

Road Traffic Accidents (Transportation injuries)

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Aims and objective

To have understanding, of injury pattern, method of causation and prevention of injuries, skills of examination and forming opinions to the court of law in

- (a) Pedestrian-A
- (b) Driver, front seat passenger, occupant-A
- (c) Motorcyclist/ Pillion Rider/ Pedal cycler-A
- (d) Investigation in a case of 'Hit and Run' -A
- (e) Investigation of body found on or by the rail tract.
(Accidental, suicidal, homicidal or postmortem disposal)-B

To produce a graduate who will be able to examine and describe injury patterns in alleged cases of RTA of both living and the dead and form opinions in a court of law as well as participate in prevention of RTA

Knowledge, skills and attitudes

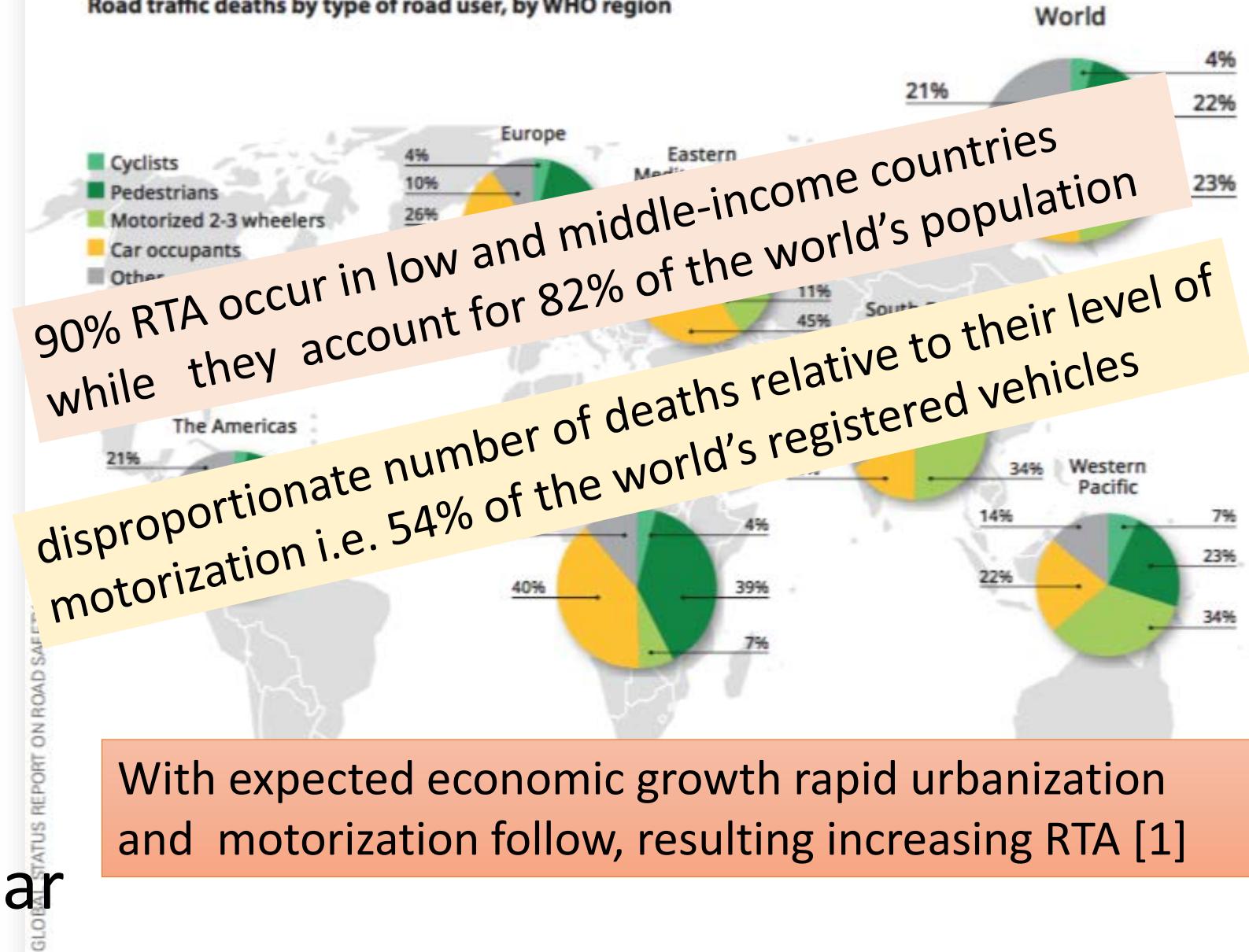
GLOBAL STATUS REPORT ON ROAD SAFETY 2015



RTA deaths
1.25 million per year



FIGURE 7
Road traffic deaths by type of road user, by WHO region



'Vulnerable road user' & Sri Lankan road user"

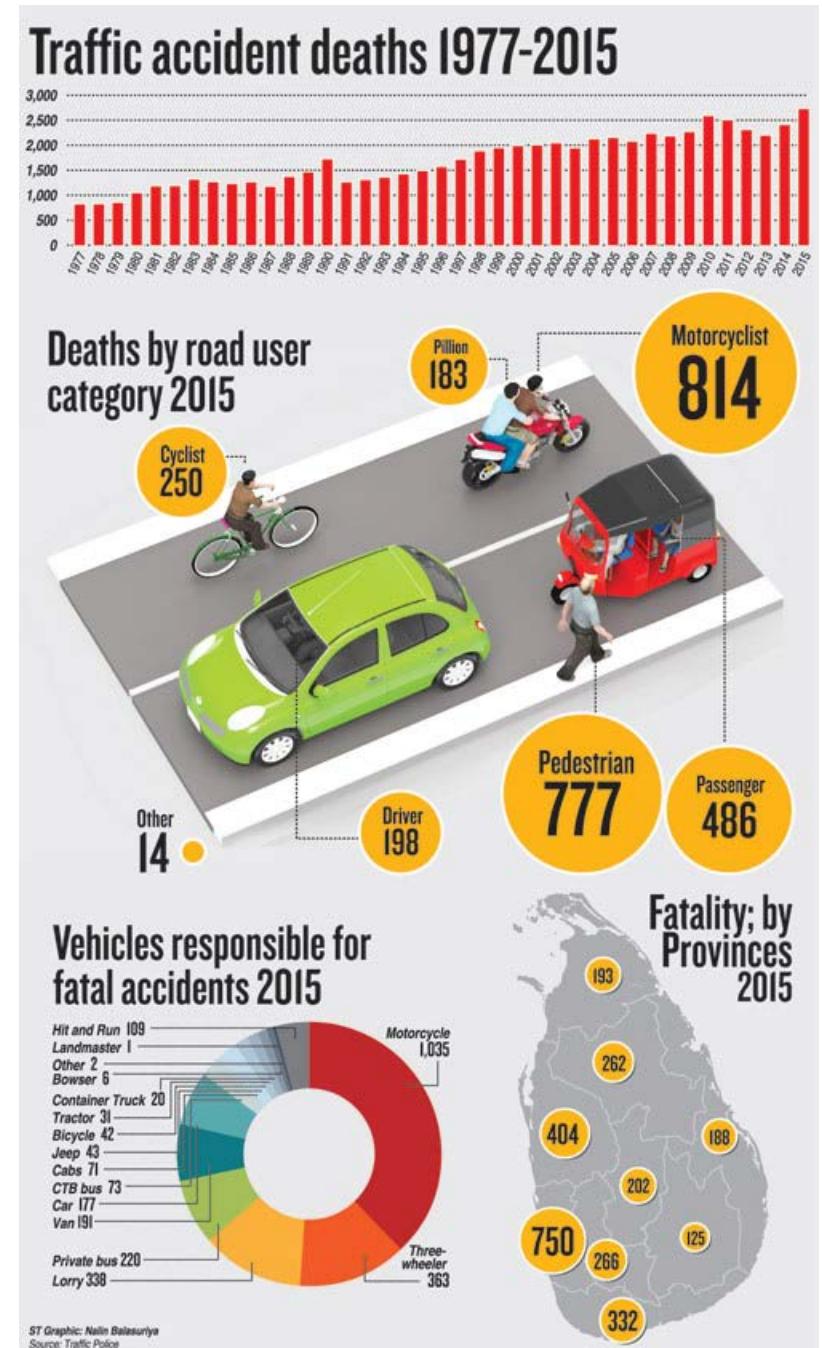


A road user at risk in traffic due to not having a outside protective shield to absorb energy in a collision. (WHO)



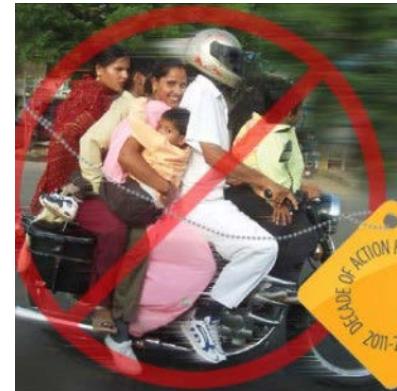
Sri Lankan situation

- Road fatalities has been fluctuating around 2300-2500 for past few years and then show a upward trend
- In 2016: 3003 deaths
- Fatal accidents in 2016: 2824
- 150 accidents are reported daily
- loss of 5-6 lives daily
 - pedestrian fatalities 33%
 - drivers and riders 41%



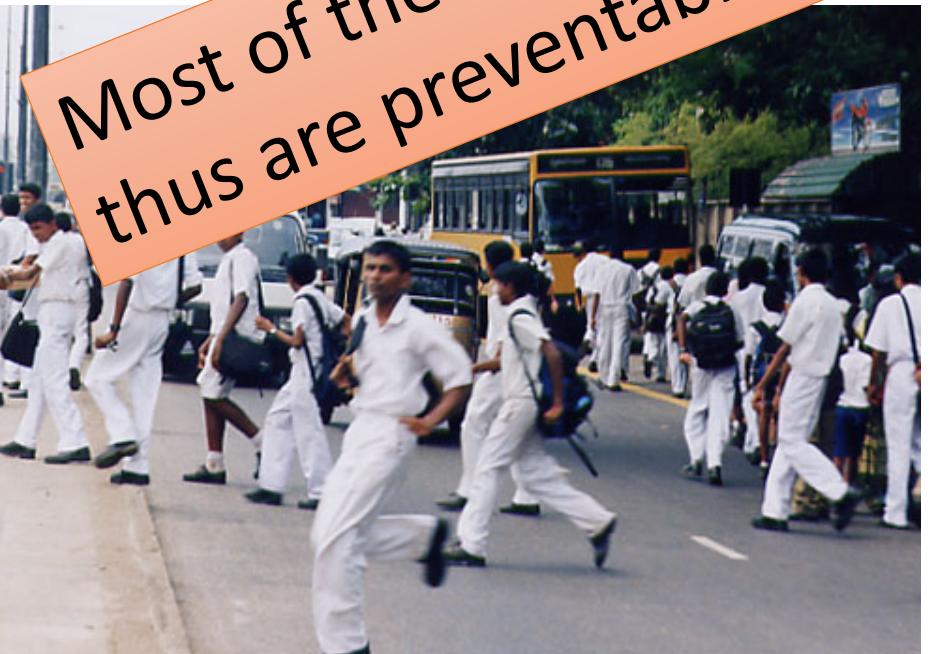
The causes of RTA

- Human factors
 - Pedestrian
 - Driver/rider
- Road factors
- Vehicle factors





Most of the road traffic crashes are predictable and thus are preventable.



The dynamics of vehicle injuries

- Tissue injury is caused by a change of rate of the movement
- A constant speed, however rapid, has no effect.
- It is the change of rate
 - acceleration
 - deceleration.
- Change of rate is measured in 'gravities' or 'G forces'.
- The amount that a human body can tolerate depends on the direction and the type of tissues in which the force acts.

