

INJURY AND DEATH ON THE ROAD

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OBJECTIVE

- CAUSES OF MOTOR VEHICLE ACCIDENTS
- Natural Disease and Motor Vehicle Accidents
- Categories of Motor Vehicle Accidents
- Fires Secondary to Motor Vehicle Crashes
- AUTOMOBILE RESTRAINTS
- Motorcycle accidents
- Pedestrian accidents
- Suicide by motor vehicles
- Determination of who was driving

CAUSES OF MOTOR VEHICLE ACCIDENTS

Alcohol and drug impairment, human error, and environmental hazards are the leading causes of fatal motor vehicle accidents

Alcohol and Drug Impairment

- One of the leading causes of fatal motor vehicle accidents
- 65-75% of drivers responsible for accidents are under the influence of alcohol or drugs.
- These substances are not limited to illegal drugs but also include prescription medications.
- Benzodiazepines
- Diphenhydramine
- Antidepressants agent

• Human Error in Driving

- The second most common cause of fatal accidents is human error, which includes:
 - . Excessive speed.
 - . reckless driving.
 - . Falling asleep at the wheel.
- While speeding is often a secondary factor, it is usually associated with alcohol intoxication.

• Environmental Hazards

- Another cause of fatal accidents such as:
 - Bad weather conditions like heavy rain or fog.
 - Slick or icy roads.
 - Poorly marked or poorly maintained roads.

Dangerous roads, especially during adverse weather conditions, increase the likelihood of accidents

Accidents

These factors are less common, but they can still be deadly in certain situations.

- Vehicle defects: such as faulty brakes or worn-out tires.
- Natural diseases: such as a driver suffering a heart attack or stroke while driving, leading to loss of vehicle control.

NATURAL DISEASE AND MOTOR VEHICLE ACCIDENTS

Accidents caused by natural diseases are rare and generally affect only the driver.

In many cases, the driver is able to stop the vehicle before a fatal incident occurs, reducing damage and injuries.

CATEGORIES OF MOTOR VEHICLE ACCIDENTS

An Overview of Crash Types and Associated Injuries

Categories of Motor Vehicle Accidents

1. Front Impact Crashes

- Direct collision between two vehicles or a vehicle crashing into a fixed object.

2. Side Impact Crashes

- A vehicle colliding with another vehicle from the side.

3. Rollovers

- A vehicle overturning onto its side or roof.

4. Rear Impact Crashes

- A vehicle colliding with the rear of another vehicle.

Factors Affecting Fatalities

- **Size and Type of Vehicle**

- Smaller vehicles are less able to absorb crash energy.
- Larger vehicles like pickups are generally safer for occupants.

- **Type of Collision**

- Fatalities are more common in multi-vehicle crashes compared to single-vehicle accidents.
- Frequency of crash types in fatalities:
 - In car accidents: front impact, side impact, rollover, and rear impact
 - In pickups: rollover, front impact, side impact, and rear impact.

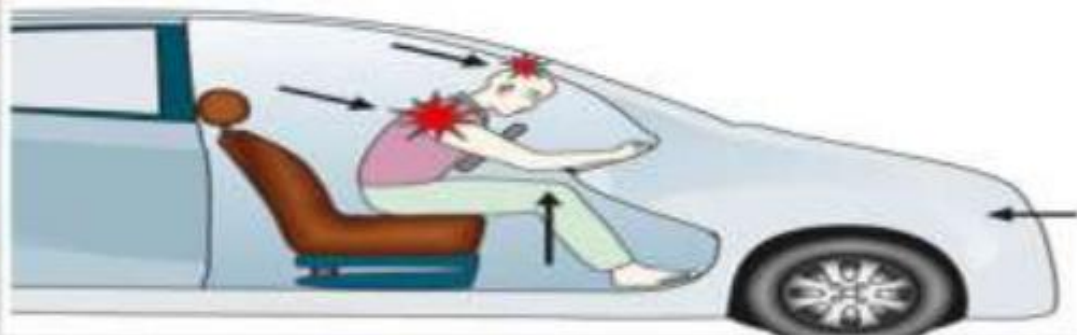


FRONT IMPACT CRASHES

Injury Mechanism

Continuation of passenger movement after the vehicle has stopped.

Areas of impact: knees, chest, and head.



