	Deep	Shallow
Condylar facets	Long and slender	Short and broad
Foramen magnum	Large	Small
Palate	Large, broad and 'U'-shaped	Small and parabola in shape
Tooth sachets	Large	Small

Fig. 3.1 Skull: Male and female — Sloping forehead, square orbits and placed low on face, large cheek bones, prominent supraorbital ridges in male; Steep forehead, highly placed rounded orbits and less prominent muscular markings in female

Fig. 3.2 Mandible: Male and Female — Large condyles and less obtuse angle of ramus in male; small condyles and more obtuse angle in female

Table 3.2 Sex difference in pelvis bone

Features	Male	Female
General body	Heavy, rough and deep funnel shaped	Light, smooth and flat bowl shaped
Ileum	Less vertical, curve of the crest reaches higher level and is more prominent	More vertical, height of the curve of the crest is less and not prominent
Preauricular sulcus (Attachment of anterior sacroiliac ligament)	Not frequent, narrow and shallow	More frequent, broad and deep
Acetabulum	Large, 52 cm in diameter and directed laterally	Small, 46 cm in diameter and directed anterolaterally
Obturator foramen	Oval and large	Triangular and small
Greater sciatic notch (Diagnostic)	Narrow, deep and 'V'-shaped. The angle fits into index finger and middle finger	Wide, shallow and 'U' or 'L'-shaped. Fits into the thumb and index finger
Ischial tuberosity	Inverted	Everted and widely separated
Subpubic angle	'V'-shaped and angle is 70 to 75	'U'-shaped and angle is 90 to 100
Pelvic cavity	Heart-shaped and conical	Oval, spacious, broad and rounded
Sacroiliac articulation	Large and extends 2.5 to 3 segments	Small and extends 2 to 2.5 segments
Sacrum	Tall and narrow. Uniformly curved and body of 1st vertebra larger	Short and wide. Upper half almost straight and lower half curves forward. 1st V is small
Coccyx	Less movable	More movable

Fig. 3.3 Male Pelvis: Deep funnel shaped

Fig. 3.4 Female pelvis: Flat bowel shaped

Fig. 3.5 Sciatic notch: Male and Female — Narrow and deep in male and wide and shallow in female

Fig. 3.6 Pelvis: Male and Female — Less vertical ileum and "V" shaped sub-pubic angle in male; More vertical ileum and 'U' shaped large angle in female

Table 3.3 Sex difference in mandible

Features	Male	Female
General	Large and thick	Small and thin
Chin	Square shaped	Rounded
Height	Taller	Smaller
Condyles	Large	Small
Ramus	Broad	Small
Angle of body and ramus	Less obtuse and everted	More obtuse and inverted

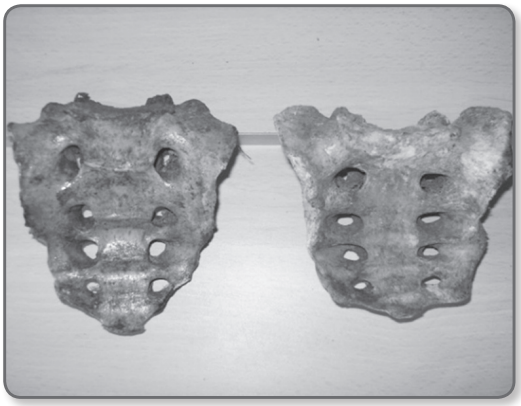


Fig. 3.7 Sacrum: Male and Female — Tall, narrow and uniform curve in male; short, broad and curve only in lower portion in female

Fig. 3.8 Femur: Female and Male — Head small and less obtuse angle with the shaft in female; large and more obtuse angle in male

Fig. 3.9 Condyles: Female and Male — Small in female and large in males

Table 3.4 Closure of skull sutures

Sagittal suture:	Posterior 3rd	30–40 years
	Anterior 3rd	40–50 years
	Middle 3rd	50–60 years
Coronal suture:	Lower half	40–50 years
	Upper half	50–60 years
Lambdoid suture:	Upper half	50–60 years
	Lower half	60–70 years
Temporal suture		80 years

Table 3.5 Some of the indices useful to determine the sex

Index	Formula	Male	Female
Sciatic notch index	Width of the notch/depth x 100	4–5	5–6
Ischiopubic index	Pubic length/ischial length x 100	73–94	91–115
Sternal index	Length of manubrium/length of the body x 100	46.2	54.3
Corporo-basal index of sacrum	Breath of 1st sacral vertebra/breath of base of sacrum x 100	45	40.5
Medullary index	Diameter of the medulla/diameter of the whole bone x 100		

Table 3.6 Sex difference in femur

Features	Male	Female
General	Long, heavy, with more prominent muscular markings	Light and smooth
Head	Large, forms more than 2/3 of sphere and vertical diameter is more than 47 mm	Small, forms less than 2/3 of sphere and diameter is less than 45 mm
Neck shaft angle	Obtuse angle with the shaft, more than 125	Less obtuse, almost at right angle
Bicondylar width	More (74 to 89 mm)	Less (67 to 76 mm)
Angulation of the shaft with the condyles	Around 80	Around 75
Popliteal length	More (around 145 mm)	Less (around 106 mm)

amined and lastly the fusion of skull sutures is examined to arrive at the age of the given skull. The skull sutures starts fusion first on the inner surface, endocranially, the fusion starts 5 to 10 years earlier than the ectocranium. Hence, during examination, the inner table is first examined using a torch light through the foramen magnum.