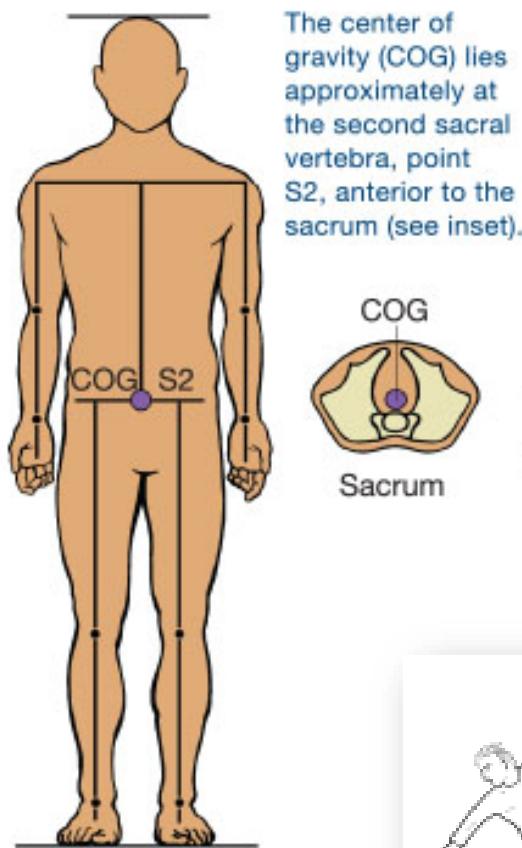
Pedestrian injuries



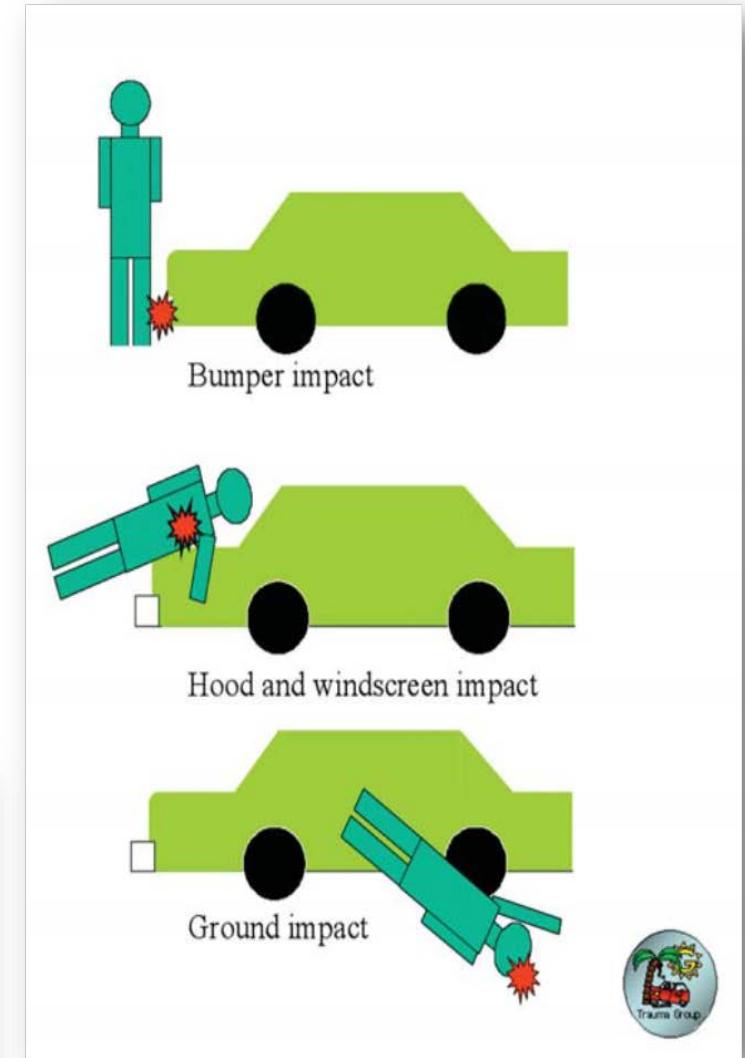
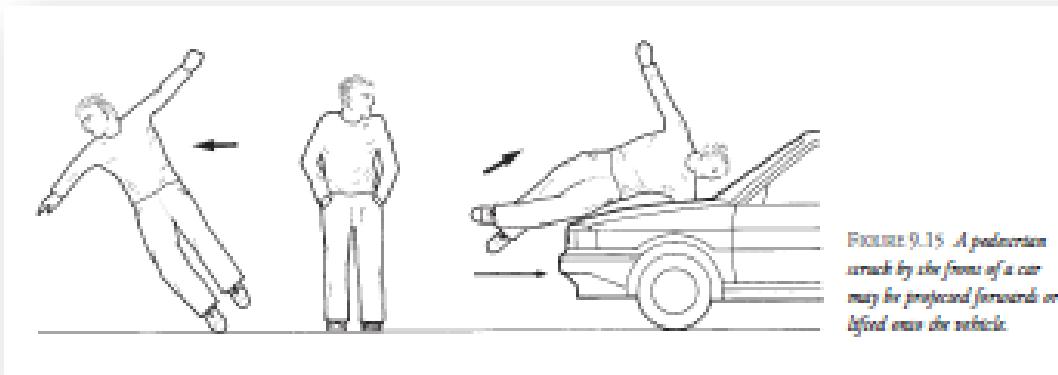
Factors influencing pedestrian injuries

Vehicle	Victim	Road
<ul style="list-style-type: none">• Type of vehicle (car, lorry, bus, motor cycle)• Height of the vehicle• Region of the impact of the vehicle (front, rear, sides)• Speed of the vehicle• Behavior of the vehicle	<ul style="list-style-type: none">• Height of the victim• Region of the impact of the victim• Center of the gravity• Stationary/ moving (standing, walking, running)• Movements of the victim after impact• Alcohol taken by victim• Hearing and vision of the victim	<ul style="list-style-type: none">• Nature of the road surface (wet, slippery, bumps, projections)• Objects on the road (lamp post, etc)• Moving objects on the road• Lighting of the road

Dynamics of the impact



If the impact is above the COG the victim is thrown forwards while impact is below the COG the victim is scooped up



INJURY PATTERNS

1

- Primary impact injuries (vehicle)

2

- Secondary impact injuries (vehicle)

3

- Secondary injuries (Tertiary impact Injuries) (ground)

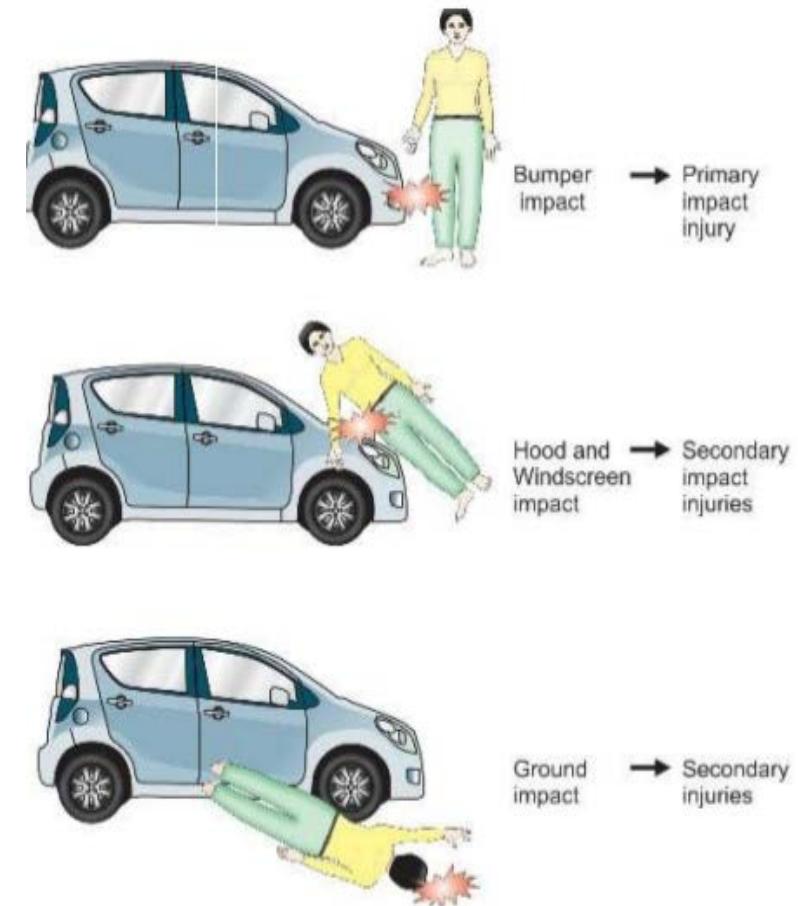
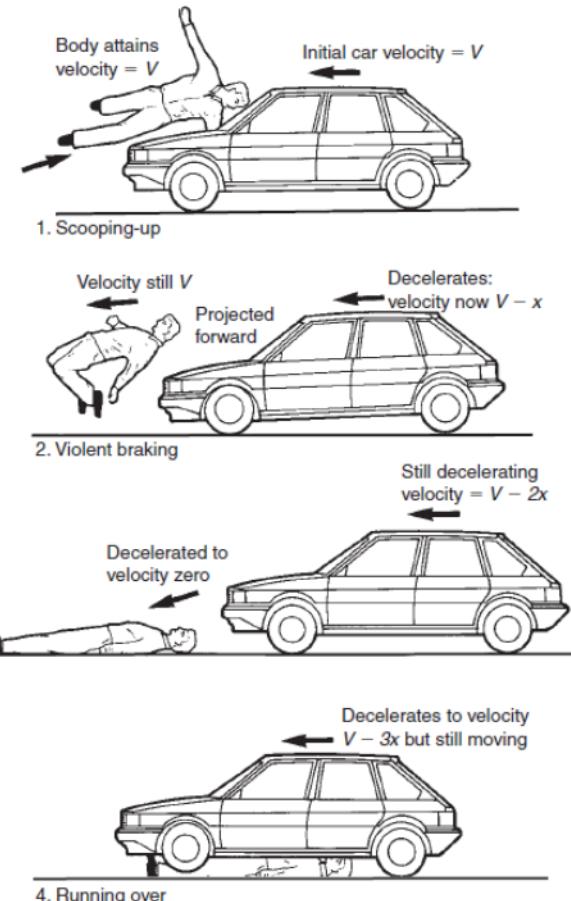
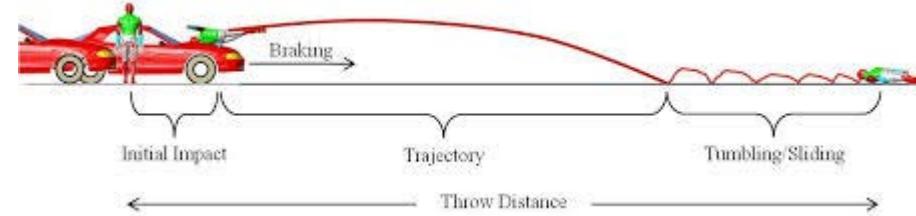


FIGURE 9.17 Sequence of events when a carried pedestrian is projected forwards during braking.



Primary impact injuries

- These injuries are caused by the vehicle when the pedestrian
 - is crossing
 - is walking with or against traffic
- The first impact with the vehicle
 - Which part of the vehicle was impacted
 - Bumper, Side mirrors (wings), grill, head lights, fender, radiator, door handle



- The primary impact may leave a the design or the pattern of the part of the vehicle as an imprint abrasion or pattern bruise



Head lamp ring

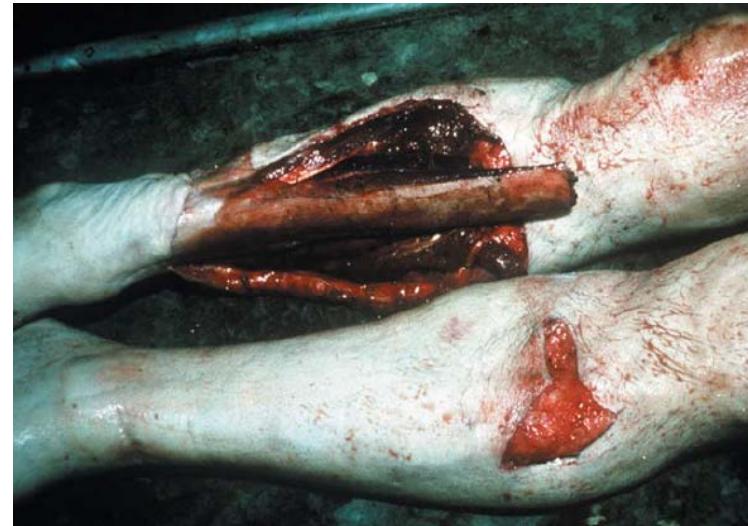


Bumper bar
striking the leg



Primary impact injuries

Can be abrasions,
imprint abrasions,
contusions,
lacerations, muscle
contusions and
lacerations



Bumper injuries

- Due to impact with the bumper of the vehicle injuries are seen in lower limbs
- Severe impact causes wedge fractures of the tibia (adults)
- The base of the wedge indicate site of impact and the apex, the direction of the travel



- Measuring the height of the injury is important in interpretation
- Sometimes bumper fracture occur at a lower level than the height of the bumper (due to applying breaks)
 - bumper fractures occur (14 mph)
 - Multiple bumper fractures (25 mph)
- Bumper injuries at different level of two legs or presence of it in one leg indicate person is walking/ running
- Bumper injuries at same level of both legs indicate standing
- Children may sustain a bumper fracture in the femur



Secondary impact injuries

- Victim hitting on some other part of the vehicle after the initial impact
- The injury pattern depends on
 - Type of vehicle (bonnet or flat)
 - Speed
 - Breaking
 - Projections of the vehicle
 -
- Secondary impact injuries are seen in head, chest and upper limbs



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Secondary injuries (Tertiary impact injuries)

- Injuries sustained by the victim on hitting the surface on the road, any projections or any erection on the road such as lamp post
- Common injuries are
 - Abrasions (grazed abrasions)
 - Contusions
 - Lacerations
 - Fractures
 - Head injuries
 - Internal injuries
- After secondary injuries victims may be subjected to run over injuries by same or other vehicles

Run Over injuries

- Run over injuries are severe injuries (crushing effect)
- Weight of the vehicle moves over the body ‘flaying’ injury, where a rotating motor wheel tears the skin and muscle from a limb or head.
- The rotatory effect against a fixed limb may strip off almost all tissue down to the bone.
- Run over injuries are
 - Crush lacerations (de-gloving)
 - Crush fractures
 - Severe internal injuries
 - Tyre mark on clothing or skin





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**De-gloving
laceration**

Run under injuries

- The body gets pinned between the undercarriage of the vehicle and the hard surface of the road
- Oil and grease marks may be seen on the clothing and skin surface



Drag injuries

- When the victim get entangled with the vehicle and be dragged along the road by the vehicle.
- The injuries are large areas of grazed abrasions with mud and dirt from the road



