

## Chapter (1)

# IDENTIFICATION

### *ILOS:*

- *To ensure the value of identification in clinical and medico-legal practice.*
- *To understand methods of identification of living or dead persons as well as human remains.*
- *To Know MLI of specific ages.*
- *To recognize the value of trace evidence examinations as finger prints and hairs.*

### Definition:

It is the recognition of a person through certain features that distinguish him from all other individuals. It is required in civil situations (inheritance, missing persons or disputed paternity), medico-legal conditions (medical documents or certificates) and legal cases (accidents, crimes or mass disasters). It includes:

- I- Identification of a living person.
- II- Identification of a dead body or parts of it.
- III- Identification of bones.

## I-IDENTIFICATION OF THE LIVING

### Methods of identification:

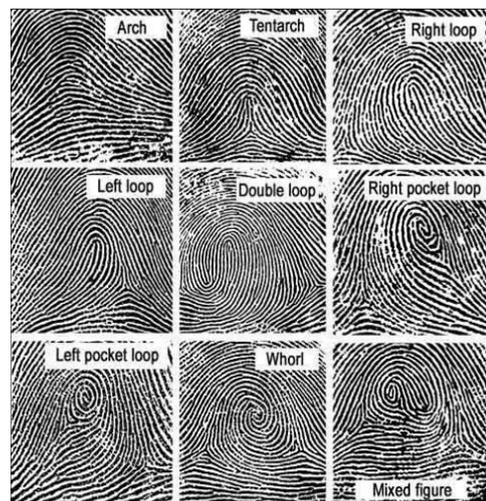
- 1. General physical characters:** **Sex** (usually obvious except in transvertees or hermaphrodites), **Age** (external appearances, bones, internal degenerative disease) and **Race**.
- 2. Specific physical characters:** features such as **skin** color, **hair** (nature, color and distribution as moustache or beard), **eyes** (color and shape) and **characteristic marks** (moles, warts, scars, tattoo, circumcision, congenital anomaly or deformity).
- 3. Clothes:** may indicate sex, age, social class, occupation (special attire/stains), religion, residence, and brand or name of the tailor.

4. **Possessions:** identity papers, cards or tickets, cash money or jewelry.
5. **Photography (e.g. ID card or driver's license):** Profile and face views are needed. It is more useful in identifying the living than the dead.
6. **Anthropometry:** various body measurements e.g. Stature, span, head dimensions, etc..
7. **Fingerprints (Dactylography) "applied by the police":**  
The skin of the finger tips shows ridges alternating with grooves on which the sweat pores open in certain characters that are specific for each person.

**Poroscopy:** Is the examination of pores of sweat glands for their size, shape, spacing, number and distribution.

**Finger prints may present as one of the following patterns:**

- 1) **Arches:** (6%),
- 2) **Loops:** **Radial** loops open to the right (3%) or **Ulnar** loops open to the left (65%).
- 3) **Whorls** (25%).
- 4) **Composite** (1-2%).



**MLI of Finger prints:**

- Finger prints is developed at the **16th weeks** intrauterine and remains constant for life.
- The pattern is absolutely individual even in **uniovular twins**.
- Finger prints are present in both **epidermis and dermis** so they could be detected after peeling of the superficial epithelium that may occur in submersion under water or putrefaction.
- **Permanent loss** to finger prints may occur in Leprosy, amputated fingers, surgical removal, deep burns, deep corrosives or laser. **Transient** loss may occur with ionizing irradiation.

## 8. Foot Print (Sole Print):

### MLI of foot prints:

- Sole prints of newly born infants are taken in maternity hospitals to prevent mixing.
- Tracers can follow the pathway of the thieves or missed people by tracing their foot-prints or shoe prints on the ground.
- Distance between the two prints of a person gives an idea about his height, ie. Wide spacing → tall & vice versa.
- Running is indicated by the presence of impression of anterior part.
- Carrying heavy object is assumed when deeper impression appears on one side.
- Wearing shoes → pattern of the shoe and its brand can help in identification.
- Congenital anomalies (flat foot, extra toe,...).

**9. Other types of prints:** Include iris prints, sound prints, lip prints, hard palate prints and ear prints.

**10. Blood grouping & DNA fingerprints.**

**11. Criteria of communication:** Handwriting, gait, voice, language and accent.

## II-IDENTIFICATION OF THE DEAD

### 1. Recently dead and intact body (un-mutilated):

The same as in the living **except** criteria of communication.

**2. Recently dead and mutilated body:** e.g. gravely injured or mutilated body or groups of bodies found in mass disasters (**aircraft crash, fire, bomb explosions**).

- **Presumptive identification (Grouping):** including physical & anthropometric data. The presumptive information usually identifies the victim as a member of a sub group of the population rather than a unique individual.
- **Positive identification (Individualization):** legal identification based on comparison of antemortem and postmortem **personal records;** including x-ray, dental casts, fingerprints, palm prints, footprints, or

DNA profiling. The fundamental principles of positive identification are those of comparison if the ante mortem records of the proposed deceased are available and exclusion when A.M. records of other persons are only available.

### III-IDENTIFICATION OF BONES

A medico legal report on collection of bones should answer the following inquiries:

#### 1- Are they actually bones?

Sometimes stones or even pieces of wood are mistaken by the public or police for bones: the **anatomical shape and texture** should be obvious to a doctor.

#### 2- Are they human bones?

- **The anatomical features:** in case of complete bones (skull, pelvis...etc.)
- **Precipitin test:** in case of bone fragments, where the saline extract of the bone is examined against known antiserum.

#### 3- Does the collection of bones belong to one person?

- **Repetition of the single bone** (skull, sternum) denotes that they belong to more than one person.
- **Ipsilateral double bones:** eg. 2 Right Humeri → 2 persons.
- **Difference in age or sex:** right and left femur of different age or sex → 2 persons.

#### 4- Identification of Sex from Bones (only after puberty):

The degree of accuracy in sexing adult remains is as follows:

- Entire skeleton→100%
- Pelvis &skull→98%
- Pelvis alone→95%
- Skull alone→90%
- Long bones alone→80%

**A. SKULL**

	Male	Female
<ul style="list-style-type: none"> <li>- General.</li> <li>- Parietal eminence.</li> <li>- Superciliary ridges.</li> <li>- Frontonasal angle.</li> <li>- Occipital condyles.</li> <li>- Mastoid process.</li> <li>- Styloid process.</li> </ul>	<ul style="list-style-type: none"> <li>Big and heavy.</li> <li>Well marked.</li> <li>Prominent.</li> <li>Angular.</li> <li>Long and narrow.</li> <li>Long and bulky.</li> <li>Long.</li> </ul>	<ul style="list-style-type: none"> <li>Small and light.</li> <li>Less marked.</li> <li>Less prominent.</li> <li>Smooth curve.</li> <li>Short and broad.</li> <li>Short and small.</li> <li>Short.</li> </ul>

**B. PELVIS**

	Male	Female
<ul style="list-style-type: none"> <li>- Iliac crest</li> <li>- Obturator foramen</li> <li>- Acetabulum</li> <li>- Greater sciatic notch</li> <li>- Subpubic angle</li> <li>- Sacrum</li> <li>- Sacroiliac joint</li> <li>- Promontory</li> <li>- Pelvic inlet</li> <li>- Pelvic cavity</li> </ul>	<ul style="list-style-type: none"> <li>High arched</li> <li>Oval</li> <li>Wide and deep</li> <li>Deep &amp; narrow</li> <li>Acute</li> <li>Long, narrow &amp; curved</li> <li>Occupies 3 segments</li> <li>Projecting</li> <li>Triangular (heart-shaped)</li> <li>Deep &amp; narrow</li> </ul>	<ul style="list-style-type: none"> <li>Less arched</li> <li>Triangular</li> <li>Narrow and shallow</li> <li>Shallow &amp; wide</li> <li>Obtuse</li> <li>Short, wide &amp; straight</li> <li>Occupies 2 segments</li> <li>Not projecting</li> <li>Ovoid</li> <li>Wide &amp; shallow</li> </ul>

**C. STERNUM:**

	Male	Female
<ul style="list-style-type: none"> <li>- General</li> <li>- Length of body</li> </ul>	<ul style="list-style-type: none"> <li>Long and broad</li> <li>More than double the manubrium length</li> </ul>	<ul style="list-style-type: none"> <li>Short and narrow</li> <li>Less than double the manubrium length</li> </ul>

**D. Long bones:**

- **Person's formula:** if the vertical diameter of the head of humerus exceeds 48mm. → the bone is male and if less it is female.
- Recently, **Purkait** declared that the measurements of olecranon-coronoid angle, width and length of inferior medial trochlear notch of ulna were a possible tool for sex identification.

## 5- Identification of Age from Bones:

(Skull, ossification centers appearance, union of epiphysis of long bones and extent of medullary cavity).

### I. SKULL :

a) **Dimensions:** in full term infants, the circumference is 13 inches, length is 5 inches and width is 4 inches.

b) **Fontanels:** the posterior fontanel is closed at full term while the anterior fontanel is 3 fingers at full terms and closes at 18 months after birth (1 finger every 6 months).

c) **Sutures :**

- **Frontal** suture closes at 2 years (30 years in Negroid).
- **Basiocciput – basisphenoid** suture closes at 23 years.
- **Sagittal suture** closes at 25-30 years (starts to close from the middle of the inner table at 25 years and is completely closed at 30 years).
- **Coronal** suture closes at 40 years.
- **Lambdoid** suture closes at 50 years.
- At 70 years all sutures are united **except** the suture between the parietal and temporal bones which closes at extreme old ages.

d) **The mandible :**

i- **The angle of the mandible:**

Obtuse in infants → Right in adults → Obtuse in old age.

ii- **Mental foramen:**

- In infant: mental foramen is near lower margin
- In adults: mental foramen is midway
- In old age: Mental foramen is near the alveolar margin due to its atrophy.

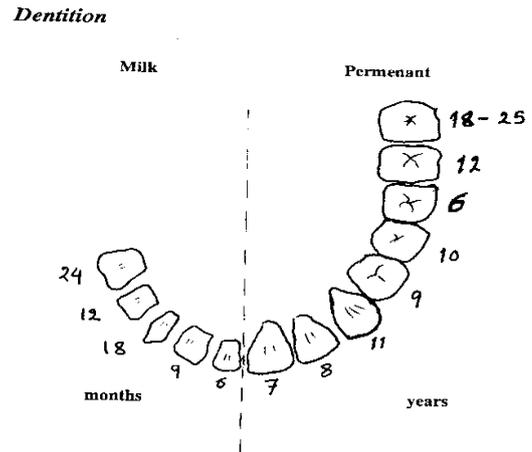
e) **Teeth :**

a. **Dentition**

*i- Milk dentition (20 teeth)*

They are small, narrow and delicate. They are white in color with serrated edges. They erupt at the 6<sup>th</sup> month in the following order:

- The central incisors at 6<sup>th</sup> month (the lower before the upper).
- The lateral incisors at 9<sup>th</sup> month.
- The first molar teeth at 12<sup>th</sup> month.
- The canine teeth at 18<sup>th</sup> month.
- The second molar teeth at 24<sup>th</sup> month.
- Space behind the last molar → 3- 5 years.



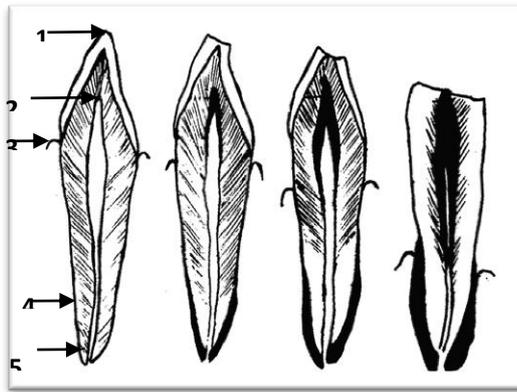
### **ii- Permanent Dentition (32 teeth)**

The permanent teeth are ivory white in color without serrated edges. They are larger, stronger, and broader than milk teeth. They start to erupt at 6<sup>th</sup> year of life in the following order:

- The 1<sup>st</sup> permanent molars at 6<sup>th</sup> year.
- The central incisors at 7<sup>th</sup> year.
- The lateral incisors at 8<sup>th</sup> year.
- The 1<sup>st</sup> pre-molars (bicuspid) at 9<sup>th</sup> year.
- The 2<sup>nd</sup> pre-molars (bicuspid) at 10<sup>th</sup> year
- The canine teeth at 11<sup>th</sup> year.
- The 2<sup>nd</sup> molars at 12<sup>th</sup> year.
- Space behind 2<sup>nd</sup> molar → more than 12 years.
- The 3<sup>rd</sup> molar (**Wisdom tooth**) at 18-25<sup>th</sup> years (may not erupt).

### **b. After dentition, the age is estimated through examination of the following criteria:**

- 1- Attrition (eating up of the grinding surface).
- 2- Secondary dentin deposition.
- 3- Pulling down of gingival attachment.
- 4- Cementum deposition.
- 5- Transparency and resorption of the root.



Aging of Teeth: ASPCT

## Medico Legal Importance of Teeth Examination:

### 1. *Personal identity:*

- Special characters in the teeth, e.g. size of teeth, irregularities, crowding, deformities, fillings and denture... etc., make teeth examination helps in personal identity in civil and criminal cases.
- Teeth resist decay and burn so their use in identification of decomposed or charred bodies is too much valuable.
- Examining DNA fingerprinting from cells obtained from dental bulb helps in identification in mass disasters.

### 2. *Age estimation*

3. **Race Identification:** Mongoloid race has characteristically "shovel-shaped" concave upper incisor teeth.

### 4. *Bite marks:*

- The bite is considered as a print or a cast from the teeth in the form of abrasions and bruises, which helps in identification of the assailant by comparing it with his teeth and by determination of its age, from the process of healing; and so we can compare it also with the date of the assault.
- Bite marks are frequently present in sexual crimes, murder or child abuse.
- Human bite is formed of two curved rows of abrasions and bruises while animal bite is formed of two parallel rows.

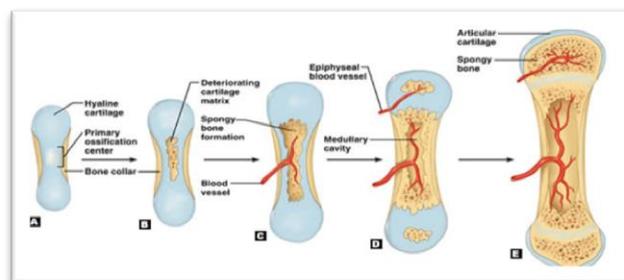
### 5. *Diagnosis of poisoning:*

- In chronic Arsenic poisoning, As is deposited in teeth and could be detected chemically.

- In chronic poisoning, there will be a discolored line at the gingival junction of the teeth which helps in diagnosis and detection of the cause;
  - Grey in “Mercury”,
  - Blue in “Lead”,
  - Green in “Copper”,
  - **Black** in “Bismuth”,
  - Yellow in “Cadmium” &
  - Dirty yellow in “Tetracycline”.

## II. Appearance of ossification centers (O.C.):

The bones of human skeleton develop from separate ossification centers that progress till the bone is completely formed.



PROGRESSION OF BONY OSSIFICATION

### Ossification centers appear by the end of the following ages:

#### a- During Intra-Uterine Life:

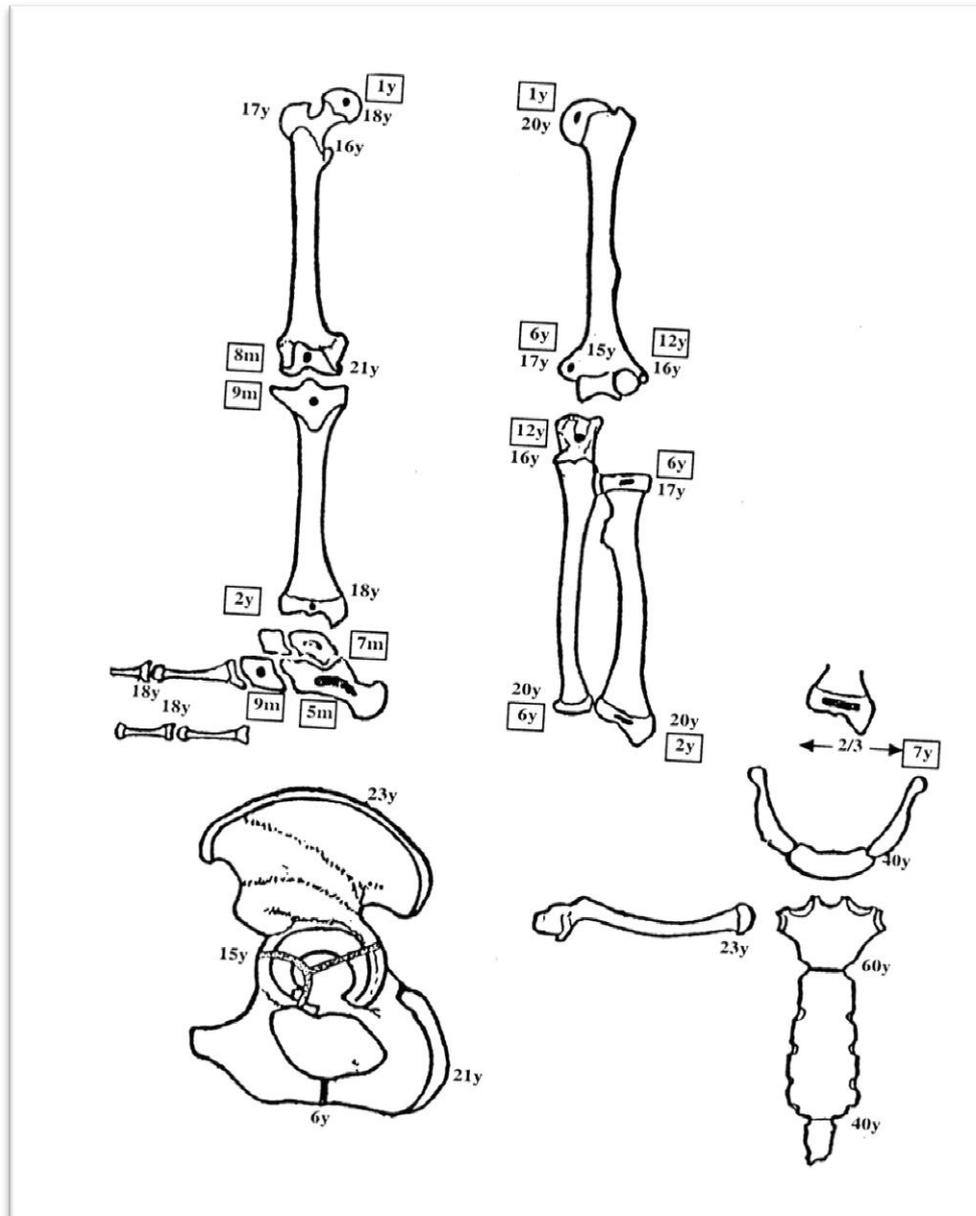
- O.C. calcaneus → 5<sup>th</sup> month.
- O.C. talus → 7<sup>th</sup> month.
- The lower end of the femur → 8<sup>th</sup> month.
- The upper end of the tibia, the cuboid bone and that of the lower end of the femur reaches 5 mm in diameter → 9<sup>th</sup> month (**full term baby**).

#### b- After Birth:

- The upper end of the humerus & femur → 1<sup>st</sup> year.
- The lower end of radius & tibia → 2<sup>nd</sup> year.
- The upper end of the radius → 6<sup>th</sup> year.
- The lower end of the radius, O.C. reaches 2/3<sup>rd</sup> breadth → 7 years.
- The upper end of the ulna → 12<sup>th</sup> year.

### III. Union of Epiphyses

Age	Union of Epiphysis
6 years	<ul style="list-style-type: none"> <li>• Pubic ramus unites with ischial ramus (<b>hip bone</b>)</li> </ul>
14 years	<ul style="list-style-type: none"> <li>• Trochlea unites with the capitulum (<b>humerus</b>)</li> </ul>
15 years	<ul style="list-style-type: none"> <li>• Trochlea and capitulum with <b>humerus</b> shaft</li> <li>• Ilium, ischium and pubic bones (Y shape) (<b>hip bone</b>)</li> </ul>
16 years	<ul style="list-style-type: none"> <li>• Lateral epicondyl of <b>humerus</b> with the shaft</li> <li>• Upper end of <b>ulna</b> with the shaft</li> <li>• Lesser trochanter of <b>femur</b> with the shaft</li> </ul>
17 years	<ul style="list-style-type: none"> <li>• Medial epicondyl of <b>humerus</b> with the shaft</li> <li>• Upper end of <b>radius</b> with the shaft</li> <li>• Greater trochanter of <b>femur</b> with the shaft</li> </ul>
18 years	<ul style="list-style-type: none"> <li>• Distal ends of metacarpal and phalanges with their shaft</li> <li>• Distal ends of metatarsal and phalanges with their shaft</li> <li>• Distal ends of <b>tibia</b> and <b>fibula</b> with their shafts</li> <li>• Head of <b>femur</b> with the shaft</li> </ul>
20 years	<ul style="list-style-type: none"> <li>• Head of <b>humerus</b> with the shaft</li> <li>• Lower ends of <b>radius</b> and <b>ulna</b> with their shafts</li> </ul>
21 years	<ul style="list-style-type: none"> <li>• Distal end of <b>femur</b> with the shaft</li> <li>• Upper ends of <b>tibia</b> and <b>fibula</b> with their shafts</li> <li>• The ischial tuberosity unites with the ischium (<b>hip bone</b>)</li> </ul>
23 years	<ul style="list-style-type: none"> <li>• The iliac crest unites with the ilium (<b>hip bone</b>)</li> <li>• Sternal end of <b>clavicle</b> with its shaft</li> <li>• Basisoccipital with basisphenoidal bones in <b>skull base</b></li> </ul>
40 years	<ul style="list-style-type: none"> <li>• The xiphoid process with the body of <b>sternum</b></li> <li>• Body of <b>hyoid</b> unites with its greater cornu</li> </ul>
60 years	<ul style="list-style-type: none"> <li>• The body unites with the manubrium ( <b>sternum</b>)</li> </ul>



*Ages of appearance of ossification centers and union of epiphysis.*

#### IV. The Extent of Medullary Cavity

The medullary cavity of the humerus reaches the level of surgical neck at 30 years and the anatomical neck at 33 years.

##### N.B.:

- After puberty the dates are about 2 years less in females than males.
- These findings are detected by X-ray in living persons and by dissection in dead persons.

## 6- Identification of Stature: From Pearson's formula:

- Height = span (distance between the tips of the middle fingers of the outstretched upper limbs).
- Femur = 25% of the height.
- Humerus = 18% of the height.

## 7- Identification of Race:

- **Negroid skull has the following characteristics:**

1. Persistent frontal suture.
  2. Dolicocephaly (increased anteroposterior diameter of the skull).
  3. Flat nasal bridge.
  4. Wide nasal openings.
  5. Less arched palate → prognathism
  6. Short mastoids.
  7. The pterion (area of union of frontal, parietal, temporal and sphenoid bones) is one point or X shaped. In non Negroid it is H shaped.
- **Mongoloid teeth:** see MLI of teeth.

## 8- Deformities from Bones:

- Cleft palate, extra-toe and mal-united fractures.
- Longer mastoid on one side → torticollis.
- Depressed sternum → shoemaker.

## 9- Cause of Death:

- Pathological: e.g. T.B. or malignancy.
- Traumatic: Fractures or Firearm injuries.
- Toxic: Metals deposited in bones can be detected (Pb & As).

## 10- Time Passed Since Death:

- Before 6 months: soft tissues are found on bones.
- 6-12 months: Bones are attached by ligaments.
- After one year: Bones only are present. Bones get lighter, whiter, and less smelly and more brittle the more time passed.

## AGES OF MEDICO LEGAL IMPORTANCE (MLI)

Ages	MLI	Diagnosis
<b>7<sup>th</sup> intrauterine month</b>	<b>Age of Viability:</b> after which a preterm infant can survive.	O.C. of talus
<b>9<sup>th</sup> intrauterine month</b>	<b>Full-term baby</b>	O.C. of upper end of tibia and lower end of femur (5mm).
<b>2 years</b>	<b>The legal age of the end of infancy period:</b> Execution of a condemned mother is postponed if a woman has a child below this age till weaning.	Closure of the anterior fontanel, eruption of all milk teeth & O.C. of lower end of radius.
<b>6 years</b>	<b>Admission to school</b>	Eruption of first permanent molars.
<b>7 years</b>	<b>Age of discrimination:</b> below which the child is not legally responsible, ie. cannot discriminate between right and wrong.	Eruption of permanent central incisors & O.C. of lower end of radius is 2/3 <sup>rd</sup> breadth.
<b>10 years for boys &amp; 12 years for girls</b>	<b>The maternal custody:</b> for the children in in case of divorce.	<b>10 years</b> (eruption of 2 <sup>nd</sup> premolars) and <b>12 years</b> (eruption of 2 <sup>nd</sup> permanent molars).
<b>14 years</b>	<b>Age of Puberty in Males:</b> below which males are unable to commit rape or sodomy.	Fusion of trochlea and capitulum.
<b>15 years</b>	<b>The person is tried in front of juvenile court.</b>	Fusion of Y-shaped suture of acetabulum.
<b>18 years in females</b>	<b>Age of marriage Age of consent in rape</b>	Union of head of humerus and lower ends of radius and ulna.
<b>18 years in males</b>	<b>First call for military service</b>	Union of head of femur, lower ends of tibia & fibula and distal ends of metacarpal bones and phalanges.

<b>18 years in both male &amp; female</b>	<b>-Governmental employment,</b> <b>-Voting in election,</b> <b>-Driving license eligibility</b> <b>-Full criminal responsibility</b> <b>-Age of consent for medical procedures</b>	As before
<b>21 years</b>	<b>-Age of complete civil rights.</b> <b>-Age of marriage in males</b>	<b>Males:</b> fusion of epiphyseal ends around the knee joint and ischial tuberosity. <b>Females:</b> fusion of of iliac crest and proximal end of clavicle.
<b>60 years</b>	<b>Age of pension</b>	Union of manubrium with body of the sternum

### Identification of Sex:

#### Medico-legal Importance of Sex Identification

1. Inheritance.
2. Marriage.
3. Intersex.
4. Identification of dead:
  - a. **Non-putrefied bodies:** it's easy through general appearance, clothes, and primary and secondary sex characters.
  - b. **In putrefied or mutilated bodies:** it's difficult and is done through: Prostate or non gravid uterus (delayed putrefaction), bones (skull, pelvis and sternum) and cells.

**Cellular or Nuclear Sexing** is performed through detection of:

- **Barr Bodies:** show one or more characteristic tiny nodes of chromatin attached to the inner surface of the nuclear membrane of cells from buccal smear in **females**.
- **Davidson Body:** white blood cells show a stalked drumstick projection of the polymorph nucleus in **females**.

- **Chromosomal study (karyotype):** help in sexing as **Y chromosome** can be seen by fluorescent microscope in cells of hair follicle sheath, nerve & dental pulp.

### Identification of Race

- 1- Color of the skin and eyes.
- 2- Skull characters and teeth examination (see before).
- 3- Scalp hair is kinked and black in Negro (flat in cut section) while it is straight and light colored in white races (oval in cut section) and straight and dark in Mongolian race.
- 4- DNA (some genetic diseases are associated with certain races).

### Identification of Social Status and Occupation

- **Social Status** is known from clothes, cleanliness, and care of hair, teeth, nails and feet.
- **Occupation: e.g. agricultural labors** show thick fissured epidermis of hands and feet. **Dye workers:** show stains on both hands. **Mechanics:** show stained hands with grease.

### Identification from Operations and Scars

- Amputation of a limb, appendectomy, hysterectomy or pitting scars of small pox on the face.
- The scar is red up to one week, coppery brown for 2-6 months, and white from 6 months onwards.
- The scar is avascular and hairless.

### Identification from Tattoo Marks

- Tattooing is the introduction of non-absorbable pigments or dyes e.g. carbon, Indian ink, Prussian blue or aniline dye deep into the skin (dermis) by a needle.
- Constant and removed only by surgical interference or caustic substances lead to scar formation.
- Common among farmers, sailors, criminals and addicts.
- In the form of sword, birds, symbols or names.
- In different sites like temples in chronic headache, or in joints in rheumatic pain or gout, wrist for personal data or face as cosmetics.
- Tattoo may indicate name, residence, religion, habits and morals.

## ***Medico legal Importance of Hair Examination***

### **1- Personal identification:**

- Color, form and distribution of hair.
- DNA profiling (absolutely individual) of the root sheath (nuclear DNA) is of great help in personal identification and paternity testing.
- Estimation of Age: Lanugo hair in premature infants, at full term scalp hair is 3 cm., growth of pubic and axillary hairs at puberty, grayness of hair at old age.
- Sex and race identification (see before).

### **2- In criminal cases:**

Identification of the assailant: A hair found in the hand of the victim (attached to the nails), may belong to the assailant; and so constitutes a good evidence against him.

### **3- In case of wounds:**

Sometimes contused wounds appear similar to cut wounds as in case of scalp and the skin over the shin of the tibia, in these cases examination of hair tips will help in differentiation, as they appear angular in case of cut wounds; and crushed in case of contused wounds.

### **4- In cases of burns:**

Differentiation between types of burns. In case of burn due to dry heat; hair will be singed i.e. comma-shaped with clubbing of tips, but in case of moist burn (scald) hair is not singed, while in corrosive burns it is eroded and discolored.

### **5- In cases of firearm injuries:**

Hair is burnt in near firing inlet and hence helps to differentiate between inlet and exit.

**6- In cases of sexual offences:**

- Examination of the pubic hair of the victim may show semen or blood of the assailant.
- Also the assailant's loose hair may be found on the victim's private parts (or the reverse may occur sometimes).
- Fecal stains may be detected on the pubic hair of active sodomist.

**7- Diagnosis of cases of poisoning**

In some cases of chronic poisoning with heavy metals as arsenic or drugs of addiction as (morphine & cocaine) the metal or drug is deposited in the hair of the victim, starting from the root and spreading to the tip (so long as exposure or administration is continuous). Also period of exposure to the poisoning could be estimated from the rate of hair growth.

**8- Examination of the hair root:**

It gives an idea about the manner of getting out of this hair, i.e. whether it was fallen by itself (in case of degenerated root) or pulled by force (in case of ruptured sheath of the root).

**9- Examination of the hair tip:**

It gives an idea about the date of its cutting, as it appears angular and sharply cut in case of recently cut hair, rounded in cases of hair cut from few days or tapering in cases of hair cut from more than 2 weeks.

10- **Human hairs should be differentiated from animal hairs:**  
see practical.

11- **Hairs should be differentiated from different fibers:**  
see practical.

## FORENSIC GENETICS

### **ILOS**

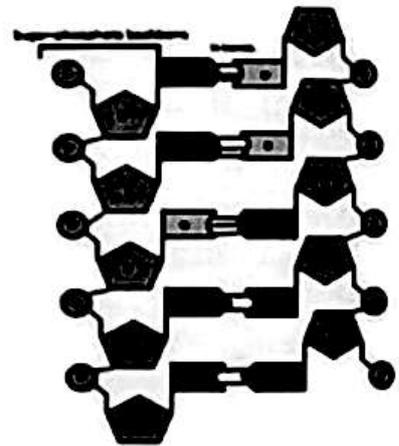
- To realize Forensic applications of genetic karyotyping.
- To select the proper source and method of DNA analysis.
- To understand the structure of human genome.

### Medico Legal Applications of DNA Typing

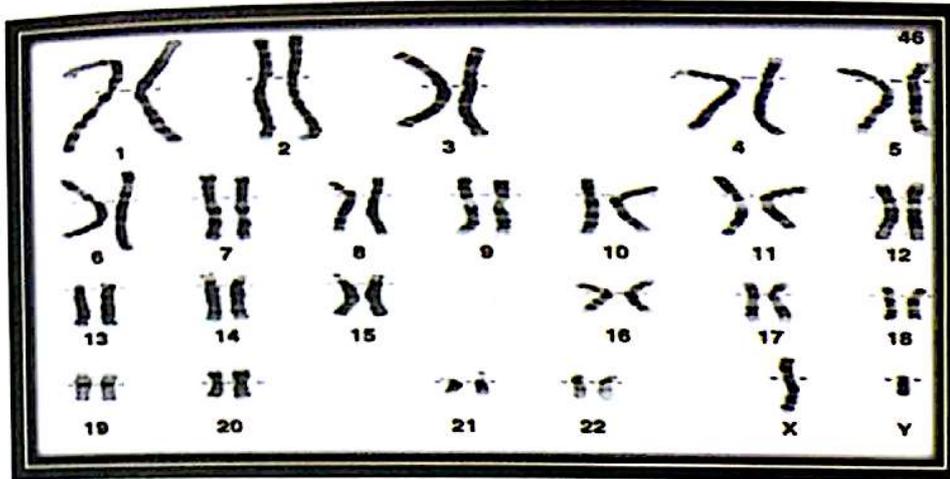
1. Identification or elimination of crime suspects (With the exception of identical twins, no two individuals have the same DNA).
2. Paternity/family relationship: as it is a definite positive paternity test unlike other tests which are all good negative test.
3. Identification of catastrophe victims (mass disaster or burn).
4. Identification of sex and species.
5. Identification of body remains.

### DNA structure and the genome

- The basic building block of the DNA molecule is the nucleotide triphosphate. This comprises a triphosphate group, a deoxyribose sugar and one of four bases adenine (A), guanine (G), cytosine (C) and thymine (T).
- DNA normally exists as a double stranded molecule which adopts a helical arrangement "spiral ladder". The strands, or sides of the ladder, are made up of alternating phosphate and sugar molecules. The nitrogen bases, joining in pairs, act as the rungs.
- Each base joins with its complementary one by hydrogen bonds; adenine pairs with thymine and cytosine pairs with guanine.



- Human genome is organized into 23 chromosomes. Humans contain two sets of chromosomes; one version of each chromosome is inherited from each parent giving a total of 46 chromosomes.



The male human karyotype contains 46 chromosomes (22 autosomes & the X and Y sex chromosomes).

### Genetic Terminology

- The **Genetic Code** is made up of combinations of three successive nucleotides or **codon** (each codon encodes a single amino acid). The **sequence** of the base triplets (or codons) within the gene defines the order of the amino acids in the polypeptide chain and hence the coded information.

First base	Second base			
	U	C	A	G
U	UUU } Phenylalanine UUC } UUA } Leucine UUG }	UCU } Serine UCC } UCA } UCG }	UAU } Tyrosine UAC } UAA } Stop codon UAG } Stop codon	UGU } Cysteine UGC } UGA } Stop codon UGG } Tryptophan
C	CUU } Leucine CUC } CUA } CUG }	CCU } Proline CCC } CCA } CCG }	CAU } Histidine CAC } CAA } Glutamine CAG }	CGU } Arginine CGC } CGA } CGG }
A	AUU } Isoleucine AUC } AUA } AUG } Methionine start codon	ACU } Threonine ACC } ACA } ACG }	AAU } Asparagine AAC } AAA } Lysine AAG }	AGU } Serine AGC } AGA } Arginine AGG }
G	GUU } Valine GUC } GUA } GUG }	GCU } Alanine GCC } GCA } GCG }	GAU } Aspartic acid GAC } GAA } Glutamic acid GAG }	GGU } Glycine GGC } GGA } GGG }

Genetic code

- A **gene** is a section of DNA containing a specifically ordered set of thousands of base pairs. Genes represent unique molecular codes for protein, which determine traits such as eye color and blood type.

- The position a gene occupies along the DNA thread is its **locus**; every individual has one gene from each parent at a given locus.
- Each locus can contain as many as 100 different gene forms. These alternate forms are called **alleles**. Different allele combinations result in variations of a trait, such as eye color.
- Since all human cells require producing the same human proteins and enzymes, the DNA sequences are almost identical in all individuals. Only about 10% of the DNA molecule is used for genetic coding. Between these coding genes there are repetitive non-coding segments, which show marked individual variations that are unique to every individual. These sequences are called **Tandem Repeats**.

**NB.** Forensic analysts are interested in both the potential number of allele combinations and the relative frequency with which certain combinations appear within a population.

### **Tandem repeats**

Two important categories of tandem repeat have been used widely in forensic genetics; **Variable number tandem repeats (VNTRs)** and **Short tandem repeats (STRs)**.

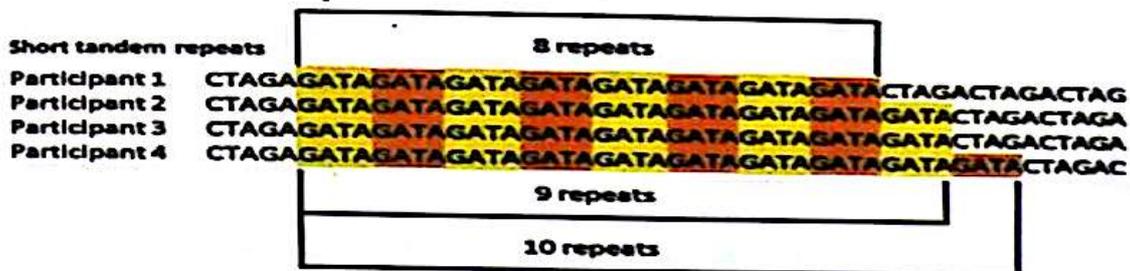
The general structure of VNTRs and STRs is the same. Variation between different alleles is caused by a difference in the number of repeat units that results in alleles that are of different lengths and therefore tandem repeat polymorphisms are known as **length polymorphisms**.

**Variable number tandem repeats (VNTRs); also referred to as minisatellites:**

- They represent the first polymorphisms used in DNA profiling and they were successfully used in forensic casework for several years. The use of VNTRs was, however,
  - **Limited** by the type of sample that could be successfully analyzed; because a large amount of non-degraded DNA was required.
  - **Problematic** in interpreting; as VNTRs profiles have a core repeat sequence that ranges in size from 6 to 100 bp (**base pair**).
- So, their use in forensic genetics has now been replaced by **short tandem repeats (STRs)**.

**Short tandem repeats (STRs); also referred to as microsatellites:**

- STRs are currently the most commonly analyzed genetic polymorphism in forensic genetics.
- STR loci spread throughout the genome including the 22 autosomal chromosomes and the X and Y sex chromosomes.
- They have a core unit of between 1 and 6 bp.
- *STRs satisfy all the requirements for a forensic marker as:*
  - They are robust,
  - The results generated in different laboratories are easily compared,
  - They are highly discriminatory, especially when analyzing a large number of loci simultaneously.
  - They are very sensitive, requiring only a few cells for a successful analysis.



**DNA profiling technique:**

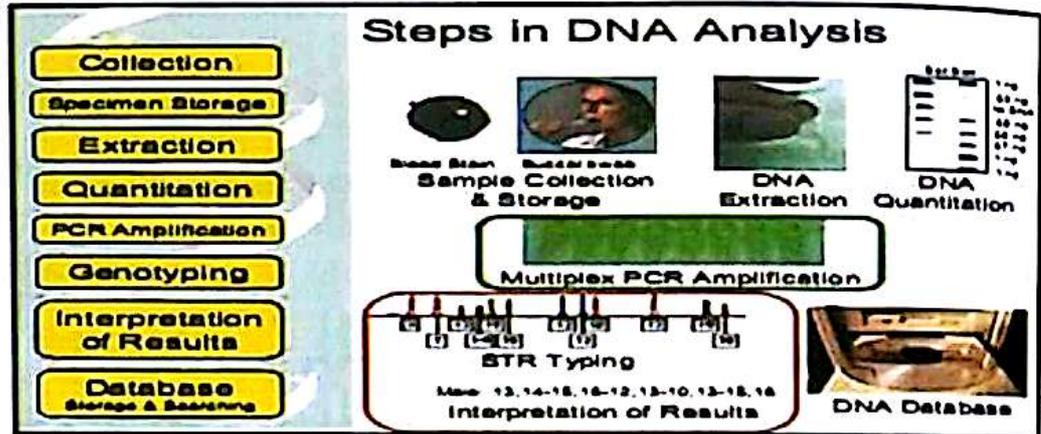
**Sources of DNA:**

The DNA presents in every nucleated cell. Samples commonly examined for DNA in forensic cases include mouth swabs, blood, semen, saliva, cellular tissue, hair root bulbs and dental bulbs.

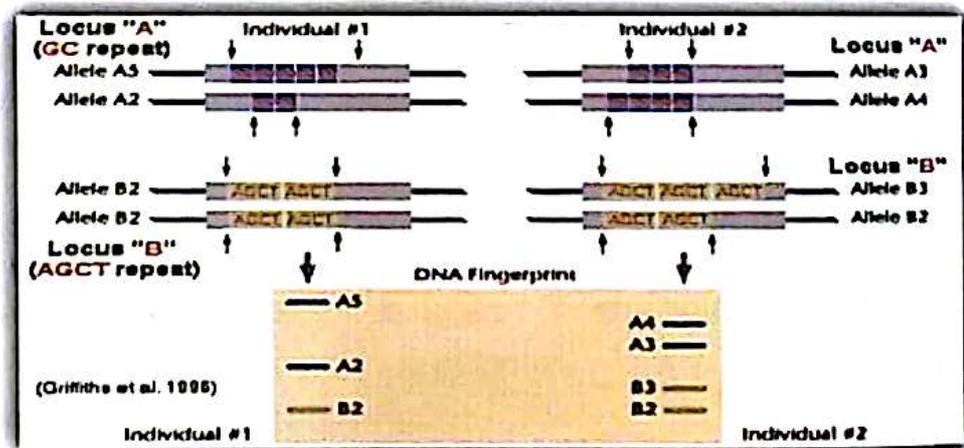
**Methods Employed for DNA Testing:**

- The method of DNA profiling used today is based on **Polymerase Chain Reaction (PCR)** and uses short tandem repeats (STR).
- PCR is used to produce many copies of the STRs by multiple cycles of cooling and heating in a reaction catalyzed by a heat stable DNA polymerase enzyme.
- These STR loci are targeted with sequence-specific primers and amplified using PCR. The resultant DNA fragments are then separated and detected using electrophoresis. The different lengths will show up as bands at different spots on the electrophoresis gel.

- The power of STR analysis comes from looking at multiple STR loci simultaneously. The pattern of alleles can identify an individual quite accurately. So, the chances of two unrelated individuals sharing the same sequence is estimated at one in a million billion and even amongst siblings only one in ten thousand million.
- It is quick, sensitive, rapid and applicable to degraded or minute DNA amounts.



