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FORENSIC SCIENCE
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 **Pathshala**
पाठशाला
A Gateway to All Post Graduate Courses

1. Learning Outcomes

After studying this module you shall be able to know about –

- Automobile Accidents
- Primary and secondary impact injuries
- And the medico-legal importance of automobile injuries

2. Automobile Accidents

“There is more to life than simply increasing its speed”... Mahatma Gandhi.

A large variety of injuries are sustained by persons involved in traffic accidents.

A) Injuries to Pedestrian:

Three types of injuries are seen:

- 1) **Primary impact injuries:** caused by initial strike, i.e., the first part of the vehicle that strikes the victim (usually legs).
- 2) **Secondary impact injuries:** After the primary impact, the victim is then again thrown back over the vehicle, causing further injuries.
- 3) **Secondary injuries:** Then the victim is thrown on the ground causing secondary injuries.
- 4) Finally the victim is run over by the vehicle causing crush injuries.

➤ Primary impact injuries:

The part of the body struck depends on the position of the person in relation to the vehicle struck.

- a) **Pedestrian struck from behind, both feet fixed to the ground:** Whether feet is fixed or not, depends on the nature of the road surface, whether slippery or not, whether it has rained or not etc. The injuries produced are:

- 1) **Bumper injuries:** Injuries at the site of bumper impact, in the form of abrasion, contusion, laceration, internal hemorrhage in the calves etc. Most characteristic fracture due to bumper fractures are fracture of the tibia. The fracture fragments are wedge shaped and is displaced forwards. The base of the wedge indicates the site of the impact, the apex points in the direction in which the vehicle was travelling. Rarely, fibula also may get fractured. If the bumper fractures are on different level on both legs, then it indicates that the victim was either running or walking.

In children, bumper fracture is seen in femur. Femoral head may be driven through the acetabulum. The vehicle can be identified from the height of the bumper fracture from the ground and matching the same with the offending vehicle's height of bumper from the ground. When brakes are applied, the height of the bumper dips down, thus the height of the bumper fracture is less than the height of the bumper. When accelerator is pressed, the phenomenon is reversed.

- 2) **Impact against mud guard or head lamp:** This will cause fracture of the pelvis, pubic ramus fracture, fracture-dislocation of the sacro-iliac joints, imprint abrasions-due to head lamps and radiators. Injuries usually depend how the victim was positioned. Frontal impacts may cause head injury, chest injury, fracture of ribs. Side impact causes injuries of arms. Rear impact causes injuries to buttocks and sacroiliac joints. The fractured portion of the vertebral column may move forward and may cause transection of the spinal cord and thoracic aorta.
- b) **Struck from behind when feet not firmly fixed with car at high speed:** This situation arises when the victim is walking. If one leg is lifted, fracture is often transverse.
- c) **Struck from front:** Injuries are virtually the same, except that the injuries are more on the frontal aspect. Intra-abdominal injuries are seen, like linear superficial tears of the abdomen and inguinal regions, due to over stretching of the skin. They appear dry, yellow and bloodless. Liver and splenic injuries are common. There may be injuries to chest wall and thoracic contents. Direct impact to thorax may cause rupture of the aorta below the arch at the level of ligamentum arteriosum due to sudden increase in the intravascular pressure. The heart may show bruising, laceration and rupture.

- d) **Struck on one side:** The injuries are seen predominantly on one side. The opposite side receives injuries while falling on the road.
- e) **Struck on front corner of car:** Knocked diagonally out of the path of the car, may be run over by other cars coming from behind.
- f) **Pedestrian walks into the side of the moving vehicle:** There may be injuries on the side of the front of face, chest and arms in the form of glancing abrasions, patterned abrasions, crush lacerations, tear lacerations, fracture ribs with or without lung involvement, abdominal injuries etc.

➤ **Secondary impact injuries:**

If the feet slide forward, the whole body falls backwards, with a secondary impact of the head against the windshield. If the victim falls on the hood, tangential force is directed by hood to the buttock and thigh, causing separation of the skin and sub cutaneous tissues from the muscle. This produces a pocket in the upper thigh and buttock, leading to collection of large amount of blood, which is often not visible, externally. If the feet is not firmly fixed on the ground, the victim may be scooped up and thrown in the air and may land over the roof of the vehicle, head hitting first, or may even land on the road behind the vehicle, where he may be run over by other vehicles. Atlanto-occipital dislocation and partial disruption of intervertebral discs are quite common in this situation.

