Mechanisms of Injury

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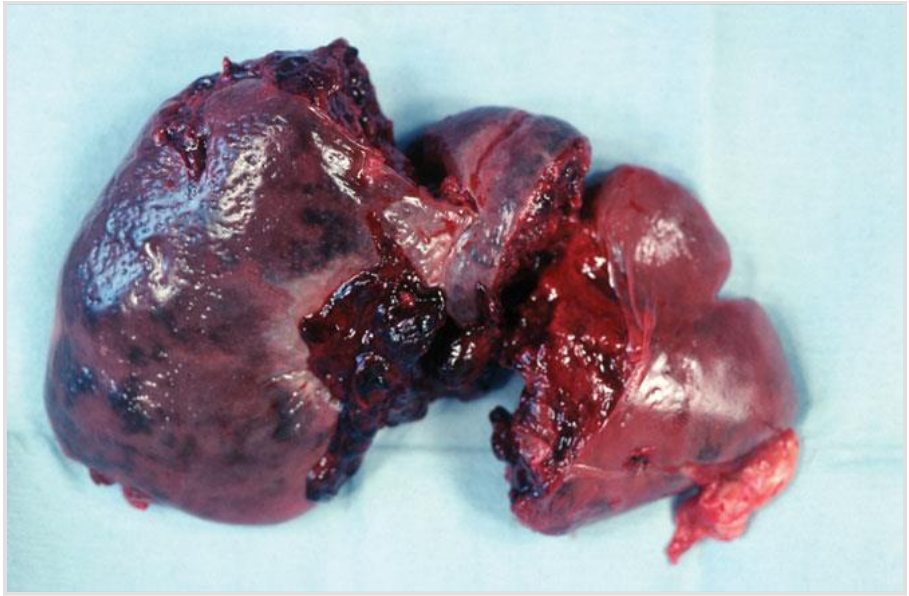
Introduction

- 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.



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 × velocity^2**

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

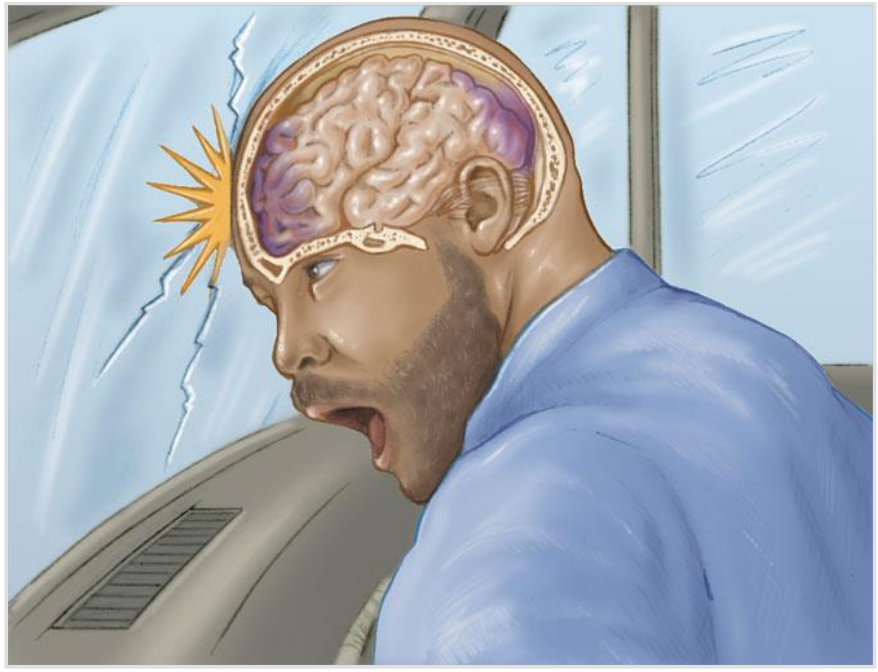
Motor Vehicle Crashes

- 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

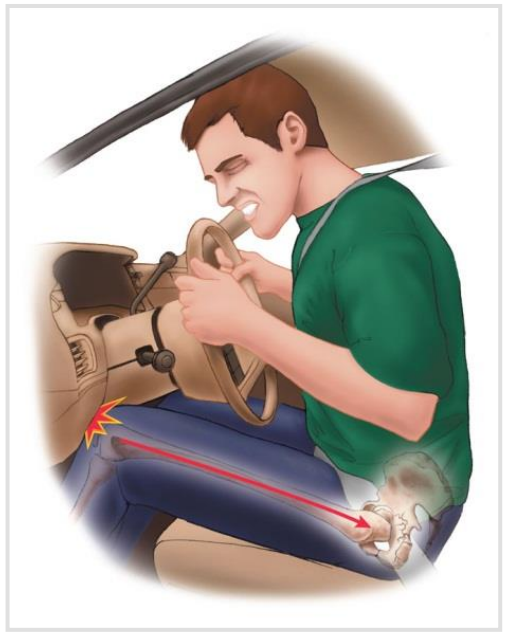


Impact Patterns

- **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.