Injury Patterns of VRU

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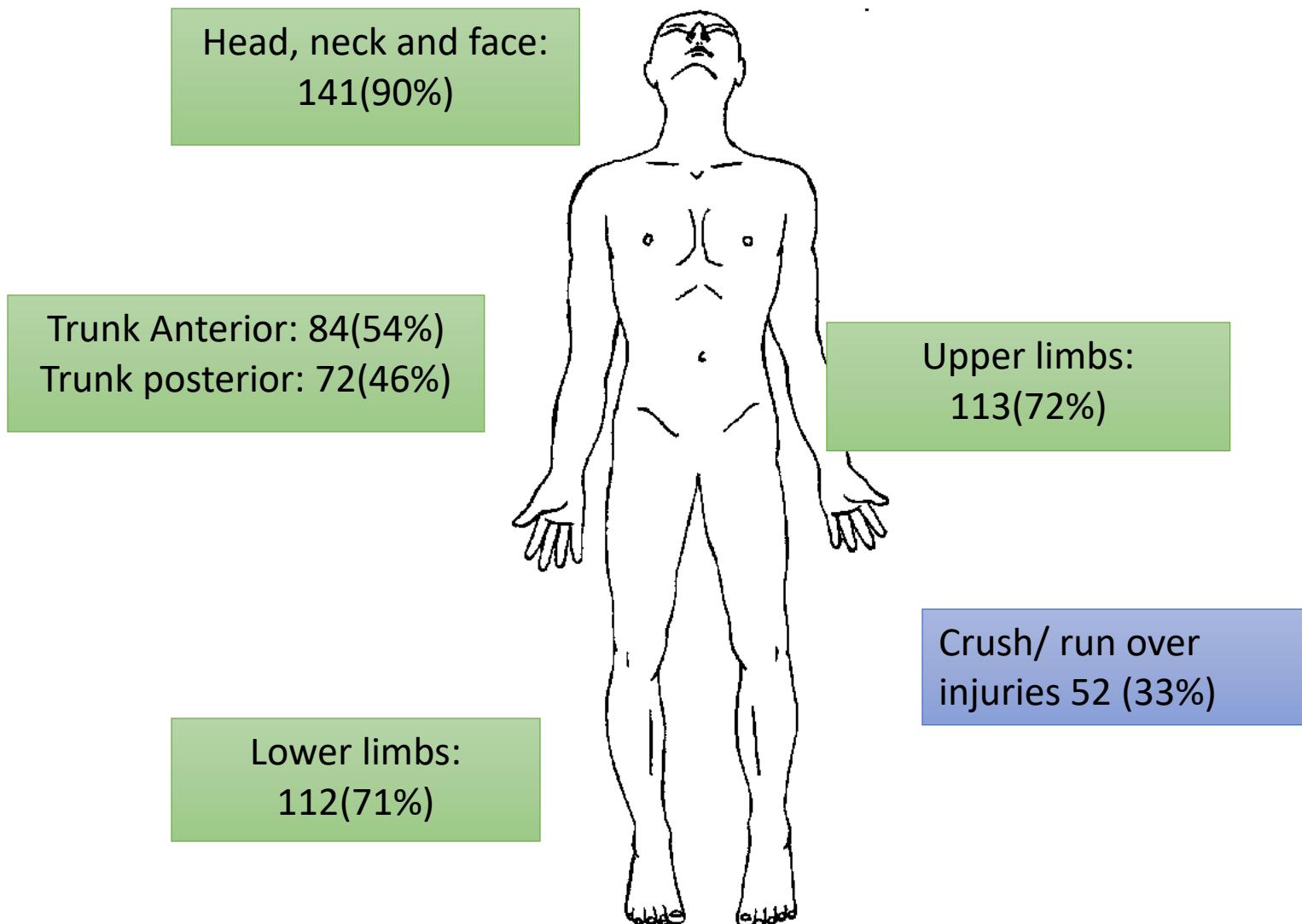


Department of Forensic Medicine, Faculty of Medicine, University of Kelaniya, Thalagolla Road, Ragama, Sri Lanka

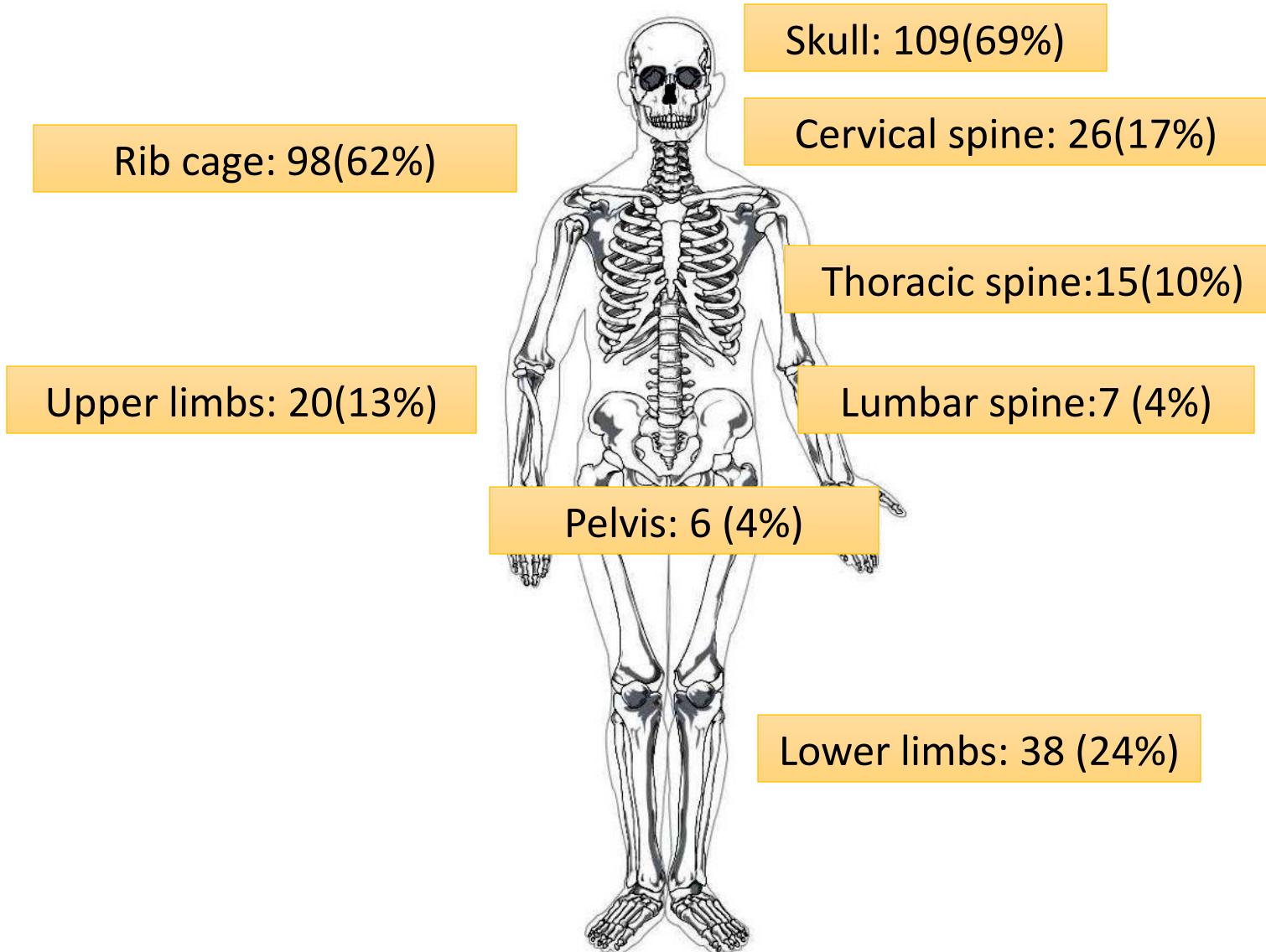


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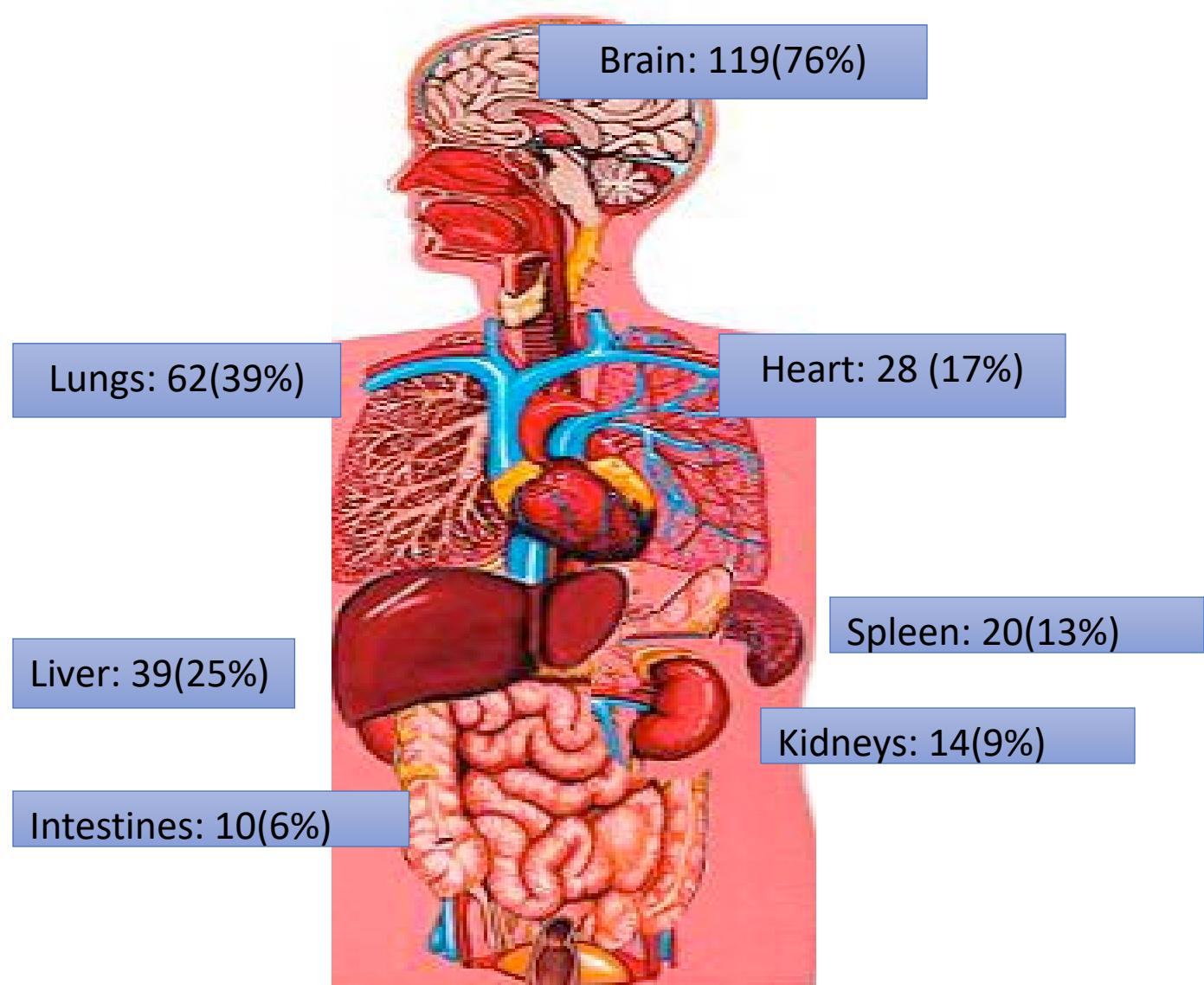
Injuries: Injury distribution (A study from Ragama 157 deaths



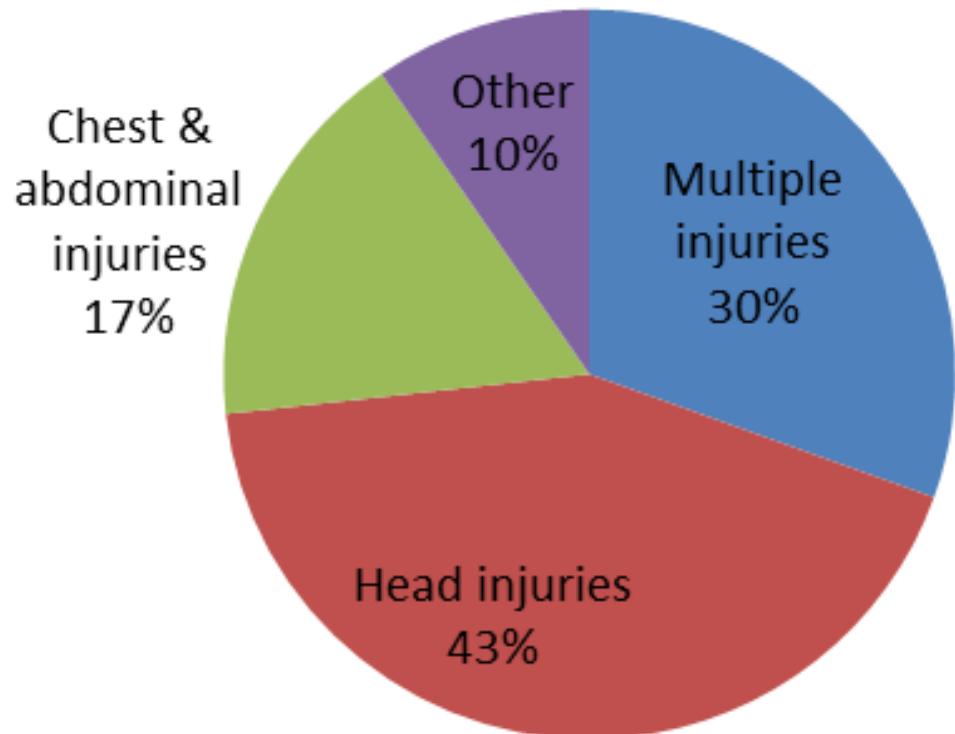
Injuries: Skeletal injuries



Injuries: Visceral injuries



Cause of Death



Pedestrians injuries with run over injuries

- [SR 4536 RTA Pedestrian.docx](#)
- [SR 1670- 2009.doc](#)
- [SR 5692 RTA.docx](#)
- [SR 1728-2009 RTA Cinnaya Nadeshan.docx](#)
- [SR 3537. 2011 RTA Maj.docx](#)



Motorcycle/ Peddle Cycle Accident Rider / Pillion Rider



Two-wheel vehicle riders/pillion riders are categorized as vulnerable road users due to absence of an outside protective shield to absorb energy during a collision.[1]



- Their inherent instability make them more vulnerable to accidents.
-
- In 2004, Peden M. [1] has stated that the risk of dying for every kilometer travelled from a motorcycle crash is 20 times higher than from a motor vehicle crash.





Being the favoured vehicle among commoners, motorcycles and bicycles are a popular means of transport in Sri Lanka and at times it is the family vehicle of the middle class. In Asian countries, it is not an uncommon site to see 3 or 4 members of the same family riding on a bicycle.