Example of DNA fingerprinting:



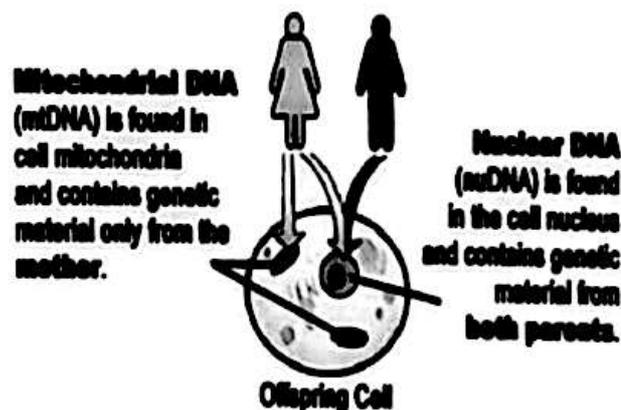
This example includes 2 loci simultaneously (A&B):  
 Locus A is a tandem repeat of the sequence GC: there are four alleles, with two, three, four, or five repeats (A2, A3, A4, and A5, respectively).  
 Locus B is a tandem repeat of the sequence AGCT: there are only two alleles, with two or three repeats (B2 and B3, respectively).

Individual #1 is heterozygous at Locus A (A2 / A5) and homozygous at Locus 2 (B2 / B2).

Individual #2 is heterozygous at both loci: (A4 / A3 and B3 / B2) respectively). The two individuals are distinguishable at either locus.

## Mitochondrial DNA (mtDNA)

In humans, mitochondrial DNA can be assessed as the smallest chromosome coding for 37 genes and containing approximately 16,600 base pairs. Human mitochondrial DNA was the first significant part of the human genome to be sequenced. In most species, including humans, mtDNA is inherited solely from the mother. Certain portions of the control region of mtDNA are highly variable among individuals.



**Mitochondrial DNA offers two primary advantages over nuclear DNA analysis:**

1. Thousands of copies of mtDNA are present in a cell compared to two copies of nuclear DNA, leading to higher sensitivity. This appears valuable especially in samples such as hair, bones, and teeth which contain low concentrations of DNA, making them unsuitable for nuclear DNA examinations.
2. mtDNA is maternally inherited, enabling distant maternal relatives to be compared to the analyzed samples for relationship hypothesis testing or when the original depositor of the sample is not available.

However, since mtDNA is maternally inherited and multiple individuals can have the same mtDNA type, unique identifications are not possible using mtDNA analyses. But still mtDNA is an excellent technique to use for obtaining information in cases where nuclear DNA analysis is not feasible.

## Chapter (3)

# BLOOD STAINS

### ILOS:

- To illustrate the methods of blood stains examination.
- To recognize the MLI of blood grouping.

Blood stains are very important medico-legal evidences at the scene of the crime and they should be examined and documented before any evidence collection.

**On examination of blood stains in the crime scene, the following questions should be answered:**

- I. Is this stain blood?
- II. Is the blood stain of human origin?
- III. Is the blood stain belonging to a certain person?

### I. *Is this stain actually blood?*

#### 1- Physical characters:

- Fresh blood is red in color (it contains oxyhemoglobin) and soluble in H<sub>2</sub>O.
- Old blood is brown (Hb is transformed to metHb) and soluble in diluted acid or alkalis.
- Very old blood is black (Hb is transformed to hematoporphyrin) and soluble in concentrated acids or alkalis.

#### 2- Identification tests of blood:

##### A) Preliminary (presumptive) tests:

##### i. Peroxidase tests:

They are quick, sensitive, easy but **not specific** for blood.

**Principal:** Depend on the presence of peroxidase enzyme in the blood.

**Value:** They are all good –ve tests (i.e. they can exclude the presence of blood in absence of peroxidase enzyme but cannot prove that the stain is blood as peroxidase enzyme is also present in rust & iodides.

**Method:** ½ cc. of the reagent + ½ cc. of stain extract + ½ cc. H<sub>2</sub>O<sub>2</sub> (O<sub>2</sub> donor) → change in color of the reagent on oxidation.

**Examples:**

1. Guaiacum test: (1: 5000 Sensitivity)

Guaiacum reagent → **Green**.

2. Benzidine test: (1: 300 000 Sensitivity)

Benzidine reagent → **Blue**.

No longer used as it is carcinogenic.

3. Kastle-Meyer (ph.ph) test: (1: 5000 000 Sensitivity)

Phenolphthalin reagent → **Pink**.

**ii. Chemical tests (Luminol):**

Luminol is frequently used in identifying blood stains, particularly when the perpetrator has attempted to clean up the blood.

**Principal:** emission of blue-green luminescence as a result of oxidation of luminol enhanced by iron in hemoglobin and its derivatives, so trace amounts of blood can be detected.

**Disadvantages:**

- Luminol has been known to react with other substances, including copper containing chemical compounds, saliva, and various proteins.
- It is limited to use in dark environments.
- The duration of illumination (30 seconds).
- May pose a detrimental effect on subsequent DNA analysis.

**B) Confirmatory (conclusive) Tests:****1. Microscopic Examination: (Fresh blood only)**

-The presence of RBCs is an absolute evidence for the presence of blood. - Old and dried stains with degenerated cells give -ve results.

**2. Microchemical tests (Dry stains only)**

**Principal:** Depend on the presence of hemoglobin (Hb).

**Procedure:** The reagent + the dried crushed stain (by mild heat) → microscopic crystals in presence of Hb.

**Examples:** Teichman and Takayama Tests.

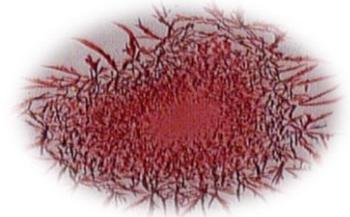
- (a) **Teichman test**→brown, rhombic, regular crystals of acid hematin (**Hemin crystals**).

Teichman reagent is composed of NaCl, NaBr, NaI (0.1 gm each) in 100 cc of glacial acetic acid.



- (b) **Takayama test**→ pink, needle-shaped crystals arranged in rosette of reduced alkaline Hematin (**Hemochromogen crystals**).

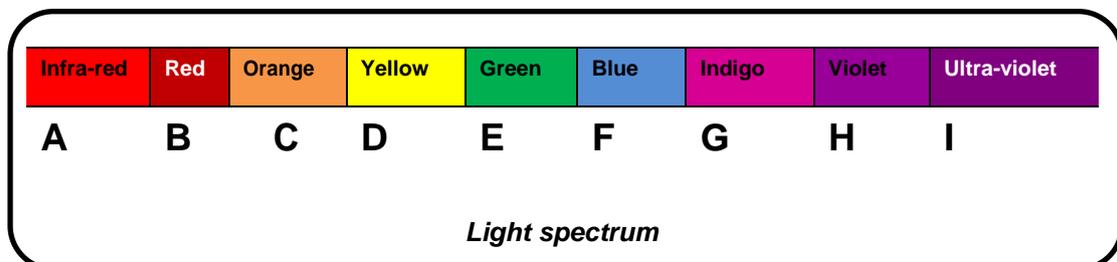
Takayama reagent is composed of NaOH (alkali), pyridine (catalyst), glucose (reducing agent) and H<sub>2</sub>O (solvent).



### 3. Spectroscopic tests:

#### Principal:

The spectroscope contains a prism which analyzes white light into the 7 colors of the spectrum. Each color has its own wave length. Various pigments absorb different wave lengths with production of specific absorption bands.



#### Value:

- Diagnose the presence of hemoglobin or its derivatives by giving characteristic absorption bands in the yellow spectrum i.e. between D & E lines.
- Also, diagnose poisoning (CO, CN and nitrites).

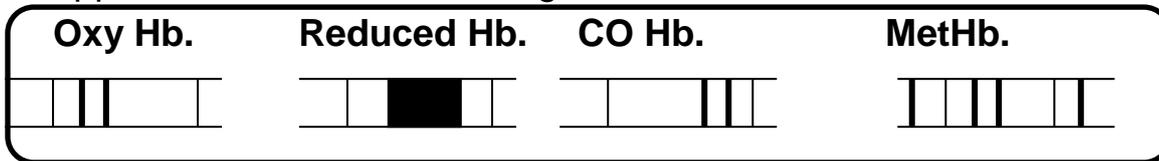
#### Advantages:

- Easy.
- Needs minute amount of blood.
- Does not cause chemical changes in the sample, which could be used in other tests.

**Method:**

- Place the sample between the prism and the spectrum.

Observe the site and number of the resulting absorption bands which appear as dark lines in the region of D & E lines.



- **Oxy Hb (bright red):**

Present in fresh stains, gives 2 bands between D & E lines.

- **Reduced Hb (violet):**

Gives one broad band between D & E lines.

- **Carboxy Hb (crimson red):**

Gives 2 bands between D & E lines, shifted to the right.

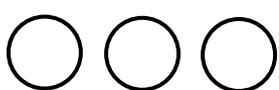
- **Met Hb (brown):**

Gives 4 bands; one before D, 2 between D & E lines and one after E lines.

## II. Is a blood stain human?

### 1) Microscopic examination (fresh blood only)

From the shape of RBC'S, species can be determined, as follows:

Human RBCs	Camel RBCs	Non-mammalian RBCs (Frog, Hen)
Circular, non nucleated, biconcave	Oval, non nucleated	Oval, nucleated
		

### 2) Immunological Tests:

#### i. Precipitin Test:

**Definition:** It is an antigen-antibody reaction leading to precipitation.

The *Antigen (Ag)* is the unknown stain extract (blood Stain).

The *Antibody (Ab)* is a previously prepared antihuman serum by injecting human blood into a rabbit which will form Ab against human protein of the blood, so the collected serum is called ***anti-human serum***.

**Value:** This test determines the origin of the protein in the blood and tissues -as well as any biological fluid- but does not determine whether this protein is blood or not.

**Precautions:** To prevent false results:

**1. The antigen (the unknown stain extract), must be:**

- a) Clear, to detect precipitation
- b) Neutral, to prevent precipitation by pH changes.
- c) Dilute 1/1000, to prevent non-specific precipitation with other mammalian blood if they are concentrated, which is called "*mammalian reaction*".

To avoid this reaction, the stain extract must be tested by addition of one drop of nitric acid. A faint opacity indicates a dilution of 1/1000.

**2. The antibody (the anti-human serum), must be:**

- a) Clear.
- b) Neutral.
- c) Specific (i.e. against human only).
- d) Potent, i.e. effective. On addition of 0.1 ml. from it, it causes precipitation of 2 cc of known human blood.
- e) Dilute, to prevent non-specific precipitation with any blood from animals of the same group, which is called "*group reaction*".

To avoid this reaction, the anti-human serum is diluted by addition of normal rabbit-serum, as it is prepared in rabbit.

**3. Control of the test by testing the anti-human serum against:**

- a) Known human blood,
- b) Blood of other animals,
- c) The solution used for the extraction of the stain &
- d) The extract of the material on which the stain was found but away from the stained area.

**Procedure:**

Few drops of the stain are put in a series of tubes. To the 1<sup>st</sup>, few drops of antihuman serum are added & in the rest of the tubes we put different anti-animal sera. The result is read after 15 min. If a ring of ppt. appears only in the 1<sup>st</sup> tube containing antihuman serum, the stain is human.

**ii. The One Step Hema-Trace test strip:**

It is an immune-chromatographic test for the detection of human blood.

**Principle:** If human hemoglobin is present in the sample, it will combine with a mobile monoclonal anti-human hemoglobin antibody in the test strip.

**Procedure:** Any antibody-antigen complex formed migrates to the test area → a pink dye becomes visible in the test region.

**Value:** It is a highly sensitive, convenient, and rapid test.

### III. *Is a blood stain belonging to a certain person?*

Individualization can be detected by the genetic markers of the blood.

#### 1- RBCs markers:

- RBC's **surface** antigens: A, B, Rh, M, N etc.
- The red cell **isoenzymes**: phosphoglucomutase (PGM), erythrocyte acid phosphatase, etc.

2- **Plasma markers:** the **serum proteins** polymorphism: haptoglobin (Hp), GM, GC protein, etc.

3- **Haemoglobin variant:** Hb A, Hb A<sub>2</sub>, Hb F, abnormal Hb (S, C or E).

4- **WBC's markers:** the **histocompatibility** antigens: Human Leucocytic Antigen (**HLA system**).

5- **DNA fingerprinting.**

## BLOOD GROUPING

### They are good negative tests

#### a) The ABO system:

Blood group	Agglutinogens in the RBC's	Agglutinins in the serum
A (40%)	A	anti B
B (11%)	B	anti A
AB (4%)	AB	—
O (45%)	—	anti A & anti B

**N.B:** A agglutinogen is of 2 types: (A<sub>1</sub> & A<sub>2</sub>) and also, agglutinin is of 2 types: (anti A<sub>1</sub> & anti A<sub>2</sub>).

**b) MN system:**

- M & N agglutinogens are present in the RBCs with no corresponding agglutinins in serum.
- Humans are not able to form antibodies against M & N agglutinogens so; there are no complications in blood transfusion.
- Used to distinguish between persons of similar ABO groups.

**N.B:** A, B, M & N agglutinogens are also found in urine, semen, saliva, sweat, milk etc. in 75% of people (secretors) (S+ve), the other 25% are non-secretors (S-ve).

**c) Rh factor:**

- Rh factor is present in RBC's in the form of 6 antigens (agglutinogens): (C, D, E, c, d & e) which are also found in 100% of the "Rhesus Monkey" red cells.
- These agglutinogens have no corresponding agglutinins in the serum.
- Humans have no ability to form agglutinin against them except for D.
- According to the presence or absence of D antigen, people are either:
  - **Rh +ve:** 85% have D agglutinin (DD or Dd).
  - **Rh -ve:** 15% have **NO** D or antibodies against it but they can form agglutinins against D when they become sensitized by introduction of this antigen as in:
    - Blood transfusion of Rh +ve blood to Rh -ve recipient.
    - Pregnancy → Rh -ve mother & Rh +ve fetus.
- Genetically, any person must have 3 pairs one from each group (CC, Cc, cc/ DD, Dd, dd/ EE, Ee, ee), so there are 36 possibilities.

**Medicolegal importance of blood grouping:****I- Identification:*****Civil cases:***

- 1- Identity cards must include the blood group for:
  - Blood transfusion in emergency cases.
  - Identification purposes.
- 2- Before marriage: of Rh +ve male and Rh -ve female.

**Criminal cases:**

- 1- A blood stain on the suspect's clothes which is different from his blood group is good evidence against him.
- 2- In cases of secretions as semen and saliva, grouping may identify the assailant (in S +ve cases).

**II- Disputed paternity:****Tests applied in cases of disputed paternity are:**

- Blood grouping.
- Plasma markers e.g. haptoglobin (Hp), Gm and GG.
- RBC's isoenzymes.
- DNA probing.

**NB.** Blood grouping is a good –ve test i.e. it can exclude only and not prove, taking into consideration the following:

- **O father** can never have **AB child**.
- If both parents **Rh-ve**, the child is never **Rh+ve**.
- If both parents **M**, the child is never **N**.

**III- Hemolytic transfusion reaction:**

This occurs due to destruction of the **donor's** RBCs following blood transfusion.

**Cause:** Incompatibility is due to either ABO system or Rh factor (in case of sensitized Rh –ve person after previous exposure to Rh +ve blood).

**Clinical picture:**

1. Fever with rigors.
2. Jaundice due to hemolysis of RBCs.
3. Chest pain and dyspnea.
4. Lumbar pain because free hemoglobin in the blood (hemoglobinemia) blocks the renal tubules leading to renal failure.

**Medico-legal investigations in case of hemolytic reaction:**

- The blood sample of the patient which was sent for grouping is reexamined (the original sample).
- Post transfusion sample is examined (obtained directly from the patient) to detect hemolysis.
- Samples from every bottle used for transfusion are examined
- Sample from the urine of the patient is examined for hemoglobinuria.

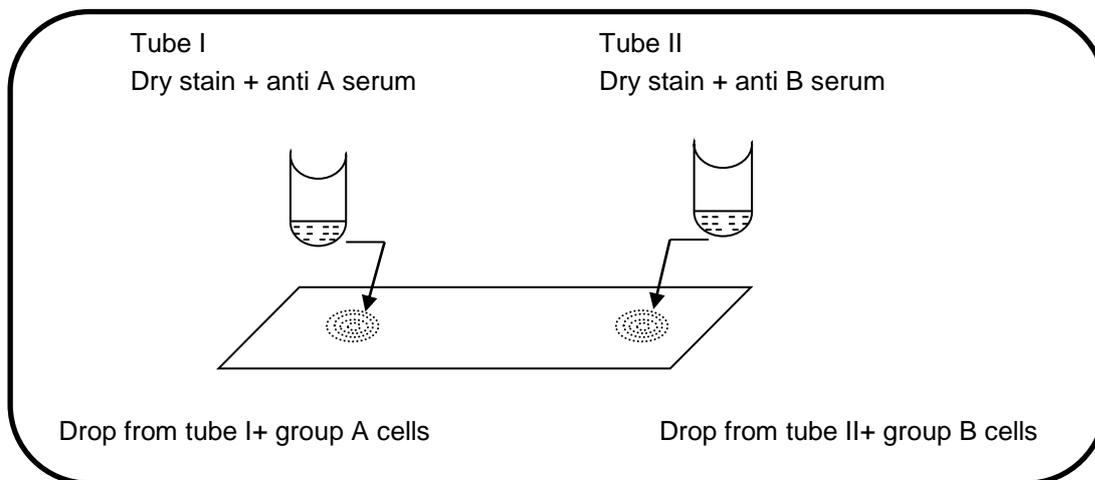
**Technique of grouping**

**1- For Fresh blood (Direct agglutination)**

- Drop of bl. + Anti A serum → agglutination (group A)
- Drop of bl. + anti B serum → agglutination (group B)
- Agglutination in both slides → (group AB)
- No agglutination in both slides → (group O)

**2- For old dried stain and body secretions (Indirect agglutination)**

- The stain is divided between 2 tubes.
- Anti A serum is added to the 1<sup>st</sup> and anti B serum is added to the 2<sup>nd</sup>.
- Leave for 24 hours to allow the agglutinins in the sera to absorb the agglutigen in the stain.
- Centrifuge the tubes and test the supernatant sera for the presence of Alfa and beta agglutinins by adding to them known red cells (A to the 1<sup>st</sup> and B to the 2<sup>nd</sup>). Absence of agglutination of these cells means that the unknown stain absorbed the agglutinin content of the antiserum.



If no agglutination with A	→ the blood group is A
If no agglutination with B	→ the blood group is B
If no agglutination with both	→ the blood group is AB
If agglutination with both	→ the blood group is O

## Chapter (4)

# MEDICOLEGAL ASPECTS OF DEATH

### ILOS:

- *To achieve proper death diagnosis.*
- *To formulate death declaration certificate.*
- *To differentiate between natural and unnatural death.*
- *To identify sudden death and related events.*

**Death occurs in two stages; the first is somatic, clinical, or systemic death followed by the stage of cellular or molecular death.**

### 1- Somatic (Clinical) death

It is the failure of the body as an integrated system due to complete & irreversible cessation of vital functions of the brain, heart, and lungs.

### 2- Molecular (Cellular) death

It is the death of individual organs and tissues secondary to the cessation of circulation.

#### **Molecular life**

- It is the period between somatic & cellular death. Although life ceases in the body as a whole, it persists in its components such as the tissues & cells that respond to physical, chemical or thermal stimuli.
- It lasts from few minutes to few hours depending upon the oxygen requirement of the tissues and cells (*usually* within 3 – 4 hours of somatic death).
- **The most sensitive** cells are the nerve cells (die within few minutes of somatic death) while **the least sensitive** are the connective tissue cells (die within hours).
- **Characters of molecular life:**
  - Muscle contraction on electrical and mechanical excitation of skeletal muscles.
  - Ciliary muscle reaction to atropine by dilatation of the pupil, and to physostigmine by its constriction.
  - Motile sperms may be found in the genito-urinary system at autopsies for few hours after death.
  - Some enzymatic processes or activities continue after death.

- **MLI of molecular life::**

**Organ Transplantation** could be carried out only during the period of molecular life. The liver should be taken within 15 min. after death, the kidney within 45 min., the heart within 60 min and cornea up to 6 hours.

## Classification of Death

### ***I. According to the mode (mechanism) of death :***

#### ***a. Coma***

It occurs due to functional failure of the brain & paralysis of its vital centers.

Causes:

- 1- Diseases of the brain e.g. inflammations or tumors.
- 2- Injuries of the brain e.g. hemorrhage & vascular lesions.
- 3- Intoxications with certain poison e.g. opiates & alcohols.
- 4- Metabolic errors e.g. uremic or hepatic encephalopathy.

#### ***b. Syncope***

It occurs due to functional failure of the CVS resulting in brain anemia.

Causes:

1. Cardiac causes; valvular diseases, infarctions & coronary diseases, penetrating wounds of the heart & cardio-toxic drugs e.g. digitalis or aconitine.
2. Circulatory causes; excessive hemorrhage (external/ internal).
3. Nervous causes; Reflex Cardiac Inhibition (RCI).

#### ***c. Asphyxia***

It occurs due to functional failure of the respiratory system resulting in tissue anoxia.

Causes:

1. Pathologic such as pneumonia, pulmonary edema, pulmonary embolism, obstruction of airways (diphtheria, foreign bodies, tumors).
2. Violent causes as strangulation, smothering or drowning.
3. Poisoning by opiates (depress the respiratory center), strychnine (spasm of respiratory muscles).

## **II. According to the manner (condition) of death**

### **a. Natural death**

It refers to death of pathological etiology and occurring in non-suspicious circumstances as in life-threatening diseases e.g. epilepsy, cerebrovascular stroke, myocardial infarction, or terminal diseases e.g. Advanced malignancy.

### **b. Unnatural death**

Death that occurs due to any other cause rather than diseases. This could be:

#### **1) Accidental**

It refers to death due to accidents and unintentional incidents causes e.g. traffic accidents.

#### **2) Suicidal**

It refers to the cases where a person deliberately kills oneself e.g. drowning, suicidal wounds, and suicidal firearm injuries.

#### **3) Homicidal**

It refers to the willful killing of the human being by another one e.g. homicidal firearm injuries or homicidal wounds such as stabs.

## **III. According to the cause of death**

The cause of death is the physical condition that directly contributed to the person's death. This may be pathological, traumatic, or toxic conditions which end fatally.

## **Diagnosis of Death**

***Diagnosis of death depends upon:***

***-ve vital functions***

***&***

***+ve postmortem changes (see chapter 5)***

## Signs of Arrested Vital Functions

### **A. Signs of arrested circulation**

1. Absence of pulsations in big arteries i.e. femoral and carotid.
2. No perceived blood pressure.
3. Inability of auscultating the heart sounds by the stethoscope on the 5<sup>th</sup> intercostal space for a continuous period of 5 minutes. It is a more reliable method than palpating the pulsations but not definite since auscultation of the heart is difficult in:
  - Very weak, feeble beats & ventricular fibrillation.
  - Thick chest wall & obese persons.
  - Emphysema.
4. Electrocardiogram (ECG) is flat or isoelectric in all leads for at least 5 min continuously.
5. Other observations:
  - Arrest of bleeding from wounds, eg. surgical wounds.
  - Webs of figure are opaque to transillumination.
  - No hyperemia on putting a hot object on the skin.
  - SC injection of fluorescein dye → no spread of its green color.

### **B. Signs of arrested respiration** (must be complete & continuous)

1. *No respiratory movements* detected by careful inspection of the chest and anterior abdominal wall.
2. *No respiratory sounds* detected by auscultation for continuous 5 minutes of the upper parts of lungs and larynx. (The larynx is easier than the lungs due to direct auscultation i.e. no intervening structures).
3. Arterial Blood Gas (**ABG**) Analysis, in hospital setting, reveals severe hypoxia ( $\downarrow O_2$ ) and hypercapnea ( $\uparrow CO_2$ ) not consistent with life.
4. Other simple tests:
  - No movement of a piece of cotton placed in front of mouth or nostrils.
  - No dimness of a mirror placed in front the mouth or nostrils.

### **C. Signs of arrested brain function**

*Brain death is defined as the permanent absence of all brain functions including those of brain stem.*

**i. Signs indicating cortical death**

- Unconsciousness or deep irreversible coma characterized by lack of wakefulness and awareness.
- Absence of visual fixation and visual tracking.
- Total absence of any movements, tremors or fasciculation.

**ii. Signs indicating brain stem death**

- **Loss of spontaneous breathing i.e. apnea.**  
Check for persistent apnea by "Apnea Test" for mechanically ventilated patients:
  - a) Disconnect ventilator,
  - b) Deliver oxygen into trachea and
  - c) Check blood gases after 10mins.
  - d) If CO<sub>2</sub> rises to 55 mmHg and there is no attempt to breathe → the test is positive and apnea is present.
- **Loss of cranial reflexes:**
  - Absence of corneal reflex.
  - Absence of light reflex.
  - Absence of gag reflex.
  - Loss of oculo-cephalic reflex (doll's eye sign).
  - Loss of oculo-vestibular reflex (caloric test).

**iii. Investigations suggesting brain death:****a. Electro-encephalogram (EEG)**

The presence of flat EEG is an indicative criterion of brain death; however, it is not reliable as:

- It reflects only the electric activity of the cerebral cortex, thus do not indicate brain stem death.
- Flat EEG may be present in viable persons e.g. hypothermia or CNS depressant drugs.

**b. Cerebral blood flow (CBF)**

Absence of CBF is incompatible with brain survival. CBF examination can be carried by contrast cerebral angiography or Doppler technique.

**Diagnosis of death is difficult in certain cases:**

- Soon after death when the body is still warm.
- Coma following excessive doses of sedatives/hypnotics e.g. barbiturates.
- Hypothermia especially in elderly.

- Suspended animation (apparent death)
  - The vital functions of the body (heart beat & respiration) are depressed to minimum level compatible with life; that they would not be detected by routine methods of clinical examination.
  - It may persist from few seconds to few minutes. Thus the doctor has to continue resuscitation until either the person recovers or a sure sign of death appears eg. Rigor mortis.
  - The condition may be either:
    - **Involuntary** as in cases of drowning, electric shock, after anesthesia, or in cerebral concussion.
    - **Voluntary** as in cases of yoga practitioners.

#### **MLI (significance of diagnosis of death):**

- It allows switching off mechanical ventilation.
- It allows the doctor to write the death certificate.
- It allows burial of the dead bodies.
- Organ donation could be carried out.

#### **Premature burial is prevented by:**

- Diagnosis of death should be confirmed.
- Anybody is not transferred from the ward to postmortem unless at least **2 hours** have passed since the occurrence of clinical death,
- Burial is not allowed except after obtaining the permission of public health authorities.

### **Brain stem death**

- The cerebrum is intact; however, the cerebral functions are cut off by the brain stem lesion.
- Brain stem death with intact cortex is rare since the lesion that cause injury to the brain stem usually causes injury to the more susceptible cortex.
- A brain stem dead person is legally announced dead in many countries (**BUT not in Egypt**).
- **Medico-legal aspects:**
  - To take the decision of termination of life-support systems i.e. switch off mechanical ventilation and pharmacological life-support
  - Declare death and write the death certificate.
  - Organ transplantation: The brain stem death should be confirmed by two medical experts each separately not including any of the transplantation team and perform examination twice.

### Persistent vegetative state (PVS)

- The term persistent vegetative state was introduced to describe the patient who loses the higher cerebral powers of the brain but the functions of the brainstem remains relatively intact.
- In this case the patient exists in a “**vegetative state**” where the survival of the brain stem ensures spontaneous respiration & therefore cardiac function is not compromised. The condition is “**persistent**” i.e. may remain for years.
- PVS may results from traumatic (head trauma) and non-traumatic injuries (hypoxic – ischemic encephalopathy), degenerative and metabolic disorders, and developmental malformations.
- It is a clinical condition characterized by:
  - Wakefulness without awareness with oneself or the surroundings.
  - Sleep and wake cycles with circadian rhythm.
  - Head and eyes can follow a moving object or move towards a loud sound.
  - They may grind their teeth, smile, shed tears, grunt or moan without any reason.
- **Medico-legal Importance:**
  - The medical care team should work on (1) prevention of infection as pneumonia, and (2) maintenance of the patient’s clinical condition by preventing bedsores and providing balanced nutrition.
  - Withholding life support measures is considered a form of “**passive euthanasia**”. This term is defined as the intentional ending of one’s life by a medical omission i.e. Withdrawal of life supporting measures when death is not imminent.

#### **N.B. Whole brain death**

- Both cortical brain death and brain stem damage occur.
- Artificial ventilation keeps the ‘corpse’ alive and prevents heart from failing, until disconnected from ventilator (**beating heart cadaver**).

## SUDDEN DEATH

### **Definition:**

It is the sudden unexpected death of an apparently healthy individual, or death within a short time (24 hours) of a terminal disease.

Obtaining a thorough history from family members or other witnesses is necessary to obtain insight into sudden death events.

### **Etiology:**

1. Trauma: head injuries, burns, electric shock .....
2. Poisoning: CO, insecticide, narcotics or hypnotics .....
3. Pathological (natural death): CVS, CNS, Respiratory, GIT.....

### **Sudden Natural Death Causes:**

#### **I. Cardio-vascular system**

1- **Coronary artery diseases:** it is responsible for at least one third of the sudden deaths due to natural causes.

- Coronary atherosclerosis: More common in males. It is the commonest circulatory condition causing sudden death especially the left anterior descending coronary artery; that is named "*The widow maker*".
- Coronary aneurysm: More common in females.

2- **Massive Pulmonary embolism (PE):**

Mortality from PE is high, particularly if patients present with sudden cardiac arrest. Massive PE may be misdiagnosed and often diagnosis is established only by autopsy.

3- **Myocardial diseases:**

- Cardiomyopathies: amyloidosis or sarcoidosis.
- Acute or subacute myocarditis following rheumatic fever, diphtheria and septic infections.
- Myocardial fibrosis following active myocarditis or myocardial infarction.
- Fatty infiltration of the myocardium as a result of acute infections and toxemias.
- Acute heart failure that may occur spontaneously with hypertrophied myocardium.
- Ruptured myocardium due to myocardial aneurysm or following massive myocardial infarction (MI) → in cardiac tamponade.
- Sudden arrhythmic death syndromes SADS: Familial genetic disease.

4- **Valvular & endocardial lesions:** Such as acute or subacute endocarditis, mitral or aortic stenosis.

5- **Pericardial diseases:** Rheumatic, septic or even tuberculous pericarditis may present without noticeable symptoms.

6- **Aortic lesions:** As atheromatous degeneration that may result in dissecting aneurysm.

## **II. Respiratory system (next common group of causes)**

### **1- Pulmonary embolism:**

It is usually due to dislodgement of a thrombus from one of the big veins of the lower limb or pelvis.

### **2- Acute edema:**

- Acute laryngeal edema:

It may occur as a complication of local infections, tumors, foreign body impaction and sometimes as a part of generalized edema.

- Acute pulmonary edema:

It particularly occurs in old peoples with hypertension.

3- **Infections:** as pneumonia and bronchopneumonia.

4- **Hemoptysis:** Fatal hemoptysis may be the 1<sup>st</sup> symptom of a tuberculous or bronchiectatic cavity or even bronchial carcinoma if the lesion opens up a big vessel.

5- **Bronchial asthma** may be attributed to the over use of adrenergic drugs especially the self-administered inhalers.

## **III. Central nervous system**

1- **Epilepsy:** It is the commonest cause of sudden death due to intracranial lesion.

### **2- Cerebral hemorrhage:**

- Rupture of the lenticulo-striate artery in the region of the basal ganglia, following upon arteriosclerosis is the commonest cause.
- Hemorrhage may also occur in other places of the brain as the cerebrum, pons, midbrain & cerebellum.

### **3- Subarachnoid hemorrhage:**

Hemorrhage may rapidly occur in the subarachnoid space in the base of the brain following the rupture of a berry aneurysm.

### **4- Intra-cranial infections:**

Acute suppurative meningitis or base brain abscess complicating otitis media or lung abscess may cause sudden death. Other

fulminating infections of the brain & meninges are meningococcal meningitis and polioencephalitis.

#### **IV. Gastrointestinal System:**

1. ***Peptic ulcers:*** either due to bleeding or ruptured ulcer.
2. ***Intestinal infarction:*** following strangulated hernia or torsion of intestinal loops around adhesions.
3. ***Peritonitis.***
4. ***Fulminant hepatitis:*** with liver cell failure.
5. ***Severe gastroenteritis:*** with significant dehydration (in infants).

#### **V. Obstetrics and Gynecology:**

1. ***Antepartum and postpartum hemorrhage.***
2. ***Amniotic fluid embolism.***
3. ***Ruptured ectopic pregnancy.***

#### **VI. Anaphylactic deaths:**

- The most common etiology is IV injections, insect bites, and drug or food intake.
- The symptoms are faintness, itching, wheels of urticaria, chest tightness, respiratory difficulties and collapse.
- The onset of symptoms is usually immediate or within 15-20 min.
- Death occurs within 1-2 hours due to acute respiratory distress or cardiovascular collapse.

## Chapter (5)

# POSTMORTEM CHANGES

### ILOS:

- To interpret medico-legal evidences from postmortem changes.
- To estimate postmortem interval.

## **Primary Flaccidity & Contact Flattening**

الإرتخاء الأولي

### Primary flaccidity

- Is defined as the complete relaxation and loss of both tone & reflexes of voluntary and involuntary muscles immediately after death.
- The face acquires a peaceful look, the lower jaw drops, the eye balls lose their tension & the pupils dilate. The muscles become soft & flabby, and the joints are flexible. The sphincters relax resulting in incontinence of urine and feces.
- The duration of 1ry flaccidity is about **3 hours** after clinical death. During this period, the muscles still react to the external stimuli (period of molecular life).

### Contact flattening

- Is the flattening of the convex parts of the muscles compressed against flat surface.
- It is due to the effect of the body weight, loss of muscle tone, and loss of elasticity after death.
- MLI: presence of contact flattening in opposite sites indicates alteration of the body position after death, eg. Flattening of buttocks in hanged body indicates postmortem (PM) suspension.

## **Ocular changes**

### Reflexes

Loss of corneal and light reflexes immediately after death.

### Sclera

Shows "**Taches Noires**" which is brownish black discoloration that occurs due to accumulation of cellular debris & dust on the sclera when the eyes remain opened for few hours (**3–4 hours**).

### Cornea

Loss of the clear glistening appearance & the cornea becomes dry, cloudy and opaque (**2 hours**).

### Pupils

- The pupils usually assume a midsized dilate position, which is the relaxed neutral position of the papillary muscle. With the development of rigor mortis the pupils become constricted & lastly they become dilated again with the development of 2ry flaccidity.
- The state of the pupils after death is of no indication of their ante-mortem appearance.
- The pupil may lose their circular shape after death as a result of uneven relaxation.

### Intra-ocular pressure (IOP)

The eye ball feels progressively softer within minutes due to drop of IOP. The normal intra-ocular pressure is (10 – 20 mm Hg), this pressure drops to its half at the time of death & becomes nil by **2 hours** after death.

### Fundus

- Pallor of the optic disc.
- Segmentation of retinal vessels “**trucking**” that occurs within 15 min of death (one of the earliest positive signs). It is due to loss of blood pressure that allows the blood to break up into segments inside the blood vessels. This phenomenon occurs all over the body, but only in the retina it is accessible to direct viewing.

## ***Skin Changes***

- After death, the skin becomes **pale**.
- The skin **loses its elasticity** leading to absence of P.M. gaping of wounds.
- It **loses its translucency** due to absence of circulation (the webs of the fingers are opaque to transillumination).

## ***P.M. Cooling (Algor Mortis)***

### Mechanism:

- During life there is balance between heat production (mainly by the oxidative processes) & heat loss (by conduction, convection & radiation).

- After death, heat production stops & the body continues losing heat at an average rate of 1–1.5 °C per hour, till attaining equilibrium between the dead body & the temperature of its surroundings after about 12- 18 hours in moderate temperature.
- Heat loss occurs only on the body surface and the core heat (visceral temperature) from the interior can reach the body surface only by conduction so the fall of internal body temperature is delayed for about 45 minutes till the establishment of a temperature gradient towards the surface and may thus remain unchanged for some time.

### **Sites of measuring the temperature of the corpse using chemical thermometer:**

- The rectal temperature and the vagina may also be used.
- The under surface of the liver (visceral temperature), through a midline stab in the abdomen (at autopsy).
- Alternative sites include the axilla, deep nasal passage or external ear → surface temperature which is lower than visceral.

### **Factors affecting the cooling rate:**

1. *Initial body temperature.*
2. *Age:* infants cool more rapidly because of large surface area/body mass ratio and scanty subcutaneous fat.
3. *Posture of the body:* A curled body into the fetal position will cool less rapidly than the extended one due to less exposed surface area.
4. *Gender & obesity:* obese peoples & females cool slower than thin peoples & males (Subcutaneous fat acts as heat insulator).
5. *The surroundings:*
  - *Ambient temperature* is the major factor in cooling. A body will not cool in very hot weather.
  - *Air movements & humidity* accelerate cooling by convection.
  - *Water & fluid media:* cooling is far more effective and the rate of cooling in cold water is double that of the air.
  - *Clothing & coverings* reduce heat loss. Wet clothing will accelerate cooling compared with dry coverings.
6. *Cause of death:*
  - Severe hemorrhage shortly before death causes a more rapid rate of cooling.

- **P.M. caloricity (heating):** conditions in which the body heat may be retained or even increased in the first two hours after death as:

- Sunstroke & pontine hemorrhage (heat regulation is profoundly disturbed before death).
- Strychnine poisoning & tetanus (great increase in heat production by the muscle contractions).
- Acute bacterial or viral infection e.g. pneumonia, typhoid, or encephalitis.
- Intense asphyxial conditions (extensive muscle contractions).

### **Medico-legal importance of cooling:**

- It denotes the time passed since death.
- It denotes the cause of death from rate of cooling.
- Differentiation between primary and secondary flaccidity.

## ***Hypostasis***

الرسوب الرمي

It is also known as P.M. lividity, P.M. staining, suggillation or livor mortis.

### **Definition:**

It is P.M. bluish or purple discoloration of the most dependent parts of the body (externally & internally), due to gravitation of blood inside the blood vessels of these parts.



### **Medico-legal Importance:**

1. It is a **sure sign** of death.
2. It denotes the time passed since death (**Post Mortem Interval**):
  - The process **starts immediately** after death, and it becomes pronounced within **3 hours** as mottled patches on the dependent parts.
  - These patches increase in size and then coalesce together and become fixed and fully developed in about **8 hours** except at sites of compression (**contact pallor**).
3. Its site denotes the **position** of the body at the time of death.
  - In supine position, hypostasis is observed over the posterior aspects of the body.
  - In prone position, hypostasis is distributed over the anterior aspects of the body.

- In hanging, hypostasis is observed in the lower limbs; external genitalia and lower parts of the forearms & hands.
- In drowning, hypostasis is observed in the head; front of the trunk and front of the limbs.

**NB.** Change of the body posture after death **before** the fixation of hypostasis will result in the presence of two different areas of hypostasis.

2. It denotes the **cause** of death from:

- a. **Site** of hypostasis, as in case of hanging & drowning.
- b. **Color** of hypostasis which depends on the color of hemoglobin & the mode of death
  - Normally, the color of hypostasis is bluish purple.
  - In severe anemia & hemorrhage hypostasis is ill defined & very faint.
  - In asphyxia, hypostasis is dark blue due to reduced hemoglobin.
  - In case of red asphyxia (CO, cyanide & cold) there is red hypostasis.
  - In case of nitrite poisoning, hypostasis is brown due to formation of met-hemoglobin.
- c. **Extent** of hypostasis:
  - More marked in asphyxia and congestion.
  - Ill-defined in hemorrhage.

3. Early Hypostasis (during the first 3 hours P.M.) must be differentiated from bruises (*see wounds*).

### **Rigor mortis (P.M. Rigidity)**

التيبس الرمى

#### **Definition:**

It is a P.M. condition characterized by progressive rigidity of voluntary and involuntary muscles following primary flaccidity and preceding secondary flaccidity.

#### **Mechanism:**

It is due to chemical changes involving muscle proteins (actin and myosin).

- ATP (Adenosine Triphosphate) is responsible for the elasticity & plasticity of the muscles.

- After death, there is a drop in the muscle ATP level leading to fusion of myosin & actin filaments into a “dehydrated stiff gel” resulting in rigor mortis.
- Rigor is initiated when the ATP concentration falls to 85 % of normal and the rigidity of the muscle is at maximum when the level declines to 15 %.

### **Factors affecting rigor mortis:**

#### 1- *Effect of temperature*

In cold weather, rigor is delayed in onset and offset while in hot climate it is rapid in onset and of short duration (rapid autolysis of ATP).

#### 2- *Muscle bulk & age:*

Rigor is more rapid in onset & offset and of short duration in less developed body musculature e.g. bodies of infants, females, weak debilitated peoples. On the other hand, in muscular athletes it is delayed in onset and lasts longer (abundant ATP).

#### 3- *Muscle activities before death (cause of death):*

Convulsions and exertion before death e.g. in electrocution, strychnine, tetanus, exercise or violence are usually followed by rapid onset and offset of rigor mortis (depleted ATP).

### **Medico-legal importance of rigor mortis:**

1- It is a sure sign of death.

2- It denotes the PMI (***Post Mortem Interval***):

Rigor mortis starts **2 hours** after death, in the small muscles of the face then the neck, and trunk, followed by the upper extremities then the legs. The last to be affected are the muscles of fingers and toes. It takes **12 hours** to develop, then secondary flaccidity sets in and the muscles start to soften gradually in the same descending order, due to onset of autolysis.

3- The position of the body after death is fixed by rigor mortis.

4- The cause of death is suggested from the time of onset & offset of rigor mortis: *see before*.

5- **Differential diagnosis of rigor mortis:**

**Cadaveric spasm, cold & heat stiffness.**

## I. Cadaveric spasm (Instantaneous rigor) التوتر الرمي

### Definition:

It is a condition of muscle contraction that involves one group of voluntary muscles (usually hands) due to intense emotional or physical stress at the moment of death. This condition is difficult to imitate and occurs without primary flaccidity.

### MLI of cadaveric spasm:

1. It indicates sudden death, associated with great tension; and denotes the muscles in physical activity at the time of death.
2. It indicates the manner of death:
  - **In suicide:** the used weapon is firmly grasped by the victim,
  - **In homicide:** the hands of the victim are found clenching over things belonging to the assailant (hairs or clothes); which helps to identify the assailant.
3. In drowning; the hands of the victim are found grasping sand, mud or sea weeds.

