MEDAVIE HealthEd ÉduSanté

Kinetics of Trauma

Primary Care Paramedicine

Module: 08

Section: 01b

Kinetics of Trauma

MECHANISM OF INJURY

Mechanism of Injury Analysis

- Processes and forces that cause trauma
- Identify:
  - Forces involved
  - Direction of the forces
  - Affected areas of the patient
- First step in focused history is the physical assessment of the trauma patient

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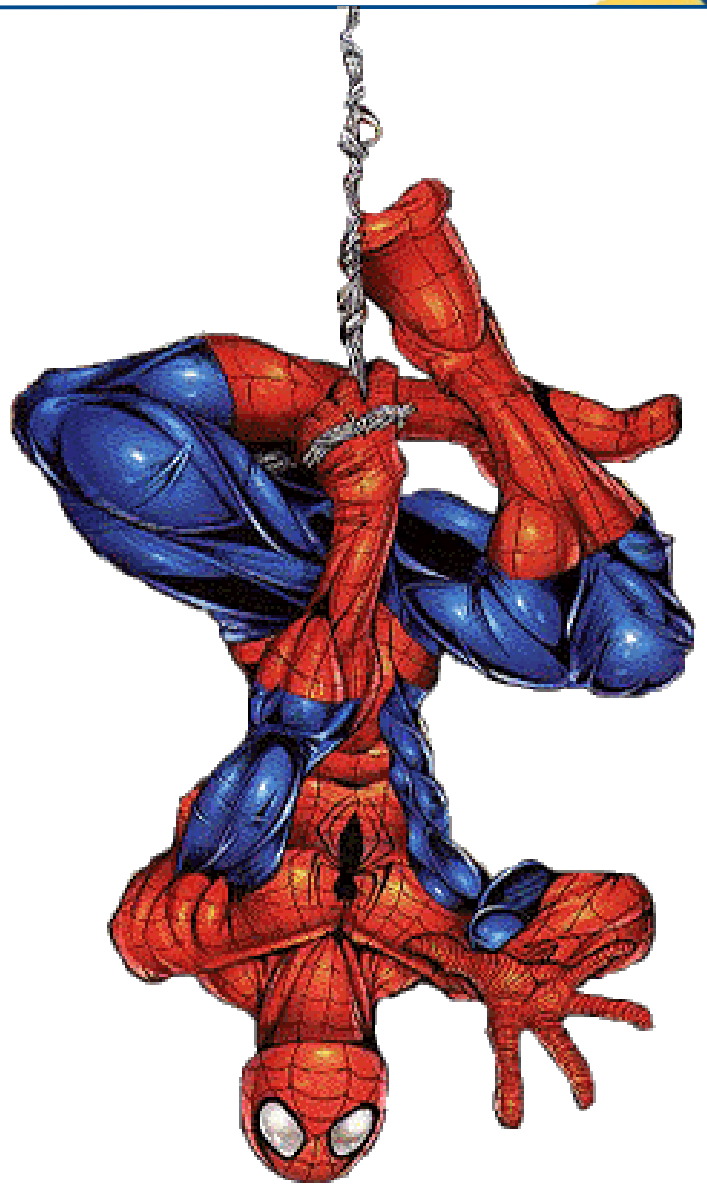
Mechanism of Injury

Index of Suspicion



- Anticipation of injury to a body region, organ or structure based on analysis of mechanism of injury
- Shock and head injuries are the principle killers in trauma
  - May present subtly at first
  - Trauma patients require frequent reassessment and trending

Golden Hour

- Research demonstrates that survival rates go up as time to surgery is decreased
- Golden Hour
  - Current goal for incident to surgery time
- Platinum 10 Minutes
  - Limit scene time to 10 minutes
- Air transport
  - Usually governed by protocol
  - Balance of speed versus need

