ASPHYXIA

1) Many rapid death of Medico-legal importance are fundamentally due to an interference with oxygenation of the times. For practical purpose such death may be clarified by the manner in which the hypoxia (O2 deficiency) or the anoxia (total lack of oxygen) is initialed.
2) Death due to an interference with oxygenation of the times result from hypoxia of anoxia.

General pathological changes- Asphyxia–

1) Capillaries are particularly susceptible to hypoxia and anoxia, and hypoxic or anoxic injury of the capillaries is the result in there dilation. This is followed by stagnation of blood in the dilated capillaries and in the veins, which accounts for the capillaceous engagement which is a major feature of the general pathological findings in rapid hypoxic and anoxic death.
2) Injury to the capillary wall is often accompanied by petechial haemorrhage in the times.
3) ↑ Capillary permeability, oedema.
4) Cyanosis
5) Post mortem fluidity of blood
6) Cardiac dilatation

Different types of Asphyxia

- Mechanical Asphyxia
- Environmental Asphyxia
- Pathological Asphyxia
- Traumatic Asphyxia

MECHANICAL ASPHYXIAL DEATHS

Hanging is that form of asphyxia which is caused by suspension of the body by a ligature which encircles the neck, the constricting force being the weight of the body. The whole weight of the body is not necessary, and only a comparatively slight force is enough to produce death. In 'partial hanging' the bodies are partially suspended, the toes or feet touching the ground, or are in a sitting, kneeling, lying down, prone or any other posture. The weight of the head (5 to 6 kg) acts as the constricting force. In typical hanging, the ligature runs form the midline above the thyroid cartilage symmetrically upward on both sides of the neck to the occipital region.

Ligature: A suicide will use any article readily available for the purpose, like a rope, metallic chains and wires, leather strap, belt, bed sheet, scarf, dhotie, saree, turban, sacred thread, etc. The doctor should note whether the mark on the neck corresponds with the material alleged to have been used in hanging and if it is strong enough to bear the weight and the jerk of the body. He should also note its texture and length, to know whether it was sufficient to hang. Before removing the ligature from the neck, it should be described as to the nature and composition, width, mode of application, location and type of knot. Sometimes, the rope will break or become

detached and the deceased will be found lying on the ground with a ligature around his neck.

Symptoms: The first symptoms are loss or power and subjective sensations, such as flashes of light and ringing and hissing noises in the ears. There is intense mental confusion, all power of to logical thought is lost; the individual can do nothing to help himself even if it were possible. These are to followed by loss of consciousness, which is so rapid, that it is regarded as a painless form of death. Then follows a stage o convulsions. The face is distorted and livid, eyes prominent, and there is violent struggling. Respiration stops before the heart, which ay continue to beat for about 10 to 15 minutes.

Causes of Death :

(1) **Asphyxia:** The constricting force of the ligature, causes compressive narrowing of laryngeal and tracheal lumina, and forces up the root of the tongue against the posterior wall of the pharynx, and folds the epiglottis over the entrance of the larynx to block the airway. A tension of 15 kg. on ligature blocks the trachea.

(2) **Venous congestion:** The jugular veins are blocked by the compression of the ligature which results in stoppage of the cerebral circulation, and a rapid rise in venous pressure in the head. This occurs if ligature is

made up of broad and soft material, which cannot sink into tissue to any depth. The jugular veins are closed by a tension in the rope of 2kg.

(3) **Combined asphyxia and venous congestion:** This is the commonest cause.

(4) **Cerebral anaemia:** Pressure on the large arteries on the neck produces cerebral anaemia and immediate coma. This occurs with ligature made of thin cord, which sinks deeply into tissues. A tension of 4 to 5kg on ligature blocks carotid arteries, and 20 kg. the vertebral arteries.

(5) Reflex vagal inhibition form pressure on the vagal sheath or carotid bodies.

(6) Fracture or dislocation of the cervical vertebrae.

Delayed Death: Death delayed for several days is rare. Delayed deaths occur due to (1) aspiration pneumonia, (2) infections, (3) oedema of lungs, (4) oedema of larynx, (5) hypoxic encephalopathy, (6) infarction of brain, (7) abscess of brain, (8) cerebral softening.

The secondary effects fo hanging in persons who have recovered are sometimes hemiplegia, epileptiform convulsions, amnesia, dementia, cervical cellulitis, parotitis, retropharyngeal abscess, amnesia, and dementia.

Fatal Period : Death occurs immediately if the cervical vertebrae are fractured, or if the heart is inhibited; rapidly if cause is asphyxia, and least rapidly if coma is responsible. The usual period is 3 to 5 minutes.

Treatment: After the ligature is cut to remove the constriction of the neck, artificial respiration and stimulants should be given.

Post-mortem Appearances : External: The ligature mark in the neck is the most important and specific sign of death from hanging. Ligature mark on the neck depends on: 1) Composition of ligature: The pattern and texture is produced upon the skin, e.g., if thick rope is used, its texture may be impressed in the form of superficial abrasion. 2) Width and multiplicity of ligature : When ligature is narrow, a deep groove is made because much more force per sq. cm. Of ligature is directed inwards. A broad ligature will produce only a superficial mark. If the ligature is passed twice round the neck, a double mark, one circular, and the other oblique may be seen. The ligature may have one, two or more layers. There may be multiple congested areas where the skin has been caught between the various layers. 3) The weight of the body suspended and the degree f the suspension: Heavier he body and greater the proportion of the body suspended, the more marked is the ligature impression. 4) The tightness of encircling ligature: The ligature impression is deeper opposite the point of suspension, but it may tail off vary rapidly if ligature consists of loop rather than a noose. If the noose tightness completely around the neck, the ligature mark will be seen completely encircling the neck. 5) The length of time body has been suspended: Longer the suspension, deeper is the groove. Even a soft, board ligature can cause a clear-cut groove if suspended long. If the ligature is cut down within a short time and a soft broad ligature has been used, there may be no external mark. 6) Position of the knot: The main force applied to the neck b ligature is opposite to the point of suspension. If the point of suspension is in occipital region, front of the neck

is involved. If in front, the depth of the groove is limited posteriorly by cervical spine. 7) Slipping of ligature during suspension: Frequently, only the portion adjacent to the knot moves. There is a tendency for the ligature to move upwards, this being limited by the jaws. The upward movement may produce double impression of ligature. The lower mark is usually very superficial and is connected by fine abrasions, caused by the slipping ligature, to the mark made by ligature in its final position.

Knot: It is frequently in the form of a simple slip-knot to produce a running noose or fixed by granny or reef-knot; occasionally a simple loop is used. The knot is usually on the right or left side of the neck, ligature usually rising behind the ear to the point of suspension. Sometimes, the knot is in the occipital region and rarely under the chin. After suspension in hanging, the knot is at higher level than the remainder of ligature, the movement of knot being due to the act of suspension. The involvement of another party may be suggested by certain types of knots and nooses. Removal of the noose from the neck is done by cutting the noose away from e knot and tying the cut ends with string or wire.

Ligature Mark: The ligature produces a furrow or groove in the tussue which is pale in colour, but it later becomes yellowish or yellowbrown and hard like parchment, due to the drying of the slightl abraded skin. The course of the groove depends on whether a fixed or running noose has been used, when the loop is arranged with a fixed knot, the curse of the mark is deepest and nearly horizontal on the side opposite to knot, but as the arms of the ligature approach the knot the mark turns upwards towards it. This produces an inverted 'V' at the site of the knot, the apex of the 'V' corresponding with the site of the knot. An impression from a knot any be found if the ligature is tight on the skin, usually on one or other side of the back and occasionally beneath the chin. A slip-knot may cause the noose to tighten and squeeze the skin through the full circumference of the neck. In the case of a fixed loop with a single knot in the midline at the back of the head, the mark is seen on both sides of the neck and is directed obliquely upwards towards the position of the knot over the back of the neck. In the case of a fixed loop with a single knot in the midline under the chin, the mark is seen on the back and both sides of the neck, and is directed obliquely forwards towards the position of the knot over the front of the neck. In the case of fixed loop with the knot in the region of one ear, the mark differs on each side of the neck. On the side of the knot, the mark is directed obliquely upwards to the knot, and on the other side it is directed transversely. If the ligature is in the form of a loop, the mark will be

most prominent on the part of the neck to which the head has inclined and less marked over the region of the open angle of the loop. When a running noose is applied, the weight of the body will cause the noose to tighten in a mainly horizontal position. The mark is seen on both sides of the neck, and is usually directed transversely across the front of the neck resembling that of a ligature mark in strangulation, except that it is likely to be seen above the level of thyroid cartilage. If a running noose fails to tighten, the mark may resemble one produced by a fixed loop. If the noose is a belt dig into the skin. In hanging from a low point of suspension, the groove produced by the ligature is less well marked, and may be at about the level of the upper border of the larynx and more horizontal. In partial hanging when the body leans forward, a horizontal ligature mark may be seen. The ligature mark usually encircles the entire neck except for the place where the knot was located. The firmer muscular tissues at the back of the neck do not show clear and deep grooves, as are teen of the depression, a thin line of congestion or haemorrhage will be seen above and below the groove at some point, usually the deepest, if not throughout its course. Ecchymoses alone have no significance as to whether hanging was caused during life or not, but abrasions with haemorrhage are strongly suggestive of suspension taking place during life.

