

# Asphyxia:

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Asphyxia: exclusion of air from lungs

Hypoxia: deprivation of adequate oxygen supply at tissue level that results from asphyxia

Anoxia: complete deprivation of adequate oxygen supply at tissue level.

→ Normal oxygen saturation of arterial blood: 95 mm Hg

(Persons  $>60$  years have somewhat lower saturation  $\sim 80$  mm Hg)

Mild hypoxia: 60 mm Hg

Severe hypoxia: 40 mm Hg

Fatal hypoxia: 20 mm Hg (1/5 of normal)

## Classification of Asphyxial Deaths:

### I) According to mechanism of production:

#### 1) Mechanical: PT TIME

##### i) When exclusion of air from lungs is by ligature around the neck:

Hanging: constriction force of ligature = weight of the body

Strangulation: constriction force of ligature is anything other than the weight of the body

##### ii) When exclusion of air from lungs is by any means other than ligature around the neck:

Suffocation: external orifices of respiration (mouth, nose) are blocked

Smothering: foreign object is pushed through mouth up to posterior pharyngeal wall

Gagging: foreign object enters trachea

Choking: mechanical obstruction by interference with respiratory movements

##### iii) When exclusion of air from lungs is by mechanical entry of liquid into lungs: Drowning

2) Pathological:

- acute poliomyelitis (paralysis of respiratory muscles)
- bronchitis
- edema of glottis
- laryngeal spasm
- tumours & abscess around the neck

3) Toxic:

- Hb binding of oxygen lowered [CO]
- Tissues unable to utilize oxygen [CN]
- Respiratory centre paralyzed [barbiturates, opium, strychnine]
- Muscles of respiration paralyzed [gold-sodium]

4) Environmental: • high altitude

- insufficient oxygen in environment
- irrespirable gases in the environment [CO, CO<sub>2</sub>, sewer gas, chlorine]

5) Traumatic: • bilateral pneumothorax

- pulmonary embolism

6) Iatrogenic: anaesthetic deathsII) According to time of survival:1) Rapid asphyxia [survival < 15 min]:

- Hanging
- Throbbing
- Choking

2) Slow/ Protracted asphyxia [survival > 30 min]:

- CO intoxication
- Opiates
- Initial excitements followed by death.

# Classical Signs of Asphyxia:

(E<sup>2</sup>P<sub>1</sub>C<sup>2</sup>)

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E - Edema (due to obstructed venous return)

P - Engorgement of right side of heart (due to collapse of pulmonary vasculature)

P - Petechial haemorrhages (Tardieu's spots) (due to back pressure in venous system)

I - Increased fluidity of blood (hypoxia → release of fibrinolysis)

C - Congestion of internal organs (due to obstructed venous return)

C - Cyanosis (due to obstructed venous return)

Petechial haemorrhages: (0.1 - 2 mm)

→ small pin-point collections of blood in skin, sclera, conjunctivae, skin of eyelids, forehead, upper cheeks, lining of mouth & throat, muscles of temples.

→  $\geq 2$  mm  $\Rightarrow$  ecchymoses

→ Petechial haemorrhages due to asphyxia = Tardieu's spots

→ Density of petechiae  $\Rightarrow$  severs as indicator for the duration of process.

# Hanging: form of death caused:

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- either by exclusion of air from lungs or oxygenated blood from the brain
- by means of a ligature round the neck
- constricting force = weight of the body.

→ If a person survives a hanging incident  $\Rightarrow$  Near hanging.

## Classification:

### I) According to position of knot:

- i) Typical hanging: knot is at occiput
- ii) Atypical hanging: knot is at any other position (other than occiput)

### II) According to position of feet:

- i) Complete hanging: when feet do not touch the ground
- ii) Incomplete/partial hanging: if feet or other parts of the body touch the ground.

### III) According to Manner of Hanging:

i) Suicidal	iii) Accidental
ii) Homicidal	iv) Judicial

## Cause of Death in Hanging: (it is not necessary for ligature to completely encircle the neck in order to cause death)

I) Asphyxia: trachea is occluded  $\longrightarrow$  No air supply to lungs  $\longrightarrow$  No oxygenation  $\longrightarrow$  Death

II) Occlusion of neck blood vessels: Neck blood vessels are occluded by ligature  $\longrightarrow$  Blood supply to the brain ceases  $\longrightarrow$  cerebral ischemia  $\longrightarrow$  Death

→ cerebral ischemia occurs when both arteries & veins are occluded.

→ venous congestion occurs only when veins are occluded (arteries are patent)

III) Reflex Vagal Inhibition of Heart: Pressure over carotid arteries  $\rightarrow$  Carotid body stimulated  $\rightarrow$  Vagal stimulation  $\rightarrow$  Cardiac inhibition  $\rightarrow$  Death

IV) Fracture dislocation of cervical vertebra: in hangings associated with a long drop (ex: judicial hanging)

Current thought:

→ Asphyxia is the main cause of death in complete hanging

→ Occlusion of neck blood vessels is the main cause of death in incomplete hanging.

## Fatal Period:

Suicidal hanging: • death due to asphyxia  $\Rightarrow$  5-10 min.

• death due to occlusion of neck blood vessels  $\Rightarrow$  12-20 min.

