

Mechanisms of Injury

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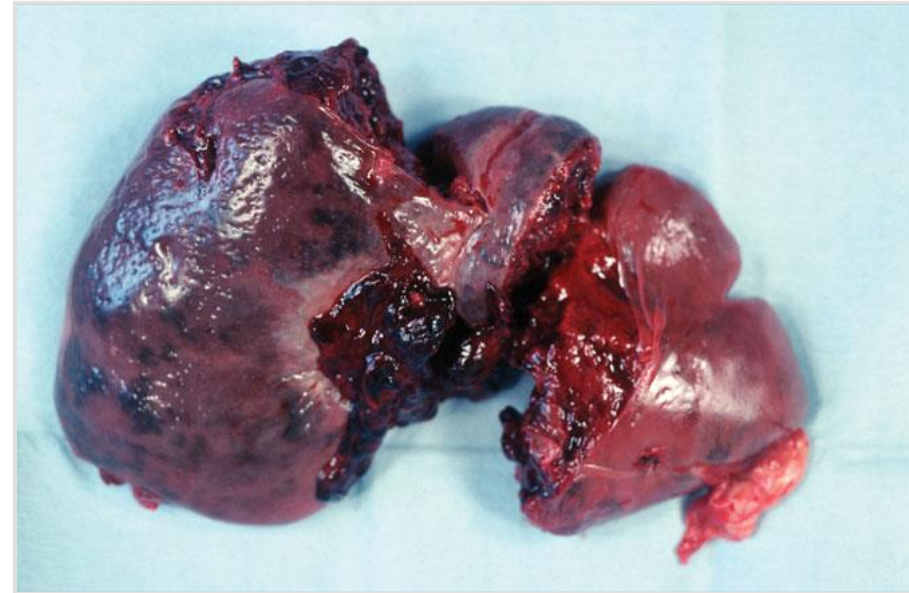
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Introduction

- Trauma is the primary cause of death and disability between ages 1 to 44 years.
- Analyzing a trauma scene is a vital skill.
- Determining the events that lead to trauma, often predict the injuries encountered.

Trauma

- Injury occurs when an external source of energy affects the body beyond its ability to sustain and dissipate energy.



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Trauma

- Different forms of energy produce different kinds of trauma.
 - Mechanical energy
 - Chemical energy
 - Electrical energy
 - Barometric energy

Factors Affecting Types of Injury

- Ability of body to disperse energy delivered
- Force and energy
 - Size of object
 - Velocity
 - Acceleration or deceleration
 - Affected body area
- Duration and direction
 - The larger the area, the more energy will be dissipated.
- Position of victim

Factors Affecting Types of Injury

- The impact resistance of body parts has a bearing on types of tissue disruption.
 - Organs that have gas inside are easily compressed.
 - Liquid-containing organs are less compressible.

Kinetics

- Study of the relationship among speed, mass, direction of force, and physical injury caused by these factors



Kinetics

- **Newton's first law of motion:** A body at rest will remain at rest unless acted on by an outside force.
- **Newton's second law of motion:** The force an object can exert is the product of its **mass** times its **acceleration**.

Kinetics

- Velocity (V): Distance per unit of time
- Acceleration (a): Rate of change of velocity
- Gravity (g): Downward acceleration imparted to any object moving toward earth
- **Kinetic energy = mass/2 × velocity²**

Kinetics

- Kinetic energy of a subject in motion that stops suddenly must be transformed or applied to another object.



Kinetics

- Other factors that will affect energy dissipation in a crash include:
 - Vehicle's angle of impact
 - Differences in sizes of the two vehicles
 - **Restraint** status and **protective** gear of occupants
- Energy dissipation: Process by which KE is transformed into mechanical energy
 - Protective devices can manipulate the way in which energy is dissipated.