Injury Patterns in Front Impact Crashes

- **Unrestrained Occupants:**

- Forward motion impacts:

- **Driver:** Knees → . Instrument panel, Chest → . Steering wheel, Head → . Windshield.

- **Passengers:** Hit dashboard, head impacts windshield.

- **individuals** in the back seat will hit the back of the front seat

- **Restraints:**

- With belts: Reduced injuries, but knee impacts still occur and the head flexes forward .

Windshield Impact Injuries

- **Injuries:**

- Abrasions and cuts on forehead, nose, and face.
- Possible embedded glass in wounds.

- **Severe Impacts:**

- Can cause soft tissue injuries, skull fractures, or closed head injuries .

Common Head Injuries

- Basilar skull fractures.
- Closed head injuries.
- Injuries to neck (upper cervical fractures/dislocations at the atlanto-occipital junction).
- Blunt force impact on the windshield can cause soft tissue injuries without serious cuts, which often draw the attention of emergency doctors to the head, while fatal injuries in the chest or abdomen may be overlooked



Fatal Thoracic Injuries

- transection of the aorta: common cause of death.
- Cardiac injuries include:
 - Myocardial contusion, pericardial laceration, atrial/ventricular ruptures.
- In cases of motor vehicle accidents, there may be instances where , after a complete autopsy and toxicological screening, no anatomical cause of death is identified. Such fatalities can result from fatal cardiac arrhythmia secondary to cardiac contusions.
- Minor injuries in elderly individuals may result in death due to unstable cardiac status.

Abdominal Injuries

- **Liver Injuries**

- Superficial capsular lacerations
- Rupture (bursting)
- Complications:
- Potential rupture of the left hemi-diaphragm with massive blunt trauma.

- **Splenic Injuries**

- Injuries may be underestimated; subcapsular hematomas can be the finding.

- **Diagnostic Challenges:**

- Patients may appear to have minor injuries.
- Peritoneal tap may initially show no blood.

- **Delayed Recognition:**

- Patients may die hours or days later from ruptured subcapsular hepatic or splenic hematomas.



Note the cardiac contusion, which resulted in death by fatal arrhythmia.



transection of the aorta in the proximal descending region. This is a common location of laceration.



Note the abraded contusion from his seatbelt



His face went through the front windshield. This type of pattern is consistent with a front windshield impact.

2 SIDE IMPACT CRASHE

Definition: Second most frequent type of fatal motor vehicle collision, often occurring at intersections.

Mechanism: Vehicle is struck broadside by another vehicle at right angles or hits a fixed object while skidding sideways.



Injury Patterns

- **External Injuries:**

- Dicing injuries (abrasions/lacerations) on one or both sides.
- Fractures predominantly on the left side when impacted from the left.

- **Internal Injuries**

- **Common Injuries:**

- Rib fractures (left side predominates).
- Possible transections of the aorta, ruptured heart.
- Lacerations of the liver and spleen, as well as fractures of the neck.

- **Outcomes:**

- Fatalities more likely in the car being impacted, due to protective structure of the engine in impacting
- Unrestrained occupants may be ejected partially through windows, increasing injury risk.

Seat Belts : Help prevent ejection and mitigate injury severity.



Note the dicing type injuries to the scalp with cubed fragments of glass imbedded in some of these injuries



This individual was the passenger in a front seat collision. Note the abraded contusion from his seatbelt.

ROLLOVER CRASHES OVERVIEW

Definition: Less lethal than head-on or side impacts if occupants are not ejected.



Injury Patterns in Rollovers

- **Unrestrained Individuals:**

- Injuries vary widely due to random impacts in the passenger compartment.
- No specific injury pattern exists for ejected individuals.

- **ejection Risk:**

- Unrestrained occupants may be ejected through windows.
- Complete ejection can occur, or only the head and upper trunk may protrude

- **Autopsy Findings** : Internal injuries (massive ruptures of lungs, heart, liver, spleen) may not have external trauma..

REAR IMPACT CRASHES



Common Injuries

- Rear impact crashes are the least common form of fatal accidents.
- Occupants in the front seat of the impacted vehicle are typically protected by the trunk and rear passenger area.

- **Risks of Fuel Tank Rupture**

- One danger in rear impact crashes is the potential ruptured of the gas tank, leading to ignition.
- The risk of rupture is proportional to the speed of impact.
- Most fatal automobile fires start under the hood, not from rear impact.