KINETICS OF TRAUMA

Energy

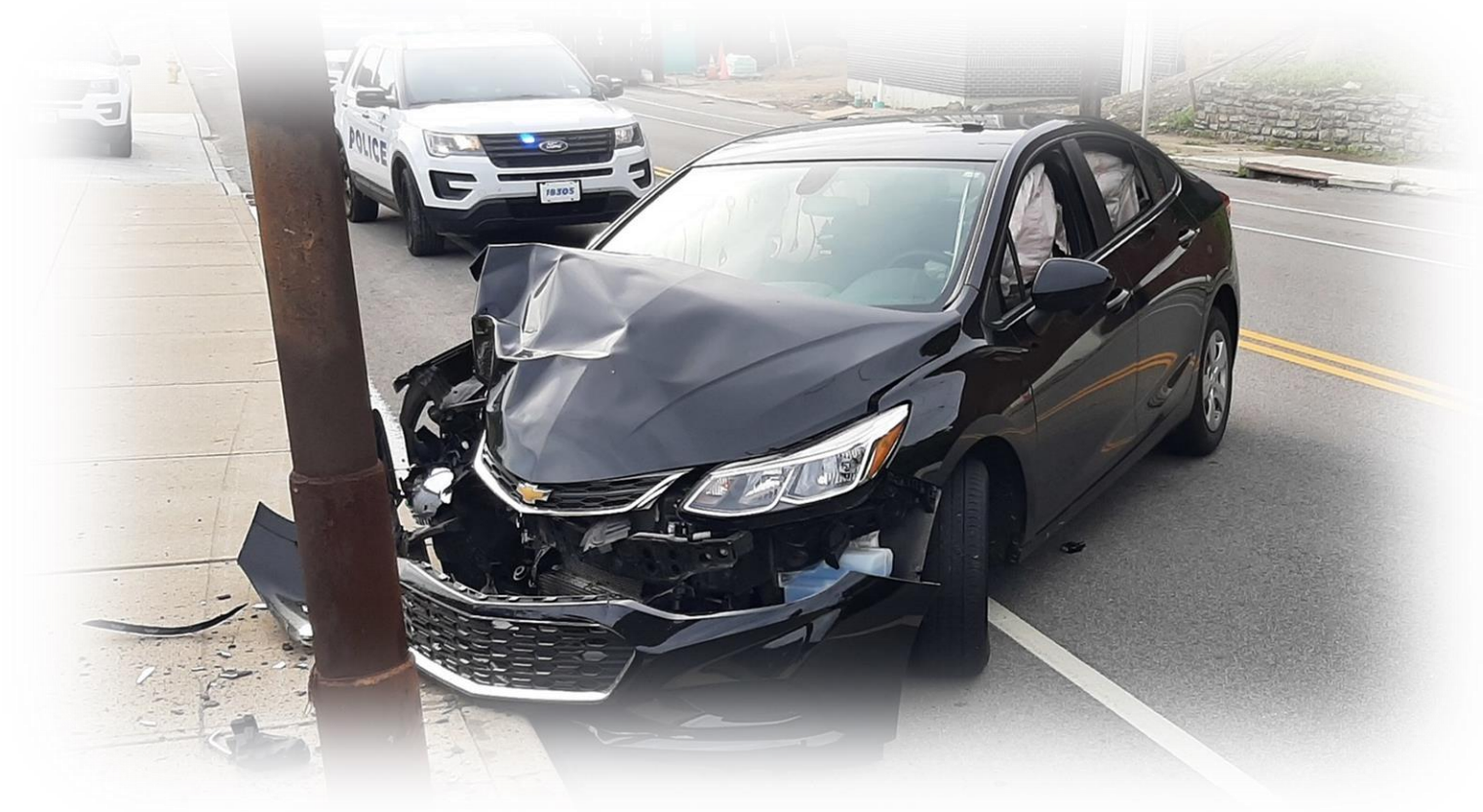
- Transfer of energy from an external source to the body causes injury.
- The extent of injury is based on:
  - Type of energy
  - Amount of energy applied
  - Speed of force applied
  - Location of body force is applied to

Kinematics

- Process of examining the MOI of an incident to determine what injuries likely resulted from the forces and motion and changes in motion involved

Questions

- You arrive on scene to find this. What questions should you be asking yourself in terms of the MOI



Kinematics

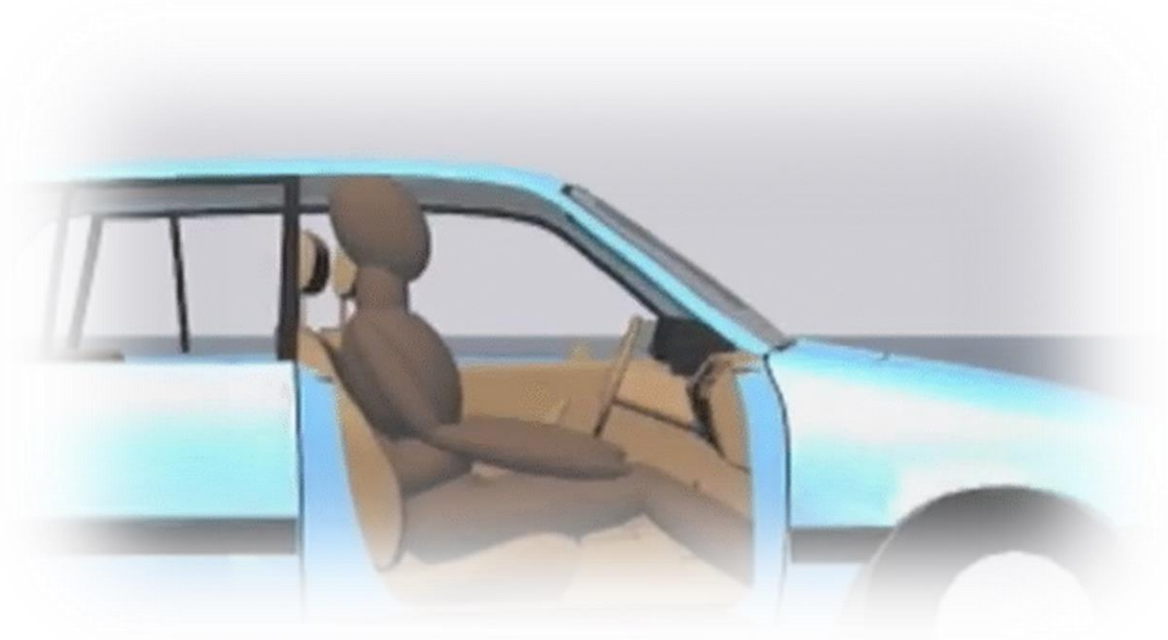
- Consider:
  - Individual factors
    - Age
    - Protective devices (seat belts, helmets, etc)
  - Other applicable factors
    - Force of energy applied
    - Anatomy
    - Energy