Vehicle Type	Fatal	Critical
Motor Cycles	1227	1178
Lorry	357	341
Dual Purpose Vehicles		
Private Buses	167	155
Three-Wheelers	405	372
SLTB Buses	50	50
Motor Cars	225	206
Cycles	48	48



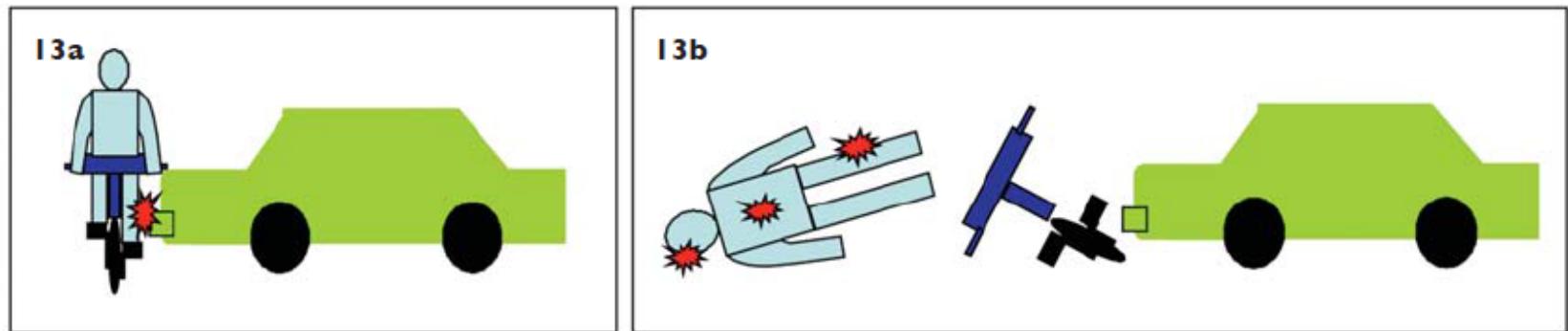
Motor Cycle accidents in Sri Lanka Police Statistics

- 2006-2010 : Total number of accidents reported 50,000-60,000 (2010)
 - Motor cycle/ Moped: 11,000-16,000
 - Car: 8,000-10,000
 - Dual purpose vehicles: 8,000-10,000
 - Lorry: 6,000-7,000
 - Three-wheeler 5,000-7,000
 - Private bus: 4,000-5,000
 - Cycle: 3,000
 - SLTB Bus: 1,500

Vehicle Type	Fatal	Critical
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National transport commission 2015

Rider injuries



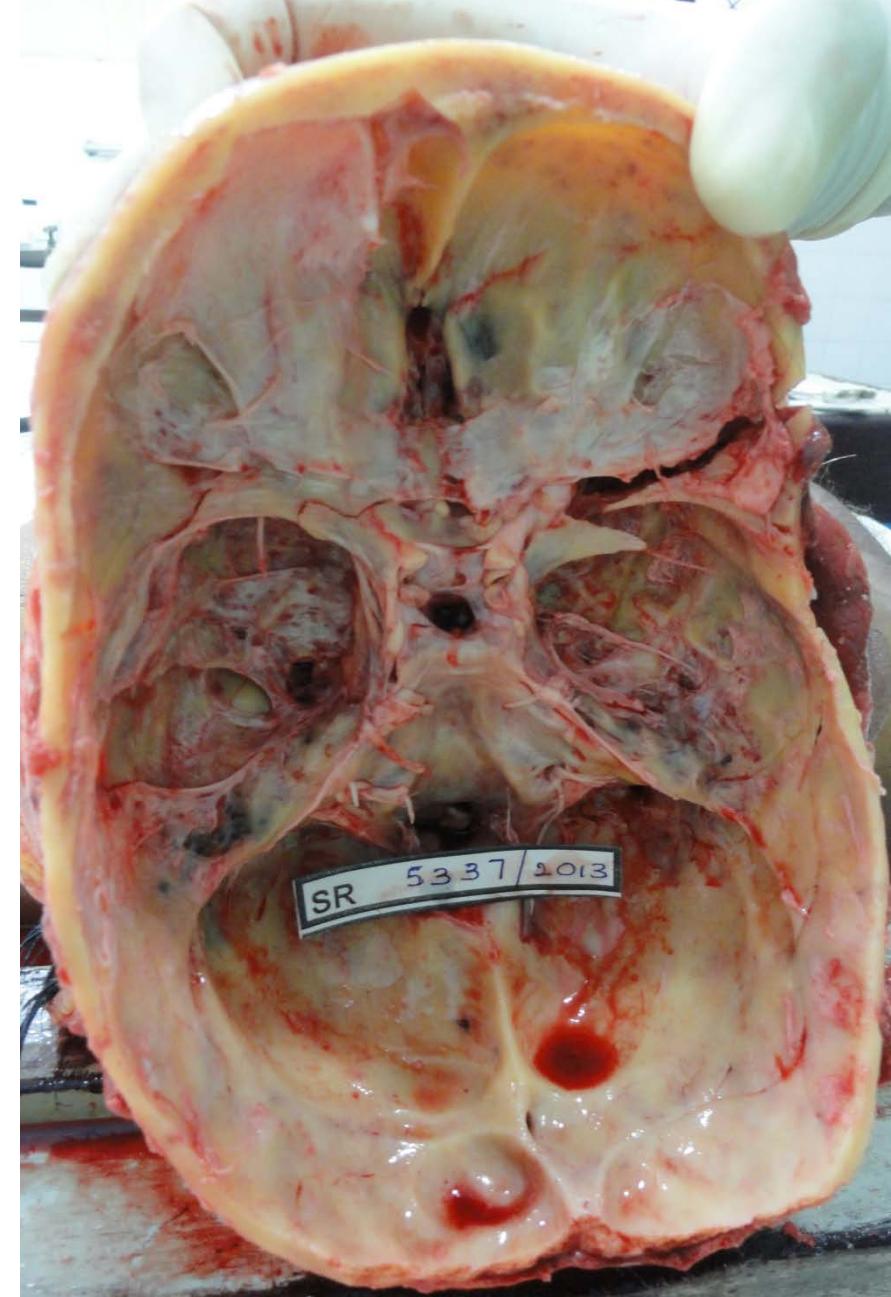
- Frontal or side impact with a moving vehicle Hitting a stationary object
- Because of the instability usually thrown forward and upward and land on the ground
- If the speed is high secondary impact with same or another vehicle and may be run over by same or another vehicle
- Components of bicycle itself may cause injuries

Rider injuries



Common injuries

- Head injuries (skull and brain) temporo-parietal.
- A common complication is a basal skull fracture, especially a 'hinge' fracture. (The motorcyclist's fracture)
 - This transverse crack across the floor of the skull, crossing the petrous base or behind the greater wing of the sphenoid bones through the pituitary fossa to the opposite side



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Ring fracture

ring fracture around the foramen magnum in the posterior fossa caused by an impact on the crown of the head.

- Cerebral contusions, lacerations, brain tissue to extrude through compound fractures of the skull. SAH
- Brain damage may be severe, even with a helmet in place.
- Cervical fractures
- lower limb injuries (fractures, contusions lacerations, abrasions, burns) (direct impact or due to crash bars)
- Chest and abdominal injuries are less compared to pedestrian

- Genital injuries and perineal tears with dislocation of pubic symphysis (due to wide separation of thighs as he straddles over the seat)



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Post-mortem reports of motor cycle riders

- [SR 3951.2012 multiple injuries RTA \[tox\].docx](#)
- [SR 5337 RTA.docx](#)



Pillion Rider



Pillion rider

- Unlike the rider pillion rider has noting to hold on except the rider and small holing bar
- Pillion riders are usually thrown upwards and forward any may impact on the vehicle or run over by others
- The clothing get entangle with the machine and fall (sari guard)
- May get burns from the silencer
- Injuries pattern is similar to the rider

Postmortem reports of pillion rider

- [SR 4265.2012 Head injuries pillion rider RTA 1.docx](#)
- [SR 5425 RTA.docx](#)

Protective gear



Half Helmet (Shorty)



Open Face (3/4) Helmet



Full Face (Street Bike)



Off Road / Motocross



Modular



Snowmobile / Snocross



Gern



Shoena



© webBikeWorld.com



- Helmets

- Jackets

- Knee guard

- Gloves



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Pedal Cycle Accidents



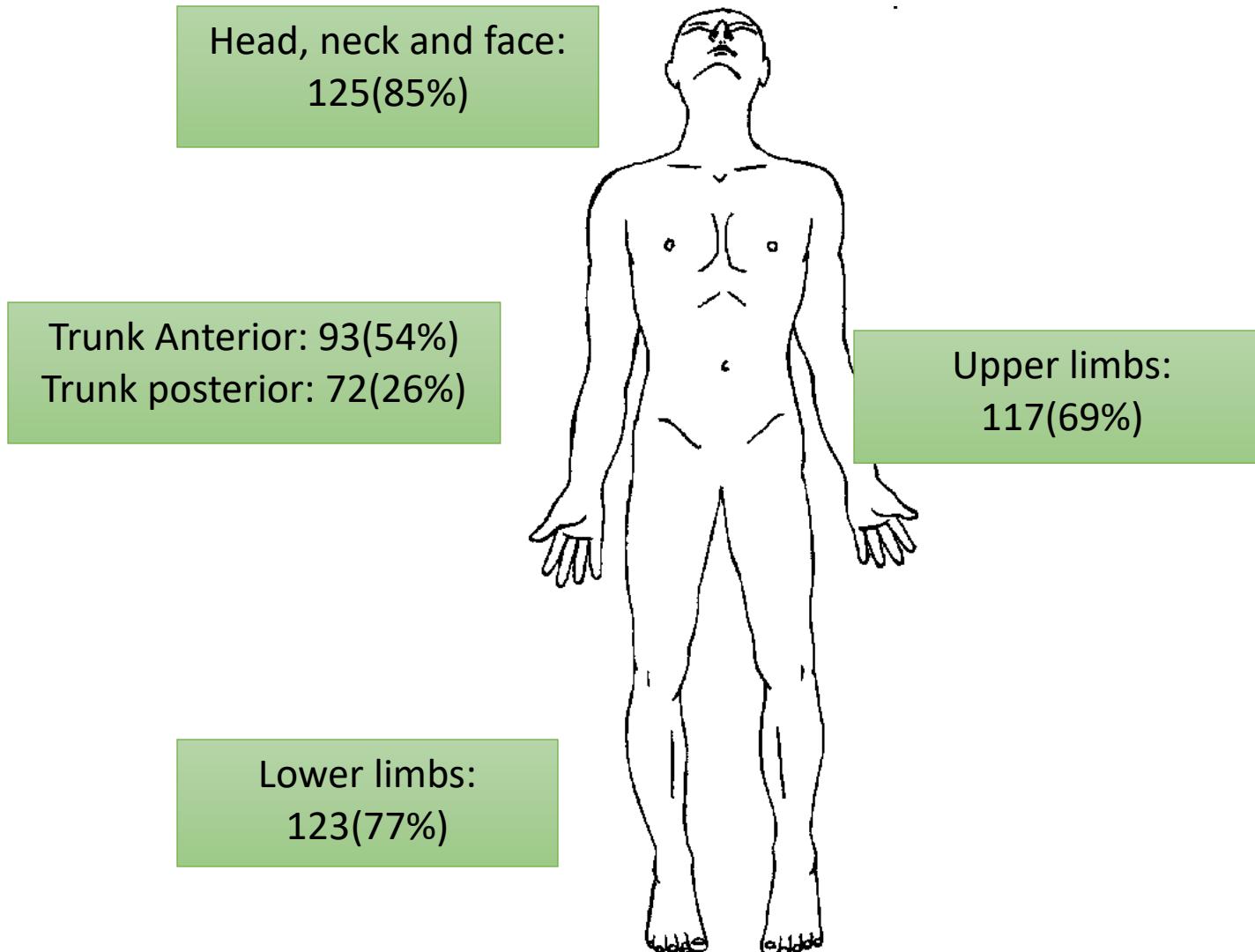
Pedal cycle (bicycle) accidents

- Most vulnerable second to pedestrians
- Machine is unstable upon impact
- No protective gear most of the time
- Injuries depends on the speed and the impact of the offending vehicle and whether the victim was subjected to a run over
- Common injuries
 - Head injuries (falls)
 - Fractures (limbs)
 - Large grazed abrasions

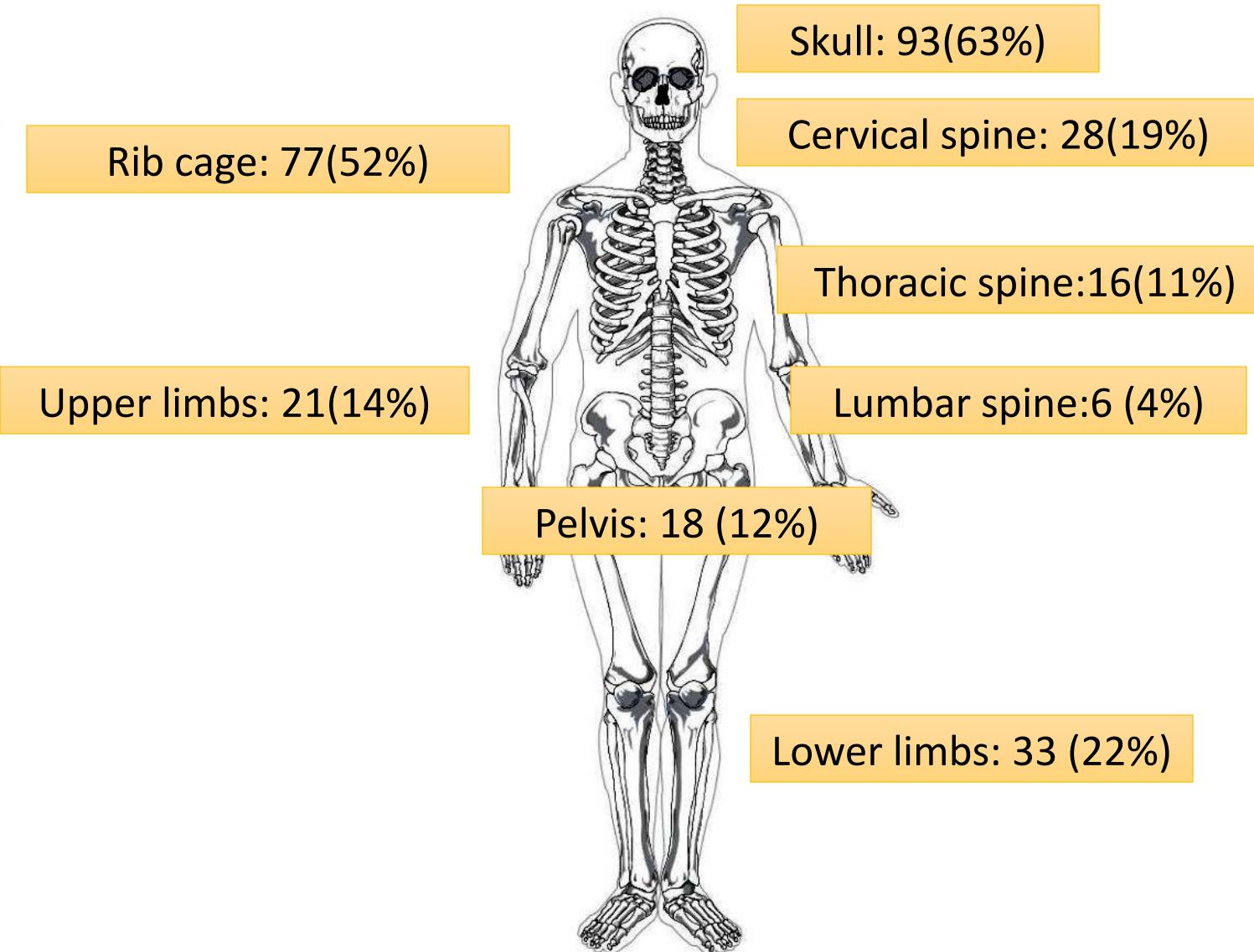
Post mortem reports of pedal cyclists

- [SR2387.10 RTA.docx](#)
- [SR4395 RTA Pedal CYCLIST.docx](#)