### Differences between cadaveric spasm & rigor mortis:

	<b>Cadaveric spasm</b>	<b>Rigor mortis</b>
Timing	A.M. (at the time of death).	P.M. (after 2 – 3 hours).
Onset	Immediate	Gradual
1ry flaccidity	Do not occur	Proceeded it
Muscles	One group of voluntary muscles.	All muscles (voluntary & involuntary)
Type of deaths	Deaths associated with emotional tension & exertion	All deaths
Mechanism	Nervous.	Chemical.
contraction	Quite marked & considerable force is required to break.	Less marked & only moderate force is required to break it.
MLI	Help to indicate the mode of death.	Help to indicate the PMI

## II. Cold stiffening:

This occurs due to exposure to a very cold temperature (below - 5 °C) that lead to freezing of all tissue fluids (intra & extra cellular). Icing of the synovial fluid in joints leads to cracking when trying to move them. As temperature rises, tissues become soft again then rigor mortis occurs.

## III. Heat stiffening:

- This refers to muscle rigidity that occurs when the body is exposed to high temperature (over 70 °C) that causes coagulation and denaturation of muscles proteins.

- The muscles are shriveled, desiccated and even carbonized. Beneath this there is a zone of brown pink cooked meat.
- The stiffness usually leads to “pugilistic attitude”, due to marked shortening of the greater mass of flexor muscles compared with the extensors.
- Rigor mortis does not occur.

### **Secondary Flaccidity**

- With the development of 2ry flaccidity, the muscles become soft and flaccid once again, but do not respond to mechanical and electrical stimuli. This stage is synchronous with the onset of putrefaction.
- **Differential diagnosis between 1ry and 2ry flaccidity:**

	<b>Primary flaccidity</b>	<b>Secondary flaccidity</b>
1. Onset	Immediately after death (before rigor mortis).	12-24 hours after death (After rigor mortis).
2. Cause	Loss of muscle tone.	Autolysis of muscles.
3. Body temperature	warm	cold
4. Response of muscles to electric & chemical stimulation (Atropine to the eye).	Positive	Negative

### **Putrefaction**

*التعفن الرمي*

**Definition:**

It is the process of decomposition of soft tissues resulting in resolution of the body from organic to inorganic state.

**Mechanism (by 2 processes):**

**1. Autolysis** (auto = self, lysis = destruction)

Certain enzymes are released from the tissue cells after death causing liquefaction of the body tissues. The process of autolysis continues steadily for 2- 3 days, sometimes longer till body tissues are autolysed.

**2. Bacterial action:** Bacteria produce a large variety of enzymes that breaks down body tissues and produce gases. Types involved are:

- Saprophytic bacteria responsible for putrefaction are both anaerobic (*Cl. Welchii*) and aerobic (streptococci, *B. coli* & proteus).
- Pathogenic strains accelerate the rate of putrefaction.

**N.B.** The most offender is ***Cl. Welchii*** that produce lecithinase which hydrolyzes the lecithin present in all cell membranes.

### Medico-legal importance of putrefaction:

- 1- It is a *sure sign* of death.
- 2- It can be used for estimation of the *PMI*.

- **After 1 day in summer or 2 days in winter, (color changes):**

- The first external sign is *greenish discoloration* of the right iliac region over the *caecum* (fluid faeces, full of bacteria and the caecum lies fairly superficial).
- *Arborisation (marbling)* of blood vessels on the root of the neck, over the shoulder and on the groin. This occurs due to the distension of veins by putrefactive gases and bluish to green discoloration by altered blood (sulph-Hb).



- **After 3 days in summer or 1 week in winter (mainly gas formation):**

- Spread of green discoloration and arborisation over the whole body.
- Distension of the abdomen and genitals.
- Formation of gas filled skin blisters.
- Swelling of the face with protrusion of the tongue & eye balls.
- Coarse, foul smell, bloody **froth** comes from the mouth & nostrils.
- Blurring of features and discoloration make identification very difficult even by near relatives.



- **After 1 week in summer or 2 weeks in winter:**

- Peeling of the epidermis with falling of hair & nails.
- Bursting of the abdomen and the viscera are liquefied to a dark doughy mass.
- Eggs of flies laid at body orifices will hatch into larvae.

- **After 6 months:**
  - All soft tissues are liquefied and percolate to the surroundings and to the ground.
  - Bones attached by ligaments are left (avascular structures).
- **After 1 year:**

Separate bones become lighter, whiter less smelly & more brittle.

3- *Cause of death* may be suggested from the rate of putrefaction (see below).

4- *Differential diagnosis:*

- **Froth of putrefaction** should be differentiated from froth (foam) of drowning (see drowning).
- **Blisters of putrefaction** should not be confused with blisters of burns. A putrefactive blister contains mainly gas & little reddish colored fluid with no evidence of vital reaction.

### **Effect of putrefactive gases:**

- Protrusion of tongue and eyes with a dark foul bloody froth on mouth and nose.
- Formation of putrefactive blisters.
- PM defecation and vomiting.
- Expulsion of a fetus from a gravid uterus.
- Flotation of the drowned bodies.

### **Factors modifying the rate of putrefaction:**

#### **A- Environmental factors:**

1- *Temperature:*

The optimum temperature is 25- 40 °C at which bacteria flourishes, below 10 °C or above 50 °C bacterial growth is arrested.

2- *Medium where the body is disposed*

The rate of putrefaction is almost equal (at constant temperature) after 1 week in air, 2 weeks in water & 8 weeks when bodies are buried in the ground.

3- *Moisture*

- Humidity enhances putrefaction: bodies recovered from water decompose very rapidly.
- Dehydration delays putrefaction: as in mummification.

4- *Air:*

Most putrefactive organisms are aerobes so putrefaction is delayed in drowned bodies and sealed coffins.

**B- Individual factors:**1- *Vascularity:*

- Congested organs & those with high blood content as liver, spleen & gravid uterus putrefy rapidly, while the prostate & non-gravid uterus are the last organs to putrefy.
- Also, in drowning putrefaction starts at the head & neck (site of hypostasis).

2- *Age:*

Newly born & still-born putrefy slowly due to absence of bacteria inside the gut, and also their bodies cool rapidly leading to slowing of putrefaction.

4- *Cause of death:*

- **Rapid** rate; in septicemia & deaths associated with edema and ascites (congestive heart failure or hepatic failure).
- **Slow** rate; in deaths due to hemorrhage, metallic poisoning as arsenic (dehydration and bactericidal) & emaciated cachectic bodies.

**Conditions Replacing Putrefaction**

1. Adipocere: in submersion in water.
2. Mummification: in death in deserts.
3. Maceration: in intrauterine fetal death.

***Adipocere (Saponification)***

التصبين

**Definition:**

Adipocere (adipo = fat; cere = wax) means the transformation of fat into waxy like greasy material with a rancid odor.

It refers to post mortem condition that replaces putrefaction. It occurs in fatty areas of bodies submerged in water or buried in wet ground.



**Mechanism of formation:**

The unsaturated soft fatty acids are hydrogenated to firm saturated fatty acids.

**MLI:**

- It denotes long submersion under water.
- It denotes the time passed since death from its extent & texture. It starts at **3 weeks** in the subcutaneous fat of cheeks, breasts, buttocks & abdomen, and takes about **6 months** to cover the whole body.
- It helps personal identification as the changes in the subcutaneous tissues keep features of the face & body contour in a recognizable form.
- It may indicate the cause of death since injuries are easily recognized.

**N.B.**

- After adipocere, putrefaction does not occur due to low pH.
- In partial submersion; the exposed parts putrefy and the submerged parts will show adipocere formation.

**Mummification***التحيط***Definition:**

It is a post mortem condition that replaces putrefaction. It refers to the dehydration or the desiccation of body tissues & viscera after death in cases of bodies left in the desert.

**Mechanism:**

As a result of dry hot environment, the body desiccates by losing moisture through evaporation and absorption by sand. Also, bacterial growth is arrested and putrefaction stops. Once the process is complete, the body becomes dry with dark wrinkled leathery skin.

**MLI:**

1. It denotes exposure to hot dry atmosphere.
2. It indicates the time elapsed since death from the extent of dryness and shrinkage of tissues as it starts in lips, nose, fingers and toes after **3 weeks**. Complete mummification of a body requires **3- 12 months** depending on the size of the body and the atmospheric condition.

3. It helps identification of the cause of death since injuries are preserved.
4. It helps personal identification in some instances, as facial features are preserved though the distortion from skin shrinkage & loss of eyes and full lips considerably alter the features.

## **Maceration**

التسلخ

### **Definition:**

It is a post mortem condition that replaces putrefaction. It refers to aseptic autolysis of the dead fetus inside the uterus (sterile environment with no bacteria).

### **Characters of maceration:**

1. Maceration starts **immediately** after IUFD (Intra Uterine Fetal Death).
2. Within **3 days**, the fetus may present a fairly normal appearance, but the skin is usually softened.
3. After **5 - 7 days**, it is characterized by:
  - Softening of the dead fetus that it flattens when placed on the table.
  - There is over-mobility of the joints.
  - Over-riding of skull bones with hyperflexion of the spine due to absorption of C.S.F. This may be detected by X- ray of the skull and is known as "**Spaulding sign**".
  - Brown peeled skin.
  - Soft edematous tissues and the body cavities are full of reddish serum.
  - The smell is somewhat rancid & **gases are not formed** because maceration is a sterile process.



### **MLI of maceration:**

1. It indicates IUFD (still birth).
2. It notifies a false allegation of a live birth baby (inheritance, infanticide & induction of abortion).
3. It indicates time of fetal death from its extent.

## ***Post-Mortem Interval (PMI)***

### **Definition:**

PMI is the time passed since death till examination of the cadaver by the physician.

### **Medico-legal importance:**

- In civil cases: as in cases of inheritance.
- In criminal cases: in order to establish the involvement of a suspect in a crime of homicide.

### **Methods of Estimation of PMI:**

#### **1. The average rate of post mortem changes.**

#### **2. Stomach emptying**

Estimation of the PMI can be determined roughly from the rate of emptying of the stomach (full stomach denotes that the time passed after the last meal is less than **3 hours**).

#### **3. Entomological studies for Fauna of the cadaver**

The probable time of death (in the region of days to months) can be determined by examination of the populations and stages of development of the various insects that invade the body, different species of flies (the most common the blowflies) are attracted by the smell of putrefied bodies and lay their eggs around moist body orifices. They give larvae, then pupae in about 2-3 weeks.

##### **MLI of entomological studies**

- It may denote the time passed since death.
- It helps in determination of the geographical place of death.
- The absence of eggs or maggots on a body may sometime be useful as it indicates that the body has been in a sheltered place inaccessible to flies.

#### **4. Biochemical changes:**

Analysis of blood, CSF, vitreous humor content of sugar, electrolytes, amino acids, lactic acid, non protein nitrogen and some enzymes show variable changes that may help to estimate p.m. period when plotted against worked out graphs.

P.M. change	Signs	P.M. Time
<b>1. Eye changes</b>	-Loss of corneal and light reflexes -Segmentation of retinal vessels -IOP is Zero -Opacity of the cornea -Tache Noire	At moment of death  15 min  2 hrs. 2 hrs. 3-4 hrs.
<b>2. Primary flaccidity</b>	Contraction of muscles by electric current.	Up to 3 hrs.
<b>3. Cooling</b>	1-1 ½ °C per hr. till equilibrium with surrounding temperature	Up to 18 hrs.
<b>4. Hypostasis</b>	patches Fixed	3 hrs. 8 hrs.
<b>5. Rigor Mortis</b>	Face and lid muscles Whole body	2 hrs. 12 hrs
<b>6. Putrefaction (in winter)</b>	Greenish staining of lower abdomen Whole body greenish-black staining Burst abdomen and larvae Bones attached by ligaments Separate bones	2 days  1 weeks  2 weeks 6 months  12 months
<b>7. Adipocere formation</b>	Start to appear in S.C. fat Whole body fats	3 weeks 6 months
<b>8. Mummification</b>	Start Complete body	3 weeks 3-12 months
<b>9. Maceration</b>	Evident Extensive	3 days IU death 5-7 days IU death

## Chapter (6)

### MEDICO LEGAL ASPECTS OF WOUNDS

#### **ILOS:**

- To realize legal and medico-legal classification of wounds.
- To know the diagnosis and differential diagnosis of different wound classes.
- To identify victim with permanent infirmity.
- To interpret medico-legal evidences from wound examination.
- To recognize different timely risks of fatality in trauma victims.

#### **Definition:**

A wound is the disruption of the continuity of tissues (skin, bone, blood vessels, or organs) produced by external **mechanical trauma**.

#### **Types of Mechanical traumas:**

##### **1. Blunt trauma (non-penetrating trauma):**

It is caused by impact or other force applied with a blunt object. When the limits of load tolerance are exceeded, tissues are disrupted.

##### **2. Penetrating trauma:**

It is caused when a foreign body such as a bullet or a knife enters the body tissue, creating an open wound.

##### **3. Blast injury**

It results from direct or indirect exposure to an explosion. It commonly includes both blunt and penetrating trauma, and may also be accompanied by a burn injury.

#### **Classifications of Injuries:**

##### **I. Legal Classification (according to the severity):**

1. **Simple wounds:** which heal in less than 20 days leaving no permanent infirmity.
2. **Dangerous wounds:** which heal in more than 20 days or leave a permanent infirmity.
3. **Fatal mortal wounds:** which lead to death, immediately or within a short time after its infliction.

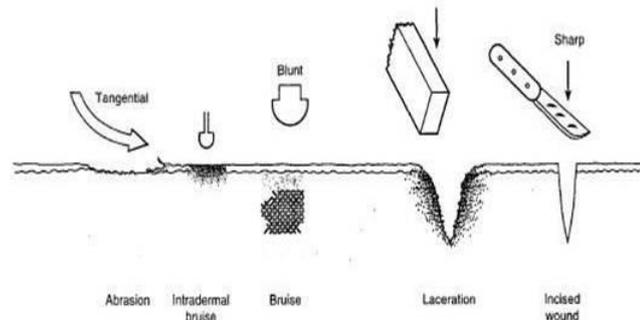
“**Permanent infirmity**” can be defined as loss of functioning organ or loss of the function of this organ as permanent loss of vision following trauma, while loss of a non-functioning organ is referred to as “**Disfigurement**” as loss of a blind eye.

## II. Medico legal classification (according to the etiology):

1. Mechanical Injuries (wounds).
2. Physical or Thermal Injuries (See chapter 11).

### Types of Wounds:

1. Abrasions.
2. Contusions or bruises.
3. Lacerated or contused wounds.
4. Incised or cut wounds.
5. Stab wounds.
6. Fractures.
7. Fire arm wounds.



## ABRASIONS

### Definition:

Abrasions are defined as destruction of the superficial layers of the skin epidermis alone or involve the upper dermis- due to pressure or friction with a rough blunt object.

### Types of Abrasions:

1. **Pressure or impact abrasion** caused by stamping of blunt object against the skin as:
  - Teeth marks.
  - Nail abrasions
  - Grazes: when rough object comes in contact with a wider surface of the skin (e.g. the ground).
2. **Friction (sliding or dragging) abrasions** caused by linear pressure upon the skin accompanied by movement as:
  - Nail abrasions
  - Car accidents
  - Hanging and strangulation by ligature.
  - Scratch: linear abrasion produced by drawing a sharp pointed object over the skin (e.g. needle).

### Medico legal Importance of abrasions:

Abrasions are the simplest form of wounds from the clinical point of view, yet they pose a great medico legal importance; because:

1. **Abrasions denote signs of violence and resistance**, e.g. in rape and murder.
2. **Abrasions take the shape and pattern of the causal object**, e.g. nail abrasion in smothering and throttling, ligature marks in strangulation and hanging, teeth marks in bites and tire marks in car accident.
3. **Site of abrasion reflects the site of impact and the sort of the assault** eg. Semi lunar nail abrasions around the neck in throttling, and around the mouth and nostrils in smothering.
4. **The direction of injury and position of the assailant** is detected in case of linear scratches where tags of epithelium are collected at the end of the wound. Also in semilunar nail abrasion and the direction of the crescentic impressions.
5. **The age of abrasion indicate the date of the crime from:**
  - First two days: covered by a soft scab.
  - After three days: covered by dry scab.
  - After one week: the scab falls leaving a coppery red area.
  - After three weeks: disappears leaving no scar.
- N.B.** Scab is formed by serum, red cells and fibrin.
6. **Abrasions help to identify the assailant from:**
  - Shape of the bite marks fitting with victim's teeth.
  - Finger nail abrasions may tell whether he is left or right handed or missing a finger.
7. **A.M. abrasions should be differentiated from P.M.:**
  - A.M. abrasions are characterized by presence of redness, bruises and vital reactions (healing and/or sepsis).
  - Post-mortem abrasions are due to rough handling of dead bodies or due to effect of insects as ants.
8. **Abrasions help to differentiate between:**
  - **Cut and contused wounds** (present around contused wounds)
  - **Hypostasis and bruises** (present with bruises).
  - **Inlet and exit wounds in firearm injuries** (present around inlet).

## CONTUSIONS (BRUISES)

### Definition:

Bruises are extravasations of blood into the tissues following rupture of blood vessels due to blunt trauma.

Bruises are most commonly seen in the skin but it can also occur in the deeper tissues, e.g. muscles and internal organs.

### Factors modifying the detection of bruises:

1. **Severity of the blow.**
2. **Rapidity of death:** bruises may be absent with rapid deaths.
3. **Pathological bruises:** Some diseases may increase susceptibility to develop bruises after minor trauma as in case of liver cirrhosis, purpura and leukemia.
4. **Sex:** females bruise easily as they have much subcutaneous fat.
5. **Age:** children bruise easily because of their delicate juvenile skin and senile persons also because of wasting of subcutaneous tissue.
6. **Skin color:** bruises are more obvious in light colored persons than in dark colored.
7. **Type of tissue:** Vascular sites as scalp bruise much more. Lax tissue as eye lids bruise easily (accommodate much blood) than tough tissue as palms and soles (blood vessels are protected with dense fibrous tissue).
8. **Underlying tissue:** underlying bones will enhance bruises formation, while underlying cavities (eg. peritoneal cavity) will minimize bruises.
9. **Gravity:** see below.

### Medico legal importance of bruises:

1. **Bruises denote violence or resistance** as in case of rape and murder.
2. **Bruises take the shape of the causal object (patterned injury), e.g.:**
  - Blow with a stick → two elongated parallel lines (railway bruises).
  - Human bite → two curved rows of bruises that may be accompanied by abrasions.
  - Animal bite → two parallel rows of bruises.
    - Whip mark → linear bruises twisted around the body.
    - Forceful hand slaps → multiple parallel linear bruises.
    - Pinch → two identical small rounded bruises.
    - Run over accidents → tire mark bruises.
3. **Site of bruises is usually the same site of force application, but sometimes it may shift by gravity, e.g.**
  - Blow to the forehead may appear as a black eye due to gravitation of blood from the scalp to loose tissue of the lids.
  - Blow to the temple may find its way to the cheeks.
  - Blow to the calf may trickle to the ankle.

#### 4. **Age of the bruise coincides with the date of the crime:**

This can be estimated from the color changes that occur due to disintegration of hemoglobin of the extravasated blood and reflects the progress in the process of healing. It begins from the periphery towards the center of the bruise as follows:

- a. When first formed the bruise is bright red in color (oxyhemoglobin).
- b. Gradually it becomes blue (reduced hemoglobin).
- c. Then it becomes green (biliverdin), and finally it becomes yellowish (bilirubin).

Each color change requires 2-3 days. It completely fades away in 2 weeks. However, accurate dating of bruises is difficult as the time course of resolution is variable as it depends on:

- Adequacy of lymphatic and venous drainage,
- Size, site and depth of the bruise,
- Age of person (very slow in elderly) and
- General health.

#### **Color changes may differ in special situations, such as:**

- **Brown Bruises:** Sometimes the bruises acquire a brown tinge that may mask its actual color. This is due to the release of hemosiderin (an iron containing pigment). It completely fades away in 2 weeks (engulfment by phagocytes).
- **Deep bruise** may first appear few days after the injury as the blood tracks from deeper tissue to the surface and hence its color is blue when first detected. It can be indicated originally by tenderness or slight swelling. Also, infrared photography can demonstrate them in early stages.
- **Subconjunctival bruises** retain their bright color until they are completely absorbed. This is attributed to the plenty oxygenation either due to rich oxygen supply of the conjunctiva or through direct air exposure. Rapid recovery occurs due to the abundant phagocytic cells.

#### 5. **A.M. bruises should be differentiated from P.M.:**

- A.M. bruises are characterized by presence of swelling, color changes and may be of any size.
- P.M. bruises may occur after death as trauma crush the capillaries containing fluid blood, but as there is no blood pressure; thus the amount of the expelled blood is very small.

## 6. Bruises should be differentiated from hypostasis:

Item	Hypostasis	Bruises
Time	PM	AM or PM.
Site	in dependent parts	at any part of the body
Edges	ill defined	well defined.
Color changes	absent	may be present
Effect of pressing	Cannot be blanched	blanched
Swelling	absent	present
Abrasions	absent	may be present
Blood accumulation	intravascular	extravascular
Cut, and wash	disappear (washable)	remains (unwashable)
Micro. Ex.	no blood cells are seen	Leucocytic infiltration

## CONTUSED / LACERATED WOUNDS

### Definition:

Tearing, splitting or rupture of the skin and subcutaneous tissues due to compression or grinding by heavy blunt object; e.g. motor vehicles accidents or falling from height.

### Characters of lacerated wounds:

#### 1. The edges are:

- ***Irregular and abraded***; except in areas where skin is stretched over bone e.g. scalp and shin of tibia.
- Accompanied with ***abrasions and bruises***.
- Not gapping; due to ***tissue bridges*** (e.g. blood vessels, muscle fibers or nerves) as tissue layers are splitted at different depths in irregular manner.

#### 2. **Minimal bleeding**, due to crushing of the blood vessels and clot formation.

#### 3. **Hair stem and follicles** are crushed.

#### 4. **Healing is usually delayed** with secondary intention due to contamination with foreign bodies and microorganism and devitalized tissue

**Sub-Types of contused wounds:**

1. **Crushed wound:** where the tissue of a limb is crushed or amputated e.g. run over accidents.
2. **Avulsion:** by grinding compression separating the skin from the tissue leaving a pocket of fat and blood with bruising.
3. **Split (cut-lacerated) wound:** by heavy edged instrument against bone, best seen in laceration of the scalp.
4. **Torn wounds:** ragged irregular **flap** of the skin is separated in most of its contour; e.g. by a revolving belt of a machine.

**INCISED / CUT WOUNDS****Definition:**

These are wounds caused by drawing the edge of a sharp object (knife or razor) on the skin and underlying tissues; e.g. surgical wounds.

**Characters of incised wounds:**

1. The edges are:
  - *Regular edges;* except if the skin is corrugated like axilla or scrotum or irregular instrument edge (broken glass),
  - *No bruising or abrasions.*
  - *No tissue bridges* across the edges, thus the edges usually gape due to retraction of the tissues by elasticity.
  - Gapping depends on the direction of the wound with respect to the direction of the muscle fibers; more gapping when the wound crosses the muscle fibers and less gapping when the wound is parallel to the muscle fibers.
2. *Free bleeding* and cleanly cut blood vessels.
3. *Cleanly cut hair stem* and follicles.
4. Minimal contamination with *rapid healing* by primary intension.
5. They are *longer than deep* and they have no relation to the size of the instrument.

**Manner of infliction of incised wounds:**

1. **Homicidal:** Incised wounds are usually homicidal.
2. **Suicidal:** e.g. suicidal cut throat and cut wrist.
3. **Accidental:** falling on a sharp edge or in road traffic accidents.

**Varieties of incised wounds:**

1. **Hesitation wounds:** multiple superficial parallel cuts at beginning of incision indicate hesitation in suicidal wounds "**Hesitation or Tentative marks**".

2. **Defensive wounds:** see later.
3. **Fabricated wounds:** see later.
4. **Surgical wound.**

### Age of Incised Wounds

The changes that occur in uncomplicated wounds are:

- First 12 hours→ the edges are red and swollen.
- After 36 hours→ new vessels start to grow towards the skin surface.
- 5 days→ Obliteration of the new vessels.
- 10 days→ Healing by primary intension.
- 3 weeks→ The scar is red.
- 3 months→ The scar is coppery brown.
- 6 months→ The scar is white and may be invisible.

### Differences between Cut and Contused Wounds:

Item	Cut wounds	Contused wounds
1. The causal object	Sharp edged object; e.g. knife, razor or broken glass	Blunt object; e.g. heavy stick or stone.
2. Edges	Regular cleanly cut edges <i>except</i> if the skin is corrugated (axilla or scrotum) or irregular instrument edge.	Irregular <i>except</i> in areas where the skin is stretched over bone, e.g.: scalp and tibia.
3. Tissue bridges	absent	present
4. Gapping	present	absent
5. Abrasion & bruises	absent	present
6. Hair end	Sharply cut	Crushed
7. Bleeding	Free external bleeding (cut vessels)	Less bleeding (crushed vessels)
8. Base	Bloody	Contains necrotic tissue, foreign bodies & blood clots.
9. Healing	Rapid healing with a thin scar (1 <sup>ry</sup> intension).	Delayed healing with a thick scar (2 <sup>ry</sup> intension).
10. Sepsis	Less sepsis	More sepsis
11. Varieties	Hesitation, defense & fabricated wounds.	Crushed, avulsion, split (cut lacerated) & torn.

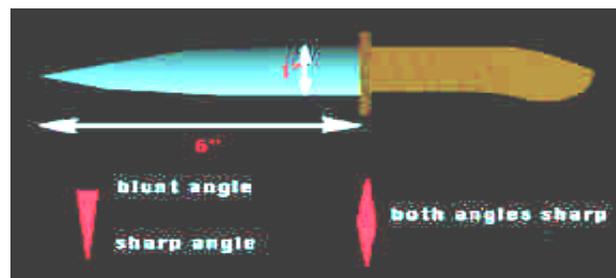
## STAB WOUNDS

### Definition:

Stab wounds are caused by forcing a sharp pointed object into the body, e.g. knife or dagger.

### Characters of stab wounds:

1. Cleanly cut edges.
2. They are more deep than long.
3. They give an idea about the causal instrument:
  - Single sharp bladed (knife) → one acute angle.
  - Double sharp bladed (dagger) → two acute angles.
4. The length of the wound approximately equals the breadth of the weapon unless the wound is enlarged during withdrawal of the weapon.
5. The depth of the wound equals the length of the weapon in case of complete penetration of the weapon.



6. A broken tip of the weapon may be found in the wound which helps in identification of the weapon and consequently the assailant.
7. They are very dangerous due to internal injury, hemorrhage & sepsis.

### Sub-Types of Stab Wounds:

1. **Punctured wounds:** These occur due to pointed object, e.g. nail, closed scissors, and needle. The wound takes the shape of the cross section of the weapon e.g. rounded, square,.....
2. **Transfixing wounds:** the weapon passes from one side of a limb to the other or connects two organs as the lung and the heart.
3. **Perforating wounds:** These are penetrating wounds that extends into a viscus or body cavity.

## DEFENSE WOUNDS

These are injuries sustained by the victim to defend himself.

- **In case of hitting:** there will be abrasion or bruises on the outer side of the forearm, back of hands and fingers that may be broken in an attempt by the victim to shield himself.
- **In kicking:** defense bruises occur on the outer side of the thigh as the victim tries to protect his genital region.
- **In attacks by knife:** The blade may be gripped by the victim, so that cut wounds may occur across the fingers and the palm.

### Medico legal Importance:

Defense wounds may be of value in differentiating between homicide and suicide. But, their absence does not rule out a homicidal attack, for it is possible for the victim to be incapable of defense for a variety of reasons including surprise, loss of consciousness, or weakness.

## FABRICATED WOUNDS

These are simple wounds which are self-inflicted by oneself or by the help of others.

### The aim beyond wound fabrication:

- Revenge
- To pretend that the crime was self-defense.
- To allege bad treatment by police authorities.
- To avoid work in the prison.
- To obtain illegal compensation.
- To escape military service.

### Characters of Fabricated Wounds:

1. Superficial and relatively harmless.
2. In safe site area which is readily accessible to the victim.
3. They are inflicted on a bare skin so no corresponding tears of clothes.
4. The age of the wound does not usually correlate with the date stated by the fabricator.
5. Careful examination and history about the manner of assault or type of weapon will prove that allegation was false.

## MECHANISM OF DEATH IN WOUNDS

### Early causes:

- Hemorrhage → external and internal.
- Traumatic shock → Primary neurogenic & Secondary hematogenic.
- Embolism → air, fat and thromboembolism

### Late Causes:

- Sepsis.
- Disseminated intravascular coagulation
- Supra-renal hemorrhage.
- Adult respiratory distress syndrome
- Crush syndrome
- Acute renal failure.
- Surgical interference.

### I. Early Causes:

#### 1. HEMORRHAGE (HGE) AND HEMORRHAGIC SHOCK:

Hemorrhage may be external or internal.

- External hemorrhage occurs with open wounds reaching big vessels. Easily diagnosed. Fatality depends on amount and rate of bleeding. Loss of 1.5 to 2 liters (1/3 of blood volume) is fatal.
- Internal hemorrhage is more dangerous and not easily diagnosed. The amount causing death depends upon the site of bleeding; 10-20 c.c. in the cranium, 100 c.c. in the pleural cavity, 200 c.c. in pericardial sac (cardiac tamponade) & 500 c.c. in the peritoneal cavity.

#### **Clinical picture:**

Tachycardia, hypotension, rapid Shallow respiration & cold clammy skin.

#### **P.M.P.**

- *External:*
  - Pale skin,
  - Pale ill-defined hypostasis,
  - Blood on the ground and clothes.
- *Internal:*
  - Pale organs,
  - Contracted empty heart with subendocardial hemorrhage, as the heart squeezes itself to supply the last drop of blood to the brain.
  - Contracted spleen with corrugated splenic capsule (autotransfusion).

## **2. SHOCK:**

### **A. Primary Neurogenic Shock:**

#### **i. Parasympathetic shock (Vagal shock or Reflex Cardiac Inhibition):**

##### **Causes:**

- Sudden good or bad news, or
- Blow to trigger areas rich in parasympathetic nerve endings (the larynx, precordium, external ear, epigastrium and testes).

##### **Clinical Picture:**

- Bradycardia, hypotension, slow shallow respiration and subnormal temperature.
- The condition is rarely fatal. It may lead to cardiac arrest unless vagus escape occurs; i.e. the ventricles beat by their own rhythm (25-30/minute).

**P.M.P:** pale organs.

#### **ii. Sympathetic shock:**

This occurs after painful wounds or severe fright causing adrenaline release with rise of blood pressure and increase in heart rate. Young healthy subjects can tolerate these effects, but those with previous heart disease may develop myocardial infarction (MI) or ventricular fibrillation (VF). The condition may pass to heart failure leading to acute pulmonary edema.

##### **Clinical Picture:**

- Tachycardia, hypertension, difficult short breathing, pale cool sweaty skin, dry mouth and mydriasis.
- Acute pulmonary edema due to acute H.F.

##### **P.M.P.**

- Congested viscera
- Cut section of the lungs oozes frothy blood
- Preexisting heart disease.

### **B. Secondary Hematogenic or Traumatic Shock (Surgical Shock):**

This occurs few hours after the trauma due to absorption of histamine like substances from the site of trauma causing vasodilatation leading to decreased venous return, cardiac output and blood pressure which leads to circulatory failure and death.

##### **Clinical Picture:**

- Rapid weak pulse, hypotension, rapid Shallow respiration and subnormal temperature.
- Finally coma and death occurs from tissue anoxia.

##### **P.M.P:**

Petechial hemorrhage and effusion in serous membrane.

**D.D. Between types of shock:**

	<b>Parasympathetic Shock</b>	<b>Sympathetic Shock</b>	<b>Secondary Traumatic shock</b>
<b>Causes</b>	-Sudden psychic shock -Blow to the trigger areas	-painful wounds -severe fright	Tissue destruction →histamine-like substances→VD→↓VR & ↓CO→collapse.
<b>Timing</b>	Instantaneous	After few minutes	After few hours
<b>C.P.</b>	<i>Pulse:</i> Slow. <i>B.P.:</i> Low. <i>Resp.:</i> Slow & shallow.	<i>Pulse:</i> rapid. <i>B.P.:</i> high <i>Resp.:</i> difficult & short breathing	<i>Pulse:</i> Rapid weak. <i>B.P.:</i> Low. <i>Resp:</i> rapid & shallow.
<b>Fatality</b>	Rare; from cardiac arrest	Common in predisposed persons; from acute pulmonary edema	circulatory failure & tissue anoxia
<b>PMP</b>	Pale organs	-Congested viscera. -Frothy Lung cut section	-Peticeal Hge -Effusion in serous cavities.

**3. EMBOLISM:**

- A. Air Embolism.
- B. Fat Embolism.
- C. Thromboembolism

**A. Air Embolism:****i. Venous air embolism:**

Causes:

- Cut throat
- I.V. infusions
- Tubal insufflations and criminal abortion.

Air fills the right side of the heart and pulmonary arteries leading to **acute heart failure** (100-200 c.c. are fatal).

**P.M. Diagnosis:**

- X ray: Air fills the right side of the heart and pulmonary arteries.
- Filling the pericardial sac with water then puncturing the right ventricle with a needle → air bubbles come out.

## **ii. Arterial air embolism:**

### **Causes:**

- Transfixing stab wound connecting a bronchus with a pulmonary vein.
- During artificial pneumothorax if the needle passes in a pulmonary vein.
- Barotraumas: By rapid ascent of divers and release of nitrogen gas emboli.

Few c.c. are fatal due to occlusion of the coronaries and cerebral arteries. Death is prevented by lowering the patient's head.

### **P.M. Diagnosis:**

- Coronary and cerebral arteries are beaded.
- Air bubbles in the retinal arteries, detected by ophthalmoscope.

## **B. Fat Embolism:**

### **Causes:**

- Fracture of long bone with torn vein.
- Trauma to a fatty area.
- Burns in a fatty area with torn vein.
- Iatrogenic as I.V. injection of oily drugs or Hystro-salpingography.

The fats will reach the right side of the heart and pulmonary artery leading to acute heart failure. Fatal systemic emboli may reach the brain, heart or kidneys.

### **P.M. Diagnosis:**

Sections of the lungs stained with fat stains as osmic acid stain (black) and sudan III stain (orange) will show fat cells.

## **C. Thromboembolism:**

Usually occurs few days after trauma due to:

- Immobilization leads to stasis of blood in veins and thrombus formation.
- Shock, sepsis and hypoxia lead to tissue devitalization and thrombus formation.

## **II. Late Causes:**

1. Sepsis and septic shock.
2. Disseminated intravascular coagulation (DIC).
3. Supra-renal hemorrhage.
4. Adult respiratory distress syndrome (ARDS).
5. Crush syndrome.
6. Acute renal failure.
7. Surgical interference.

### **1. SEPSIS:**

- Generalized infection (septicemia, and pyemia).
- Localized infection which may be transmitted to vital organs as the lungs and meninges resulting in fatal pneumonia or meningitis.
- Tetanus caused by *Cholistridium Tetanii* in non-immunized feeble patient, if wounded in the street and contaminated with the spore forming organism.
- Gas gangrene is another serious infection caused by *Cholistridium Welchii*.

### **2. DISSEMINATED INTRAVASCULAR COAGULATION (DIC):**

- Trauma can trigger thromboplastin-initiated coagulation. Reduction and stasis of blood flow can precipitate intravascular coagulation. Also tissue devitalization and endothelial damage predispose to phlebothrombosis especially when the limbs are immobilized.
- Bleeding diathesis occurs due to consumption of platelets and fibrin in thrombi.

### **3. SUPRA-RENAL HEMORRHAGE:**

- Usually occurs after impaction of loins in traffic accidents. It occurs few days after trauma.
- Bilateral adrenal hemorrhage is rarely due to trauma. When unilateral, it is often clinically silent. However, bilateral adrenal hemorrhage leads to catastrophic adrenal insufficiency.

### **4. ADULT RESPIRATORY DISTRESS SYNDROME (ARDS):**

- This lung condition is a complication of traumatic and stressful incidents including aspiration of gastric contents, inhalation of irritant gazes, pulmonary infections and systemic shock.
- The lungs become stiff and hard and respiratory failure develops due to poor gas exchange.

## 5. CRUSH SYNDROME:

In case of crushing of a whole limb, as in car accidents, there will be release of myoglobin from the crushed muscles which will reach the circulation and cause irritation of the renal tubules leading to their swelling and obstruction and finally causing renal failure and death.

## 6. ACUTE RENAL FAILURE:

*Causes:*

- Shock and decrease renal blood flow.
- DIC due to micro-thrombi formation.
- Crush injuries.
- Iatrogenic: e.g.: use of vasopressor agent e.g.: epinephrine, nephrotoxic antibiotics e.g. amino glycosides.

## 7. SURGICAL INTERFERENCE:

The assailant is responsible for the result of the operation so long it was indicated and skillfully done.

## Chapter (7)

# INJURIES OF SPECIAL ORGANS

### ILOS:

- To identify varieties of wounds in dangerous body sites in trauma victims.
- To know general clinical manifestations, expected complications and deferential diagnosis of these wounds.
- To realize medico-legal importance of specific traumatic situations.

## NECK INJURIES

### Most common neck injuries:

1. **Abrasions & bruises;** as in throttling, strangulation and hanging.
2. **Stabs;** almost always homicidal.
3. **Cut “incised” wounds;** the commonest that may be from the front→ **“Cut Throat”**, or from the back→ **“Cut Nape”**.

### Differentiation between homicidal and suicidal cut throat

Item	Homicidal Cut Throat	Suicidal Cut Throat
<b><i>I. Circumstantial Evidences</i></b>		
1. History	Previous threatening by an enemy.	Previous attempt of suicide, failure or troubles.
2. Scene of the crime	-Outdoors, or -Indoors with doors locked from outside. -Disturbed furniture. -Threatening letter may be present	-Indoors with doors locked from inside & in front of mirror. - Furniture not disturbed. -Suicidal note may be present in victim's handwriting.
3. Blood, hair or finger prints.	Belonging to the assailant	Belonging to the victim.
<b><i>II. Victim</i></b>		
1. Sex	Any sex	Usually male
2. Site of blood	Mainly posteriorly behind the neck.	Mainly on the anterior parts

3. Signs of struggle	Present; lost buttons, or tears in clothes.	Absent
4. Cadaveric spasm	On hair or clothes of the assailant	On the weapon.
5. Other injuries	-Defensive wounds. -May be other stabs.	-Previous suicidal attempts (cut wrist). -Superficial cuts on index or thumb (to test weapon sharpness).
<b>III. Examination of the wound:</b>		
1. Site	Low; below the thyroid cartilage.	High; above the thyroid cartilage.
2. Direction	Transverse	Oblique
3. Depth	Deep all through; may separate the neck.	Tailing, begins deep & ends superficial.
4. Number	May be multiple	Single
5. Hesitation marks	Absent	May be present
6. Special characters	Not slanting, i.e. perpendicular; cutting all tissues at the same level.	Slanting; cutting the skin at a higher level than the deeper structures in the neck.
<b>IV. Examination of the weapon</b>		
1. Presence at the scene	Usually absent	Present; may be grasped by cadaveric spasm.
2. Blood, hair or finger prints on it	Finger prints of the assailant; blood & hair of the victim.	Of the victim.
<b>V. Examination of the assailant</b>		
1. Signs of struggle	-Tears in clothes. -Wounds of age comparable to the date of crime.	No assailant
2. Blood group & finger prints	Compared to those found at the scene.	No assailant

### **Mechanism of death in cut throat:**

1. **Neurogenic shock**; severe pain→ **sympathetic shock** or injury to carotid sinus→ **parasympathetic shock**.
2. **Hemorrhage**; severed carotid arteries.
3. **Venous air embolism**; open jugular veins.
4. **Asphyxia**; inhalation of blood in opened trachea.
5. **Transection of spinal cord**; in cut nape.
6. **Delayed death**; rare due to edema of the glottis or aspiration pneumonia.

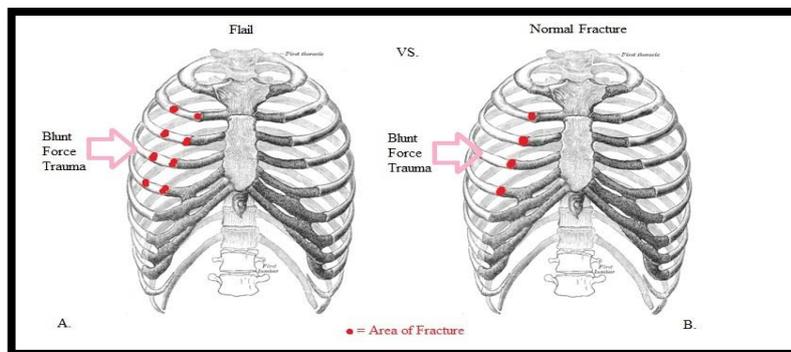
## CHEST INJURIES

### I. Injuries to thoracic cage:

Fracture ribs are the most common injury either due to direct or indirect trauma. Extensive rib fracture may occur during cardiopulmonary resuscitation (CPR). Also, falls from a height are usually accompanied by fracture ribs except in children (malleable or elastic ribs).

#### **Flail chest:**

It occurs in extensive bilateral fractures on the antero-lateral sides of the thorax → loss of rigidity of the chest cage → attempts at expanding the thoracic volume during inspiration are impaired and the loose section is sucked inwards during inspiration (**paradoxical respiration**).



### II. Injuries of the heart:

#### 1. Blunt trauma may cause:

- Instantaneous death (R.C.I.) without bruises detected at P.M
- Myocardial contusions → cardiac arrhythmia.

#### 2. Stab in the heart:

- **Atrium** → immediate death; thin wall → extensive hemorrhage.
- **Ventricle** → delayed death; thick wall and especially if the wound is oblique → closed by cardiac contractions by a valve-like mechanism. Right side is thin walled than left side.

#### 3. Rupture of the heart:

##### a. Traumatic:

- Severe blows to the chest.
- Run-over accidents, by a vehicle.

- Crushed by antero- posterior chest compression.
- Falls from height.
- Drivers pushed suddenly on steering wheel.

**b. Pathologic:**

- Extensive fatty degeneration of the myocardium.
- Myocardial fibrosis.
- Rupture of myocardial infarction.
- Ruptured aneurismal dilatations.

**4. Subendocardial hemorrhage:**

These are petechial hemorrhages under the endocardium.

Mechanism and etiology:

- a. Traumatic:** direct trauma to heart → rupture of capillaries under endocardium.
- b. Hypovolemia** as in extensive hemorrhage or severe vomiting and diarrhea. The heart reflexly squeezes itself by forcible myocardial contractions to the extent that it injures itself to supply the last drop of blood to the brain.
- c. Toxic capillarities;**
  - Burns; due to burn toxins as histamine.
  - Phosphorus or chronic arsenic poisoning.
- d. Increased capillary permeability;** in blood diseases, e.g. purpura.