In cases of examination of bones, the doctor should be able to answer the following;

1. Whether the given bones belong to human or animal?

By the morphological appearance and knowledge of anatomy, it can be easily found out as the bones are of human origin or animal origin.

In case of long bones, when the entire bone is available, there exists no difficulty in finding out the origin of the bone, but when the ends are not present and only the shaft is available and also in cases of small bones like carpal and metacarpal bones, there exists difficulty in finding out whether the bones are of human origin.

In those circumstances, we can do a precipitin test to find out the origin of the bones.

2. Whether all the given bones belong to the same individual?

By finding out the sex and age of each individual bone, we would be able to say, all the bones does not belong to the same individual (different sex and/or different age groups).

If all the bones are of same sex and age, then we can say they may belong to the same individual.

To confirm this, we can do ABO grouping (screening test) and DNA analysis (confirmatory)

3. Cause of death:

If there are any injuries found on the bones, we would be able to opine about the cause of death. The bones can be subjected to chemical analysis for detection of any poisons (heavy metals like arsenic and lead). The bones can also be subjected to diatoms test to find out whether death could be due to drowning.

4. Any additional information could be provided?

(i) The **skull** can be used to find out the **race** and the approximate stature of the individual. Skull can also be used for superimposition if necessary.

Race is identified by finding out the cephalic index.

The height of the skull with mandible × 8, will give the approximate stature of the individual.

(ii) If any **long bone** is given, the **stature** of the individual can be calculated.

There are two types of formulae commonly used to find out the stature from long bones; only femur would be discussed. The basis is same for all the bones, but the constant values differ for different bones.

(a) *Percentage formula:* The femur is about 27% of the height of an individual. Multiplication of length of femur × 3.6–3.8 will give the height of the individual.

(b) *Pearson's regression formula:*
Males: 81.306 + 1.88 × F (Length of femur)
Female: 72.884 + 1.943 × F

5. Time since death.
The time since death could be approximately found out by the soft tissue attachments present on the bones. But in the examination, the bones provided are laboratory specimens and hence, TSD could not be ascertained.

Carbon dating: The amount of radioactive carbon C14 present in the bones is useful in finding out the age of the bones; it is applicable only for those bones which are more than a century old, as the half life of C14 is 5,600 years.

EXERCISE 4

Wound Certificate

Wound Certificate

Every doctor in his profession has to come across cases of injuries. There are various treatment modes for different types of injuries, but the legal implications of injuries are the same for any form of injury.

In practical examination in UG course, you would be given a set of data and you will have to frame the certificate. But in real time practice, the scenario is different.

1. **Naming the injury**: By knowledge and experience, you have to find what injury is it? When you have named the injury, then you will automatically know what type of force is involved in causation of the injury and many times you can find out the weapon also. Next you have to find out the time of infliction of the injury. Finding out up to which level is basic for any Doctor. I have seen plenty of doctors documenting cut injuries as laceration and the case starts losing from that stage itself. Because all these benefits of doubts would be given to the accused only.

To learn those basic skills, first read the chapter on injuries and then the exercise becomes so simple.

You will be given a set of data and would be asked to frame an AR copy and/or wound certificate.

Accident Register (AR Copy)

This is a legal document made by the casualty medical officer, who receives any MLC (medicolegal case). In all these cases, you are the first reliable and expert witness to the court. Sometimes, the patient may be seriously injured and lifesaving measures are given priority over legal duties.

Fill up the preliminary particulars in the AR copy.

History as narrated by the patient or the attender is documented briefly with relevant particulars. Document all the injuries from head to toe with reference to the type of injury, accurate dimension and the exact location on the body.

Sample Exercise 1:

AR. No: 2345/2013 (Year) Dated: 01.10.2013.
Name: Age and Sex: Address:
Accompanied by:
History Narrated by: The patient himself

History

On 01.10.2013, at 5 am, while he was walking on a road near his residence, he was assaulted by 4 people, out of whom two people were known to him. They have assaulted him using the fist and also weapons wooden club, iron rod and a pocket knife. He sustained injuries on face, left forearm, right hand, abdomen, right thigh and left knee. He has pushed those people away and has escaped from there in an auto.

General examination:

Height, weight, chest and abdominal girth; Pulse, BP, heart rate.

CVS, RS, CNS and P/A examination.

Injuries:

1. Lacerated wound 3 × 2-1 cm × bone deep, on left side of the forehead.
2. Reddish contusion 5 × 4-3 cm × muscle deep, on the right cheek.

3. Reddish, irregular abrasion 8 × 4-3 cm, vertically oblique on back of left forearm.
4. Stab wound 1.5 × 0.3 × 3 cm, on upper part of right side of the abdomen; peritoneum intact.
5. Linear incised wound 7 × 0.5 × 1-0.5 cm, on inner aspect of right palm.
6. Abraded contusion 6 × 4-3 cm × muscle deep, horizontally oblique, on front and outer aspect of upper third of right thigh.
7. Multiple, reddish, irregular abrasion of size varying from 0.2 × 0.2 cm to 0.5 × 0.4 cm on the front of left knee, over an area of 6 × 4 cm.

Investigations Advised:

X-ray skull, abdomen, right hand and right thigh.

Date:

Place: Signature of the doctor.
(Name in block letters, with designation and Registration Number)

Injury/Wound Certificate

The doctor who is treating the patient should issue the wound certificate. The objective of the wound certificate is to certify:

(i) Which all the injuries are simple and which are grievous.
(ii) If the weapon is known/made available for examination, then which all the injuries were caused by which weapon. If the weapon is not known to the investigation agency, then the doctor has to opine the probable weapon/force involved in causation of the injuries.
(iii) The time of infliction of the injuries.