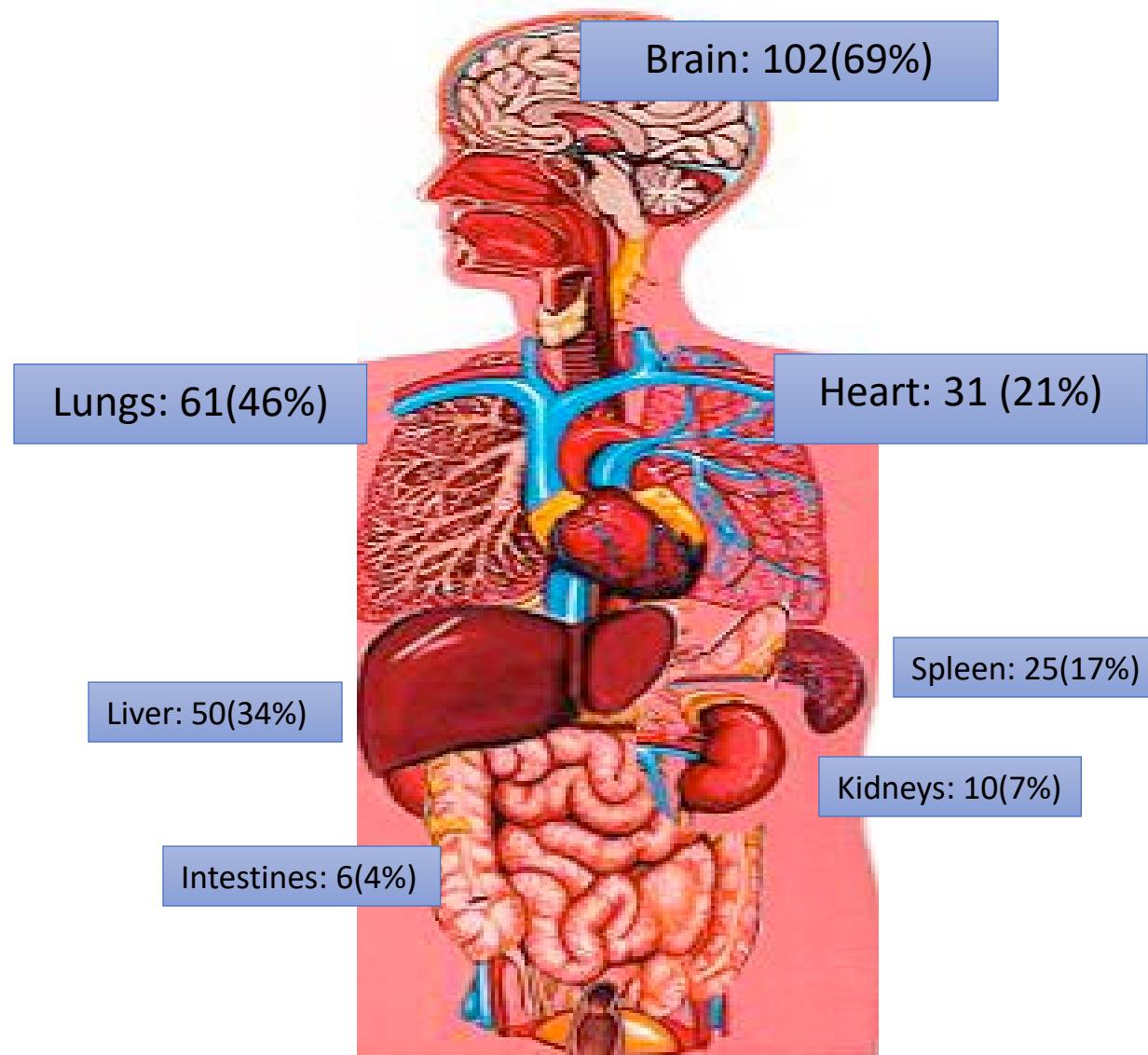
Injury distribution of two wheel vehicles(Ragama Study 147)



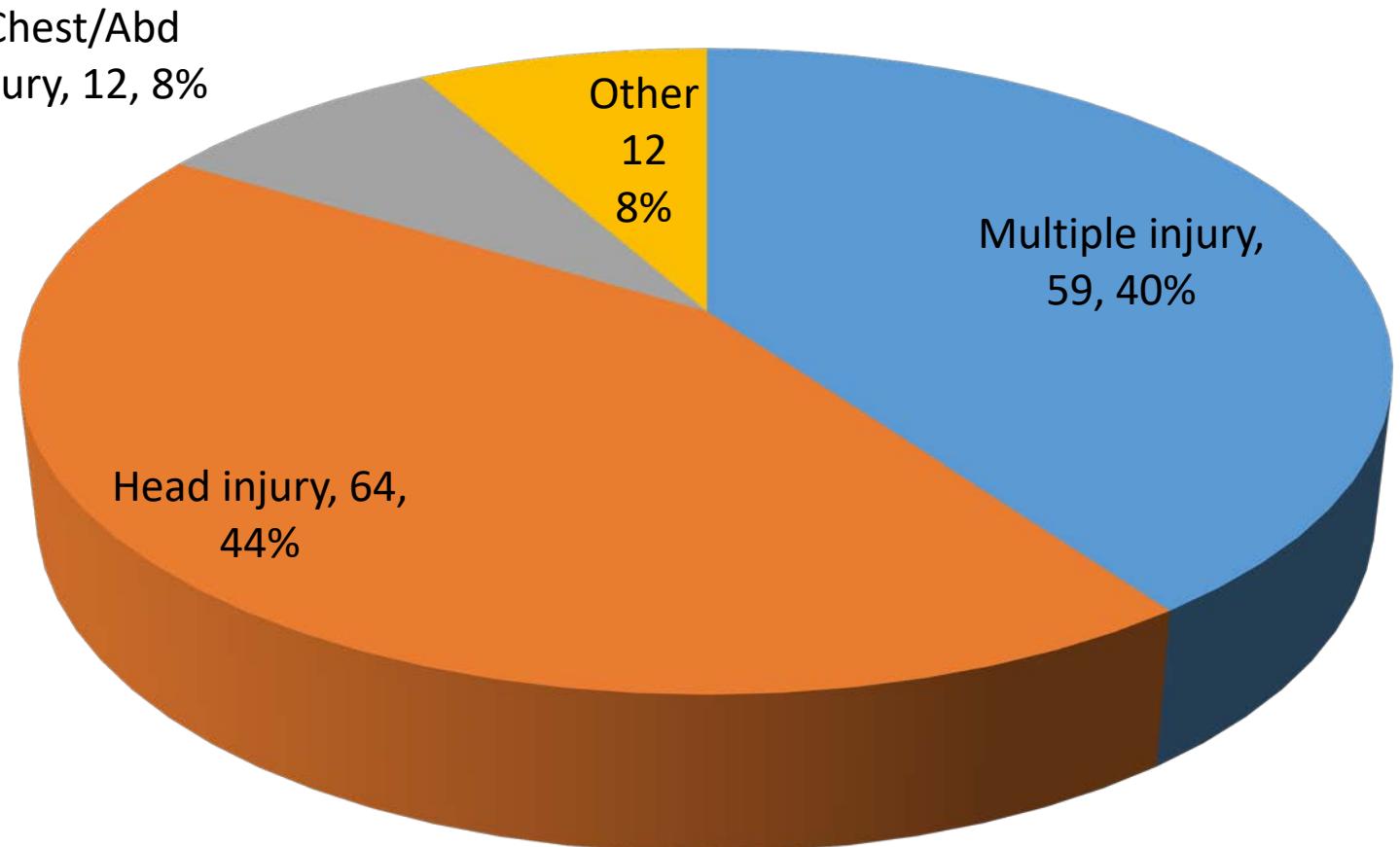
Injuries: Skeletal injuries



Injuries: Visceral injuries



Cause of death...





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Department of Forensic Medicine, Faculty of Medicine, University of Kelaniya, Thalagolla Road, Ragama, Sri Lanka





A study into blood alcohol concentration in fatal accidents among vulnerable road users in a tertiary care hospital Sri Lanka

Anuruddhi Samanthika Edirisinghe*, Indira Deepthi Kitulwatte and Udara Dilrukshi Senarathne

Department of Forensic Medicine, Faculty of Medicine, University of Kelaniya, Thallagolla Road, Ragama 11010, Sri Lanka

(Received 28 June 2013; accepted 14 October 2013)

The alcohol influence among pedestrians represents a significant risk factor for fatal road traffic accidents



Three-wheeler accidents



Injury pattern in three wheel accident

- Accidents are due to impact with other vehicles
- Toppling is common
- Thrown out of the vehicle
- Both driver and occupants sustains injuries
- Fatalities are mainly due to head injuries
- Rear seat passenger may sustain facial and limb injuries



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Death of a three wheeler occupant



[SR-3807 Head injury.docx](#)

[SR 6082 RTA.docx](#)

Trauma sustained by occupants of vehicles

Driver injuries

Front seat occupant

Back seat occupant



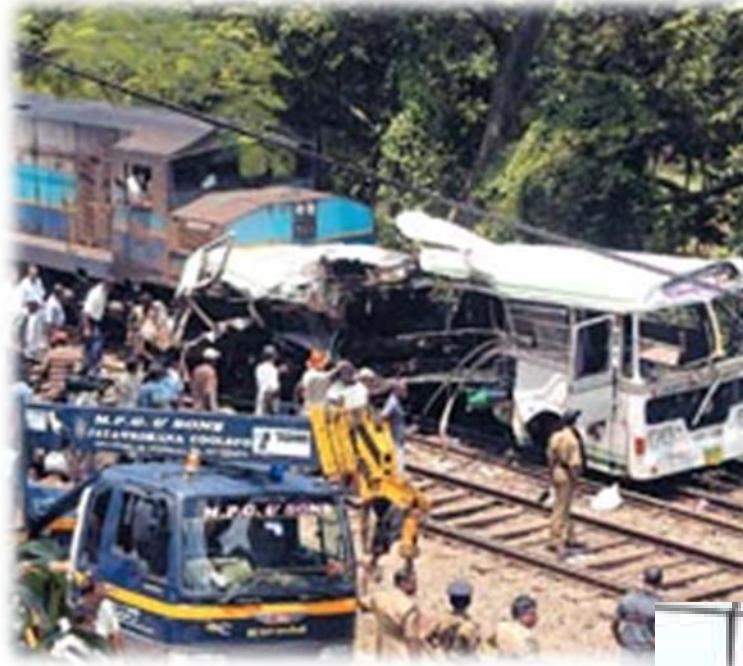
Driver/Occupants of vehicles

- The injuries are caused by the change in rate of the movement
- Frontal impacts results in deceleration
- Rear impacts results in acceleration
- G forces acting on persons
 - $G=C(V^2)/D$
 - (C is a Constance 0.0039)
 - V is velocity in KMH
 - D is stoppage distance in meters

Driver/ occupant injuries depend on



Moving vehicle



Collided with a train



Crashed into a static object

Nature of the impact



Direction of the impact





Speed of the vehicles



Type of vehicle



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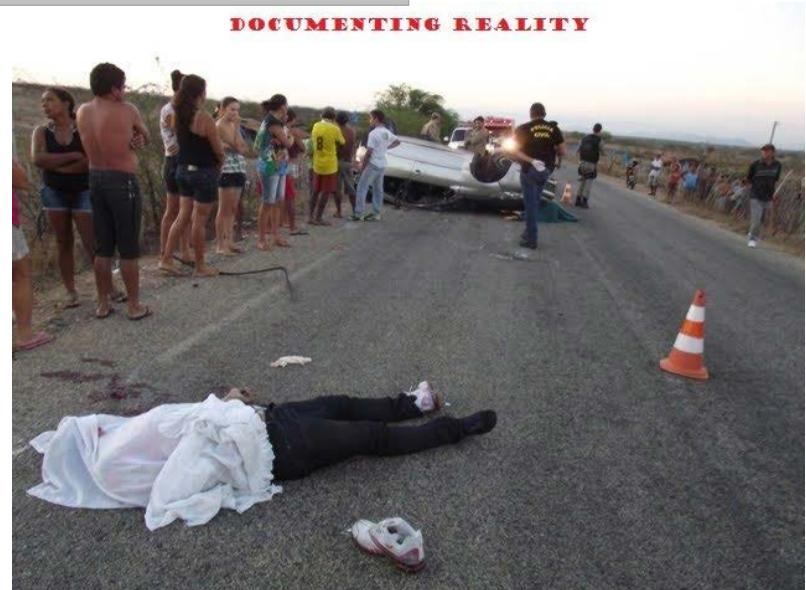


