Mechanism of Injury (MOI)

“Let common sense prevail”

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If this ain’t injury than I don’t know!

• “At the anthem's conclusion, large parts of the crowd were left openly laughing and several Bok players looked over angrily as the singer made his muted departure from the field. “

• "It's almost like receiving a jersey - every week's a special moment," Matfield said of lining up to sing the anthem.

• “It was a joke out there. The guys couldn't sing along to it and even the crowd were starting to laugh. It was very disappointing."
Anthem at Rugby video
Synopsis

• Background and Definitions
• Energy principles
• Motor Vehicle Collisions
• Pedestrian Injuries
• Internal organ Injuries
• Falls
• A little quiz: Associated injuries with orthopaedic injuries
• What does the literature say about “MOI”...
• Take home Points
Background and Definitions

• Biomechanics of road traffic collision injuries - diagnosing and managing injured patients.

• MOI – sequence of events that result in injury.
Physical Principles and Physics

• Kinetic Energy

• Newton’s First Law of Motion

• Law of Conservation of Energy
Kinetic Energy

• Energy of motion - When two objects collide, each of them has an amount of energy.

• K.E. = \( \frac{1}{2} \) mass \( v^2 \)

• Major factor = Velocity

• “Speed Kills”
Newton’s First Law of Motion

- Body in motion stays in motion unless acted on by outside force
- Body at rest stays at rest unless acted on by outside force
Law of Conservation of Energy

- Energy cannot be created or destroyed
- Only changed from one form to another
Conclusions regarding Energy principles!

• When moving body is acted on by an outside force and changes its motion, Kinetic energy must change to some other form of energy.
• If the moving body is a human and the energy transfer occurs too rapidly, Trauma results.
Motor Vehicle Collisions

- Front impact
- Back impact
- Side impact (T-boned)
- Combined impact.
- Vehicle may be turned over
- Patient may be ejected from vehicle
- The amount of energy and the direction of impact are major factors that determine the outcome of a collision
Front

- Deceleration of the vehicle as it hits another vehicle
  - Initially, the impact of injury is transmitted through the **lower limbs** of the patient from foot to hip.
  - The hip is the weakest part of the lower limb
  - Flexed knee may also hit the dashboard
  - Unrestrained, a hinge effect occurs at the hip
  - The driver will lean forward and the chest will be compressed against the steering wheel
  - Finally, the head will hit the windscreen
Fig. 4 (a) Diagram shows a driver who was not wearing a seat belt and who had a front impact collision. Radiographs show fractures of the (b) right femur; and (c) left acetabulum, caused by the energy transmitted to both lower limbs from the collision.
Fig. 6 Diagram shows how an unrestrained driver will sustain injuries to the chest and head in a collision with frontal impact. (Modified and reproduced with permission from the American College of Surgeons, Advanced Trauma Life Support for Doctors, 7th ed, 2004:320, Fig. 2).\textsuperscript{(1)}

Fig. 7 Photograph shows a front seat passenger, who sustained the classical windscreen injury of the face, in a frontal impact collision while not wearing a seat belt.
STEERING WHEEL INJURIES

FORCE

C-SPINE FRACTURES

SOFT TISSUE NECK INJURIES

LARYNX & TRACHEAL INJURIES

FRACTURED STERNUM

MYOCARDIAL CONTUSION

PERICARDIAL TAMponade

FORCE

CHEST INJURIES

PNEUMOTHORAX

HEMOTHORAX

FLAIL CHEST

INTRAABDOMINAL INJURIES (RUPTURED SPLEEN OR LIVER)

BOWEL INJURIES
Flying Bullets!!!!

• Unrestrained backseat passengers pushing their extended upper limbs

• Transmitted energy through their upper limbs classically causes upper limb fractures/dislocations.
Back impact

• Associated with acceleration of the vehicle which leads to hyperextension of the head.
• Restrained, this will be followed by a rebound flexion of the head.

Both movements are called whiplash injury.
Side Impact

- Region of the body which is closest to the side of impact will be injured directly, while those away from the impact may hit the other side of the vehicle.
- Severe brain and thoracic injuries and mortality occur more frequently.
- The nearer the occupant is to side of the impact, the more serious his/her thoracic or abdominal injury will be.
Side Impact

Fig. 9 Photograph shows the remains of a car after a side-impact collision with a palm tree. The 30-year-old female driver answered her cell phone while she was driving and lost control of her car. She sustained frontal brain contusion, needed ventilation and was admitted to the ICU. At discharge one month later, she had no neurological deficit but was found to lack concentration.
Rollover and Roof Impact

Fig. 10 Photograph shows a rollover and roof impact accident of a four-wheel vehicle. The driver was travelling at 160 km/hour and lost control of the vehicle. The car rolled over and the roof of the car impacted with a palm tree, which was pulled out from its roots from the collision.
Rollover and Roof Impact