After writing the preliminary particulars:

Draw a table with seven columns. From the AR copy, document the injuries in the table. Arrive at the opinion. (The previous AR copy is used here to prepare the sample wound certificate).

Opinion: (In all medicolegal cases, the opinion should be framed in this following way)

On examination of Mr.___, ___Yrs, Male/Female, residing at No: _____, bearing the following identification marks,

1. A black mole on upper part of right side of the chest, 1 cm above the nipple.
2. A black mole on outer aspect of middle third of right forearm.

Table 4.1 Wound certificate

Sl. No.	Type of injury	Size	Location	Simple / grievous	Weapon involved	Time of injury	Remarks, if any
1.	Laceration	3 x 2-1 cm x BD	Left side of the forehead	Grievous	Iron rod/ wooden club	Fresh	
2.	Contusion	5 x 4-3 cm x muscle deep	Right cheek	Simple	Fist/(Blunt force)	Fresh	
3.	Abrasion	8 x 5-4 cm	Vertically oblique on back of right forearm	Simple	Wooden club /Iron rod	Fresh	
4.	Stab wound	1.5 x 0.3 x 3 cm	Right side of the abdomen	Simple	Pocket knife	Fresh	
5.	Incised wound	7 x 0.5 x 1-0.5 cm	Inner aspect of right palm	Simple	Knife	Fresh	
6.	Abraded contusion	6 x 4-3 cm x muscle deep	Horizontally oblique on middle third of right thigh	Simple	Iron rod/ wooden club	Fresh	
7.	Multiple Abrasion of size 0.2 x 0.2 to 0.5 x 0.4 cm	Over an area of 6 x 4 cm	Front of left knee	Simple	Blunt force	Fresh	

3. A raised black mole 0.3 cm in diameter, with a few hairs present on the center of the mole, on outer aspect of right side of the jaw, 6 cm below the right mastoid process. (Two ID enough)

I am of the opinion that:

1. Injury No: 1 is Grievous and Injuries No: 2, 3, 4, 5, 6 and 7 are simple in nature.
2. Injuries No: 1, 3 and 6 could be caused by Iron rod/wooden club; injury No: 2 could be caused by blow with the fist; injury no: 4 and 5 could be caused by pocket knife and injury no: 7 could be caused by fall on the ground.
3. All the injuries are fresh in nature and hence, time of infliction could be less than 6 hours.

Date:
Place:

Signature of the doctor
(Name in block letters, with designation and registration number)

VIVA Questions

1. Definition of injury.
2. Classification of mechanical injuries.
3. Grievous hurt (Must know).
4. Endangering injury.
5. Dangerous weapon.
6. Defence injury, self-inflicted injury, hesitation cuts and fabricated injury.

All these are discussed in detail in theory in chapter no. 11.

EXERCISE 5

Drunkenness Certificate

DRUNKENNESS

Definition

Drunkenness is a condition produced in a person, who has consumed alcohol in sufficient quantities, so as to lose control over his faculties to such an extent, that he is unable to execute the occupation safely, in which he is engaged at the material time.

Drunkenness is a clinical condition; blood alcohol concentration (BAC) is only corroborative and should not be fully relied upon. An acute alcoholic person with BAC 80 mg/mL could be under the influence of alcohol and a person with BAC 240 g/mL could be normal and able to perform all the tests properly.

Hence, certification of drunkenness can be done only by physical examination by a medical expert.

BAC estimated from dead bodies is useful to find out whether he has consumed alcohol or not and the approximate quantity of alcohol consumed, but cannot conclusively say whether he was under the influence of alcohol or not.

The preamble of the report consisting of general particulars like name, age, sex, accompanying police constable are filled up in the routine way.

General Examination

Height, weight, chest measurement at the level of nipple, abdominal girth at the level of umbilicus, pulse rate, respiratory rate and blood pressure are recorded.

Systemic examination of CVS, RS, CNS and per-abdominal examination are done.

Specific examination is focused on:

1. *State of clothing:* Well-dressed, neatness, stains of vomitus, etc. are noted.
2. Smell of alcohol in breath.
3. *Speech:* Talkative, precised, etc. are noted.
4. *Behavior:* Neat, rude, etc.
5. *Eyes:* Checked for congestion and nystagmus and state of the pupil.
6. **Tests for muscular coordination.**

The opinion of drunkenness is mainly based on **smell of alcohol in breath** and the **tests for muscular coordination**. These tests are easy to perform and elicit the findings thus enabling the medical expert to give a direct positive opinion in cases of drunkenness.

(i) Finger nose test.
(ii) Finger-finger test.
(iii) Picking up small objects from the floor.
(iv) Buttoning and unbuttoning of shirt.
(v) *Romberg's sign:* The individual is asked to stand straight with both feet together, stretch his hands apart and then close the eyes. He cannot perform the test properly rather he will sway, if he is under the influence of alcohol.
(vi) Walk in a straight line (**Gait**—Staggering gait)
(vii) *Reaction time:* The individual is asked to perform an act and then interpreted with a new command; the time taken to change over from one action to the other is called the reaction time.

Example: When the individual is walking in a straight line, give a new command like stop, turn right, etc., the time taken to change over to the new command will be delayed, if he is under the influence of alcohol.

The delay in reaction time is one of the main reasons for road traffic accidents. The time taken to change over from accelerator to brake and clutch etc. would be delayed.