AUTOMOBILE RESTRAINTS

Seat belts and airbags

Advantages and Risks of Seat Belt Types

- **Lap Belts**

- Advantages:
 - Reduce mortality and morbidity.
 - Prevent ejection during crashes.
 - Protect from head impacts with the windshield, steering wheel, and dashboard

- Potential Risks of Lap Belts

- Injury Mechanisms:

- Compression fractures of lumbar vertebrae.
- Soft tissue injuries (contusions and lacerations).

- **Shoulder Belts:**

- Injuries from Shoulder Belts
 - Cervical, thoracic, lumbar spine fractures.
 - Rib and sternum fractures.
 - Injuries to larynx, liver, spleen, and kidney



Restraints and Airbag Function

Advantages of Three-Point Restraints

- **Advantages:**

- Reduce mortality and morbidity.
- Prevent ejection during crashes.
- Protect from head impacts with the windshield, steering wheel, and dashboard

- **Possible Injuries:**

- Rib fractures, clavicular and cervical spine fractures.

- Role of Airbags in Vehicle Safety

- **Function :** Must deploy rapidly to fill space between occupant and steering wheel/dashboard.

Injury Risks Associated with Airbags

- **Possible Injuries** : Cervical spine dislocations/fractures, basal skull fractures, abdominal injuries.
- **High-Risk Groups** : Small-statured women and children under 13 years

• Statistics on Airbag-Related Fatalities

• NHTSA Data (Nov 2000):

- 169 deaths attributed to airbags since 1990.
- Majority involved children under 12.
- Most fatalities occurred in unrestrained or improperly restrained children



• Pre-Tensioners in Safety Systems•

Function:

- Activated by crash sensors to tighten seatbelts before airbag deployment .
- Reduce impact force between airbag and occupant

Motorcycle accidents

Motorcycles are inherently dangerous due to lack of protection. Approximately 6% of all traffic fatalities involve motorcycle

.Accident Severity: Minor injuries in cars can be fatal on motorcycles due to ejection during accidents.

Common Fatal Injuries:

Head injuries (most common)

Neck injuries

Types of Head Injuries:

Extensive skull fractures, especially base fractures (Temporoparietal fractures)

.Injuries occur from impacts with the ground or objects (e.g., curbs, lampposts).

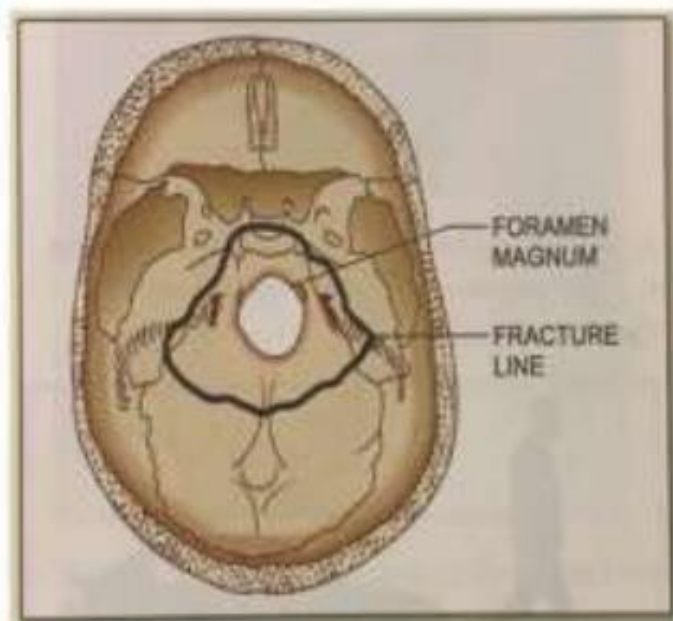


Motorcycle injuries

- 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.

- o Ring fractures- commonly seen because of impact of crown of head upon vertebral column.