Impact Patterns

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

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

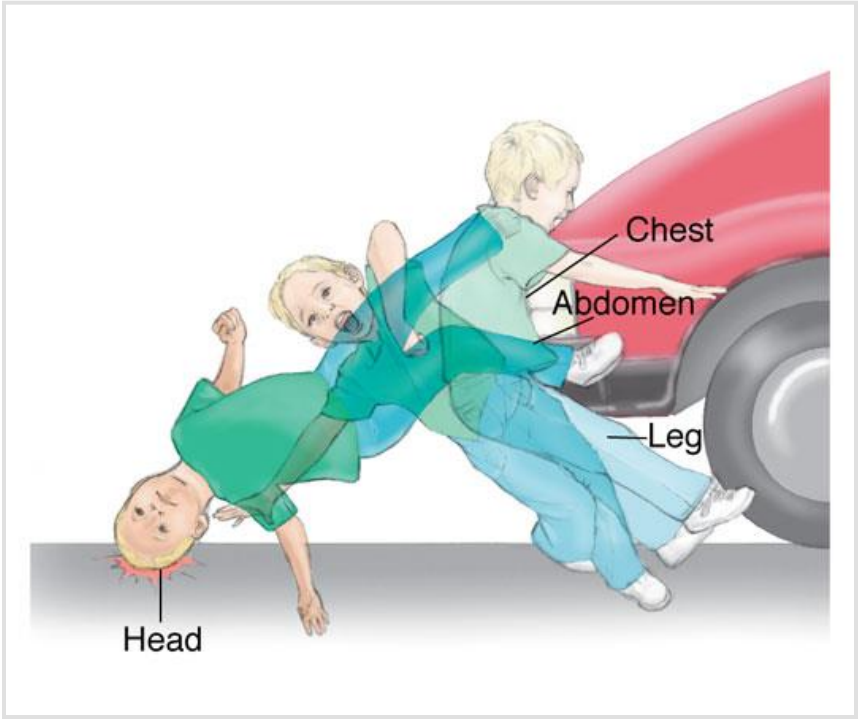
- Air bags have reportedly reduced deaths in direct frontal crashes by about 30%.
  - Can also result in secondary injuries:
    - Direct contact
    - Chemicals

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.