(viii) Deep tendon reflexes like knee jerk are tested; they would be initially exaggerated but later on diminished as the BAC increases.

Opinion:

The opinion is based on whether smell of alcohol is present in breath or not, and whether he is able to perform the tests for muscular coordination.

After examination, there are three types of opinions which could be arrived at:

1. The individual has not consumed alcohol (When smell of alcohol in breath is absent and he is able to do all the tests for muscular coordination properly).
2. He has consumed alcohol, but not under the influence of alcohol (When smell of alcohol is present in breath, but he is able to do all the tests for muscular coordination properly).
3. He has consumed alcohol and is under the influence of alcohol (When smell is present and he is unable to perform the tests for muscular coordination).

VIVA Questions

1. Define drunkenness.
2. Delirium tremens.
3. Korsakov's psychosis and Wernike's encephalopathy.
4. Mc Evans sign.
5. Widmark's formula.

   All are discussed in theory; chapter no; 28.

EXERCISE 6

Sexual Offence Certification—Victim

Sexual Offence Certificates

Every medical expert must possess in them the basic knowledge of how to derive and frame opinions in any case of sexual assault. Both the accused and the victim are presented for examination.

In case of accused, we should certify about his potency and find out whether there are any evidences which could suggest that he has taken part in recent sexual intercourse?

In case of victims, we should certify whether there are any evidences suggestive to say that the female has taken part in recent sexual intercourse; also make attempts to find out whether such sexual intercourse was forceful?

In many a circumstances, the authorities would ask to estimate the age of the victim and/ the accused of any sexual offence.

Examination of Victim of Sexual Offence

Fill up the preliminary particulars and note down the accompanying person (relative) name; informed written consent is mandatory and any victim cannot be examined against her consent. Consent of the legal guardian is also obtained when the victim is less than 18 years of age.

Medicolegal Examination of Rape Victim

Prerequisites

Requisition for examination from the concerned authority (Investigating Officer, Court)

An authorized person (accompanying Police constable) to identify the victim.

A proper written informed consent has to be obtained.

Presence of a female attendant is mandatory, if examined by a male doctor.

Proforma of examination of an alleged victim of rape:

Preliminary data: It should contain the following details

Name:
Age:
Sex:
Address:
Occupation:
Brought by: (Police constable name and number)
Accompanied by: (The female attender)
Date, time and place of examination:
Written informed consent, signed by the guardian if the female is less than 18 years.
Two identification marks.

Examination:

A comprehensive history is essential and integral part of sexual offence examination. It includes general medical history, marital and obstetric history, and a thorough complete history of the alleged crime.

General medical history:

Past history: For example, bleeding disorders.
Medication and allergies.
Details of any medication or alcoholic intake during last 24 hours.

Marital and obstetric history:

Age of menarche, frequency and regularity of menstruation.
Date of last menstruation.
History of previous sexual exposure.
Married/unmarried and details of siblings, if married.

History of sterilization and use of contraceptives.
History of any STD: Whether treated or not.

History of the alleged crime: Date, time and place of the alleged sexual assault.
Specific nature of the assault: Whether penetration has taken place or not? If yes, whether penetration was vaginal, oral or anal.
Any instruments/objects were inserted?
Any body fluids were left on the victim: Ejaculation, saliva, urination or defecation.
Post-incident: Whether the victim has washed her genitals/taken bath/change of clothing?
Number of assailants involved.

General examination:
Height, weight, and general built:

Abdominal girth at the level of umbilicus and chest circumference at the level of nipples.

Examination of BP, pulse, heart rate and respiratory rate.
Examination of teeth: Eruption and injuries.
Presence or absence of secondary sexual characteristics.

Examination of clothing:

The victim is made to stand on clean white sheet of paper, and asked to undress herself. Collect any material that falls onto the paper, if the victim has not washed her genitals, taken bath or changed her clothing.

Examine the clothing for tears, any stains (blood, semen, etc.) or any foreign bodies adherent to the clothing (sand, mud, etc.). If satins are present on the clothes, it has to be dried, preserved, packed, labeled and sent to the forensic science laboratory.

Examination of the body surface:

The whole body surface must be examined for injuries, old and new. Document everything with care, as to the nature of injury, size, shape and location with reference to prominent anatomical landmarks wherever necessary.

Specific attention for recent injuries. (scratches and bite marks)

Examination of skin:

Any soiled area on the body must be swabbed, preserved and sent for analysis to FSL.

Use of ultraviolet lamp will reveal areas of fluorescence (seminal soiling)

Search for loose foreign hair or any other foreign material on the skin.

Examination of finger nails:
Ragged or broken nails.

Blood, skin tags or any foreign bodies under the nails.

Fingernail scrapings of all the ten fingers are collected in separate plastic bags, labeled and sent to FSL for examination; torn up epithelial cells if detected would belong to the accused and may help to prove the crime by doing a DNA analysis on the detected cells.

Local examination

External genital examination:
Pubic Hair: Matted or not; if matted, the bunch of matted hair are cut and preserved separately. Combing of pubic hair to be done for any loose pubic hair, if present they are preserved separately. A bunch of pubic hair from the victim to be collected separately, for comparison purpose.

Look for injuries like bruises, bite marks, nail scratches, etc. over the inner aspect of thigh and labia and should be properly documented.
Internal examination: Using a vaginal speculum:
Vaginal swabs are taken.
Examine the lining vagina.
Note for any abrasion, erosion, bruise or tears.
Digital examination: (Two fingers test) which will reveal:

Areas of pain and tenderness in vagina.