Blunt Trauma

- Injuries in which tissues are not penetrated by external object



Motor Vehicle Crashes

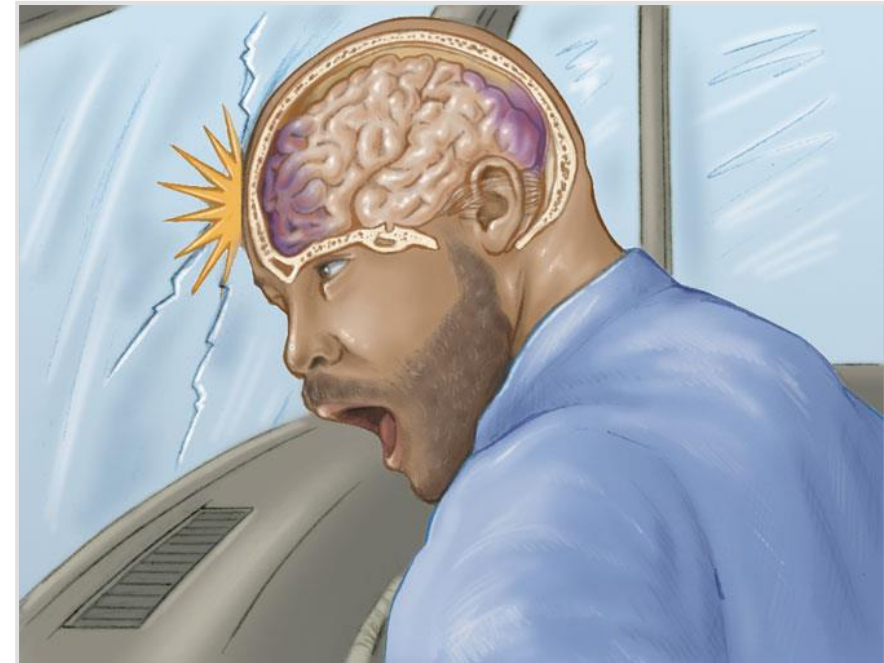
- Five phases of trauma:
 - Phase 1: Vehicle Deceleration
 - Phase 2: Occupant deceleration



Courtesy of Captain David Jackson, Saginaw Township Fire Department

Motor Vehicle Crashes

- Five phases of trauma (cont'd):
 - Phase 3: Deceleration of internal organs
 - Phase 4: Secondary collisions
 - Phase 5: Additional impacts received by the vehicle



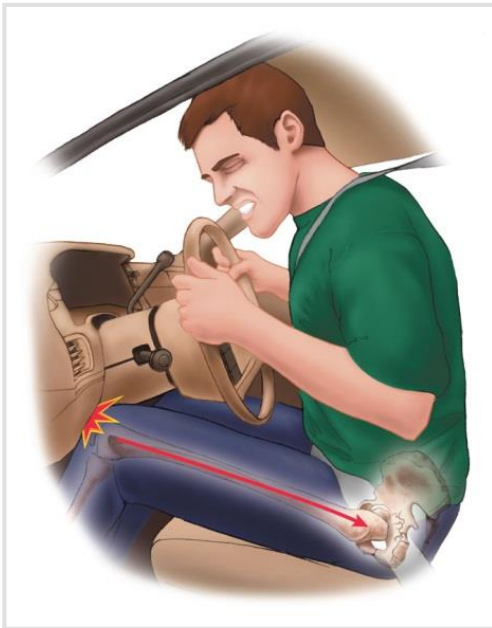
Impact Patterns

- **Frontal or head-on impacts**

- Front end of the car distorts.
- Passengers decelerate at same rate as vehicle.
- Abrupt deceleration injuries are produced by a sudden stop of a body's forward motion.

Impact Patterns

- Frontal or head-on impacts (cont'd)
 - Unrestrained occupants usually follow one of two trajectories:
 - Down-and-under pathway
 - Up-and-over pathway



Impact Patterns

- Lateral or side impacts
 - Impart energy to the near-side occupant
 - Seat belts offer little protection.
 - The body is pushed in one direction, while the head moves toward the impacting object.