➤ **Secondary Injuries:**

Due to striking of the victim on ground: It may be caused after secondary impact injuries or immediately after primary impact injuries, when the victim is thrown high up in air and strikes the ground. All kinds of injuries, including abrasions, contusions, lacerations, fractures etc may be seen.

➤ **Run over injuries:**

Abrasions in the form of grazes, impact or imprint abrasions of the tire marks may be seen. They are spread out a little due to yielding and flattening of body from pressure. The rotator effect against a fixed limb may strip off almost all tissues down to the bone, causing avulsion laceration. The avulsed wound may be segmental or circumferential, completely encircling the arm or leg. If head is involved, complete avulsion of the ear may occur. If intestines or scrotum are involved, they may be extruded out.

Head injury with egg shelling of the skull- skull may be crushed from side to side or forced open with extrusion of the brain matter. The ribs may be fractured at multiple places. The abdomen may be ruptured with extrusion of the contents. The whole body maybe crushed or hemisected, if the vehicle is very heavy and passes through the middle of the body. The legs may be crushed. Brush burn may be seen due to dragging of the body.

➤ **Rolling over injuries:**

This is produced when a vehicle with low chassis rolls the victim along the roadway, instead of running him over. Injuries produced are abrasions like graze, patterned (caused by undersurface of chassis), burns from exhaust system, fractures, soiling of garments and skin by grease. These injuries will be present circumferentially all around the body.

B) Injuries to Vehicle Occupants:

Usually depends upon type of impact.

Two broad types are recognized- Non-ejection and ejection injuries.

➤ **Non-Ejection Injuries:**

A) Frontal impact: This is the most common and about 80% of the injuries are frontal impact. The sequence of events upon frontal impact is that, the driver and passengers receive some common (due to deceleration injuries) and some different set of injuries.

• **Driver:**

Secondary accident: The driver, if not wearing seat belt, slides forward, so that his legs strike the instrument and dashboard area, and his chest and lower abdomen strikes the lower edge of the steering wheel. This is known as second collision. The first collision is the one between the vehicle and the outside object.

Facial impact on windscreen causing imprint abrasions, bruises, fracture jaws, facial bones.

Flexion across the steering wheel: The body flexes across the steering wheel and begins to rise, causing steering wheel injuries on the chest and abdomen like chest contusion, bilateral fracture of the ribs, liver laceration.

Flexion of the spine: The head goes forwards causing flexion of the cervical and thoracic spine. It is followed by hyperextension, resulting in whiplash injuries.

The upward and forward component of the force of impact causes the head to strike the windscreen.

Air bag injuries:

Although air bags decrease the incidence of fatal injuries, they themselves also may cause serious injuries. At least one air bag related injury occurs in every 43% of air bags deployed. This injury is common in adults with short stature and children. Majority of the injuries are minor e.g., lacerations and abrasions over the skin and eyes. Fatal injuries may be seen in children sitting in passenger seat.

Fatal injuries are caused by impact of chest against the air bag. Multiple rib fracture with bilateral hemothorax, subdural hemorrhage, laceration of pericardium and right atrium with hemopericardium, retro pharyngeal hematoma with airway obstruction etc may be seen. Non-fatal lesions are seen in the form of ocular injuries. It is caused due to the impact of face against air bag or projection of any object leading to contusion, abrasion, lacerations of face. Orthopedic injuries in upper and lower limbs for lateral airbags, fracture of ribs, sternum, pulmonary contusions, cardiac trauma, spinal lesions are less common. Fore arms, especially the distal third may be involved.

Deceleration Injuries:

Deceleration injuries include a variety of thoracic injuries resulting when the moving thorax decelerates rapidly as a result of impact against a stationary or relatively stationary object.

Salient features: Not peculiar to driver only and can be seen in all vehicle occupants.

- ❖ **Aortic injuries**- are classic in deceleration injuries. The location of the aortic injuries is usually in the aortic isthmus, a few centimeters distal to the ostium of the left subclavian artery. This is most frequently seen in frontal and near –side crashes where a large magnitude of force is being involved.