Kinetics

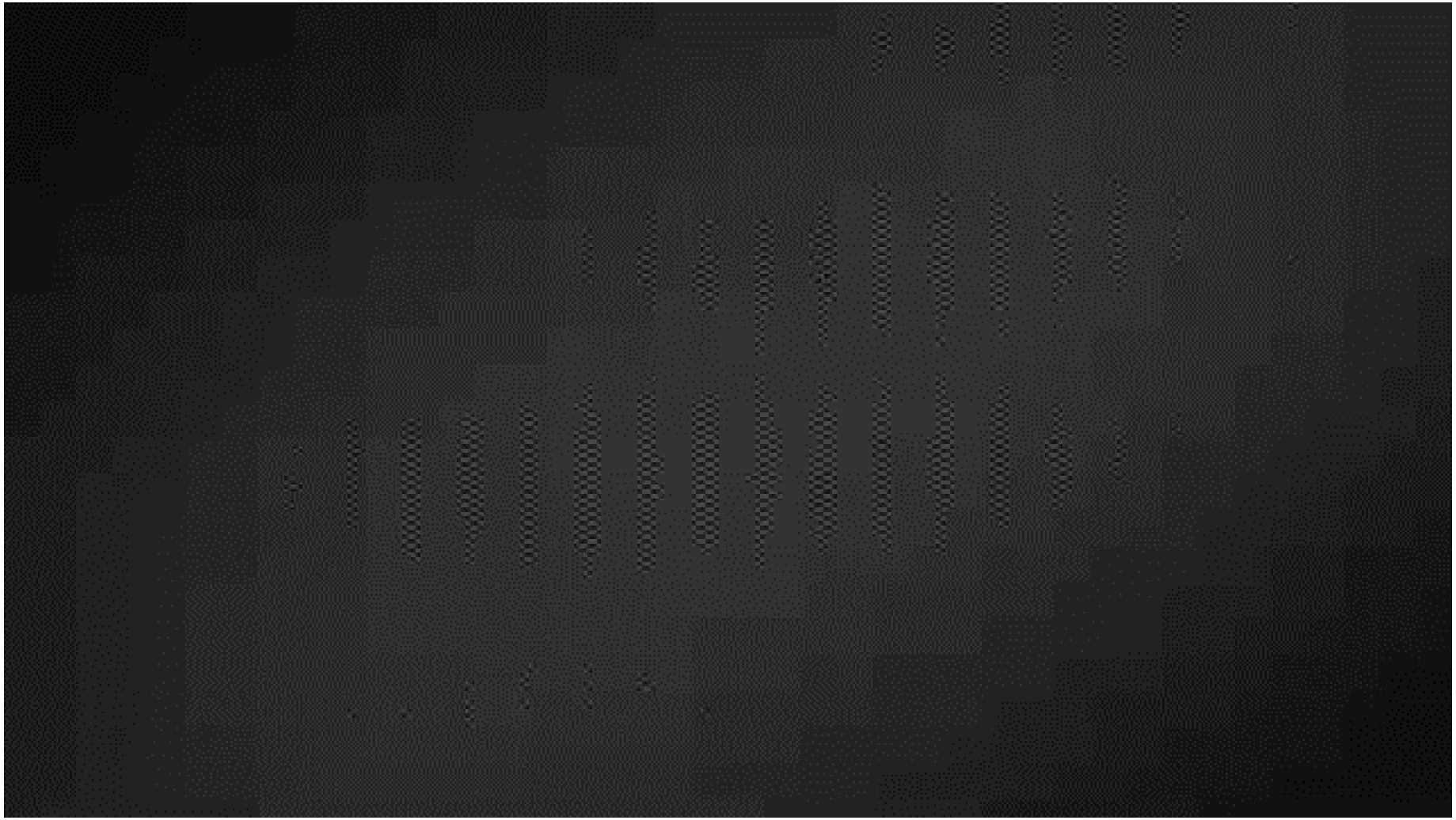
- Branch of physics dealing with:
  - Forces affecting objects in motion
  - Energy exchanges that occur as objects collide
- Helps appreciate and anticipate the results of auto and other impacts
- Two basic principles:
  - Law of inertia
  - Law of conservation of energy

Laws of Motion

- Law of Inertia (Newton's First Law of Motion)
  - Tendency of an object to remain at rest or remain in motion unless acted upon by an outside force
    - Car into tree
    - Passenger collisions within a car
    - Organ collisions within a body



Inertia and MVC's



Mechanical Principle

- General principles of rapid deceleration mechanisms (MVCs, falls, etc.)
  - Car strikes object and stops
  - The rest of the car continues forward, causing deformation