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Impact Patterns

- Rear impacts
 - Have the most survivors
 - Whiplash injury is common.
 - Energy is imparted to the front vehicle.



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Impact Patterns

- Rotational or quarter-panel impacts
 - Occurs when a lateral crash is off center
 - The vehicle's forward motion stops, but the side continues in rotational motion.

Impact Patterns

- Rollovers
 - Patients may be ejected.
 - Patients may be struck hard against the interior of the vehicle.



Restrained Versus Unrestrained Occupants

- Seat belts stop the motion of an occupant traveling at the same speed as the vehicle.
 - Associated injuries include cervical fractures and neck sprains.

Restrained Versus Unrestrained Occupants

- Air bags have reportedly reduced deaths in direct frontal crashes by about 30%.
 - Can also result in secondary injuries:
 - Direct contact
 - Chemicals



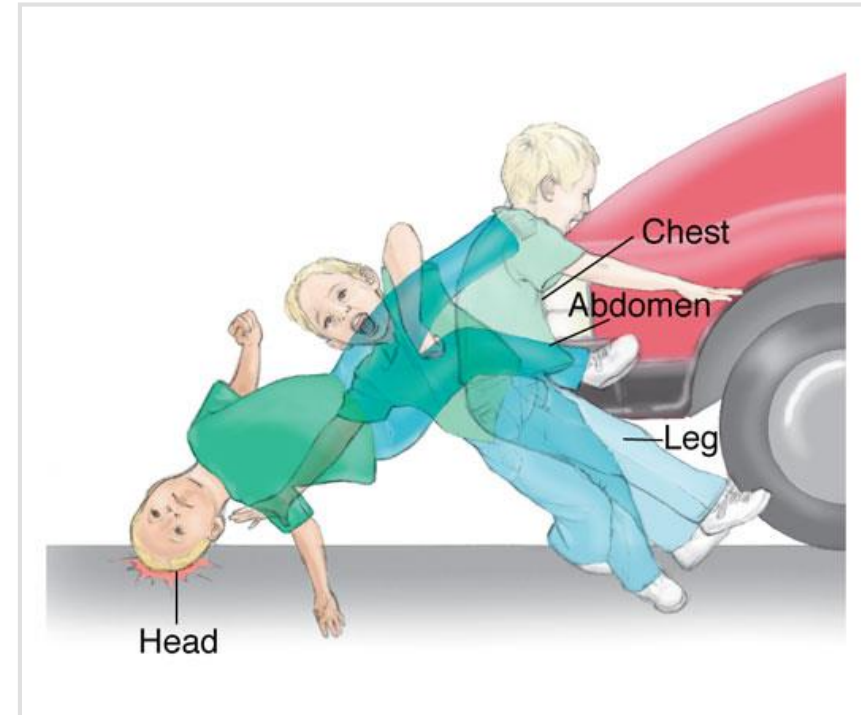
Courtesy of AAOS

Pedestrian Injuries

- Three predominant MOIs:
 - First impact:
 - Car strikes body with its bumpers.
 - Second impact:
 - Adult is thrown on hood and/or grille of vehicle.
 - Third impact:
 - Body strikes the ground or some other object.