Laxity of vaginal orifice (indicates previous penetration).

Elongation of posterior fornix (indicating habitual sexual intercourse).

The size of the vagina should be noted as admitting 1, 2 or 3 fingers as the case may be.

However, the significance and relevance of digital examination is highly controversial. Recent school of thought and some of the court judgments advices to dispense with this practice.

Vaginal washings and washings from the posterior fornix are to be collected separately and labeled to look for spermatozoa and prostatic secretions (Acid phosphatase test).

Hymen:

Rupture of the hymen occurs with the first sexual intercourse.

Tearing usually occurs in the 4 or 8 o'clock position, or in the middle.

Soon after the act, the margins of the torn hymen are sharp and red, which bleed on touch.

By 3 to 4 days, the edges are congested and swollen, which heal completely in 1 week.

Rupture of the hymen due to sudden stretching can be caused by agents other than the penis, such as fingers. And therefore, evidence of local injury is not a proof of penetration.

Frequently, in the absence of frank hymeneal tearing, there is abrasion and bruising of hymen, vaginal orifice and the vaginal canal.

Certification of rape

Rape is a legal term and not a medical diagnosis and hence, while issuing a certificate in cases of sexual assault, we should restrict ourselves within the boundaries of science.

Never use the word rape in the certificate.

The objective of our examination is to say, whether there are any evidences suggestive of recent sexual intercourse, if present then, whether such intercourse could be with mutual consent or whether there are evidences of struggle to say, such sexual intercourse was forceful.

Opinion:

There are evidences suggestive of recent sexual intercourse/no signs of recent sexual intercourse. (or)

There are evidences suggestive of recent sexual intercourse and it could be forceful (if evidences of struggle are present, with severe injuries in and around the genitals).

Proper documentation of all the injuries present on the body would automatically indicate that victim offered resistance.

It is for the court to decide whether such sexual intercourse was a rape or not. Since, in a female who has delivered children, even forceful vaginal penetration may not leave any signs and we would be forced to opine as there are no evidences suggestive of recent sexual intercourse (especially, when laboratory reports are negative).

EXERCISE 7

Examination of Accused of Sexual Offence

Examination of the Accused

It is almost similar to victim, only the examination of the genitalia vary.

Preliminary particulars are filled up and the development of genitals is examined.

History, mental state and general behavior
Influence of alcohol and/or drugs
Clothes: Tears, stains, loss of buttons, etc.
Hair/Foreign material, cosmetic contact traces, etc.
Stains on the body : Blood, semen or others.
Marks of struggle : Scratches, bite marks, bruises etc. and age of injuries to be determined.

Examination of Genitals

Development with special reference to potency.
Injuries: Scratches, bruise, tear of the frenulum and abrasion on the skin covering the glans penis and reddening of the glans:

Dried blood stains may be found on the shaft of the penis, scrotum and adjoining skin.
Examination of glans for vaginal cells: Lugol's iodine test (Positive upto 4 days).

Presence or absence of **Smegma** (smegma is thick, white, cheesy material present beneath the skin of the glans penis of every male and would be absent if he is circumcised).

Smegma is produced by smegmatus bacilli which are normal inhabitant of the male genitalia. It is customary for every male to wash up the smegma during bathing.

Inference:

Absence of smegma suggests that he could have taken part in sexual intercourse or he has washed his glans penis recently. But presence of smegma strongly goes in favor of the accused as it suggests that he has not taken part in sexual intercourse recently.
Specimens to be collected:

- Swab from coronal sulcus and prepuce
- Blood for grouping.
- Pubic hair combing, matted pubic hair and comparative sample of pubic hair.
- Nail scraping: Any loose hair found anywhere on the body.

Opinion:

In examination of the accused, we have to opine whether there any evidences to say that the individual has taken part in recent sexual intercourse and also about his potency.

Certificate of potency is always given in a double negative form:
There is nothing to suggest that the individual is incapable of performing normal sexual intercourse (or) there is nothing to suggest that he is impotent.

The double negative format is used because psychological impotence cannot be ruled out by routine physical examination.

EXERCISE 8

Fetal Examination

Fetal Examination

In real time cases, we would have to do a complete autopsy to find out dead born, still born or live born. But for undergraduate examinations, a fetus would be given to examine and find out the age of the fetus and comment about viability.

To understand about infant deaths, refer chapter no. 20.

Gestational Age

The crown-heal length of the fetus is measured and the gestational age is calculated using Rule of Hasse. If the length is less than 25 cm, the square root value will give the approximate months of gestation; if the length of the fetus is more than 25 cm, the length divided by 5 will give the approximate age of gestation in months. *Example:* If length is 9 cm, $\sqrt{9}$ + 3 months; if length is 40 cm, 40/5 = 8 months.

Viability

Viability is the ability of a fetus to have a separate existence of its own, outside the mother's womb. It is due to certain physical development in the fetus, which makes it viable. Seven lunar months or 210 days is the minimum period of viability. When the crown-heal length is more than 35 cm, then it's a viable fetus. Rigor mortis does not appear in non-viable fetus (Myofibrils are formed only by 7 months of IUL).