The mark is situated above the level of thyroid cartilage, between the larynx and the chin in 80 percent of cases. It may be at the level of the cartilage in about 15 percent, and below the cartilage in about 5 percent cases, especially in partial suspension. The width of the groove is about, or slightly less than the width of the ligature. Any well-defined pattern in the ligature is match of patterns. When fresh, the ligature mark is less clear, but becomes prominent after dying for several hours. A portion of skin and deeper tissue in relation to ligature should be examined microscopically for evidence of tissue reaction, which if present indicated ante-mortem hanging. The absence of tissue reaction does not exclude ante-mortem hanging (Gordon, et al). however, hanging may occur without visible marks on the victim's neck. If there is a beard. Or if a portion of clothing is caught between the ligature and the skin, no ligature mark any be found under it. When a folded cloth has been used, there may be great difference between the appearance of the neck mar and the size of the ligature. When fabric is pulled tight, certain parts of it become raised into ridges, which form the ligating surface, and only these may be reproduced on the skin. When nylon, silk or terylene fabrics are used, they may leave a mark only 2 to 3 mm wide. A loop made of soft material e.g., towel, scarf, etc. may not produce a ligature mark, but the knot may produce an abrasion due o its firmness. If there is no ligature, the mark should be taped, as it may pick up some fibers by the ligature and facilitate

the identification of the material of which the ligature was made. The ligature mark of hanging may be reproduced by dragging a body aong the ground with ligature passed round the neck soon after death. decomposition obliterates the ligature mark. The ligature mark may disappear after several bourns following removal of the ligature.

In obese persons or infants, skin folds on the neck may resemble a ligature mark, especially after refrigeration of the body has caused coagulation of the subcutaneous fat. When there is swelling of the neck tissues due to decomposition, marks may be produced by jewellery or clothing.

Partial Hanging: Hanging may occur simply by leaning against the noose secured to a chair or door knob, the leg of a table, a bedpost or rail, or the handrail of a staircase, which is slightly higher than the position of the head, the deceased being in a kneeling position, or fall back or forward and lie prone with only the face and chest off the ground. In these cases, the constricting face is less and congestive changes are more marked. Hanging may occur when pressure is applied only at the font of the neck, e.g. by the arm of a chair, rung of a ladder, etc. in such case, the marks on the neck may be indistinct or absent.

Other Signs: Asphyxial gins are present in about half the cases of death due to hanging. The neck is stretched and elongated and the head is always inclined to the side opposite to the knot. The face is usually pale, due to cerebral ischaemia or vagal inhibition, but is sometimes congested and swollen (swelling often disappears when the body is cut down), f the veins were constricted before the arteries. Occasionally, the congestion drains away from the head, inspite of the ligature being still in position. This probably occurs through the vertebral venous plexus, which is not easily compressed as the jugular veins. The brain is often drained of blood in this way. The petechial haemorrhages in the skin and conjunctivae remain, as they are extravascular. The signs of asphyxia are most marked in cases in which the noose as placed high up on the throat. Obstruction of the jugular veins, while the arteries remain patent, leads to severe engorgement of the head and neck. Slow asphyxia is the exception in hanging and is likely to occur only when the point of suspension is a low one, or ligature exerts pressure below the chin and does not encircle the neck. When suspension is in complete or in the standing posture, asphyxial signs are slight, petechial haemorrhages are relatively uncommon due to the complete obstruction of the arterial system, but are usually present when hanging has been from low

point. Sometimes, they are so minute and diffuse that the head and neck have a dusky appearance which may be mistaken for congestion, especially when petechiae are in subcutaneous tissues. They may be completely than usual due to congestion. Te conjunctive are open, and the pupils are usually dilated. If the ligature knot presses on cervical sympathetic, the eye on the same side may remain open and its pupil dilated. It indicates ante-mortem hanging (le facile sympathique). The tongue is usually swollen and blue especially at the base, and usually forced against the teeth when the jaw is shut, or the tip may be found projecting between the lips. The protruding part of the tongue is usually dark-brown or even black due to drying. The lips, and the mucous membrane of the mouth are blue. Saliva may be found dribbling from the angle of mouth when the head is drooping forward. This is due to the increased salivation before death due to the stimulation of the salivary glands by the ligature. Slight haemorrhage or bloody froth is sometimes seen at the mouth and nostrils, and some blood may be found under the head. This results from rupture of engorged blood vessels, and should not be mistaken for evidence of foul play. Occasionally, haemorrhage into the middle ears is seen due to excessive congestion. The hands are clenched, especially in violent hanging. Engorgement of the penis with blood occurs from hypostasis' it may be semierect, and semen may be found at the tip. Urine and faeces may escape due to relaxation of the sphincters. If the body has been suspended for sometime, post-mortem hypostasis is seen in the legs, feet, hands and forearms, while the upper part of the body will be pale. Petechial haemorrhages may be found in the skin of the legs in 2 to 4 hours. If the body in removed within 4 hours after death and is placed in supine position, post-mortem hypostasis in the limbs will fade and new areas of lividity will appear along the back and buttocks.

Internal: The neck should be examined after removal of the brain and viscera from the chest and abdominal cavities. Superficial incision of the groove may show small haemorrhages in the underlying layers f skin, caused by the direct trauma produced by the ligature. The tissues under the mark are dry, white and glistening with occasional ecchymses in the adjacent muscles. In most cases, there is no bruising of strap muscles or other soft tissues, the muscles of the neck, especially the platysma and sternomastoid are ruptured (5 to 10%), if violence has been considerable. In some cases (5 to 10%), the intima of he carotid arteries show transverse splits with extravasation of blood in their wall due to stretching and crushing. Several horizontal intimal tears scattered along the carotid arteries at different levels are sometimes found in hanging associated with a long drop. To demonstrate these tears,

the carotid arteries should be opened to the level of mandible. The vertebral arteries show rupture, intimal tears, and subintimal haemorrhages in some cases. Opinion varies regarding the frequency of fracture of the hyoid bone. Estimates range from 0 to 60%, but the average is 15 to 20%. Fractures are rare below 40 years because of the elasticity of the cartilage and mobility of the joints. The fracture is common in persons above 40 years and involves the great horns, at the junction of inner two-thirds and outer one-third. The fracture is usually a direct result of the ligature, but it can be a traction or "tua" fracture. The superior horns of the thyrohyoid may be fractured from pressure on the thyrohyoid ligament in about 40% of cases above 40 years. Injury to the trachea is unusal. Petechial haemorrhages may be found on the epiglottis, in the larynx and trachea. The trachea is usually congested. The lungs are congested, oedematous, and exude bloody serum on section in cases of constriction occurring at the end of expiration; but they are pale if constriction occurred at the end of inspiration. Subpleural ecchymoses may be found. The abdominal organs are usually congested. The brain is usually normal, but may be pale or congested according to the mode of the death. subarachnoid effusions are common.

Diagnosis: 1] Ligature mark around the neck, 2] presence of abrasions, ecchymoses and redness about the ligature mark, 3] trickling of saliva from the mouth, 4] ecchymoses of the larynx or epiglottis, 5] rupture of the intima of the carotid, and 6] post-mortem signs of asphyxia.

The Circumstances of Death: Scene of Crime: Note the posture of the body, any signs of violence or disorder of furniture, etc., and the condition of the clothing of the deceased. The texture and length of ligature should be noted to know whether it was sufficient to hang. If the ligature had broken and the victim is found on the ground, free ends of the ligature should be compared to know whether they coincide and that a break had occurred.

Accidental hanging: Accidental hanging may occur [1] during play or at work, and [2] in sexual deviation. It is seen in children during play while imitating judicial hanging or in athletes who are in the habit of exhibiting hanging. Some padding between ligature and neck suggests accident. Workmen in falling from scaffolding may be hanged by becoming entangled in ropes. When boys climb trees or railings they may loose their foothold and in falling, some garment is caught by branch of tree or bar and is drawn tight round the neck. Infants wearing restraining apparatus may wriggle partly out of it, and become asphyxiated by its tightening around their neck as they try to crawl away or fall over the side of the bed. The ligature need

not completely encircle the neck to cause death. It is sufficient if it is applied beneath the chin so as to compress the sides of the neck, e.g. suspension of the chin by the steering wheel of a motor car, the tailboard of a lorry or cart, the edge of a sofa, or the arm of chair. A person who slips when descending a ladder may be suspended by one of its rungs, or a slip on a staircase may result in suspension on the edge of one of the treads. It may be associated with abnormal sexual behavior.