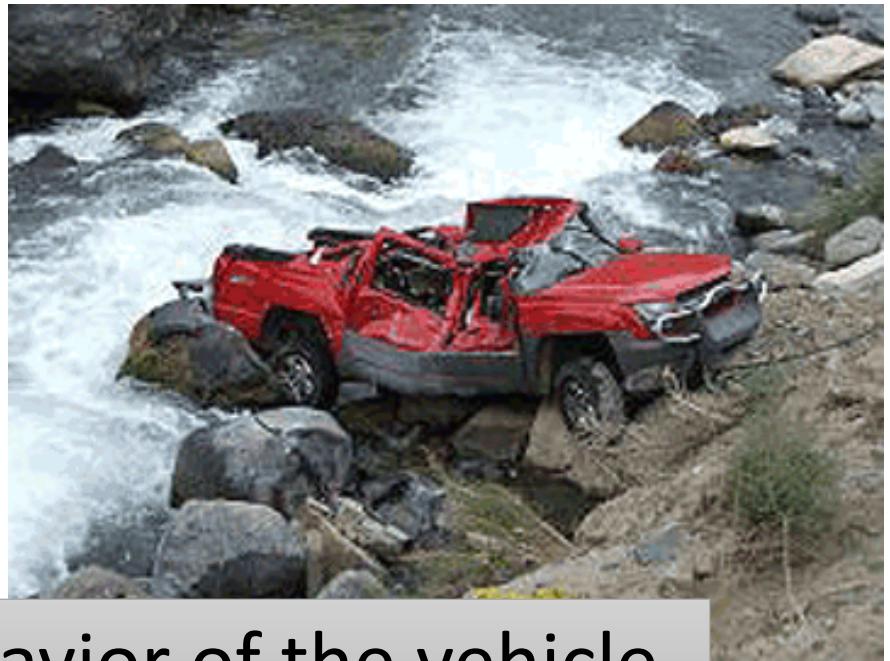
Use of restraints





Trapped within or thrown out of vehicle





Subsequent behavior of the vehicle



Driver injuries



G Forces and injuries : Driver

G=.0039 V2 /D

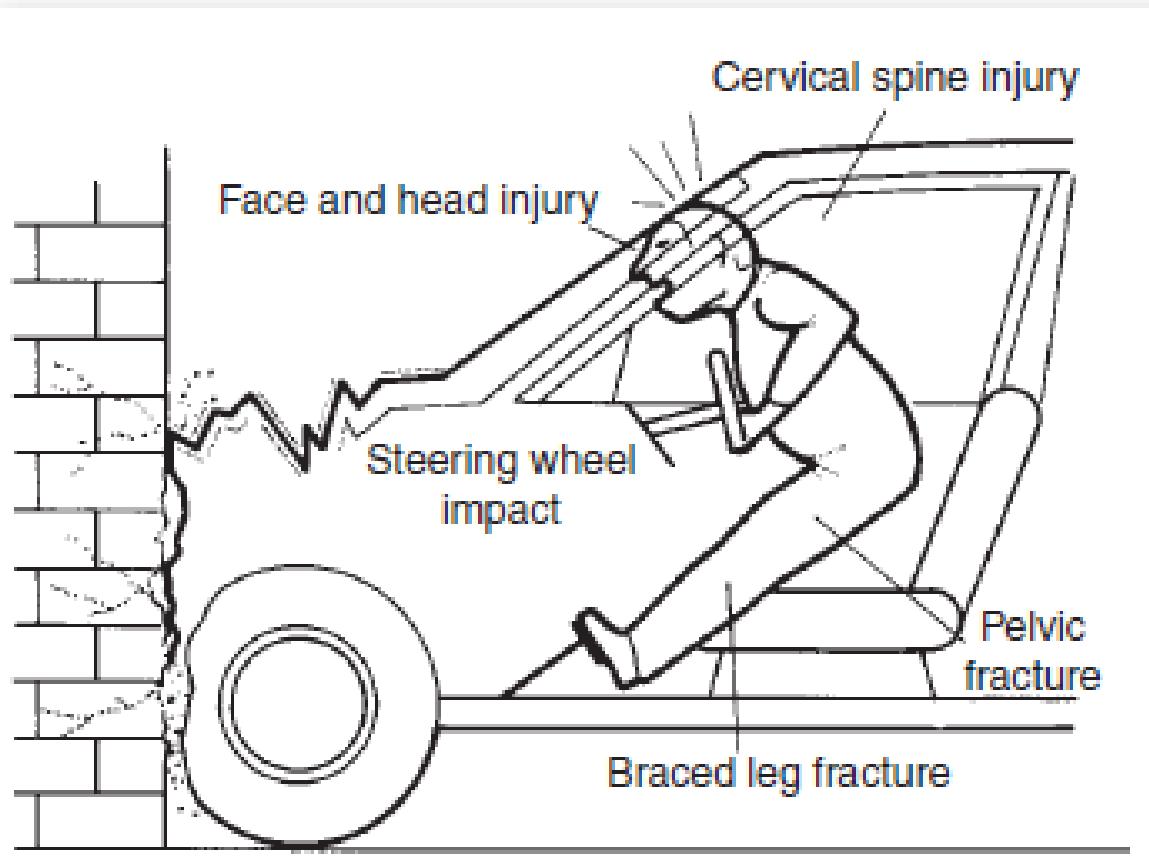
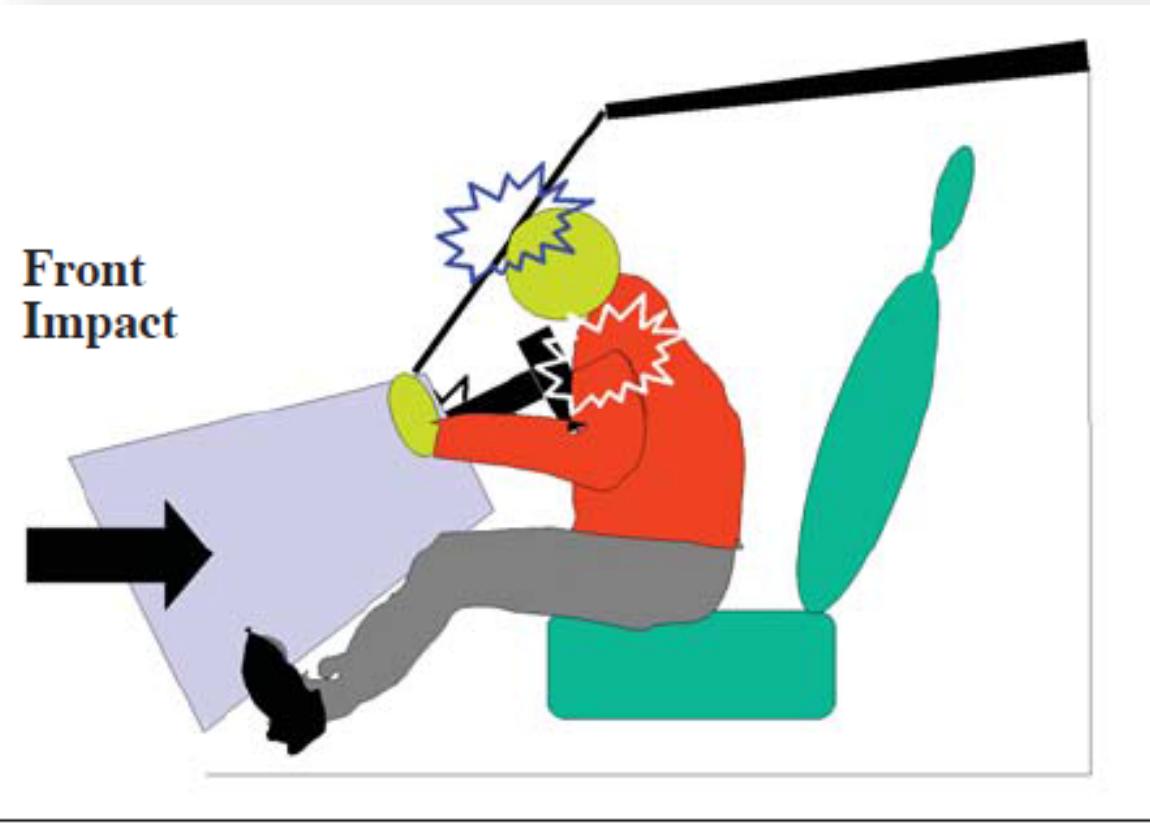


FIGURE 9.1 *Major points of injury to an unrestrained driver of a vehicle in deceleration impact.*

80 km/h
25cm penetration to wall
50cm Crumpling
33G deceleration

If restrained : the G forces can be tolerated by tissues
If no restrain: tissue injuries

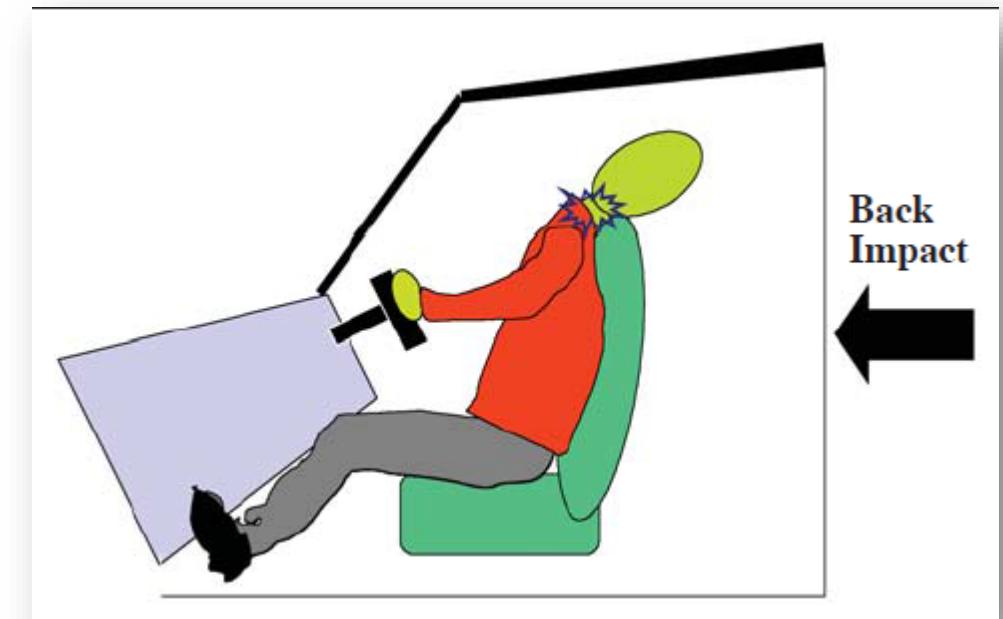
Mechanisms of injuries



Whip lash injuries in unrestrained head

Head and chest impact of unrestrained driver

Hyper-extension is the most dangerous



Injuries to the head

- Head struck on the steering wheel, windscreen pillars, windscreen , thrown out and head struck on various objects
- Both blunt and sharp force injuries
 - Abrasions
 - Contusions
 - Lacerations
 - Cut injuries
 - Skull fractures , brain injuries , whip lash injuries
 - Cervical bone fractures



Injuries to the face



- Can sustain both blunt and sharp force injuries
- Lacerations and cut injuries on the face
- Injuries to the eye
- Internal eye injuries



Injuries due to head struck on the windscreen/ windscreen pillars



- Head hit on scattered windscreen small pebbled glass
- Small multiple irregular lacerations on the face
- 'sparrow foot' lacerations

Steering wheel/ column impact

- The flexing head may hit the steering wheel
- The chest may impact on the steering wheel
 - Imprint abrasions
 - Contusions in chest wall
- Fractures of rib and internal injuries to lungs and heart (compression between sternum and the spine)
 - Cardiac contusion, haemothroax, pneumothroax
 - Lung contusions



Steering wheel/ colum impact

- Rupture of the rectus abdominis
- Liver lacerations
- Spleen lacerations
- Mesenteric, duodenum and ileum injuries (contusions, lacerations)



Figure 1.8 Classic appearances of a steering wheel abrasion.

Aorta injury

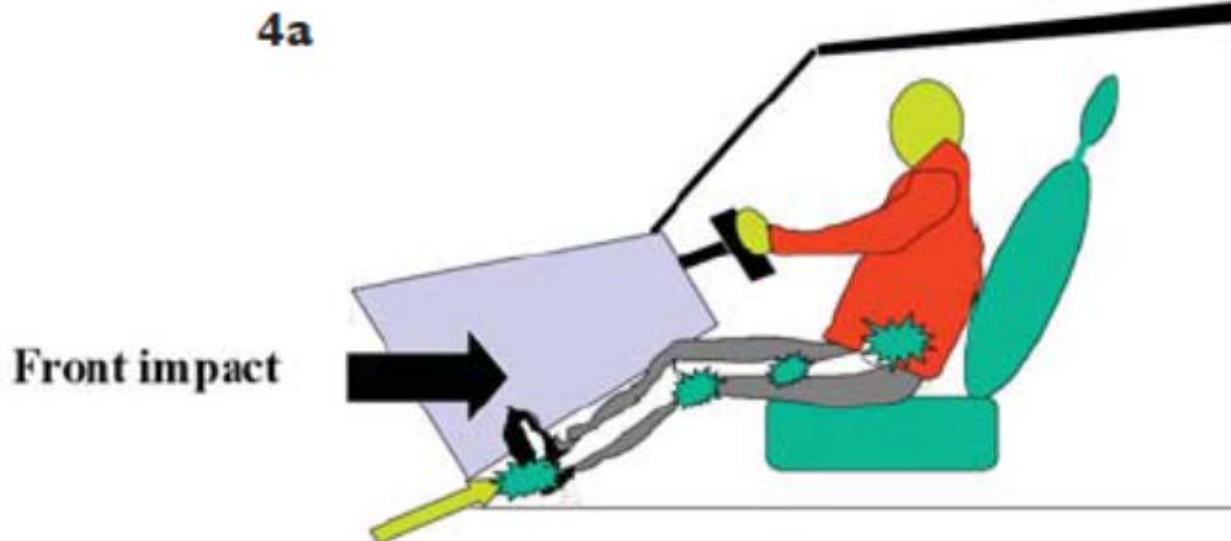
- Sudden deceleration causes rupture of the aorta (ladder tears)
- End of the arch of the aorta at which aorta is anchored to thoracic wall
- Pendulum effect of the heart



FIG 10.5 A common fatal lesion in unrestrained car occupants, following a deceleration impact. The thoracic aorta has been cleanly severed at the termination of the arch, with a resulting massive haemorrhage.