Forms of Energy

a) Potential energy

(b) Kinetic energy

Conservation of Energy

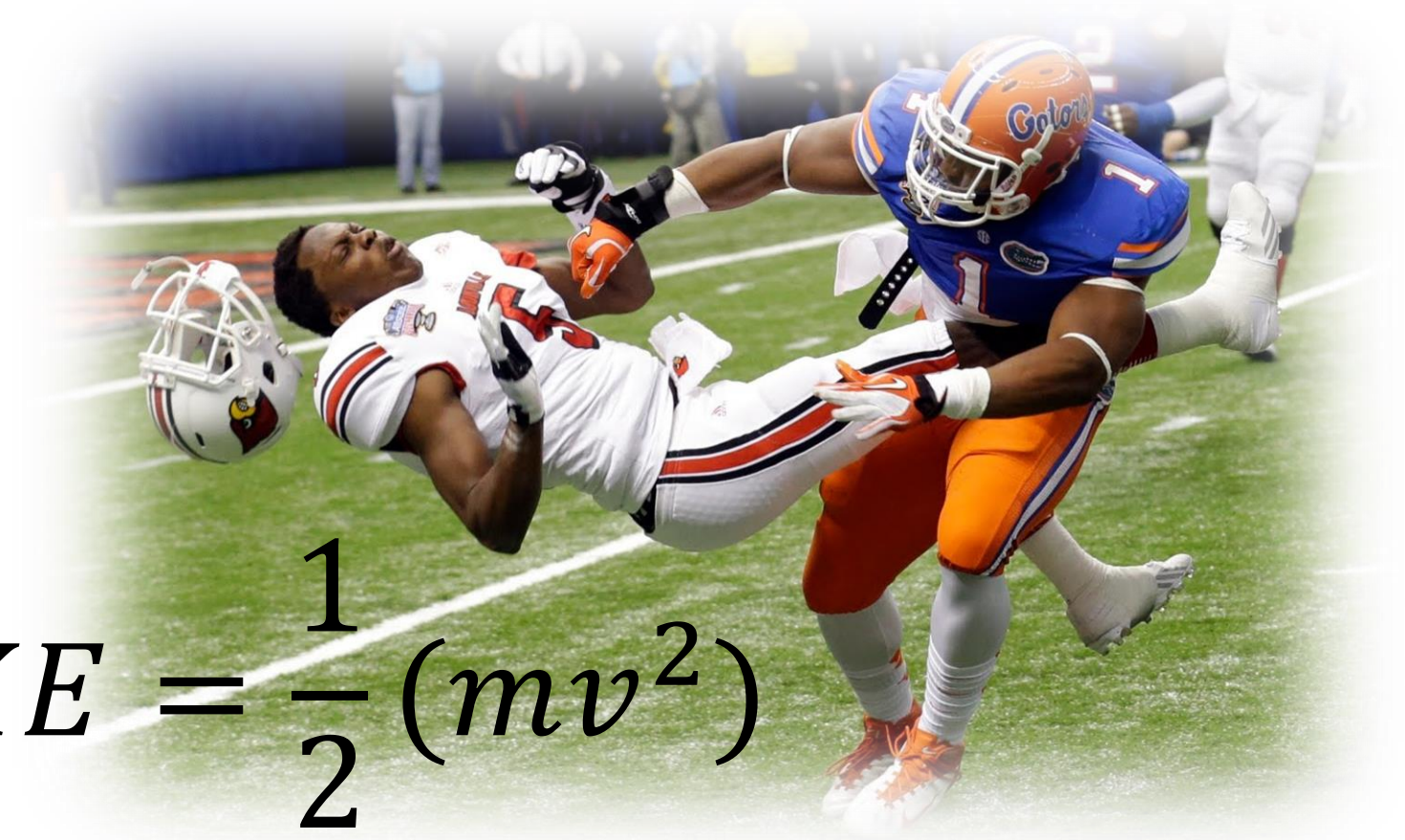
- Energy cannot be created nor destroyed but can change in form

Conservation of Energy

- When our car hits the brick wall, the kinetic (motion) energy is dissipated by heat and noise and by destruction of the frame
- Whatever energy remains is transferred to the occupants and their internal organs

Kinetic Energy

- Kinetic energy is a function of an object's mass and velocity



$$KE = \frac{1}{2}(mv^2)$$

Kinetic Energy

- Let's take a look at this in other terms:
  - How much kinetic energy would a 70 kg person travelling at 50 km/hr have?

$$KE = \frac{1}{2}(mv^2)$$

$$KE = \frac{1}{2}(70\ kg\ X\ (14\ m/s)^2)$$

$$KE = 6860\ Joules$$

KE = Kinetic Energy (joules)
m = mass (kg)
v = velocity (m/s)