Suicidal Hanging: Hanging is a common method of committing suicide. A typical method of self-suspension is to attach a rope to a high point, such as a beam, window-casing, ceiling fan, branch of a tree, etc. The lower end is formed into either a fixed loop or a slip-knot which is placed around the neck. The victim stands on a stool, chair or other platform and jumps off or kicks away the support, due to which the body is suspended. The body must be in a position compatible with self-suspension. It is important to examine the point of attachment and the surrounding area. If the point is high, then it is likely that there will be recent disturbance of dust caused while attaching the ligature. The deceased's hands and sometimes part of his clothing may also show the presence of corresponding dust marks. There may also be disturbance of dust from the attached cord or from an abraded area particularly if a beam has been used to attach the ligature. Complete suspension of the body is the absence of any platform is unusual in suicide. Unusual positions, e.g., where the parts of the body touched the ground, kneeling or reclining, are almost diagnostic of suicide. The hands and feet himself, to prevent a change of mind. The position of the ligature with reference to the knot and the manner in which it is attached to the support must be compatible with self-suspension. Determination of purpose will often compensate bodily infirmity. Blindness or age is no bar to hanging. The victim might pull away the ligature to free himself from the constriction and if he had long nails, nail marks may be inflicted on the neck. Sometimes, the upward movement of the rope at the time of suspension may scratch the skin. In an attempted resuscitation, scratches or nail marks on the neck may be produced by another person. Sometimes a person may hang himself after other forms of suicide, e.g., cutting the throat or wrists, stabs, firearm wounds, ingestion of poison, etc., have failed to produce death. suicide pacts effected by hanging are rare.

Homicidal Hanging: It is extremely rare. It is difficult for a single assailant to carry it out unless the victim becomes unconscious by injury or by a drug, or is taken unawares, or is a child or a very weak person. Homicide should

be suspected (1) where there are signs of violence or disorder of furniture or other objects, (2) where the clothing of the deceased is torn or disarranged, (3) where there are injuries, either offensive or defensive. Any definite scratches, especially crescentic nail marks point to manual strangulation, and if associated with bruising of neck structures and fracture of larynx, the probability of murder is strong. In all doubtful cases, circumstantial evidence is important.

Lynching: It is homicidal hanging. Sometimes a suspect, accused or enemy is hanged by a rope from a tree, etc., by the mob.

Post-mortem Hanging: A person may be murdered, and the dead body suspended to simulate suicide. Look for signs of dragging to the place of suspension. When a dead body is suspended, the rope is usually tied first around the neck, and then around the beam, branch of a tree, etc. The beam shows evidence of the rope having moved from below upwards as the body has been pulled up. In true suicidal hanging, the rope moves from above downwards. Further, fibers from the rope may be found on the hands of the victim in suicidal hanging, but not in case of post-mortem hanging. The rope should be examined for presence or absence of any paint similar to one on the beam. In most cases, the internal signs are clearly not those of hanging, although in most cases ligature mark cannot be distinguished. Rarely, for motives of revenge, fraud or for some other reason, a victim arranges his suicide to appear to have been a murder.

Judicial Hanging: In Indial, legal death sentence is carried out by hanging the criminal. The face of the person is covered with a dark mask, and he is made to stand on a platform above trapdoors which open downwards when a bolt is drawn. A rope to allow a drop of 5 to 7 metres according to the weight, age and build of the person, is looped round the neck, with the knot under the angle of the jaw. The placement of the knot beneath the chin, in the submental position is said to be more effective. On drawing the bolt, the person drops to the length of the rope. The sudden stoppage of the moving body associated with the position of the knot causes the head to the jerked violently. This causes fracture-dislocation usually at the level of the second and third, or third and fourth cervical vertebrae. Less commonly, dislocation of the atlanto-occipital joint or odeontoid process of the axis vertebra occurs causing pulping of the spinal cord and transection of the cervical spine, causing the neck to be lengthened considerably. The upper cervical cord is stretched or torn across, and sometimes the medulla is torn at the border of

the pons. It results in immediate unconsciousness, but heart bearts and respiratory movements may continue up to 10 to 15 minutes and spasmodic muscular jerking may occur for a considerable time. The pharynx is usually injured and the carotid arteries may be torn transversely, either partly or completely.

STRANGULATION

Strangulation is that form of asphyxia which is caused from constriction of the neck by ligature without suspending the body. Pulling a U-shaped ligature against the front and sides of the neck while standing at the back can cause death. It is of two types: [1] Strangulation by a ligature, and [2] manual strangulation or throttling.

Symptoms: Sudden and violent compression of the windpipe causes almost immediate insensibility and death. If the windpipe is partially closed, buzzing in ears, congestion and cyanosis in head, vertigo, tingling, muscle weakness, bleeding from the mouth, nose and ears, clenching of the hands and convulsions occurs before death.

Cause of Death: Death may be due to (1) asphyxia, (2) cerebral anoxia or venous congestion, (3) combined asphyxia and venous congestion, (4) vagal inhibition, and (5) rarely fracture-dislocation of cervical vertebrae.

Medico-legal Questions:

1] Whether Death was caused by Strangulation?

- In death due to strangling, the general features of asphyxial death are present. Their local distribution in the head and neck is strongly presumptive of strangulation. This is confirmed by the ligature mark on the neck. Evidence of violent compression or constriction of the neck during life is obtained from the presence of bruising or ecchymoses about the marks on the neck, haemorrhages in the strap muscles, under the skin, in the sides of the tissues around the trachea and larynx, in the larynx and in the laryngeal structures themselves. The ligature mark alone is not diagnostic, for it may be indistinct or absent, if a soft ligature material is used. The ligature mark may be produced by the application of a ligature to the neck even after death. Certain marks on the neck produced after death may simulate ligature mark. The possibility of other causes of suboxic or asphyxial death should be excluded. In the absence of ligature mark in the neck or deeper injury, it will be difficult to form an opinion, except from circumstantial evidence. In cases of putrefaction, a medical opinion about strangulation can be given fairly, if there are signs of mechanical violence applied to the neck, e.g., fracture of the larynx or hyoid bone, bruising of the muscles and visible skin impressions. Indistinct marks on the neck, patches of discolouration or signs of asphyxia cannot be relied upon as evidence of strangulation in a putrefied body.

2] Whether the Strangulation was Suicidal, Homicidal or Accidental?

- **Suicidal Strangulation:** Suicide by strangulation is rare. Various methods of tightening the ligature are employed by the victims. The number of knots, tightness and method of knotting should be considered. Sometimes it is tightened like a tourniquet, but the person can apply a single or double knot, before consciousness is lost. In most cases, some mechanical device is always made to keep the ligature tight after insensibility develops. Several turns of rope are tied round the neck with the side or back of the neck. A cord may be tied around the neck and twisted tightly by means of a stick or some other solid material used as lever. When consciousness is lost, although grip on stick is released, the ligature will not become loose as it gets arrested against the shoulder or chin. In some cases, a running noose is applied to the neck, and the free end of the rope to which a weight is attached, is thrown over the end of the bed on which the victim lies. A person may strangle himself by leaning with the whole weight of

his body on a cord passed round the neck and attached to a fixed point.

In suicidal strangulation, the signs of venous congestion are very well developed above the ligature, and are especially prominent at the root of the tongue. This severe congestion probably results by the slow tightening of the ligature, and also because it is usually so secured that it remains in place after death, preventing post-mortem drainage of blood. Injuries are usually less marked because less force is used. In all cases of suicidal strangulation, the ligature should be found in situ, and the body should not show signs of violence or marks of struggle. If ligature is still present, the number of turns and type of the knots require detailed study. The application of ligature with several turns, whether closed with a half-knot or even a complete knot, is consistent with suicide. A correct medical opinion may be usually formed from the course and direction of the tie, the way in which it was secured or fixed to produce effective pressure on the windpipe, and the amount of injury to the muscles and parts beneath.

Homicidal Strangulation: Strangulation is a common form of murder. Many of the victims are adult women and frequently strangulation is then associated with sexual interference. Usually there is a single turn of ligature round the neck, with one or more knots (granny or reef knots) at the front or side of the neck. When there are two or more firm knots, each on separate turns of the ligature, homicide is almost certain. There may be more than one ligature mark, each of varying intensity and crossing each other, in parallel or at an angle to each other. Abrasions are usually seen due to movement of the ligature across the neck. Fingernail marks may be seen, either from the victim attempting to remove the ligature, or from the assailant attempting to secure the ligature, and/or restrain the neck from moving, or even attempting manual strangulation. The victim's clothing may sometimes be caught in the ligature during a struggle and produce marks, which require careful evaluation. The mark may either completely encircle the neck or may be seen only at the front, when the ligature is pulled tightly from behind. The mark may also be sloping if the ligature is pulled upwards from behind, and the position is high up at the level of the hyoid bone. Sometimes, a ligature is passed over the body, and then tied to the hands and feet to simulate suicide. In such cases, the manner of tying should be examined. Infanticide by strangulation may be caused by winding the umbilical cord round the infant's neck. In such cases, the cord will show appearances indicative of rough handling with displacement of Wharton's jelly, and other signs of

violence are present on the body. The presence of a complex type of knotting in the cord, e.g., the presence of reef knot, suggests homicidal strangulation. Sometimes, homicidal strangulation is feigned by an individual to bring a false charge against his enemy. Hysterical women sometimes feign it without any obvious motive.

