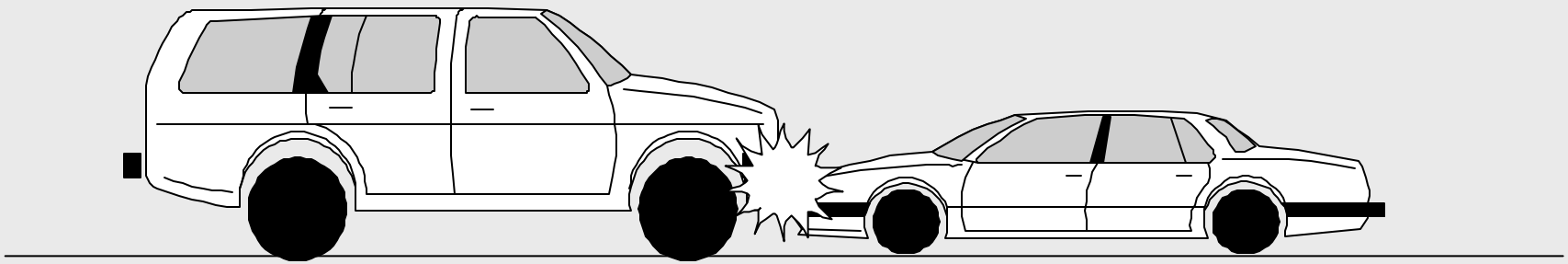
Crash Injury Mechanisms in Vehicle Mismatch Collisions



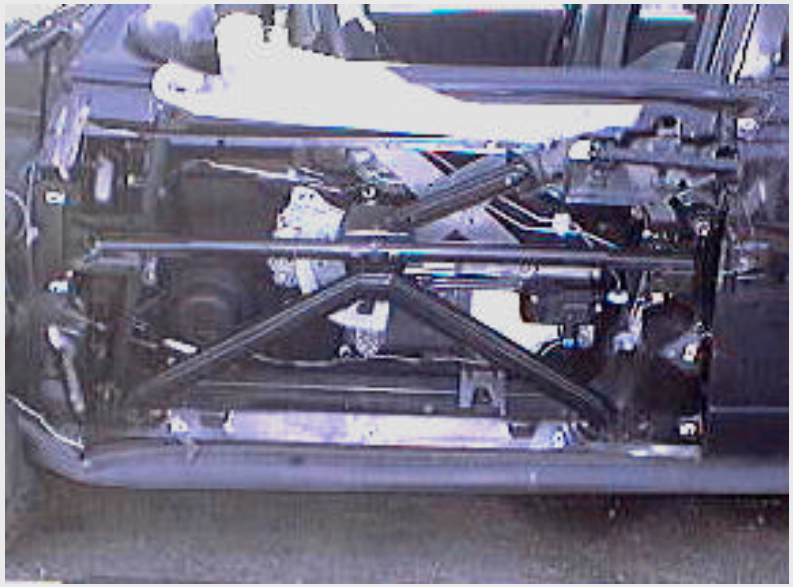
Presenters: Stephanie Acierno, MD
Rob Kaufman, BS

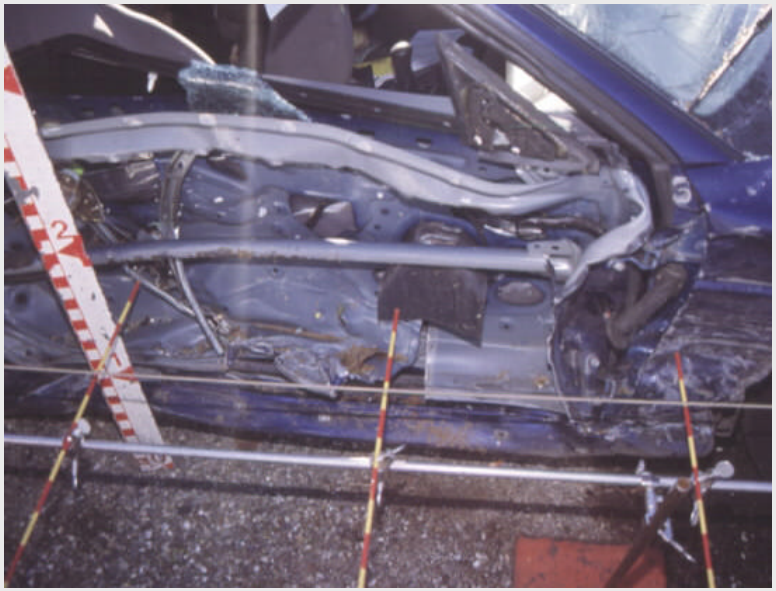
CIREN Seattle

HARBORVIEW INJURY PREVENTION AND RESEARCH CENTER

HARBORVIEW MEDICAL CENTER

Side impact standard improvements (SS214)