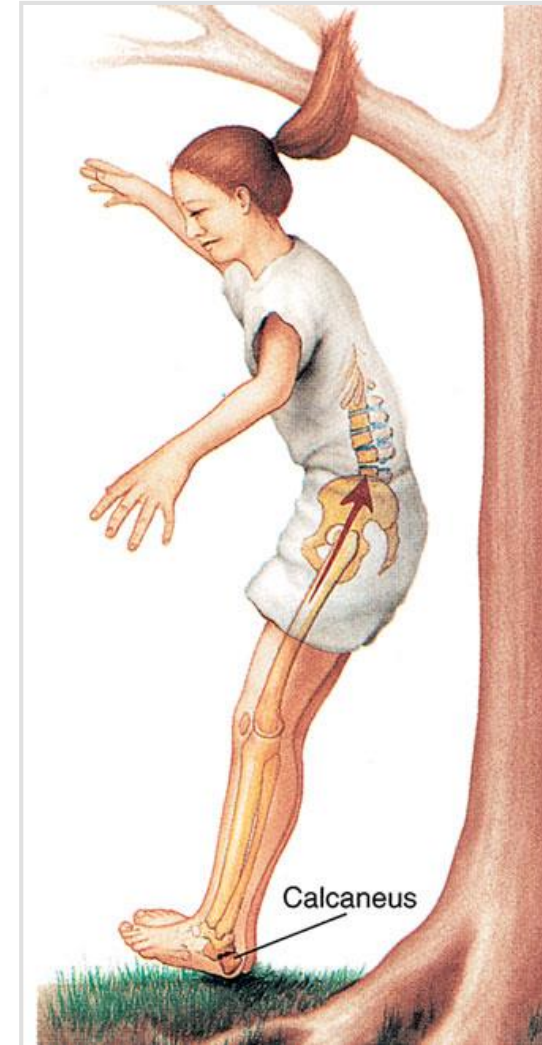
Pedestrian Injuries

- **Waddell triad:** Pattern of injuries in children and people of short stature
 - Bumper hits pelvis and femur.
 - Chest and abdomen hit grille.
 - Head strikes vehicle and ground.



Falls from Heights

- Severity of injuries impacted by:
 - Height
 - Position
 - Surface
 - Physical condition



Penetrating Trauma

- Involves disruption of skin and tissues in a focused area
 - Low velocity: Caused by sharp edges
 - Medium and high velocity: Object might flatten out, tumble, or ricochet.



Stab Wounds

- Severity depends on:
 - Anatomic area involved
 - Depth of penetration
 - Blade length
 - Angle of penetration

Gunshot Wounds

- Severity depends on:
 - Type of firearm
 - Velocity of projectile
 - Physical design/size of projectile
 - Distance of victim from muzzle
 - Type of tissue struck

Gunshot Wounds

- Handgun
 - Revolver holds 6 to 10 rounds of ammunition
 - Pistol holds up to 17 rounds of ammunition
 - Accuracy is limited.
- Shotguns
 - Fire round pellets
- Rifles
 - Fire single projectile at a very high velocity
 - Impart a spin for accuracy