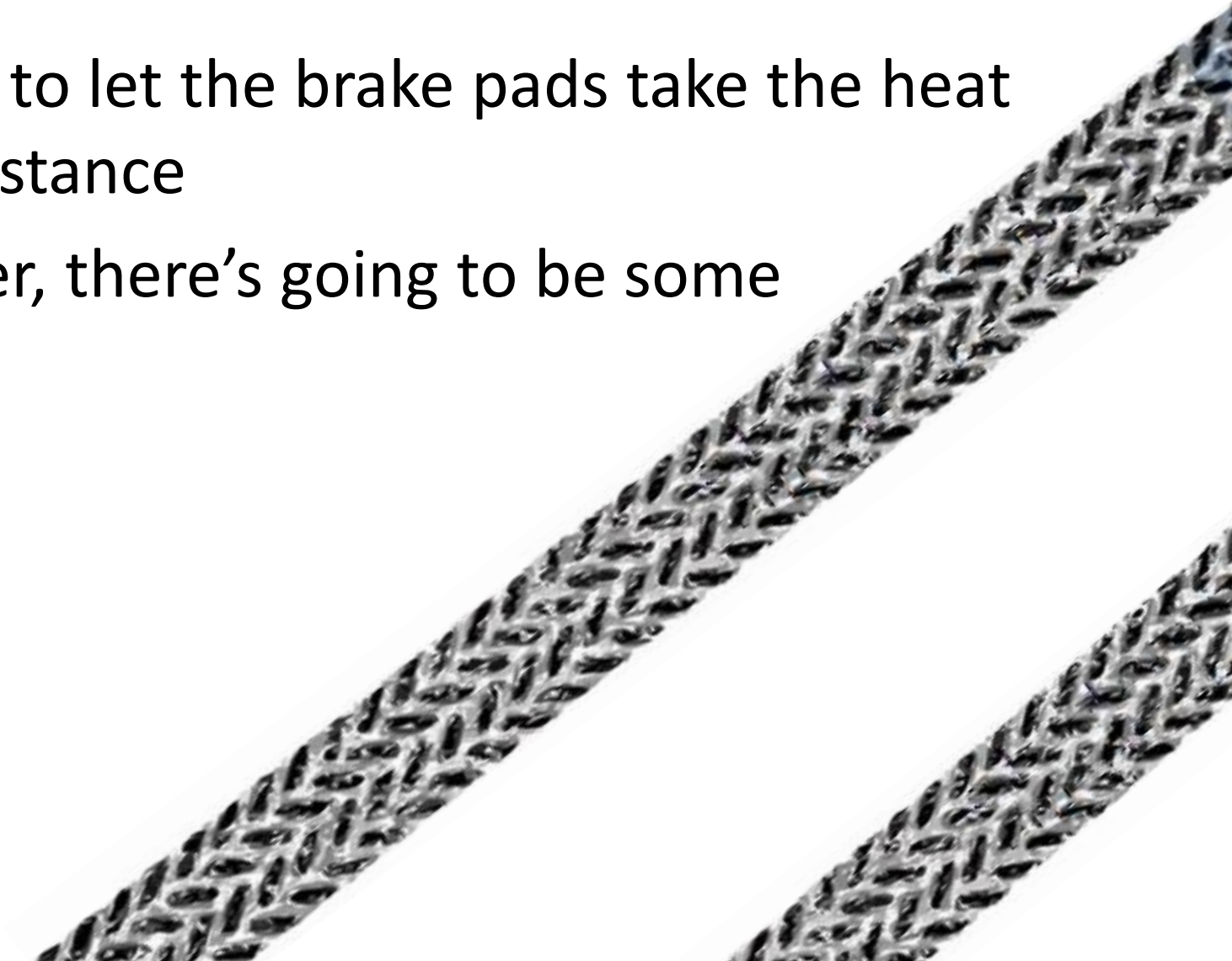
Kinetic Energy

- This means that, in order to stop, the driver of the vehicle will have to convert all of that energy (6860 J) into something else.

Bending this stop sign for instance

Kinetic Energy

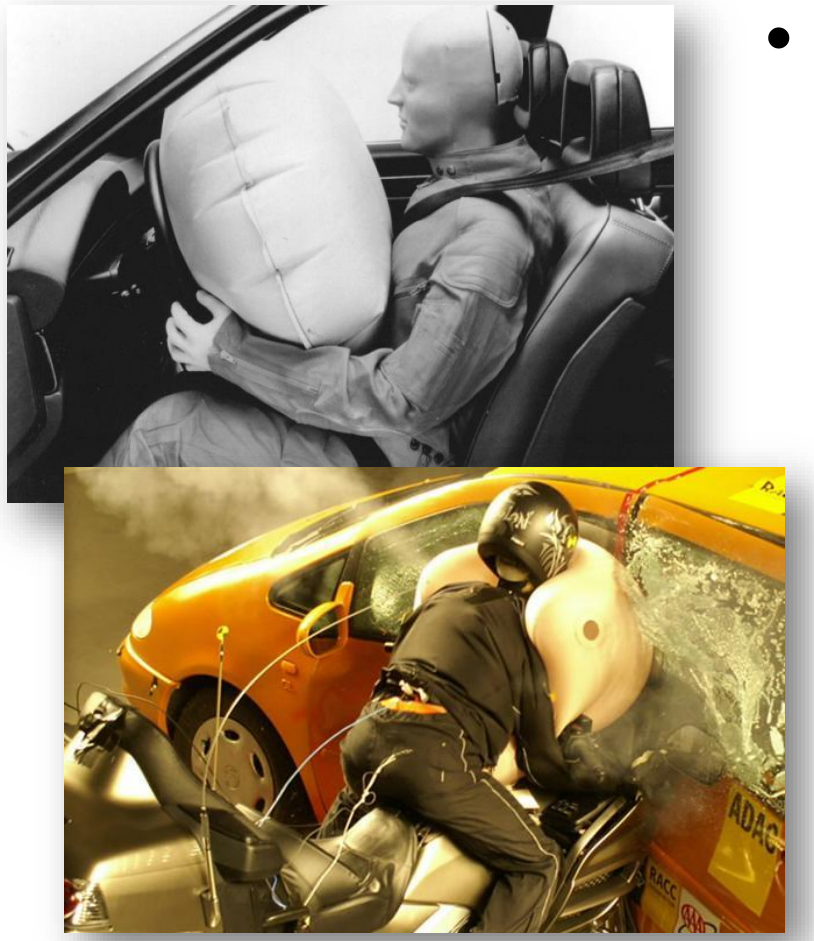
- The preferable method is to let the brake pads take the heat but that requires some distance
- If you want to stop quicker, there's going to be some consequences