Evidences of struggle are usually found, but if the person is taken unawares, and the ligature is suddenly placed around the neck and pulled tightly, the person loses consciousness quickly and is unable to offer much resistance. If the person is weak and infirm, or made unconscious by blows on the head or by intoxicating drugs and in children, there may be few or no signs of struggle. If the clothing of the deceased is torn or disarranged, it indicates that a struggle has taken place. If there is a struggle, both assailant and victim may show abrasions and contusions.

Strangulation should be assumed to be homicidal until the contrary is shown. As a rule, the murderer uses for more force than is necessary, and as such, injuries to the deeper structures are well marked. If the ligature is around the neck with two or three knots at the back of the neck, it is presumptive of homicide. The ownership of the ligature may sometimes become an important clue, e.g., if the ligature found around the dead body may be proved to correspond with parts of the same material found in the possession of suspected assailant. Unusual ligatures may narrow the search for the assailant, since they may be material of the kind used in a particular occupation. If the ligature is removed or lies loose, unless explained, are presumptive of homicide.

If the ligature mark of occhymosis in the neck does not accurately correspond with the ligature found, it is presumptive of homicide. Sometimes, circumstantial evidence, such as time, place, locked doors, and windows, motive, etc., is almost the only ground for a suggestion either of suicide or homicide.

Ligature marks produced after death do not show bruising. Either a grooved impression is seen on the skin which is not injured, or yellow or brown abrasion without signs of vital reaction. There may be ligatures or other marks around the limbs especially wrists and ankles, which may be placed either before or after death.

The common methods of homicidal strangulation are: (1) strangulation by ligature, (2) throttling, (3) bansdola, (4) garroting, and (5) mugging.

BANSDOLA: One strong bamboo or stick is placed across the back of the neck and another across the front. Both the ends are tied with a rope due to which the victim is squeezed to death. sometimes, a stick is placed across the front of the neck, and the assailant stands with a foot on each end of the stick. If a stick or foot is used, a bruise is seen in the center of the neck across the windpipe corresponding in width to the substance used. If two sticks are used, a similar mark will be seen on the back of the neck. Sometimes, the chest may be squeezed forcibly between two sticks placed across the back and front of the upper part of the chest. This interferes with respiration and causes laccration of the muscles and fractures of the ribs.

GARROTTING: The victim is attacked from behind without warning. The throat may be grasped, or a ligature is thrown over the neck and quickly tightened, by twisting it with a lever, (rod, stick, ruler, etc., known as Spanish windlass), which results in sudden loss of consciousness and collapse. This method had a refinement in which the neck was forced against a sharp spike which penetrated the spinal cord. The assailant is then able to tie the ligature with one or more turns. In this way, a single assailant can kill a healthy adult male. Garroting as a mode of execution was practiced in Spain and Turkey.

MUGGING: Strangulation is caused by holding the neck of the victim in the bend of the elbow. Pressure is exerted either on front of the larynx, or at one or both sides of the neck by the forearm and upper arm. The attack is

usually made from behind. The post-mortem appearances are those of ligature strangulation with a broad object, i.e. the signs are minimal. Sometimes, a diffuse abrasion may be seen along the margin of the jaw due to the friction of the forearm. Internally, there may be diffuse bruising, but this may be slight or absent. There may be bruising behind the larynx and in the strap muscles of the neck. Fracture of superior horn of thyroid or hyoid is rare. In some case, the neck may pressed by the foot or knee. When the neck is stamped on repeatedly, there will be crushing of the larynx and trachea, and bleeding in the soft tissues with swelling.

Accidental Strangulation: Children may get entangled in ropes during play, or the neck may be caught in window cords, etc. infants are sometimes strangled in their cots when the neck is caught inside bars, in restrainers, braces, etc. Occasionally, an infant is strangled with a string attached to a toy tied to the crib. Persons under the influence of alcohol, epileptics, and imbeciles may be strangled either by a tight scarf or collar and neck tie. It may occur if an intoxication person rests the neck against a bar or other hard object. It may occur when a string used in suspending a weight on back, slips from across the forehead and compresses the neck. In industry, belts, ropes or parts of clothing may be caught in the rollers or other parts of the moving machinery and cause accidental strangulation. Accidental strangling may occur in uterus when the movement of the foetus causes the umbilical cord to encircle the neck. In such case, there is relatively slight cervical tissue injury. Wharton's jelly is not damaged and lungs are usually incompletely expanded. In a charge of murder, it may be suggested that the deceased might have been accidentally strangled in a state of intoxication, either by a tight scarf or collar and tie. When there is pressure on the windpipe, the victim attempts to pull the ligature, and scratches may be found on the neck, which may arouse a suspicion of throttling. If the relations of the body to surrounding objects and the constricting agent have not been disturbed, cases if accidental strangulation present no difficulty. If the body has been removed from the place in which it was first discovered, or the ligature has been removed, the presumption of accident can only be established from the description given.

THROTTLING OR MANUAL STRANGULATION

Asphyxia produced by compression of the neck by human hands is called throttling. Death may occur due to asphyxia, or the pressure may continue for sometime for asphyxia signs to appear, and then a change in grip may allow the fingers to press on the carotid structures and cause reflex cardiac arrest. Vagal inhibition is much more common in manual strangulation than with a ligature.

Medico-legal Questions:

1) Whether death was caused by throttling?

- The usual diagnostic signs of death due to manual strangulation are: [1] Cutaneous bruising and abrasions. [2] Extensive bruising with or without rupture of the neck muscles. [3] Engorgement of the tissues at and above the level of compression. [4] Fracture of the larynx, thyroid cartilage, and hyoid bone. [5] Cricoid cartilage is almost exclusively fractured in throttling. [6] General signs of asphyxia.

When all the signs are present, the diagnosis is easy. In the absence of external signs, or when they are equivocal, care is necessary. The pressure must be applied for two minutes or more to cause death. fingernail abrasions are often produced due to the victim and assailant may indicate their origin. When a suspended body shows extensive injuries to the neck structures, there is a strong probability that the victim was first throttled and then suspended after death. In such case, signs of violence on the body, and sometimes of rape, if present are helpful. The discolourations produced in

decomposing bruises are usually localized, but similar areas of decomposition may be found when decomposition affects localized ante-mortem intravascular collections of blood in the cervical tissues, or localized patches of post-mortem lividity. Hyoid bone fracture is strongly suggestive of throttling.

When throttling has been attempted at about the moment of death, one cannot be certain whether the deceased was alive or dead at the time. Nail marks will appear much the same whether produced just before or just after death, but contusions are only produced during life.

2) Whether the throttling was suicidal, homicidal or accidental?

Suicidal Throttling: Suicide by throttling is not possible, because the compression of the windpipe produces rapid unconsciousness and the fingers are relaxed.

Homicidal Throttling: Throttling is a common mode of homicide because the hand is immediately available. It is a method of choice in infants. The victims are usually infants, children or women. Adults can be throttled when under the influence of drugs or drink, or stunned or taken unawares. In an adult, signs of struggle are usually present, but if the throat is forcibly grasped and firmly compressed, the victim cannot struggle. The assailant may also sustain injury, especially scratches and bruising of the face and

arms, or his hands and fingers may be bitten. The alleged assailant should be examined to correlate any injuries that may have been inflicted on him by the fingernails of the victim, such as scratches. The fingernail scrapings of the assailant should be taken to compare any debris found and the tissue types of the victim. Sometimes, it is preceded by rape or attempted rape. The victim may have been held down b the throat during intercourse or throttled to stop her cries. If contusions and fingernail abrasions are present on the neck, the presumption must be of homicide. The defense may allege that such marks have been produced due to fall by the deceased while his hand was passively applied to his neck, the marks being produced accidentally by the pressure of his own fingers. This is highly improbable. Sometimes, a person might bry to strangle himself with his hand, and upon failure might use a ligature. In such case, the degree to which the impressions exist will usually clear the doubt.

Accidental Throttling: A sudden application of one or both hands on other person's throat as a demonstration of affection, in joke, as a part of physiological experiment, etc., may cause death from cardiac inhibition.

3) How much force could have been used by an assailant?

If there is severe damage to neck structures, it indicates use of considerable force, and is indicative of intent to injure, if not to kill. If there is fracture of hyoid bone or larynx, it indicates the use of appreciable force and is homicidal in nature, for it cannot be an accidental touch or momentary grip. A brief and minor contact with the neck would be consistent with restraint, without intention of injuring and causing death. minor damage or absence of damage to the neck structures is presumptive of innocence, but sometimes deliberate interference with the neck structures can kill without producing much damage, e.g., the karate blow. If a only slight changes are seen in the neck structures, a guarded opinion should be given about the probable degree of force used.

SUFFOCATION

Suffocation is a general term to indicate that form of asphyxia, which is caused by deprivation of oxygen, either due to lack of oxygen in the environment or from obstruction of the air-passages.

SMOTHERING

This is a form of asphyxia which is caused by closing the external respiratory orifices either by the hand or by other means, or blocking up the cavities of the nose and mouth by the introduction of a foreign substance, such as mud, paper, cloth, etc.