Judicial hanging: instantaneous

Delayed deaths: few days

## PM Appearance:

### (1) Description of Ligature:

i) Ligature material: when a narrow wire is used  $\Rightarrow$  it may eat into the flesh of the neck (cheese-cutter method)

ii) Colour & composition

iii) Pattern & texture of ligature: these ligatures produce patterned abrasions.

iv) Intact: whether ligature is intact or has been cut off

v) Cut ends: if cut  $\Rightarrow$  whether appears torn or cut sharply by scissors

vi) Extraneous material on ligature: blood, epidermis, hair, saliva, vomit

vii) Length: if length of ligature is sufficient to hang from the point from where victim's body was found hanging

viii) Width: if it corresponds with ligature mark

ix) Multiplicity: if ligature shows single/multiple turns around the neck.

x) **Strength:** if ligature is strong enough to support weight & jerk of the body

xi) **Tightness:** Tighter ligature  $\Rightarrow$  deeper groove

→ Slip (running) knot does not produce uniform pressure all around the neck

→ pressure is maximum just opposite the knot & then it tapers off gradually

xii) **Padding**

xiii) **Spontaneous breakage:** sometimes ligature may break spontaneously & body may be found lying on the ground.

xiv) **Knot:**

→ **Location:** occiput / below the chin / below either ear (subaural)

- Knot is always above the rest of the ligature  $\Rightarrow$  inverted V shaped ligature mark

- apex of V shaped ligature mark = site of knot.

→ **Types of knots:**

- Granny
- reef

→ **Removal of ligature:** Knot should never be opened

- ligature should be cut opposite to knot & the two cut ends must be secured with a string

(a) **Ligature mark:** type of pressure abrasion due

to continued pressure by ligature on neck.

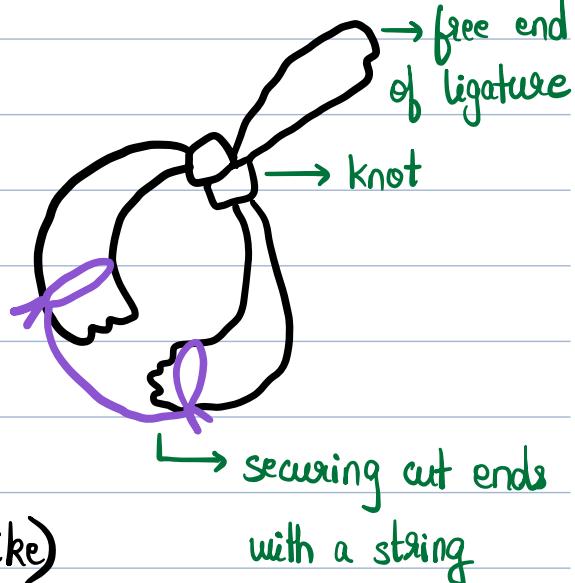
→ seen in both, hanging & strangulation

→ seen as a furrow or groove in the tissue which is:

- soft & pale initially

- skin dries up & becomes hard (parchment-like) & dark brown.

→ runs from midpoint of neck upwards, outwards & backwards to reach behind the neck where it is deficient (in typical hanging)

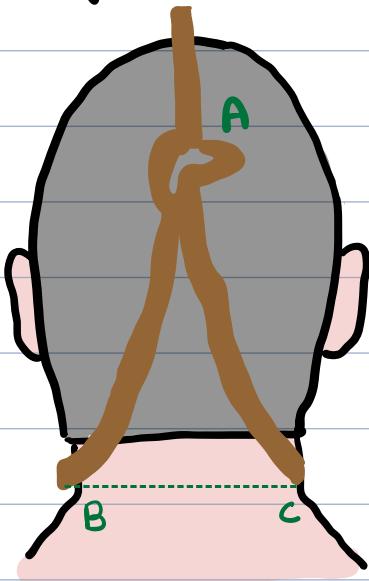


→ ligature mark is situated:

- above thyroid cartilage  $\Rightarrow$  in 80% cases
- at the level of thyroid cartilage  $\Rightarrow$  in 15% cases
- below the thyroid cartilage  $\Rightarrow$  in 5% cases

→ heavier body  $\Rightarrow$  deeper ligature mark

→ longer the suspension  $\Rightarrow$  deeper the groove



A = Suspension peak  $\Rightarrow$  distinguishing feature of hanging & strangulation

typically absent when  
Knot is in front (at the chin)

(3) PM Staining: glove-stocking distribution  $\Rightarrow$  on legs, feet, soles, hands, forearms, undersurface of breast, penis.

→ upper part of the body is pale

(4) Head, Neck & Face:

→ head is inclined to the side opposite to that of the knot

→ neck is elongated & stretched. (neck should be examined after removal of brain & viscera from the chest & abdomen to produce a bloodless field)

→ Face: • usually pale (due to occlusion of carotids & vertebral arteries)

- rarely congested

- may be swollen

- eyes are frequently protruded & firmer than usual (due to congestion)

- conjunctiva are congested

- **Le facies sympathiques:** eyes on same side is open & its pupil is dilated & the other eye is closed & its pupil is constricted  
→ **Stoap muscles:** may be torn & may show haemorrhages

### (5) Petechial haemorrhages:

- in skin & conjunctivae
- in typical hanging ⇒ face is pale; no petechiae
- when knot is under chin → lower jaw protects neck from deep pressure by the noose → arterial flow continues → venous flow stops → abundant petechiae & prominent congestion
- when knot is on one side → subconjunctival haemorrhages are one-sided

### (6) Other features:

i) **Nose:** bloody froth (due to rupture of engorged blood vessels)

ii) **Tongue:** protruding & caught between the teeth

→ protruded part is dark brown / black-blue due to drying

iii) **Lips & mucus membrane of mouth:** blue

iv) **Saliva:** • dribbling from the mouth (may be blood-stained)

• sweet sign of antemortem hanging

→ Cause: - stimulation of pterygopalatine ganglion

- direct stimulation of salivary glands by ligature

v) **Hands:** clenched

vi) **Penis:** • engorged with blood (due to hypostasis)

• may be semierect

• semen may be found at the tip.

vii) **Relaxation of sphincters** ⇒ escape of urine & feces

(7) Carotid Arteries: intima shows several horizontal splits with extravasation of blood in their wall  $\Rightarrow$  Amussat's sign

$\rightarrow$  more common in long drops (as in judicial hanging)

$\rightarrow$  similar damage is also seen in vertebral arteries

(8) Epiglottis & larynx: may show petechial haemorrhages

(9) Trachea: congested

- rarely injured

- may show petechial haemorrhages

(10) Lungs: • congested, edematous, exude bloody serum on cut-section

- may be pale (if constriction of lungs occurred at end of inspiration)

[congestion occurs if constriction of lungs occurred at end of expiration)

- subpleural ecchymoses

(11) Abdominal organs: congested

(12) Brain: normal/congested/pale

- may show subarachnoid haemorrhages

(13) Middle ear: haemorrhage

(14) Hyoid: may show anteroposterior compression fractures

$\rightarrow$  rare  $< 30$  y  $\because$  apices of greater cornu is cartilaginous below 30 y.