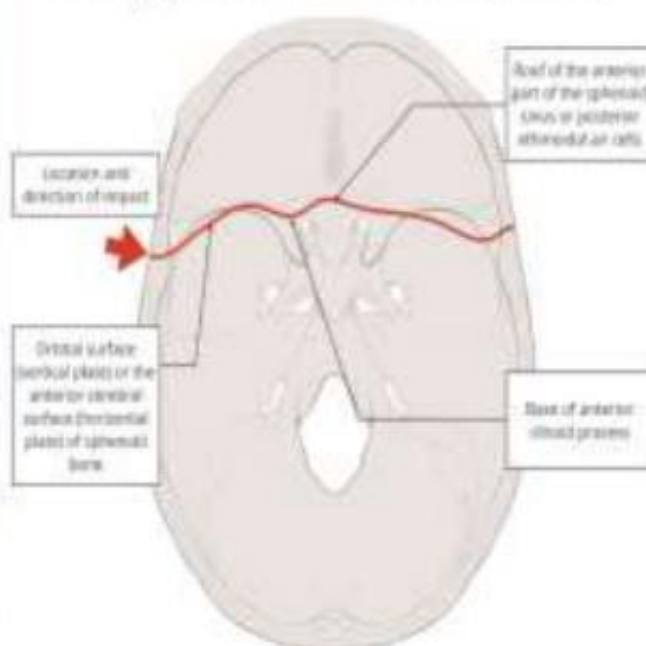
- o Motorcyclist's fracture (Hinge fracture) - Classical feature seen due to falling on ground. A transverse crack is seen across the middle cranial fossa, It thus divides the skull roughly into two equal halves, an anterior and posterior, which can be moved independently against each other like a hinge, Brain matter may extrude out through the fractured fragments.



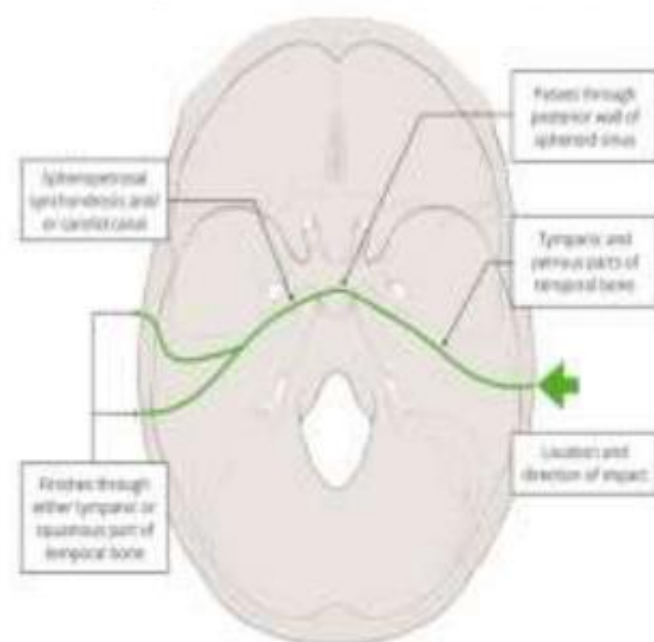
RING FRACTURE

Ring fracture in the base of skull is seen in fall from height landin on feet or buttocks

Anterior transverse transsphenoidal basilar skull fracture



Posterior transverse transsphenoidal basilar skull fracture



Motorcycle injuries

- 5) Injuries to lower extremities ,Tibia is the most commonly fractured long bone, then femur, foot bones and patella.
- 6) Run over- by another speeding vehicle.
- 7) Strangulation- due to pull of the helmet string around neck.

Motorcycle accidents

Skin Abrasions:

Abrasions are common from sliding on pavement. Incisions reveal superficial injuries with no underlying hemorrhage.

Passenger Injuries:

Lacerations to the back of the head.

Fractures of the posterior fossa.

Countercoup contusions in the frontal lobes.

Abrasions on the back and elbows; facial abrasions if tumbling forward.

Helmet Effectiveness:

Helmets reduce head trauma in low-speed accidents.

In moderate to high-speed accidents, helmets mainly prevent brain matter dispersion.

Causes of Motorcycle Accidents

Common Causes of Accidents:

- 1) Alcohol or drugs (28% of motorcycle operators have aBAC of 0.10 g/dL or higher).
- 2) Environmental factors (oil slicks, bumps, potholes).
- 3) Reckless driving.
- 4) Car drivers' failure to see motorcycles.

Severe Injuries:

Beheadings or arm avulsions caused by cables or wires stretched across roads (Sharp wounds from such injuries often resemble cuts made by a knife).



Figure 9.13 (continued) (A) Complete avulsion of right arm by guy wire. Note sharp margins.