Following appearances are seen commonly-

- **Aortic rupture**- which is circular, clean cut, appears sharp as if transected with knife. Ladder tears- multiple transverse intimal tears, adjacent to main rupture.
- **Myocardial injuries**- there may be contusions, lacerations, contusions of the pericardium and myocardium may be seen without fracture of the ribs, avulsions and laceration of the chambers of heart.

- ❖ Tracheo bronchial disruption- Bruising of the lungs especially on the posterior aspect, due to blunt impact etc.
- ❖ Two or more deceleration injuries are mostly fatal.

Seat belt injuries:

Seat belts reduces the risk of death by 40% by keeping away from potentially hazardous object like steering wheel and wind screen and also spreads the deceleration force over the broad surface area of the strap. Although it reduces the risk of aortic injury, the same is not true for side impact crashes.

Seat belt syndrome:

- Caused by lap-strap belts: Frontal collision where the driver is forced forwards violently, then jackknives over the lap belt at the waist. The injuries sustained are- Surface injury to abdomen, injury to abdominal organs at the mid lumbar level, omental and mesenteric lacerations, lacerations of the abdominal organs, fracture and dislocations of the thoracic and lumbar vertebrae and spinal damage causing paralysis. The most characteristic triad of injuries associated with rapid deceleration against a fixed fulcrum is spinal trauma, seat belt aorta and bowel injuries.
- Caused by modern 3 point belts: These were developed to minimize the seat belt syndrome, However, even though the abdominal injuries were reduced, the diagonal strap introduced new injuries. It contributes to the hyper flexion and hyper extension of the neck, leading to the fracture of the cervical and upper thoracic vertebra, carotid laceration, tracheal transection, injuries to brachial plexus, accidental strangulation in children etc.

Under running:

A small vehicle, following a larger vehicle, may run under the larger vehicle (tail gating) like truck, running at a high speed and suddenly stopping in front of the large vehicle, causing severe crushing of the car. The occupants may receive severe crush injuries and in case if tail gating vehicle is a motorcycle, then, head and shoulder of the rider are smashed against the tail board and in extreme cases, decapitation may occur.

Front seat occupants:

Same sequence as in driver except, those steering wheel injuries will be absent; rather injuries by dashboard will be seen.

Back seat occupants:

Mechanism of injury is usually violent deceleration. No seat belt injuries will be present. Most commonly injuries are sustained over-head and knees, due to the head striking the front of seat and the head rest. Sometimes, the victim may be thrown over the front seat and strike the front structures of the car, or even ejected outside.

B) Side Impact:

This is the second most common type of vehicular injuries after frontal collisions. Seen when the offending vehicle strikes the sides of the victim's vehicle, or the vehicle skid sideways and hits a fixed object. The occupants sitting on the struck side is injured the most. Generally, the injuries are very severe, as the side of the car has very thin metal plate and usually no other components are preset to absorb the shock.

Dicing injuries: When the driver or occupants impacts the tempered glass windows of the vehicles during the crash, the glass breaks into fragmented cubes or dice shapes. These may cause dicing injuries over the face, shoulders and arms. These are small linear V shaped or sometimes irregular cuts, lacerations or abrasions. The driver will have dicing injuries on the right side of the body and a passenger will have them on the left.

C) Rear Impact:

Rear impacts are the least common form of fatal automobile accidents and unless impact was of very high speed, fatalities are rare. The injuries which may be sustained are : whiplash injuries, fracture cervical vertebrae, burns (in cases of high velocity injuries causing deformation and rupture of petrol tank), dicing injuries etc.

Ejection Injuries:

Ejection injuries are very dangerous and fatal. The victim may sustain head injury by striking the head against road, divider, poles, any stationery object, etc. Or may sustain injuries over projecting surfaces like knees, elbows etc.

3. Medico-Legal Importance

Most commonly they are accidental in nature. Suicidal automobile incidents are rare but not unheard of. Sometimes they are masqueraded as accidents in order to get insurance claims by the family. Homicidal motives can also be present behind hit and run cases. Some accidents may be faked to conceal the crime. e.g., the person may be killed by some other means, and then later on an accident is staged in order to conceal the original cause of death.