**III. Injuries of the lung:**

- 1. Blows to the chest** may cause pneumonia (especially in old people) due to restricted chest movement.
- 2. Stabs in the lung:** the angles of the wound tell whether the stabbing instrument is single bladed → one acute angle or double bladed → two acute angle; due to lung elasticity. Air embolism may complicate the case.
- 3. Lung lacerations** may occur with fractured ribs.
- 4. “Blast lung”** is a direct consequence of the blast injury. It is characterized by the clinical triad of apnea, bradycardia, and hypotension. It may pass to ARDS.
- 5. Subpleural hemorrhage “Tardieu spots”:** see asphyxia.

**Complications and sequelae of chest injuries:**

- 1- Reflex cardiac inhibition (blow to the precordium).
- 2- Hemothorax.
- 3- Pneumothorax.
- 4- Arterial air embolism (Transfixing stab wound connecting a bronchus with a pulmonary vein).
- 5- Coronary thrombosis & myocardial insufficiency.
- 6- Cardiac tamponade: accumulation of the blood in the pericardium will interfere with cardiac dilatation during diastole (circulatory failure).
- 7- Interstitial emphysema: it occurs due to rupture of alveoli or injury air passages → air escapes into the surrounding tissues of the mediastinum and may reach neck, face or upper limbs.

**ABDOMINAL INJURIES**

1. **Blows to the epigastrium** may kill (R.C.I.).
2. **Stabs** may penetrate through hollow or solid viscera → laceration, sepsis, or hemorrhage which may end fatally.
3. **Rupture of abdominal organs:**
  - a. Solid organs, e.g. spleen, liver or kidneys;
    - Traumatic; car accidents & kicks.
    - Pathologic; Bilharzial splenomegaly.
  - b. Hollow organs, e.g. stomach or intestines,
    - Traumatic: car accidents and kicks.
    - Pathologic: typhoid, peptic or burn ulcers.

**D.D. of traumatic and pathological intestinal rupture:**

Item	Traumatic	Pathological
1. History	Recent trauma.	Disease (eg. typhoid)
2. Evidence of trauma	Bruises may be present.	Absent.
3. Evidence of GIT disease	Absent.	Present.
4. Shape of rupture	Irregular with bulging mucosa.	Regular, rounded without bulging of mucosa.

### **Complications of abdominal injuries:**

- 1- Reflex Cardiac Inhibition (blow to the epigastrium).
- 2- Hemorrhage (external and/or internal).
- 3- Shock.
- 4- Venous air, fat and/or thrombo-embolism
- 5- Abdominal infection & Peritonitis.
- 6- Supra renal hemorrhage.
- 7- Acute renal failure.

## **MUSCULOSKLETAL INJURIES**

**They are divided into four main types:**

- I. Bone fractures.
- II. Joint dislocation.
- III. Ligament sprain.
- IV. Muscle strain.

### **I. Bone fractures:**

***Types of fractures:***

#### **A. According to the presence of external wound:**

- **Closed (simple)** bone fractures are not accompanied by open wounds on the surface of the skin.
- **Open (compound)** bone fractures are accompanied with open wounds on the surface of the skin. Open bone fractures are serious due to the risk of external bleeding, contamination and infection.

#### **B. According to shape of the fracture:**

Bone fractures may be transverse, longitudinal, oblique, spiral or comminuted. **Greenstick** fracture with intact periosteum is more common in children.

#### **C. According to etiology of the fracture (DD):**

Traumatic fracture should be differentiated from pathologic fracture that is due to fragility of the bone:

- Old age.
- Osteoporosis
- Osteogenesis imperfecta.
- Osteomalacia.
- Sarcomata, and bone metastasis.

### **Healing of fractures:**

The stages of healing proceed as follows:

- After 1 week: organization of the blood clot in between the bone fragments.
- After 2 weeks: 1<sup>ry</sup> callus is formed in the organized clot.
- After 6 weeks: intermediate callus is formed.
- After 3 months: complete healing with a firm callus.
- In next few months: an approximate estimation can be made from the smoothness of the edges.
- After complete union it is difficult to determine whether the age of the fracture or even to tell whether the bone was fractured at all.

**NB.** Healing of bone is affected by the age, nutrition, health, gapping of the bone ends and sepsis. Approximate time of healing is as follows:

Fracture femur takes → 7 weeks; tibia → 6 weeks, humerus → 5 weeks; radius & ulna → 4 weeks; phalanges → 3 weeks.

### **Medico Legal importance of fractures:**

Simple fracture is not considered dangerous to life, but they are considered grave or dangerous from the legal point of view because:

- The long period of treatment (more than 20 days).
- The danger of severing important vessels.
- The liability to leave a permanent infirmity.

## **II. Joint dislocation:**

Displacement of one of the end of bones from inside to outside the joint space. This usually occurs in the shoulder, hip or elbow joints.

## **III. Ligament sprain:**

Injury to ligaments surrounding joints due to overstretching beyond their normal capacity. Ankle, and to a less extent wrist and knee joints are the most susceptible ones.

## **IV. Muscle strain:**

Tearing to a muscle or its tendons as a result of overstretching. Calf muscles are considered a good example for muscle strain.

## General manifestations of musculoskeletal injuries:

### **Symptoms:**

- Pain and swelling of the place of injury.
- Difficulty or inability of movement or use of the injured part.
- If the ligament is ruptured, one may hear a popping sound.

### **Signs:**

- Bruising and change in the color of the skin (may be delayed).
- Sense of friction between the fractured bone ends.
- Prominent broken bone ends from the skin (**compound fracture**).
- Significant deformity of the injured part.

### **Complications:**

- Block of circulation and/or sensation of the affected part.
- Hemorrhage and shock.
- Infection.
- Fat and pulmonary embolism.
- Acute tubular necrosis.

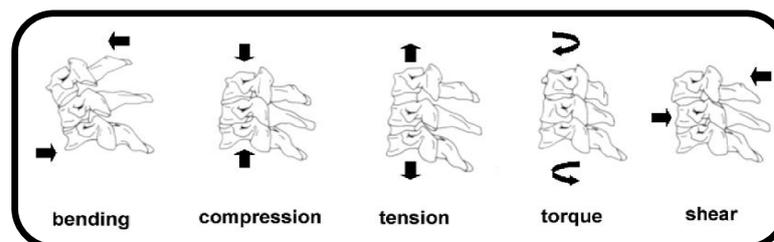
## SPINAL INJURIES

The spine is commonly injured in major trauma as:

- **Blunt Injury:** Motor vehicle collisions, assaults or falls from height.
- **Penetrating Injury:** Gunshot wounds, stabbing or explosions.

### Possible Mechanism of injury includes:

1. Hyperextension.
2. Hyperflexion.
3. Hyperextension followed by hyperflexion (Whiplash Injury).
4. Compression.
5. Tension.
6. Axial torsion.
7. Shear.



**Mechanism of spine Injury is illustrated in the following figure:**

DESCRIPTION	DIAGRAM	EXAMPLES
<b>Hyperextension</b> Excessive posterior movement of head or neck		Face into windshield in MVC Elderly person falling to the floor Football tackler Dive into shallow water
<b>Hyperflexion</b> Excessive anterior movement of head onto chest		Rider thrown off of horse or motorcycle Dive into shallow water
<b>Compression</b> Weight of head or pelvis driven into stationary neck or torso		Dive into shallow water Fall of greater than 10 to 20 feet onto head or legs
<b>Rotation</b> Excessive rotation of the torso or head and neck, moving one side of the spinal column against the other		Rollover MVC Motorcycle accident
<b>Lateral Stress</b> Direct lateral force on spinal column, typically shearing one level of cord from another		"T-bone" MVC Fall
<b>Distraction</b> Excessive stretching of column and cord		Hanging Child inappropriately wearing shoulder belt around neck Snowmobile or motorcycle under rope or wire

\*MVC: Motor Vehicle Collision.

\*T-Bone: Broadside collisions are where the side of one vehicle is impacted by the front or rear of another vehicle, forming a "T".

**General manifestations of spinal injuries:**

- Severe pain in the neck or back.
- Inability to move the neck or back.
- Weakness, numbness, paralysis or lack of control of the limbs.
- Lack of control on the bladder or bowels.

**Medico-legal aspects of spinal injuries:**

- In case of paralysis ± impotence due to spinal injuries, there is often claims for compensation e.g. car accidents. Thus it is important to differentiate between spinal concussion and spinal compression & laceration as the former is characterized by spontaneous rapid recovery.
- Laceration of the cord without an external injury of the spinal column is not uncommon especially in children, due to momentary distortion of the profile of the spinal canal.
- Laceration of the spinal cord may occur in case of firearm though the missile has not entered the cord. The damage in this case results from the high velocity effects of the missile.

## Chapter (8)

# MEDICO LEGAL ASPECTS OF TORTURE

### **ILOS:**

- *To identify types of torture.*
- *To recognize consequences of torture.*
- *To properly diagnose cases of torture.*

### **Definition**

Torture means, intentional infliction of severe pain or sufferings by any act, whether physical or mental on a person for certain purpose.

### **Purposes and objectives of torture are usually one or more of the following:**

1. Obtaining information, confession or testimony against others.
2. Punishing the victim for an act he committed on a third person.  
Revenge
3. Destroying personality.
4. Spreading terror in the community to exercise social control.

### **Epidemiology and nature of torture:**

Torture is world-wide spread. According to Amnesty, more than 90 countries around the world systemically practice torture. It is considered violation of human rights. Victims of torture include all age groups of both sexes, social classes, religions and professions. Modern technology, psychological techniques and drugs that leave few physical signs are used to make it difficult to diagnose torture. Although fatal end is not intended, many cases may progress to death of victims.

### **Types of torture:**

According to the method used for infliction of pain or sufferings, torture is classified into:

- 1) **Physical torture:** as beating, burning, electrocution, asphyxiation, suspension, hair or nail pulling, dental extraction and exhaustion by fixed abnormal positioning.
- 2) **Psychological torture:** as verbal insult, shame execution, forced observation of others or beloved ones while being tortured or showing the instruments used for torture.

- 3) **Sexual torture:** as rape, sodomy, genitalia exposure or mutilation and raping by trained animals.
- 4) **Pharmacological torture:** by pain-inducing or hallucinating drugs and truth-serum.
- 5) **Environmental torture:** by isolation, sleep-deprivation, heat or cold temperature, starvation or drinking dirty water or urine, shaking, severe noise, isolation in dark, damp narrow cell, or closure of eyes or coughed head which leads to disorientation of time and space.

### **Consequences of torture:**

Torture is often difficult to prove, particularly when there is time lapse between the event and the medical examination, or when the torturers are immune from prosecution. Moreover, many torturers around the world use methods designed to have maximum psychological impact while leaving only minimal trace evidences.

#### **1) Physical damages:**

- a. Tears, sprains, or rupture of muscles, ligament, joints or bone fractures → disability, disfigurement or permanent infirmity.
- b. Neuronal impairment especially after head injuries, suffocation or prolonged malnutrition, dementia or epilepsy.
- c. Sexually-transmitted diseases (STD), pregnancy, tears of genitalia or mutilation.

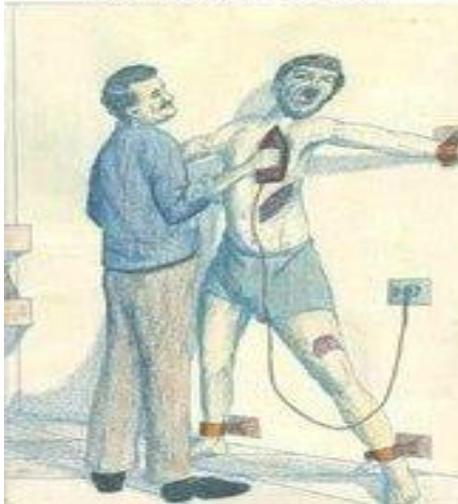
2) **Psychological sequelae:** depression, flash-backs, night-mares, memory-disturbances, out-bursts of anger, lack of concentration avoidance, damage of self-concepts, post-traumatic stress disturbance (PTSD), loss of trust in others and sexual dysfunction.

### **The role of health professionals for prevention of torture:**

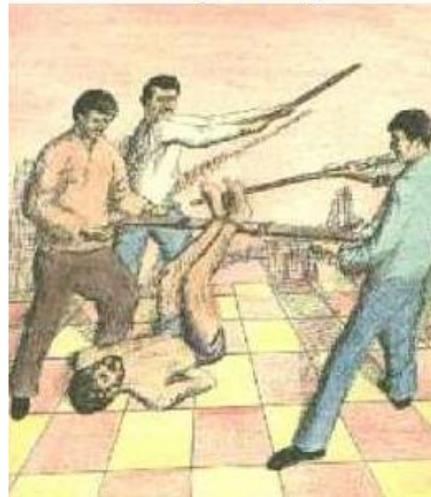
- 1) Doctors should never share or be involved in torture process and medical syndicate should protect doctors from pressures or threatening.
- 2) Early detection and diagnosis of victims of torture.
- 3) Notification of cases to proper authorities, to prevent further torture.
- 4) Medical examination, investigation and documentation of damages by medical reports, photography, radiology and psychiatric assessment, according to international codes and standards regarding torture victims.

- 5) Treatment of victims and rehabilitation of survivors.
- 6) Follow-up of survivors, medical evaluation and presenting an expert testimony in courts.
- 7) Determining the cause and manner of death and the identity of the victim where fatal torture is alleged.
- 8) Close co-operation between law and medical professionals is essential for prevention of torture and protection of human rights.

*Clothes Iron To Skin*



*Binding & Beating*



*Suspending & Whipping*



*Severing limbs*



## Chapter (9)

# HEAD INJURIES

### *ILOS:*

- *To understand Mechanism of head trauma.*
- *To diagnose different varieties of head injuries.*
- *To evaluate medico-legal responsibility in management of head trauma victims.*
- *To recognize residual long term sequelae after head injuries.*
- *To interpret fatality risks in victims with head injuries.*

### **Definition:**

Head injuries include any damage affecting the scalp, skull, meninges and/or the brain due to mechanical trauma.

### **Conditions:**

- **Accidental:** home and occupational accidents, falls, bicycle and motorcycle accidents & firearms.
- **Homicidal:** by stick, hammer, axe or firearm.
- **Suicidal:** e.g. by firearms & falls from height.

**Mechanism of trauma:** (I) Blunt or (II) Penetrating trauma

(I) **Blunt trauma** may occur through one of the following mechanisms:

#### **1) Direct impact trauma by an object:**

- a. *Moving object hit the head* e.g. Blow with a stick, baseball, falling a block of wood over the head → *acceleration* of the head.
- b. *Moving head impact a fixed object* e.g. fall on the ground → *deceleration* of the head.
- c. *Local impact* usually results into local deformation of the skull and subsequent deformation of the underlying brain tissue.

#### **2) Inertial trauma by either:**

- a. *Rotational acceleration or deceleration of the head:*

The layers of brain tissue are accelerated/decelerated at different speeds as they have different densities. This

causes the layers of brain tissue to glide over each other like a pack of cards, causing shearing or stretching, of the tissue throughout the brain.

*b. Linear acceleration/deceleration (Whiplash).*

**(II) Penetrating trauma** by any heavy sharp object e.g. knife, or penetrating object e.g. poker or missile. Damage occurs in the brain tissues through which the weapon travels.

### Types of Head Injuries:

#### **I. According to presence or absence of scalp injury:**

1. **Closed:** not associated with scalp injury.
2. **Open:** associated with scalp injury.

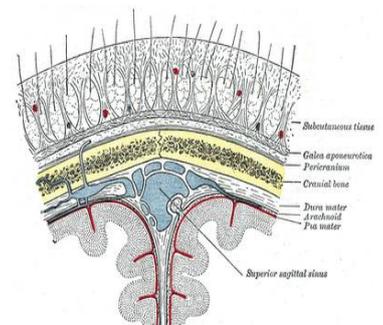
#### **II. According to the anatomical structure that was injured:**

1. Scalp wounds.
2. Skull fractures.
3. Meningeal injuries.
4. Brain injuries.

## **Scalp Injuries**

### The Scalp consists of several layers:

1. **(S)** Hairy *skin*.
2. **(C)** Subcutaneous fat and connective tissue layer with fibrous strand (blood vessels are attached to it).
3. **(A)** The galea *aponeurotica* (a thin fibrous layer to which the flat occipitofrontalis muscle is attached).
4. **(L)** **Loose** connective tissue layer (contain emissary veins that traverse the scalp from the superficial fascia, penetrate the skull and communicate with the intracranial venous sinuses).
5. **(P)** The *pericranium* (the periosteum which is confined to every bone).



**Types of scalp injuries:**

- ***Contusions or scalp haematoma:***

	<b>Subcutaneous</b>	<b>Subgaleal</b>	<b>Sub periosteal</b>
Site	Between skin & aponeurosis	Below aponeurosis	Below periosteum
Size	small	large	Take the size of the underlying bone
Limited by	dense fibrous strand	attachment of occipitofrontalis	Suture lines
Character	Firm, circumscribed & painful.	Soft, diffuse & less painful.	Limited to one bone Eg. cephalhematoma in the newly born

- ***Lacerations:*** simulate cut wounds due to stretched skin over the skull bone. They are confirmed by hand lens examination to visualize the irregular bruised edges, tissue bridging and the crushed hair ends.
- ***Torn flap wounds:*** Avulsion of the scalp at the layer of loose connective tissue may occur if hair is pulled by a rotating machine like electric fan.
- ***Cut wounds.***
- ***Cut lacerated wounds*** caused by heavy instrument with sharp edges e.g. axe.
- ***Firearm wound*** (inlet&/or exit).

**Complications of scalp wounds:**1. ***Hemorrhage:***

Scalp wound bleeds profusely because

- It is rich in blood supply.
- Fibrous tissue is attached to its blood vessels preventing them from vasospasm.

2. ***Septic infection:***

- Cellulitis, erysipelas or tetanus.

- Intracranial spread of infection through the emissary veins → osteomyelitis, meningitis, encephalitis brain abscess and cavernous sinus thrombosis.

Traumatic meningitis must be differentiated from meningococcal meningitis; and meningitis complicating “Otitis media”.

	<b>Traumatic meningitis</b>	<b>Meningococcal meningitis</b>	<b>Otitis Media Complication</b>
<b>History</b>	Trauma	Sore throat or epidemic (neck rigidity).	Otitis media
<b>Skull</b>	May be fractured	Normal	Temporal necrosis
<b>Pus</b>	Beneath the scalp wound	Basal	Temporal area
<b>Bacteria</b>	Staph. or Strept.	Meningococci	Similar to the ear infection

## **Skull Fractures**

### **Mechanism of skull fracture:**

- The skull is deformed by localized impact, if the force and deformation exceed the skull elasticity and plasticity it will fracture at or near the site of impact.
- Skull fractures may occur with no associated intracranial damage and conversely, fatal injury to membranes, blood vessels and/or the brain may occur without overlying fracture.
- Skull Fracture may be simple or compound according to the absence or presence of scalp wound.

### **Factors affecting shape of the fracture:**

- Force of the impact (momentum):** depends on the **mass**, **velocity** of the striking object and **time** of contact of the object with the head (*Mass X Velocity*).
- Site of the impact:** thin bone is easily deformed and fractured e.g. temporal bone.
- Striking surface area:** localized or wide.
- Head coverings:** as helmets to protect the head.

- e) **Support of the head:** freely movable head → fracture may not happen, and if supported → fracture is more likely to occur.
- f) **Elasticity:** fractured are less likely to occur in infants.

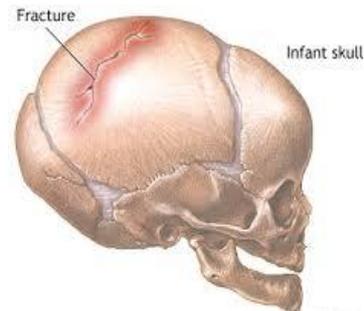
### Types of skull fractures:

#### A. Fissure fracture:

**Causative object:** heavy blunt instrument with considerable momentum e.g. stick, stone, blow by fist, falls may occur in the vault or base of the skull.

#### Characters:

Linear, with no bone defect, occurs at site of impact and extends along lines of anatomical weakness.



#### Subtypes:

##### 1. Vault fractures:

- a) **Polar fracture:** occurs at the most bulging poles when the head is supported.
- b) **Diastatic fracture:** fissure fracture causing separation of sutures.
- c) **Thermal fracture:** Occurs due to severe burn of the head (see thermal injuries).

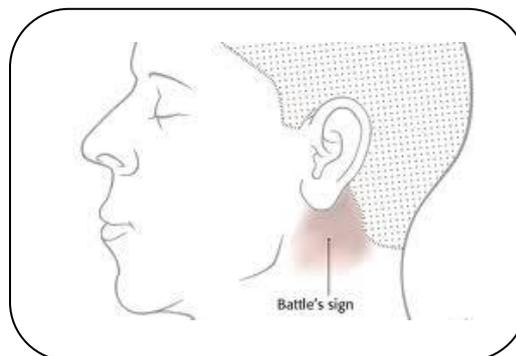
##### 2. Fracture base:

- a) **Ring fracture:** around foramen magnum due to a falling from height on heels or buttocks or on the top of the head.
- b) **Hinge fracture:** basal fracture that extend to sides of the skull and separate it into two halves (e.g. motor cyclist fracture).



c) **Extension from vault fracture or direct basal blows** may lead to:

	<b>Anterior cranial fossa fracture</b>	<b>Middle cranial fossa fracture</b>	<b>Posterior cranial fossa fracture</b>
Mechanism	Forehead blow or Extension from Frontal bone fracture.	Blow to the chin (boxing) or extended from temporal bone fracture	Falls on the occiput or extended from occipital bone fracture.
Suggestive signs	- <b>Raccoon's eyes</b> (Bilateral black eye). -CSF rhinorrhea. -Epistaxis.	- <b>Battle's sign</b> (hematoma behind the ear over the mastoid). -CSF otorrhea and rhinorrhea. -Epistaxis & bleeding from the ear.	Blood accumulate in the muscles of the back of the neck.
Cranial nerve affection	Olfactory → anosmia, Oculomotor → dilated pupils, Abducent & Trochlear.	Facial → facial paralysis, Vestibulocochlear → deafness, Trigeminal → paralysis of mastication & face sensation.	Vagus & Glossopharyngeal → visceral paralysis.

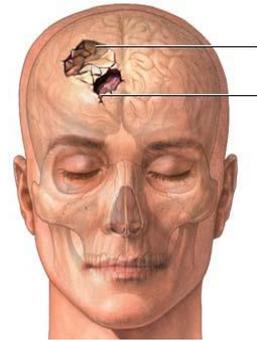


## **B. Depressed fracture**

**Causative object:** heavy blunt object with localized sticking surface area and considerable momentum e.g. head of hammer or stone.

### **MLI:**

- a) Occurs at site of impact.
- b) Take the shape of the striking surface of the causal object (Triangular, rounded ...).
- c) Denote the position of the assailant (the more depressed part is nearer to the assailant).
- d) In children, thin elastic bones do not fracture but form a concave depression (**pond fracture**).



## **C. Comminuted Fracture: Spider's web:**

**Causative object:** heavy blunt object with wide striking surface area and considerable momentum e.g. falls from heights.

Radiating lines connected by concentric fracture rings. Comminuted fracture may be depressed called **depressed comminuted fracture**.



## **D. Cut fracture:**

**Causative object:** heavy sharp object e.g. chopper, or axe.

**Characters:** has regular sharp straight edges, with bone defect, may be triangular if striking with axe angle where its base is near the assailant side.

## **Healing Of Skull Fractures:**

### **1. Fissure: within 3 months**

- Edges are approximated → complete healing
- Edges are separated by tissues → smoothing of edges.

**2. Bone defect** in the vault heals by membrane formation (as the bones of the vertex are membranous in origin in embryo). It starts after 3 months & completely closes the defect in 12 months. At first the membrane is thin and later it becomes quite thick and hard.

## ***Intracranial Hemorrhage (ICH)***

There are 4 types of ICH:

### **1. Extradural (epidural) hemorrhage (EDH):**

EDH is always traumatic.

**Site:** Arterial blood accumulates between the periosteal layer of the Dura and the inner skull table. They are always unilateral.

**Bleeder:** The commonest is the **middle meningeal artery** as it passes upwards within a groove in the temporal bone usually associated with fracture in 85 % of cases. This accumulation can be immediate or delayed. Bleeding of venous origin is rare.

**NB.** EDH may be of venous origin in cases of ruptured emissary vein or venous sinuses.

**D.D.** heat hematoma with thermal fracture (*see before*).

**Clinical picture:**

- a. Concussion passing to compression with lucid interval (*see concussion*) or
- b. Cerebral compression in case of severe bleeding.

### **2. Subdural hemorrhage (SDH):**

SDH is usually **traumatic** (inertial trauma). It is **more common** than EDH.

**Site:** Blood accumulates between the meningeal layer of the Dura and Arachnoids.

**Bleeders:** bridging veins which cross the Dura to the brain surface.

**Types:**

#### a) **Acute SDH:**

**Caused by** sudden jarring or rotation of the head (***eg. Shaken baby syndrome***) causes movement of the brain relative to the Dura which leads to shear and tear of the bridging veins.

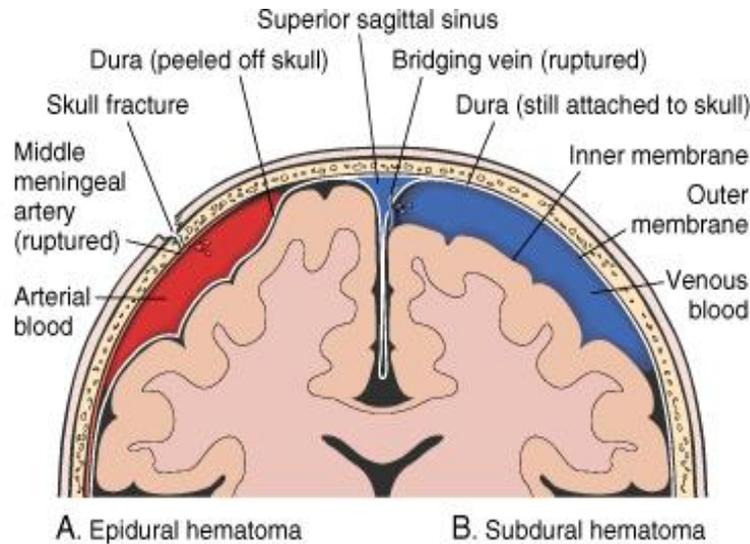
**Clinically** presented as concussion passing to compression with or without lucid interval.

#### b) **Chronic SDH:**

**Caused by** repeated minor trauma to the head more common in elderly, diabetics or alcoholics (frequent unprotected falls and prolonged bleeding times).

**Clinical** presentation includes persistent headache, fluctuating drowsiness, confusion, and memory changes.

**PM:** thin layer of coagulated blood with granulation tissues invading it at different sites. It shows different colors indicating that it is of different ages.

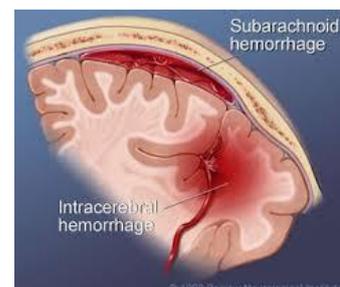


	EDH	SDH
Site	Between skull & Dura	Between Dura & arachnoid
Frequency	Less common	More common
Bleeding	Arterial (MMA)	Venous
Trauma	Direct	Inertial
Skull fracture	Present in 85% of cases	Not present

### 3. Subarachnoid hemorrhage (SAH):

It is mostly pathological, due to:

- a. Extension of pathological intracerebral hemorrhage,
- b. Rupture of aneurysm; which may be:
  - Congenital aneurysm: (common in females) in the vessels “Circle of Willis”, i.e. in the base of the brain.



- Mycotic (thrombotic) aneurysm: complicating sub-acute bacterial endocarditis, due to detachment of its vegetations

and their embolic impaction in one of the subarachnoid vessels; and it is usually in the vessels of the vertex.

**May be traumatic:**

- a. Usually associated with contusion and laceration of the brain surface at parietal, temporal or under surface of frontal poles.
- b. Rarely due to a kick or blow to the side of the neck with rupture of the vertebral artery as it enters the cranial cavity (traumatic basal SAH).

**4. Intracerebral hemorrhage (ICH):**

- **Pathological ICH:** (cerebral apoplexy), mostly due to hypertension and atherosclerosis of cerebral arteries. The main bulk of the hematoma is in the brain substance and tapers as it approaches the brain surface. The usual site is the corpus striatum and the pons and rarely in the cerebellum. Pontine hemorrhage is presented by coma with fever, pin-point pupils and muscle paralysis (D.D. opioid coma).

- **Traumatic ICH:** rupture of blood vessels in brain substance due to shearing stress or extension from surface contusion. It may occur in the same side of the trauma (coup) or the opposite side (contre-coup).

	Traumatic ICH	Pathological ICH
<b>Age</b>	Any age	40-60
<b>Sex</b>	Both sexes	Male
<b>Common site</b>	Temporal or frontal poles	Corpus striatum and pons
<b>History</b>	Trauma	Hypertension, atherosclerosis, left ventricular hypertrophy

## ***Brain Injuries***

### **A. Localized Brain Injury: (Contusions and lacerations)**

#### **Types of cerebral contusion:**

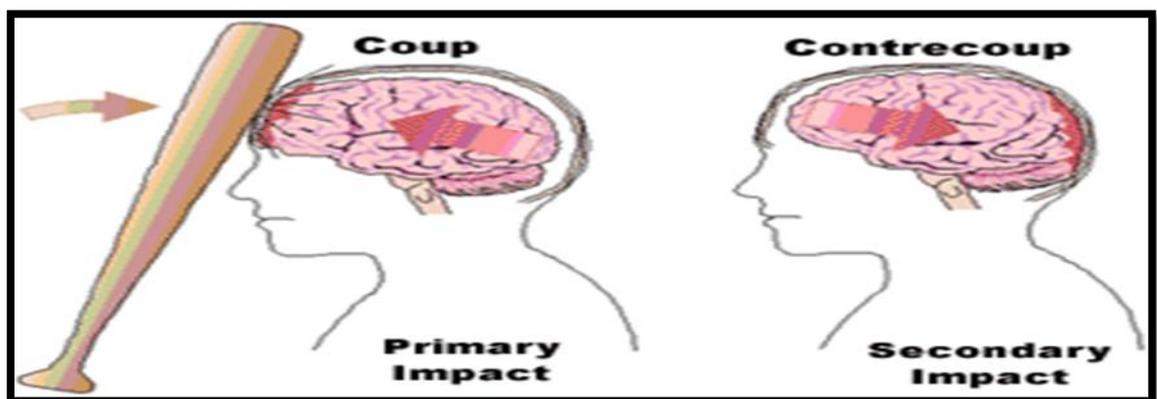
- **Coup contusions:** due to acceleration of the head from blow causing contusion at the point of impact or due to skull deformation.

- **Contre-coup:** opposite to the site of impact due to deceleration of the head where the brain glides over the irregular, jagged contours of the skull.

**Example:** A backward fall striking the back of the head on the ground causes scalp abrasion, bruising or laceration on the occiput with a localized coup contusion at the occipital pole of the brain and a more marked contre-coup contusion over the frontal and temporal poles.

**MLI:**

1. In cases of head trauma, the physician should not depend on the site of external wound as a guiding evidence of the intracranial lesion.
2. The assailant may claim that he is not responsible for the brain injury.



**B. Diffuse Brain Injuries:**

**1-Concussion**

**Definition:**

It is a clinical state of transient loss of conscious due to temporary impaired cerebral functions.

**Mechanism:**

The trauma will cause a propagation of a vibratory wave in the whole brain affecting all brain centers, and particularly the Reticular formation in the brain stem which is governing the consciousness state of the individual.

**Clinical picture:**

- Mild confusion which is temporary.
- Brief loss of conscious which lasts from 15 minutes to 6 hours, during which there will be manifestations of shock (rapid weak pulse, low blood pressure, cold clammy sweating, low body temperature).
- Post traumatic amnesia (events just before or after the injury may be lost).

**Treatment:**

The patient should be hospitalized and remains under observation for **48 hours**; give the patient fluids and glucose to treat hypotension and hypoglycemia.

**Prognosis:****1. Complete recovery:**

In most cases of pure concussion; the patient will recover completely without any residual effect.

**2. Incomplete recovery:**

The patient will recover but incompletely, i.e. suffer from "**Post-concussion syndrome**" manifested by group of symptoms as: headache, drowsiness, amnesia, irritability and confusion. These symptoms will disappear completely after few days to few weeks.

**3. Concussion passing to compression:****a) With a lucid interval:**

- Infliction of the trauma to the side of the head will produce concussion; that may be accompanied by tearing of the middle meningeal artery or one of its branches as they are running inside grooves in the temporal bone.
- No bleeding occurs from the torn vessel as there is low blood pressure during concussion; but after recovery of the patient and normalization of the blood pressure, the bleeding starts and increases gradually leading to another stage of loss of consciousness due to cerebral compression.

- This stage of consciousness between the unconsciousness of concussion and that of compression is called "**lucid or latent interval**", during which the patient can walk and speak.

#### **The medico-legal importance of "Lucid interval":**

- i. Alleged negligence: any patient presented to the hospital with a history of head trauma should be carefully examined and subjected to thorough investigation and kept under observation for at least 24-48 hours with continuous monitoring to vital signs, level of conscious, state of pupils, motor power and reflexes. If the pulse falls below 60/minute, decompression operation must be urgently done.
- ii. The assailant defense may assume that the cause of death is not due to the trauma.
- iii. The victim may tell the name of the assailant.

**b) Concussion passing to compression directly:** (i.e. without a lucid interval):

It occurs in case of extensive intracranial haemorrhage from the start, or depressed cranial bone.

#### **4. Fatal concussion:**

Rarely, there is prolonged arrest of the vital centers that end fatally. PM examination reveals presence of minute petechial hemorrhages scattered in the brain tissue, with congestion of the cerebral vessels.

## **2- Diffuse Axonal injury (DAI)**

### **Definition:**

The term **diffuse axonal injury** is used clinically to denote a condition of diffuse injury of the axons of the brain cells associated with immediate unconsciousness and coma longer than 6 hours duration following head trauma. Common in road traffic accidents (RTA).

**Pathophysiology:**

- Severe rotational impact and deceleration cause tearing of the nerve tissue and disrupt the brain's regular communication and chemical processes.
- This disturbance in the brain can produce temporary or permanent widespread brain damage, coma, or death.

**PMP:**

- There may be nothing to see on the surface of the brain or on slicing at autopsy.
- Special stains are used to demonstrate microscopic damage. Diffuse axonal injury is often associated with brain swelling. Shearing or gliding injury may also rupture small blood vessels deep within the white matter of the brain detected as numerous deep small hemorrhages.

**3- Cerebral Compression**

A state of increased intracranial pressure more than (10-15mmHg) due to several causes.

**Causes:**

- Intracranial hemorrhage whether traumatic or pathological.
- Depressed skull fracture.
- Intracranial tumors.
- Infections.
- Brain edema.
- CSF obstruction (hydrocephalus) or increase production (meningitis).

**Stages:**

1. ***Irritation stage:*** Increased ICP → occlusion of cerebral veins (thin walled and low pressure) → congestion and edema → Irritation.
2. ***Paralytic stage:*** further increase in ICP → occlusion of arteries (thick walled with high pressure) leading to ischemia and brain infarction.

3. **Conisation stage:** The Increase in ICP → brainstem compression and herniation of the medulla through foramen magnum → Death (Asphyxia or syncope).

**N.B.** Compression following head trauma may develop immediately after the trauma, or it may appear a few hours or even days later.

### Clinical picture of traumatic cerebral compression:

1. History of a recent head trauma.
2. Gradual loss of consciousness.
3. Irritability or disorientation.
4. Headache, projectile vomiting and blurred vision.
5. **Cushing's triad:** Slow full regular pulse, hypertension, slow breathing which may be irregular.
6. **Cerebral fever** (affection of heat regulatory center).

### 7. **Signs of lateralization:**

- **Unequal pupil size:** ipsilateral constriction followed by dilatation of the pupil due to compression of the ipsilateral 3<sup>rd</sup> cranial nerve, then contralateral affection in the same manner, finally bilateral pupillary dilatation.
- **Contra-lateral hypertonia then weakness** and/or paralysis due to compression of the ipsi-lateral cortico-spinal tracts because these tracts decussate at the level of the medulla.

### Treatment:

**Decompression operation** to remove the cause of compression. A residual permanent defect in the skull after the trephine drilling of the bone, which is considered permanent infirmity.

## **Long Term Complications Of Head Injuries**

1. **Post traumatic epilepsy:** healing and scarring of the meninges and brain surface may be the focus of later epileptic fits that may occur months to years (usually not more than 4 years).
2. **Meningitis and brain abscess:** particularly common after penetrating head injury and after fractures which disrupt the nasal and frontal air sinuses.

3. **Permanent disability** of varying degrees to death. The type and severity of disabilities depend on the site and severity of the brain damage.
4. **Cranial nerve damage** (anosmia, ocular palsies).
5. **Cognitive disabilities:** including all cognitive skills like thinking, reasoning, problem solving, and memory. The most common of these impairments is short-term memory loss.
6. **Sensory problems:** (touch, taste, and smell) e.g. persistent ringing ears, bitter taste, bad smell, blind spots or double vision.
7. **Language difficulties:** whether spoken and written language. Communication problems are common and also forgery claims because of the change in handwriting.
8. **Personality changes:** depression, anxiety, aggression, acting out, and social inappropriateness.
9. **Alzheimer's, Parkinson's disease or Dementia.**

### ***Causes of Death in Head Injuries***

#### **Early causes:**

1. Cerebral lacerations.
2. Severe cerebral contusions.
3. Diffuse axonal injury.
4. Cerebral compression with brain herniation.

#### **Delayed causes:**

1. Septic complication,
2. Epilepsy

## Chapter (10)

# FIREARM INJURIES

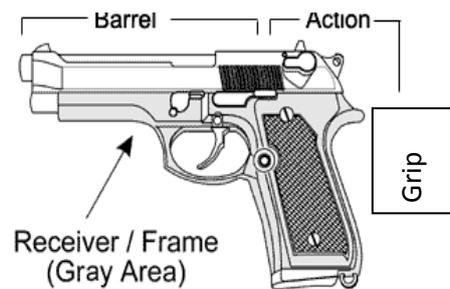
**ILOS:**

- To identify types of firearm weapons and cartridges.
- To know the sequence of events on firing.
- To diagnose firearm wounds.
- To estimate distance and direction of firing.
- To judge the manner of firing.
- To investigate Firearm deaths.

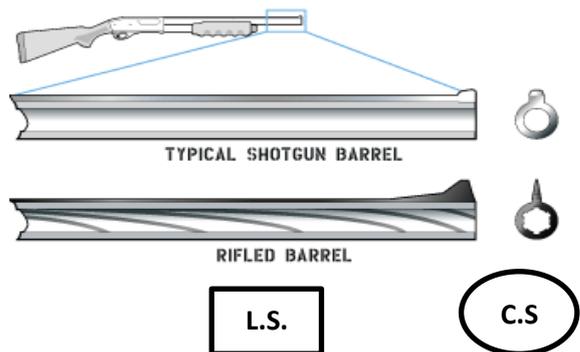
### Firearm weapons

**Definition:**

**Firearm weapon** is an instrument which discharges a missile by the expansive force of the gases produced by the combustion of the propellant in a closed space. Principally a firearm weapon consists of three parts; Barrel, Action and Grip.



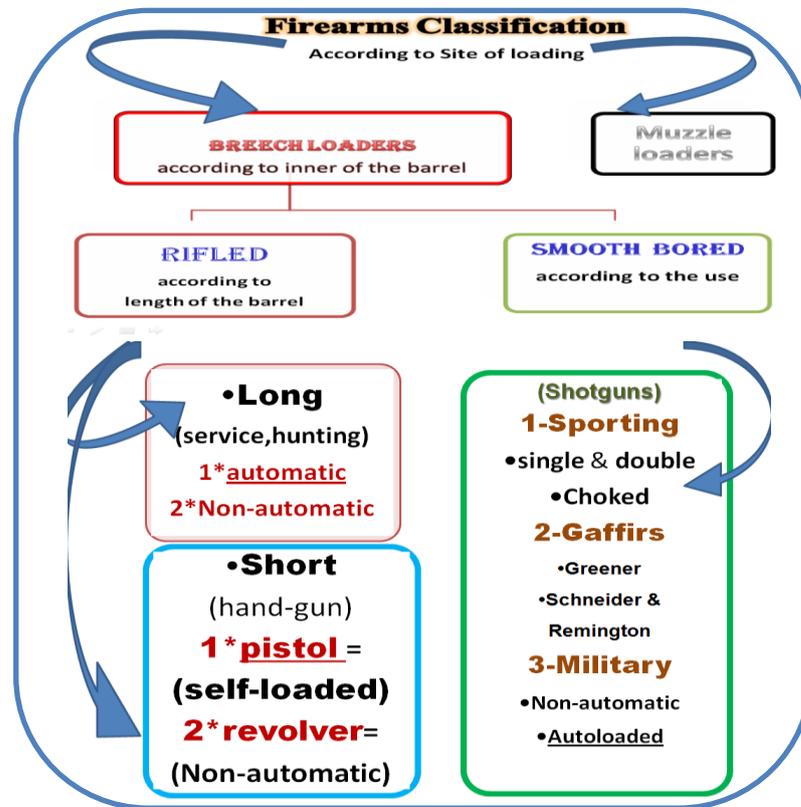
The barrel has smooth or rifled inner surface. **Riflings** are **grooves (depressions)** alternating with **ridges (lands)** that run spirally on the inner surface of the barrel.



**Rifling** imparts rotational spin to the bullet along its longitudinal axis (the gyroscopic stability) thus **affects the bullet so as to:**

1. Overcome the resistance of air and gravity → increased stability → increase in the range of firing.
2. Increase in the striking velocity → impact powerful penetration.
3. Help in the identification of the causal weapon.

**Classification of Firearm weapons:**



I. **Rifled Weapons** (with rifled barrels)

1. **Short Weapons (Handgun):** A firearm designed to be fired from the hand and having a **short rifled barrel**.

**Revolver (non- automatic);** having a revolving magazine (cylinder) which is rotated manually each time the trigger is released. The empty cartridge case is retained within the cylinder after firing.



a) **Pistol (Semi-automatic);** having a removable magazine in the grip storing cartridges and having a spring for auto-loading. This type of weapons **automatically** ejects an empty cartridge and loads the next one through **the gas** energy of the previously fired cartridge. It fires one cartridge with each pull of the trigger.



2. **Long Weapons (Military or Service and Hunting Rifles):** A firearm with a **long rifled barrel**, designed to be fired from the shoulder.

a) **Non-automatic,**

b) **Automatic,** A firearm **automatically** feeds cartridges, fires, extracts and ejects cartridge cases as long as the trigger is fully depressed and there are cartridges in the feed system, thus capable of discharging a **succession of bullets** within seconds.