Suicide by Smothering: Suicidal smothering by the hand is impossible. Suicide is possible by burying the face in a mattress or lying against the bed clothing to obstruct the nose and the mouth, it is usually seen in the mental patients or prisoners. Sometimes, in cut-throat wounds, the trachea may be completely cut and the soft parts may obstruct the trachea and the victim is smothered. Suicidal suffocation can be effected by tying a polythene or similar bag over the head.

Accidental Smothering: Most fatal smothering is accidental. Rarely, infants during the first month of life, especially when premature may be smothered by the weight of the bed clothes when they cover the nose and the mouth. Suffocation also occurs when the infant 3 months or less, turns on its face and buries it in soft pillow or mattress, it is not necessary that the mouth and nostrils should be completely closed at the start, for as obstruction increases and congestion develops, saliva, mucus, oedema fluid, and traces of blood will pour out into te mouth and cause obstruction to breathing. An

epileptic or intoxicated person may smother himself accidentally by burying his face in a pillow or covering with bed clothes. A person may accidentally fall into a large quantity of semisolid or finely divided material like mud, ashes, grain, sand, coal dust, etc., so that his mouth and nose are covered by the substance. The victim may struggle, inhale some of the material into his air-passages, and swallow some into his stomach in an effort to breathe. Children may be suffocated accidentally while playing with plastic bags. Death may occur even if the open end of the bag is not tied around the neck due to cardiac inhibition. Smothering from plastic bags may occur due to the addictive habit of "glue-sniffing", in which the organic solvents of certain glues is used as an intoxicant, by putting obtain a high concentration of vapor. In such cases, chemical analysis is essential. Plastic bags may be applied to the head for experiment or auto-erotic exercise, as partial asphyxia is believed to increase sexual sensation. It also occurs if the membranes remain round the head of the newborn after delivery.

Environmental Suffocation: Asphyxia is due to insufficient oxygen in the environment. Deaths are almost always accidental. An oxygen concentration of 16% or less is dangerous, and with 5% concentration, consciousness is lost rapidly and death occurs within a few minutes. Smothering occurs in airtight place or one in which ventilation is negligible. This may occur when children become locked in old disused refrigerators or when they lock themselves into large boxes or trunks during play. Suffocation due to lack of oxygen in the atmosphere may occur in the vicinity of lime kilns and wells or excavations in chalk rock, where the oxygen is displaced by CO_2. In a confined space, such as tanks, grain-bins, silos, deep tanks of a ship, fermenters, tanning vats, unused wells, sewers, etc., hazardous gases, vapour, dust or fumes may accumulate or the oxygen may be deficient. A person may be suffocated on entering such a confined space. Inhalation of irrespirable gases, such as CO_2, CO, hydrogen sulphide, or smoke from a burning house, or entering into disused wells produce suffocation. CO_2 and methane are the most commonly encountered suffocating gases. Suffocation may occur in decompression, such as cabin failure of aircraft at high altitudes. It also occurs in ship's tanks or other industrial metal chambers, in which oxygen is replaced by nitrogen. In deaths associated with replacement of oxygen with an inert gas, rapid death is common before hypoxia had any physiological effect. In hypoxic death petechial haemorrhages are absent. Congestion and cyanosis may or may not be present.

Homicidal Smothering: Homicide is possible where the victim is incapacitated from drink or drugs, very weak, child or old person, in ill-health and when the victim is stunned by a blow. Usually, the mouth and nose are closed by a hand or cloth, or the face may be pressed into a pillow.

Autopsy: Obstruction by bed clothing, a pillow, a cushion, etc., applied with skill, may not leave any external signs of violence, especially in the young and the old, except signs of asphyxia. When the face is pressed into a pillow, the skin around the nose and mouth may appear pale or white due to pressure, with cyanosis of the face. Saliva, blood, and tissue cells may be found on the pillow. If the orifices are closed by the hand, there may be scratches, distinct nail marks, or laceration of the soft parts of the victim's face. The lips, gums and tongue may show bruising or laceration. slight bruising may be found in the mouth and nose, which should be confirmed by microscopy. The asphyxial signs and symptoms are severe, because death usually results due to slow asphyxia and often the fatal period is 3 to 5 minutes. The head and face may show intense congestion and cyanosis with numerous petechial haemorrhages in the skin of the face and beneath the conjunctivae. Blood may ooze out from the mouth and nose. The tongue may be protruded and may have been bitten. Petechiae are usually present, even in cases where hypoxic changes are slight. Often, the head and face enclosed in a plastic bag are pale, with few petechial haemorrhages in the eyelids and pericardium. In some cases, death is rapid due ot reflex cardiac arrest, and asphyxial signs are absent. In environmental suffocation, congestion and cyanosis may or may not be present; petechial haemorrhages are rare.

Internal: Blood-stained frothy fluid is present in air-passages. Mucus may be found at the back of the mouth. Slight acute emphysema and oedema of the lungs with scattered areas of atelectasis, petechiae and congestion are the major findings. The internal organs are deeply congested and sometimes show small haemorrhages.

Homicidal smothering is extremely difficult to detect. The autopsy may reveal asphyxia, but there may not be any corroborative medical evidence to prove foul play. The pathological changes must be interpreted keeping in view the medical history of the deceased, the scene of death, and the specific circumstances surrounding the death.

GAGGING

This is a form of asphyxia which results from forcing a cloth into the mouth, or the closure of mouth and nose by a cloth or similar material, which is tied around the head. A gag (such as rolled up cloth) pushed into

the mouth sufficiently deep to block the pharynx will cause asphyxia. Initially, the airway may be patent through the nose; collections of saliva, excessive mucus with oedema of the pharynx and nasal mucosa, progressively causes complete obstruction. In adults, false dentures may impact in the throat and sometimes during anaesthesia. In injuries to the nose and mouth, blood may seep into the back of the throat and clot. It is almost always homicidal and the victim is usually an infant. It is not possible for one person to gag and bind another. Sudden death due to reflex vagal inhibition may occur.

Gagging is usually resorted to prevent the victim's shouting for help, and death is usually not intended. The victim's hands are tied behind to prevent their removing the gag, and the legs are tied together to prevent walking or running for help. It should be noted, as to how the cloth piece is wrapped round the nose and mouth, how it is tied, and how far the mouth gag is stuffed inside the mouth.

OVERLAYING

Overlaying or compression suffocation results due to compression of the chest, so as to prevent breathing. It occurs when the mother or other person shares a bed with an infant. During sleep, the older person rolls on to or crushes the infant. The thoracic movements are limited and respiratory exchange is either reduced or completely prevented. In many such cases, the mother or older person goes to the bed under the influence of alcohol. It is very rare. Flattening of the nose and face may or may not be seen. These parts are pale. The nostrils are often filled with froth, which may be blood-stained and this may stain the pillow or garment. The usual findings are those of asphyxia.

BURKING

Burking is a method of homicidal smothering and traumatic asphyxia. William Burke and William Hare, killed 16 persons in Edinburgh during the years 1927 and 1928, and sold their bodies to Dr. Robert Knox for use as specimens in his anatomy classes. A victim was invited to their house and given alcohol. Then the victim was thrown to the round and Burke used to kneel or sit on the chest and close the nose and mouth with his hands, and Hare used to pull him round the room by the feet.

CHOKING

Choking is a form of asphyxia caused by an obstruction within the air-passages.

Accidental Choking: Choking is almost always accidental. Choking from objects being lodged in the throat is commonly seen in the very young, elderly, psychiatric patients or in the infirm, particularly where the ability to swallow or masticate is severely impaired. Choking commonly occurs during a meal when food is accidentally inhaled, especially when the victim is laughing or crying. Vomited matter may be inhaled by a person under the influence of drink or of an anaesthetic, during a fit of epilepsy, or while in a state of insensibility from other causes. Infants usually regurgitate clotted milk after a meal, and this may fall into the larynx. Choking may occur due to inhalation of blood from facial injuries, such as a broken nose, or dislodged teeth, and laceration of the lips and gums inflicted during fight, if the victim becomes unconscious and lies on his back. Impaction of solid bodies, such as a large bolus of fold, piece of meat, fruistone, corn, button, coin, rag, rubber teat, seeds, live fish, mud, leaves, cotton, or a set off false teeth amy cause asphyxia. Gauze packs inserted during an operation can be inhaled and cause death. children often place objects like marbles or coins in their mouths, which may pass into larynx or trachea during a sudden deep inspiration. Objects like rubber balloons may be inhaled by children during

play. Choking due to regurgitation of food may occur during rape or violent sexual intercourse. In head injury, irritation of the brain causes vomiting, which may be inhaled. The foreign body becomes arrested at, or just below the vocal cords and may produce an inflammatory reaction with oedema. Food aspiration following suppression of the gag reflex by tranquilizing drugs is sometimes seen in lunatic asylums. Microscopically, lungs show intense interalveolar oedema and collection of desquamated respiratory type epithelium. If there is struggle to breathe and attempts to remove the occluding object are unsuccessful, asphyxial changes are well marked. When a foreign body is inhaled, there is immediate acute respiratory distress, but once this has passed, the victim has little subsequent distress. Complications may develop after a latent interval.