Gunshot Wounds

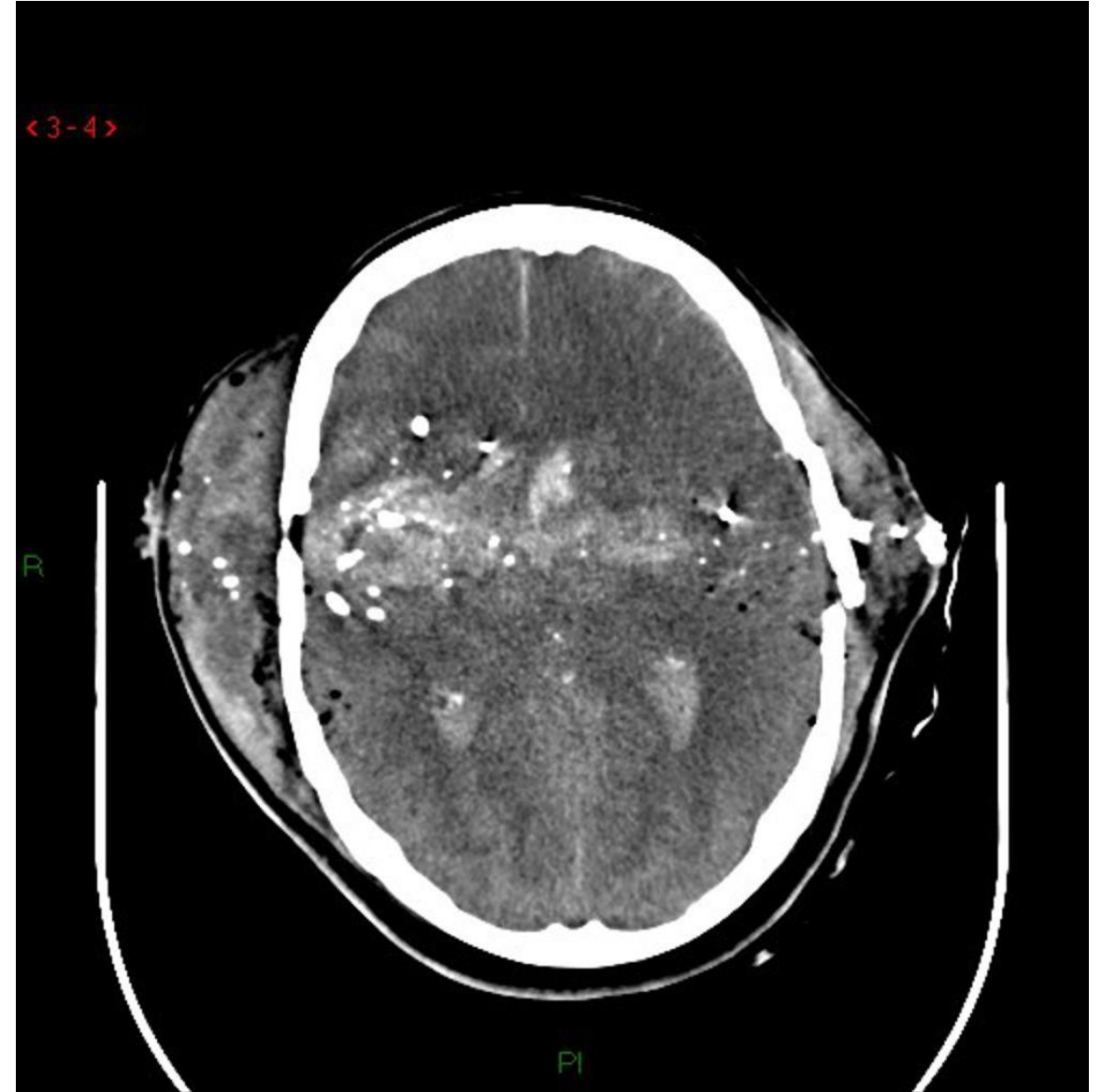
- The most important factor for seriousness of wound is type of tissue involved.
- Entry wound is characterized by the effects of the initial contact and implosion.

Gunshot Wounds

- Deformation/ tissue destruction is based on:
 - Density
 - Compressibility
 - Missile velocity
 - Missile fragmentation