## II. Non-rifled weapons

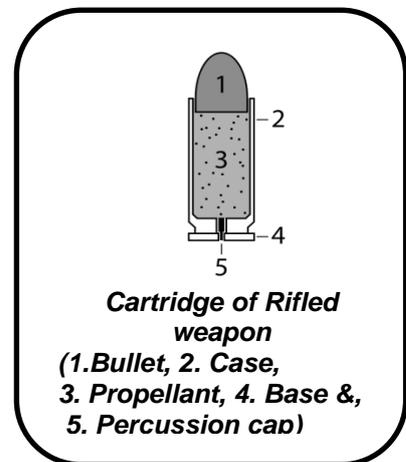
### Shotguns (Long Smooth Barrel Weapons)

The shotgun is a firearm with a **smooth long barrel** designed to fire multiple shots/pellets and to be fired from the shoulder.

1. **Ghaffir gun (Greener, Schneider and Remington)**, now rarely used.
2. **Sporting Gun, Single** and **double** barreled.
3. Recently, **Military Shotgun**.
4. Handmade, **Country shotgun**.

## **Firearm Cartridges (Ammunition)**

Principally, a cartridge consists of a cylinder (**case**) with gun powder (**propellant**) inside, missile (**bullet** or **shots/slugs**) on its top and percussion cap fixed in its base.



- **Cartridge Case**

- Usually composed of brass (70% copper 30% zinc) in many sizes. Shotgun case may be all plastic, all brass, or plastic with a brass. Older Shotgun cases were made of brass and cardboard. Ghaffir gun case is made of brass with trimmed upper end **without external wad**.
- It keeps the various components in place.
- The cartridge base has **rim** except in semiautomatic and automatic guns where the cartridge base has a **groove**.

- **Percussion Cap**

A small cylinder made of brass that fits in the center of the base of any cartridges. It contains **the primer**; that is composed of:

1. Powered glass to produce heat on friction.
2. Highly inflammable substance (an explosive substance) such as fulminate of mercury that explodes when struck. Recently, **styphnate** priming compounds are used.
3. Oxygen-donor substance, as potassium chlorate.

- **Propellant (Gun Powder)**

There are two types of gunpowder; **black and smokeless** powder. Gun Powder burns to produce large volume of gases under pressure. On ignition, one volume of black powder → 300 volume gases leaving an alkaline residue, while one volume of smokeless powder → 900 volume gases leaving a neutral residue.

**Differences between black and smokeless powder:**

	<b>Black</b>	<b>Smokeless</b>
<b>1.Character</b>	<ul style="list-style-type: none"> <li>• An old propellant.</li> <li>• Easier to ignite but less potent.</li> </ul>	<ul style="list-style-type: none"> <li>• A recent propellant.</li> <li>• Safer and more potent.</li> </ul>
<b>2.Composition</b>	potassium nitrate + sulfur + charcoal	nitrocellulose with/without nitroglycerine
<b>3.Shape</b>	Black amorphous powder	Scales, cordite, rods or amorphous..
<b>4.Volume of Gases on ignition</b>	1 vol. →300 ml gases.	1 vol. →900 ml gas.
<b>5.Smoke</b>	Heavy	Minimal
<b>6.Residue (MLI)</b>	Alkaline (could be detected)	Neutral residue
<b>7.Weapon</b>	Old revolvers, Sporting and Ghaffir (Schneider and Remington)	All automatic & semi-automatic, Sporting and Ghaffir (Greener)

- **Projectiles (missile)**

Missile is the part of the cartridge which exits the muzzle.

1. **Projectiles of rifled weapons are bullets:**

- Bullets are originally made of lead and sometimes covered (fully or partially) with a jacket of copper alloy or other metal

harder than lead. Bullet jacket offers increasing resistance to expansion and fragmentation. Thus bullets are either:

- **Lead bullets** → revolvers,
  - **Jacketed bullets** → semi-automatic pistols and high velocity rifles.
- Its tip of the bullet is either pointed or rounded. The pointed one offers least resistance to air; so it is more potent than the rounded one.

- **Varieties of Bullets:**

- a. **The 'dum-dum' Bullet:**

- This was a British military bullet developed for use in India, in an Indian state called “Dum-Dum”.
    - It has a jacketed bullet with opened jacket **nose (tip)** to expose its lead core.
    - The aim was to improve the bullet's effectiveness by increasing its expansion and fragmentation upon impact, resulting in more **tissue destruction**.
    - The phrase '**dum-dum**' was later taken to include any soft-nosed or hollow pointed bullets and explosive-tipped bullets.



- b. **A frangible bullet or a Glazer bullet:** is one that is designed to disintegrate into tiny particles upon impact to minimize their penetration for reasons of range safety.

- c. **Rubber and Plastic Bullets:** In less lethal ammunition, projectiles designed to incapacitate but not kill. They are used by the police and security forces for riot control. Injury patterns include lacerations, fractures, and sometime penetrations.



## 2. Projectiles of In non-rifled guns are: Shots/pellets or slugs and Wads.

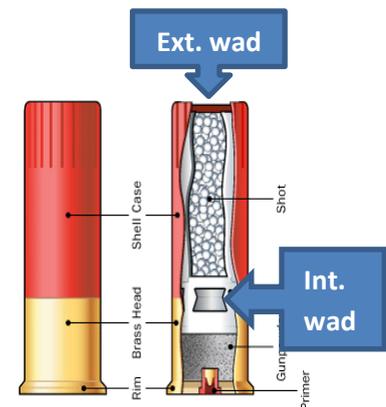
- a) **Shots** vary in **shape, size** and **number**. Small spherical machine-made shots are present in **sporting guns** and **Greener**. While large irregular shots and semi-cubical slugs are present in **Schneider and Remington**.

**Country-made** shotgun cartridges are filled with projectiles which may be home-made shots of lead, stout nails, metal scraps or stone pieces.

### b) Wads:

**External wad** is only found in **sporting gun** ammunition, about 1mm. thick and made of cardboard to cover the shots and keep them in place.

**Internal wad** is found in **all shotguns** ammunition, about 1cm. thick, originally made of felt and recently plastic. It separates between the powders and shots/slugs to keep them in place, and acts as a piston to them during firing.



3. **Blank shells:** contain only a small amount of powder and no actual load. When fired, the blanks provide the sound and flash of a real load, but with no projectile.
4. **Air gun ballistics:** Air rifle uses **CO<sub>2</sub>** (compressed gas) cartridges. Air guns are not included in gun regulation. Homicide and suicide have been reported with air guns.

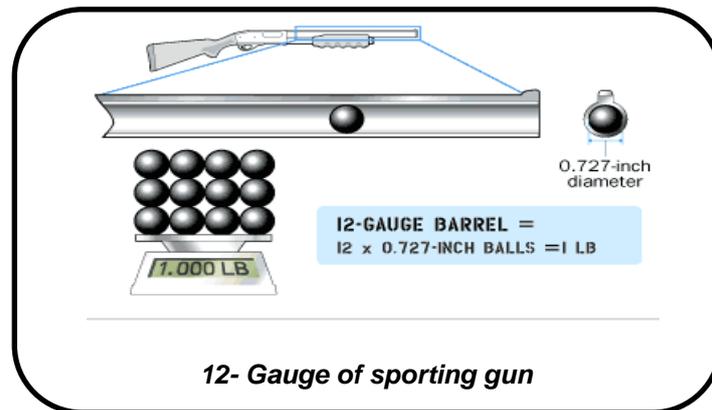
## ***Bore (Caliber or Gauge) of Firearm weapons***

### A. Rifled Firearm:

- i) Equal to the inner diameter of the barrel from one land to another land, **OR** the diameter of the base of the bullet.
- ii) Measured in millimeter or fraction of an inch.

## B. Non- Rifled Firearm:

- i. Gauge is calculated as number of equal lead balls required to make up one pound weight and each ball has the same diameter of the barrel.
- ii. In sporting gun **12**, the **diameter** of its barrel equals that of an imaginary lead ball **weighing** 1/12 of an English pound.



## *Mechanism of Firing*

- 1- On pulling the trigger the firing pin is released and strikes the percussion cap, releasing the spark of the primer and igniting the propelling powder.
- 2- The burning powder produces gases that build up the internal pressure.
- 3- The missile is forced forward at increasing velocity, accompanied by flame, smoke and unburnt powder. All propelled out of the muzzle at the same time, each of them has a distinct effect on the target.
  - a. The flash of light '**Muzzle flash**' is seen before the sound of explosion is heard (velocity of light > velocity of sound).
  - b. Hot explosive gases come out from the muzzle and travel to a distance of 15 cm. causing tears at the entrance.
  - c. Flame causes **burning** and reaches a distance equals to half the length of barrel.
  - d. Smoke causes **blackening** (soot) around the inlet, reaches a distance equal to 1-1.5 the length of the barrel.
    - le. In long weapons with smokeless powder; soot travels for one meter while in long weapons with black powder it travels for 1.5 meters. In short weapons, it travels for 25 cm.

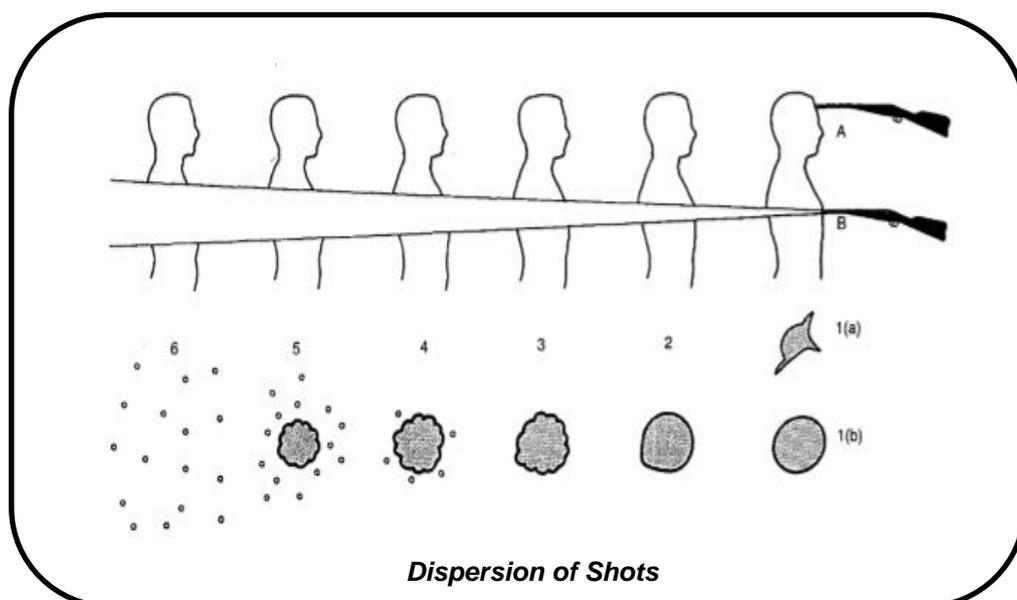
e. **Unburnt powder particles** cause **tattooing** around the inlet. They travel to a distance of 2 times the barrel length in long weapons with smokeless powder and a distance of 3 times the barrel length in long weapons with black powder. In short weapons, it travels for 50 cm. **Powder marks:**

- They include **burning, blackening and tattooing**. They are detected at the inlet wound and may be blocked by hair or clothing. They are condensed in circular fashion in perpendicular firing and eccentric in oblique firing.
- They cause the following effects:
  - **Burning**→ of cloths, skin and hairs (singed & comma shaped).
  - **Blackening**→ soot around the inlet.
  - **Tattooing**→ numerous reddish-brown to orange-red punctuate lesions surrounding the inlet wound.
- **MLI of powder marks:**
  - 1- Diagnosis of firearm injuries,
  - 2- Differentiation between inlet and exit,
  - 3- Identification the type of powder used,
  - 4- Estimation of the distance of firing, and
  - 5- Determination of the direction of firing.

f. **Projectiles:**

i. **Shots**

The mass of shots leaves the weapon initially as one mass which progressively diverge from the weapon.



**The inlet wound varies according to distance of firing as follows:**

Distance of Firing in meters	The inlet shape
1	Central hole 2 cm. in diameter
2	Smaller central hole with dispersion 4 cm. in diameter
3	Smaller central hole with dispersion 9 cm. in diameter
4	No central hole; <b>full dispersion of 16 cm. in diameter</b>
10	Dispersion area is 60 cm. in diameter
20	The whole body is covered with shots
50	The shots lose power of penetration and fall down

ii. **Wads** (in cases of shotguns)**Internal wad causes:**

- Skin penetration within 3 meters.
- Circular abrasion within 3 – 10 meters.

**External wad causes:**

- Skin penetration within one meter.
- Circular abrasion within 1 - 3 meters.

**MLI of wads:**

1. Diagnosis of firearm injury.
2. Diagnosis of firearm weapon type.
3. Estimation of distance of firing.
4. Determination of the weapon bore.

iii. **Bullets**

Bullet causes a hole with no dispersion and the distance of firing is estimated from the degree of bullet penetration.

***Firearm Injuries*****Definition:**

**Firearm injuries** are injuries produced by firearm projectiles. They show peculiar characters depending on the firearm weapon used, distance and direction of firing.

## Mechanism of Firearm Injury

Projectiles cause tissue damage by two principal mechanisms:

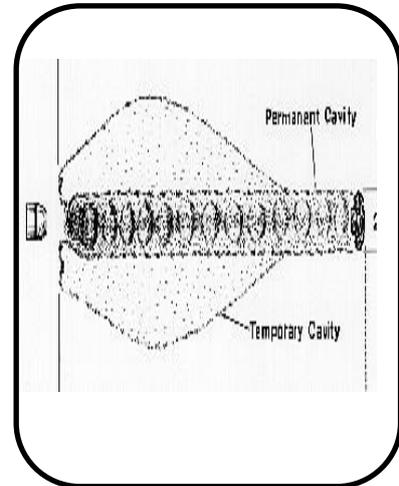
### 1. Direct laceration of the tissues "drilling effect":

In **low velocity** gunshot wounds e.g. from a pistol. In such cases the "permanent cavity" seen at autopsy accurately reflects the tissue damage produced by the path of the bullet.

### 2. Kinetic energy effect:

An additional effect in **high velocity** rifle wounds, e.g. hunting rifles, due to the large amount of kinetic energy transferred to the tissue producing the "temporary cavity".

This is detected at autopsy as a wide zone of hemorrhage around the permanent cavity.



## Characters of Firearm Injuries

1. **Loss of substance:** especially at entrance wounds. This is due to high velocity, spinning movement and heat effects.
2. Presence of two wounds inlet and exit or may be one wound.
3. Presence of Powder marks (Blacking, Burning and Tattooing) in near firing.
4. Beveling in flat bones (skull, ileum, sternum and scapula); which is a bone defect having circular, regular and sloping edge that is wider towards the inner table in inlet (Internal Beveling) and towards the outer table in exit wounds (External Beveling).



## Types of Firearm Injuries

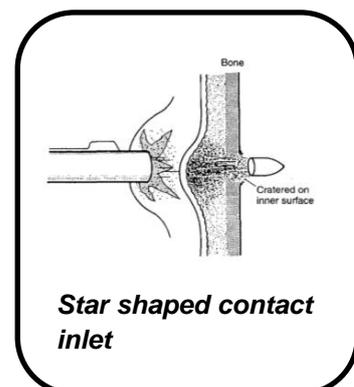
### I. Entrance Wounds:

They could be further divided into four broad categories, depending on the distance from the muzzle to the target.

#### **1-Contact Wounds**

(the muzzle touching the skin)

- Round or oval central defect that may be lacerated and acquire cruciate or star



shaped appearance due to subcutaneous expansion of gases.

- The bullet abrades the skin surface as it passes through it to form an '**abrasion collar**'.
- Soot and powder marks.
- Surrounding tissues are pink (Carbon monoxide effect →COHB).
- Vaporized metals are deposited in and along the wound tract (**metallization effect**).
- The imprint of the muzzle is detected on the surrounding skin if the weapon is firmly supported against the site of impact.



*Entrance Wound  
with Muzzle  
contusion*

## 2- Close Wounds

- Within the range of 25 cm in short weapons and 1.5 m in long weapons.
- The wound margin is usually smooth, regular and bordered by a pinkish red abrasion "**soiling ring**".
- Powder marks are detected.

## 3- Intermediate Wounds

- Within the range of 50 cm in short weapons and 3 m in long weapons.
- The occurrence of **tattooing** is pathognomonic.

## 4- Distant Wounds (out of tattooing range)

The only marks on the target are those produced by the mechanical action of the bullet in perforating the skin as:

- Abraded margin →"**Abrasion ring**".
- Lubricant on bullet surface wiped off onto the wound edge→ grey contact ring →"**Bullet wipe**".

## Causes of Atypical inlet wounds:

### • **Large inlet may occur in:**

1. Contact or near contact firing (gases effect).
2. Shot gun firing (before dispersion).
3. Oblique firing.
4. Ricochet bullet: when it strikes a hard object before entering the body, and become deformed or fragmented causing widening of the inlet that shows no powder marks.

- ***Irregular inlet may occur in:***
  1. Cruciate or star shaped in contact or near contact firing (gases effect).
  2. Corrugated area of skin (axilla, neck, and scrotum) may appear irregularly lacerated.
  
- ***Everted inlet may occur in:***
  1. Contact or near contact firing (gases effect).
  2. Fatty area.
  3. Putrefaction.

## **II. Exit Wounds:**

- The exit wound is produced when the bullet perforates the tissues in its way out of the body “***perforating wounds***”.
- However, the exit wound may not be detected if the missile is retained in the body or passes out through a body orifice (mouth, nose, ect...).
- Exit wounds are usually larger than the inlets, with irregular and everted edges. The deformation and tumbling of the bullet are the reasons why the exit wound is usually larger and more irregular than the entrance.
- Exit wounds show minimal loss of tissue but massive bleeding.
- Exits are unusual with shotgun injuries as the shots are usually dispersed in the tissues.
- The bullet path may be altered by striking bone, thus the bullet track may not be linear, and exit wounds may not appear directly opposite entrance wounds.
- Multiple exits may occur with single inlet because of:
  - The missile may shatter bone and fragments may pass out separately acting as extra missiles.
  - Dum dum bullets.
  - Near firing of non-rifled weapon (shots).

**Differences between inlet and exit wounds:**

	<i>Inlet</i>	<i>Exit</i>
<b>1. Loss of substance</b>	More	Less
<b>2. Size</b>	Small, <b>except</b> in near injuries and in case of shots.	Large
<b>3. Edges</b>	-More regular, <b>except</b> in near injuries and in wrinkled areas.  -Inverted, <b>except</b> after putrefaction	-Less regular.  -Everted
<b>4. Powder marks</b>	Present (near firing)	Absent
<b>5. Beveling</b>	Internal	External
<b>6. Bullet wipe (Soiling ring)</b>	Present as bullet wipes its surface in the skin around the inlet leaving a metallic tinge around.	Absent
<b>7. Abrasion</b>	Present due to external friction of the bullet	Absent
<b>8. Bleeding</b>	Less due to cauterizing effect of heat.	More
<b>9. Microscopic examination</b>	Embedded powder particles	Absent

***Determination of the Direction of Firing***

- 1) Perpendicular firing causes circular inlet wound, a tangential one causing a tract and if slanting causes an oval wound with the wider part of the abraded soiling ring towards the assailant.
- 2) Powder marks (*see before*).
- 3) Drawing an imaginary line between the inlet and the exit may point to the position of the assailant.

**Fabricated Firearm Wounds**

- Usually, it is a superficial wound with a missile pushed inside. The margins are blackened.
- There is no loss of substance and characteristics of the inlet not consistent with the expected distance of firing.
- Cloths usually spared.

**Incapacitating Power**

- Incapacitation or “**Stopping**” a victim of firearm insult depends not only on the characteristics of a cartridge but also on the organ(s) injured, the severity of the wound(s) and the physiologic makeup of the injured person.
- The time necessary for incapacitation can vary from a few seconds, to minutes and may be hours.
- In non-lethal cases, the rapid incapacitation is due to psychological and physiological reactions to the trauma, specific to the victim, and not the nature of the wounds.

**Manner of Infliction of Firearm Injuries**

	SUICIDE	HOMICIDE	ACCIDENTAL
<b>I. CIRCUMSTANCIAL EVIDENCES</b>			
<b>History</b>	Previous attempt of suicide, failure or troubles.	Previous threatening by an enemy.	-----
<b>Scene of the crime</b>	.Indoors with doors locked from inside. .Furniture not disturbed. .Suicidal note may be present in his own handwriting.	.Outdoors, or indoors with doors locked from outside. .Disturbed furniture. .Threatening letter may be present.	.Outdoors (wedding or ceremonies), or .Indoors (cleaning of the weapon).
<b>II. EXAMINATION OF THE VICTIM</b>			
<b>Gender</b>	Usually male	Male or female	Male or female
<b>Blood spatter</b>	.On the back of the hand steadying the muzzle and .The back of the firing hand.	Not significant	May be present

<b>Blackening of fingers</b>	The tips of the left index and thumb.	Not present	May be present
<b>Cadaveric spasm</b>	On the weapon.	On the hair or clothes of the assailant.	Not present
<b>Tear of clothes opposite the injury</b>	Absent	present	present
<b>Signs of struggle</b>	Absent	present	Absent
<b>Other wounds</b>	Extra self-inflicted injuries	May be present	Not present
<b>III. EXAMINATION OF THE WOUND</b>			
<b>Site</b>	Within the reach of the hand and against vital organs e.g. right temple, roof of the mouth, over the heart.	Against vital organs.	Any site.
<b>Number</b>	Single fatal wound except in automatic guns.	Multiple wounds.	Usually one.
<b>Distance of firing</b>	Contact or near firing.	Any distance.	Any distance.
<b>IV. EXAMINATION OF THE WEAPON</b>			
<b>Presence at the scene of the crime</b>	Usually present beside the body of the victim or clenched by Cadaveric spasm.	Usually not present, but in some cases it may be present.	If present, the weapon is examined for the presence of any defect that may cause its accidental discharge.
<b>Type</b>	Usually short weapon, but soldiers may use service rifle.	Any type.	Any type.
<b>Finger prints &amp; blood stains</b>	Belongs to the victim.	Points to the assailant.	Points to the assailant.
<b>V. EXAMINATION OF THE ASSAILANT</b>			
<b>Signs of resistance &amp; struggle</b>	-----	.Tears in cloths. .Victim's blood on his cloths. .Injuries coincide with the date of the crime.	Not present

## ***Investigation of Gunshot Deaths***

### **A. Radiologic Imaging**

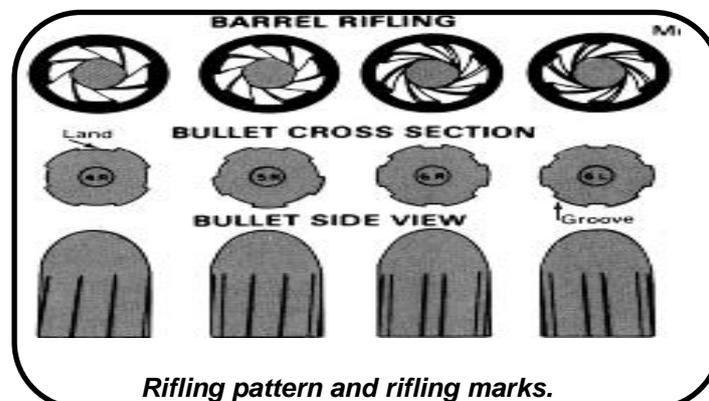
- X-ray prior to removing clothing. Radiographic imaging may be needed to account for retained bullets and fragments and to help determine the bullet track.
- CT provides multiple views with higher resolution than plain film radiography.

### **B. Gunshot Residue (GSR) Analysis**

- The residue of the combustion products, called gunshot residue, consist of both burned and unburned primer or powder components, and can be used to detect a fired cartridge.
- Gunshot residue may be found: 1) on the hands and clothing of the assailant, 2) around the entrance wound and clothing of the victim, 3) on other target materials at the scene, 4) in swab from the barrel of the fired weapon.

### **C. Examination of 'whole bullets'**

- If a bullet is recovered from the scene or from the body, it may be compared to bullets obtained by “***experimental firing***” of the suspected weapon.
- Comparison of bullets involves **preliminary** and **confirmatory** marks.
- **Preliminary comparison** refers to the type, caliber and rifling pattern. **Rifling pattern** (marks) may turn to the right or left, with a given rate of twist. The number, width and depth of grooves are also compared to seized bullets.



- **Confirmatory comparison is** used to determine if a specific gun was used. These individual characteristics (marks) are based upon imperfections in the barrel (rust, dust...) that impart specific markings to fired bullets. These fine marks are examined by using a comparison microscope

**D. Identification of the weapon used is based on:**

- **The suspected weapon is examined for:** finger prints, smell of burnt powder, type and bore compared with projectile extracted from the victim's body or collected from the scene of the crime.
- The barrel is examined to determine the type of the used powder and the time since firing. This is done by taking a swab or washing of the barrel gun residue.
- **Experimental examination of the suspected weapon using a special comparison microscope,** to compare between characteristics on the experimental fired missiles with that extracted from the dead body.
- **Any empty cartridge at the scene of the crime** is also examined and compared with the caliber of the suspected weapon. Experimental cartridges are compared with the empty cartridge for the following characteristics:
  - Size, shape, depth and location of firing **pin marks** (the most important identifying marks)
  - Breech **block marking**.
  - Size, shape and location of extractor marks.
  - Size, shape and location of ejector marks.
- **Manufacturer's serial number:** Each firearm sold, other than black powder weapons, has a stamped number which may be used to identify the weapon.

***N.B. Before examining any weapon, be sure that it is not loaded and fit for firing ie. Not destructed.***

### ***Doctor's duty in firearm injuries***

- Firearm injuries must be reported to the police.
- Documentation by photography, sketches and primary wound reports is mandatory.

- Any missile, foreign body such as wads and any skin removed from the margin of a repaired firearm wound should be carefully preserved for further investigations.
- Antibiotics are routinely employed. Contamination must always be suspected in gunshot injuries.
- In general, low-velocity wounds in the extremities rarely require debridement. All that may be required is thorough but gentle irrigation with physiologic fluids to remove surface debris and contaminants.
- The skin in post-mortem examination around the entrance wound should be removed and kept without formalin, but refrigerated if necessary, for gun powder residue detection.

## ***Explosion Injuries***

### **Explosives may occur in:**

- 1- Industries: factories, mining, digging or building destruction (dynamite).
- 2- Domestic: by butane gas bomb.
- 3- Military wars.
- 4- Terrorist activities: by bombs or grenades (molotov bombs).

The explosive process can be mechanical, thermal, electrical, nuclear, but the majority of explosions are chemical.

Chemical explosives: consist of oxidizing agent and inflammable fuel. The common oxidizing agents include inorganic nitrate or chlorates. The fuels are carbon, hydrocarbon, sugar, carbohydrates or sulphur. They are contained in shells, grenades or bombs.

### **Ignition or detonation of the explosives results in:**

- 1- Rapid release of energy causing violent effects.
- 2- Powerful blast of hot gases (shock wave), where pressure exceeds the ability of the container to hold.
- 3- Dispersion of the container's fragments at very high speed.

## **Injuries Produced by Explosions**

### **1) Primary injuries:**

Blast wave → Destructive effect on the objects and bodies lying within the area of spread of blast waves. A suicidal bomber or bomb-setter is the victim when detonation occurs.

Primary injuries include:

- a) **Blast lungs:** with massive subpleural and intrapulmonary hemorrhages, marginal bullae and shredded alveolar epithelium. Air passages are filled with bloody froth causing obstruction, hypoxia or asphyxia. Living survivors show adult respiratory distress syndrome (ARDS).
- b) **Blast bowel:** perforation and focal hemorrhage.
- c) **Air embolism.**
- d) Liver, brain and abdominal viscera show displacement and/or subserous hemorrhages, due to shearing effect.

### **B) Secondary injuries:**

By flying missiles from objects within the bomb, as nails, nuts, bullets or secondary missiles from fragmented container (metals and glass pieces) or fragmented targets that are projected at high speed.

### **C) Tertiary injuries:**

These injuries sustained by the individuals thrown by the blast to strike large objects or from collapsed buildings.

### **D) Quaternary injuries:**

Produced by the heat and hot fumes from the explosion in the form of burns accompanied by blackening and tattooing (peppering) from non-exploded particles driven into the skin.

Hot fumes cause superficial burns affecting exposed skin of victims near the explosion. Severe burns usually refer to secondary fires resulting from the initial explosion. Smoke inhalation may also occur.

### **E) Quinary injuries:**

Injuries or health hazards produced by materials added to bombs, as bacteria, chemicals or radiations.

## Chapter (11)

# THERMAL INJURIES

### ILOS:

- To recognize proper management of heat diseases.
- To identify different types of burns.
- To allocate burn victims with increased risk.
- To know complication and fatality causes in burn victims.
- To maintain adequate documentation of burn victims.
- To demonstrate different irradiation injuries.

### Exposure to heat leads to:

1. Heat diseases (systemic).
2. Burns (local).

## Systemic Heat Diseases

They may occur with increasingly high temperature as in pilgrimage during the summer, soldiers, and workers in bakeries or in the engine room of a ship.

### Predisposing factors:

1. Non- acclimatization.
2. Fatigue,
3. Old age,
4. Humidity: decrease heat loss by perspiration.
5. Drugs, e.g. alcohol & anti-cholinergic.

### Types of Heat Diseases:

#### 1. **Heat Cramps:**

- Due to excessive loss of Na Cl in the sweat → painful spasms in striated muscles.
- Rapidly relived by administration of Na Cl tablets or I.V. saline.

#### 2. **Heat Exhaustion "Syncope":**

- Due to the effect of heat on the cardiac muscle → gradual peripheral vascular collapse.
- The patient shows rapid & weak pulse, low blood pressure, subnormal body temperature, and pale moist skin; without fever, convulsions or coma.
- Treatment is by transfer to colder place and correction of shock.

### 3. Heat Hyperpyrexia "Sun Stroke":

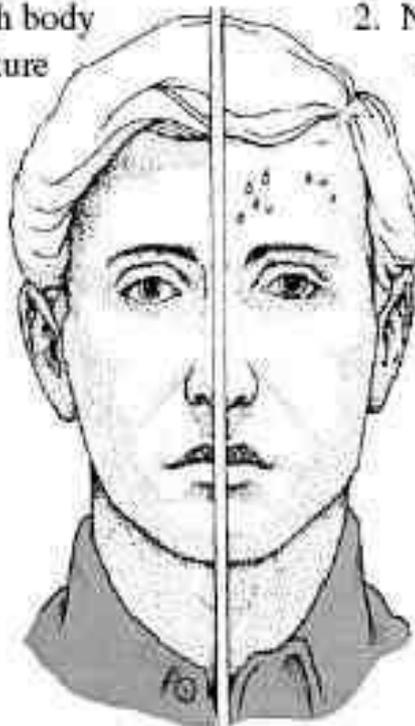
- Due to the effect of heat on the head → degeneration of the heat regulating center in the hypothalamus → failure of the body to lose heat.
- The patient shows high fever, dry skin, convulsions with full pulse, and sudden coma then death.
- Treatment is by:
  - a) Transfer the patient to cold dry atmosphere.
  - b) Reduce body temperature by any means: e.g. cold fomentations & cold enema.
  - c) IV saline.
  - d) Emergency care for coma and convulsions.
  - e) Follow up to detect relapses.
- Postmortem picture include:
  - a) Delayed cooling.
  - b) Rapid rigor mortis and putrefaction.
  - c) Congested viscera and brain.

#### Heat Stroke

1. Dry, hot skin
2. Very high body temperature

#### Heat Exhaustion

1. Moist clammy skin
2. Normal or subnormal temperature



## Burns

**Definition:**

Destruction of tissues produced by direct local exposure to heat effect.

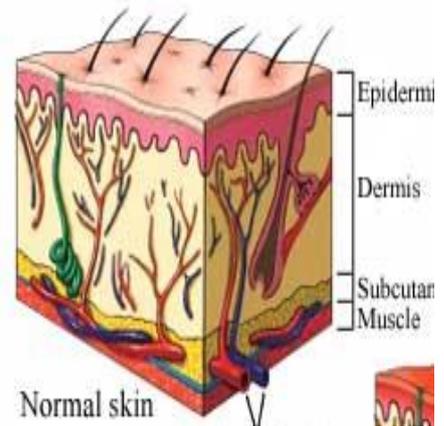
**Types of burn according to the causative agent:**

1. **Dry burn:** due to dry heat (flame or hot solids).
2. **Moist or wet burn (Scald):** due to moist heat (hot liquids or steam).
3. **Chemical burn (corrosions):** due to corrosives.
4. **Electric or flash burn:** due to electrocution.
5. **Radiation burn:** due to ionizing or non-ionizing irradiation.

**Classification:**

**I. Dupuytren’s classification:**

- 1<sup>st</sup> degree:** redness or erythema of skin.
- 2<sup>nd</sup> degree:** vesicles or bullae.
- 3<sup>rd</sup> degree:** destruction of superficial layers of skin down to sensory nerves (the most painful).
- 4<sup>th</sup> degree:** destruction of the whole skin.
- 5<sup>th</sup> degree:** destruction of S.C. tissues.
- 6<sup>th</sup> degree:** complete charring of the tissues (charring or carbonization).

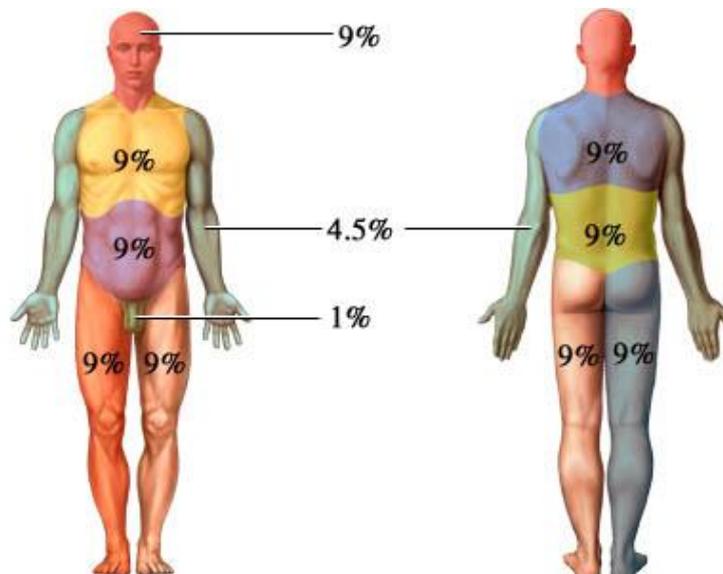


**II. Wilson’s classification “Surgical classification”:**

	Epidermal	Dermo-epidermal	Deep burns
<b>Layers involved</b>	epidermis only	epidermis & dermis	skin & underlying tissues
<b>Relation to Dupuytren’s classification</b>	1 <sup>st</sup> & 2 <sup>nd</sup> degrees	3 <sup>rd</sup> & 4 <sup>th</sup> degrees	5 <sup>th</sup> and 6 <sup>th</sup> degrees
<b>Manifestation</b>	erythema with or without vesicles	puckering & distortion of the skin	Disability & disfigurement
<b>Prognosis</b>	heal without scarring	cannot heal without scarring and may need skin grafting	Amputation and major surgical interference.

### III. Wallace's classification "Rule of Nines":

- Extent of burn is estimated according to the surface area involved.
- Rule of Nines is sufficient for prognostic purposes; ie. A large area involved may be more dangerous to life than a deeper more localized one.
- It doesn't apply to infants whose body proportions are different from adults.
  - Head and neck → 9%
  - Each upper limb → 9%
  - Each lower limb → 18%
  - Front of the trunk → 18%
  - Back of the trunk → 18%
  - Perineum → 1%



### Factors affecting gravity (prognosis) of burns:

#### I) Factors related to the burn:

1. Extent "surface area"; burns affecting > 60% of the body are considered fatal.
2. Degree; 3<sup>rd</sup> degree is the most painful.
3. Site; burns of head, neck, genital organs, and trunk are more dangerous than limbs.

#### II) Factors related to the individual:

1. Age; young and old age victims are more affected.
2. General condition; debilitating diseases increase the severity of burns.

**Differential Diagnosis between burns, scalds & corrosions:**

	<b>Burn</b>	<b>Scald</b>	<b>Corrosions</b>
<b>1. Cause</b>	Flame or hot solids	Hot Fluids or steam	Corrosives
<b>2. Clothes</b>	Burnt	Wetted	Eaten
<b>3. Hairs</b>	Singed & clubbed "coma-shaped"	Wetted	Eaten & may be discolored
<b>4. Spread</b>	Below upwards	Above downwards	Above downwards
<b>5. Degrees</b>	6 degrees	1 <sup>st</sup> & 2 <sup>nd</sup> only	All except 2 <sup>nd</sup>
<b>6. Vesicles</b>	Around burnt area	All over the area	Absent
<b>7. Scar</b>	Variable	Thin	Thick
<b>8. Charring</b>	In 6 <sup>th</sup> degree	Absent	With sulfuric acid
<b>9. COHb in blood</b>	May be present	Absent	Absent
<b>10. Soot in air passages</b>	May be present	Absent	Absent
<b>11. Skull "thermal" fracture</b>	May be present, In severe head burns	Absent	Absent

**Differential Diagnosis between thermal & traumatic skull fracture:**

	<b>Thermal</b>	<b>Traumatic</b>
<b>1. Scalp: A.M. wounds</b>	Absent	present
<b>2. Skull fracture</b>	Only fissure	Any type
<b>3. Brain</b>	Shrunken (wide sulci , thin gyri)	Edematous
<b>4. Extra Dural hemorrhage</b>	Small (not filling the space) & chocolate brown	Large
<b>5. PMP of burn</b>	Present	Absent

**Manner of death from burns:**

- **Accidental burns:** common in Egypt, especially from defective petrol or gas stoves, usually in females whose clothes catches fire easily. Also occur in motor car or aircraft accidents.
- **Suicidal burns:** are relatively common in Egypt among females by pouring petrol over their clothes and setting fire to themselves.
- **Homicidal burns:** are rare and usually postmortem to conceal crimes or by throwing of acid on face for disfigurement.

**Differences between A.M. &P.M. burns:**

	<b>A.M. burn</b>	<b>P.M. burn</b>
<b>1- Hyperemia</b>	Present	Absent
<b>2- Vesicles</b>	Present; tense filled with serum (rich in albumin and chloride)	Usually absent; if present it is soft filled with air and may be fluid (poor in albumin and chloride)
<b>3- Soot in air passages</b>	Present	Absent
<b>4- CoHb in blood</b>	Present	Absent
<b>5- Hemoconcentration</b>	Present	Absent
<b>6- healing or sepsis</b>	Present	Absent
<b>7- Other causes of death</b>	Absent	Present e.g., strangulation, head injuries, ... etc.

**Causes of death from burns:****I) Immediate causes; within 6 hours:**

- 1) Primary neurogenic shock (sympathetic) due to fear or pain.
- 2) Injury of a vital organ, e.g. head.
- 3) Asphyxia:
  - a) Inhalation of smoke → pulmonary edema.
  - b) Inhalation of noxious gases, e.g. CO, CO<sub>2</sub>, SO<sub>2</sub> and NO<sub>2</sub>.
  - c) Traumatic asphyxia; crushing due to overcrowding and panic.

**II) Rapid causes; 6-48 hours:**

- 1) Oligemic shock (hemoconcentration); resulting from:
  - a. Evaporation of plasma from burnt area.
  - b. Accumulation of plasma in vesicles or bullae.
  - c. Perfusion of plasma into tissues due to capillary damage "↑ permeability".
- 2) Toxic shock; due to tissue destruction and release of toxins mainly histamine → generalized capillary dilatation → hypotension and collapse.

- 3) Acute edema of the glottis; in burns of the neck → asphyxia.
- 4) Pulmonary fat embolism, in burns of fatty areas as buttocks and breast.

### III) Delayed causes "2 days onwards"

- 1) Suprarenal hemorrhage → acute suprarenal insufficiency (5<sup>th</sup> day).
- 2) Perforation of acute duodenal ulcer "**Curling ulcer**"; due to burn toxins excreted with bile in duodenum (12<sup>th</sup> day).
- 3) Infection: as local sepsis, septicemia or Inflammation of serous membranes as peritonitis, and bronchopneumonia.
- 4) Degeneration of internal organs (liver necrosis; acute tubular renal necrosis).

### Postmortem picture of burn:

- 1) Antemortem burns of various degrees & may be the pugilistic or boxer's attitude "generalized flexion".
- 2) Generalized redness of the body due to COHb in the blood.
- 3) Generalized visceral congestion and hemorrhages in organs.
- 4) Soot in the air passages.
- 5) Hemoconcentration.
- 6) Thermal fracture of the skull.
- 7) Heat ruptures; splits of the skin caused by contraction of the heated and coagulated tissues.



## ***Electric or Flash Burns***

### **Cause:**

Burns caused by high electrical discharge (***electrocution***) and transformation of electrical energy into thermal energy which lead to coagulation of tissue protein along the pathway of the current together with superficial charring of the body.



### **Conditions:**

#### **1. Accidental:**

- Domestic accidents.
- In factories.
- In hospitals during routine ECG, EEG, diathermy, and electro-convulsive therapy.
- In case of electric cables falling on the head (the body must be earthed).
- Lightening.

#### **2. Homicidal: Rare**

- Torture by electric burns.
- Child abuse.
- Execution of murderers in some states of U.S.A. is done by the electric chair (2000 volts).

#### **3. Suicidal: Rare.**

### **Factors affecting the severity of the electric current:**

1. ***Earthing***: if the victim is earthed, the circuit will be complete.
2. ***Humidity***: it decreases the resistance to the passage of the current.
3. ***Path of current***: Through the heart or the brain stem is fatal.
4. ***Type of current***: alternating current (A.C.) is more dangerous than direct current (D.C.).
5. ***Amount of current***: is directly proportionate to the severity of the injury.

$$\text{Amount} = AV/R$$

A: Amperage, V: Voltage and R: Resistance.

6. ***Duration of current flow***: directly proportional to the severity of the injury.

**Clinical picture:**

1. **Ventricular fibrillation:** No pulse, no heart sounds can be felt, coma, pale skin, respiration continues for a few minutes → death.
2. **Respiratory failure:** No respiration, coma, weak pulse can be felt, hypotension and cyanosis.
3. **Muscle spasm:** The victim may grip the conductor. Spasm of respiratory muscles leads to peripheral asphyxia.
4. **Cutaneous burns** at the inlet of the current in the form of ulceration of dry parchment like skin (coagulative necrosis) and surrounded by hyperemia. The skin at the exit is punched out.