Injuries to the limbs

- Driver grips the steering wheel
- Forces transmitted causes injuries (fractures and dislocations) in the upper limb
- Feet of driver on clutch, accelerator or break pedal
- Forces transmitted causes injuries in the long bones and dislocations
- Knees hit on dash board causes patella fractures



Posterior dislocation
of hip
Fracture of femur
Patella injuries
Ankle injuries

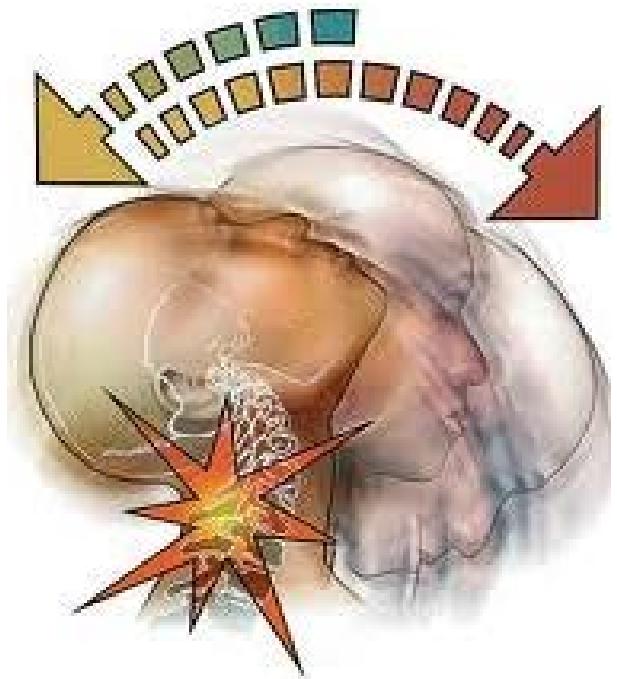


Fig. 5 Radiograph of a patellar fracture of a 29-year-old driver who sustained a dashboard injury.

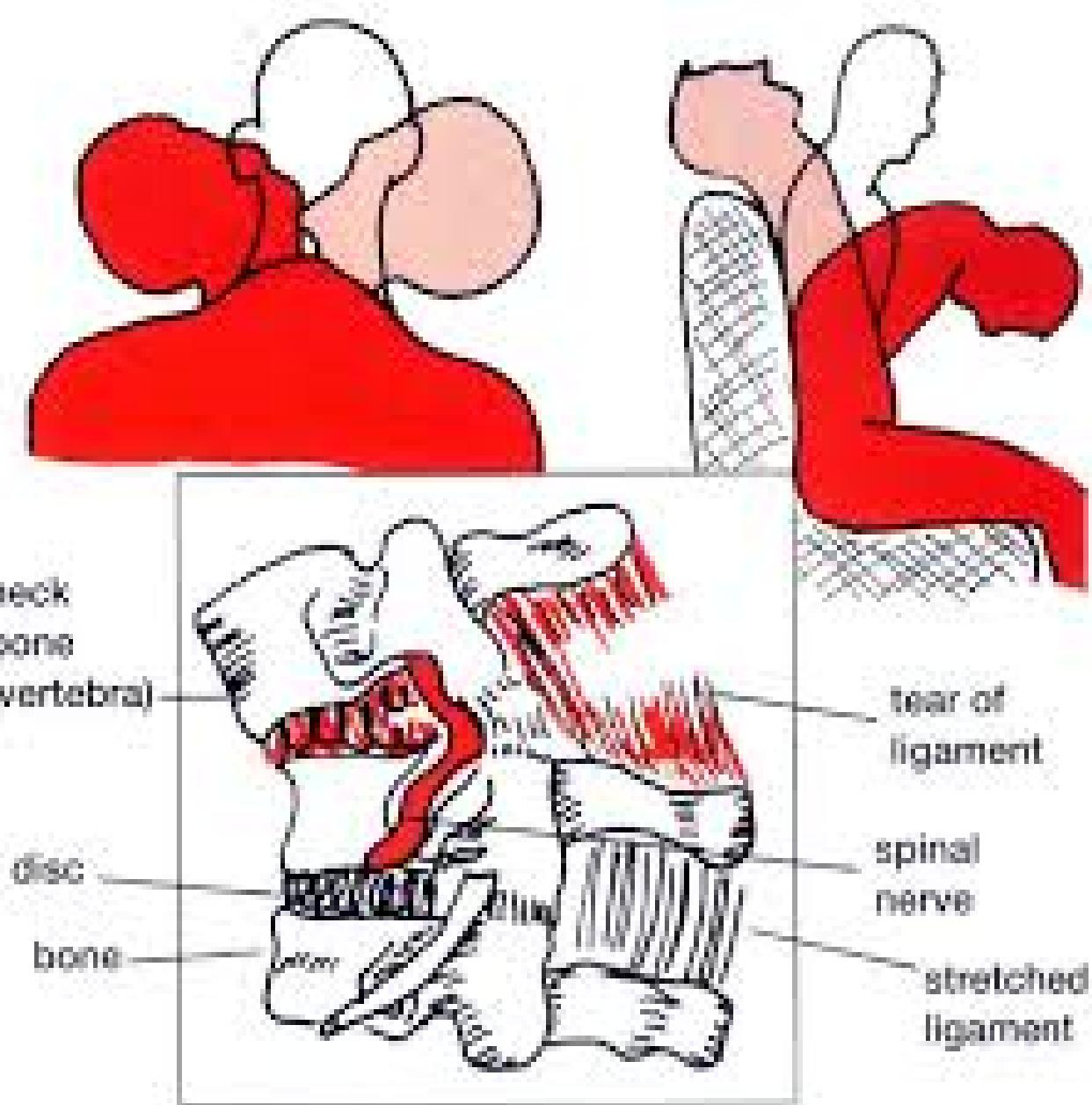


Whip lash injuries

- Acute hyper-flexion followed by hyper-extension
- Injuries to spine and the cord (C1, C2 & atlanto-occipital joint)
 - Bleeding into surrounding muscle
 - Rupture of anterior longitudinal ligament
 - Tearing of intervertebral discs
 - Compression of nerve roots
 - Ischemic hemorrhage and pulping of the spinal cord



(C1, C2 & Atlanto-occipital joint)





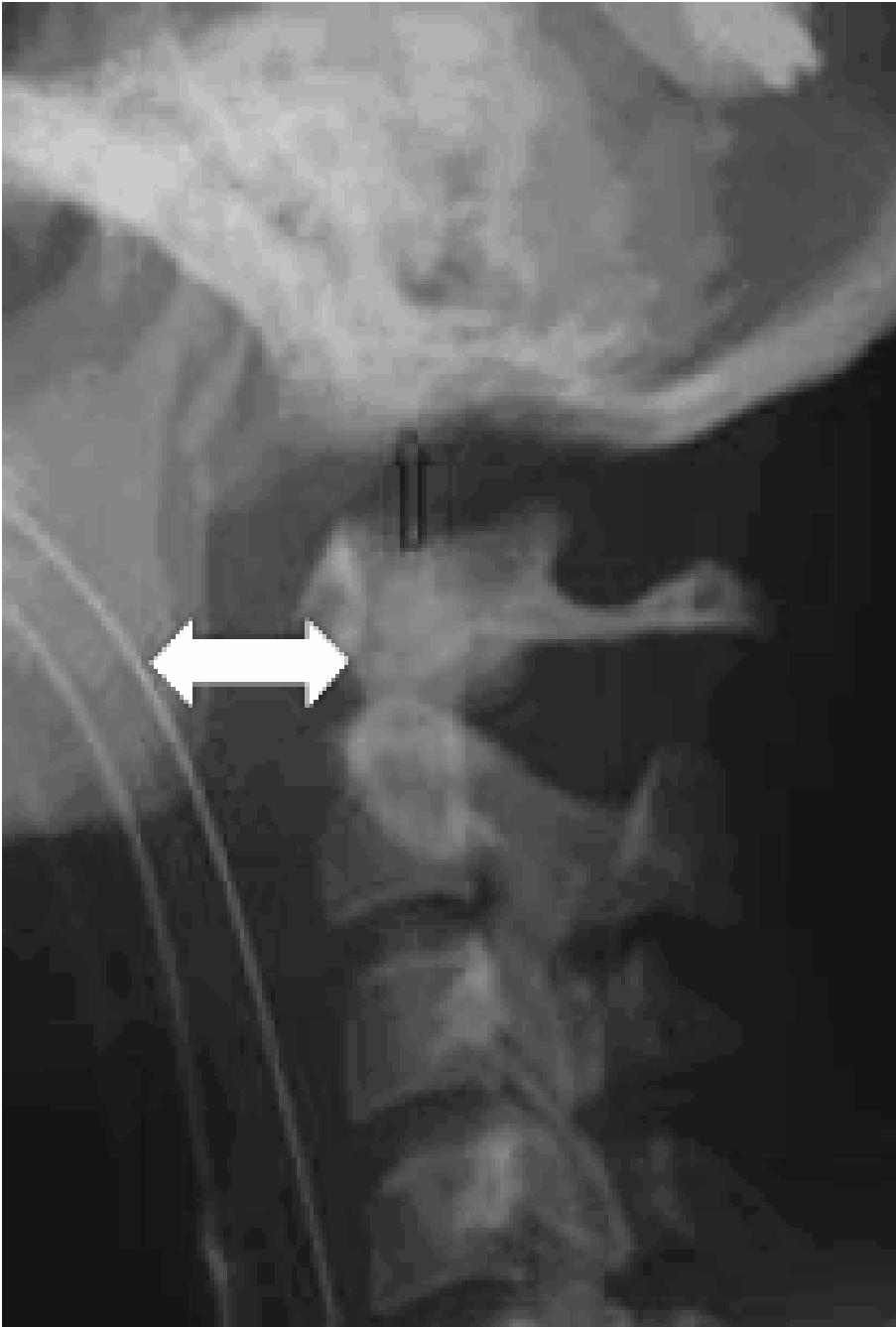
Pre-Accident



Post-Accident



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46-year-old woman
who suffered an AOD
after a motor vehicle
crash

CJEM 2006

- In side impact (right) the driver will have injuries on the right side of the body including cut injuries from the window glasses
- Roll over injuries: projections in the cabin causes further damage
- If fire: burn injuries or even charring
- If driver is ejected 5 times greater chance of dying

Front seat passenger injuries



Injuries in the front seat passenger

- Front seat passenger injuries are similar to the driver except
 - No steering wheel
 - No anticipation of an accident
- Runs a risk of being thrown forwards and sustaining injuries from windscreen glass and windscreen pillars
- Ejected out of the car if not restrained

- Injuries on the face & head due to hitting on the windscreen
- Sparrow –foot injuries on face (cuts and lacerations)



- Forward movement will cause impact on the dashboard, cubby lock, door and window handle
- Abrasions/ contusions, fractures



Similarities and differences between driver / front passengers

Driver

- Whip lash injuries if no head restraints
- Head injuries (deceleration)
- Face injuries (lacerations) windscreen
- Knee, pelvic and lower limb fractures and dislocations (dash board and intrusion of engine)
- Chest injuries due to steering wheel

Front seat passenger

- Whip lash injuries if no head restraints
- Head injuries (deceleration)
- Face injuries (lacerations) windscreen
- Knee, pelvic and lower limb fractures and dislocations (dash board and intrusion of engine)
- No chest injuries due to steering wheel



Rear seat passenger



Rear seat passenger injuries

- Severity depends on whether the passenger is restrained or not
- Thrown forwards or sideways (hit the seat in the front or sides)
- Dislocation of hips
- Fractures of limbs
- Deceleration of injuries of the head & brain
- Whip-lash injuries