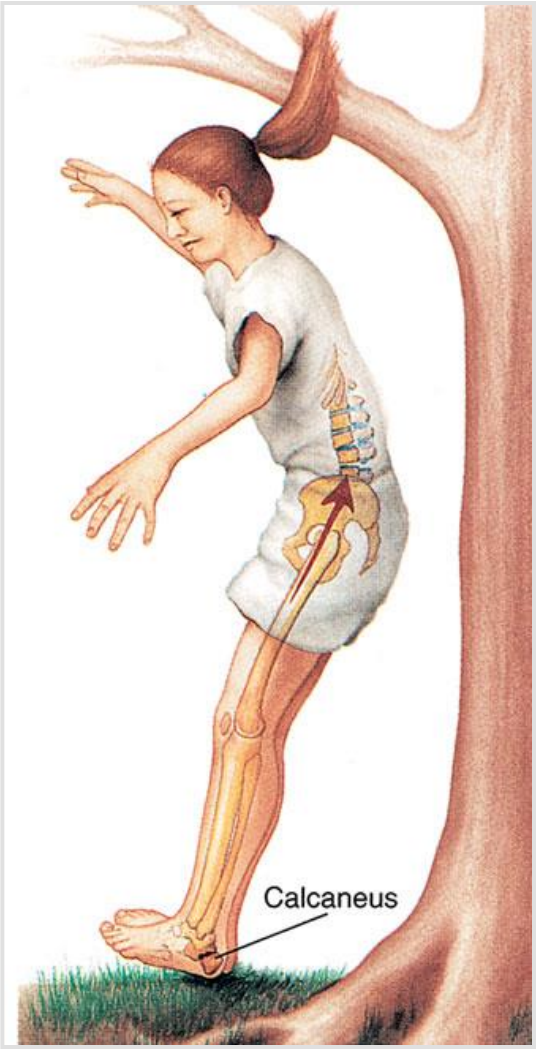
Pedestrian Injuries

- **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

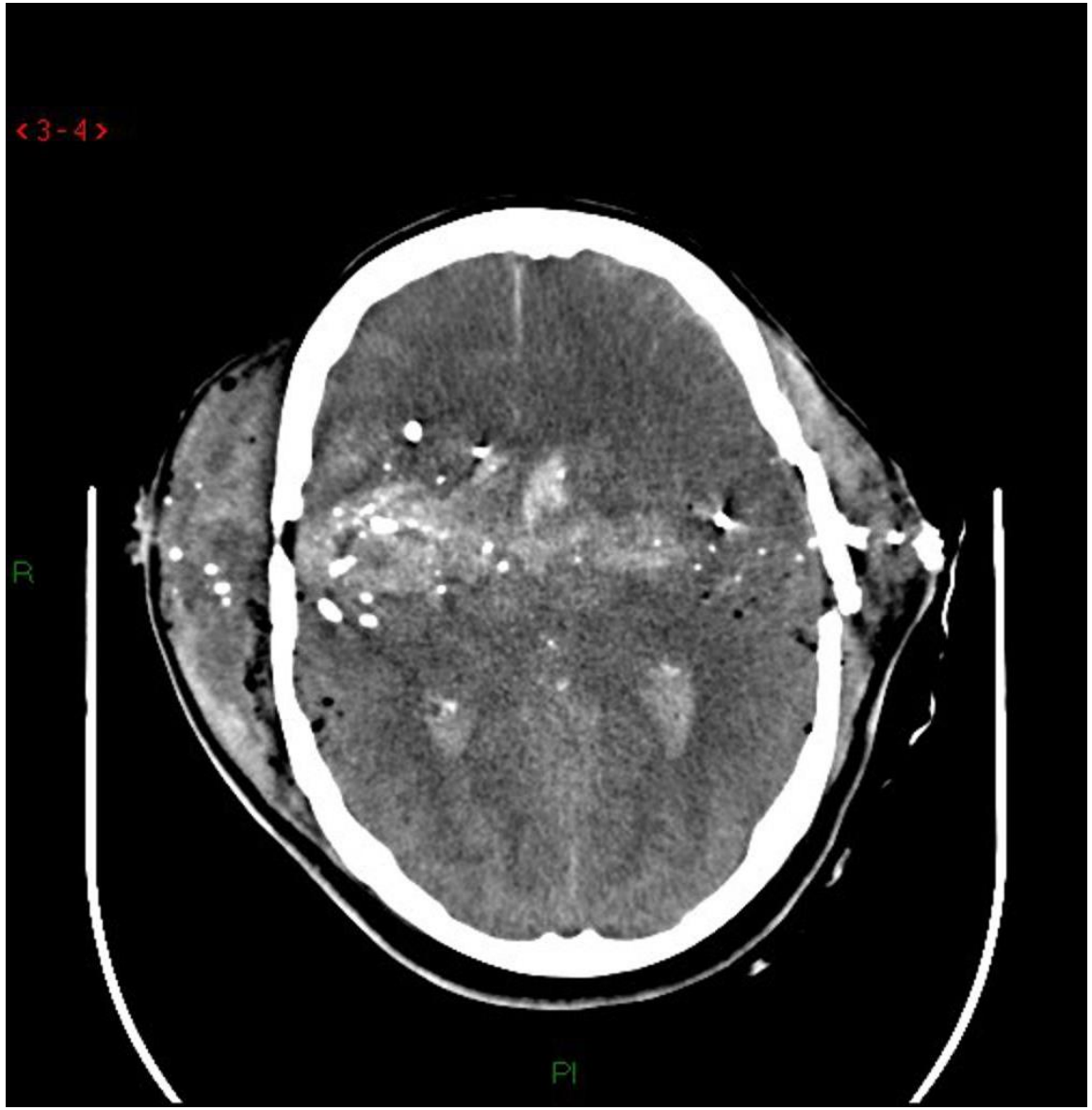
- The most important factor for seriousness of wound is type of tissue involved.
- Entry wound is characterized by the effects of the initial contact and implosion.

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

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Exit wound

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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