$\rightarrow$  site: junction of inner 2/3 & outer 1/3.

$\rightarrow$  fractures of hyoid are also found in chronic alcoholics.

(15) Thyroid: superior horns may show fractures

$\rightarrow$  more common  $> 40$  y

(16) Vertebral Column: • haemorrhages beneath the area of anterior longitudinal ligament of intervertebral disks in the lower thoracic & lumbar vertebrae (Simon sign)

$\rightarrow$  look like dark red to violet horizontal lines between vertebral bodies.

$\rightarrow$  Cause: overstretching of the spine because of free suspension of the body.

$\rightarrow$  More frequent in younger individuals.

# MLI of Hanging:

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## (1) Pressures Required to obliterate neck structures:

- jugular vein  $\Rightarrow$  2 kg
- carotid arteries  $\Rightarrow$  5 kg
- Trachea  $\Rightarrow$  15 kg
- vertebral arteries  $\Rightarrow$  30 kg
- vertebral venous plexus  $\Rightarrow$  5 - 30 kg
- pale face  $\Rightarrow$   $> 30$  kg
- congested face  $\Rightarrow$  2 - 30 kg

## (2) Partial Hanging: specialized form of hanging in which some part of the body

is supported either by ground / object other than neck.

- deceased may be in sitting / kneeling / completely lying down position.
- congestive force is less, congestive changes are more marked



## (3) Manner of Hanging:

### i) Accidental:

- Infants  $\Rightarrow$  in cribs with restraining vertical bars & neck gets caught in between the bars.

→ sexual hanging

→ stuntmen (exhibiting hanging as a stunt)

→ workmen falling from scaffolding may get entangled

Sexual Hanging: aka Asphyxiophilia / Autoerotic asphyxia / Masochistic hanging / Sexual asphyxia

- accidental death caused by a self-induced decrease in oxygenation of blood (hypoxia) produced most commonly by partial hanging.
- Oxygen deprivation of the brain  $\Rightarrow$  enhancement of sexual orgasm due to:
  - feeling of light headedness
  - induction of erotic hallucinations
  - ↑ sympathetic arousal
- Mechanism of accidental death: noose touches carotid sinus  $\longrightarrow$  consciousness is suddenly lost  $\longrightarrow$  victim is incompletely suspended with legs on the ground
- there may be evidence of previous episodes on the neck (old scars)
- MLI: differentiation from suicide ( $\because$  insurance policies have a clause stating that no money would be paid in case of suicide)
- Scene of typical sexual hanging:
  - tying up of legs (evidence of masochism)
  - seminal stains (evidence of recent orgasm)
  - mirror
  - video camera for recording
  - weight on the legs used to control pressure on ligature

ii) Homicidal: very rare

ex: Lynching

Lynching: extrajudicial hanging carried out by a mob by hanging without a fair trial.

→ signs of struggle may be found.

iii) Suicidal: very common.

(4) Postmortem Suspension: when a person is first killed & then suspended to simulate hanging ∴ aka Simulated hanging.

→ ligature applied to the neck during supravital period will produce a ligature mark.

	Antemortem hanging	Postmortem hanging
Ligature mark	shows vital reaction; skin is parchment-like	No vital reaction; tissues underneath show no changes
Salivary dribbling mark	Present / absent	Absent
Cyanosis	seen (face, ears, lips, etc.)	Not seen
Tongue	protruded	Not protruded
Fecal & urinary PM staining	Yes, expelled glove - stocking distribution	Not expelled If body is hung soon after death ⇒ same as in AM hanging; Hanging after 8 hours ⇒ no glove - stocking pattern.
Struggle marks	No	Yes
Le facies sympathique	Present / Absent	Absent
Cause of death	Hanging	Other than hanging
suicide note	May be present	Absent
Door closed from inside	generally, Yes	Never
Point of suspension	Such a height that victim could have reached	May or may not be so
Overtumed stool/chair below feet	generally present	generally absent

**(5) Judicial Hanging:** method of execution in which a noose is tied around the neck of the condemned criminal, & he is made to drop between 1-5 m depending on his weight.

→ official method of execution in India

→ face of the victim is covered with a black mask & hands are tied behind the back.

→ ideally, knot is placed submentally → hyperextension of head → traumatic spondylolisthesis of axis (**hangman fracture**) & bilateral fracture of pars interarticularis of C2.

→ subaural position of knot → fracture of base of skull

→ left subaural position of knot was used officially because it does not slip

→ height of drop = 1-5 m (depending on the weight of the victim)

- < 1 m ⇒ asphyxiation

- > 5 m ⇒ decapitation.