Motor Cycle Accidents:

Motor cycle riders are 8 times more prone to have injuries per vehicle per mile travelled and the fatalities of injuries in times of crash are 34 times higher risk of death than other vehicles.

A. Single vehicle accidents:

The motorcycle may slide, overturn and finally pin the rider. The rider may be ejected out or catapulted out either alone or along with the passenger.

Injuries sustained:

- 1) Typical primary impact, secondary impact and secondary injuries.
- 2) Fractures of the bone especially open fractures of long bones.
- 3) Graze abrasions
- 4) Head injuries, which is the leading cause of death.
 - a) Ring fractures- commonly seen because of impact of crown of head upon vertebral column.
 - b) Motorcyclist's fracture- Classical feature seen due to falling on ground. A transverse crack is seen across the middle cranial fossa behind the greater wing of sphenoid bones, crosses the pituitary fossa, to reach the opposite side. It thus divides the skull roughly into two equal halves, an anterior and posterior, which can be moved independently against each other like a hinge. This is common in both driver and pillion rider. Brain matter may extrude out through the fractured fragments.
- 5) Injuries to lower extremities- most common site of injury. Tibia is the most commonly fractured long bone, following femur, foot bones and patella. Femora fractures are the most common long bone injury in motorcycle deaths.
- 6) Run over- by another speeding vehicle.
- 7) Strangulation- due to pull of the helmet string around neck.

B. Collision with other vehicles:

Injuries to driver-

1. Primary impact injuries- There may be disarticulation of the limb. More severe lesions like lung contusion, rupture and separation of the heart from aorta, rupture of abdominal viscera. Chest and abdominal injuries are the second most common injuries in fatal motorcycle crashes. There may be tail gating of the vehicle along with the rider.
2. Secondary impact injuries- Head injuries, when secondary impact is on the colliding vehicle. When secondary impact is due to projection of the own vehicle, then large lacerations on groin and legs are seen, laceration of the internal organs by impact of the handle bars etc., leading to internal hemorrhage.
3. Secondary injuries- when thrown on the ground, there may be burns, crush injury of the head, facial injuries, thoracic spine injuries (most common), cervical spine injuries.

Injuries to pillion rider-

As the pillion rider falls back from the motor cycle, there may be fracture posterior cranial fossa, abrasions and lacerations of the back, especially the projecting parts, countercoup contusions of the frontal lobes.

C. Accidental striking of a pedestrian:

Injuries suffered by pedestrian are same as those found when a pedestrian is struck by four wheelers.

Bicycle Accidents:

Usually such accidents are due to inexperience in riding a bicycle or callousness on behalf of the rider. The rider loses control over the cycle and falls on the ground.

The nature of injuries-

Generally, they are mild but occasionally there may be associated fracture of long bones and severe soft tissue trauma. Extensive graze abrasions may occur. Collision with a motor vehicle will cause both primary impact (when he is struck by the vehicle) and secondary injuries (when he is struck by the pavement and also by his own vehicle).

Bicycle spoke injuries- Occur when the foot of a passenger, usually a child is caught in between the spokes of a rotating wheel. There are abrasions, lacerations and crushing of foot. The right foot is commonly involved as it is usually closer to the wheel in the side-saddle position.

4. Summary

- Primary impact injuries are caused by initial strike, i.e., the first part of the vehicle that strikes the victim (usually legs).
- The part of the body struck depends on the position of the person in relation to the vehicle struck.
- In children, bumper fracture is seen in femur. Femoral head may be driven through the acetabulum.
- Due to striking of the victim on ground: It may be caused after secondary impact injuries or immediately after primary impact injuries, when the victim is thrown high up in air and strikes the ground.
- The rotator effect against a fixed limb may strip off almost all tissues down to the bone, causing avulsion laceration.
- Fatal injuries may be seen in children sitting in passenger seat. Fatal injuries are caused by impact of chest against the air bag.
- Motorcyclist's fracture- Classical feature seen due to falling on ground. A transverse crack is seen across the middle cranial fossa behind the greater wing of sphenoid bones, crosses the pituitary fossa, to reach the opposite side.
- Injuries suffered by pedestrian are same as those found when a pedestrian is struck by four wheelers.
- Bicycle spoke injuries- Occur when the foot of a passenger, usually a child is caught in between the spokes of a rotating wheel.