Sample Exercise:

1. *External appearance:* Color of skin, whether wrinkled.
2. *Crown heal length:* 40 cm.
3. *Weight of the fetus:* 1600 g.
4. *Scalp hair:* Fully appeared, measures 1.2 cm.
5. *Body hair (Lanugo hair):* Well-appeared (not appeared/appeared/well-appeared)
6. *Eye brow and eye lashes:* Well-appeared.
7. *Fingernails and toe nails:* Appeared and cover upto the tip of the fingers.
8. *Shape of chest:* Barrel-shaped.
9. *Meconium:* Found in the large intestine.
10. *Position of the diaphragm:* At the level of 4th rib.
11. *Sex:* Male/Female (Differentiation easy after 14 weeks.
12. *Umblical cord:* Attached.
13. *Ossification centers:* (Check talus, calaneum, sternum, lower end of femur).
14. *Age of the fetus:* 8 months.
15. *Viability:* Viable.
16. *Cause of death:*

Date:

Signature of the MO with seal

Place:

EXERCISE 9

Leave and Fitness Certificate

Leave Certificate and Certificate of Fitness.

1. Certificate for medical leave/extension of leave: (Sample certificate)

Medical Certificate for Leave / Extension of Leave

Signature of the Candidate: _____ I (Dr. _____ _____) after careful personal examination of the case hereby certify that _____, Male/Female, whose signature is given above, working as _____, in the office of _____, is/was suffering from _____ _____, based on clinical condition and investigation done as is given below, and I consider that the period of absence from duty for _____ days, from _____, is/was absolutely necessary for the restoration of his/her health.

Station:
Date: (Authorized Medical Attendant)
Signature and seal with Reg. No.

Clinical History:
Investigations Done:

Station:
Date: (Authorized Medical Attendant)
Signature and seal with Reg. No.

2. Certificate of fitness to join duty: (Sample certificate)

Medical Certificate of Fitness to Return to Duty

Signature of the Candidate: _____

I (Dr _____) after careful personal examination of _____ _____, Male/Female, aged about _____ years, working as _____ _____, in the office of _____ _____, certify that, he/she has recovered from his/her illness and is fit to resume to duties from _____.

I have also verified the original leave certificate before arriving at the opinion.

Station:
Date: (Authorized Medical Attendant)
Signature and seal with Reg. No.

EXERCISE 10

Death Certificate

Death Certificate

While issuing death certificate the WHO format has to be used:

FORM NO. 4A
(See Rule 7)
MEDICAL CERTIFICATE OF CAUSE OF DEATH
(For non-institutional deaths. Not to be used for still births)
To be sent to Registrar along with Form No. 2 (Death Report)

I hereby certify that the deceased Shri/Smt/.Km..... son of/wife of/daughter of ..... resident of ..... was under my treatment from .....to ..... and he/she died on ..... at ..... AM/PM.

NAME OF DECEASED					For use of Statistical Office
Sex	Age at Death				
	Age in completed years	If less than 1 year age in months	If less than one month age in Days	If less than one day, age in Hours	
1. Male 2. Female					
CAUSE OF DEATH				Interval between on set & death approx.	
I **Immediate cause** State the disease, injury or complication which caused death, not the mode of dying such as heart failure, asthenia etc.	(a) ..... Due to (or as a consequences of)				
Antecedent cause Morbid conditions, if any, giving rise to the above Cause, stating underlying condition last	(b) ..... Due to (or as a consequences of)				
II Other significant conditions contributing to the death but not related to the disease or conditions causing II	©				

If deceased was a female, was pregnancy the death associated with? 1. Yes 2. No
If yes, was there a delivery? 1. Yes 2. No

Name and signature of the Medical Attendant certifying the cause of death
Date of Certificate .....

(To be detached and handed over to the related of the deceased)
Certified that Shri/Smt/Km ..... S/W/D of Shri ..... R/O ..... Was under treatment from ..... to ..... And he/she expired on ..... at ..... AM/PM

Doctor .....
Signature and address of Medical Practitioner/ Medical attendant with Registration No.

The medical data to be filled is designed as per the WHO norms and has two parts:

Part I: Mentions the events which lead to death.

Part II: Mentions the conditions which contributed to the death.

Cause of Death

One cause is to be entered on each line. Underlying cause is to be filled on the lowest line. It is the condition that started the sequence of events which lead to immediate cause of death from normal health to immediate cause of death.

a. **Immediate cause of death**: Disease or injury or complication that precedes death. It's not the mode of dying, e.g. heart failure, respiratory failure should not be entered.
b. Due to (or as a **consequence of**): If immediate cause occurred as a consequence of another condition, it should be entered here. Antecedent condition might have just prepared the ground for immediate cause of death, even after a long interval.
c. Morbid condition leading to the underlying condition.

Example 1

A patient died from bronchopneumonia following an intracerebral hemorrhage caused by cerebral metastases from a primary malignant neoplasm of the left main bronchus.

a. *Immediate cause:* Bronchopneumonia.
b. *Antecedent cause:* Intracerebral hemorrhage.
c. *Underlying cause:* Cerebral metastases from squamous carcinoma of left main bronchus.

Note: While writing neoplasm, the exact pathological variant must be specified.

Example 2

A 45-year-old chronic alcoholic patient, who was on regular treatment for diabetes, died from acute exacerbation of chronic pancreatitis.

Part I

a. Immediate cause: Acute exacerbation of chronic pancreatitis.
b. Antecedent cause: Chronic pancreatitis.
c. Underlying cause: Chronic alcoholism.

Part II

Contributory cause: Diabetes mellitus.

EXERCISE 11

Postmortem Certificate

Postmortem Certificate

A set of findings could be given and the student is asked to frame the postmortem certificate; or a certificate would be given and the student is asked to write the opinion and answer some questions about the basis of his opinion.

Logical and straight forward approach with the knowledge gained by reading this textbook would help any doctor to approach, dissect and opine with confidence in any case of postmortem.