**Treatment:**

1. Disconnect the victim very rapidly from the conductor.
2. Artificial respiration must be continued till recovery or rigor mortis occurs.
3. Oxygen inhalation and cardiac massage

**Causes of death:**

1. **Ventricular fibrillation:** if the current passes through the heart.
2. **Spasm of respiratory muscles:** if the current passes through the chest.
3. **Central asphyxia:** if the current passes through the head.
4. **Sympathetic shock:** in cutaneous burns that may be severe (up to 3<sup>rd</sup> degree).
5. **Extensive cutaneous burns** may lead to gangrene and death.

**PMP**

1. Cutaneous burns at the inlet and punched out skin at the exit.
2. Petechial hemorrhages along the path of the current.
3. Ext. and internal signs of asphyxia may be present.

***Burns and Diseases Due to Radiation*****I. Ionizing Radiation**

Alpha, beta, gamma rays, neutrons and protons are known as ionizing radiation.

**Exposure occurs usually accidentally during:**

- **Radio-therapy:** by radium, cobalt radiation, or X-ray (prolonged and/or repeated exposures).
- **Industrial** exposure to radioactive chemicals.

- **Nuclear explosions:** reactors (e.g., Chernobyl explosion) or weapons (e.g., atomic bomb).

**Pathophysiology:**

The exposed tissues are physically damaged by ionization, resulting into atrophy or multiplication and abnormal growth (tumor formation).

**Clinical picture after exposure:**

**Skin lesions:**

- Burns (hyperemia and blister formation).
- Loss of hairs (alopecia) and nails.
- Pigmentation and hyperkeratosis.
- Dermatitis, ulcerations and loss of finger prints.
- Cancer.

**Bone lesions:** Osteogenic sarcoma.

**Bone marrow depression:** Aplastic anemia, agranulocytosis, thrombocytopenia, or leukemia.

**Eye:** Cataract

**Gonadal depression:** Sterility, abortion, stillbirths & congenital anomalies

**Acute post-irradiation syndrome:** Due to exposure of the whole body (vomiting, diarrhea, melena and dehydration).

## **II. Non-ionizing Radiations (NIR)**

NIR include a group of **electromagnetic radiation**; e.g. ultraviolet (UV), infrared (IR), ultrasound (US) and LASER (light Amplification by stimulated Emission of Radiation).



**Pathophysiology:**

They react with human tissues by generating heat.

**Clinical picture after exposure:**

- Acute exposure to UV radiations produces sunburn and eye damage (e.g.: dazzling, functional temporary blindness), cataract or chorioretinal damage and blindness.
- Prolonged exposure to UV and IR sources produces aging and pigmentation of the skin and cancer.
- Chronic exposure to NIR increases the incidence of cancer 2-3 folds particularly leukemia.
- Uncontrolled exposure to LASER beam may result in skin burns or cancer and eye damage (e.g., macular burns, keratitis and cataract).

## ***Death From Cold***

It is very rare in Egypt. It mostly occurs in children and elderly people who are undernourished and badly clothed (homeless & street children). It may also encountered in high altitude.

### **Mechanism of Death:**

- Cooling of the body leads to failure of heat regulating mechanism and lower dissociation of oxyhemoglobin → red asphyxia.
- Prolonged hypothermia results in peripheral circulatory stasis (*Stagnant anoxia or stagnant red asphyxia*).

### **Clinical picture:**

- Frost bite or gangrene especially in nose, toes, and fingers.
- Skin red patches (in stagnant anoxia).
- Devitalization of tissues leads to: Gastric and intestinal erosions, pancreatic fat necrosis and hepatic necrosis.

## Chapter (12)

# TRANSPORTATION INJURIES

### ILOS:

- To recognize injuries sustained by transportation vehicles.
- To anticipate the risk of fatality in transportation injuries.
- To manage properly groups of victims in mass disasters.

Every form of transport is associated with a risk of injuries and deaths. The most commonly encountered are:

- I. Road traffic accidents(RTA)
- II. Train (railway) accidents.
- III. Aircraft accidents.

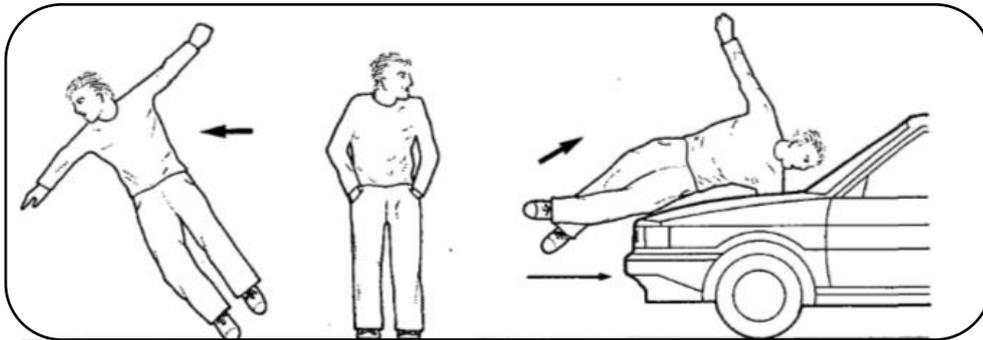
## ROAD TRAFFIC ACCIDENTS (RTA)



Those injured on the road by accidents can be divided into 3 broad categories:

1. Pedestrians' injuries.
2. Car occupants' injuries.
3. Motor or Pedal cyclist injuries.

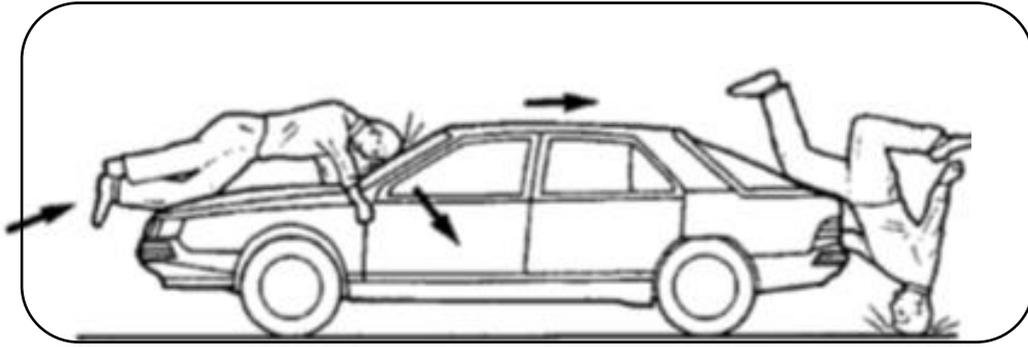
## Pedestrians' Injuries



### ***Pattern of injuries in pedestrians:***

#### **1- Injuries of primary impact:**

- Abrasions and patterned bruise imprint the shape of the component of the vehicle. These wound together with clothing crushed between the vehicle and the skin, indicate the point of impact.
- They are due to direct impact of the vehicle with the victim.
- The height of the wounds from the heels may correspond with the height of the part of the vehicle, which usually comes in contact with the body of the victim:
  - Knee or just below it → front bumper bar,
  - Thighs or hip → radiator grille or bonnet hood
  - Chest, arms or head → large vehicle or children (short stature).
- There are often additional primary sites on thighs, hip or pelvis due to contact with the bonnet ***“scooping-up injury”***, as follows:
  - At low speed (20 km/h) → the victim will be thrown off the bonnet either forwards or to one side.
  - Between 20 & 60 km/h → the victim will be tipped onto the bonnet and the head may strike the windscreen or its metal frame.
  - At higher speeds (60-100 km/h) → the victim will be projected or into the air and sometimes they will pass over the car and avoid hitting the windscreen or other points on the vehicle.



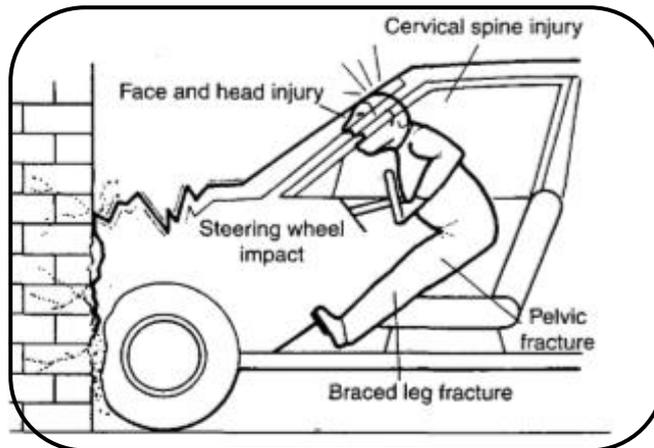
## 2- Injuries of secondary impact:

- These injuries are produced when the victim hits the ground or other objects.
- They are present on the other side of the primary impact injuries, but if the victim is thrown far away by the hit of the vehicle, then these injuries can be anywhere on the body (head, chest or pelvis); therefore they are far more serious and potentially lethal than primary injuries.
- Different types of injuries are produced ranging from the most common sliding abrasions or brush abrasions, bruises, lacerations, to fracture skull or spine.

## 3- Run-over injuries:

- These injuries are relatively unusual and vary according to; the involved site of the body, the weight of the vehicle and the surface area of contact.
- Several injuries may occur as severe distortion of the head, fracture spine, internal organs rupture, crushing of limbs, flail chest and “flaying injury” where a large area of skin and subcutaneous tissues is stripped off by rotating tires against the body.
- Tire marks imprinted on the victim’s body can help in identifying the vehicle.

## Car Occupants' Injuries



- Vehicle accidents are mainly frontal impact (deceleration), and less commonly rear impact (acceleration), side impact or rollovers.
- In the most frequent situation of frontal impact, if the passengers are not restrained with seat belts; they will continue their forward movement even though the car is stopped.
- Any of the following injuries may occur according to the place of the passenger in the car. Therefore, injuries can be divided into the following categories:
  1. Driver's injuries.
  2. Front seat occupants' injuries.
  3. Rear seat occupants' injuries.

### 1) **Driver's injuries:**

The driver is most often injured, due to the fact that he is so frequently the only occupant.

On deceleration impacts the following occurs:

- The knees will impact the instrument panel,
- The chest will impact the steering wheel,
- The head will impact the wind screen.

#### **a. Head injuries**

- Abrasions, lacerations and superficial cuts.
- Skull fractures, intracranial hemorrhage or brain damage. Road traffic accidents are the commonest cause of traumatic axonal injury of the brain.

### **b. Neck injuries**

- The deceleration commonly causes a “**whiplash injury**”. The head is thrown violently down on the neck in a frontal impact ‘hyperflexion’ and a fraction of a second later, when the vehicle stops, the head swings back over the seat, causing a ‘hyperextension’ stress, which is more dangerous than hyperflexion.
- This cracking whiplash effect can dislocate or fracture the spine in the cervical region. Vertebrae can be crushed or displaced, with the danger of spinal cord injury and paralysis.
- This also occurs in rear impact with reversed sequence, ie. Hyperextension followed by hyperflexion.



### **c. Chest injuries**

- This can be caused by impact with the steering wheel, ejection through the windscreen or impact with the road.
- There may be bruising or laceration on the chest from the steering wheel, though, airbags and seatbelts have reduced the incidence of this formerly common lesion.
- Sternal and rib fractures are common (flail chest may occur).
- Injuries of the lung caused by fractured ribs.
- Transection of the aorta: Typically, this occurs at the descending segment of the aortic arch.
- Injury to the heart [e.g. myocardial rupture] is less common than aortic injuries. Fatal cardiac arrhythmia may occur secondary to a cardiac contusion.

### **d. Abdominal injuries**

- Liver lacerations may occur in the form of shallow, multiple, parallel tears that is not serious. A fatal injury may result from deep tear that may even transect the organ.

- The right lobe of the liver is more frequently injured than the left because it is relatively less protected by the rib cage.
- Subcapsular liver tears can occur with the formation of a subcapsular hematoma, which can rupture later.
- The spleen also shows shallow tears in some accidents, often around the hilum; in rare cases, it may be avulsed from the pedicle.

**e. Bony fractures**

- If the knees impact the dashboard, there may be fractures of the patella or the distal femur.
- There also can be dislocation at the hip joint or a fracture of the femur at its neck.
- The lower limb is fractured in 30 % of accidents and the upper limb in 15 %.

**2) Front seat occupant “La place du rnort”**

- The pattern of injury is similar to that of the driver, but this position in the car is even more dangerous. Though the steering wheel can inflict its own injuries on the driver, it prevents so much forward projection. Another factor is that the driver gives his attention to the road and so has momentary warning of an impending crash.
- Children in the front seat, either alone or on the lap of an adult, have a high injury rate, and in some countries, it is illegal for them to occupy this position.

**3) Rear seat occupants**

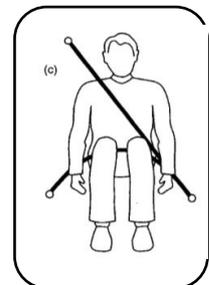
- Fatalities less common than in the front seat occupants, but there are still potentially lethal risks.
- The passengers may be projected forwards onto the front seat occupants or even thrown through the windscreen. Ejection may also occur, sometimes through the rear window.
- Injuries from interior fittings, such as door handles, window winders, mirrors and lights may occur, especially if the car overturns, the occupants may be whirled around the periphery of the compartment.

### Rollovers

- Rollover crashes are generally less lethal than head-on and side impact collisions, provided the individual is not ejected.
- Ejection may be complete with the car rolling over the ejected person, or partial where just the head and the trunk may protrude to be rolled over by the vehicle.
- Because of better design, present-day car doors usually do not open in rollovers. Instead, the unrestrained individual is ejected out the window. Thus, use of a seat belt is very beneficial in such accidents. Anything that prevents ejection of an occupant increases the probability of survival.

### Seatbelts injuries:

- Seatbelts are now almost all of the lap-strap and shoulder diagonal type, the so-called 'three-point attachment belt'.
- Although seat belts can produce injuries, death rate drop substantially, and facial injuries and especially eye damage was dramatically reduced.
- Sustained injuries may be:
  - Bruising is the most common injury especially in the abdominal or chest wall.
  - Visceral lesions including rupture of mesentery, small or large gut, and bladder.
  - The aorta may be crushed and the lumbar spine may suffer compression fracture or dislocation.
  - Injuries to the small intestine, colon and lumbar spine, in the plane of the lap belt, are referred collectively to as the **“seat belt syndrome.”**



### Airbags injuries:

These injuries can be immediately lethal. Drivers seated too close to the steering wheel (less than 25 cm) can be seriously injured or killed by deploying air bags. Short drivers are injured more frequently because they must sit closer to the steering wheel to reach the gas and brake pedals.

**The sustained injuries vary from:**

- Head and neck bruising, burns from hot gases or corrosions from the effect of the enclosed alkaline material (sodium hydroxide).
- There may be partial or complete amputation of fingers, dislocated and fractured arms or cervical spine and fatal head injuries.
- Eye injuries are common and range from mild corneal abrasions and chemical burns to globe rupture from blunt trauma or perforation by interposed objects.

**Motor or Pedal cyclist injuries****Motor cyclist Injuries**

- Most injuries are due to falling from the machine onto the roadway. Many injuries could be prevented or reduced by wearing protective clothes and crash helmet.
- Abrasions are very common.
- Head injuries sustained in 80% of fatalities. A typical injury has been called the '**motor-cyclist's fracture**' or "**hinge fracture**", being a side to side crack across the base of the skull due to violent impact on the side of the head.
- Leg injuries occur when the lower limbs are trapped under the falling machine.
- Chest and spine injuries may also occur.
- Another injury occurs when a motor-cyclist drives under the back of a truck, known as '**tail gating**' causing severe head or neck injuries, or even decapitation.

**Pedal cyclist Injuries**

- Because of the lower speeds, the gross head injuries seen in motor cyclists are not so common, but are still present.
- The primary impact from a car or truck may cause rib or pelvic fractures, but most damage occurs from secondary injuries due to being projected or falling from this unstable machine.
- Stripping of legs skin is common, being forced between wheel spokes.

## Manner of Death in RTA

Not all deaths on the road are accidents, some are the result of natural disease and others are suicides or homicides:

- **Natural disease:** ischemic heart disease is the main cause of natural death at the wheel, and occasionally the cause is a disease of the brain.
- **Suicide** by motor vehicle represents a very small percent of driver fatalities. Typically the single occupant car drives at high speed, for no apparent reason, into oncoming traffic, often a heavy goods vehicle. Parking at a railway level crossing may be used also as a suicide method.
- **Homicide** A driver may use a vehicle as a weapon, deliberately striking a pedestrian, bicyclist or other road user. Occasionally a simulated vehicle crash and post-crash fire is used in an attempt to conceal a homicide.

## TRAIN (RAILWAY) ACCIDENTS

- These are common; especially where there is many 'level crossings' (public road crosses a railway track).
- Track workers may be run down and some die from electrocution by overhead cables or crushed anteroposterioly (shunter).
- The malicious damage caused to trains, either by placing objects on the tracks, which may cause a derailment, or the dropping of objects from bridges.
- Passengers occupying the roof of the train may fall and sustain multiple fatal injuries due to repeated impacts and rolling.
- Some accidents occur with children playing on the line.
- The other fairly common railway fatality is the suicide who lays himself in front of an approaching train. Decapitation is the most common injury and the obvious features are the local tissue destruction, usually with grease, rust or other dirt soiling of the damaged area.

## AIRCRAFT ACCIDENTS

### ***Sustained injuries may be:***

- Large aircraft are pressurized and if the integrity of the cabin is breached→ rapid decompression → barotrauma. If the defect in the cabin is large→ victims may be sucked out and fall to their death.
- When an aircraft hits the ground; the resultant injury will depend on the acting forces of the speed and angle of impact.
- If severe forces, all passengers are killed by deceleration injury or multiple trauma.
- In lesser impacts; injuries sustained are similar to motor vehicle crashes but more severe. Lap straps offer little protection except in minor accidents.
- Fire is one of the greatest hazards in air crashes and account for many deaths.

## ROLE OF THE DOCTOR IN MASS DISASTERS

For the non-specialist doctor at the scene of a mass disaster of any kind, the first consideration is, of course, the treatment of casualties, which may involve taking difficult ethical decisions about triage.

***Victims who survive the disaster*** can be divided into the following five main groups, after that the doctor can react accordingly:

- Those who can be saved and whose lives are in immediate danger;
- Those whose lives are not in immediate danger but who are in need for urgent but not immediate medical care;
- Those who have minor injuries only and who can be treated later on by unskilled personnel;
- Those who have been psychologically traumatized and who need reassurance and/or sedation if acutely disturbed;
- Those whose condition exceeds the available therapeutic resources and who have suffered from such extremely severe injuries of whatever type that they cannot be saved in the specific circumstances of that time and place: these victims can be termed 'beyond emergency care'.

***In case of deaths***, the task will be directed to: the identification of the dead (see *chapter 1*), and the investigation of the causes of death.

- A team of pathologists, assisted by police officers together with mortuary staff and backed up by dental and radiological facilities, inspects, code by numbers, photograph every intact body or any human parts in situ. Also all clothing, jewelry and personal belongings still attached to the bodies are recorded.
- The body or body parts are then carefully examined for every aspects of identity, including sex, race, height, age and personal characteristics.
- All these details are recorded to be compared with the information obtained from relatives, friends, etc.
- An autopsy is performed to determine the cause of death, retrieve any foreign objects and to seek any further identifying factors, such as operation sites, prostheses, etc.

## Chapter (13)

# MEDICOLEGAL ASPECTS OF ASPHYXIA

### **ILOS:**

- *To know types of asphyxia.*
- *To recognize clinical stages experienced by an asphyxiated person.*
- *To identify conditions that may carry the risk of asphyxia.*
- *To interpret medico-legal evidences in violent asphyxia deaths.*
- *To identify mechanism of death in different types of violent asphyxia.*

### **Definition:**

Exactly the word asphyxia means 'absence of pulsation', yet it is commonly used to describe a range of conditions of lack of oxygenation either partial (hypoxia) or absolute (anoxia).

### **Classification of asphyxia:**

#### **I. According to the etiology:**

**A. Pathological:** as angioneurotic edema of the glottis, paralysis of brainstem or cord damage, poliomyelitis, ect.....

**B. Poisonous: central** as in opiates or barbiturates or **peripheral** as in strychnine.

**C. Violent or mechanical interference with respiration, due to:**

- Obstruction of respiratory orifices (smothering),
- Obstruction of internal airways (choking),
- Obstruction of respiratory passages in the neck (strangulation, hanging or throttling),
- Interference with respiratory movements (traumatic asphyxia),
- Drowning.

## II. According to the mechanism:

### A. Anoxic Anoxia:

- **Ambient** (due to decrease oxygen content in the atmosphere) e.g. High altitude or irrespirable gases(CO<sub>2</sub>, N<sub>2</sub>, ect),
- **Central** (due to depression of respiratory center) e.g. central depressants as barbiturates),
- **Peripheral** (due to paralysis or spasm of respiratory muscles) eg. Overdose of succinyl choline or curare, Botulism, OPP,
- **Mechanical** (violent asphyxia)

### B. Anemic Anoxia: Decreased oxygen carrying capacity of blood due to:

- **Abnormal hemoglobin** (as COHb in CO poisoning)
- **Hemolysis** (e.g. Incompatible blood transfusion, Naphthalene or Arsine intoxication and Viper envenomation).

### C. Stagnant Anoxia: Interference with the flow of blood to the tissues as in advanced heart failure, RCI, anaphylactic shock, ect....

### D. Histotoxic Anoxia: It is diminished ability of cells to utilize oxygen as in cyanide poisoning or cold exposure.

## The Classical Stages of Asphyxia :

A person with obstructed air entry will show phases of distress and physical signs as listed below:

### 1- **Stage of dyspnea:**

Lack of oxygenation increase the level of reduced hemoglobin in the blood with resulting stimulation of the respiratory center.

#### **Clinical picture:**

- Forced respiration with increased rate and depth.
- Facial congestion and the onset of cyanosis.

### 2- **Stage of convulsions:**

Cerebral irritation due to anoxia and hypercarbia.

**Clinical picture:** increased cyanosis and constricted pupils. Generalized convulsions → *increase in blood pressure* and rupture of sub mucous and sub serous capillaries and appearance of **petechial hemorrhages**. Also convulsions increase the intra-alveolar pressure resulting in ruptures of the superficial unsupported alveoli of the lungs called **Silvery spots**.

### 3- **Stage of paralysis:** irreversible brain damage

#### **Clinical picture:**

- Loss of consciousness,
- **Irregular breathing** (Chyne-stocks) breathing,
- Deepening of cyanosis,
- Drop of blood pressure,
- Muscle relaxation (evacuation of bladder and vomiting).
- Dilated fixed pupils.
- Death occurs in about 5 minutes.

**NB.** At any stage through this progression, death may occur from cardiac arrest.

## The Classical Signs of Asphyxia:

### A. External Signs:

1. Cyanosis: dark blue discoloration (lips and nails) depends on the absolute amount of reduced hemoglobin, rather than the proportion of reduced hemoglobin to oxyhemoglobin.
2. Facial edema with petechial hemorrhages.
3. Prominent eye balls (retro-orbital edema) with sub-conjunctival hemorrhage.
4. Protruded tongue and bloody forth from the mouth and nostrils.
5. Dark blue hypostasis.

### B. Internal signs:

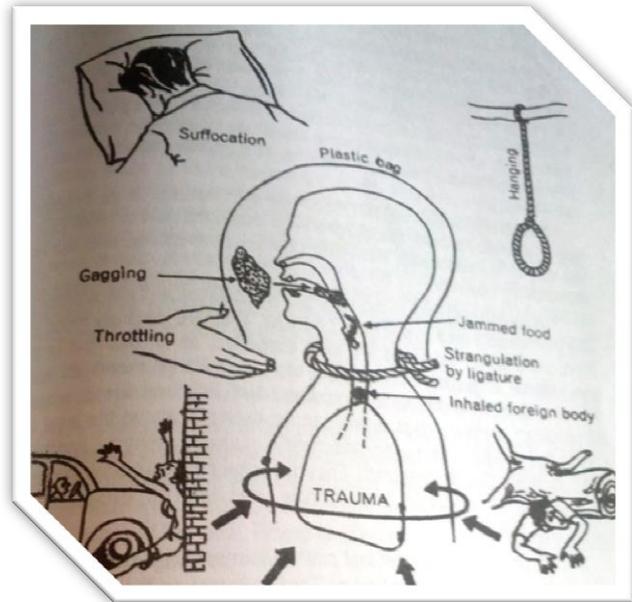
1. Congestion of the viscera and the mucosa of air passages, with bloody forth.
2. Petechial hemorrhages '*Tardieu's spots*':
  - These are small pin-point collections of blood.
  - They are seen **under** the skin, the sclera or conjunctivae and under **serous membranes** such as the pleura, pericardium and **peritoneum**.
  - They are caused by an acute rise in venous pressure that in turn causes over distension and rupture of thin-walled peripheral venules, especially in lax tissues, such as the eyelid and in unsupported serous membranes, such as the pleura and pericardium.
  - They may disappear with increased PMI, in putrefaction and prolonged immersion.
3. Silvery spots:

These are shiny grey spots that appear sub-pleural and detected by hand lens examination. They occur due to increased intra-alveolar pressure during the convulsive phase with subsequent rupture of the superficial unsupported sub-pleural alveoli.

**VIOLENT ASPHYXIA**

**Types of Violent Asphyxia:**

1. Smothering.
2. Suffocation.
3. Choking.
4. Throttling.
5. Strangulation.
6. Hanging.
7. Traumatic asphyxia.
8. Sexual asphyxia.
9. Drowning.



**1. SMOTHERING**

**Definition:** A type of violent asphyxia due to manual obstruction of the external respiratory orifices (*mouth and nostrils*) usually by the hands or soft objects.

**Conditions:**

**1. Homicidal:**

- Most commonly applied to old feeble persons, infants or unconscious victims who cannot resist.
- **Gagging:** Fabric or adhesive tape is used to occlude the mouth and prevent speaking or shouting as sometimes happens in robbery with violence. In this case the nasal passages remain patent, air can enter, but later blockage by mucus and/or edema may lead to death.

**2. Accidental:**

- Infants sleeping in prone position.
- **Overlying:** a nursing mother accidentally laying her heavy lactating breast on her suckling baby's mouth and nostrils. The same may occur if an adult person sleeping beside an infant and rolling on it by his arm or his body.

**Mechanism of Death:** Mechanical anoxia.

**Post mortem picture:**

*A. General:*

- External and internal signs of asphyxia.
- Signs of struggle or resistance (in homicide).
- Ventral hypostasis in cot death.

*B. Local:*

- Semilunar nail abrasions and bruises detected at external respiratory orifices which coincide with the number and distribution of the nails (four on the left side and one on the right side if the assailant used the right hand and vice versa if the left hand was used). These findings may be absent if a soft pad or pillow was intervening between the hands and the face.
- Bruises and contused wounds in the inner aspect of the lips, cheeks and gums as they were pressed against teeth which may be broken.

## 2. CHOKING

**Definition:** A type of violent asphyxia due to blockage of the internal respiratory passages, at the pharyngeal, the laryngeal or the tracheal level.

**Conditions:**

1- **Pathological:** angioneurotic edema of the glottis

2- **Accidental:**

- Inhalation of irritant fumes.
- Inhalation of dust and sand as in falling houses with resulting edema of the glottis or occlusion of the respiratory orifices.
- Accidental swallowed vomits or extracted teeth as in dentistry or blood clot after tonsillectomy.
- Falling back of the tongue in comatosed patients.
- **Café coronary:** Choking occurs suddenly while eating. The obstructing foreign body will wedge into laryngopharynx & stimulate nerve endings resulting in reflex cardiac arrest.

**C. Homicidal:** Rare; often occurs in infanticide by packing the infant pharynx with a piece of cotton or tissue.

**Mechanism of death; either**

1. Asphyxia: where airway obstructed by foreign body which may be (partial) that is completed by laryngospasm or increased mucous secretion, with appearance of external and internal signs of asphyxia.
2. RCI: rapid silent death from vasovagal cardiac arrest (sensitivity of the pharynx or larynx to sudden stimulation).

**Post mortem picture:**

- A. General: signs of asphyxia may occur.
- B. Local: The foreign body is detected in air passages.

### **3. SUFFOCATION**

**Definition:** It usually refers to a death caused by reduction of the oxygen concentration in the respired atmosphere.

**Plastic bag suffocation:**

It may occur accidentally in children or deliberately in adults as a suicidal act.

It may also be homicidal.

**Mechanism of death:**

- Hypoxic,
- Reflex Cardiac Inhibition.

**Postmortem picture:**

The 'classic signs' of asphyxia are almost always absent.

- 1- It is very rare to find any petechial hemorrhages, as these are mainly due to venous obstruction, which is absent in suffocation.
- 2- Congestion and cyanosis are often absent and the autopsy findings are essentially negative.

### **4. THROTTLING (MANUAL STRANGULATION)**

**Definition:** A type of violent asphyxia in which the neck is constricted forcibly by the hands (performed by one or both hands from front or back).

**Conditions:**

- 1- **Homicidal:** It is a common mode of homicide of a man against a woman or less often a child by a man.
- 2- **Suicidal:** Impossible; because as soon as the person throttles himself, he loses consciousness with subsequent relaxation of his hands and released neck grip. A rare condition occurs when cadaveric spasm continues the obstruction.
- 3- **Mugging (*arm-lock*):** by the application of pressure to the neck by means of an arm crooked around from the rear.

**Mechanism of Death:**

- 1- Mechanical anoxia is the chief cause of death.
- 2- Reflex cardiac inhibition (compression of carotid sinus).
- 3- Cerebral anemia (compression of carotid artery).
- 4- Delayed edema of the glottis.

**Post mortem picture:**

A. *General:* External and internal signs of asphyxia.

**N.B.** In cases of rapid death due to RVI, there will be no facial congestion, petechiae or cyanosis indicating continuous pressure on the carotid sinus lasting not more than 5 seconds.

B. *Local*

- 1- Semilunar nail abrasions and bruises on the front and sides of the neck. Their distribution and number help for detecting the identity of the assailant (right or left handed or missing a finger), his position with respect to the victim and whether he used one or both hands.
- 2- Linear abrasions; due to the movement of the victim's fingers along his neck in an attempt to release the pressure.
- 3- Hemorrhage and bruises under the skin and in the muscles of the neck.
- 4- Internal fracture of greater horn of hyoid bone or subluxation of the joint between cornu and the body of the bone.
- 5- Damaged larynx and fracture or split of the thyroid cartilage.

## 5. STRANGULATION

**Definition:** A type of violent asphyxia in which neck is constricted forcibly by a rope or any ligature (wire, electric cable, etc....) thus preventing air entry through respiratory passages.

**Conditions:**

**Homicidal:** Most common.

**Accidental:**

- Children playing with ropes or
- Strangulation of the fetus by the umbilical cord during labor.
- Victim's clothing such as a necktie or scarf caught in moving machinery.

**Suicidal:** Rare but may be achieved by using:

- Tourniquet mechanism (a solid object is applied bet the rope turns and the neck, then twisted continuously and become impacted between chin and clavicle when fainting occurs)
- Adhesive ligatures or
- Winding several firmly tightened turns of a rope around the neck before loss of consciousness.

**Mechanism of Death:**

- 1- Mechanical anoxia is the chief cause of death.
- 2- Reflex cardiac inhibition.
- 3- Delayed edema of the glottis.

**Post mortem picture:**

A. *General:* External and internal signs of asphyxia.

B. *Local*

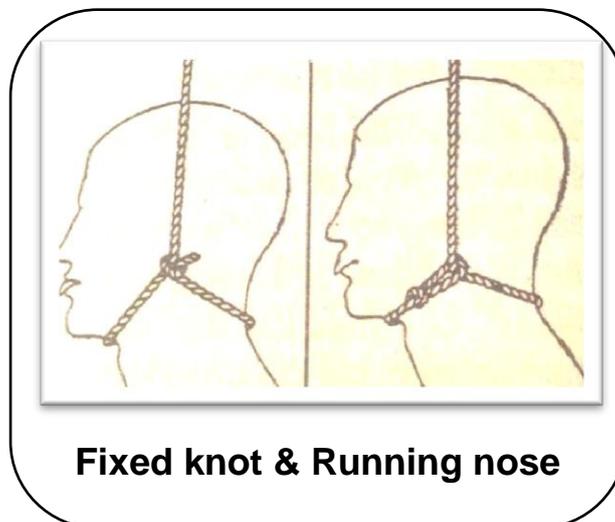
1- Ligature mark:

- Formed of abrasions and contusions and surrounded by congestion, petechiae and hyperemia
- Takes the pattern and size of the ligature.
- Well defined and deep if a wire or thin cord is used, diffuse and faint in case a soft fabric is used, may be absent if the ligature is removed immediately after death.
- Transverse and located just below the laryngeal prominence
- Complete circle involving the whole circumference of the neck.

- 2- There may be scratches and abrasions on either side of the neck as a sign of resistance (if the victim tried to pull the ligature).
- 3- Congestion and bruises of neck muscles,
- 4- Fractures of the thyroid cartilage and the hyoid bone with inward displacement but of less severity than manual strangulation.

## 6. HANGING

**Definition:** It is a type of mechanical anoxia due to suspension of the body from the neck by a ligature. The constricting force is produced by the weight of the body.



### Conditions:

**1-Suicidal:** Self suspension hanging is the commonest form in which a slip knot or running noose (the end of the ligature passes through a loop) is done by the suicide and the free end of the rope is fixed at a higher point.

**2-Accidental:** Not common and occurs in:

- Children playing with ropes or entrapped by head between double bars (beds, windows, stairs).
- Falling men from scaffolding entangled in ropes.

**3-Homicidal:** Very rare except in narcotized or unconscious victims and post mortem suspension to simulate suicide.

**Types of Hanging:**

- Complete: if the body is freely suspended without touching the ground at any point.
- Incomplete: if any part of the body touches the ground (eg. Toes knees, shoulders,...)

**Mechanism of death:**

- 1- *Cerebral anemia*: The commonest cause, due to stretch of the carotids and their elongation with subsequent narrowing. This mechanism explains the rapid loss of consciousness (victim cannot save himself).
- 2- *Reflex cardiac inhibition*: due to pressure on the carotid sinus.
- 3- *Mechanical asphyxia*: due to backward displacement of the base of the tongue.
- 4- Tearing of the medulla: following *Fracture dislocation of the cervical vertebrae*. Common with "Judicial hanging" due to the long drop of more than two meters.

**Post mortem picture:****C. General**

- 1- External and internal signs of asphyxia.
- 2- Hypostasis in the lower parts of the body (lower limbs, hands, lower abdomen & genitalia).
- 3- Engorged genital organs with ejaculation in males.

**D. Local**

- 1- Ligature mark, as in strangulation **but**:
  - Incomplete circle around the neck as it is absent at point of suspension (in fixed Knots) where the rope rising upward away from the skin to a peak point at the junction between the knot and the vertical part of the rope,
  - Asymmetrical: deepest opposite the point of suspension and fades gradually upwards to be absent at the site of the knot.
  - Oblique and located high up in the neck.
- 2- Dribbling of saliva due to pressure on the sub mandibular gland.

- 3- Neck muscles show bruises and lacerations.
- 4- Carotid arteries show transverse intimal rupture (due to their elongation).
- 5- Outward Fracture of the hyoid bone or posterior horn of the thyroid cartilage due to stretch of the stylohyoid and thyrohyoid ligament.

Ligature mark	Strangulation	Hanging
1- Site	Low below larynx	High above larynx
2- Shape	Complete circle	Incomplete circle (except running noose/ double turns).
3- Direction	Transverse	Oblique
4-Compression	Symmetrical	Asymmetrical

**MLI of Hyoid Bone**

- 1. **Age estimation:** the joint between greater cornu and the body ossifies at 40 years.
- 2. **Cause of death** could be identified:
  - a. Toxic: chronic arsenic poisoning (Reinsch test).
  - b. Pathological: Bone diseases and tumors (sarcoma).
  - c. Violent: Fractured hyoid occurs in case of:
    - Throttling or high strangulation →Inward fracture.
    - Hanging →outward fracture.
    - Direct neck trauma.

Fractured hyoid if occurs before 40 years must be differentiated from non- ossified joint between greater cornu and the body, as the joint is symmetrical, has smooth surface and lined with synovial membrane. While the fracture is not symmetrical, with irregular edges and surrounded by bruises if antemortem.

## 7. TRAUMATIC (CRUSH) ASPHYXIA

**Definition:** A type of mechanical asphyxia due to fixation of the chest and abdomen by external mechanical compression preventing respiratory movements.

### Conditions:

**1-Accidental:** the commonest cause due to

- Runover traffic accidents.
- Falling houses.
- Crushing in crowds

**2-Homicidal:** Historical method of killing called "**Burking**".

### Mechanism of death;

- 1- Mechanical asphyxia.
- 2- Injury of vital organs.

### Post mortem picture:

It provides the most remarkable demonstration of the 'classic signs' of asphyxia

- 1- The most classic feature is the blue congestion of the face, neck and upper part of the chest. Together with pallor at the site of compression. There is a distinct line of demarcation between the congested and the pale parts.
- 2- The conjunctivae are grossly congested and hemorrhagic.
- 3- There may be local bruises and abrasions from the compressing weight.
- 4- Internally, the congestion is less marked than externally, but the lungs are usually dark and heavy and may as well show subpleural petechial hemorrhages, the true '**Tardieu spots**'.
- 5- Other injuries: contusions and abrasions of chest wall, fracture ribs or sternum and rupture of heart or lungs.

## 8. SEXUAL ASPHYXIA

- Death in sexual asphyxia is accidental self-induced; that happens suddenly during attempts of inducing hypoxia in order to reduce the blood supply to the brain; which appear to produce auto erotic hallucinations in some persons during the course of solitary sexual activity.
- The condition is more common in males of any age. It usually occurs in isolated closed places. There may be evidence of transvestism, exhibitionism, mirrors, cameras, pornographic materials.
- Many forms of violent asphyxias are applied as; smothering, strangulation, hanging or suffocation.

## 9. DROWNING

**Definition:** A type of asphyxia caused by submersion of the mouth and nostrils under the water.

**Conditions:**

1- **Accidental:**

Most common; may occur in bathers after sudden cramps, drunken, narcotic or epileptic patients.

2- **Suicidal:**

Next common and diagnosed with positive circumstantial evidences and may be presence of ties of the hands or stones in the pockets.

3- **Homicidal:**

Rare and difficult to prove; victims are usually infants, children or unaware persons. If true homicide, there are signs of resistance and back pressure bruises.

Post mortem immersion of murdered victims is common in order to conceal the crime. No signs of drowning could be detected and other cause of death is present.

## Mechanism of Immersion deaths:

### A. Typical Drowning:

1. **Mechanical anoxia:** filling of air passages with water results in deprivation of oxygen and irreversible cortical brain damage.
2. **Profound fluid and electrolyte imbalance:**
  - i. *In freshwater drowning* there is a massive absorption of water through the alveolar membranes, which could amount to 70 per cent of the original blood volume within 3 minutes. This leads to hypervolemia and **cardiac overload**. Also hemodilution occurs with resultant hemolysis of red cells and potassium release leading to severe hyperkalemia and powerful myocardial toxemia. Death typically takes about 4-5 minutes.
  - ii. *In seawater drowning* the hypertonic medium caused a withdrawal of water from the plasma into the lungs and a rise in plasma sodium concentration. This condition is less deleterious to heart function and explains the longer survival time in seawater immersion (8-12 minutes).

### B. Atypical drowning: (atypical PMP of drowning)

1. **Laryngeal spasm:** in about 20% of cases of drowning leading to a hypoxic death from closure of the airway preventing water entry, the so-called '**dry-lung drowning**', in which, the lungs appear normal in all aspects.
2. **Hydrocution or submersion inhibition:** death is due to cardiac arrest as a result of vagal inhibition by immersion in cold water. As with any reflex cardiac arrest, there will be nothing to find at autopsy, this forces diagnosis to be based on the circumstances and exclusion of other conditions.
3. **Secondary drowning syndrome (post-immersion syndrome or near drowning):** Death results from cerebral anoxia with irreversible brain damage within half an hour to several days after resuscitation. Also, pulmonary infection

(contaminated water) or heart failure (exhaustion) may end fatally from pulmonary edema.

4. **Traumatic conditions:** eg. Head injuries when the victim's head strikes a rock in water leading to death under water or in faulty diving or boat accidents.

#### **Diagnosis of drowning depends on signs denoting:**

- I) Long submersion (probable).
- II) Struggle for breathing and inhalation of water (sure signs).

#### **External signs:**

##### **a) Probable signs (signs of immersion):**

- 1- ***Cutis anserine "Goose skin"***: due to contraction of erector pilae muscles of hair follicles due to coldness during life and rigor mortis after **death**.
- 2- ***Washer-woman hands***: Corrugated sodden skin of hands and feet occurs after 24 hours submersion.
- 3- ***Peeling of epidermis***: especially that of hands and feet in the **form** of gloves and sockets, due to accumulation of putrefactive gases between dermis and epidermis. It usually occurs 2 weeks after submersion. Finger prints could be detected on both dermis and epidermis.
- 4- ***Immersion effects on Postmortem changes:***
  - i. ***Cooling***: rate of cooling under water is double than that in air.
  - ii. ***Hypostasis***: pale, in the head, neck, shoulders and upper limbs. **Because** the body is usually suspended in oblique position and the head lower down.
  - iii. ***Adipocere***: appears after 3 weeks and completed in 6 months.
  - iv. ***Putrefaction***: takes double the time as that in air. Floatation occurs after 3-7 days in summer and 7-10 days in winter.

##### **b) Sure signs:**

- 1- ***Froth***: composed of a mixture of air, water & mucous that resulted from the vigorous respiratory movement. It is abundant, whitish, odorless, fine small bubbled foam, present at the mouth and

nostrils, if wiped away it gradually reappears by simple pressure on the chest.

**D.D:** froth due to putrefaction (putrefaction gases & decomposed blood); coarse, dark & offensive.

2- ***Cadaveric spasm:*** The victim catches firmly sand, mud or sea weeds, denoting life under water.

### **Internal signs (all are sure signs)**

**1- Air passages:** contain froth and foreign bodies from water (sand, weeds, mud,..). The mucosa is congested with petechial hemorrhages.

#### **2- Lungs**

a) Pale, large, voluminous & filling chest cavity. The normally bare area over the heart may be covered and the lungs may bulge upwards, meeting in the midline to obliterate the anterior mediastinum. The edema fluid in the bronchi blocks the passive collapse that normally occurs at death thus holding the lungs in an inspiratory position sufficient to mark the lateral surfaces of the lungs with the impression of the ribs, leaving visible and palpable grooves after removal of the organs from the thorax.

b) Froth oozes from its cut surface.

b) There are almost never sub pleural petechial hemorrhages in drowning.

**3- The heart:** the heart and great veins have often 'dilated and engorged with fluid blood, especially the left side. Subpericardial hemorrhage is detected.