### Cause of death:

→ bilateral fracture of C2 with anterior subluxation [C2-C3 dislocation]

→ dislocation of atlanto-occipital joint

→ fracture of odontoid process of C2 → pulping of spinal cord

→ complete transection of cervical spine

### PM findings: Findings of hanging + additional findings:

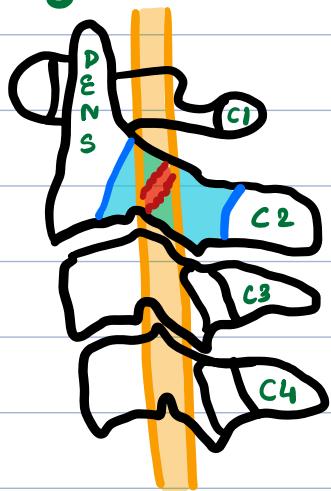
→ fracture of base of skull & cervical vertebrae with trauma to spinal cord.

→ Intima of carotid shows transverse lacerations

→ injury to pharynx.

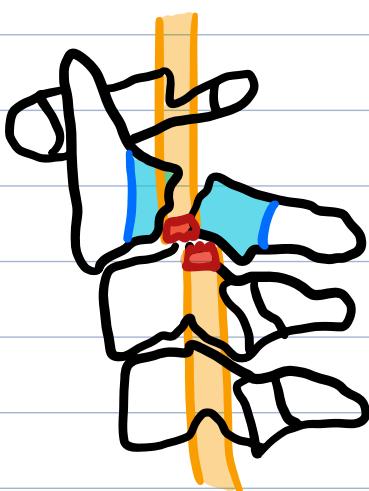
# Hangman Fractures:

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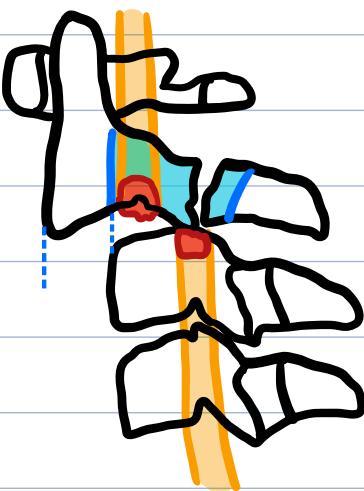
Type I

Non-displaced fracture  
of pars interarticularis



Type II

Displaced fracture of  
pars interarticularis



Type III

Fracture of pars interarticularis  
with dislocation of C2-C3  
facet joints

## Strangulation: death caused by:

- exclusion of air from lungs or oxygenated blood from brain
- means of a ligature around the neck
- constricting force being anything other than the weight of the body.

## Types of strangulation: (based on type of ligature used)

Ligature Used	Type of strangulation
Traditional ligature (rope / cloth wire, etc)	Ligature / classical strangulation (most common)
Hand	Throttling (manual strangulation)
Palm	Palmar strangulation
Bend of elbow	Mugging
Executioner's cord	Garrotting
Two pieces of bamboo	Bandsela

## Cause of Death: occlusion of carotid arteries

→ In throttling → groping fingers may suddenly impinge upon carotid sinus  
→ sudden death by vasovagal inhibition.

## PM Appearance: (in classical ligature strangulation)

(1) Ligature Mark: examination must be done in — regular light  
— oblique light  
— UV light

→ Appearance: reddish, soft, less depressed in skin

→ ligature mark is transverse & completely encircles the neck; equally prominent all around the neck

→ mark is present below thyroid cartilage

→ petechial haemorrhages around ligature are more common.

→ abrasions & ecchymoses at the edges of the ligature mark are common.

(a) Pseudostangulation: ligature mark resembling a strangulation mark

(pseudoligature mark) is seen on the neck, but it is produced by mechanisms other than anteromedial pressure by a ligature.

Causes: i) Blanching of PM staining (by a tight collar, neck tie, etc.)

ii) Decomposing bodies (with buttoned shirt at the neck)

iii) Mummified bodies

iv) Infants & children (short neck  $\Rightarrow$  skin folds due to bending of head & due to hypothermia)

v) short-necked adults.

(3) Signs of Asphyxia:

→ classical signs of asphyxia are seen (signs are marked if pressure applied

→ Head, face, neck - congestion  $\text{is } > 30 \text{ kg}$

- petechial haemorrhages

(d) Other Signs:

→ If struggle present  $\Rightarrow$  abrasions & contusions on face

→ If pressure applied  $< 2 \text{ kg} \Rightarrow$  death is due to vasovagal shock  
(most external & internal signs absent)

→ If pressure applied 2-30 kg: • marked congestion of face

- bleeding from nose (epistaxis), mouth (stomatorrhagia) & ears (otorrhagia)
- TM is congested / ruptured

→ If pressure applied  $> 30 \text{ kg} \Rightarrow$  asphyxial signs are marked

(e) Internal findings:

i) Neck: haemorrhages: • beneath ligature mark under the skin

- in strap muscles
- in laryngeal structures

ii) Lungs: show emphysematous bullae.

# MLI of Strangulation:

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	Homicidal Strangulation	Accidental strangulation by umbilical cord in infants
Cervical tissue injury	More	Less
knot	More complicated (eg: reef knot)	Less complicated
Lungs	Completely expanded	Incompletely expanded

	Suicidal Strangulation	Homicidal Strangulation
Incidence	Uncommon	Common
Ligature	Always present around neck (in-situ)	May/may not be present around neck (absence $\Rightarrow$ sure homicide)
Number of ligature materials	Usually single (loss of consciousness after tying first ligature)	Usually single; but multiple ligatures confirms homicide
Knots	Usually single	Usually multiple ( $\geq 2$ firm knots confirm homicide)
Position of knot	Usually in front	Usually at the back
Venous congestion	Much more developed above ligature (prominent at tongue root)	Less developed
Injuries around neck	Less marked	More marked
Associated injuries	Usually none	Associated stab/head/ firearm injury
Signs of violence & marks of struggle	Absent	Present
Scene	Not disturbed	Disturbed
Door	Usually closed from inside	Always open
Suicide note	May be present	Absent

## Accidental strangulation:

Isadora Duncan Syndrome: Long scarf / end of a sari / dupatta worn by women around their necks can get entangled within the spokes of a moving cycle / rickshaw → quick death by accidental strangulation.

