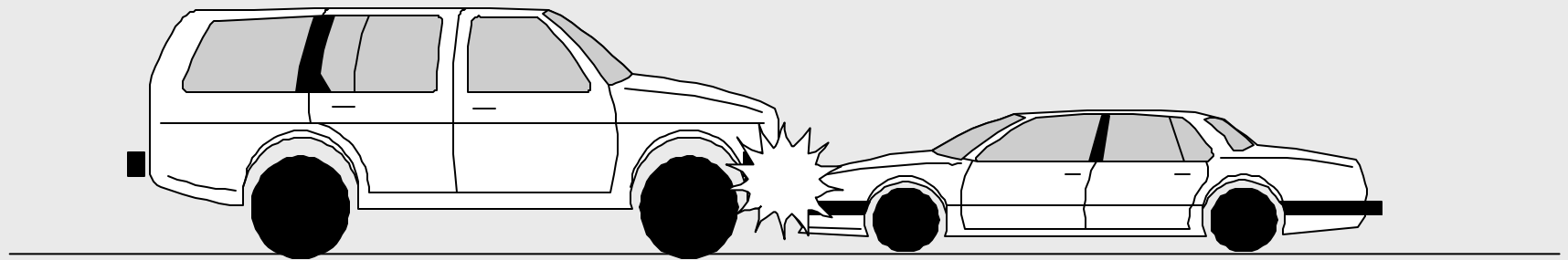


Injuries Due to Vehicle Mismatch: Implications for Prevention and for Medical Care – Seattle CIREN



Presenters: Charles Mock, MD, PhD, FACS

Rob Kaufman, BS Crash Investigator



CIREN Seattle



HARBORVIEW
INJURY PREVENTION
& RESEARCH CENTER

Seattle CIREN team research on incompatibility

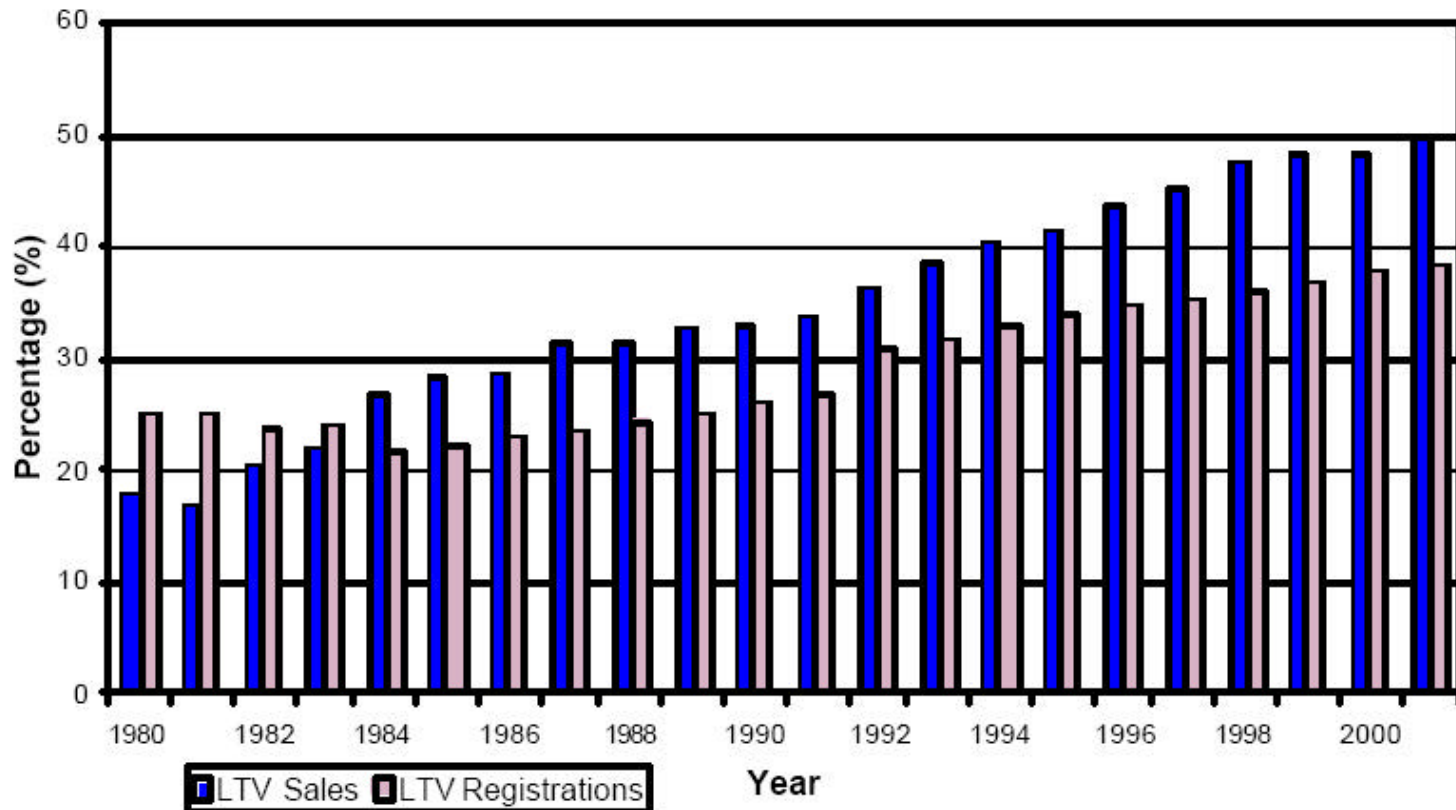
Current Publication:

Acierno S, Kaufman R, Mock C, Rivara F, Grossman D. Vehicle mismatch: Injury patterns and severity. Accident Analysis and Prevention 39 (2004) 761-772.

Reviewed and selected cases from CIREN network:

1. Side Impacts (Passenger vehicle struck by LTV)
2. Frontal Impacts (Passenger vehicle)
3. Frontal Impacts (LTV)

Increasing LTV Sales/Registrations

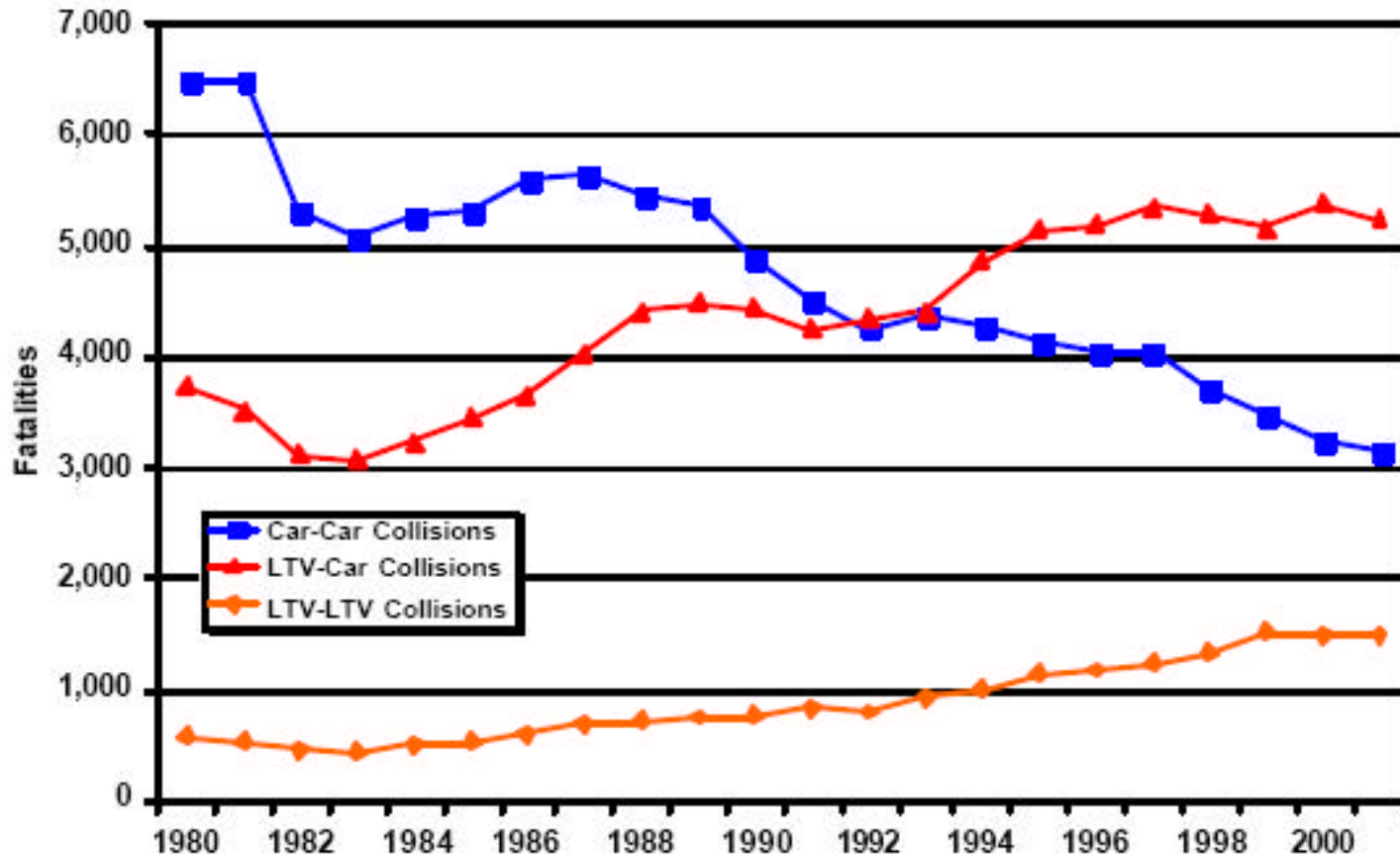


NHTSA's Research Program For Vehicle Aggressivity and Fleet Compatibility - Hollowell, Summers, Prasad.