Suffocation may occur from diseases, such as diphtheria, infectious mononucleosis, H. influenzae infection in children, rupture of aortic aneurysm in air-passages, haemoptysis in pulmonary tuberculosis, a tuberculous gland eroding into a bronchus and prolapsing into its lumen, acute oedema of the larynx due to inhalation of steam or ingestion of irritant substances, pharyngeal abscess, laryngeal and bronchial growths, haemorrhage into the trachea, etc., and from the effects of certain poisons. Insect bites especially those of bees, wasps and hornets, and drug reaction

from penicillin, etc., can cause swelling of the lining membranes of the larynx and death within a few minutes due to an allergic reaction. A blow to the front of the neck may cause sever swelling of the mucosa of the airway due to oedema and haemorrhage. Death may occur due to reflex vagal inhibition.

Choking from external causes may occur from impaction of a relatively large foreign body, a bolus of food, or a denture in the oesophagus, compressing the trachea.

Suicidal Choking: It is rare. The victims are usually mental patients or prisoners. For this a foreign body is thrust into the throat.

Homicidal Choking: Choking as a mode of infanticide may be caused by stuffing a wad of paper or cloth into the pharynx or larynx. It is very rare and is practicable only when the victim is suffering from disability or disease.

Cause of Death: (1) Asphyxia, (2) Cardiac inhibition is the common cause, (3) Laryngeal spasm. (4) Delayed death may result from pneumonia, lung abscess or bronchiectasis.

Mechanism of Death: Large foreign bodies may be impacted in the pharynx and cover the opening of the larynx. By completely obstructing the airway, such impacted bodies may cause death from hypoxic hypoxia or anoxic anoxia. A small cause death by laryngeal spasm. Usually laryngeal spasm passes off before the hypoxia becomes fatal. Sudden reflex neurogenic cardiovascular failure is probably produced by reflex parasympathetic cardiac inhibition. Impaction of a foreign body at the bifurcation of the trachea may cause death by asphyxia, but irritation in this region usually causes parasympathetic cardiac inhibition. A foreign body impacted in a bronchus may produce reflex cardiac inhibition.

CAFÉ CORONARY: This is a condition in which a healthy but grossly intoxicated person (restaurant patron), who begins a meal, suddenly turns blue, coughs violently, then collapses and dies, without much fuss. Death appears to be due to sudden heart attack. At autopsy, a large piece of poorly chewed food (bolus or a piece of meat) may be found obstructing the larynx. The clinical signs of choking are absent, because of the high blood alchohol content which anaesthetizes the gag reflex.

Treatment: A blow on the back or on the sternum may cause coughing and expel the foreign body. If this is not successful, the foreign body should be removed from the hypopharynx with the middle and index fingers or with forceps.

Autopsy: The foreign body which caused the occlusion of air-passages will be found in the mouth, larynx or trachea. When food or vomited matter has been inhaled, particles of food material may be observed embedded in thick mucus in the trachea and bronchi, and particles may be drawn into the bronchioles which distinguishes the condition from those cases in which food is forced up the oesophagus and falls into the larynx after death. Other signs of asphyxia will be seen.

TRAUMATIC ASPHYXIA

Traumatic asphyxia results from respiratory arrest due to mechanical fixation of the chest, so that the normal movements of the chest wall are prevented. Fatal cases are only due to accident. Usually, there is a gross compression of the chest by powerful force. Multiple deaths are likely to occur when there is an outbreak of fire in a theater or whenever large crowds gather in an enclosed place. Some are crushed by the weight of the crowd, the chest being pressed violently, or may even get trampled on and crushed under feet (riot crush or human pile deaths). Another common cause is crushing by falls of earth or stone usually in a coal mine or during tunneling or in a building collapse. Sometimes, the victim is pressed to the ground by some heavy weight as by a motor vehicle or other machinery. A person repairing a car may be crushed when the jack slips and the vehicle falls on top of him. It may occur in assault cases, where the victim is jumped or stamped upon and crushed by one or more assailants. Occasionally, it results from indirect compression, when the body is subjected to force in such a manner that his thighs and the knees are driven against his chest, the so-called “jack-knife” position.

DROWNING

Drowning is a form of asphyxia due to aspiration of fluid into air-passages, caused by submersion in water or other fluid. Complete submersion is not necessary, for submersion of the nose and mouth alone for a sufficient period can cause death from drowning.

Duration of Submersion in Fatal Cases: When a person falls into water, he sinks partly due to the force of the fall, and partly to the specific gravity of the body. Shortly afterwards, he rises to the surface due to the natural buoyancy of the body. In sudden immersion into cold water, the victim may take a deep inhalation of water due to reflex from stimulation of the skin. He may hold his breath for varying periods until the CO_2 in his blood and tissues reaches sufficient levels to stimulate the respiratory center. At that time, an inevitable inhalation of water may occur. When he cries for

help and struggles, he is likely to inhale water, which produces coughing and drives out large volume of air out of lungs, and leads to disturbance of the rhythm of the breathing. The victim may vomit and aspirate some gastric contents. His struggle increases and again he sinks. If this occurs during inspiration, he will inhale more water. The cerebral hypoxia will continue until it is irreversible and death occurs. With warm water, cerebral anoxia becomes irreversible between 3 to 10 minutes. Consciousness is usually lost within 3 minutes of submersion. The struggle for life with rising and sinking of the body goes on for a variable period, depending on the vitality of a person, until he remains submerged. Convulsive movements then occur, followed by coma or suspended animation and death.

The Mechanism of Drowning: Brouardel carried out experiments with dogs as follows. The four limbs of the dog were fixed to a wooden hoard, and a weight of head was fixed to the lower end. A connula was introduced into the femoral artery to record the blood pressure and heart beats, and a pneumograph attached to the epigastrium for recording respiratory movements. The dog was then lowered into a tub filled with water. The dog's head was kept about 30cm. below the surface throughout. The process was divided into five stages. (1) The stage of surprise lasting for 5 to 10 seconds. The animal inspired once or twice but inactive. (2) The first stage of respiratory arrest, lasting for about one minute. The dog was violently agitated, fighting against its bonds and obviously trying to reach the surface. The mouth was shut and respiration arrested. (3) The stage of deep respiration, lasting for about one minute. The dog made some deep inspirations and expelled white foam to the surface. The agitation stopped. The eyes and mouth were open. A few swallowing movements were noted. (4) The second stage of respiratory arrest, lasting for about one minute. Thoracic movements were not observed. The corneal reflex was lost and pupils were widely dilated. (5) The stage of terminal gasps, lasting for about 30 seconds. The dog made 3 or 4 respiratory movements. The lips and jaw muscles showed fibrillary contractions. The whole process of drowning of these dogs in fresh water took 3 ½ to 4 minutes. Under identical conditions, sea water is approximately twice as lethal as fresh water. In man, probably the course is similar except rising to the surface once or more. Hypoxic convulsions may occur in the fourth stage.

Kylestra (1965) reported that mice submerged in suitably oxygenated physiological saline solution, could survive for 18 hours. If this medium was replaced by sea water or tap water, the mice succumbed in less than 12 minutes. The volume inhaled is also important. Model (1966) showed that in dogs, if the volume inhaled exceeded 44 ml. Per kg. body weight, the chance

of survival was very small. The critical volume of sea water was 22ml. Per kg. In humans, it is believed, similar phenomenon occur in drowning.

Types: Drowning is of four types: [1] Wet Drowning: in this, water is inhaled into lungs and the victim has severe chest pain. If resuscitated, he has no pleasant recollections. [2] Dry Drowning: In this type, water does not enter the lungs, but death results from immediate sustained laryngeal spasm due to inrush of water into the nasopharynx or larynx. Thick mucus, foam and froth may develop, producing a plug. This is seen in 10 to 20% cases of immersion. Resuscitated victims have panoramic views of past of life and pleasant dreams without distress. [3] Secondary Drowning: (post-immersion syndrome or near drowning): In this type, death occurs from within half hour to several days after resuscitation. Electrolyte disturbances and metabolic acidosis occur. Death occurs from cerebral anoxia with irreversible brain damage. Microscopically, the lungs show haemorrhage, desquamative and exudative reaction. Later changes are of inhalation pnemonitis with hyaline membranes in alveolar ducts, and foreign body reaction to inhaled particles, progressing to bronchopneumonia or abscess formation. The loss of the normal surfactant by the inhaled water can result in large areas of atelectasis. Death may occur from cerebral anoxia with irreversible brain damage. Myocardial anoxia may cause delayed heart failure. [4] Immersion Syndrome (hydrocution or submersion inhibition): Death results from cardiac arrest due to vagal inhibition as a result of (a) cold water stimulating the nerve endings of the surface of the body, (b) water striking the epigastrium, (c) cold water entering ear burns, nasal passages, and the pharynx and larynx which cause stimulation of nerve endings of the mucosa. Falling or diving into the water, feet first, or “duct-diving” by the inexperienced, or diving involving horizontal entry into the water with a consequent blow on the abdomen cause such accident. Alcohol increases such effects, due to the general vasodilatation of skin vessels, and possibly by some central effects on the vasomotor center. This is seen in one to 2% of cases of drowning.