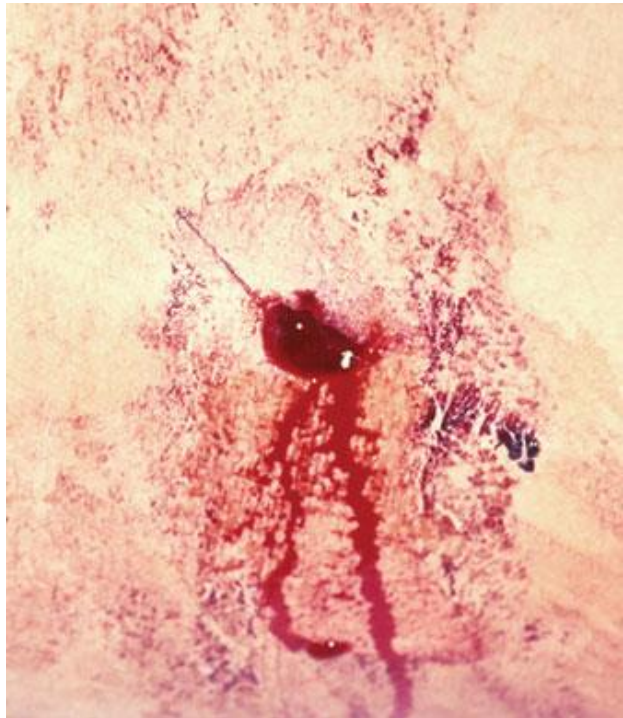
Gunshot Wounds

- Projectile creates a permanent cavity.
 - May be straight line or irregular pathway
 - Pathway expansion: Tissue displacement that results from low-displacement sonic pressure
 - Missile fragmentation: Projectile sends off fragments that create paths through tissues.

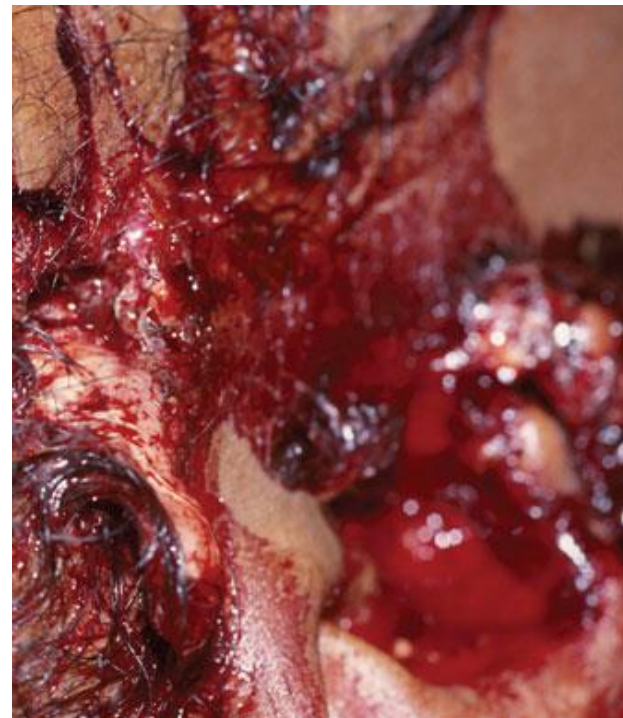


Gunshot Wounds

- Exit wounds occur when projectile's energy is not entirely dissipated.
 - Size depends on energy dissipated and degree of cavitation.



**Entrance
wound**



**Exit
wound**

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Gunshot Wounds

- Wounding potential depends on:
 - Powder charge
 - Size and number of pellets
 - Dispersion of the pellets
 - Range at which the weapon was fired
 - Barrel length
 - Type of choke at the end of the barrel

Gunshot Wounds

- Try to obtain the following:
 - Weapon used
 - Range fired
 - Bullet used
- Look for:
 - Powder residue around the wound
 - Entrance and exit wounds

Primary Blast Injuries

- Damage is caused by pressure wave generated by explosion
- Close proximity to the origin of the pressure wave carries a high risk of injury or death.

Secondary Blast Injuries

- Result from being struck by flying debris
- A blast wind occurs.
- Flying debris may cause blunt and penetrating injuries.

Tertiary Blast Injuries

- Occur when a person is hurled against stationary, rigid objects
- Ground shock: Physical displacement when the body impacts the ground

Quaternary (Miscellaneous) Blast Injuries

- Occur from the miscellaneous events that occur during an explosion
- May include:
 - Burns
 - Respiratory injury
 - Crush injury
 - Entrapment

Quinary Blast Injuries

- Caused by biologic, chemical, or radioactive contaminants added to an explosive
- Associated with “dirty bombs”

Summary

- Trauma is the primary cause of death and disability in people between ages 1 and 44 years.
- Understanding mechanisms of injuries will help in management of trauma victims by predicting injuries.

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