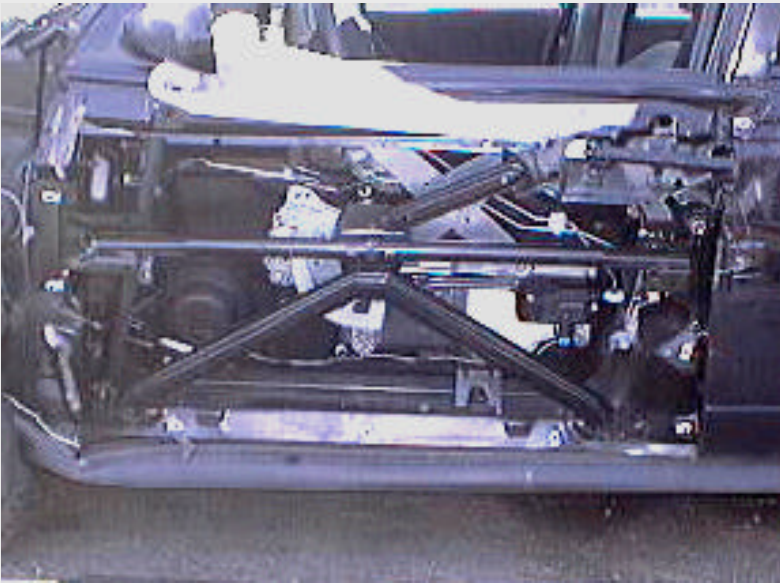
Increasing LTV-Car Fatalities

NHTSA research paper#307-Summers, Hollowell,Prasad

Fatalities in Vehicle-to-Vehicle Collisions



Side impact standard improvements (SS214)

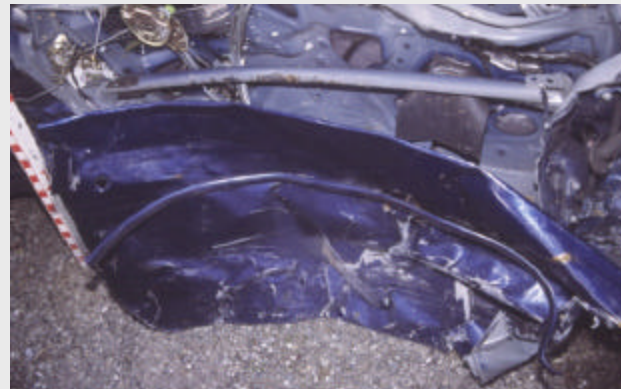


Use of side impact beams in doors

Protection from side impact beams

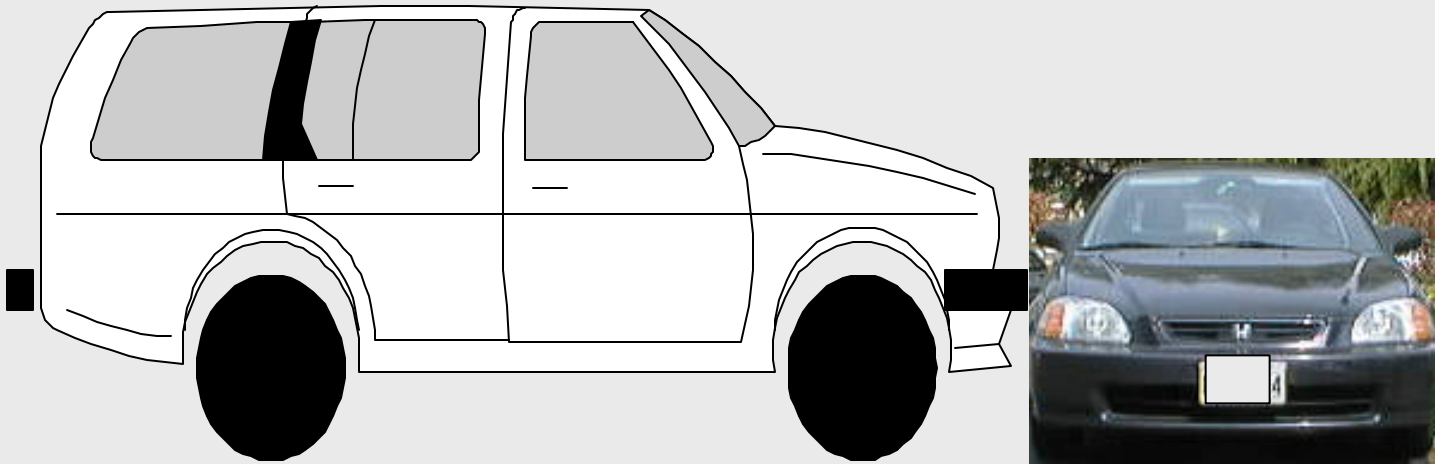


- Minimal intrusion
- No injury
- Delta V = 12 mph
- 01RYEW2



Striking vehicle

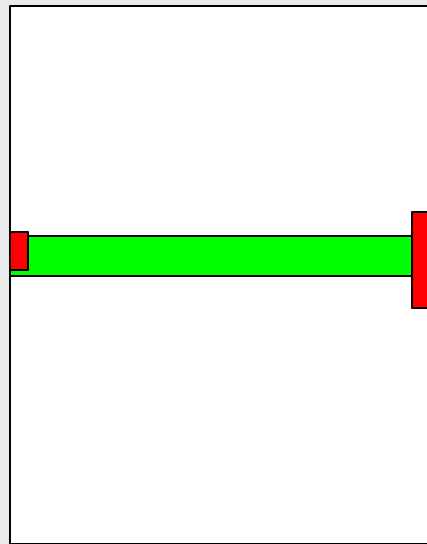
Larger Vehicle and Side Impacts



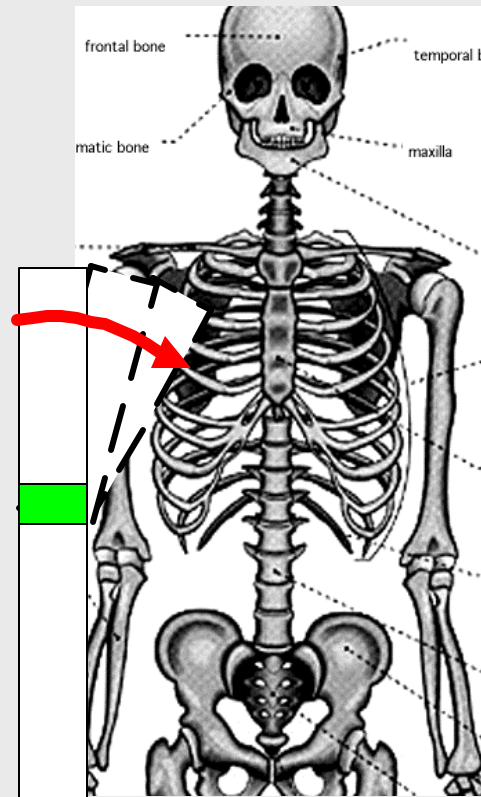
Light Truck Vehicles vs. Passenger Vehicles

Some bumper heights/frames are overriding the side impact supports

Side impacts with larger vehicles with lateral door support beams



Side View



End View

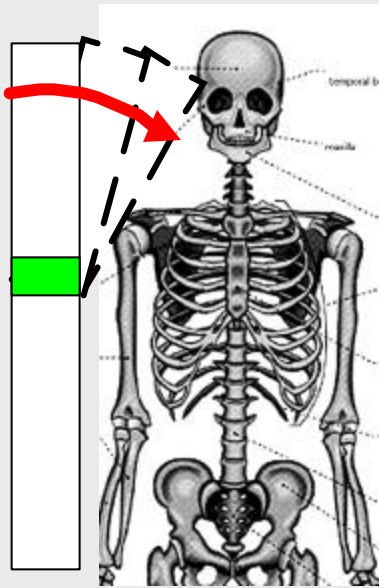
Intrusion = Injury



Adults -Think
Thorax!!