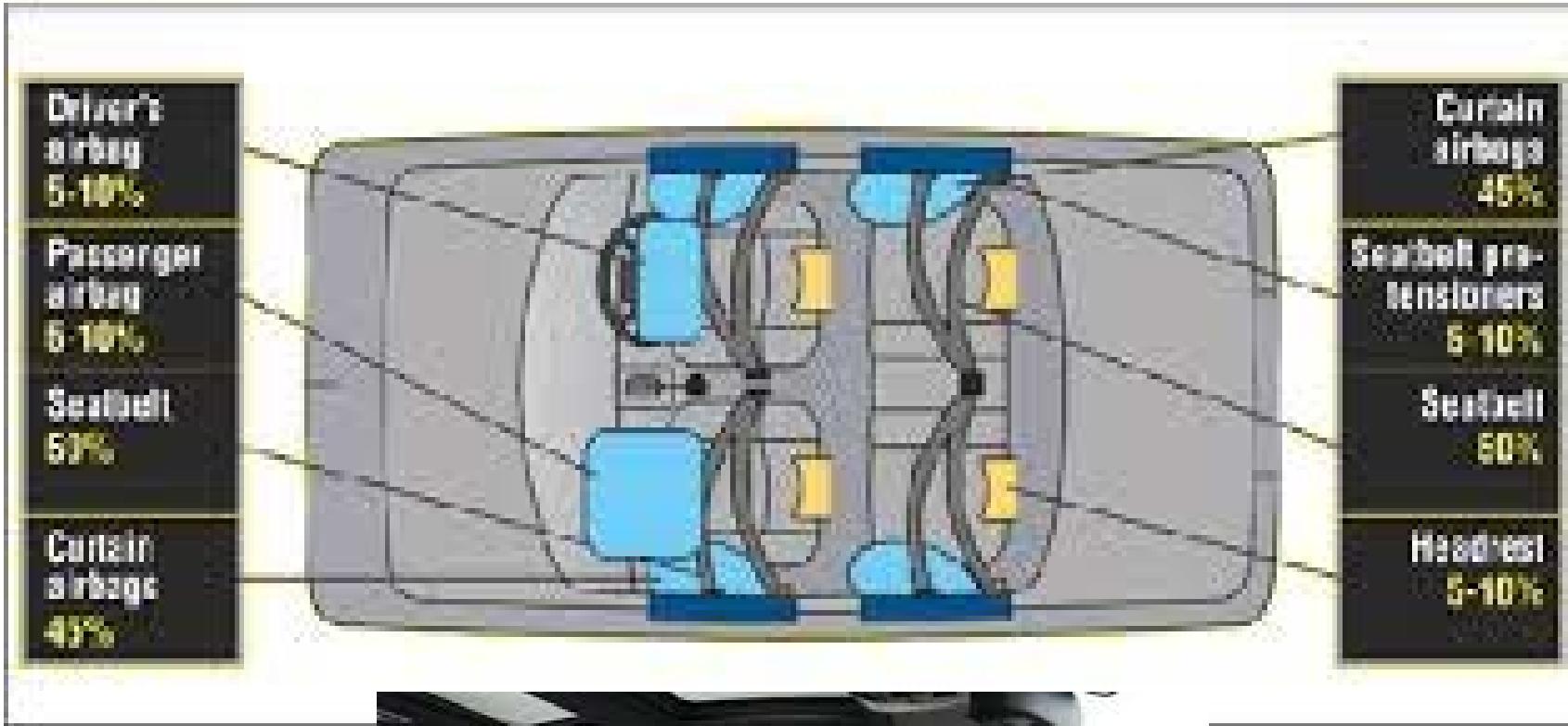
Seat belts, air bags and head restraints are expected to reduces these injuries



Safety measures in vehicles to prevent/minimize injuries

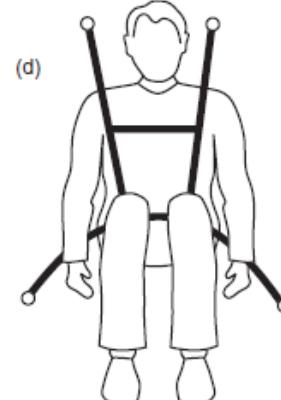
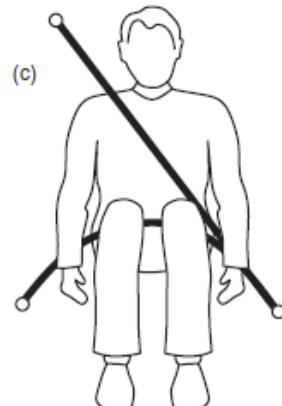
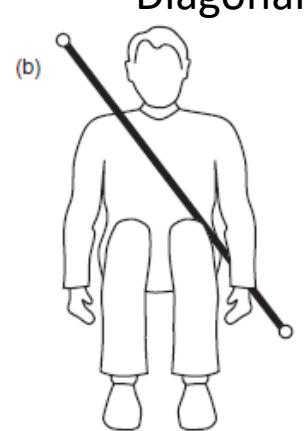
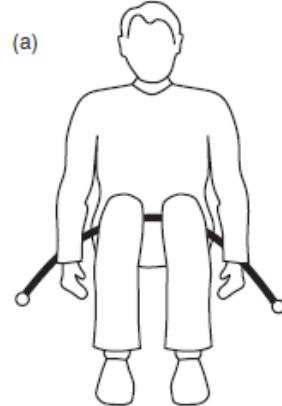
Measure	Prevents
Windscreen : Laminated glass	severe cut injuries
Minimal outward projections (bumper: fiberglass)	Reduce impact injuries in the pedestrians
Minimal projections within the cabin	injuries to passengers
Collapsible steering wheel	Injuries to head, chest and abdomen
Seat belt	Prevent projecting out and reduce deceleration injuries
Air bags (driver & passenger)	Head & chest impacts from steering wheel and dashboard
Curtain air bags	Reduce side impact injuries
Front engine and rear made up of material that absorb force and crumble and deform	Cabin space is preserved and passengers are safe

Safety features and their capacity for reducing the risk of injury



Injuries from seat belts

Lap strap

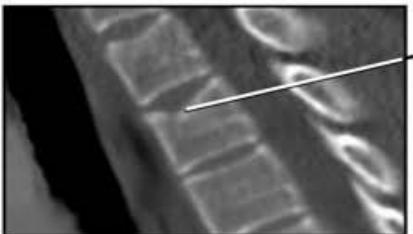


Diagonal and Lap
strap (cars)

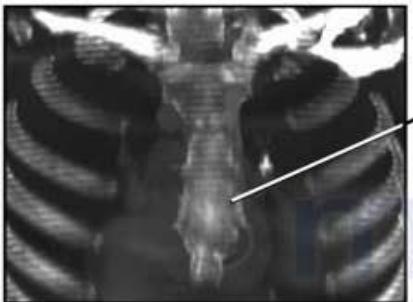
Shoulder harness
(racing cars/ aircrafts)



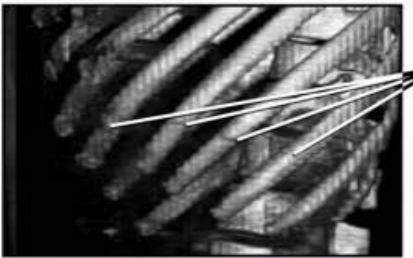
Summary of Injuries



Compression fracture
of the superior endplate
of T3 vertebral body



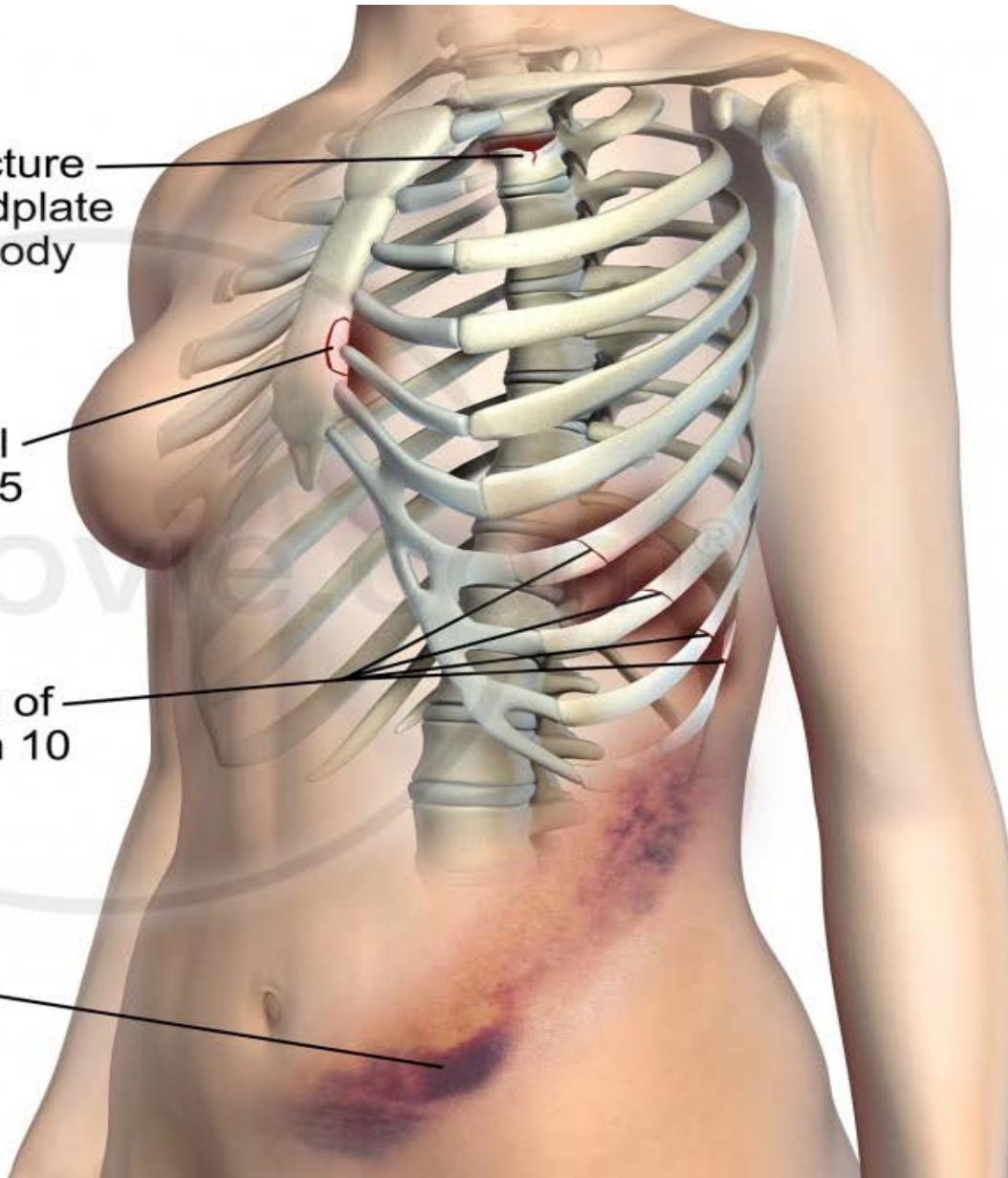
Displaced sternal
fracture at level T5



Lateral fractures of
left ribs 7 through 10



Bruising



Seat belt Injuries

- Use of seat belts have significantly reduced sustaining serious injuries especially head injuries
- They can cause
 - Clavicle injuries/ sternal injuries
 - Muscle contusion
 - Breast contusions
 - Gastrointestinal tract injuries (stomach, small bowel, colon and rectum) mesenteric lacerations
 - Lumber fractures and thoracic aorta injuries
 - Bladder injuries

Air bag injuries



- Large fabric bag
- Placed in the steering wheel hub/ fascia in front seat passenger
- Activates within milliseconds (nitrogen filled)
- Prevent the impact with fascia and hyper flexion
- It deflates also quickly



- Minor injuries to severe
- Facial bruising
- Eye injuries
 - Mild corneal laceration
 - Globe rupture
 - Orbital fracture
 - Retinal detachment
 - Chemical injuries of eye
- Temporo-mandibular joint injuries
- Shoulder and clavicle injuries
- Dislocated or fracture of arms/
amputation of fingers

Investigation of a case of hit and run accident

Medico-legal investigation of 'hit & run' accident

History

- When, where, and how the body was found
- Witness accounts

Visit to the scene

- Brake marks, trace materials from vehicle droppings
- Fragments from head lamps, windscreen fragments, paint flakes, mud guard dropping

Identification of the victim

- Facial features
- Dental, anthropology, accessories, tattoos and marks, finger prints, DNA

Preliminary procedure

- Photography (tyre marks, imprint abrasions)
- Collect trace materials , parts of the vehicle (glass, paint flakes, oil drips, grease, weeds dust) to compare with the suspecting vehicle

Examination of Clothing

- Clothing for identification
- Trace material from the vehicle
(paint/grease/ oil/dust/ glass/ parts)
- Tyre marks on cloths

General external examination

- Body stature, male/female, medical surgical interventions, features of identification, general features of disease, post mortem intervals

Specific external examination

- Each injury in detail: regarding type, special patterns, (primary and secondary impact, secondary or run over injuries, height of occurrence, which can be compared with a suspected vehicle

Internal examination

- All the systems for natural illness exclusion
- Internal injuries leading to death

Special investigation

- Alcohol and drugs of abuse
- Laboratory analysis of trace materials
- Analysis of suspected vehicles and compare with trace materials found from the body and the scene

Documentation

- PMR including COD, OPINION reconstruction of the incident, identification of the vehicle, contributory causes/ circumstances of the RTA, accident, suicide or homicide

Postmortem report of a HIT & RUN

- [SR 5555 RTA.docx](#)



Investigation of body found on or by the rail tract.

(Accidental, suicidal, homicidal or postmortem
disposal)



Kelaniya
Medicine

Investigation of a body recovered at or near the rail tract : The circumstances

- Accidental fall from an overcrowded train
- Accidental impact with a train at unprotected crossing
- Lightening, electrocution, snake bite
- Suicide : jumped from a train or jumped into the train or kept the head on the rail tract (decapitation)
- Homicide : pushed from a train (fall injuries)
- Homicide: done from another method and body was taken to the rail tract to conceal injuries or as a way of disposal
- Natural: the deceased died of a sudden natural condition near or on the tract
- Possibility of intoxication/ poisoning

The investigation

- As the hit and run injury investigation a thorough examination of the body is needed with a scene visit examination
- Collection of trace material both from the body and the scene
- COD including an opinion
- [SR.4697 Train & Alcohol.docx](#)

Further reading

- Dr. LBL de Alwis -Lecture Notes in Forensic Medicine
- Transportation Injury- Pekka Saukko & Bernard Knight 3rd Edition Knight' s Forensic Pathology 2003
- Transportation Medicine Jason Payne-James, Anthony Busuttil, William Smock Eds Forensic Medicine, Clinical and Pathological Aspects 2004

- Eid H O, Abu-Zidan F M Biomechanics of road traffic collision injuries: a clinician' s perspective. Singapore Med J 2007; 48(7) : 693.
- Edirisinghe PAS, Kitulwatte IDG, Senarathne UD. Injuries in vulnerable road user fatalities; A study from Sri Lanka Journal of Forensic and Legal Medicine

Reflect time

- Some knowledge
- Showed where to get
- Showed the skill:
 - Report writing
 - Examination of patients and conducting autopsies will be done at clinical
- Attitude to learn and serve people

A bad attitude
is like a flat tire.
You can't go
anywhere
until you change it.





Thank you