- Roof can be compressed - occupant can sustain head and spinal cord injuries
- Unrestrained – more serious
- Move around
- Ejected! – then can be run over...
- Wear your seatbelt!
• Airbag video!
Seat Belt and Airbag injuries

- Seatbelt – compression or hyperflexion
- **Seatbelt Syndrome**: Abdominal wall ecchymosis, internal abdominal injuries and spine fractures
- Clavicle fracture commonest
- Airbags!
  - upper limb fractures, corneal abrasion, eyelid laceration, retinal contusion and detachment, and eye lens dislocation
  - rapid deployment of the airbag releases large amounts of heat energy, which can lead to thermal burns on the face and forearm
  - *Chemical materials released during* airbag deployment may also cause alkali burns to the skin and eyes
Pedestrian

• Classically, pedestrian injuries consist of
• three phases: the bumper impact, hood and windscreen impact and the ground impact
• This will lead to classical lower limb injury due to the bumper impact, chest and abdominal injuries due to the hood and head and cervical spine injuries due to the ground impact – Waddles Triad
Pedestrians

• Child
  – Faces oncoming vehicle
  – Waddell’s Triad
    • Bumper → Femur fracture
    • Hood → Chest injuries
    • Ground → Head injuries
Fig. 11 Diagram shows the classical three phases of pedestrian injury.
Pedestrians

• Adult
  – Turns from oncoming vehicle
  – O’Donohue’s Triad
    • Bumper → Tib-fib fracture
      Knee ligament tears
    • Hood → Femur/pelvic fractures
Falls

- Follow path of energy through body
Fall Onto Buttocks

- Pelvic fracture
- Coccygeal fracture
- Lumbar compression fracture
Fall Onto Feet

• “Don Juan Syndrome”

  – Bilateral heel fractures
  – Compression fractures of vertebrae
  – Bilateral Colles’ fractures
Internal organ injuries

- Sudden acceleration
- Deceleration
- Strong compressive forces
Acceleration-deceleration injuries

• Blunt traumatic rupture of the thoracic aorta
• Usually sheared at Ligamentum arteriosum attachment
• Rupture with exsanguination
Compression Injuries

• Sudden increase in intraabdominal pressure can cause diaphragmatic rupture

• Compression of the hollow viscus, such as closed intestinal loops or urinary bladder, will cause injury when pressure within these organs increases suddenly.

• They are especially susceptible to injury when their walls are stretched
Fig. 15 CT scan shows a rupture to the urinary bladder (arrow), caused by an abdominal compression injury.
Associated Injuries with Orthopaedic Injuries

- Temporal or parietal bone fractures-
- *epidural hematoma*
- Maxillofacial fractures-
- *cervical spine fractures*
- Sternal fracture-
- cardiac contusion
- First or second rib fracture-
- descending thoracic aortic injury and brachial plexus injuries
Associated Injuries with Orthopaedic Injuries

- Scapular fracture
- Pulmonary contusion, haemo or pneumothorax.
- Fractured right 8th-12th ribs
- Liver laceration
- Fractured left 8th-12th ribs
- Splenic injury
- Pelvic fracture
- Ruptured bladder and/or urethral injury, rectal and perineal lacerations
- Distal radial fracture
- Brachial artery or nerve injury
Associated Injuries with Orthopaedic Injuries

• Anterior dislocation of shoulder-

• Posterior hip dislocation-
  • sciatic nerve injury

• Posterior knee dislocation-
  • popliteal artery injury
So what does some of the literature say...

2004 San Francisco study, MOI a very poor predictor of which patients required trauma team activation. Of the 700 trauma team activations for MOI criteria, only 54 (7.7 percent) patients required ICU or operating room admissions, and none resulted in death in the emergency department.

*The four least predictive MOI criteria:*
"motorcycle crash with separation of rider,"
"pedestrian hit by motor vehicle,"
"motor vehicle crash with rollover," and
"motor vehicle crash with death of occupant."
• The only MOI criteria with any degree of validity:
  • "ejection from a vehicle"
  • "prolonged extrication time."
• Several studies - "ejection from a vehicle" has positive predictive value for severe injury.
• Pediatric studies have also demonstrated that "ejection from a vehicle" is a useful predictor of severe injury and the need for a trauma
• Boyle et al - trauma transports in the state of Victoria (Australia) for 2002.
• 4,571 incidents of MOI only (62 percent males, median age of 28 years).
• Two criteria had statistically significant results: falls from greater than five meters and patients trapped greater than 30 minutes.
Conclusion and Take Home Points

• Look at mechanisms of injury
• Listen to the Handover:
• Be wary: "ejection from a vehicle"
• "prolonged extrication time."

• The increased index of suspicion will lead to:
  – Fewer missed injuries
  – Increased patient survival
Thank You!