Throffing (Manual Strangulation): compression of neck by human hands

→ Cause of death: occlusion of blood vessels of the neck.

### PM Appearances:

→ Asphyxial signs develop within 15-30s of pressure & continue to intensify if pressure is maintained.

→ tongue: usually protruded

→ neck shows bruises & abrasions

- bruises: produced by tips or the pads of fingers (Six penny bruises)

→ Subcutaneous tissue & muscles of neck:

- compressed backwards against cervical vertebrae

- engorgement at & above the level of compression

→ Bruises & frank haemorrhages: • dermis      • superficial fascia      • deep fascia

- muscles      • base of tongue      • pharynx      • tonsils

- lymphatic glands in the neck      • tissues at back of neck

→ tearing of muscles (especially, sternocleidomastoid)

→ Carotid arteries: intimal tears at / near carotid sinus (in 10-15% cases)

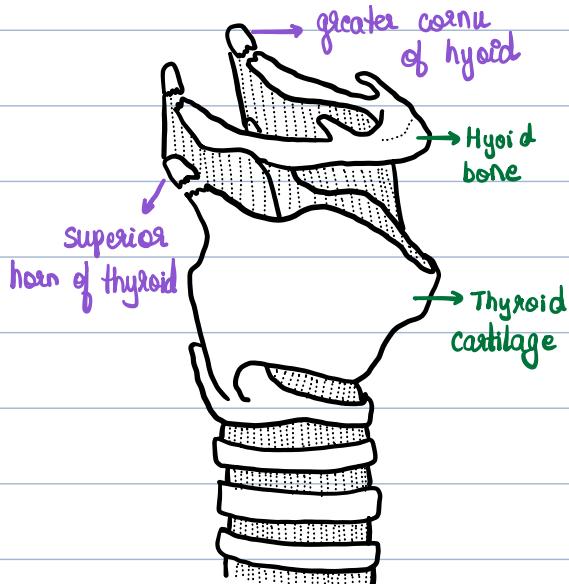
→ Epiglottis: • may show petechial haemorrhages

- very rarely shows fractures

→ Thyroid cartilage: • lamina (ala) may show fractures ⇒ either vertically in the midline or oblique/spirally across the right / left lamina

- Horns (cornua) ⇒ fracture of superior horns is much more common than that of laminae

- thyroid fractures are more common in elderly due to calcification
- Trachea: • tracheal cartilages are fractured rarely
  - may show frank lacerations
- Hyoid bone: • most common thing in throttling
  - inward compression fracture
- Lungs: • congested with subpleural petechial haemorrhages
  - pulmonary edema
  - blood-stained fine froth in bronchi
  - Microscopy: some areas are overdistended with rupture of alveolar walls
- Brain: • congested
  - petechial haemorrhages in white matter
  - subarachnoid haemorrhages



→ suicidal throttling is not possible (unconsciousness causes fingers to relax)

Palmar Strangulation: one palm is placed horizontally across the mouth

& nostrils & other palm is placed perpendicularly across the first palm in such a way that its heel presses upon the front of the neck.

→ there is an element of smothering also → generally used to stifle cries from the victim.

→ PM findings: same as that in ligature strangulation (except ligature mark)

Mugging: strangulation caused by holding the neck of the victim in the bend of the elbow.

→ Two types:

- Air choke: pressure is exerted on front of larynx
- Blood choke: pressure is exerted on both sides of neck.

→ Cause of death:

- asphyxia
- reflex cardiac arrest

PM Appearance:

- diffuse abrasion along the jaw margin
- diffuse bruising behind larynx & in strap muscles
- fracture of hyoid or thyroid is rare
- damaged intima of carotid

Garroting: method of killing by asphyxia where victim is attacked from behind without warning & his throat is constricted.

→ there is sudden loss of consciousness & collapse.

Bansdola: form of strangulation where compression of neck is achieved by bamboo.

→ one bamboo is placed over the front of neck & the other at the back.

→ both ends are tied to achieve compression of neck.

	Hanging	Strangulation
Ligature mark	<ul style="list-style-type: none"> <li>• pale</li> <li>• hard, parchment-like</li> <li>• more depressed in skin due to more weight</li> <li>• oblique</li> <li>• does not encircle the neck completely</li> <li>• more prominent at front &amp; sides (in typical hanging)</li> <li>• above the thyroid cartilage</li> <li>• petechial haemorrhages around ligature are less common</li> </ul>	<ul style="list-style-type: none"> <li>• reddish</li> <li>• soft</li> <li>• less depressed in skin</li> <li>• transverse</li> <li>• completely encircles the neck</li> <li>• equally prominent all around the neck</li> <li>• below the thyroid cartilage</li> <li>• petechial haemorrhages around ligature are more common</li> </ul>
Abrasions & ecchymoses at the edges of ligature mark	Not common	Common
Face		
Appearance	Usually pale. Petechiae rare.	Usually congested. Petechiae common
External signs of asphyxia	Less marked	More marked
Bleeding from nose, mouth, ear	Not common	Very common
Swelling & proptosis of tongue	Less marked	More marked

	Hanging	Strangulation
Saliva	Often runs out of the mouth (stimulation of parotid gland)	Absent
Neck		
Length	May be stretched/elongated	Not stretched/elongated
Bruising of neck muscles	Less common	Common
subcutaneous tissue under the mark	White, hard, glistening	Ecchymosed
carotid arteries	Damage may be seen (more constrictive force)	Damage rare (less constrictive force)
Hyoid bone fracture	Usually absent	Usually present
Thyroid cartilage	Usually absent	Usually present
Laryngeal & tracheal cartilages	Usually absent	May be present in older people (due to calcification of cartilages)
External features		
Involuntary discharge of urine & feces	Less common	Very common (parasympathetic stimulation)
Seminal fluid at glans	More common	Less common
Emphysematous bullae on surface of lungs	Not present	Very common
Circumstantial evidence		
Suicide note	May/may not be present	Absent

	Hanging	Strangulation
Place of occurrence	Usually own bedroom (doors & windows bolted from inside)	Outside (in open spaces); if inside room $\Rightarrow$ not bolted from inside.
Signs of struggle	Absent	Present
Psychological autopsy	Previous h/o unsuccessful suicide attempts may be there. Victim often depressed or under stress	No such history. Known enmity with other people.