**4- The stomach:** may contain unpalatable water and foreign bodies.

**5- The spleen:** is small, pale, contracted with wrinkled capsule.

**6- The planktons (diatoms):** these are microscopic unicellular structures that are highly complex in shape and are extremely resistant to decay. There are about 25000 species of diatoms.

***MLI of planktons:***

- i. Diagnostic of drowning as they pass through the pulmonary capillaries and blood stream to reach brain, bone marrow, kidneys and other organs, except the contracted spleen.
- ii. D.D. between antemortem & postmortem submersion in water; being in the latter condition present only in the alimentary and respiratory tracts and absent in internal organs.
- iii. Denotes the type of water by careful analysis and identification of the species detected in the tissues.
- iv. Decay resistance property makes it the only diagnostic sign for drowning after putrefaction if detected in protected tissue such as bone marrow.

## Chapter (14)

# MEDICOLEGAL ASPECTS OF SEXUAL ASSAULTS

### **ILOS:**

- *To diagnose and document cases of questioned virginity.*
- *To evaluate medico-legal aspects of impotence.*
- *To identify different varieties of sexual assaults.*
- *To interpret medico-legal evidences in persons involved in sexual assaults.*
- *To recognize different types of sexual perversions.*

## **Virginity**

### **Medicolegal conditions in which a female is examined for virginity:**

- Alleged rape.
- Alleged impotence of the husband.
- Alleged non-virginity of the wife “ **nullity of marriage** ” .

### **Diagnosis of virginity:**

#### **A. Suggestive Signs:**

- Intact posterior commissure & fourchette ( membranous fold connecting the posterior ends of the labia minora).
- Firm rounded labia majora, completely closing the vaginal orifice which remains closed in the lithotomy position.
- The vagina is narrow (approximated walls) with mucosal rugae.
- Firm hemispherical breasts with small nipples surrounded by rosy areolae.

#### **B. Sure Signs:**

Intact hymen: thin membranous diaphragm (1 mm. thick), partially closing the vaginal introitus in virgins.

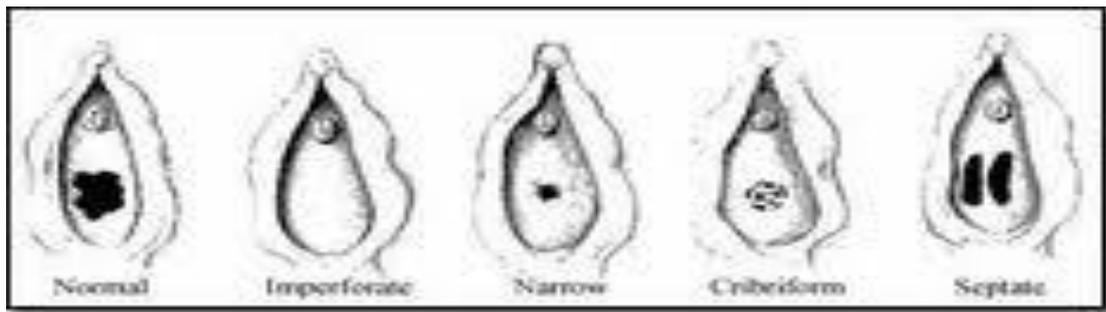
### **Examination of the hymen:**

- It should be done in day light or in good illumination.
- It is performed in lithotomy position after doing gentle traction on the labia to stretch the hymen.
- If the hymen is intact, its type should be defined.
- If the hymen is deflorated, the following items should be clarified:

1. The rupture is due to single or multiple intercoursures.
2. The tears are recent or old.
3. The cause of the rupture.
4. D.D. of hymen tears.

### I. Varieties of the Hymen

Type	Shape	MLI
<b>1. Semilunar (Crescentic)</b>	Anterior or posterior orifice.	<ul style="list-style-type: none"> <li>• commonest type.</li> <li>• ruptured on both sides.</li> </ul>
<b>2. Annular</b>	Central orifice.	<ul style="list-style-type: none"> <li>• common.</li> <li>• rupture posteriorly (at 6 o'clock).</li> <li>• may be fleshy , elastic , and dilatable allowing intercourse without being ruptured.</li> </ul>
<b>3. Dentate</b>	The orifice has indentations or folds along its edges.	may simulate ruptured hymen.
<b>4. Fimbriate</b>	The orifice has fimbria along its edges.	may simulate ruptured hymen.
<b>5. Cribriform</b>	Multiple small openings (sieve-like appearance).	
<b>6. Septate</b>	The opening has a septum(longitudinal or transverse) dividing it into two compartments.	The septum ruptures on the first intercourse .
<b>7. Imperforate</b>	No opening (closes completely the vaginal introitus).	Retention of menstrual blood and accumulation in the vagina, tubes and uterus (hematocolpus & hematometrium). The condition may simulates pregnancy. Resolves through surgical interference by cruciate incision in the center of the hymen not reaching the circumference..



*Types of the hymen.*

## II. D.D. of recent and old hymenal rupture:

	Recent tear	Old tear (>2weeks)
<b>Color</b>	Red & hyperemic	Pale & healed
<b>Tenderness</b>	present	Absent
<b>Swelling &amp; Bleeding</b>	present	Absent
<b>Covered with</b>	scab	scar
<b>Transillumination</b>	Translucent	Transopaque

## III. D.D. of ruptured hymen due to single or repeated intercourse:

Single	Repeated
One or two hymen tears.	<ul style="list-style-type: none"> <li>- Evident hymen laceration.</li> <li>- Loss of vaginal tone.</li> <li>- Examination in lithotomy position reveals separated Labia, exposed vaginal mucosa &amp; ruptured posterior commissure.</li> <li>- Carunculae myritiformes.</li> </ul>

**NB.** When there is multiple tears this results into retraction of the membrane towards the vaginal wall, the remnants of which are called

**“carunculae myritiformes”.**

## IV. D.D. of old ruptured hymen; with dentate or fimbriate hymens:

	Dentate / fimbriate	Ruptured
Nature	Folds	tears
Site	symmetrical on both sides	asymmetrical
Extension to vaginal wall	do not reach	reach
Stretch of the hymen	irregularly disappear	irregularly persist
Transillumination	translucent	transopaque

### **Misdiagnosis of virginity:**

- **False virgin:**

- a. when the hymen is elastic, fleshy and dilatable that allow intercourse without any tears and rupture only on the first vaginal delivery. This may constitute the basis on which a husband may allege the non-virginity of his wife
- b. Dentate or fimbriate hymen may simulate ruptured hymen.

- **False non virgin:**

The hymen may rupture due to any other cause rather than intercourse, as:

1. Direct trauma to the vulva as in accidents.
2. Diseases; ulcerations, tumors of the vulva or vaginal and cervical polyps protruding through the vulva.
3. Surgical Interference.

## ***Impotence***

**Definition:** Inability of penile erection in males after puberty.

**Medicolegal aspects:**

A man may be examined for impotence in the following conditions:

1. Rape: the accused may allege impotence as a defence.
2. Divorce: The wife has the right for divorce if her husband is impotent.
3. Impotence may be claimed as a result of an assault for getting compensation.

**Etiology:**

- **Physiologic** before puberty ( before 14 years ).
- **Psychic** as in fears of venereal diseases , lack of self confidence to do the act or feeling disgust and dislike of the female partener. Psychic causes are the commonest and are generally temporary.
- **Traumatic** as head and spinal cord injuries.
- **Pathologic:**
  - 1- Local causes**
    - Anatomical deficit: eg. Complete or partial loss of the penis .
    - Hormonal deficit: eg. Loss of both testicles.
    - Mechanical deficit: eg. elephantiasis, large hernia, hydrocele & advanced epispadias or hypospadias (fibrous band of tissue along the shaft of the penis preventing free erection).
  - 2- General causes**
    - Vascular causes: e.g. diabetes mellitus.
    - Nervous diseases e.g. tabes dorsalis & neuroasthenias .
    - Debilitating diseases e.g. tuberculosis .
    - Addiction e.g. alcoholism, narcotic addiction and excessive use of tobacco & cocaine.

**Diagnosis:**

**I. Consent** is taken even in prison.

**II. General examination:**

- The body built ,
- 2ry sexual characters,
- Exclusion of any diseases that may produce impotence.

**III. Local examination**

It includes examination for abnormalities or diseases of the genitalia.

**IV. Examination under anaesthesia:**

Postatic massage under light anaesthesia resulting in erection, excludes psychological causes of impotence in consciously impotent persons.

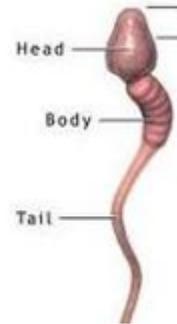
**V. Lab investigations:**

Hormonal profile, blood sugar and drug residue detection in blood and urine.

**Seminal stains****Characters of Seminal Fluid:**

- Color: yellowish white
- Odor: characteristic.
- Consistency: thick.

- Volume: 3-5 cc/ ejaculate.
- Count: average 60 million sperms/ml.
- PH: 7.2-7.8.



### Characters of human sperm:

- Formed of head, neck and tail.
- 55  $\mu$  in length.

### Examination of seminal stains includes the following goals:

#### I. To prove that the stain is seminal

##### 1- Preliminary tests:

- a) Physical examination: by naked eye & U.V. rays (pale blue fluorescence in the dark).
- b) Microchemical examination:
  - Florence test; depends on the presence of choline.
  - Barberio's test; depends on the presence of spermine.
  - Acid phosphatase content of seminal stains.
  - Sperm-specific lactate dehydrogenase isoenzyme.

##### 2- Confirmatory tests:

- a) Microscopic test: 1 complete sperm/ HPF constitute sure diagnosis. Separate heads or tails simulate cellular debris or fibers, and not considered as evidence.
- b) Acid phosphatase test: in cases of azospermia.

##### **N.B.:**

A negative Florence test means no semen, while negative microscopic one cannot exclude the presence of semen. A person suffering from azospermia has: + ve Florence test and -ve microscopic one.

#### II. To prove that the semen is human in origin or not.

- 1- Spermato-precipitin test.
- 2- Microscopic examination: for the shape of the sperms.

#### III. To relate the stain to certain person or not

- 1- Grouping test: valid only in secretors, done by the absorption method of grouping for blood stains.
- 2- DNA fingerprinting: superior evidence.

## ***Sexual Assaults***

### **Definition:**

- **Sexual assaults refer** to any non-consensual sexual act; it ranges from inappropriate touching to penetration or intercourse.
- **While Sexual offences refer** to any sexual behavior or activity which is punishable or prohibited by the law.

### **Circumstances of sexual assaults:**

- Sexual violence can take many forms and take place under very **different circumstances**.
- Although sexual violence occurs most commonly in the victim's home (or in the perpetrator's home), it also takes place in many other **settings**, such as the workplace, at school, in prisons, cars, the streets or open spaces (e.g. parks, farmland).
- A person can be sexually violated by one **individual or several** people (e.g. **Gang rape**).
- The incident may be **planned or a surprise** attack.

### **The perpetrator of a sexual assault:**

- There is no stereotypical perpetrator as sexually violent men come from all backgrounds; rich and poor, academic and uneducated, religious and non-religious.
- Large proportion of sexual assaults is committed by people known to the victims rather than strangers.
- Perpetrators may be persons in positions of authority who are respected and trusted (e.g. doctor, teacher, police officer) and thus less likely to be suspected of sexual violence (**Custodial rape**).

### **Classification of sexual offences:**

#### **I. Natural**

Sexual acts occurring between different sexes, through natural route of connection as: Incest, adultery (Infidelity) or rape.

#### **II. Unnatural**

Sexual acts occurring between:

- Similar sexes: Homosexuality (**sodomy by males & lesbianism by females**).
- Different sexes, through unnatural route of connection: Buggery or Buccal coitus.
- With dead bodies: Necrophilia.
- With animals: Bestiality.

## **I. Natural Sexual Offences**

### ***Incest***

- Sexual intercourse between persons of forbidden degrees of relationship, e.g. father & daughter, brother & sister.
- The consent of the female here is not valid and couldn't be used as a defence.
- Incestuous relations may occur unintended after heterologous artificial insemination, between offspring of the same donor.

### ***Rape***

#### **Definitions:**

**Rape** is unlawful sexual intercourse with a female without her consent.

**Unlawful** means outside the marriage bond.

**Sexual intercourse** ie. The slightest penetration of the vulva by the penis with or without emission of semen or rupture of the hymen.

**Female** ie. The offence is committed only against a woman, and so a woman cannot rape a man but she may be guilty of indecent assault against him.

**Consent** means agreement, permission or approval given by free will.

#### **Conditions of valid consent:**

1- Capacity of giving consent, the female should be capable by:

- **Age:** 18 years is the legal age of consent.
- **Mental power:** must not be mentally deficient, e.g. idiot, imbecile or insane.
- **Physical power:** must not be weak to be able of resistance. A weak victim may be over powered by a well built male.
- **Conscious level:**
  - a) Not under **narcosis:** by drugs, e.g. date rape drugs as Ketamine, Rohypnol or Gamma Hydroxy-Butyric Acid (GABA).
  - b) Not under **anesthesia:** some females under anesthesia may experience sexual hallucination and charge the surgeon for rape. Thus, there must be a third person at the theatre.

2- **Not under violence** (moral or physical) as fear or threats as this is considered submission.

3- **Not under fraud:**

- Impersonation of the husband during sleep.
- Fraudulent therapy **by doctors or quacks.**

## **Medical examination for rape**

### **The role of the physician in examining a rape case:**

- To provide immediate medical care, primary level counseling and referral for the physical and psychological sequelae of the assault.
- To obtain evidence of the crime and help judges to understand the physical and mental condition of the woman and possibly identify the assailant.
- To write a full complete illustrative report.

### ***1) Examination of the victim:***

A female medical attendant (**nurse**) must be present throughout the medical examination. In case of a minor girl, her mother and one other neutral person must be present.

**A. Written consent** for examination from the victim, or the parents or the guardian's if she is below 21 years. Better to be witnessed.

### **B. History Taking:**

- Personal details and medical history including menstrual history and details of pregnancy and last consensual sexual intercourse.
- Patient's narration of the assault including details of the place of the assault, time, nature of the force used, areas of contact, number of assailants, bleeding, penetration & emission of semen, use of condoms and sustained injuries.
- Post assault activity as changing of clothes, bath or passing urine.
- The victim story is compared with any story given before to the police or parquet and with the accused story.
- A delay in notification is against the victim.

### **C. General Examination:**

1. Her conduct, behavior and character are noticed.
2. Her age is estimated:
  - a. Below 7 years (maximum punishment to perpetrators).
  - b. Below 18 years (non valid consent).
3. Her mental condition is examined for mental deficiency.
4. Her physical development and body built are assessed.
5. Signs of narcosis; as early as possible, by both physical and chemical analysis.
6. Undress the victim while standing on clean white sheet to catch any hairs, fibers or foreign bodies falling from her.
7. Signs of general violence; resistance or struggle;
  - a) Clothes: tears, lost buttons or stains (blood, semen or saliva).
  - b) Head hair: may show disarrangement, broken hairs or stains.

- c) Finger nails: broken nails and stains or tags of epithelium under nail bed.
- d) Body: abrasions and bruises, their age coincide with the date of the assault and commonly detected in the following sites:
  - In the face and around the mouth; for prevention of crying or shouting.
  - The neck and breast (love bites).
  - Arms and legs to prevent her from escaping & abort her resistance.
  - The inner aspects of thighs to separate them.

Document the injuries using body maps or photograph if possible.

These signs vary according to the age, social class, virginity and physical development of victim as follows:

- No signs in young children (unable to resist or understand the situation).
- Minimal signs in adult virgins (sexually un-experienced & terrified by the assault).
- Maximal signs in married women (greater resistance), but a refined woman may succumb rapidly and shows minimal signs.

#### **D. Local Examination:**

##### 1. Position of examination:

- Children & prepubertal: Knee chest and supine frog leg position.
- Pubertal & adult: lithotomy position.

##### 2. Signs of local violence:

- a) The vulva: tenderness, bleeding; abrasions & bruises; the date of which must coincide with the date of the assault.
- b) Pubic hair: may be matted with semen or blood stains.
- c) Loose hair of the assailant may be found.
- d) The hymen: recent or old tears may be found.
- e) Apply Toluidine Blue Dye, and then rinse with vinegar to visualize hidden or minor injuries. The dye is taken up by metabolically active cells

These signs vary according to victim's age, virginity, genital development and marital state as follows:

- Minimal signs in young children due to deep hymen and narrow vagina (female-male disproportion) leading to impossible

penetration but external friction signs are present. If brutal force is applied severe perineal tears & laceration occur.

- Maximal signs in adult virgins and may be ruptured hymen.
- Evident signs in postmenopausal females (postmenopausal atrophy causing increased genital tissue susceptibility).
- Minimal or no signs in married women.

3. Seminal stains may be present on:

- a) Clothes: grayish white stains which cause stiffening of the fabrics.
- b) Public hair: causing matting.
- c) Around the vulva and in the vagina (can stay for 7 days maximally in the vagina and swabbed from posterior fornix).

#### **E. Lab Investigations:**

- a) Hepatitis B & AIDS.
- b) Venereal diseases as Chlamydia, syphilis or gonorrhoea.
- c) Pregnancy test.
- d) Drug residue detection in blood and urine:
  - Rohypnol (Flunitrazepam) – Found in urine up to 36-72 hours.
  - GHB (Gamma Hydroxybutyric Acid) – Found in urine up to 10-12 hours.
  - GBL (Gamma Butyrolactone) – Found in urine up to 6 hours and in the blood up to 24 hours.

#### **F. Follow-up examinations:**

- Within 72 hours after initial assessment to record developing bruises.
- Test for pregnancy; after 2 weeks.
- Repeat after six weeks for VDRL.
- Assess for psychological sequelae.

#### **II) Examination of the accused:**

**The same scheme of examination as for the victim with the following considerations:**

- a) The consent for examination is mandatory. It should be **written & witnessed** even if he is imprisoned.
- b) His own story has to be compared with the victim's one & other stories given before.
- c) His age if less than 14 years; he is considered by law incapable of committing the crime of rape.
- d) Sexual power (**Potency**) should be assessed as impotent cannot commit the crime of rape; thus impotency may be alleged by the accused as a defense.

### **False Allegation of Rape**

- False charge of rape is common; and suspected when there is a delay of notification from the woman.
- Sometimes the woman may give her consent to the act, and then she brings the charge of rape if someone has seen her to save her reputation.
- Medical men are often selected as victims, threatened by their female patients to be charged with indecent assault or improper conduct.
- Careful history and thorough examination will reveal the fabrication.
- The woman may falsely allege being raped in situations such as:
  - Revenge.
  - Blackmailing.
  - Fear of discovering adultery.
- She may substantiate any of the following methods to simulate rape:
  - Self-induced injuries and tears of clothes.
  - Fabricated blood stains
  - Fabricated seminal stains (starch/egg white).

## ***II. Unnatural Sexual Offences***

### **1- Male homosexuality (Sodomy / Male Sexual Inversion / Pederasty):**

This refers to anal intercourse between two males. The active agent is the one who perform the act and the passive agent is the one on whom the act is performed (usually a young adult or a child). Rarely, sodomy may be performed by two men who alternately act as active and passive.

The act is a crime in both parties and consenting cannot legitimise this relationship, i.e. both offenders (passive and active) are liable to penal servitude.

### **Examination of habitual passive sodomist:**

- Male homosexuals have characteristics of gait , dressing and speech and if he is asked to lie for examination he immediately and knowingly takes of the knee-chest position without any shame.
- Examination should be done in knee-chest position after taking his consent.

□ **General examination**

- This includes the age, mental status, the physical built , occupation , the gait and the type of clothes.
- For evidence of struggle as described for rape and in case of homicide a fatal injury may be present.

□ **Local examination**

- Weak or wasted external anal sphincter.
- Abnormal anal patency (funneled anal canal).
- Deep fissures crossing the anal skin margin.
- Wasting of gluteal fat.
- Anal scars and warts are commonly detected.
- Seminal stains on peri- anal hair or inside anal canal.

**Local acute signs in non-habitual passive sodomist:**

- Local tenderness and hyperemia.
- Dilated torn anus with perianal bruising and prolapsed bleeding mucosa especially with severe vigorous penetration.
- Acute anal fissures.
- Presence of semen.
- Evidence of lubricants.

**Examination of the active agent:**

□ **General examination**

- For the body built , age , mental condition .....
- Buises & abrasions over the body .
- The clothes are examined for signs of struggle as lost button or tears. They should be examined for the presence of stains (seminal, faecal or blood).

□ **Local examination**

- Bruises and abrasions over the glans penis.
- Tearing in the frenum of the penis .
- Traces of faeces, lubricant, blood and foreign hair trapped in the area of the coronal sulcus particularly in the uncircumcised.
- If there is no great disproportion between the size of the anus and that of the penis, it is possible that no signs will be found .

**2- Female homosexuality (Tribadism / Lesbianism):**

- Sexual connection between two females for gratification of sexual desire. It is not a punishable crime so long as both parties are consenting.
- Homosexual females are usually having repulsion for men. They may be suffering from *nymphomania*, which means hyper sexuality in women.

**3- Buggery:**

- Anal intercourse with a female partner.
- It can be a ground for divorce if claimed by the wife and proved by evidences.

**4- Bestiality (Zoophilia):**

- Sexual intercourse between a human being and an animal, either through the anus or the vagina.
- The animal may be used as active or passive agent. Human sperms may be detected in the vagina or anal canal of an animal, or animal sperms & hairs in human vagina or anal canal.
- Sheep are commonly used by men while dogs or cats by women.
- This offence is punishable.

**5- Necrophilia:**

- This is a sexual intercourse with a dead body.
- A dead body may be stolen from a mortuary or extracted from a cemetery to be used sexually.
- In extreme forms of necrophilia the offender may kill a woman to get a corpse to satisfy his paraphilia.

**6- Oral (buccal) intercourse:**

Mostly practiced with young children or females. Semen is detected by oral swab.

## Sexual Perversions

Sexual perversions are aberrant sexual behaviors aimed to obtain sexual gratification with or without sexual intercourse.

### 1- Sadism

- This is a perversion where the person derives sexual excitement from inflicting pain (***psychological or physical or both***) on his sexual partner.
- It may be practised by either sex but is more common in the males.
- Infliction of pain is sometimes the sole factor for sexual gratification .
- Multiple injuries are inflicted on many body areas but the breasts and external genitalia are commonly selected .

### 2- Masochism

- This is the reverse of sadism, and may occur in either sex but common among males.
- Sexual arousal and/or orgasm are achieved by receiving pain or experiencing embarrassment or humiliation by one's sexual partner.

### 3- Fetichism

- This is an obsession in which sexual gratification is associated with contact or sight of certain parts of the female body, or feminine garments such as underwear or shoes.
- These things ***do not*** normally have any sexual influence on the mind.

### 4- Exhibitionism

- This is a deliberate sexual urge in a person to expose his genitals to ***unsuspecting strangers in public*** to obtain sexual pleasure.
- It is more commonly seen in males who often expose themselves before children or women.

### 5- Voyeurism

- The perverted person derives sexual pleasure and gratification from observing ***unsuspecting and non-consenting*** people in whatever situation the voyeur finds it sexually stimulating.
- The observed people may be in the act of disrobing, partially or completely naked or engaged in sexual activity.

### 6- Frotteurism

- Touching and rubbing one's body, especially private parts, against a ***non-consenting*** person.
- The behavior usually occurs in crowded places, as in malls, elevators, public transportation vehicles, buses, subways, busy sidewalks, and public festivals.

## Chapter (15)

# MEDICOLEGAL ASPECTS OF OBSTETRICS

### ILOS:

- To understand medico-legal aspects of reproductive affairs.
- To diagnose and document cases involving pregnancy occurrence and termination.
- To identify complications and risks of fatalities related to pregnancy and abortion.
- To recognize the medico-legal responsibilities of physicians towards such cases.

## **MEDICO-LEGAL ASPECTS OF PREGNANCY**

The Medico-legal conditions in which a female is examined for pregnancy are:

1. **Inheritance:** to postpone distribution of properties.
2. **Divorce:** to get extra alimony.
3. **Honor killing:** unjustified young female death.
4. **Rape:** to intensify the punishment and to obtain more compensation.
5. **Adultery:** when a husband denies the pregnancy and accuses his wife for extra marital relation.
6. **Execution** for a female: to delay the date of execution.

### ***Diagnosis of Pregnancy***

#### **A. In living females**

- I. **Consent** is mandatory before female examination.
- II. **History** of Amenorrhea and previous pregnancy or delivery.
- III. **Clinical examination:** Probable & Sure signs.

## 1. Probable signs of pregnancy:

### a. Breast signs:

- Engorged breasts, dark nipples and areola with appearance of secondary areola and “**Montgomery’s follicles**” which are small dark tubercles around the nipple.
- The breast changes appear at 2nd to 3rd months of pregnancy.
- They remain for life, ie. They are of diagnostic importance only in the primigravida.

### b. Abdominal wall signs:

- Enlarged abdomen (detected from the 2<sup>nd</sup> trimester).
- Appearance of **linea nigra** in the middle line.
- Abdominal distension → tearing of the subcutaneous tissues → **striae-gravidarum or linea rosa or linea gravidarum** on both sides of the abdominal wall

### c. Vulval signs:

Dark pigmentation of the vulval mucosa.

### d. Vaginal signs:

- Dark pigmentation of the vaginal mucosa.
- Increased vascularity → the vagina becomes warm with pulsation and excess mucus secretion (leucorrhoea).

### e. Cervical signs:

- Excessive secretion and velvety sensation of the cervix.
- Softening of the cervix from above downwards “**Hegar’s sign**”, which is positive at 2nd month of pregnancy.

### f. Uterine signs:

Gradual enlargement of the pregnant uterus according to the period of gestation (*see fundal level*).

## 2. Sure signs of pregnancy: By the end of the 4th month.

- a. Inspection of the fetal movements.
- b. Palpation of the fetal parts and movements.

- c. Auscultation of the fetal heart sounds by “**sonic aid**” (Doppler): Fetal heart sounds are differentiated from the mother’s pulsations by being 140/minute in rate and “Tic Tac” in rythm.

IV. ***Investigations***: Biochemical & Radiology.

1. **Biochemical: Pregnancy tests:**

***Principle:***

Pregnancy tests depend upon the presence of human chorionic gonadotropin (HCG). This hormone is produced after fertilization by the chorion of the blastocyst. HCG molecule is composed of 2 subunits;  $\alpha$  and  $\beta$  subunits. It could be detected in the blood and urine of the pregnant female as early as 10 days after conception and remain positive 2 weeks after delivery or abortion.

There are two types of tests:

**A- Immunological tests (e.g. Gravindex Test):**

These tests are used to detect HCG in the urine of the pregnant female by an antigen- antibody reaction (Better use the morning sample).

False positive results may occur for several reasons, including:

- Errors of test application,
- Use of drugs containing HCG as part of infertility treatment,
- Gestational conditions producing elevated HCG: vesicular mole or choriocarcinoma
- Non-pregnant production of the HCG: liver diseases and malignancies.
- Excess luteinizing hormone (LH) due to tumors of anterior pituitary or postmenopausal. Both LH and HCG have identical  $\alpha$ -subunits but have different  $\beta$ -subunits.

**B-  $\beta$ -subunits of HCG:**

It depends on the detection of HCG in the blood or urine of the pregnant women by enzyme immunoassay. There are two types of the test:

- **Qualitative test:** gives positive or negative result for blood or urine sample.
- **Quantitative test:** for blood sample only and gives an accurate  $\beta$  subunit HCG level.

## 2. **Radiological:** Ultrasonography.

It confirms pregnancy by showing:

- The gestational sac as early as 4 weeks of gestation
- The embryo can be observed and measured by about 5 weeks.
- The heartbeat is usually visible by 7 weeks.

It has also some other advantages as determination of:

- Period of pregnancy (i.e. age of fetus).
- Sex of the fetus;
- Position of fetus (i.e. its presentation).
- Twin pregnancy.
- Fetal malformation.
- Intrauterine fetal death, by appearance of “Spalding’s sign”  
(see *P.M. changes*).

### **B. In dead females**

1. **In early pregnancy:** Histopathological examination for the chorionic tissues from uterine scrapings.
2. **In late pregnancy:** uterine & fetal examination (see later).

## ***Duration of Pregnancy (Gestational Period)***

The average duration of pregnancy is about **280 days** or **40 weeks  $\pm$  2 weeks** or **9 calendar months** or **10 lunar months** (menstrual cycles) counted from the ***first day*** of the last menstrual period.

From the **legal point** of view, the least duration of pregnancy can be accepted in the court as 6 months; as bleeding may occur in early pregnancy in case of threatened abortion and mistaken for being menstrual bleeding.

Meanwhile the greatest duration should not exceed 12 months; as amenorrhea may precede pregnancy.

**MLI:** The husband can deny the paternity of a child when it is born after a period less than 6 months from the date of his marriage; or more than 12 months after his presence away from his wife. Yet, the problem of disputed paternity is now easily terminated by DNA analysis of the fetus and the putative father.

### Estimation of the Duration of pregnancy:

#### 1. In living females

- Consent** is mandatory before female examination.
- History:** date of the first day of the last menstrual period and time of quickening (1st fetal movement) at 4- 5 months of pregnancy.
- Clinical examination:** by determination of the **fundal level** using the ulnar border of the left hand; as follows:

Fundal level	Gestational age (lunar months)
a) Pelvic brim	3 months
b) Umbilicus	6 months
c) Xiphoid	9 months
d) 3 fingers below xiphoid	full term



- Investigations:** **Ultrasonography** gives approximate date from fetal measurements (e.g. Biparietal diameter, femur length & abdominal circumference).

#### 2. In dead females

- Uterus examination:** Postmortem examination of the uterus for its weight, length and contents.

Pregnancy duration	Length of uterus inches
4 or 5 months + 2	6 or 7 inches
6 or 7 months + 3	9 or 10 inches
8 or 9 months + 4	12 or 13 inches

**b) Fetus examination:** estimation of fetal age in utero is determined by features of fetal growth; as follows:

IU month	Length in cm.	Weight In gm.	Placenta Wt. in gm.	Features
1	1	-	Chorionic Villi	-
2	4	-	Chorionic villi	-Mouth and nose separate openings. -Hands assume human appearance.
3	9	30	Placenta starts	-
4	16	150	100	-Sex distinguished. -Finger prints appearance.
5	25	300	200	-O.C. in Calcaneus. -Vernix casiosa appear. -Eyes opened by palpebral fissure.
6	30	700	300	-Eye brows and lashes appear. -Testicles are close to the kidneys. -Umbilical cord above pubis.
<b>7</b> <i>(viable fetus)</i>	<b>35</b>	<b>1500</b>	<b>400</b>	<b>-Wrinkled skin (scanty SC fat).</b> <b>- O.C. of Talus.</b> <b>-Testicles at the internal inguinal ring.</b>
8	40	2500	500	-Skin not wrinkled. -Vernix covers whole body. -O.C. in the lower end of femur. -Nails reach tip of fingers. -Testicles reach external inguinal ring.
<b>9</b> <i>(Full Term Fetus)</i>	<b>50</b>	<b>3500</b>	<b>600</b>	<b>-Umbilical cord is 50 cm, and join the body mid-way between xiphisternum and symphysis pubis.</b> <b>-O.C. at upper end of tibia appear and at lower end of femur (5mm).</b> <b>-Testicles in the scrotum.</b> <b>-Posterior fontanel is closed.</b> <b>-Nails beyond fingers but just reach the ends of the toes.</b> <b>-Head circumference is 13 inches.</b> <b>-Head hair 3cm.</b>

## **Diagnosis of Fetal Sex**

- 1) **Sex-chromatin test:** for detection of Sex-chromosomes from fetal epithelial cells obtained via amniocentesis (invasive procedure).
- 2) **Ultrasonography:** accurate, reliable and non-invasive procedure.

## **Assisted Reproductive Techniques**

Until recently, pregnancy was not possible for couples who could not conceive i.e. Sterile couple. But by the introduction of “**Assisted Reproductive Techniques**”, this problem could be solved in many instances. These techniques refer to a wide range of medical procedures adopted to initiate pregnancy through routes rather than sexual intercourse.

### **I. Artificial Insemination**

This procedure refers to instillation of semen into the genital tract of the female, through one of the following routes:

- **Intravaginal Insemination (IVI):** involves the injection of semen into the vagina.
- **Intrauterine Insemination (IUI):** the injection of sperms into the uterus by means of a catheter introduced through the cervix.

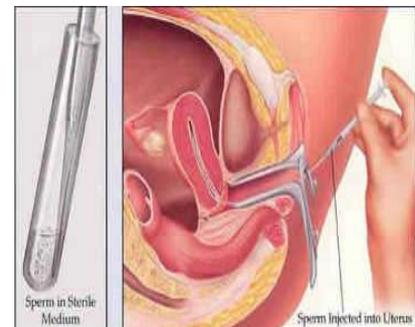
#### **Types:**

#### **1. Artificial Insemination Homologous (AIH):**

The semen is obtained from the spouse. It is a legal procedure. It must be done in front of the husband to be sure from using his semen; and so preventing suspicion.

#### **2. Artificial Insemination by Donor (AID):**

This procedure is used in case of infertile husband. The semen is obtained from a donor, so it violates good morals and religions. This procedure is illegal in Egypt and the medical physicians who practice it could be suit for malpractice.

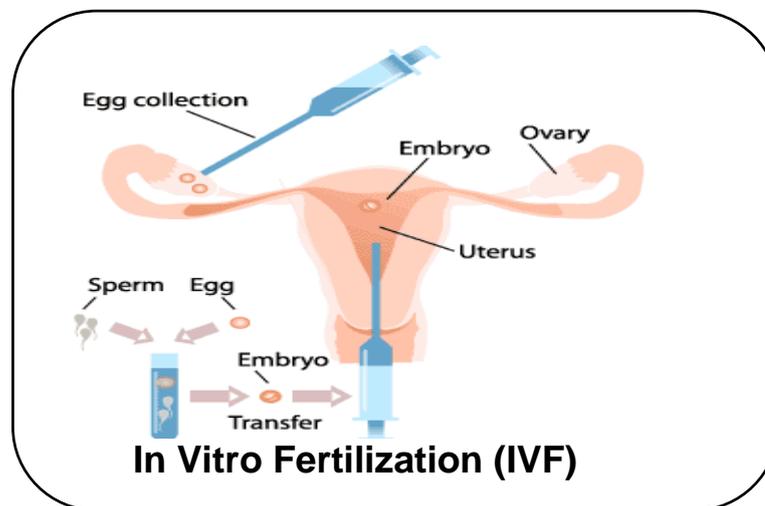


It may also result in serious social problems, as the possibility of ***incest*** may occur from possible future marriage between offspring of the same donor.

## II. In Vitro Fertilization (IVF)

It is a laboratory medical procedure in which fertilization of the ovum is induced outside the body of the individuals, i.e. in vitro; then the fertilized ovum is embedded in the uterus.

It is usually resorted to in cases of failure of normal fertilization of the ovum, i.e. due to female sterility of any cause rather than anovulation. In this case the semen is obtained from the husband and the ovum is that of his wife, it could be considered a legal procedure, otherwise it is illegal and against religions.



## III. Surrogate parenting (Third party):

The option exists of having another woman—a third party or surrogate—who bears a child for an infertile couple because of female reason. Surrogate parenting can be divided into two categories:

### 1. **Classic surrogacy :**

A classic surrogate is inseminated with sperm from the child's father. Her own egg is fertilized, and she carries the baby to term on behalf of the patient.

### 2. **Gestational surrogacy:**

It is also named “**IVF surrogacy**”. In this type, the baby may be conceived entirely by the intended parents-the biological mother's egg is

fertilized with the biological father's sperm-or by one or more donors. The embryo is then placed in the surrogate's uterus and carried to term.

Both types create great medico-legal dilemma. They are forbidden by religion and law and hence considered as illegal operation.

## ***MEDICO-LEGAL ASPECTS OF DELIVERY***

**The medico-legal expert may be asked to confirm or exclude delivery in certain conditions as:**

- 1. Inheritance:** wife alleges delivery to inherit a dead husband.
- 2. Infanticide:** when a mother is **accused** of killing her newly born infant.
- 3. Interchange of infants:** in the maternity hospitals.
- 4. Allegation of motherhood:** in case of stolen or purchased baby.

## **Diagnosis of Recent Delivery**

### **I. In a living female**

- i. **Consent** is mandatory before female examination.
- ii. **History**
- iii. **Clinical Examination:**
  - a. **General examination:**
    - 1-The woman is exhausted with rapid pulse and slightly elevated temperature.
    - 2- **Breasts:** Tender, firm with prominent surface veins. Engorgement with colostrum in the first 3 days after delivery, then milk secretion starts.
    - 3- **Abdomen:** lax, flabby with wrinkled skin and showing linea nigra and stria gravidarum (stretch marks).

### b. Local examination

- 1- **Vaginal discharge after delivery “Lochia”:** may be bloodstained for a few days and then brown for a week or more.
- 2- **Vulva and perineum** may show recent tears or bruises, episiotomy, ruptured posterior fourchette and dilatable elastic hymen after the first delivery.
- 3- **Cervix** is soft, dilated and may show recent lacerations.
  - It admits **2 fingers** at time of delivery,
  - **One finger** after 1 week later and
  - It is closed after **2 weeks** but **appears as transverse slit** that increase in size by increasing parity.
- 4- **Uterus:**
  - **At time of delivery:** the fundus is at or above the level of the umbilicus, then decreases gradually in size.
  - **Two weeks after delivery:** at the level of symphysis pubis and
  - **Sixth week after delivery:** regains the normal size of non-parous uterus.
- 5- **Pregnancy tests:** remain positive up to 2 weeks after delivery.

### II. In a dead female

Postmortem examination of the uterus for its weight, length and the placental disc size is mandatory as follows:

	Weight of uterus “ gm. “	Length of uterus “cm.”	Placental disc size “cm.”
Immediate after delivery	1000	25	10
1 week after delivery	500	15	6
2 weeks after delivery	375	12	4
6 weeks after delivery	100	8	0- 2

## Diagnosis of Old Delivery

### I- In the living:

#### i. **Clinical Examinations:**

##### a. **General Examination**

1- **Breast:** soft, lax and pendulous with large nipples and dark 2ry areola.

2-**Abdominal wall:** lax and shows linea nigra and striae albicans.

##### b. **Local Examination:**

1. **Perineum:** scars of old tears or episiotomy.

2. **Vagina:** lax and patulous.

3. **Cervix:** the external os is transverse (slit - like) with scars from old lacerations.

4. **Uterus:** increased size and length by clinical examination and ultrasonography.

### II. In the dead:

In addition to the examination of the living female, postmortem examination of the uterus may be of value in differentiation between multiparous and nulliparous uterus:

Item	Parous	Nulliparous
<b>Length of uterus</b>	3 inches	2 inches
<b>Length of body: cervix</b>	More than double	Less than double
<b>The uterine cavity</b>	Globular	Triangular
<b>The uterine wall</b>	Thin	Thick
<b>Placental site</b>	Pinched out up to 6 months	Absent.
<b>External cervical os</b>	Transverse slit with scar	Rounded narrow hole

## **MEDICO-LEGAL ASPECTS OF ABORTION**

### **Definition:**

Abortion is defined -from the legal point of view- as the termination of pregnancy before full term, either spontaneously or intentionally.

### **Medico-legal experts may have to diagnose abortion in a female in some conditions as:**

- 1. Death of a female** after abortion, commonly illegal abortion.
- 2. Alleging abortion following quarrels or traffic accidents:** for financial compensation.
- 3. Malpractice suit:** against a doctor if he prescribed a drug causing abortion.
- 4. A woman may try to conceal abortion after being charged with it.**

### **Types of abortion:**

**I- Spontaneous**

**II- Induced**

**a) Lawful (Legal or medical / therapeutic)**

**b) Illegal (Criminal)**

### **Spontaneous Abortion**

The pregnancy may terminate spontaneously without any medical or mechanical means. Another widely used term is miscarriage. It occurs in 10-25% of all pregnancies.

### **Causes of spontaneous abortion:**

- Maternal causes:
  - General causes: chronic uncontrolled diseases as diabetes mellitus, hypertension or hypothyroidism.
  - Local causes: uterine anomalies (infantile uterus or septate uterus), incompetent cervix, fibroid or uterine displacement.
- Fetal causes constitute the majority of the early abortion cases mostly due to chromosomal aberrations.
- Gestational causes as vesicular mole in early abortions, or hydramnios.

### Induced Abortion

- This refers to deliberate ending of a pregnancy by some sort of intervention.
- Types of Induced Abortion:
  1. **Legal or Therapeutic Abortion:**

**Definition:** induction of abortion on medical grounds for saving the mother's life.

**Indications:**

- **Maternal causes:** chronic diseases as advanced heart, renal, pulmonary diseases or malignancy especially hormone dependent.
- **Gestational causes** affecting the mother's life as eclampsia or hyperemesis gravidarum.

2. **Illegal or Criminal Abortion:**

**Definition:** induction of abortion for any reason other than saving mother's life as birth control or illegal pregnancy, ie. "*abortion on demand*".

In Egypt, it is illegal and not justified by neither the law nor the religion.

### Methods of Induction of Abortion

1. **General measures:** general violence as severe exercise, jumping from a height or carrying heavy weights. This may prove beneficial only in case of susceptible pregnancies.
2. **Local measures:** can be carried out through
  - a) **Nonprofessional personnel:** (The women by herself or lay abortionist).
    - i. **Foreign body insertion** commonly elm barks or knitting needle in lay people to cause rupture of the membranes and induce uterine contractions.
    - ii. **Poisons** as (lead, mercury, arsenic, potassium permanganate or capsicum) in a plug inserted vaginally to irritate the genital organs with reflex uterine contractions.

**b) Para- medical personnel:** (Nurses or midwives).

- i. Higginson syringe (widely used as a method of giving enema):** using irritant solution as glycerin, or soap to dislodge the sac from the uterine wall.
- ii. Lamicel rods** which are thin rods easily inserted in the cervical canal. They imbibe fluid and swell causing cervical dilatation and hence abortion occurs.
- iii. Plastic catheter insertion** in the uterus through the cervix.

**c) Professional physicians:**

**i. Intrauterine injection of hypertonic solution:**

This method is applied in 2<sup>nd</sup> trimester abortion. It is performed by removing the amniotic fluid through the abdominal wall using a long needle, and replacing it with a corresponding volume of hypertonic solution of saline or glucose. Abortion is expected 24-48 hours post injection.

- ii. Suction evacuation** through the cervix by using a large syringe with attached plastic cannula. This method is applied at early stage of pregnancy.
- iii. Dilatation & Curettage (D & C) operation.**
- iv. Hysterotomy** in late pregnancy.

**3. Abortifacient drugs:**

**i. Non-Specific drugs: reflex indirect action on the uterus**

- **Drastic purgatives** causing reflex uterine contractions from stimulated GIT movements.