Children- Think head

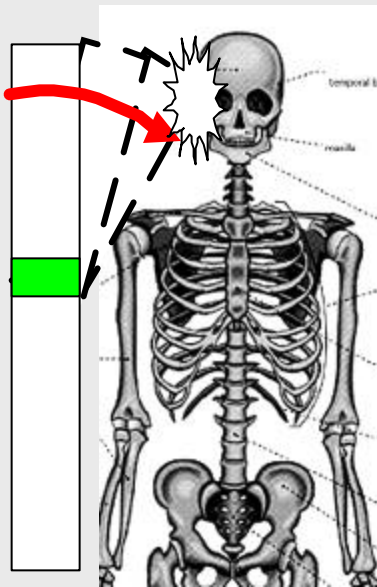
This becomes head contacts for children



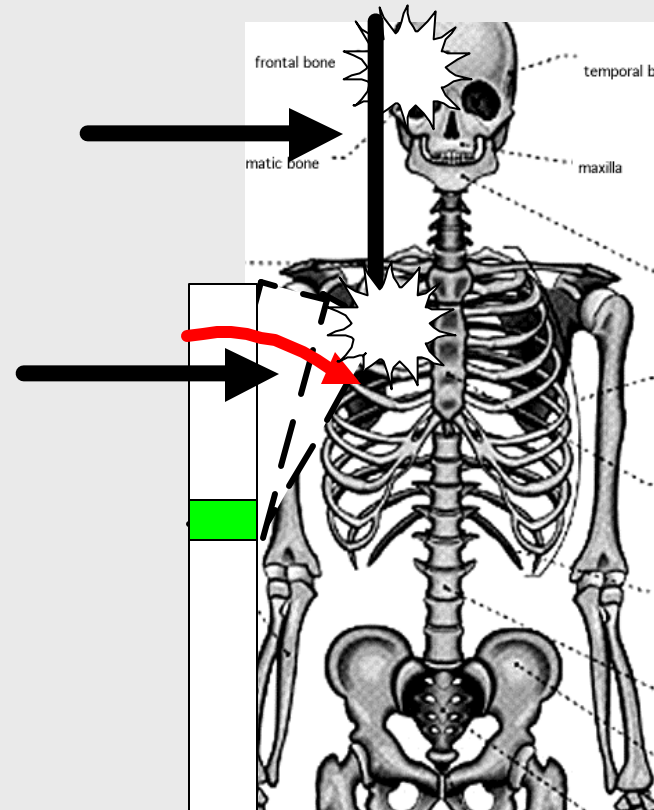
End View



Mismatch Side Impact Injury Patterns

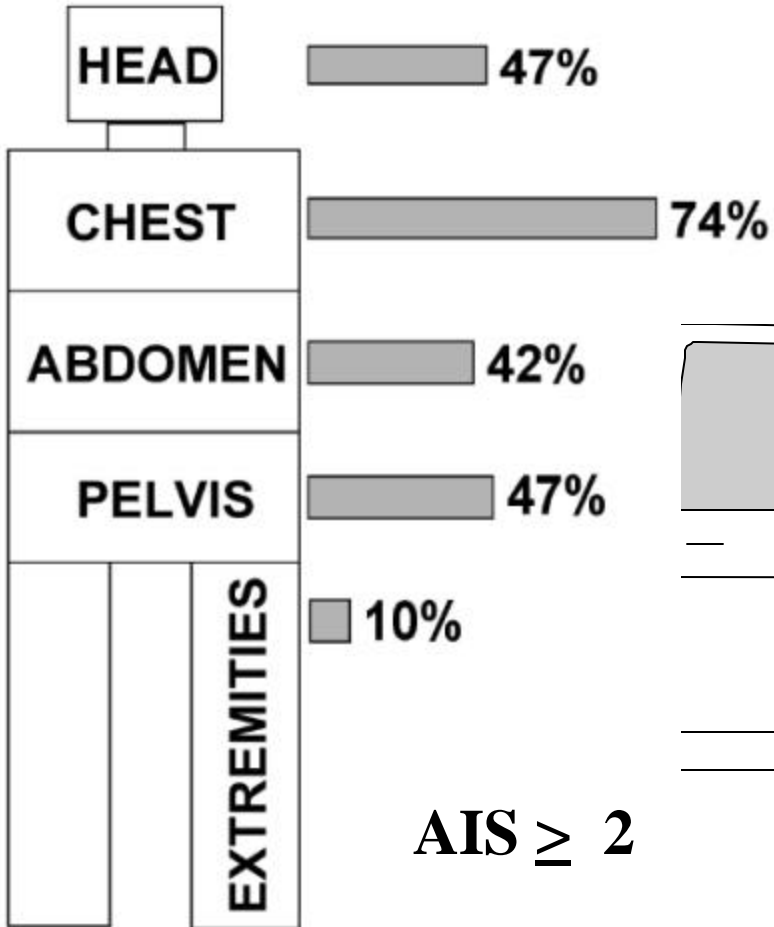


End View
CHILD



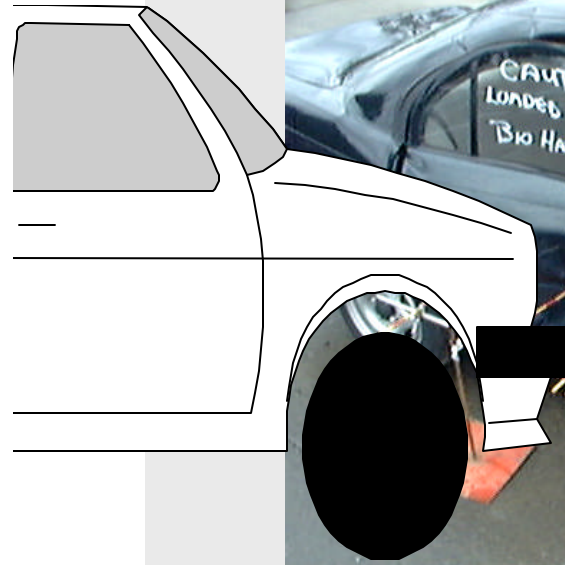
End View
ADULT

SIDE PV



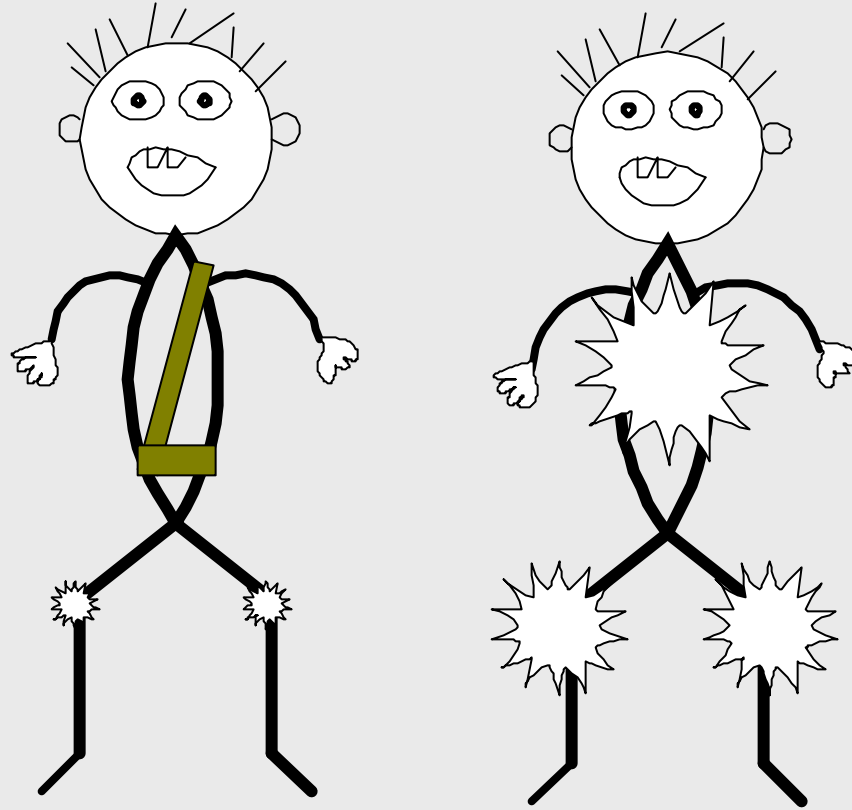
$AIS \geq 2$

LTV Front into Side Passenger Vehicle



Frontal Impacts

Occupant energy distribution

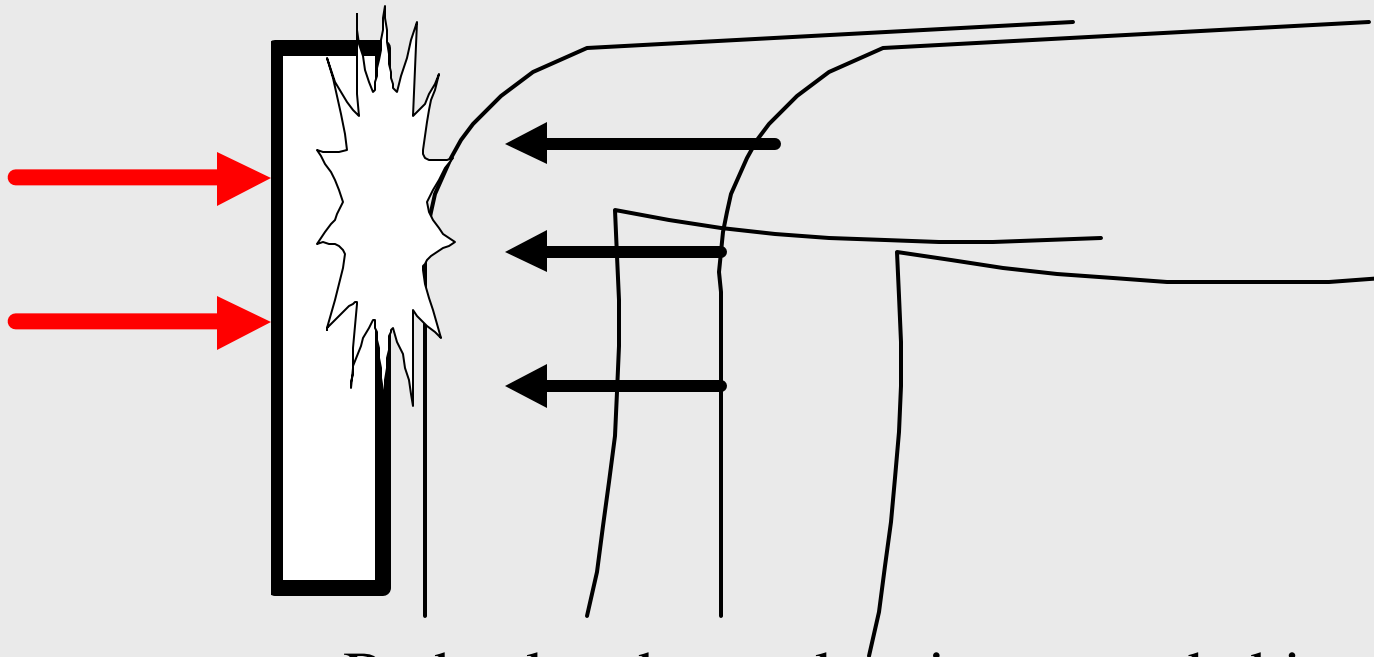


Restrained

vs.