Hyoid Bone Fractures: commonly seen in compression of neck

Types: (according to displacement of fractured ends)

(1) Inward (lateral) Compression Fractures: occurs due to inward compressive force (as in throttling)

→ fingers → squeeze greater horn towards each other → posterior (distal) fragment is displaced inwards

→ fracture may be u/l or b/l.

→ fracture may occur at 2 places on either side:

- just at the base of distal fragment
- at the joint between the greater horn & body of hyoid.

→ periosteum is torn on the outer side of bone which is overstretched (not torn on the inner side)

→ complete detachment of smaller fragment from the hyoid may occur if the compression is severe.

(2) Outward (Anteroposterior) Compression Fracture: in case of hanging

→ ligature presses on the neck → hyoid is forced directly backwards

→ ↑ divergence of greater horns → outward displacement of posterior fragment occurs, rupture of periosteum on the inside.

(3) One Side Inward & other Side Outward: may be seen in hanging.

## Demonstration of Fractures:

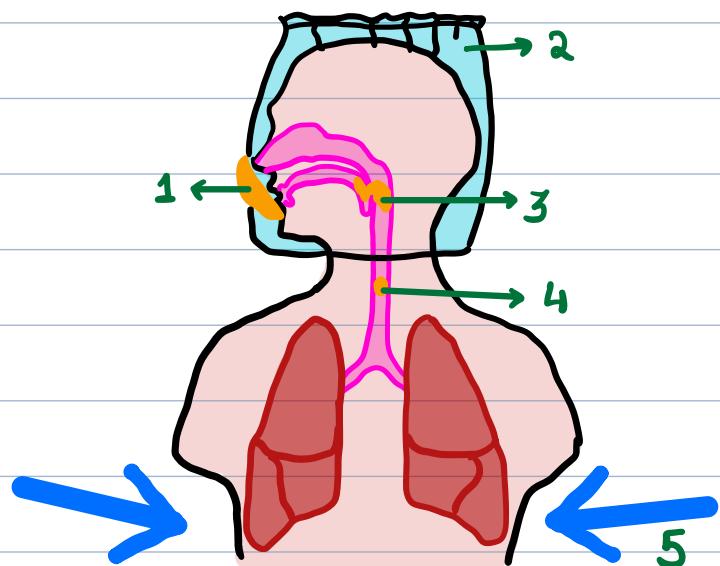
### (1) Palpitory Method:

- hyoid bone is grasped in one hand
- distal fragment (tip) is held between the fingers & thumb of other hand.
- in case of inward fracture → distal fragment can be easily bent inwards  
(due to torn periosteum on outer side)
- opposite happens in outward fracture.

### (2) Toluidine blue with stereomicroscopy

### (3) X-ray & CT

Suffocation: exclusion of air from lungs by any means other than ligature



- 1 = Smothering
- 2 = Smothering
- 3 = Gagging
- 4 = Choking
- 5 = Traumatic Asphyxia

### Types of Suffocation:

- i) Environmental suffocation
- ii) Smothering
- iii) Choking
- iv) Gagging
- v) Traumatic asphyxia
- vi) Overlaying
- vii) Burying
- viii) Positional asphyxia

Environmental Suffocation: deprivation of oxygen due to lack of oxygen in the environment.

- caused by:
  - deficiency of  $O_2$  in the environment or
  - replacement of  $O_2$  by an inert gas such as  $N_2$ .
- conc. of  $O_2$  in air = 21%
- conc. of  $O_2 \leq 16\%$  is dangerous
- Instances:
  - children getting locked into large boxes / trunks while playing
  - vicinity of lime kilns & wells / excavations in chalk rock (lack of atmospheric  $O_2$ )
  - in confined spaces (tanks, fermenters, unused wells, etc.)
  - inhalation of irrespirable gases from a burning house
  - ↓ in atmospheric oxygen in decompression  $\Rightarrow$  cabin failure of aircraft at high altitudes

Smothering: form of asphyxia which is caused by closing the external respiratory orifices either by hand or by other means, or blocking up the cavities of the nose & mouth by the introduction of a foreign substance.

suicidal smothering: impossible with hands

- possible by burying the face in a mattress or by tying a polythene bag over the head.

accidental smothering: infants covered with heavy blankets / bedding

- person may accidentally fall into a large quantity of semi-solid / finely-divided material

→ if membranes remain around the head of the newborn after delivery

homicidal smothering: possible when the victim is incapacitated with drink / drugs or is very weak or in children / elderly.

**Ligging:** form of asphyxia which results from forcing a cloth into the mouth or the closure of the mouth & nose by a foreign material (pushed sufficiently deep to block the pharynx)

→ usually resorted to when the victim is shouting for help & generally, death is not intended.

**Overlaying / Compression Suffocation:** due to compression of the chest, so as to prevent breathing.

→ occurs when an adult shares a bed with an infant.

→ thoracic movements are limited → respiratory exchange is reduced / prevented

**Choking:** form of asphyxia caused by an obstruction within the air passages (usually between pharynx & bifurcation of trachea)

→ commonly associated with alcohol intoxication, neurological injury or senility.

**Accidental choking:** choking is mostly accidental

→ during a meal when food is accidentally inhaled

→ vomited matter may be inhaled by a person under the influence of drugs / anaesthetic / fit of epilepsy

→ infants usually regurgitate clotted milk after a meal & this may fall into the larynx.