A few model postmortem certificates are given for understanding.

Sample PM Certificate: 1
PM No: **864/2010**,

POSTMORTEM CERTIFICATE

Date: 17.04.2010.
Regarding the body of a male aged about[1] 34 years, named XXXX. Requisition received at 01:00 PM on 17.04.2010. from Sub-Inspector of Police of T-14, Mangadu Police Station with the Crime No: 201/2010 dated 17.04.2010. Body incharge of Police Constable No. WPC 3693 name Mrs. XXXX.

Identification and caste marks:
1. A black mole on the middle part of right side of the chest.
2. A black mole on the lower part of left side of the chest.

The body was first seen[4] by the undersigned at 01:20 PM on 17.04.2010. Its condition then was[5] Rigor mortis present all over the body. Postmortem commenced at 01:20 PM on 17.04.2010. Appearances found at postmortem[6]: Moderately nourished male body with bluish finger nails.

Injuries:
1. An incomplete, asymmetrically oblique, well-defined, brownish ligature abrasion 23 × 2 cm, on the front and sides of upper part of neck; On the front of the neck, ligature abrasion was above the level of the thyroid cartilage and was 5 cm below the chin and 7 cm above the suprasternal notch; on the sides of the neck, the ligature abrasion was 6 cm and 4 cm below the right and left mastoid processes respectively; on the back of the neck, the ligature abrasion merges with the hairline; On dissection: The base of the ligature abrasion was pale and dry; subcutaneous soft tissues of the neck were pale; the hyoid bone and other laryngeal cartilages were intact.

There were no other external or internal injuries anywhere on the body.
Heart: Normal in size; C/S: Empty; Valves: Normal; Coronaries: Patent; Great vessels: Normal.
Lungs: Normal in size; multiple sub-pleural petechial hemorrhages on the surface of both the lungs. C/S: Congested. Larynx & Trachea: Empty. Hyoid Bone: Intact.
Stomach: Contained 160 ml of brown fluid; no definite smell; Mucosa: Congested.
Intestines: Contained brown chyme.
Liver, spleen and kidneys: Normal in size; C/S: Congested. Bladder: Empty.
Pelvis and spinal column: Intact.
Skull: Intact. Brain: Normal in size; surface vessels congested.

Opinion as to cause of death:
The deceased would appear to have died of asphyxia due to hanging.

Station: Chennai -10, Name:
Date: 17.04.2010. Rank:

Sample PM Certificate: 2

PM No: **144/2010**, **POSTMORTEM CERTIFICATE**
Date: 18.01.2010.
Regarding the body of a female aged about[1] 75 years, named M. XXXX. Requisition received at 11.30 AM on 18.01.2010 from Sub-Inspector of Police of T-10, Thirumullaivoyal Police Station with the Crime No: 26/2010 dated 16.01.2010. Body incharge of Police Constable No. HC 1538 name Mr. XXXX.
Identification and caste marks:
1. A raised black mole 0.5 × 0.5 cm, on right side tip of the nose.
2. A tattoo mark on right forearm.

The body was first seen[4] by the undersigned at 11.40 AM on 18.01.2010. Its condition then was[5] Rigor mortis present only in lower limbs. Postmortem commenced at 11.40 AM on 18.01.2010. Appearances found at Postmortem[6]: Moderately nourished female body.

Greenish black discoloration with postmortem peeling of cuticle in patchy areas on front of chest and abdomen, neck, face and both upper limbs.

There were no external or internal injuries anywhere on the body.
Heart: Normal in size; Flabby; C/S: Empty; Valves: Normal; Coronaries: Patent;
Larynx and trachea: Fine gritty mud particles mixed with brown froth adherent loosely onto the mucosal surface of larynx, trachea, primary and secondary bronchioles.
Lungs: Normal in size; C/S: Early decomposition changes. Hyoid Bone: Intact.
Stomach: Contained 40 mL of brown fluid; no definite smell; Mucosa: Early decomposition changes. Intestines: Contained brownish black chyme.
Liver, spleen and kidneys: Normal in size; C/S: Early decomposition changes.
Bladder: Empty.
Uterus: Normal in size; C/S: Empty.
Pelvis and spinal column: Intact.
Skull: Intact.
Brain: Normal in size, softened and discolored gray.
Opinion as to cause of death: The deceased would appear to have died of asphyxia due to drowning.
Station: Name:
Date: Rank:

Sample PM Certificate: 3
PM No: **02/2013,**

POSTMORTEM CERTIFICATE

Date: 12.05.2013.
Regarding the body of a male aged about 56 years, named XXXX. Requisition received at 05.20 PM on 12.05.2013 from Sub-Inspector of Police of C-5, Oragadam Police Station with the Crime No: 147/2013 dated 12.05.2013. Body incharge of Police Constable No: HC 245 name Mrs. XXXX.
Identification Marks:
1. A black mole above the left eyebrow.
2. A black mole on the right side of abdomen.

The body was first seen by the undersigned at 05.30 PM on 12.05.2013. Its condition then was Rigor mortis yet to set-in. Postmortem commenced at 05.30 PM on 12.05.2013. Appearances found at postmortem: Well nourished body of a male.