INTRUSION or Unrestrained

Direct Contact Forces w/ Intrusion



- Body already accelerating toward object
- Intrusion increases the forces loading on the lower extremities

Pre-crash

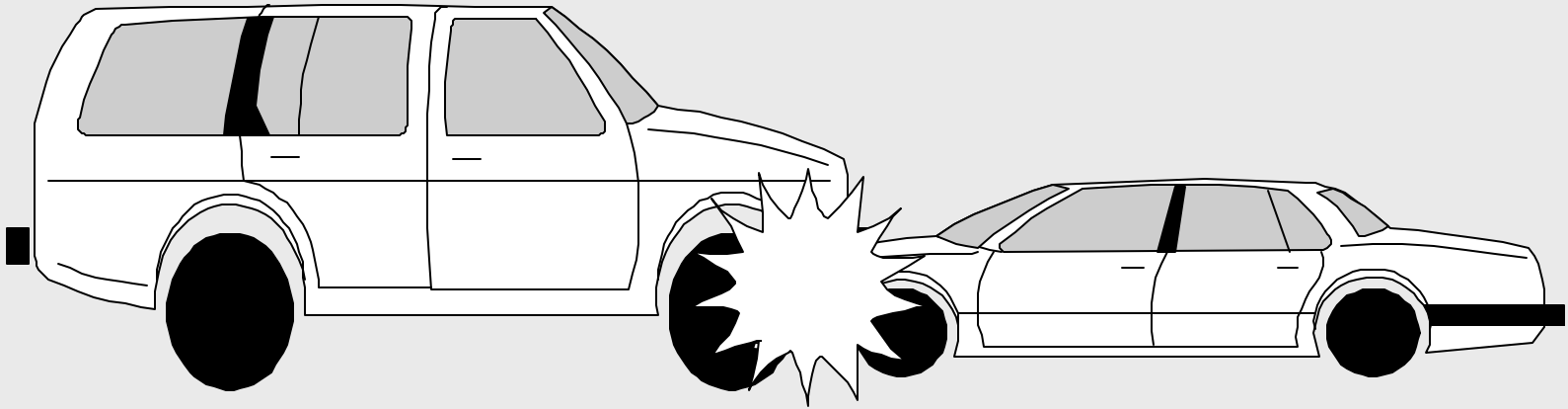


Post-crash

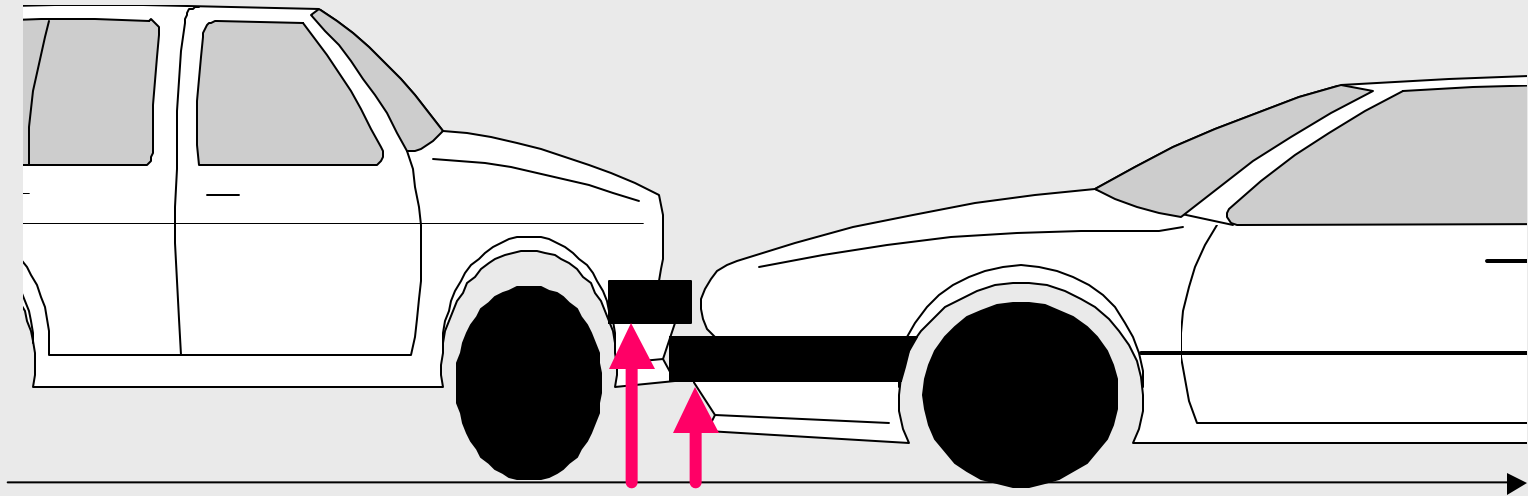


Left mid-shaft femur fracture due to override impact and intrusion to instrument panel