→ impaction of solid bodies (large bolus of food / piece of meat)

→ gauze packs inserted during an operation can be inhaled

→ rubber balloons may be inhaled by children during play.

→ food aspiration following suppression of the gag reflex by tranquilizing drugs.

**Suicidal choking:** rare

→ victims are usually mental patients or prisoners.

Homicidal choking: method of infanticide by stuffing a wad of paper/cloth

Cause of death: • cardiac inhibition

• Laryngeal spasm

• Asphyxia

• Delayed death from pneumonia, lung abscess or bronchiectasis.

Cafe Coronary: condition in which a healthy but grossly intoxicated person, who begins a meal, suddenly turns blue, coughs violently, then collapses & dies.

→ At autopsy: a large piece of poorly chewed food may be found obstructing the larynx

→ Treatment: blow on the back or on the sternum may cause coughing & expel the foreign body.

Traumatic Asphyxia: results from respiratory arrest due to mechanical fixation of the chest, by an unyielding substance/object, so that the normal movements of the chest wall are prevented.

Causes: • large crowds gathering in enclosed spaces

• crushing by falls of earth/stone in a coal mine/building collapse

• crushing by a motor vehicle/heavy machinery

• when the jack slips & the vehicle falls on top of the person repairing it.

• in assault cases, where the victim is jumped or stabbed upon

PM Appearance: intense congestion, petechial & confluent haemorrhages, cyanosis (deep purple/purple-red colour) of head, neck & upper chest above the level of compression.

→ Below the level of compression → skin is pale/mildly cyanosed

Burking: homicidal smothering + traumatic asphyxia.

Postural/Positional Asphyxia: occurs when an individual acquires a certain body position in which breathing is impaired

→ body is typically inverted (upside-down) & weight of the abdominal contents press against the diaphragm pushing it upwards → compression of thoracic organs + decreased respiratory movements → cardiorespiratory failure → death

Causes:

- when a violent/physically aggressive person is restrained in a prone position
- forcible flexion of the neck on the chest
- indirect compression when the body is forced into jack-knife position.

# Drowning:

asphyxia caused by aspiration of fluid into air-passages, caused by complete or partial submersion in water or other fluid.

process of experiencing respiratory impairment from submersion/immersion in liquid.  
→ natural tendency of body is to sink down

## Classification:

Wet drowning  
Dry drowning  
Near drowning, Secondary drowning  
Immersion Syndrome.

### ① Wet Drowning:

- involves inhalation of water into lungs
- victim suffers from severe chest pain
- death occurs within minutes of submersion
- Cause of death:
  - cardiac arrest
  - Hyperkalemia
  - Ventricular fibrillation

### ② Dry drowning:

- no significant presence of liquid in the lungs
- Mechanism:
  - Laryngospasm
  - Absorption of liquid in circulation
- Seen in:
  - children
  - adults under the influence of alcohol, sedatives or hypnotics
- Resuscitated victims display:
  - panoramic views of past life
  - pleasant dreams with no distress
- PM appearances: Diagnosed by inference & exclusion
  - Signs of asphyxia - prominent
  - Trachea - may be congested
  - Lungs - virtually dry

### ③ Near Drowning & Secondary Drowning:

Near Drowning: initial survival at least beyond 24 hours of an individual after asphyxiation due to submersion in fluid.

→ associated with secondary complications

Secondary Drowning: death following near drowning after a period of relative well-being

→ Causes:

- Posthypoxic encephalopathy (most common)
- inadequate alveolar gas exchange (due to primary alveolar membrane dysfunction)
- loss of surfactant

### ④ Immersion Syndrome: death resulting from cardiac arrest due to vagal inhibition, subsequent to immersion in liquid.

(maybe caused by cardiac arrhythmias - those associated with prolonged QT interval)

→ Causes:

- icy cold water stimulating the nerve endings at the surface of the body
- cold water stimulating nerve endings at mucosal surfaces
- water striking the epigastrium

→ Circumstances:

- diving into water feet first
- diving into water horizontally with blow on abdomen
- Duck diving (in surfers)

→ Aggravating factors:

- Alcohol - general vasodilatation of skin  
- central effects on vasomotor centre
- Emotional tension

	Fresh water Drowning	Sea water drowning
Size $\propto$ weight	ballooned, but light	Ballooned, very distended, heavier than in fresh water
Colour	Pale pink	Purplish / bluish
Consistency	More emphysematous	Less emphysematous (soft & jelly-like)
Pleural effusion	Generally absent	Generally present
Shape after removal from body	Retained (do not collapse)	Tend to flatten out
Sectioning	Releases frothy, often blood-tinged fluid ; crepitus heard on sectioning	Greater quantities of frothy fluid ; no crepitus on sectioning
Pulmonary surfactant	Greater reduction of PC & PE $\left. \begin{array}{l} \text{PC} - \text{Phosphatidyl choline} \\ \text{PC} - \text{Phosphatidyl glycerol} \\ \text{PE} - \text{Phosphatidyl ethanolamine} \end{array} \right\}$	PC is reduced more
General extent of lung injury	Lesser	Greater (due to presence of salt)
$\text{Ca}^{2+}$ , $\text{Cl}^-$ , $\text{Mg}^{2+}$ , $\text{Na}^+$ levels in blood	No increase	Appreciable increase (due to their diffusion from sea water)
General circulation	Hemodilution	Haemoconcentration
Cause of death	Ventricular fibrillation, hypoxia of heart muscles, cerebral hypoxia	Pulmonary edema, electrolyte imbalance.