The Pathophysiology of Drowning: The pulmonary alveolar lining is semi-permeable. If water enters the alveoli, an exchange of water takes place through the alveolar lining. The extent and direction of this exchange depends on the difference between the osmotic pressure of the blood and the water.

1) **Drowning in Fresh Water or Brackish Water:** In drowning in fresh water (0.6% NaCl), water passes rapidly from the lungs to the blood, leading to haemolysis and dilution of the blood, with an abrupt increase in blood volume. 2.5 liters or more of water may be inhaled

and absorbed in three minutes. Fresh water alters or denatures the protective surfactant which lines the alveolar wall, while sea water dilutes or washes it away. The denaturing of surfactant can continue even after a person if successfully resuscitated. Loss or inactivation of pulmonary surfactant and alveolar collapse decrease lung compliance, resulting in severe ventilation perfusion mismatch, with up to 75% of the blood perfusing non-ventilated areas. When water is inhaled, vagal reflexes cause increased peripheral airway resistance with pulmonary vasoconstriction, development of pulmonary hypertension, decreased lung compliance and fall of ventilation perfusion ratios. The conentration of serum electrolytes (sodium and calcium) decreases considerably. The serum potassium increases. The causes rapid overburdening of the heart and produces pulmonary oedema. The oedema fluid contains serum proteins. The heart is subjected to hypoxia, overfilling, sodium deficit and potassium excess. Cardiac arrhythmias leading to ventricular tachycardia and fibrillation occur, probably due to hypoxia and haemodilution. Haemodilution leads to haemolysis, haemoglobinaemia, and haemoglobinuria, marked hyponatraemia and hyperkalaemia. Calcium levels may fall to 2 mEq/L.

2) **Drowning in Sea Water:** Due to the high salinity of sea water (usually over 3% NaCl), water is drawn from the blood into the lung tissue, and produces severe pulmonary oedema, and hypenatraemia. This causes haemoconcentration. Simultaneously, in an attempt to re-establish osmotic balance, salts from the water in the lungs pass into the blood stream. Slow death occurs from asphyxia.

Causes of Death : [1] Asphyxia Inhalation of fluid causes obstruction to the air-passages. Circulatory and respiratory failure occur simultaneously, due to anoxia of both the myocardium and the respiratory center. [2] Ventricular fibrillation, in fresh water drowning death may occur in 3 to 5 minutes from a combination of anoxia, and a disturbed sodium-potassium ratio producing arrhythmias of the heart beat, ventricular tachycardia and fibrillation. [3] Laryngeal spasm may result from inrush of water into the nasopharynx or larynx. [4] Vagal inhibition is due to icy cold water, high emotion or excitement and unexpected immersion. [5] Exhaustion. [6] Injuries: Fracture of skull and fracture-dislocation of cervical vertebrae may occur due to the head striking forcibly against some solid object. Concussion may

occur due to striking the head against some hard substance, or the water itself while falling from a height.

Fatal Period: Death usually occurs in 4 to 8 minutes of complete submersion.

DIATOMS: They are microscopic unicellular or colonial algae. They have a complex structure of their cell-walls which are usually strongly impregnated with silica and contain chlorophyll and diatomin, a brown pigment. Diatoms belong to class Bacillariophyceae. Diatom secretes hard siliceous outer box-like skeleton called a frustule. They resist heat and acid. There are about 15,000 species. They vary considerably in size from 2 microns to one mm. in length or diameter. Most species are from 10 to 80 microns in length and if elongated, up to 10 microns in width. Diatoms measuring up to 60 microns in diameter are said to enter the pulmonary circulation during drowning. The diatom skeletons are readily recognizable as radially or axially symmetrical structures. They vary from place to place, and there are seasonal variations at the same place. They occur in cultivated soils and on surface of most rocks. Large numbers of free floating diatoms are found in both fresh water and sea water. Their shape may be circular, triangular, oval, rectangular, linear, crescentic, boat-shaped, etc. They may be demonstrated in human organs by: 1] direct digestion of the material with nitric acid and sulphuric acid, 2] incineration in electrical oven and then dissolving the ashes with nitric acid, 3] direct microscopic examination of the lungs. Water is squeezed out from the lungs, centrifuged and sediment examined, 4] microscopic examination of tissue section, whereby optically empty sections are produced.

The drowning fluid and the particles in it, e.g., diatoms and planktons, pass from the ruptured alveolar wall into lymph channels and pulmonary veins and thus enter the left heart. Only a live body with a circulation could transport diatoms from the lungs to the brain, bone marrow liver and other viscera, and skeletal muscle. They are also found in the bile and rine. The bone marrow is highly suitable and reliable. The bone marrow of long bones, such as the femur, tibia and humerus or sternum is examined for diatoms. The sternum is washed in distilled water. The periosteum is removed from the posterior surface. A piece of rectangular bone is removed with a sharp and clean knife and the marrow is curetted out from the gutter. Kidney, lung, liver or brain is also washed and 1x1 cm. pieces cut from the deeper tissue.

Technique: Five grams of bone marrow or each piece of tissue is put in a separate test tube and covered with five times the volume of concentrated nitric acid, and left at room temperature for one to two days to allow digestion. Alternatively, they can be heated in a water-bath overnight. This process chars, blackens, and destroys organic matter. Diatoms have silica shells and as such are not destroyed, the tube is centrifuged, the supernatant acid poured off and replaced with distilled water. This process is repeated 2 pr 3 times to dilute the acid. The deposit is examined under phase contrast or dark-ground illumination. The number of diatoms found in the tissues is relatively small.

Control samples of about 2 liters water should be obtained from the site of accident for comparison. About 15 ml. Of iodine solution is added to this and allowed to settle overnight. The bulk of the water is poured off and the remainder centrifuged to recover diatoms. The finding of similar diatoms in the water and in the body tissues is in favour of drowning. Recent evidence indicates that diatoms from the alimentary canal may enter the circulatory system and reach the various organs in the body, and occasionally may be found in cases other than drowning. The finding if not absolutely diagnostic, is of the greatest value, especially in cases of putrefaction.

Plasma Specific Gravity: In drowning, the specific gravity of plasma from the left side of the heart is less than that of the plasma in the right side. In non-drowning cases the reverse is the case.

Dead bodies are commonly found immersed in water and other fluids in all manner of places and circumstances. Such cases prove the most difficult medico-legal problems. The circumstances surrounding each individual case are important. It should be remembered that drowning is not limited to deep water situations like sea, tanks, rivers, lakes, wells, etc., but unconscious person can fall face down in a puddle or ditch and die of immersion. In most cases of drowning, the diagnosis of forensic pathologist is based largely n the history and investigative reports of the case.

Diagnosis: The autopsy diagnosis of drowning can pose problems, because the findings are often minimal, obscure or completely absent. When the findings are negative, cause of death may be given as " consistent with drowning" or even to admit that the cause of death is "undetermined". The reliable signs of drowning at autopsy are: 1[Fine, white froth at the mouth and nose. 2] The presence of weeds, stones, etc., firmly grasped in the hands,

3] The presence of fine froth in the lungs and air-passages. 4] The voluminous water-logged lungs. 5] The presence of water in the stomach and intestines, and 6] Findings of diatoms in the tissues.

The above signs will not be found, if death occurs due to vagal inhibition. In death from syncope, or when a person is in a state of helplessness from drink or other cause, or when a person receives an injury during fall into the water which prevents him from struggle, the signs will be slight. In dry drowning, the post-mortem appearances are those of asphyxia. A body removed from water undergoes rapid decomposition. If the post-mortem is delayed for a few hours, or if any appreciable delay has occurred before recovery of the body from water, the signs of drowning will not be found to great extent.

If the body remains in water, lividity appears in the head, neck and chest, and putrefaction begins in the same place and produces the appearance of diffuse scalp haemorrhage. The blood becomes more fluid and water is found in gradually increasing quantity in the pleural cavities. In moderately advanced putrefaction the diagnosis is difficult, the only evidence being the presence of water in the pleural cavities due to diffusion of water from the lungs, which finally collapse, and froth in bronchi. In advanced putrefaction the signs are completely absent. Algae get attached to exposed portions of drowned bodies, multiply and from a layer over the skin, which may be seen in 3 to 4 days in summer.

The Circumstances of Drowning: Bodies recovered from water may have died of: 1] natural disease before falling into the water, 2] natural disease, while already in the water, 3] injuries before being thrown into water, 4] injury while in water, 5] drowning. The manner of death cannot be interpreted from an autopsy alone. The findings have to be viewed together with the circumstances.

Accidental Drowning:

1) **Death in the Domestic Bath:** A sudden collapse from coronary or cerebrovascular disease may cause loss of consciousness, leading to immersion of head and death. similarly, epilepsy or a fall producing a disabling head injury may also cause death. Other causes include CO poisoning, alcohol or drug intoxication and electrocution. In such cases, it should be established whether the head was really in the water and if so, whether the water was inhaled. A sample of the bath and tap water should be collected. Bruising of the head is usually seen

from falling or being struck. Grip marks (finger-tip bruises) on legs or arms indicate forcible immersion. Natural disease should be excluded at autopsy and the viscera preserved for chemical analysis.