Kinetic Energy

- If sudden deceleration occurs, the energy still needs to be converted but in a much shorter time-frame

Kinetic Energy



- Crumple zones, seat belts and airbags are able to absorb a great deal of energy, but the potential for tissue damage is still significant if the stopping distance is instantaneously reduced to nothing

Kinetic Energy

- Since kinetic energy is a function of an object's mass and velocity, what happens when we change the values?
- Let's consider our 70 kg driver travelling at 50 kph and change those two values one at a time

Kinetic Energy

- INCREASING MASS
- If we double the mass

$$KE = \frac{1}{2}(mv^2)$$

$$KE = \frac{1}{2}(\mathbf{140}\ kg\ X\ (14\ m/s)^2)$$

$$KE = 13720\ kgm^2/s^2$$

$$KE = 13720\ Joules$$

Double Energy

- INCREASING SPEED
- If we double the speed

$$KE = \frac{1}{2}(mv^2)$$

$$KE = \frac{1}{2}(70\ kg\ X\ (\mathbf{28}\ m/s)^2)$$

$$KE = 27440\ kgm^2/s^2$$

$$KE = 27440\ Joules$$

Quadruple Energy

Kinetic Energy

- This exercise demonstrates that even a moderate increase in velocity creates much more kinetic energy than does a substantial increase in mass

- How do you think this principle relates to firearms?

Force

- Newton's Second Law of Motion
  - Emphasizes the importance of rate at which an object changes speed (acceleration or deceleration)

$$Force = Mass\ X\ Acceleration\ (or\ deceleration)$$

Laws of Motion

- Newton's Third Law of Motion
  - For every action there is an equal and opposite reaction

Events of A Collisions

- Newton's First Law of Motion shows us that…
- During a collision the body will be impacted by 5 separate collisions:
  - Vehicle collision
  - Body collision
  - Organ collision
  - Secondary collision
  - Additional impacts

Events of A Collisions

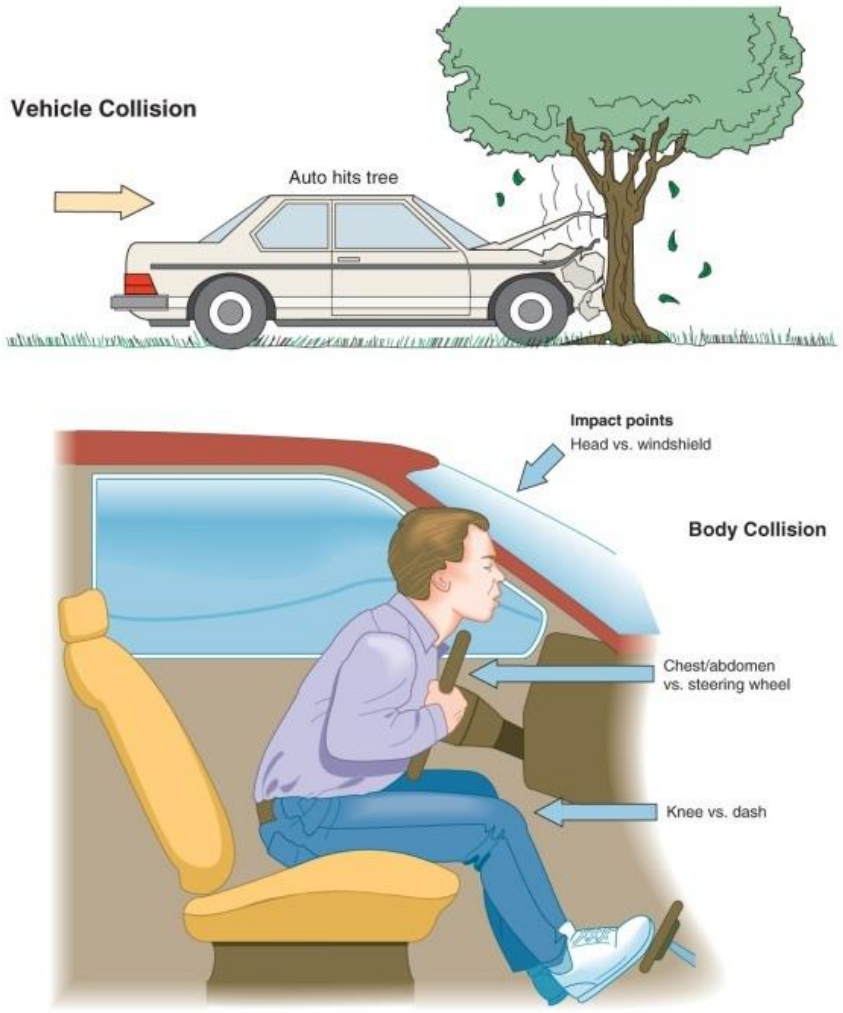


FIGURE 17-4 An automobile crash generates four major collisions: the vehicle collision, the body collision, the organ collision, and secondary collisions.