Offset Frontal Impacts with Vehicle Mismatch



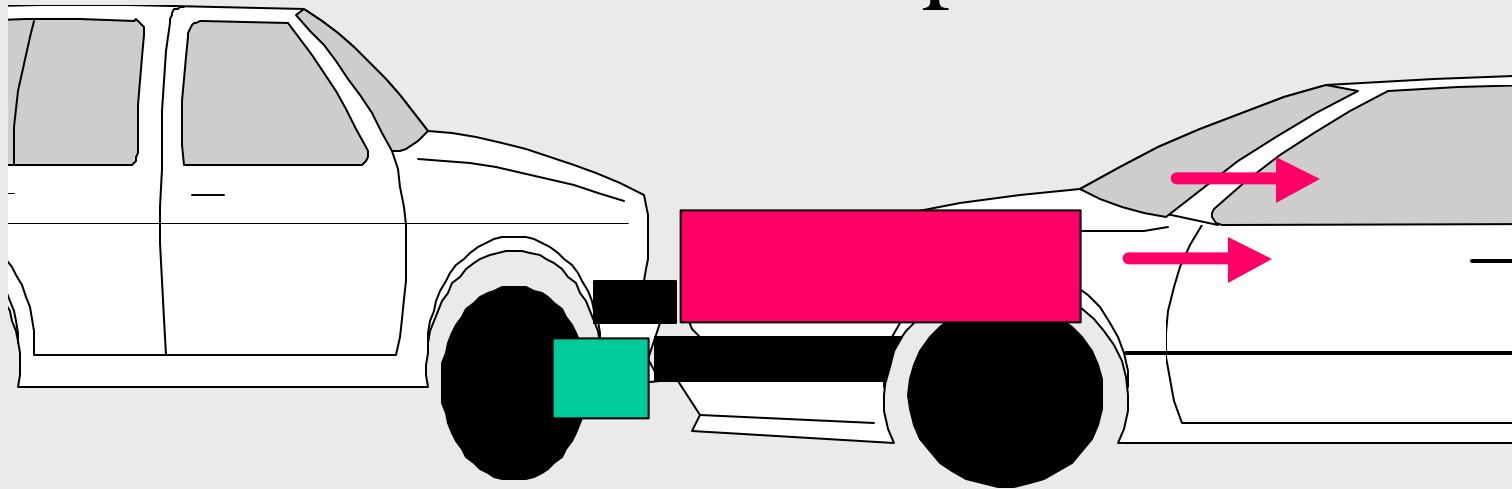
SUV-LTV vs. Sedan



Obvious mismatch in bumper
frame heights

SUV-Truck vs. Sedan

Override impact creates significant intrusion of instrument panel/hood

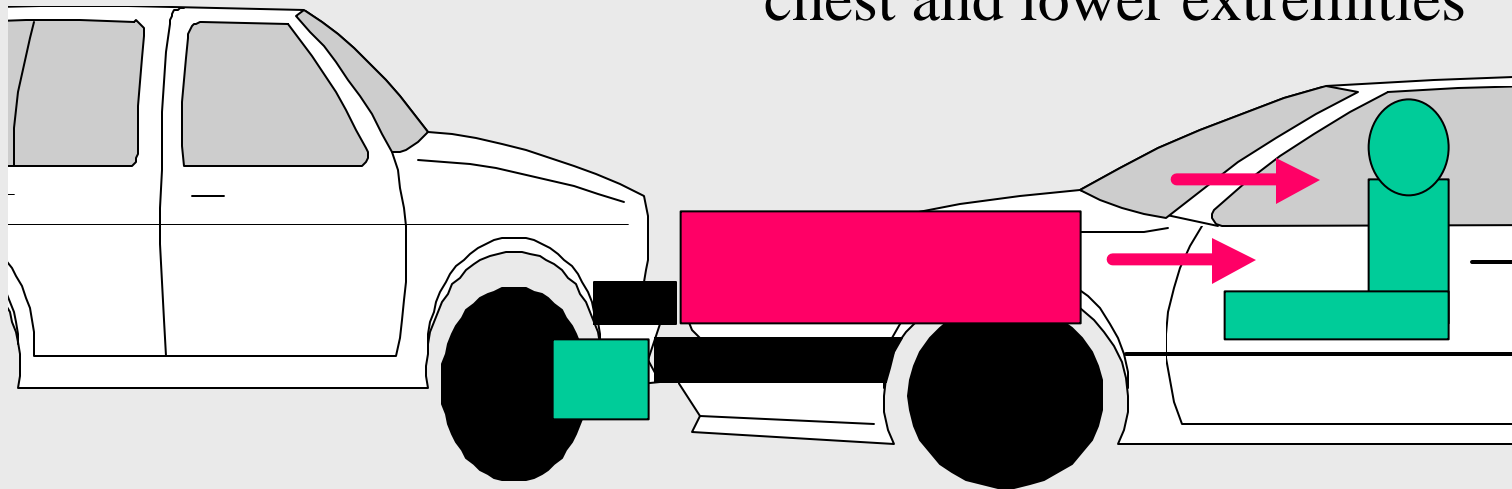


■ SUV bumper into grill of sedan

■ Sedan bumper into front tire/axle

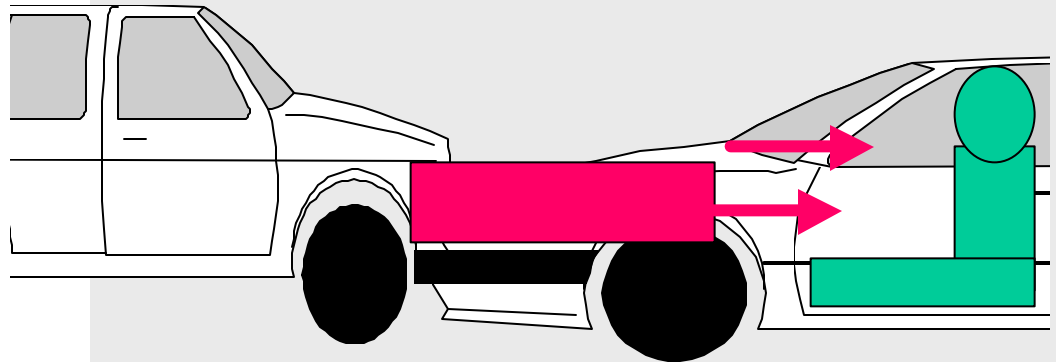
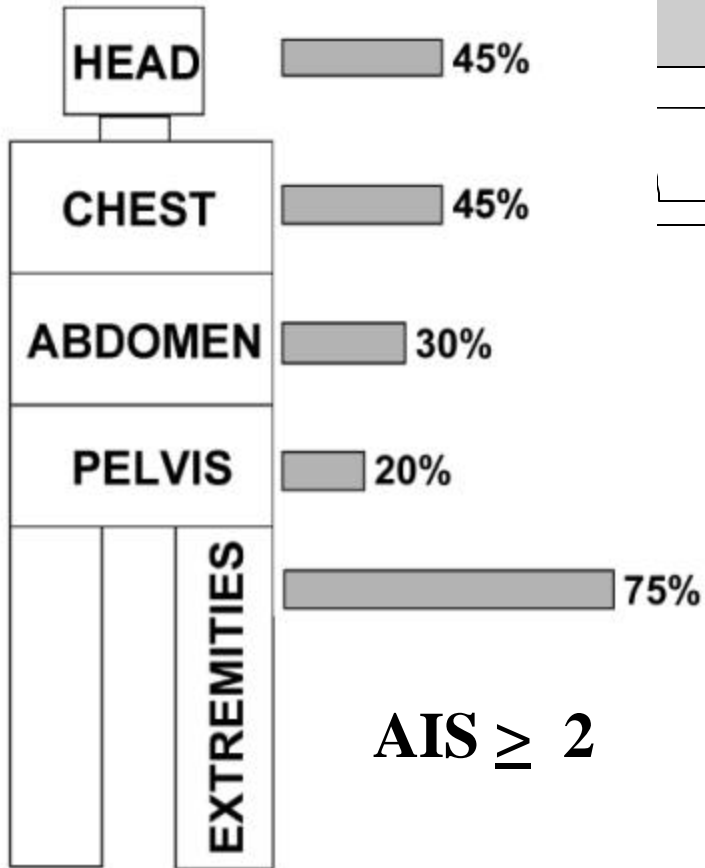
SUV-Truck vs. Sedan

Longitudinal intrusion is created and impacts the head, chest and lower extremities



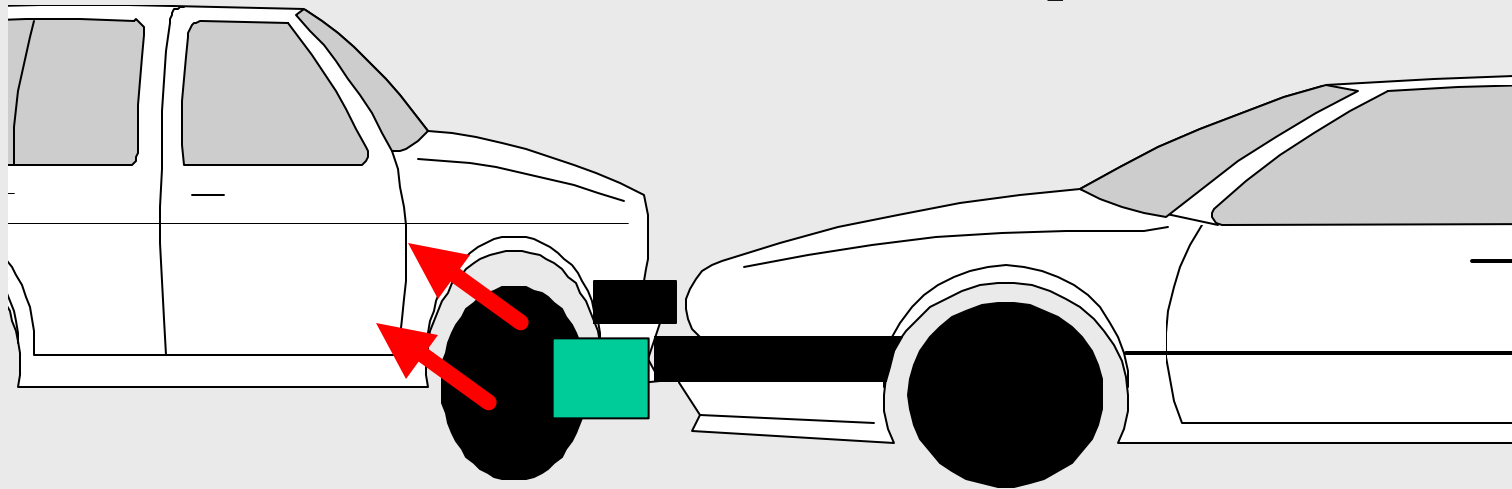
Front Passenger Vehicle into Front LTV

FRONT PV

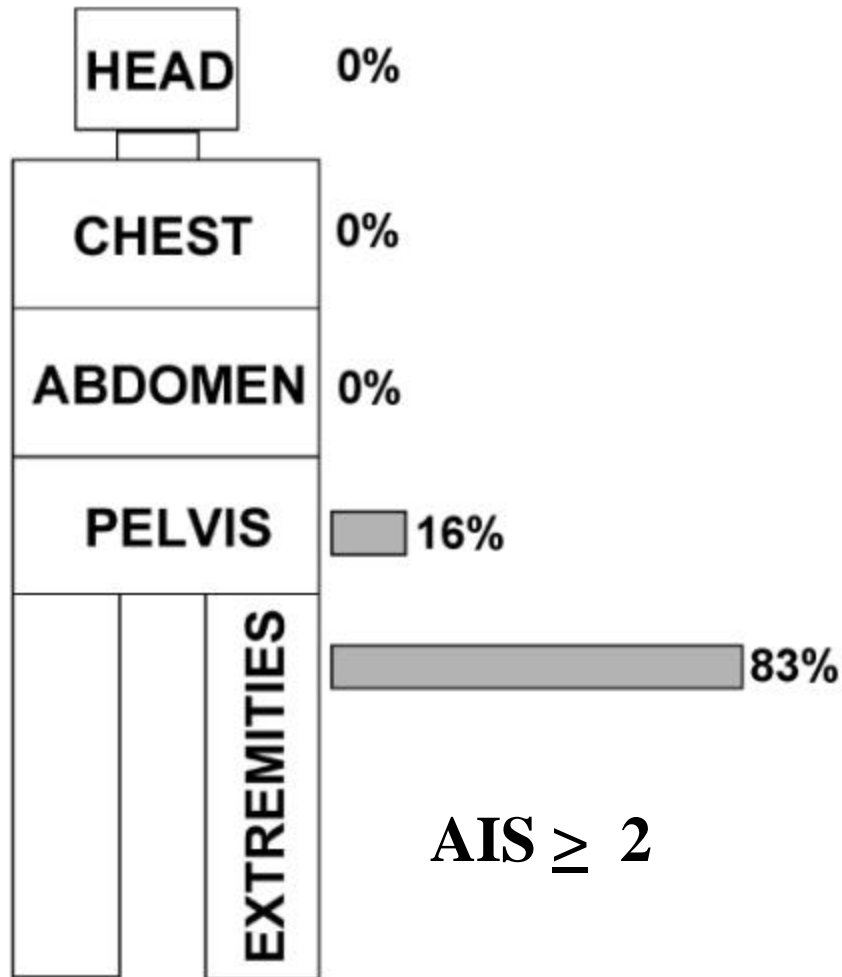


SUV-Truck vs. Sedan

Passenger bumper frame impacts the SUV tires and axle which become forced into the floor and toe pans

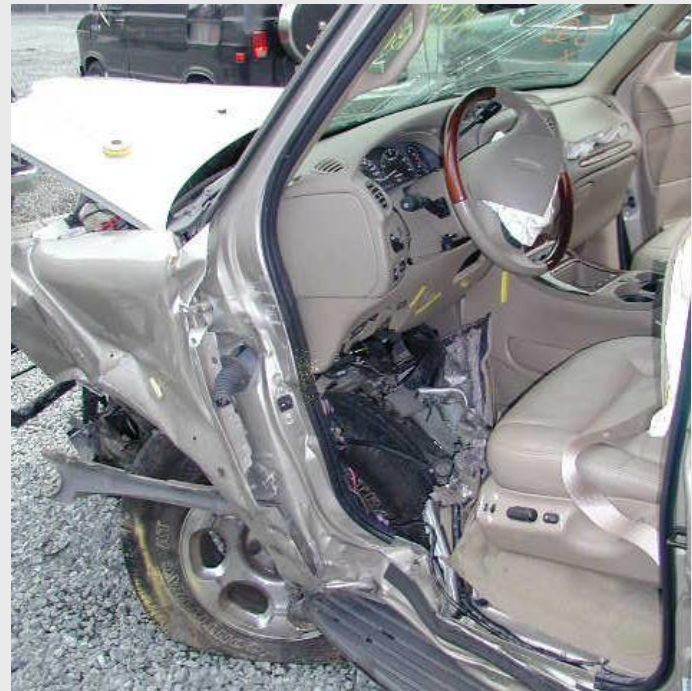


FRONT LTV

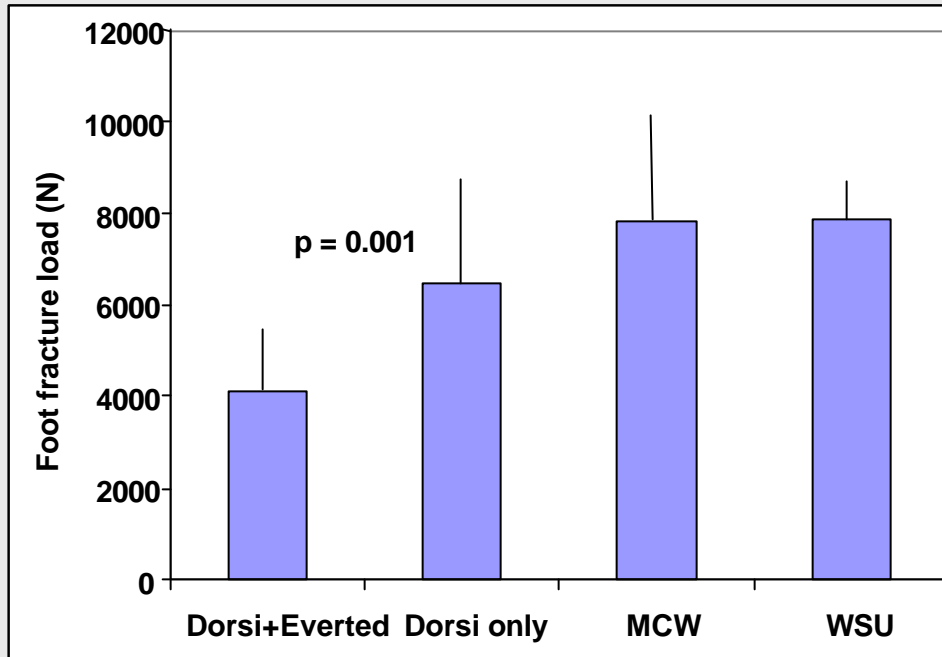


Front LTV into
passenger vehicle

6 cases - all PVs had at
least one fatality



Assal M, Huber P, Tencer A, Rohr E, Mock C, Kaufman R.
Are drivers more likely to injure their right foot or left foot in a
frontal car crash: a crash and biomechanical investigation.
Annu Proc Assoc Adv Automot Med, 46: 273-288, 2002