# Cause of Death In Drowning:

ISHITA  
KANODIA

- i) Asphyxia - obstruction of airway by fluid
  - circulatory failure (due to myocardial anoxia)
  - respiratory failure (due to respiratory centre anoxia)
- ii) Laryngeal spasm
- iii) Vagal inhibition
- iv) Cramps
- v) Exhaustion
- vi) Long QT syndrome
- vii) Ventricular fibrillation
- viii) Hypoxemia & metabolic acidosis
- ix) Posthypoxic encephalopathy
- x) Resetting of hypothalamic thermostat at a lower temperature
- xi) Electrolyte disturbance.

## Signs of Submersion:

Wrinkling: shortly after submersion

Bleaching of epidermis: 4-8 hours

Soddening:

- fingertips in 2-4 hours
- spreads upwards in about 24 hours.

## Fatal Period:

→ Fresh water: Four minutes

→ Sea water: Six - Seven minutes

## PM Appearance:

→ Classical signs:

- foam & froth at mouth & in lungs
- overdistension of lungs

External: postmortem lividity is light pink in colour (simulating CO poisoning)

→ petechial haemorrhages especially in the lower eye lids

→ pupils are dilated

→ tongue may be swollen & protruded

1] Froth: white, latherly foam/ froth seen at mouth & nostrils

→ may be blood-stained

→ if wiped away, it gradually reappears

→ quantity of froth is very large

2] Cutis anserina: (Goose skin/ Goose flesh) granules/ puckered appearance of skin

→ seen on anterior surface of the body (particularly on the thighs)

→ produced by the spasm of erector pilae muscles

→ occurs when skin comes in contact with cold water.

3] Cadaveric spasm: objects firmly grasped in the hand ⇒ strongly indicate that the person was alive when he drowned.

4] Washer woman's hands: soddening of the skin (due to absorption of water into its outer

→ 2-4 hours: seen on fingertips layer).

24 hours: spreads to palm, backs of fingers, back of the hand.

→ shortly after immersion: wrinkling of skin

4-8 hours: bleaching of epidermis

24 hours: bleached, wrinkled & soddened appearance of skin }  
white, thickened skin } Washerwoman's  
hands

### Intestinal:

1] Lung: voluminous lungs (ballooning ⇒ due to presence of fluid & air in the bronchi)

→ lungs are overdistended, alveolar walls are torn

→ impression of ribs (grooves) on the lateral surface of lungs

→ drowning fluid penetrates alveolar walls to enter tissues & blood vessels ⇒ emphysema  
aqueum.  
(cut-section exudes frothy fluid)

→ if person was unconscious at the time of drowning, lungs are flooded with water but there is no froth formation ⇒ edema aquosum.

→ subpleural haemorrhages → **Paltauf's haemorrhages** ⇒ pale pink/bluish-red.

	Fresh water drowning	Sea water drowning
Size & weight	Ballooned but light	Ballooned & heavy
Colour	Pale pink	Purplish or bluish
Consistency	Emphysematous	Soft & jelly-like
Shape after removal from the body	Retained; do not collapse	Not retained; tend to flatten out.
Sectioning	Creptus is heard. Little froth, no fluid.	No creptus. Copious fluid & froth.

→ **Keatley B-lines**: short parallel lines at the lung periphery seen on chest radiography with interstitial pulmonary oedema.

→ **Hydrostatic lung**: (seen in PM drowning) water enters into lung due to sheer hydrostatic pressure & simulates true drowning lung. [differentiated by

a] **Stomach**: contains water in 70% cases absence of froth].

→ gastric mucosa is soft & heavy

3] **Brain**: congested, swollen with flattening of gyri

4] **Miscellaneous**: haemorrhages in middle ear (in 50% cases)

→ haemorrhage in temporal bone or in mastoid air cells

## Laboratory Tests of Drowning:

1] **Diatoms**: microscopic, unicellular algae having unique cell wall made of silica (frustule)

→ contain chlorophyll-a & fucoxanthin

→ resistant to heat & acid due to frustule

**Antemortem drowning**: person is respiring → water & diatoms enter the lungs

→ violent respiratory efforts → rupture of alveolar walls →

diatoms < 20 µm pass through pulmonary veins & lymph channels →

→ diatoms reach entire body → diatoms can be demonstrated in peripheral organs & body fluids.

Postmortem hanging: person is not respiring → water & diatoms passively enter the lungs → no violent respiratory efforts → no rupture of alveolar walls → diatoms not found in peripheral organs  
→ bone marrow of long bones is highly reliable for demonstration of diatoms by phase contrast microscopy or dark ground illumination.

2] Examination of Blood: if person was respiring during drowning (Antemortem drowning) → water enters lungs → water reaches left heart through ruptured alveolar capillaries → severe physical & chemical changes in blood of left heart (no changes in blood from right heart)

3] Physical tests:

Specific gravity: (SG) SG of right atrial plasma - SG of left atrial plasma  $\geq 0.003$ .

4] Chemical tests:

i) Chloride estimation [gettier's test]:

→ Drowning in fresh water will ↓ chloride levels in left heart. } difference  $\geq$   
→ Drowning in sea water will ↑ chloride levels in left heart. } 20 mg %.

ii) Magnesium: same changes as chloride

iii) Sodium: same changes as chloride

## Circumstances of Drowning:

1] Accidental Drowning: (common in children & adolescents)

- accidental fall of non-swimmer in water
- alcohol / drug use
- lack of supervision
- seizures, cardiac arrhythmias
- hypothermia

2] Suicidal Drowning: common in India in women, in localities near water reservoirs.

- women suicides are generally, body fully-dressed
- In a non-swimmer, naked body suggests suicide
- drowning in shallow water generally indicates homicide
- heavy weights may be rarely tied to the body.

3] Homicidal Drowning: victim is forcibly pushed into water to drown him

- heavy weights are commonly tied to the victim's body.
- drowning in shallow water generally indicates homicide
- victim's hands & legs may be tied.