Pedestrian accidents



• **Factors Influencing Injury Patterns**

- 1) Speed of the Vehicle: The most critical factor affecting injury severity.
- 2) Physical Characteristics of the Vehicle: Size and design influence injury patterns.
- 3) Braking Status: Whether the vehicle was braking at impact affects the severity.
- 4) Victim's Age: Injuries may differ between children and adults.

• **Relationship Between Speed and Injuries**

- Between 20 and 40 km/h, injury severity increases significantly.

Child and adult pedestrians

Factor	Child Pedestrians	Adult Pedestrians
Non-Braking/Late-Braking	Impact is above center of gravity, slammed down and run over.	For high-front trucks: similar to children, slammed down and run over.
Hard Braking	Vehicle dips below center of gravity, child is thrown forward.	With high-front trucks, adult is thrown forward.
Injuries	Not specified.	Dents/scuff marks on the bumper, hood, or roof of the car. Amputation or severe trauma at high speeds.

Injuries to the Pedestrians

- **Primary Impact Injuries:** These are the injuries caused by vehicle when it first struck and hit the person whether crossing the road from one side to the other side or walking with or against the traffic.
- **Secondary impact injuries:** They are caused by the second impact with the vehicle (eg: the body of thrown onto the vehicle). They are caused when after sustaining primary impact of injury, the person may be lifted off the ground and thrown of the vehicle. Here the person strikes to windshield or bonnet or placed on the top of car/ vehicle. Usually, such injuries are on the opposite side of primary impact.



Injuries to the pedestrians

- **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 maybe 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.
- **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 under surface of chassis), burns from exhaust system and fractures. These injuries will be present circumferentially all around the body.



Bumper
impact



Primary
impact
injury



Hood and
Windscreen
impact



Secondary
impact
injuries



Ground
impact



Secondary
injuries

Injuries to the Pedestrians

Bumper Fractures

- The fracture fragments are wedge shaped ,The base of the wedge indicates the site of the impact, the apex points in the direction in which the vehicle was traveling.
- **Tibia and fibula** fractures caused by bumper impact, varying by leg position.
- In children, bumper fracture is seen in femur. Femoral head may be driven through the acetabulum.
- Skin abrasions or internal hemorrhaging in the calves from bumper contact.
- Medico-legal importance of this fracture: 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.
- In one leg if he was hit while crossing the road

Tire Marks

- Tread marks from the vehicle's tires on the body or clothing.
- Abrasions on the side of the body that scraped against the road.



Figure 9.20 Tire tread marks on clothing in a hit-and-run death.



Figure 9.18 "Bumper" fractures of lower legs.



Figure 9.19 A 3-year-old child run over by a truck with (A) tire marks on the back and (B) scrape abrasions on chest, which was in contact with pavement.

Waddell's triad

- Pedestrian children:
- Fracture of femur
- Chest/ abdominal injuries
- Contralateral head injury



Suicide by motor vehicles

1. Nature of the Crash:

Intentional Impact: Head-on collision with a fixed object (e.g., bridge, utility pole).

No Evasive Action: Driver steers directly into the obstacle, without veering back onto the road.

Tire Tracks: Show no attempt to avoid the crash or brake.

2. Lack of Braking:

No Brake Lights: Witnesses typically report no brake lights during the incident.

Tire Mark Analysis: Confirms no signs of braking or evasive maneuvers.

3. Psychological History:

Suicide History: Common in individuals with previous suicide attempts or psychiatric treatment.

Personal Crisis: Often follows significant emotional events, like family tragedies.

4. Confirmatory Evidence:

Shoe Examination: Gas pedal imprints on the shoe sole can indicate continued acceleration at impact, confirming intent.

Determination of who was driving

Investigating the Driver

In accidents with multiple occupants, it may be uncertain who was driving, especially if fatalities occur or survivors mislead authorities to avoid liability.

Body, car, and clothing examinations provide crucial clues.

Key Indicators

1) Injury Patterns:

Steering wheel imprint: May indicate direct contact by the driver.

2) Clothing Fibers:

Fibers from clothing found on the steering wheel or sun visor can identify the driver.

3) Shoe and Pedal Evidence

Examination of shoe soles may show a pedal pattern from the brake or accelerator. In one case, pedal imprints on a woman's shoes disproved her claim of not driving.

4) Biological Evidence

Blood on steering wheel, visor, or windshield can be tested to identify the driver through DNA analysis.



Thank You