Conclusions

- The foot position (eversion/inversion v neutral) should be considered as another variable in estimation of compressive impact force tolerance
- Toe pan intrusion is directly related to fractures of the foot

Side Impact Vehicle Mismatch Case Reviews

Side Impact - Vehicle Mismatch



- Front Seat Passenger
- Elderly person
- Lap/Shoulder belt
- Struck by a large pickup
- Lateral Direction of Force

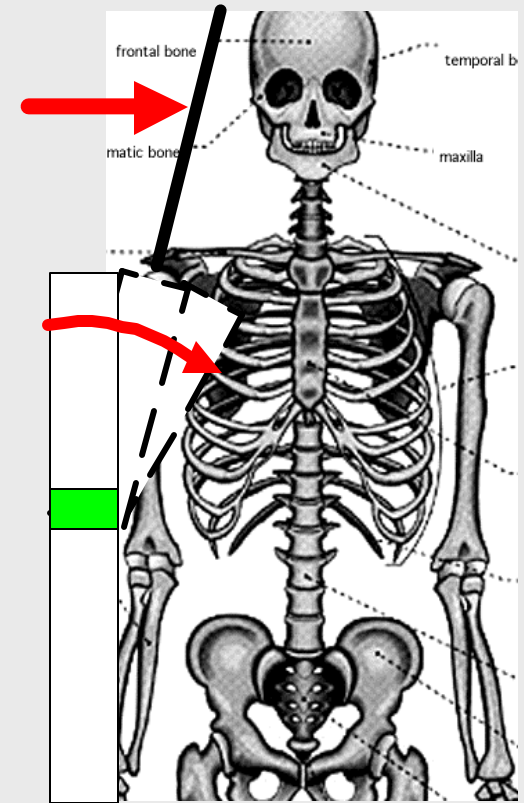
Upper door panel intrusion Override of support beams