Injuries:

1. Brown irregular abrasion 4 × 3–2 cm on inner aspect and front of left wrist, with deformity of the wrist joint; On dissection: Complete irregular fracture of lower end of both bones, with surrounding soft tissue bruising and extravasation of blood.
2. Dark blue contusion 8 × 6–5 cm on upper part of left knee; on dissection: Dark red muscle deep bruising of the underlying tissues.
3. On reflection of the scalp: Dark red, scalp deep, diffuse bruising on left fronto, parieto-temporal region of the scalp. Left temporalis muscle bruised. Two linear fissured fractures 6 cm and 5 cm on left frontotemporal bones of the skull. On opening the calvarium: Thick film of subdural hemorrhage and diffuse subarachnoid hemorrhage on left fronto, temporo-parietal region of the brain.
4. Midline, incised, surgical, sutured wound 53 cm, extending from the suprasternal notch to the symphysis pubis. On removal of the sutures: The wound margins were regular and gapping; Sternum has been opened by a cut incision on the midline. Both kidneys and the liver have been surgically removed and not in-situ.

There were no other external or internal injuries anywhere on the body.
Heart: Normal in size; C/S: Chambers were empty. Great vessels: Normal; Coronaries were patent.
Lungs: Normal in size; C/S: Congested. Larynx and trachea: Empty. Hyoid Bone: Intact.
Stomach: Empty; Mucosa: Pale. Intestines: Contained brown chyme.
Spleen: Normal in size; C/S: Congested.
Bladder: Empty. Pelvis and Spinal column: Intact.
Opinion as to cause of death: The deceased would appear to have died of head injuries.

Station: Name:
Date: Rank:

EXERCISE 12

Spotters

Spotters

Seeds:

Undergraduate student should be able to identify and know the medicolegal importance of the following seeds:

Irritants:

1. *Abrus precatorius*
2. *Semicarpus anacardium* (Marking nut)
3. *Ricinus communis* (Castor)
4. *Croton tiglium*
5. Chilli seeds

Cardiac Poisons:

6. Cerebera thevetia
7. Digitalis

CNS Poisons:

8. Poppy seeds (Morphine)
9. Nux comica (Strychnine—spinal poison)

Plants:

Irritants:

1. Calotropis
2. *Ricinus communis*

Cardiac posions:

3. *Nerium odorum*
4. Nicotine leaves
5. Aconite root

Deliriant:

6. Datura (Thorn apple)

Chemicals:

1. Arsenic
2. Lead salts
3. Copper sulfate
4. Carbolic acid (Phenol)
5. Cleaning acid (Sulfuric acid)
6. Alcoholic beverage
7. OPC compound

Soft tissues:

1. Intracranial hemorrhages
2. Skull fractures
3. Stab injury heart, lung and liver
4. Cardiomegaly
5. Scorpion
6. Cobra
7. Viper
8. Krait
9. Corrosive poisoning stomach
10. Soot particles in trachea

Photographs:

1. Hanging: Complete and partial hanging
2. Ligature abrasion
3. Cyanosis
4. Petechial hemorrhages: Lungs and heart
5. Drowning
6. Joule burns
7. Postmortem staining
8. Tattoo mark
9. Scars and keloid

All the spotters' seeds, plants and photographs are discussed in detail in theory with necessary relevant photographs in the related chapters.

Weapons:

The weapons are examined with reference to:

1. Name of the weapon
2. Blunt or sharp weapon
3. Injuries produced

Blunt weapons like wooden club, iron rod, police lathi, etc. produce abrasion, contusion, laceration and fracture dislocation.

Sharp weapon could be light cutting weapon like hand-knife or heavy cutting weapon like chopper or axe.

Light cutting weapons like hand-knife or kitchen-knife produce incised wounds (force is tangential) or stab wounds (force is perpendicular). Heavy cutting weapons like a long chopper produces cut wounds or chop wounds.

The following weapons are commonly used as weapon of assault and displayed for examination:

1. Single-edged knife: Single edged light cutting weapon; produces incised wounds and stab wounds.
2. Chopper
3. Long chopper
4. Axe
   All are heavy cutting weapon and produce cut wounds and fractures.
5. Sickle: Curved single edges light cutting weapon; produces an incised wound and after a distance of intact skin, there could be a stab wound. Both the wounds are present along the same plane, indicating that they were caused by a single strike; frequently the intact skin has a linear imprint abrasion.
6. Wooden club
7. Iron rod
8. Police lathi
   All are heavy blunt weapons that produce abrasion, contusion, laceration and fracture dislocation.
9. Cycle chain
   Flexible heavy blunt weapon; produces imprint abrasion, patterned contusion (bruise), laceration and rarely fracture dislocation.
10. Coir rope
11. Nylon rope
    These are flexible blunt weapons; produce imprint abrasion (ligature mark or hanging and strangulation). These ropes are frequently used to tie the victim, to incapacitate him during assault or robbery.
12. Hammer with nail plucker
13. Wooden hammer
    These are heavy blunt weapons with a small striking surface and hence produce depressed fracture of skull; on other parts of the body, they could produce pressure/imprint abrasion, contusion, laceration and fracture dislocation. The nail plucker produces stab wounds.
14. Screw driver
    Pointed weapon and produces stab wounds. Sometimes when the hilt is used, it produces blunt force injuries.
15. Short gun cartridge
    Draw the diagram and label the parts.
    What is choking and why it is done?
    Choking is constriction of the terminal (muzzle end) portion of the barrel done in case of shot guns. Choking prevents early dispersion of pellets (shots)
16. Bullet
    Draw a labeled diagram.
    What is rifling and why it is done?
    The barrel of rifled firearm is scrolled inside by concentric spiral groves and it is called rifling. Rifling gives the bullet a spinning motion, thus increases the penetration power of the bullet.
17. Pistol
18. Revolver
    These are rifled firearms. They are hand guns (low velocity firearms).

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