**1. Castor & croton oil**

**2. Jalap root**

**3. colocynth**

- **Protoplasmic poisons** as lead, mercury and arsenic salts (no more used).

**ii. Specific drugs “ Ecboolic”:** specific direct action on the uterus

1. Oxytocin (posterior pituitary hormones)

2. Prostaglandins E and prostaglandins analogues as cytotec.

3. Progesterone antagonists as mifepristol.

## Diagnosis of Abortion

### I. In living female:

1. Consent is mandatory before female examination.
2. History: Amenorrhea, the date of the last menstrual period
3. Clinical examination:
  - i. *General examination*:
    - Probable signs of pregnancy and
    - Signs of general violence.
  - ii. *local signs*:
    - Cervix: marks of instruments, bleeding or dilated os.
    - Vagina: Irritation, laceration, embryonic tissues as placenta or embryo.
4. Laboratory Investigations:
  - Pregnancy test is positive up to 2 weeks after abortion.
  - Syphilis and diabetes.
  - Blood, urine and stools (abortifacient drugs).
5. Ultrasonography may be beneficial early after abortion to determine large size of the uterus or tissue remnants.
6. Products of abortion :
  - Precipitin test for products of abortion.
  - Age of the fetus is estimated and compared with the history.
  - Macerated fetus → intrauterine fetal death (no legal responsibility).

### II. In Dead female

There will be signs of abortion in the living; in addition PM examination may reveal the following:

- **Peritoneum**: evidences of peritonitis and perforated or ruptured uterus.
- **G.I.T**: irritation due to purgatives.
- **Vagina**: congestion, bruises or foreign body.
- **Uterus**: perforations and hematomas
- **Cervix**: bruises and marks of instruments as vulsellum.
- **Search for the mechanism of death as embolism.**

### Causes of Ruptured Uterus

1. **Diseases:** e.g., choriocarcinoma.
2. **Difficult labor:** The rupture is transverse and present in the lower segment.
3. **Trauma:**
  - Due to a sound: in fundus.
  - Due to faulty application of forceps: The rupture is longitudinal and present in the cervix.
  - Due to external trauma (kick to the abdomen).

### Mechanism of Deaths Related to Abortion

**Complications and deaths related to abortion depend to a great extent on the applied method, the circumstances (theatre, hygiene, instruments) and the operator skills.**

#### 1. Shock:

##### a. Sympathetic due to

- i. Severe pain if no anesthesia is used.
- ii. Perforation of the uterus or vagina “common complication in illegal abortion”.

##### b. Parasympathetic due to

- i. Rapid dilation of the cervix without proper premedication and anesthesia.
- ii. Rough instrumentation during the D&C operation.

#### 2. Hemorrhage

- a. **Primary hemorrhage** at time of the operation due to perforation of uterus, or injury of vaginal wall.
- b. **Secondary hemorrhage** 24hours after the operation mostly due to infection and retained remnants in the uterus.

#### 3. Infection

It is a common complication in illegal operation due to improper sterilization.

#### 4. Embolism:

- a. **Air embolism** may occur during the use of **Higginson syringe** due to air passed through the uterine veins to Rt. Heart during douching or flushing the uterus.

- b. **Amniotic embolism** during severe uterine contractions in late abortion. Amniotic fluid containing vernix and fat can pass through opened veins to the lungs and cardiac vessels.
5. **Disseminated intravascular coagulopathy “DIC”**: with severe post- abortion bleeding.
6. **Complications of anesthesia.**
7. **Acute Poisoning**: Due to either large doses of drug or systemic absorption of local toxic plugs.

### The Legal Role of the Physician in Abortion

- The right of life to the fetus exists from the moment of fertilization and protected by legal coverage.
- To avoid a charge by committing illegal abortion a physician has to guard against through certain measures in case of therapeutic abortion:
  1. **Consent**: written consent should be signed from the patient and husband.
  2. **Consultation** of two specialist for the reason of abortion with documentation
  3. Abortion operation should be done in a licensed, well equipped **hospital**.
- However, in emergency cases to save the mother's life or to prevent grave permanent harm to the mother, the abortion may be carried out on the certification of only one medical practitioner.
- The medical practitioner should never use a uterine sound or perform IUD (intrauterine device) insertion except after confirming that the patient is not pregnant.
- In cases, where illegal abortion is proved to be done by a doctor, it is considered as professional offence; even with the presence of the woman's consent.

## Chapter (16)

# SUSPICIOUS INFANT DEATHS

### **ILOS:**

- *To know causes of infants' mortalities.*
- *To identify medico-legal frame of infant murder.*
- *To differentiate live-birth from still birth infants.*
- *To identify signs of viability and that of maturity in infants.*
- *To estimate period of survival in infanticide cases.*

### **Causes of death in infancy:**

- I. Natural & Accidental Causes.**
- II. Acts of Omission (Negligence).**
- III. Acts of Commission (Infanticide).**
- IV. Sudden Infant Death Syndrome (SIDS).**

### ***I. Natural & Accidental Causes***

#### **This includes:**

- Immaturity.
- Congenital anomalies.
- Asphyxia: cord prolapse, suffocation by inhaled mucous or accidental strangulation by the umbilical cord (D.D. Homicidal strangulation).
- Birth injury, especially subdural hemorrhage.
- Difficult or pericipitate labour (D.D. Homicidal head injuries).
- Rh Incompatibility (erythroblastosis foetalis).
- Congenital syphilis.
- Infections, e.g. acute pyogenic or viral infections & toxoplasmosis.

### ***II. Acts of Omission (Negligence)***

#### **This includes:**

- Neglecting feeding or clothing,
- Non- tying of the umbilical cord leads to septic complications but not hemorrhage as the umbilical vessels reflexly contract on respiration.

### **III. Acts of Commission (Infanticide)**

#### **Definitions:**

Infanticide is the act of killing a live-born, viable infant (below 2 years age). Yet, the majority of infanticides occur within hours or even minutes of birth which is best described as "**Neonaticide**" (during the first 14 days after birth).

The assailant is usually the mother and the victim is her illegitimate infant, but still there are various forms of non-maternal infanticide.

#### **NB.**

- **Live birth:** infant shows signs of life.
- **Stillbirth:** infant who did not -at any time after being completely expelled from the mother- breathe or show any other sign of life; hence **no charge of murder**.
- **Viable infant:** its age is more than 7 months of gestation (intra-uterine life) (28) weeks.  
If the fetus is less than 7 IU months, it is not viable and there is **no charge of murder**.

#### **The report on the dead neonate or infant should include:**

- A. Identification of the Infant.
- B. Signs of live-birth.
- C. The period of survival of the infant.
- D. Method of applied violence.
- E. Estimation of P.M. Interval.

### **A. Identification of the Infant**

1. **Date & place of discovery.**
2. **Description of everything that is related of the baby:** clothes, wrappings & any initials on them, ligatures that may be tied round the neck and any article found with the body.
3. **Examination of infant's body:** color of skin & hair, weight, length, blood group, manner of cutting the umbilical cord, birth mark or congenital anomaly, etc.
4. **Identification of the Intra uterine age of the infant:** (see pregnancy).

## B. Signs of Live- Birth

### A. Non- medical evidence:

Witnesses that infant showed signs of life (move, cry or show pulsating cord).

### B. Medical Evidence:

#### I) External signs:

1. Changes around umbilical cord base:
  - 1 day after birth → ring of hyperemia.
  - 2 days after birth → ring of ulceration.
  - 1 week after birth → stump falls "raw area".
  - 2 weeks after birth → healed wound (umbilicus is formed).
2. Desquamation of skin:
  - Starts in the trunk 2 days after birth.
  - Completed after 2 weeks.
3. Ante-mortem injury: may be due to delivery or the cause of death.
4. Yellowish well-formed stools, D.D. meconium (greenish black fluid) that may be expelled out in stillbirth.
5. Absence of maceration.

#### II) Internal signs:

##### 1. Signs of respiration:

##### a) Lung evidences of respiration:

Test	Respired Lungs	Non-respired lungs
<b>1. Macroscopic</b>		
Size	Voluminous, filling the thoracic cage & covering the heart and thymus.	Small, not filling the thoracic cage & not covering the heart and thymus.
Edges	rounded	sharp
Color	mottled pink with mosaic appearance	diffuse purple color
Consistency	Crepitate	firm
<b>2. Microscopic</b>		
Alveoli	distended	collapsed
Lining epithelium	flattened	cuboidal or columnar
<b>3. Static "Fodere's" test</b>		
Weight of lungs	80 grams 1/40 of fetal B.WT.	40 grams 1/80 of fetal B.WT.
<b>4. Hydrostatic test</b>		
Floatation	Positive	Negative

## Hydrostatic "Floatation" test of lungs:

### *Principle:*

Alveolar inflation with air lowers the specific gravity and allows floatation in water.

### *Procedure:*

- The test is done by putting the whole chest contents (the lungs with heart as one mass) in a container of water; and observed for floatation.
- Then the 2 lungs are separated and every lung is divided into small pieces; and they are put into a container of water while observing their floatation.
- If lung pieces float, some of the floating pieces must be squeezed; and then they are put again in water, observing their floatation.

### *Results Interpretations:*

- All parts sink → no respiration → evidence of still-birth.
- All parts float → full respiration → evidence of live-birth.
- All parts float but some small pieces sink → partial floatation → not an evidence of live-birth.

### *Pitfalls of the test:*

- Non- respired lungs may partially float due to either:
  - Putrefaction: characteristic foul smell is diagnostic. Also, putrefactive gases collect under the pleura and so expelled by pressure leading to failure of floatation after exposure to pressure.
  - Artificial inflation: This may result from attempts to resuscitate a still-born fetus or to allege that the fetus is borne alive in case of inheritance.
- Respired lungs may sink due to:
  - Diseases e.g. atelectasis or pneumonia. These pathological cases could be detected by microscopic examination.
  - Vagitus uterinus or vagitus vaginalis:  
It means that the infant had respired (partially), inside the uterus or the vagina. It may occur due to delayed expulsion of the fetal body after protrusion of his head; but under these circumstances, it is difficult to the child to take deep inspiration, so there will be only partial respiration.

**b) GIT evidences of respiration:**

Air swallowed during respiration can be detected by:

1. X-ray: shows air bubbles in the gut.
2. Stomach-bowel floatation test:

*Procedure:*

Put the gut parts into a water basin after being ligated at both ends and separated as closed lumen (to prevent air escape).

*Results:*

- Stomach floats → evidence of respiration.
- Stomach & upper gut float → evidence of 3 hours survival.
- All parts float → evidence of 6 hours survival.

*Pitfalls of the test:*

The stomach and bowel may float if putrefaction occurs and bullea of gases are seen in the gut wall.

**2. Sings of feeding:**

- a. In stomach → colostrum or digested milk.
- b. In intestine → well-formed stools.

**3. Cardio-vascular changes:**

- a. Umbilical vessels:
  - 2days → shrunken & filled with clots.
  - 1week → clot starts organization.
  - 2weeks → complete organization.
  - 4weeks → fibrous cord → ligamentum teres.
- b. Foramen ovale:
  - Complete closure after 7days.
  - May remain patent → patent foramen ovale.
- c. Ductus arteriosus:
  - Functional closure by reflex spasm after respiration within 6 hours.
  - Actual obliteration after 6 weeks → ligamentum arteriosum.
  - It may remain patent → patent ductus arteriosus.

***C. The period of survival of the infant***

It could be estimated from:

1. Changes around the base of the umbilical cord.
2. Desquamation of the skin.
3. A.M. wound showing vital reaction.

4. Flootation of stomach and intestine.
5. Changes in umbilical vessels.
6. Closure of foramen ovale.
7. Closure of ductus arteriosus.

### ***D. Methods of applied violence***

Any type of violence could be applied; e.g.:

Smothering, throttling, strangulation, drowning, choking, cut throat, head injuries or poisoning.

#### **D.D. between homicidal & accidental strangulation by cord:**

	<b>Homicidal</b>	<b>Accidental</b>
<b>Cord turns on neck</b>	More than one	Usually one
<b>Wharton's jelly</b>	Displaced	Not
<b>Cut section of the cord</b>	Flattened at sites of knot or stretch	Rounded all through
<b>Abrasions &amp; bruises</b>	Present	Absent
<b>Constriction marks</b>	Deep	Not deep (shallow)

#### **D.D. between head injuries in different delivery types:**

	<b>Precipitate delivery</b>	<b>Difficult delivery</b>	<b>Forceps delivery</b>	<b>Head injury</b>
<b>1.Mother</b>	Multipara	Primipara	May be primipara	May be primipara
<b>2.Disproportion</b>	Absent	Present	Present	-----
<b>3.Umbilical cord</b>	torn	cut	cut	cut
<b>4. Caput succedaneum</b>	Absent	Present	Present	-----
<b>5.Scalp</b>	Contusions	edema	Contused wounds	Contused wounds
<b>6.Site of fracture</b>	frontal or parietal	at the area of caput	Bilateral on opposite sides	Any site
<b>7.Type of fracture</b>	Fissure (polar)	Fissure	Depressed, taking the shape of the blades of the forceps	Any type

### ***E. Estimation of P.M. Interval***

Time passed since death is estimated as from postmortem changes, with some special considerations regarding infant deaths:

- Cooling is rapid because of the large body surface area with respect to mass.
- Rigor mortis in the newborn is transitory with rapid onset and offset due to undeveloped musculature.
- Putrefaction is delayed due to the relative absence of micro-organisms in the infant's bowel.

## **IV. SUDDEN INFANT DEATH SYNDROME (SIDS)**

### **Definition:**

It is sudden and unexpected death of an infant in apparent good health; without revealing a commonly accepted cause of death in autopsy.

Death occurs in silence during deep sleep without cry and hence known as "Cot Death".

**The actual cause of the condition is not identified but many suggestions have been made:**

1. Allergy to milk proteins.
2. Fulminating viral infections.
3. Abnormality of cardiac conducting tissue.
4. Malfunctioning respiratory reflexes.
5. Hypernatremia from incorrectly prepared food.
6. Neurological damage caused by minor birth trauma.
7. Hypothermia or hyperthermia.
8. Idiopathic apnea.
9. Inborn metabolic error.

### **Features of the syndrome:**

The following are the main features of the syndrome:

1. Age range between 2 weeks and 2 years, with a peak at 2 to 3 months.
2. Slight preponderance of males.
3. More common in Negroes.
4. The incidence is greater in one of twin pair whether identical or not (due to great incidence of prematurity and low body weight among twins).
5. More common in cold and wet weather.
6. Higher incidence with poor housing and low occupational status.

## Chapter (17)

# DOMESTIC VIOLENCE

### *ILOS:*

- *To recognize medico-legal aspects of domestic violence.*
- *To identify and properly diagnose cases of abuse.*
- *To participate in helping and protecting victims.*

Domestic abuse or violence refers to mal-treatment by a family member, care-giver or intimate partner.

The main victims of this type of violence are children, wives and the elderly. Victimization may extend to servants at home, students by teachers, or disabled by nursing staff.

**Domestic violence, usually involves one or more of the following elements;**

### **A- Acts of commission:**

1. **Physical injuries** of varying types, ages and etiology.
2. **Sexual offences;** any form of forced sexual activity, as incest, harassment, pedophilia, sodomy,...etc.
3. **Emotional violence,** as verbal insults, discrimination, threats, rejection, disgust and isolation. It can also include inflicting physical injury onto other targets, such as children or pets, in order to cause psychological harm to the victim.
4. **Economic abuse,** by financial exploitation.

### **B- Acts of omission:**

Neglect, by deprivation of essentials of life as food, drink, medical care, shelter, warmth, clothing and/or personal hygiene.

### MLI of Domestic Violence:

- Detection of domestic abuse is not easy as; many victims fail to seek medical care and attention for their sufferings. When they do, the reported history of injury may hide what actually happened.
- Also, domestic violence constitutes a major problem as deaths do occur to victims of abuse, and occasionally to perpetrators, who may be killed in self-defense or as revenge for past attacks.

## CHILD ABUSE

### Definition:

Child abuse refers to repeated willful mal-treatment of a child by inadequate adult in place of responsibility (parents, guardian, observer or any care giver).

### Predisposing Characters:

- **Characters of the family:**
  1. Low educational level.
  2. Low socioeconomic standard.
  3. Increased stressful life events.
- **Characters of the parents:**
  1. Young age (teenagers).
  2. Single parent.
  3. Emotionally immature and aggressive.
  4. Psychological health impacts.
  5. Alcohol or drug abuse.
  6. Criminal background.
  7. Personal history of being abused during their childhood (20 times more than non- abused).
- **Characters of the child:**
  1. Age: 1-3 years.
  2. First born child is more often affected.
  3. Unwanted child (illegal/orphan/on contraception/undesired sex).
  4. Annoying, hyperactive or disabled child.

### Types of child abuse:

- I. **Acts of commission:** Physical, sexual and emotional abuse.
- II. **Acts of omission:** Neglect.

## Physical Child Abuse

### *“Battered Baby Syndrome”*

#### **Definition:**

These are injuries detected on the general examination of a child resulting from physical aggression.

#### **Indicators of Abuse:**

##### **1-History**

- a) The history offered does not adequately explain the injury with regard to its nature, age, distribution or severity.
- b) The notifying adult changes the history over time.
- c) Discrepancy between the stories of the child and that of the accompanying adults.

##### **2-Injuries**

- a) There are multiple injuries of various types and different ages.
- b) The injuries are often symmetrical (e.g. involve either hands or feet).
- c) Injuries are found in areas typically used for punishment (e.g. buttocks, head, face and limbs).

##### **3-Significant delay** in seeking medical care.

#### **Methods of violence application:**

- Direct manual violence is the commonest method of injury.
- Simple instruments may be used as spoons, bottles, cigarettes, belts, etc...

#### **Physical Injuries typically present in child abuse:**

Physical injuries usually tell the story that the child cannot tell, being too young or too frightened. He may suffer one or more of the following injuries.

- Skin and soft tissue injuries: abrasions, bruises & lacerations.
- Oral injuries.
- Eye injuries.
- Head injuries.
- Visceral injuries.
- Skeletal injuries.
- Thermal injuries.
- Poisoning.
- Asphyxia.

## ***Skin & soft tissue injuries***

### **1. Bruises & abrasions**

- **Bite marks, pinch bruises or parallel linear bruises** are commonly detected.
- **Friction burns** of chin, cheeks or nose.

#### **D.D.**

- Hemorrhagic blood diseases.
- Mongolian spot: area of hyperpigmented skin in lumbosacral region in some infants.

### **2. Lacerated, incised or stab wounds are rare.**

## ***Oral injuries***

- Lip bruises or abrasions due to blowing the face.
- Lip lacerations by crushing against the teeth.
- **Tearing of the lip frenulum**  characteristic. It may occur due to either forcible pushing of feeding bottle or tangential blows across the mouth.
- Broken or lost tooth by punching the face.

## ***Eye injuries***

**Common in 70% of battered children.**

### **1. Black eye.**

It may result from:

- Direct violence to the eye globe.
- Gravitation from bruises of the forehead.

### **2. Subconjunctival hemorrhage.**

### **3. Lens dislocation.**

### **4. Retinal hemorrhage or detachment.**

It may result from:

- Head trauma.
- Sudden chest compression.

## ***Head injuries***

- It is the major cause of **fatal outcome** after physical abuse.
- Between 40 -70% of battered children have injuries of some form to the face or scalp.

### Two major categories of head injuries are described:

- **Focal injuries:** punches, hitting the head from throwing or swinging the child on to or against a blunt object or surface.
- **Diffuse injuries (acceleration / deceleration)→Shaken Baby Syndrome:**
  - It is a well-recognized clinical syndrome caused by violent shaking of young infants, usually to stop them from crying.
  - This causes **bleeding into the subdural space, retinal hemorrhage**, there may be no bruising or other injury to the baby.

### Commonest head injuries:

- **Scalp bruises.**
- **Subgaleal hematoma:**  It is formed if there is a skull fracture or in case of **hair pulling**. The swelling is diffuse and boggy. Hairs are broken occasionally with petechia detected around the hair roots.
- **Subdural hematoma:**
  - It is the commonest immediate cause of death.

## Visceral Injuries

Fatal injuries that occur in elder children subjected to abdominal violence, eg. Kicks, which may result in:

- Laceration of solid organs: liver and spleen.
- Rupture of hollow viscus: mesenteric vessels and intestine.

## Skeletal injuries

### Fracture Types in cases of Child Abuse:

#### •Highly Specific Sites:

- Epiphysal fractures: **Corner fracture or Bucket handle fracture.** 
- Rib fractures, especially posteriorly.
- Scapular fractures.
- Spinous process fractures.
- Sternal fractures.

#### •Moderate Specific Sites:

- Epiphyseal separation (Partial or complete).

- Vertebral body fractures.
- Digital fractures.

### •Low Specific Sites

- Clavicular fractures.
- Diaphysial fractures eg. spiral or transverse (highly frequent).
- Linear skull fractures.

**N.B. Kaffey's Syndrome** is characterized by combined head and bone injuries → chronic subdural hematoma and multiple long bone fractures. 

### Differential diagnosis:

#### 1. Normal variants

Unusual suture lines in a skull radiograph could be a normal variant.

#### 2. Birth trauma

During breech delivery the clavicle and the humerus are often broken.

#### 3. Bone diseases

- Osteogenesis imperfecta.
- Infantile cortical hyperostosis. 
- Paget's disease.

## ***Thermal injuries***

### 1. Scalds

Hot fluids are commonly used through: 

- Immersion,
- Splashing,
- Running tap water.

### **Characteristic signs of abusive scalds caused by hot immersion**

- **Doughnut Sign:**

This occurs when the child is forcefully immersed in a bath of hot water. The bottom of the buttocks is spared (being in direct contact with the bath and protected from the water), while the surrounded circumferential area of skin is scalded; looking like a doughnut hole.

- **Zebra Sign:**

The bottom of skin folds in the groin, knees or other areas may not be affected when the surrounding body part is immersed in hot water. This occurs due to reflex flexion of hip and knees as a withdrawal attitude; that subsequently results in linear areas of normal skin resembling the stripes of a zebra within larger areas of scalded skin.

- **Stocking and Glove:**

This variant of the immersion injury involves the hands or feet. The entire hand or foot is scalded circumferentially with a clearly defined upper limit of demarcation.

## 2. **Dry Burn**

- They are caused by hot objects usually metallic (fork/knife/scissors) → sharply demarcated marks (***contact imprints***) taking the shape of the used object. They tend to form thick scars.
- Cigarette burns are very common. They leave a circular mark and a tail if the cigarette is brushed against the skin.

## ***Poisoning***

- Drug and alcohol abuse during pregnancy or lactation can be harmful to the child, eg. "***Fetal Alcohol Syndrome***" (See *chronic alcoholism*).
- Applying insecticides directly on the scalp of the child as a method for combating pediculosis.
- Misuse of medicinal drugs to control crying or hyperactive children, eg. Spasmolytic with hypnotic preparations and antitussive drugs.

## ***Asphyxia***

Asphyxia is uncommon but a serious form of child abuse, if the period of brain hypoxia is prolonged permanent brain damage or death may result.

The commonest method for inducing asphyxia is by smothering. The abuser is usually the mother, using a pillow or a pad or pressing the child's face against her breasts.

## **Munchausen Syndrome by Proxy “MSbP”**



- In MSbP, an adult caregiver (typically the mother), makes a child appear sick by either fabricating symptoms or actually causing harm to the child (poisoning, suffocation, infection or physical injury), in order to gain the attention of medical providers and others.
- The adult care provider who is abusing the child often seems comfortable and not upset over the child's hospitalization.
- When parental visits are allowed, sometimes there is a disastrous outcome for the child. Therefore, medical professionals need to monitor the caregiver's visits in order to prevent any attempt to worsen the condition of the child.
- MSbP perpetrators are known to switch medical providers frequently, until they find one that is willing to meet their level of need. Even when the child is removed from their care, the perpetrator may turn their attention to another child: a sibling or other child in the family.
- Mothers who have had multiple children die from “SIDS” have been declared to have MSbP until proved otherwise.

## **Child Sexual abuse “Pedophilia”**

### **Definition:**

Child sexual abuse "**CSA**" can be defined as any use of children for sexual gratification of adults.

### **The offender is commonly a known character to the victim, eg:**

- Relatives: fathers, brothers,,.....
- Childcare professionals or babysitters.
- Teachers or athletic coaches.
- Neighbors or friends.

### **Forms of "CSA":**

- Violations of bodily privacy.
- Exposing children to adult sexuality.
- Child pornography.
- Child prostitution.
- Sexual acts with a child: incest, rape, oral sex or sodomy.

**Alarming Behavioral Clues in CSA:**

- Inappropriate interest or knowledge to sexual affairs.
- Reluctance or refusal to undress in front of others.
- Extra aggression or extra compliance.
- Unjustified fear of a particular person or family member.
- Withdrawal from the family and the entire society.

**Signs of sexual connection in a child:****➤ Signs of intercrural connection:**

- Bruising of the perineum may occur.
- The rounded labial contour may be flattened.
- Splitting of the posterior fourchette with subsequent scar.
- Hymen tears/attenuation.
- Pregnancy.
- Sexually transmitted infections.

**➤ Signs of anal connection****Acute Findings:**

- Hyperemia, swelling & tenderness of the skin around the anal verge.
- Perianal bruising or bleeding.
- Acute anal fissures.
- Dilated anal orifice with prolapsed mucosa.
- Presence of semen.
- Evidence of lubricants.

**Chronic Findings:**

- Destruction of external anal sphincter and loss of radiating corrugations.
- Abnormal anal patency (funneled anal canal).
- Deep fissures crossing the anal skin margin.
- Anal scars.
- Anal warts.

***Female Genital Mutilation “FGM”***

- FGM is a frank picture of female child abuse that is practiced widely in Egypt in spite of being illegal.
- The procedure refers to partial or total removal of the female external genitalia or other injury to the female genital organs for cultural or other non-therapeutic reasons.
- The procedure has severe bad effects on victims; physical, psychological and sexual. The girls are deceived, assaulted,

chased and violently forced to have their genitals mutilated. They may be misinformed, and misled to the imminent danger of circumcision.

- This practice should be considered legally as ***permanent infirmity***.

### ***Emotional Child Abuse***

Emotional child abuse refers to habitual harassment of a child by criticism, threats, insults or ridicule.

#### **Examples of emotional child abuse:**

- Yelling or screaming.
- Negative comparisons to others.
- Shaming, humiliating, or stigmatization.
- Threatening or frightening.
- Using extreme forms of punishment, such as confinement to a closet or dark room, tying to a chair for long periods of time.
- Witnessing the physical abuse of others.
- Child labor.
- Child kidnapping and parental child abduction.

### ***Neglect***

This comprises a lack of physical and emotional care-taking and supervision as well as failure to meet the developmental needs of the child.

#### **Examples of Neglect:**

- Failure to provide:
  - a) Adequate food,
  - b) Clothing,
  - c) Hygiene,
  - d) Health care or
  - e) Safe environment.
- Depriving the child from education.
- Delay in providing necessary psychological care.

## Sequalea of Child Abuse and Neglect

Infants	Children	Adolescent
<ul style="list-style-type: none"> <li>• Failure to thrive.</li> <li>• Disturbed psychomotor skills.</li> <li>• Recurrent infections and nappy rash.</li> </ul>	<ul style="list-style-type: none"> <li>• Poor growth rate.</li> <li>• Poor hygiene and appearance.</li> <li>• Learning difficulties.</li> <li>• Unusual patterns of defecation or urination.</li> <li>• Speech disorders.</li> <li>• Habit disorders like thumb suckling.</li> <li>• Eating disorders.</li> <li>• Nightmares and flashbacks.</li> </ul>	<p>Girls are more likely to be victims more than boys.</p> <ul style="list-style-type: none"> <li>• Drug and alcohol misuse.</li> <li>• Suicidal attempts.</li> <li>• Promiscuity and delinquency.</li> <li>• Abuse of others.</li> </ul>

## Role of physicians in child abuse

- Physicians are mandated to file a report in suspicious cases of abuse.
- Physicians should also report such cases to Child Protective Services.
- In fatal cases autopsy and postmortem skeletal survey are recommended.

## Female Abuse

The use of violence against women (wife, daughter, mother or servant) is still rife in some cultures and even accepted socially.

**Battered Wife:** is the one who suffers demonstrable and repeated injuries at the hand of her husband or x-husband.

### **These injuries may include:**

- Multiple bruises and abrasions and sometimes lacerations or fractures in exposed parts as face and limbs and/or covered organs as breasts, buttocks, or external genitalia.
- Abortion and miscarriage may occur in pregnant wives.
- Other forms of mal-treatment as verbal insults, stigmatization, rejection and economic abuse may also be included.

- Long term effects as abused women usually suffer post-traumatic stress-syndrome (PTSS) with difficulties of perception, memory and motor functions.

#### **Reaction of women towards abuse:**

- Women are often reluctant to notify their personal problems for fear of shame and disgrace.
- Some prefer just to leave home, whilst others indulge in self-hurt, poisoning or attempted suicide.
- The condition may only come to light when the victim requires medical treatment or dies under suspicious circumstances.

#### **Role of the physician:**

- Health care providers should encourage female victims to express their sufferings and may ask directly about being abused.
- Injuries should be recorded, followed up and notified to authorities after “**victim’s consent**”, if it appears serious or endangers woman’s life.

## **Elder Abuse and Neglect**

The abuse of the elderly (65 years and over) has emerged as a recognizable problem, due to increasing number of elders with the advance of medical care.

#### **Elder abuse includes:**

- Domestic abuse: by family members.
- Institutional abuse: by care givers in residential facility.
- Self-abuse or self-neglect: by refusal of basic needs, as food, drink, medical care, self-hygiene, warmth or shelter.

Elders are neglected, often insulted and occasionally battered. Also they may be the victims of sexual or economic abuse.

In cases **physical elder abuse**, it is difficult to differentiate between accidental and intentional injuries, as the most trivial trauma to the elderly may result into severe bruising, subdural hematoma, fracture of neck of femur, etc..

**Economic abuse;** may involve hastening the death of the elderly especially with the presence of financial benefits as expected inheritance of a property, insurance claims, etc..

## Chapter (18)

# MEDICAL ETHICS & MALPRACTICE

### قسم الأطباء في جمهورية مصر العربية

#### مادة (1) من لائحة آداب المهنة في جمهورية مصر العربية

أن مهنة الطب تميزت منذ فجر التاريخ بتقاليد كريمة وميثاق شرف وقسم جرى العرف على أن يؤديه الطبيب الجديد قبل ان يبدأ مزاوله المهنة . واستمرارا لهذا التقليد فأنه يجب على كل طبيب قبل مزاولته المهنة أن يؤدي القسم التالي أمام نقيب الأطباء أو من ينوب عنه :-

" أقسم بالله العظيم أن أراقب الله في مهنتي ، وأن أصون حياة الإنسان في كافة أدوارها في كل الظروف والأحوال ، وأن أكون على الدوام من وسائل رحمة الله بآذانه ، وأن أوقر من علمي وأعلم من يصغرنى ، وأكون أخل لكل زميل في المهنة الطبية متعاونين على البر والتقوى ، وأن تكون حياتي مصداق إيماني في سرى وعلانيتي نقيه مما يشينها تجاه الله ورسله والمؤمنين ، والله على ما أقول شهيد."

### *Principles of Biomedical Ethics*

- I. **Principle of Autonomy:** this refers to respect the patient's right to refuse or accept the proposed treatment (**Free decision**).
- II. **Principle of Beneficence:** This denotes that the practitioner should act in the best interest of the patient (**Benefits for the patient**).
- III. **Principle of Non-maleficence:** this is the duty of the physician to avoid inflicting physical or emotional harm on the patient (**Do no harm**).
- IV. **Principle of Justice:** This is concerning about fairness in the distribution of medical services. This requires that doctors should treat all patients equally irrespective of race, gender, color and ethnic background (**Equality of treatment**).

### What are medical ethics?

They refer to the rules of professional etiquette and regulations that represent the minimum requirements in professional medical practice.

They basically involve 3 main domains:

- Physician - patient relationship.
- Physician - physician relationship.
- Physician - society relationship.

## ***Physician Patient Relationship***

- Physicians must know that they are in a position of trust and confidence of the patient and his family.
- A medical man is responsible towards his patient as soon as he agrees to examine him; he must give him the best of care.
- If the physician knows that he cannot accomplish a cure, he must refer the patient to another specialist.
- A physician is not required by law to accept any patient; he may refuse the treatment of a patient in cold cases and in presence of other equivalent colleague. However, he cannot refuse examining the patient in emergency situations.
- Once the relation of physician and patient is established, the physician is not allowed to refuse the case unless his services are no longer required. **The main ethical and legal issues in physician-patient transaction include:**

### **Consent:**

- This refers to the agreement of the person about any medical interference including examination, investigation and treatment after being fully informed about the potential benefits and risks of his choice.
- Any physical examination or surgical operation without permission or consent of the patient is considered an assault. This rule is subjected to exception in case of ***emergency life-saving measures***. However, considering the consent of relatives in such cases is a matter of good clinical practice.

### **Forms of consent:**

#### **1- Implied consent:**

- Most of the medical practice conducted under the principle of "implied consent", where simply the fact that a person has presented at doctor's clinic to be examined, or asks the doctor to visit him, implies that he is willing to undergo clinical examination.
- Implied consent covers ***only*** basic clinical methods of examination, such as history taking, observation, palpation and auscultation, etc.

#### **2- Express consent: (Informed Consent)**

- This is required when complex medical procedures are concerned, more specific permission (either, oral or written) must be obtained from the patient or his guardian (if lacking decisional capacity) after

- explaining what is to be done and why in terms which the person can understand, this being called "express consent".
- Intimate examinations such as vaginal and rectal examination or invasive examination such as venepuncture necessitates express consent.
  - Express consent may often be obtained in writing, but this is not a legal requirement and a written consent is not more valid than verbal one. However, written consent is much easier to prove at a later date.
  - Ideally, oral or written consent should be witnessed by another person (doctor's secretary or assistant, a nurse etc.), who should also sign any document.
  - Written consent is necessary in:
    - Surgical operations,
    - Complex invasive diagnostic procedures requiring anaesthesia as endoscopy or diagnostic cardiac catheterization,
    - Termination of pregnancy or
    - Examination of persons in custody at the request of the police.
  - A written consent must be informative including the information necessary about the nature of the procedure and the expected side-effects or hazards.
- **The consent is considered illegal or invalid when:**
    - 1- It includes **unlawful operation**: illegal abortion or artificial insemination heterologous or unnecessary operation.
    - 2- When the operation has **no medical indication**, as a person ask the surgeon to amputate his finger to be unfit for military service.
    - 3- It is taken by **fraud or misrepresentation** of the operation: To tell the patient that an operation is necessary to save life or to preserve health when that is not the case.
    - 4- The consent was given by one who had **no legal capacity** to give it, e.g. a minor (below the legal age for consent, in Egypt the legal age for consent is **18 years**) or mentally ill.
    - 5- It is **not an informed** consent.

## **B. Professional Secrecy:**

- Physicians have no right to disclose any secret concerning their patients,
- Publication of patients' name or photographs in scientific journals is considered a disclosure of secrecy.
- Medical men must keep the professional secrecy. The hospital papers, prescriptions, and laboratory reports must be kept away from non-responsible persons
- However, ***disclosure of professional secrecy*** is permitted in the following conditions:
  1. **On the request of the patient** himself or his guardian, if he asks for a certificate.
  2. **For the sake of the patient**, the nature of the disease is told to his guardian to take care of him, e.g. epilepsy or mental disorders.
  3. **For the sake of the public**, to protect the community from dangerous diseases or crimes:
    - a. Highly infectious and quarantinable diseases.
    - b. Illegal procedures as illegal abortion.
    - c. Suspected crimes as stab or gunshot wounds.
    - d. Births and deaths.
  4. **For the sake of the doctor**, when he is accused of malpractice, he may divulge a professional secret of his patient to explain to the court that the complications occur to his patient are not due to malpractice.
  5. **In cases of expert witnesses**, as in case of medico-legal expert, who disclose to the court all what he find from his examination of the person.
  6. **To other doctors:** a doctor can disclose the medical facts of a case with other doctors, and non-medical health staff, such as physiotherapists, radiologists, nurses, etc.

## **C. Medical Certificates:**

- Medical practitioners are allowed to give medical certificates or reports, to their patients or their guardians, regarding their medical conditions on their own request.
- The certificate must include correct and true data.

- Writing false data or taking fees in return are considered malpractice.
- In case of certificates for age estimation, a recent photograph and fingerprints of the examined person should be obtained to avoid impersonation.
- Medical certificate should be associated with “The Medical Syndicate stamp”.

### ***Physician- Physician Relationship***

A sufficient degree of mutual respect between colleagues is required, which means that the physician is **NOT ALLOWED** to do any of the followings:

- **Criticizing** the treatment of colleagues.
- **Refusing to attend and treat** a colleague or any of his relatives to whom he is responsible.
- **Accepting any fees** for the treatment of a colleague or any of his relatives to whom he is responsible, but in case of radiological work or laboratory analysis he may accept the actual cost of the used materials only.
- **Replacing** another colleague in the treatment of a patient.
- **Asking for percentage** of fees for referral to other colleagues is misconduct (***Dichotomy***).

### ***Physician - Society Relationship***

**Prior to professional medical practice physicians must fulfill the followings:**

- **Registration** in the Ministry of Health & the Medical Syndicate.
- **Obtaining the License for medical practice** from the Medical Syndicate.

**Erasure of registration is possible in:**

- Discontinuity of practice medicine or death.
- Conviction of misconduct, malpractice or criminal offence by the disciplinary committees of syndicate.
- Refraining of paying the annual subscriptions.

**NB.** Restoration of registration is possible after 2 years at least.

**Medical practitioner is not allowed to:**

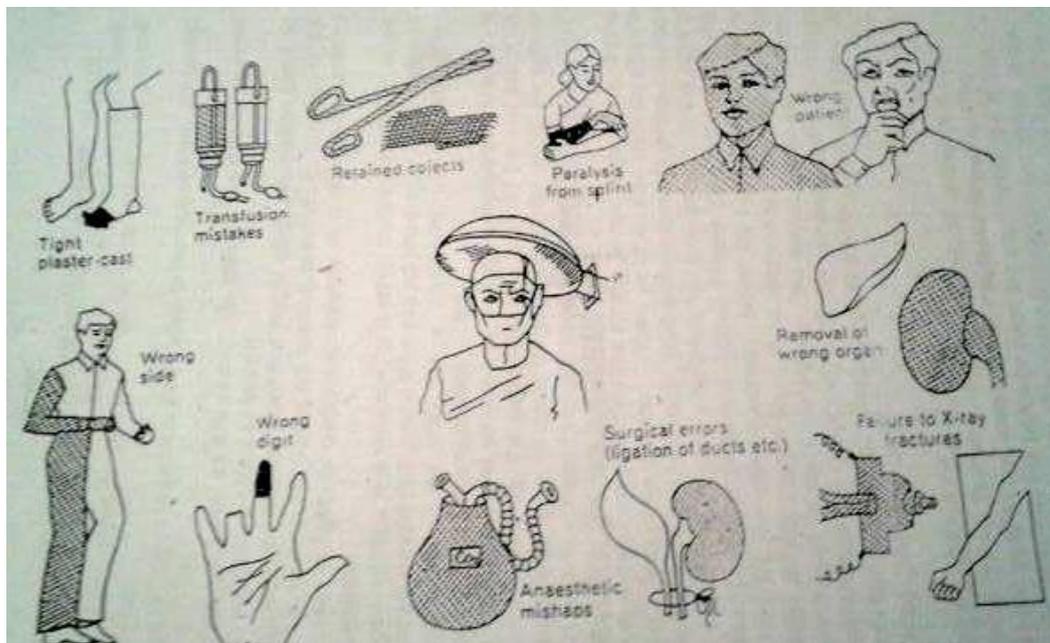
- Be involved in commercial jobs.
- Advertise in the press.
- Use false data in his title either in prescription forms or nameplate.
- Give false reports, or certificates for financial benefits.
- Adopt fraudulent method in his practice.
- Take a commission in return of prescribing certain drug, or recommending certain hospital, pharmacy, laboratory or investigation.

**MALPRACTICE (MALPRAXIS)****Malpractice can be divided into two broad categories:****1. Incompetence**

This refers to lack of reasonable knowledge or skill.

**2. Negligence**

This refers to lack of reasonable care.

**Some examples of malpractice:**

1. Prescribing an incorrect type or dose of a drug.
2. Incompatible blood transfusion.

3. Brain damage in the newborn due to hypoxia from prolonged labor.
4. Electro-convulsive therapy causing fracture of vertebrae.
5. Cutaneous burns due to infra-red therapy or diathermy.
6. Tissue and nerve damage from over-tight plaster cast.
7. Anesthetic malpractice examples:
  - a. Obstruction of air passages by vomitus, blood clot, and piece of gauze or a denture.
  - b. Light anesthesia → RVI:
    - During induction due to tracheal intubations
    - During recovery due to traction on viscera.
  - c. Fire and explosions in the theatre of inflammable vapors as ether or cyclopropane.
  - d. In local anesthesia:
    - If the is injected into a vessel in large amounts, the patient may experience a seizure and cardiac arrest.
    - In liposuction technique the use of large amounts of dilute local anesthetics injected under the skin, toxicity and death may occur.
8. Surgical malpractice examples:
  - a. Neglecting aseptic techniques in surgical operations.
  - b. Retention of instrument or a towel in operation sites, only if harm results (sepsis, adhesions, or death).
  - c. Operating on the wrong limb, digit or even organ.
  - d. Prolonged operation precipitates surgical shock and exhaustion.
  - e. Unskilled incision of a big vessel or aneurysm.

**N.B.**

- If negligence has resulted in **NO DAMAGE**, then there is no responsibility, e.g. no responsibility on a surgeon after leaving in the abdomen of his patient a towel which resulted in no complication.
- Unsuccessful treatment is not an evidence of negligence or incompetence.
- A physician is legally responsible for the acts of assistants in his professional private practice.
- A hospital is liable at law for the negligence or incompetence of its employed nurses, radiologists ...etc.

## ***Professional Misconduct***

This means that the professional behavior of a physician falls below what is expected from a doctor.

If a practitioner is guilty of dishonorable or disgraceful conduct, ***the medical council*** takes a disciplinary action against him. According to the gravity of the offence, the action may be in the nature of (1) warning or (2) temporary erasure of his name from the register.

### **Examples of professional misconduct include:**

- 1- Being habitually drunk,
- 2- Immoral conduct in the practice of the profession.
- 3- Practicing illegal procedures.
- 4- Commercialization of a secret remedy.
- 5- Permitting or aiding an unlicensed person to perform activities without a license.
- 6- Receiving or giving commission.
- 7- Improper association with drug manufacturing companies.
- 8- Being convicted of a crime.
- 9- Sexual or financial exploitation of the patients.