2) **Death of Newborn Infants:** In precipitate labour, the baby may fall into lavatory pan or bucket and die. Microscopy of the lungs and examination of the fluid in air-passages may be helpful. Foreign material inhaled into the lung parenchyma or passages may be seen and compared with a sample of fluid from bucket or lavatory pan. Chemical analysis of fluid in the air-passages, e.g., for soap or disinfectant agents present in the fluid in the lavatory or bucket is helpful.

Occasionally, swimmers, fishermen and dockworkers may be drowned accidentally, but it is common in non-swimmers. It also occurs while bathing in tanks, rivers or sea. Women may fall accidentally into a well while drawing water from it. Children may fall in ponds or lakes while playing near their banks. Usually, children die from frowning in shallow water, but adults usually epileptics, o under the influence of drink or drugs, or collapse due to coronary artery disease or dizziness due to hypertension may fall face down into shallow water and die.

Accidental drowning in the swimming pool sometimes results from jumping off the diving board. Impact of the forehead on the floor of the pool may cause hyperextension of the head and loss of consciousness with subsequent inhalation of water. In such cases, haemorrhages are seen in the deep neck muscles in the region of C_1 and C_2 with or without vertebral fractures.

Hyperventilation Deaths: For swimming for a longer time than normal under the water, the swimmer may hyperventilate before jumping into the water, due to which CO_2 tension is very much lowered. While swimming under the water, oxygen is utilized and CO_2 is produced, but the CO_2 tension does not rise sufficiently to irritate the respiratory center and cause air-hunger, due to its abnormally low starting point. He may suddenly lose consciousness and drown.

Drowning in Skin and Scuba Diving: In skin diving simple mask and fins are used. The hazards are similar to those of swimming. Scuba Diving enables prolonged independent stay under the water. Serious accidents are caused n equipment failure, environmental factors, or human factors, e.g., exhaustion, panic, pre-existing disease, improper use of equipment. Hazards of scuba diving are drowning, barotraumas (pressure changes associated with descent or ascent), bends (Caisson's disease), acute pulmonary oedema, emphysema, pneumothorax, air embolism, etc. In scuba

diving, frequently there is entrapment of air within the lungs on rising from the depths, producing fatal or non-fatal extra-alveolar air syndrome. Air escapes from the alveoli and may result in interstitial emphysema, pnemothorax or air embolism. This is caused by disproportionate expansion of air-containing alveoli, as compared to the adjacent fluid-filled vascular changes during to rapid an ascent.

Suicidal Drowning: In India, drowning is a common method of committing suicide especially amongst women, and more particularly in localities nearby the sea or river or canal. In case of a woman, the body is usually fully dressed. Suicides usually remove some of their outer clothing or shoes before leaping into the water. In a non-swimmer, a naked body suggests suicide. Suicides may drown themselves in very shallow water, or even by putting the head in a pail or cistern. In a body is found with heavy weights attached to it, it must be either homicide or suicide, and with children homicide alone. The nature of the weights, whether they are tied by ligature or fixed in clothing or found in the pockets are important. Sometimes, suicides tie their hands or legs together, and in such cases the manner of tying, and the knot of the rope or ligature should be examined to determine whether they could have been made by the suicide himself. Suicidal drowning may be preceded by the swallowing of the poison, cutting the throat or other suicidal attempts. Injuries may be caused during fall, especially if the bodies are found in the wells. Unless there are strong currents, the body will not move very far from its initial position.

Homicidal Drowning: Murder by drowning is very rare, except in the case of infants and children. A person may be pushed into a river or into the sea. Marks of strangulation or throttling or severe violence applied to the head are presumptive of homicide. Bruises are strongly suspicious. Homicidal drowning in shallow water is possible, if the assailants hold the victim's head in such a position as to cover the nostrils and mouth. Signs of struggle or marks of violence on the body are likely to be found in such cases. If a person is taken unawares or rendered senseless and defenseless by alcohol or hypnotic drugs, and head is submerged in water for 5 to 10 minutes, no marks of violence will be found on the body.

Injuries on Drowning Persons: Wounds may be produced before, at the time of, or after immersion. Before immersion, they may be of accidental, suicidal or homicidal origin. At the time of immersion, the deceased striking hard objects, such as rocks or stone, may produce them. After immersion, injuries may be produced from the striking of the body into rocks, coral or marine structures. As the body floats along the bottom, abrasions may occur on the head, face, backs of the hands, knees and the

toes. The body may be hit by ship's propeller, which may produce often parallel, long and deep cuts and amputation. Aquatic life (fish, crabs, lobsters, eels, crustaceans, etc.) attack and destroy soft parts of the face, i.e., eyelids, lips, nose, ears, penis, scrotum, and also anus. The lesions are circular or oval and punched-out.

Probable Duration of Submersion: Body heat is lost about twice as rapidly in water than in air, and the temperature of the medium is reached in about 14 hours. The time of floatation of body varies greatly. Very obese persons and infants float more readily than a thin or heavily-framed persons. The body floats in about 12 to 18 hours in summer, and 18 to 36 hours in winter in India. In cold countries the body floats in about 2 days to one week or more, depending on temperature of the water. The epidermis and nails are loosened and the skin of the hands and feet may be peeled off like glove or stocking in 2 to 4 days. In advanced decomposition, the body usually floats belly up.

SEXUAL ASPHYXIAS

Sexual asphyxias (autoerotic asphyxia; autoerotic deaths) are very rare. Partial asphyxia caused by pressure on carotid vessels, or partial obstruction of air-passages causes cerebral disturbances and may lead to hallucinations of an erotic nature in some men. The degree of asphyxia produced by mechanical means is controlled, but in some cases death occurs accidentally. These cases are associated with some form of abnormal sexual behaviour, usually masochism and tr4ansevestism. The scene is usually the victim's own house; the bedroom, bathroom, basement or attic are usually selected, and the door is locked from the inside. Adult males with homosexual preferences tend to carry out the procedure in pairs as a means of protection from accidental death.

Hanging is the most frequent from seen in sexual asphyxias. The neck is protected by a padding between the neck and the ligature. The ligature is passed around the neck in the form of a running noose, the free end of which is tied to a limb, or to a fixed object. The weight of the body is used to control the pressure. The free end of the ligature may be tied to the wrists or anklets, which are usually tied together. The noose can be tightened by extending the arms or legs, and when consciousness is lost, the relaxation of the limbs release the pressure on the neck. In some cases, a running noose may be passed upwards to some fixed point. There are indications that death is unintentional, for the individual is often found incompletely suspended wit his feet on the ground or close to an object, such as a chair or stool, that would have allowed him to release the constriction. Evidence of previous

episodes of similar activity may be found on the neck, such as old scars. Such persons are usually found naked, partly naked, or may be wearing women's dress. There may be padding of the brassieres to simulate breasts; female undergarments, and even sanitary pads, wigs make-up may be worn. Frequently, they tie their arms, legs and sometimes waist and genitalia (bondage) with a rope, string, chain, etc. In addition to bonds and restraints, there is frequent evidence of self-mutilation, such as puncture wounds, cuts or burns, or one may find weights, clamps, or pincers attached to the genitalia or breasts. Erotic or pornographic literature or attractive female nude photographs are spread out within view, and there may be evidence of recent emission of semen. The person may blindfold himself or may arrange a mirror to watch the events or camera to make a photographic record. Many of these cases are misdiagnosed as suicidal hangings, and rarely as homicides.

Sexual gratification may be obtained by electrical stimulation. For this, electrodes are applied to the genitals or on abdominal wall, usually with a low voltage supply from a battery or transformer. Other methods include, covering the head in a plastic or some impervious bag, which may be secured around the neck by an elastic band or a ligature to achieve partial anoxia. This ligature may form part of a system of bondage. It is sometimes combined with the inhalation of "glue-sniffing". Carbontetrachloride, trichloronethlene, paint thinners, petrol, ethylene choride, amyl acetate, etc., are inhaled either directly from the container or by re-breathing after placing in a plastic bag.

The scene should be examined for: [1] Evidence of abnormal sexual behaviou, e.g., masochism, transvestism. [2] Evidence that the act had been practiced previously, such as grooves in the rafter or door from ropes, or verbal communications with others regarding the nature of activities, diaries, etc. [3] Evidence of attempts to conceal the act by some method to prevent a ligature from leaving marks around the neck. [4] No evidence to suggest a suicidal act.

Medicolegal aspects

a) **Suicide:-** Notes, Isolated area, locked Doors, access easy, motive, previous attempts, rope pulled below upwards, Psychological factors, Crisis in relations ship, Financial crisis, Work related factors..
b) **Homicide –** other injuries/Ineapasitation, tieing of hands, Disturbed surroundings, Knots, rope pulled above downwards.
c) **Accidental –** children, infants, old people, Industrial accident, constructions related.