Toyota Corolla struck by large pickup truck

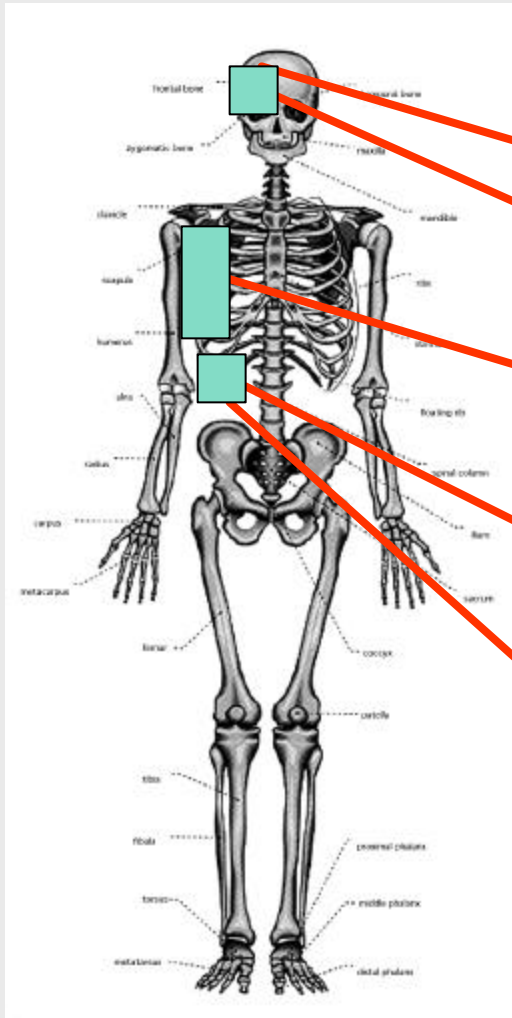
Upper door panel intrusion

Case review



End View

Injuries



AIS

2

3

4

2

2

Region

Head

Head

Chest

Abdomen

Abdomen

ISS = 29



CIREN Case Review

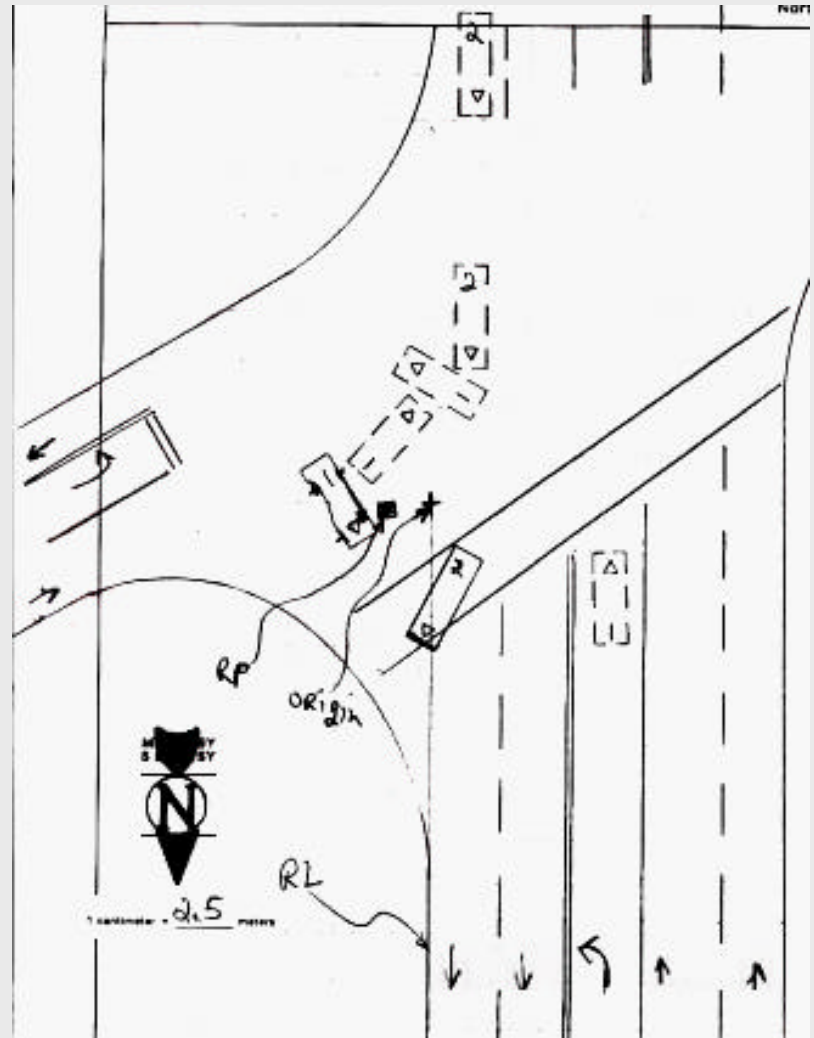


90's Ford

20 mph Delta V

PDOF = 60

Struck by large pickup



Critical Head Injuries

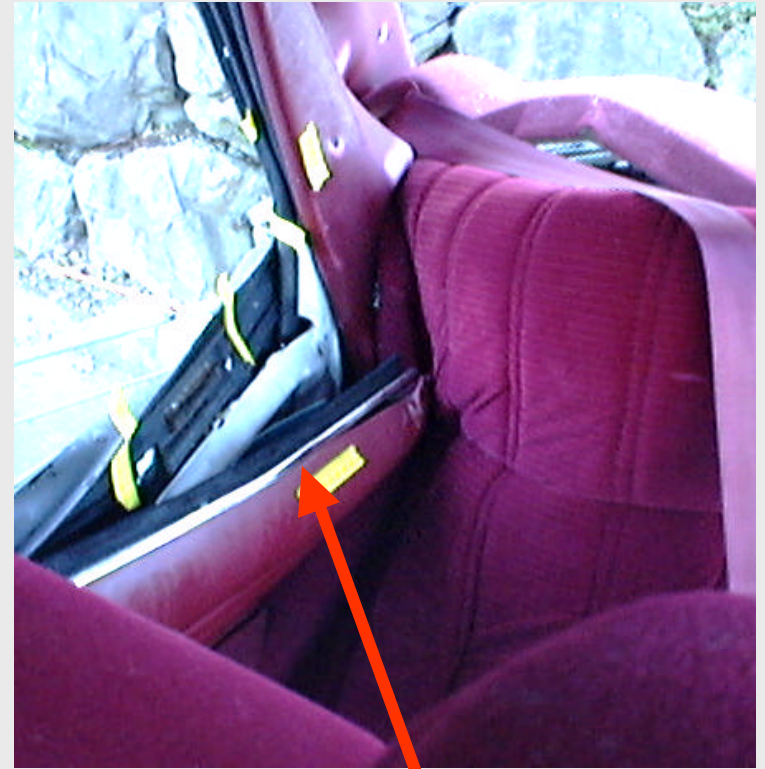
Side Impact Case review



Child

Back right seat - fully restrained

Sleeping with head against door

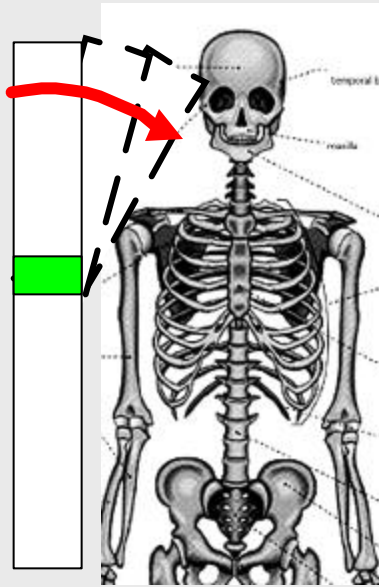


40 cm of intrusion at door panel, window sill

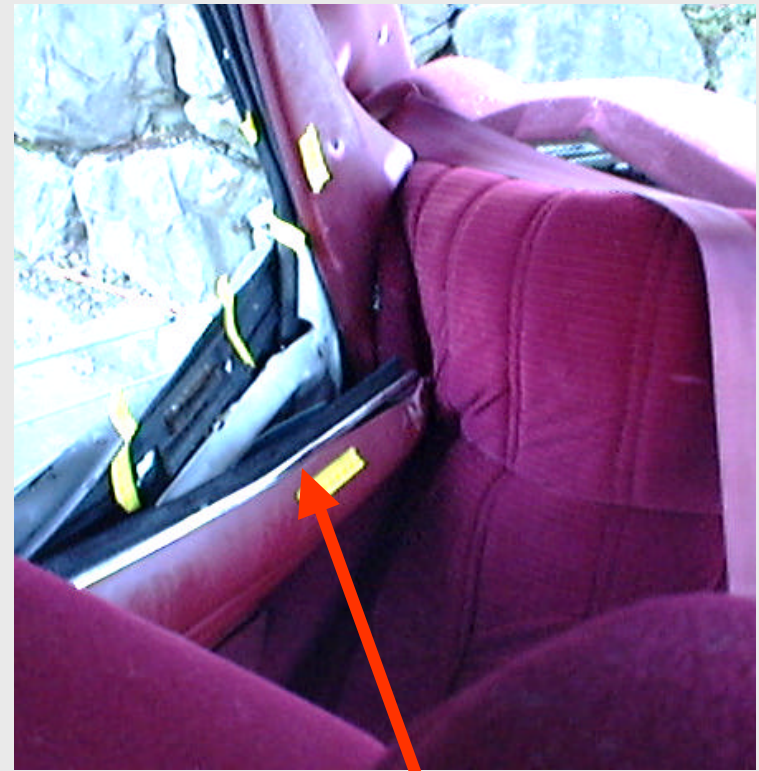
Deformation from head contact

Head Injury Summary

- Serious Brain Injury, AIS = 5



End View

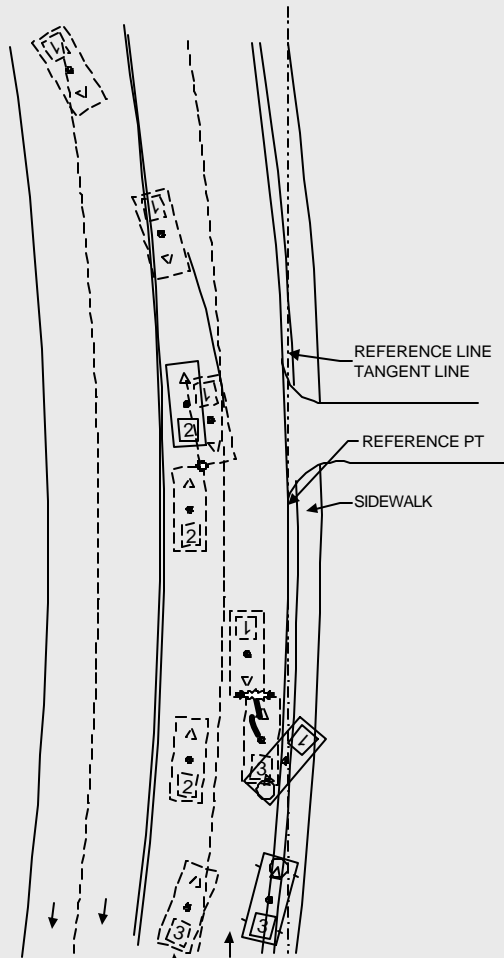


40 cm of intrusion at door panel, window sill

Deformation from head contact

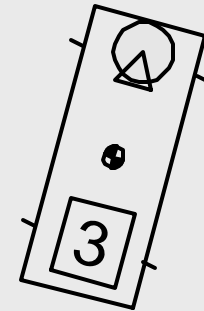
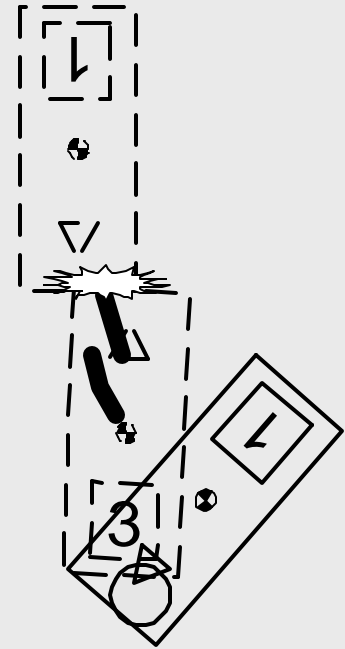
Frontal Offset Case Review

SUV vs. Minivan



V1- 80's SUV

Subject V3 - 90's Van



Posted Speed limit = 30 mph

SUV vs. Minivan



90's Van

Delta V = 27 mph



Offset = 63%

Demographics/Intrusions

Driver - Mid 30's Female.

Restraints:

_____Lap/shoulder belt

Airbag

Deployment

Driver Area Intrusions

Toe pan = 45 cm

Instr.Panel = 42 cm

A pillar = 52 cm

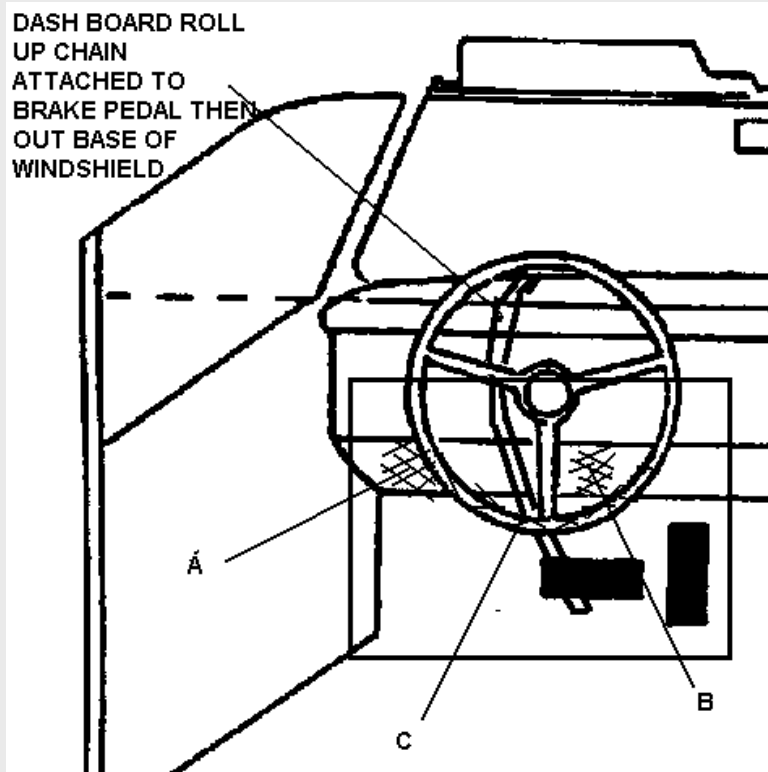
Windshield = 24 cm

Kick panel = 18 cm

Steering col. = 15 cm



Driver Contacts



INJURIES

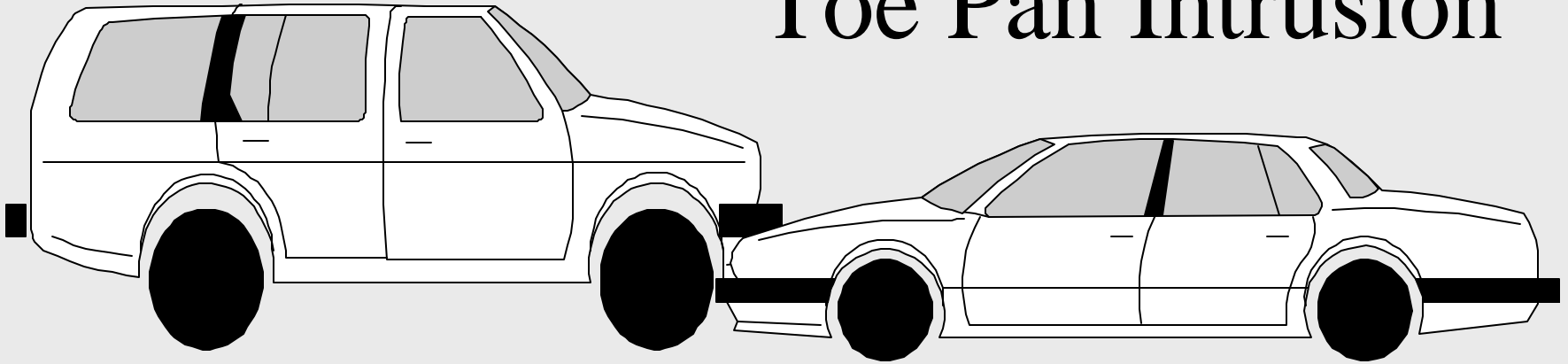
Left Mid-shaft Femur Fx

Right Mid-shaft Femur Fx

Both Knees contacted into bolster area
with severe intrusion

Offset Frontal Case Review

Toe Pan Intrusion



Late Model

Lincoln Navigator

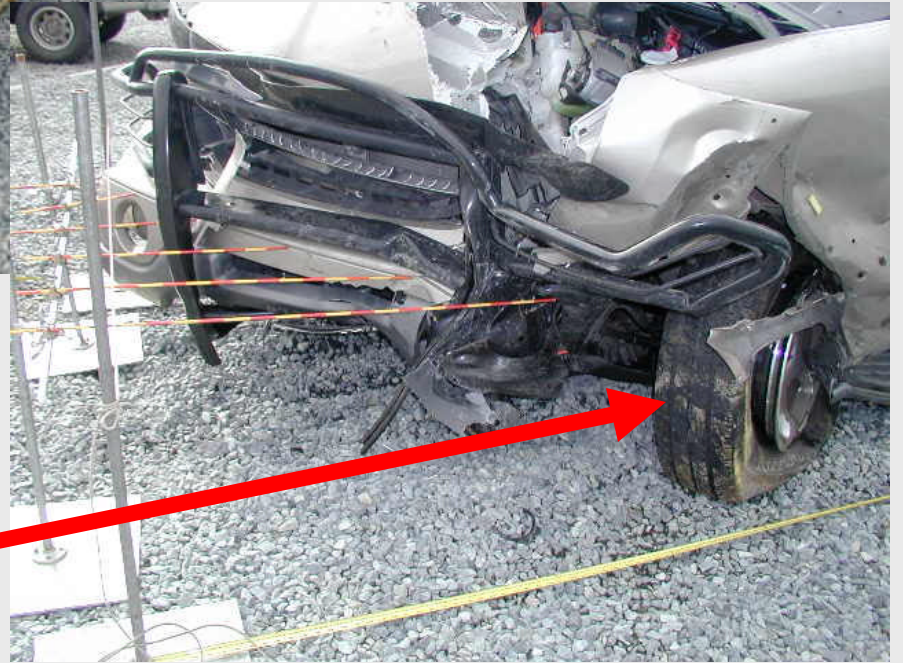
Late 90's compact
Driver fatally injured

Subject Driver

50's Female

Manual Lap/shoulder belt

Deployed Frontal and Side airbags



Impact to front left tire

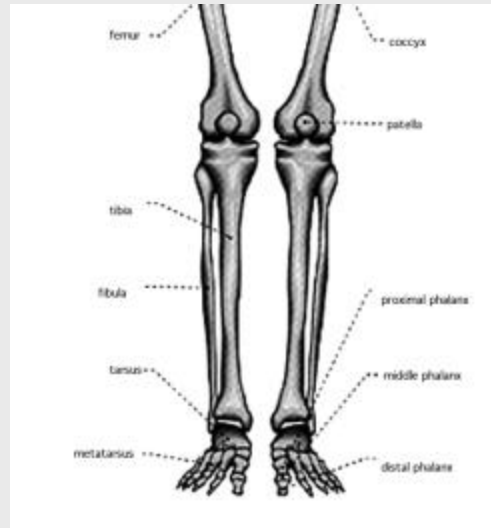


55 cm (21") longitudinal intrusion of toe pan

Injury summary

Right Foot

- Multiple fractures to the foot and ankle



Left Foot

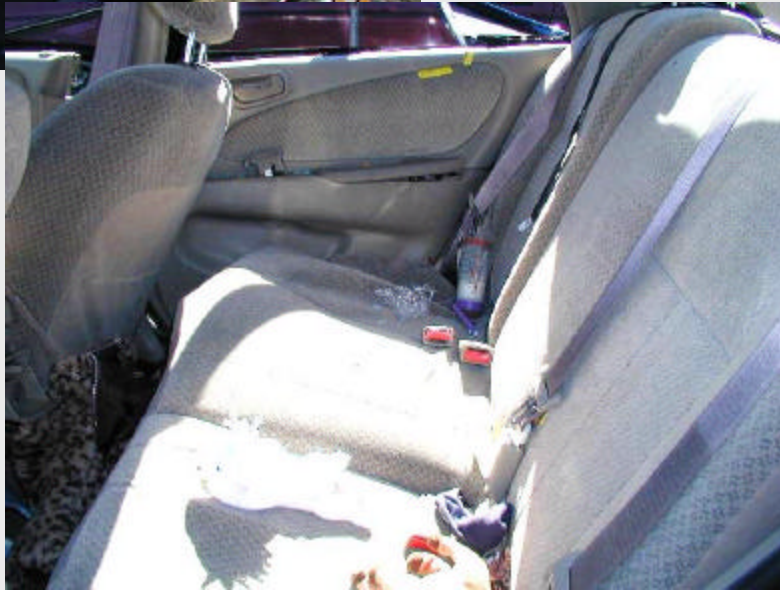
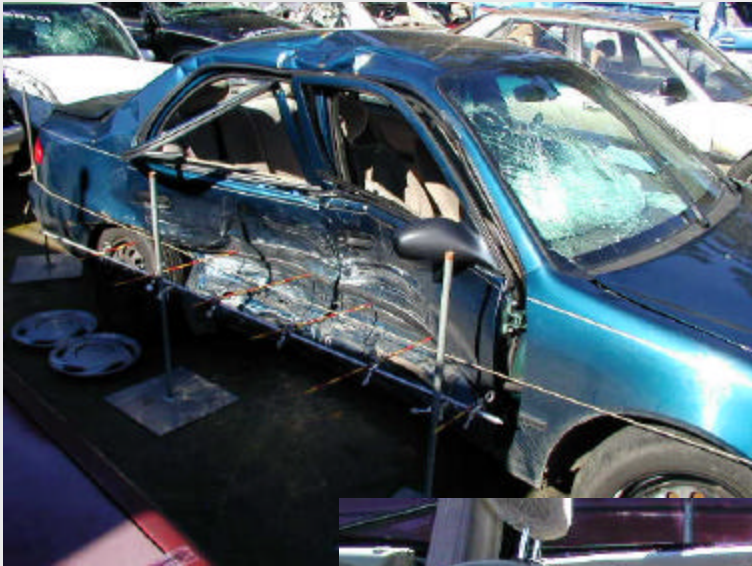
- Multiple fractures to the foot and ankle

Vehicle Mismatch Impacts

Preventive Measures

documented from CIREN research

Side impact with child in booster seats



Minimal
Head
Injury



Head positioned
above door interior

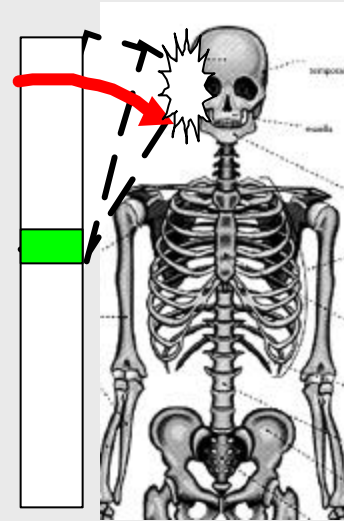


Side
Airbags
Provide
Head and
Chest
Protection

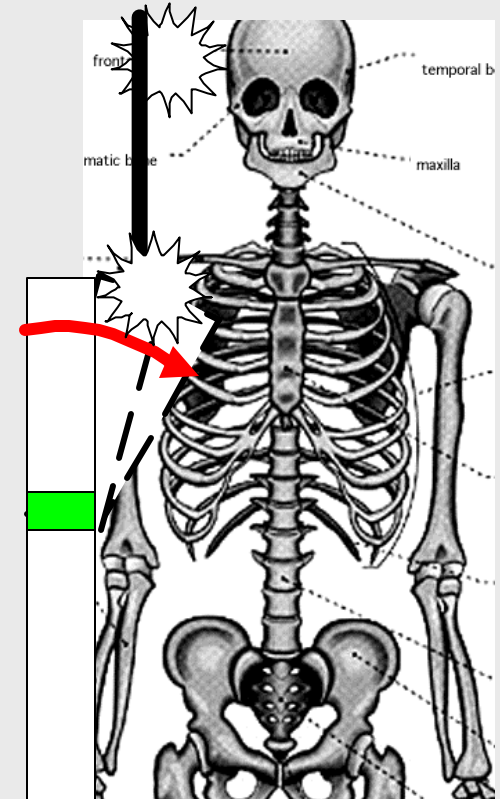
Mismatch side impact assessment of injury severity and mechanism



Intrusion = Injury

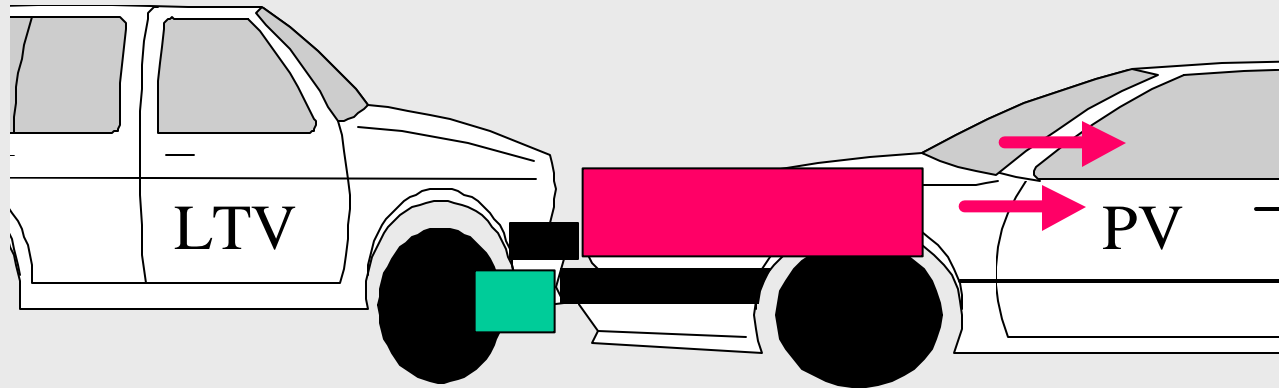


Children - Head injury mechanism



Adults - Head and Chest Mechanisms

Mismatch Frontal Impact Assessment for Injury Severity



LTV toe pan intrusion and lower extremity (foot) fractures/injuries



PV instrument panel intrusion and chest and lower extremity injuries

Thank you