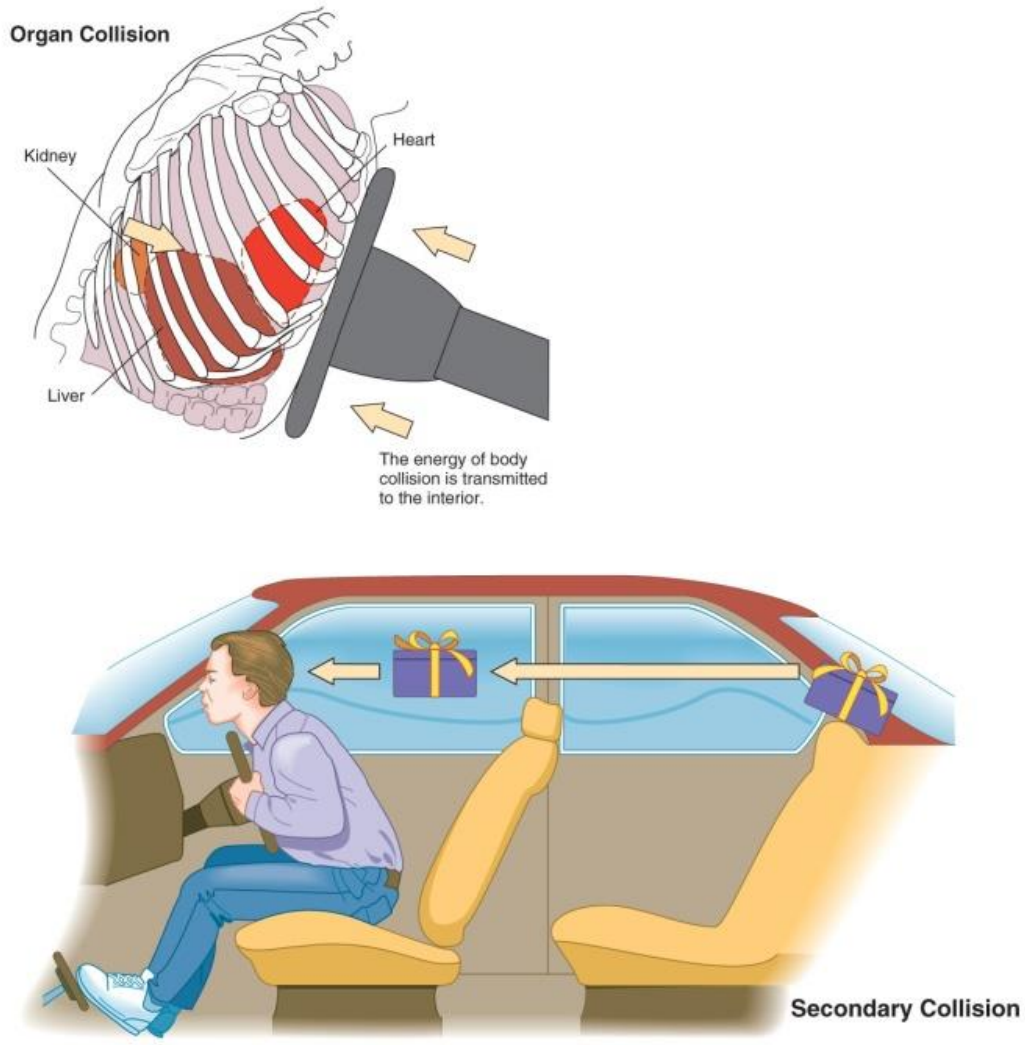


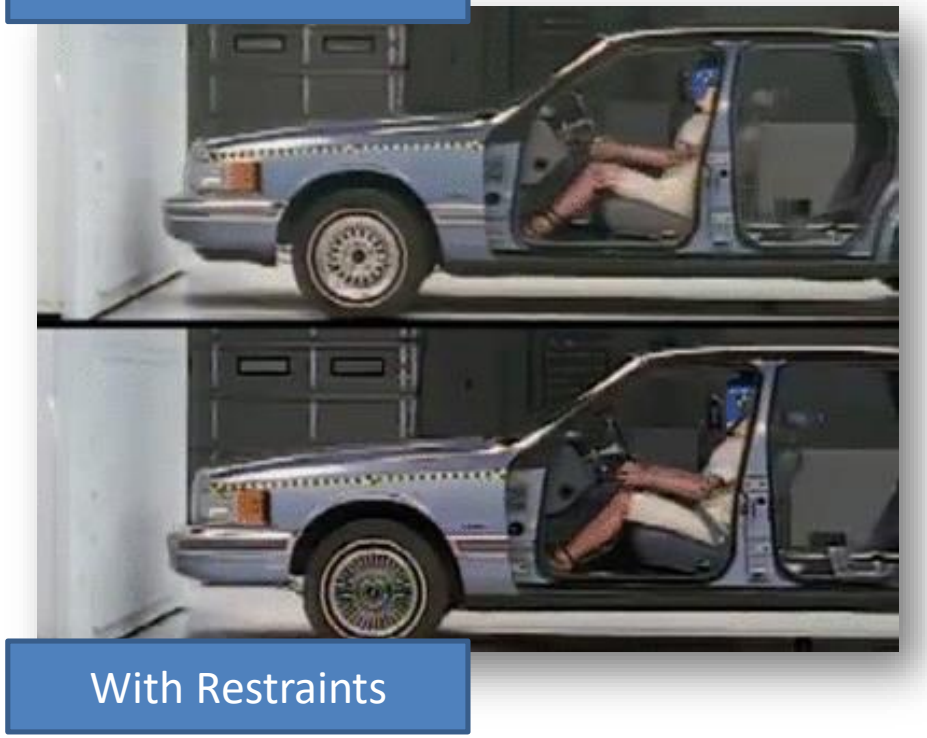
FIGURE 17-4 (CONTINUED)

Restraints

- Profound effect in reducing collision-related deaths
  - Seat belts
  - Airbags
  - Child safety seats
- It is important to determine whether restraint devices were used (and used properly)

Restraints

- Seatbelts
  - Occupant slows with vehicle
  - Shoulder and lap belts should be worn together
    - Injuries occur if they are worn separately
- Airbags (SRS)
  - Reduce blunt chest trauma
  - Cause: Hand, Forearm, & Facial Injury
  - Check for steering wheel deformity
  - Side airbags



Restraints

- Child safety seats
  - Provide the best protect for infants and small children riding in vehicles
- Infants and small children
  - Rear facing
- Older child
  - Forward facing

Kinetics of Trauma

TYPES OF TRAUMA

Types of Trauma

- Blunt Trauma
  - Occurs when a body is struck by or strikes an object
  - Closed injury
  - Transmission of energy injures underlying tissues and organs
    - Tearing of muscle, vessels and bone
    - Rupture of solid organs
    - Organ injury

Type of Trauma

- Penetrating Trauma
  - Wounds that break the skin, energy source enters into body
  - Low energy
    - Knives
    - Injury limited to the path of the weapon
  - High energy
    - Guns
    - Energy may be transmitted to surrounding tissue, extending the trauma

Blunt Versus Penetrating Trauma

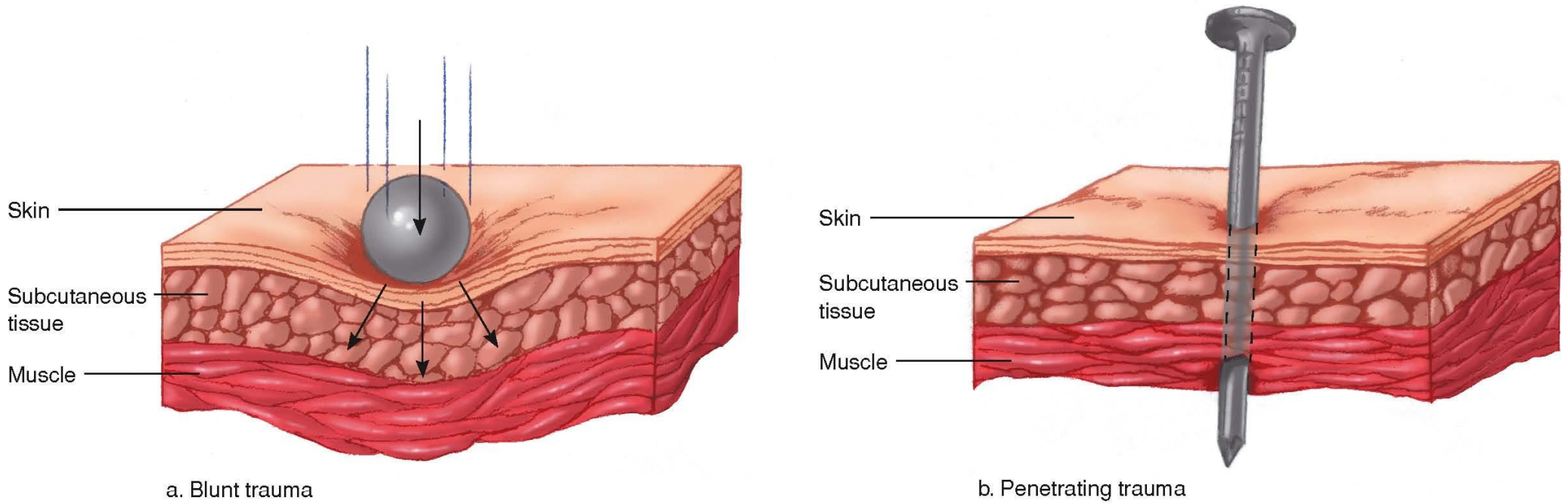


FIGURE 17-3 Blunt trauma results when an object or force hits the body and kinetic energy is transferred to the involved body tissues. Penetrating injury is produced when an object enters the body resulting in direct injury.