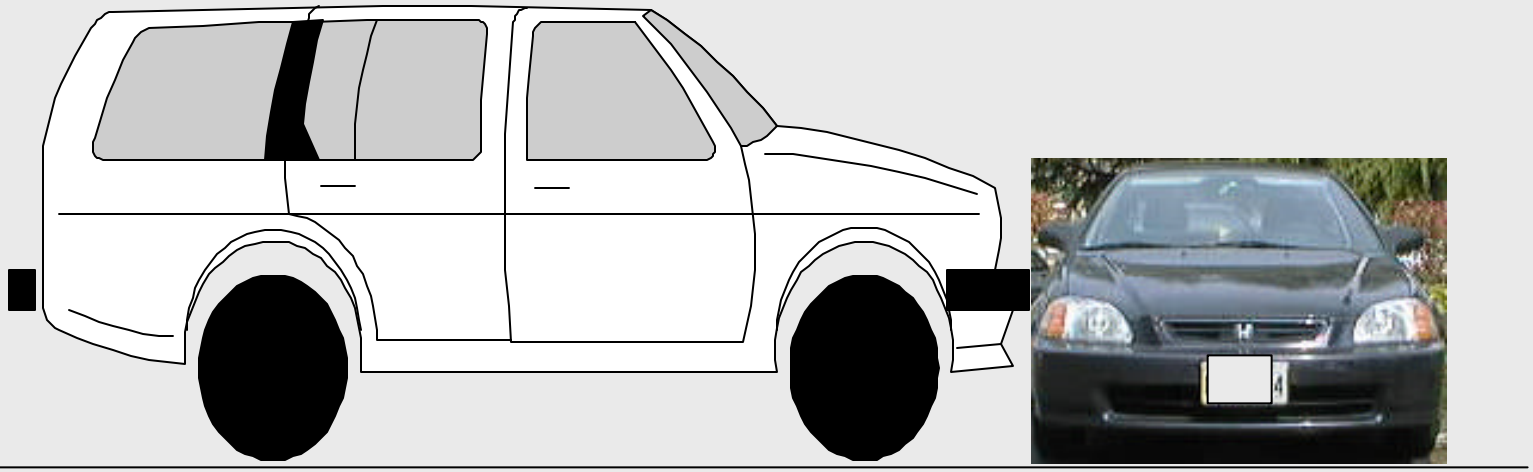
Use of side impact beams in doors

Protection from side impact beams

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

Striking vehicle

Larger Vehicle and Side Impacts

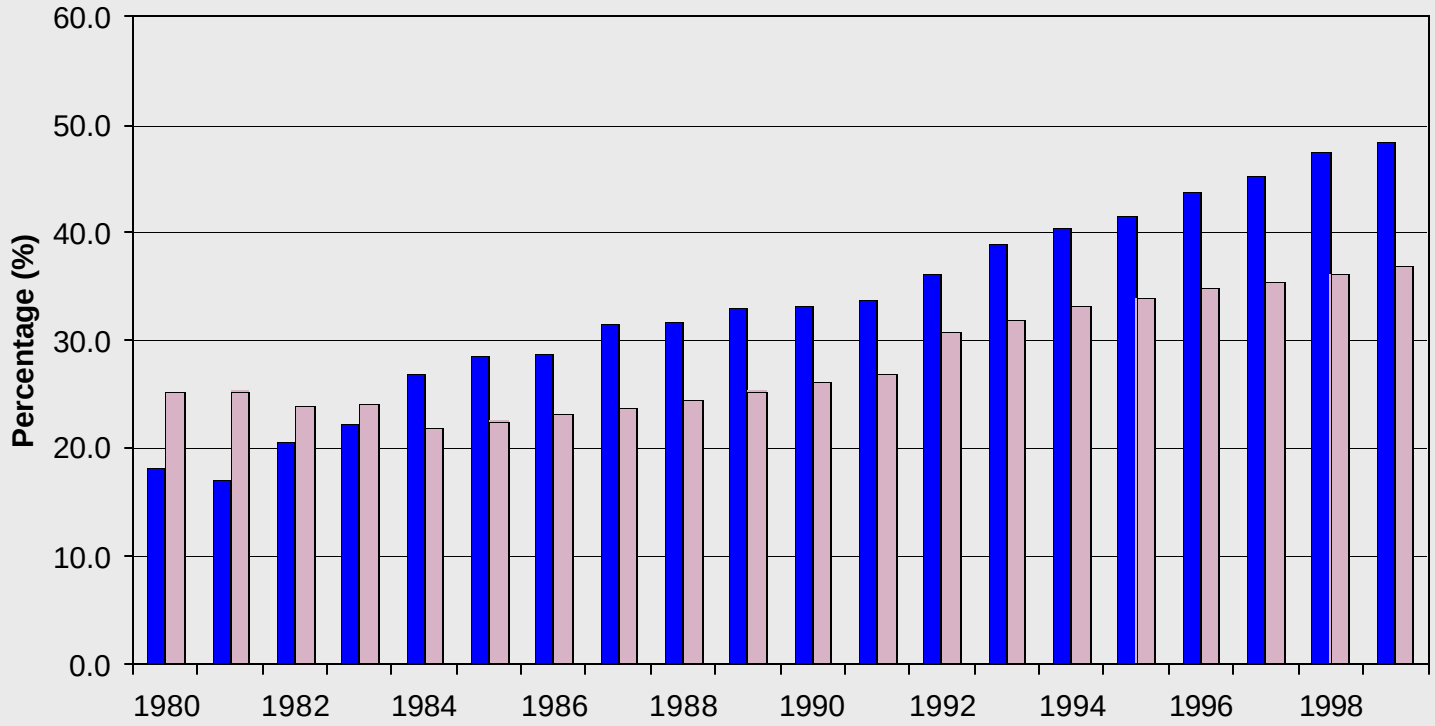


Subdivisions vs. compact/economical

Some bumper heights are overriding the side impact supports

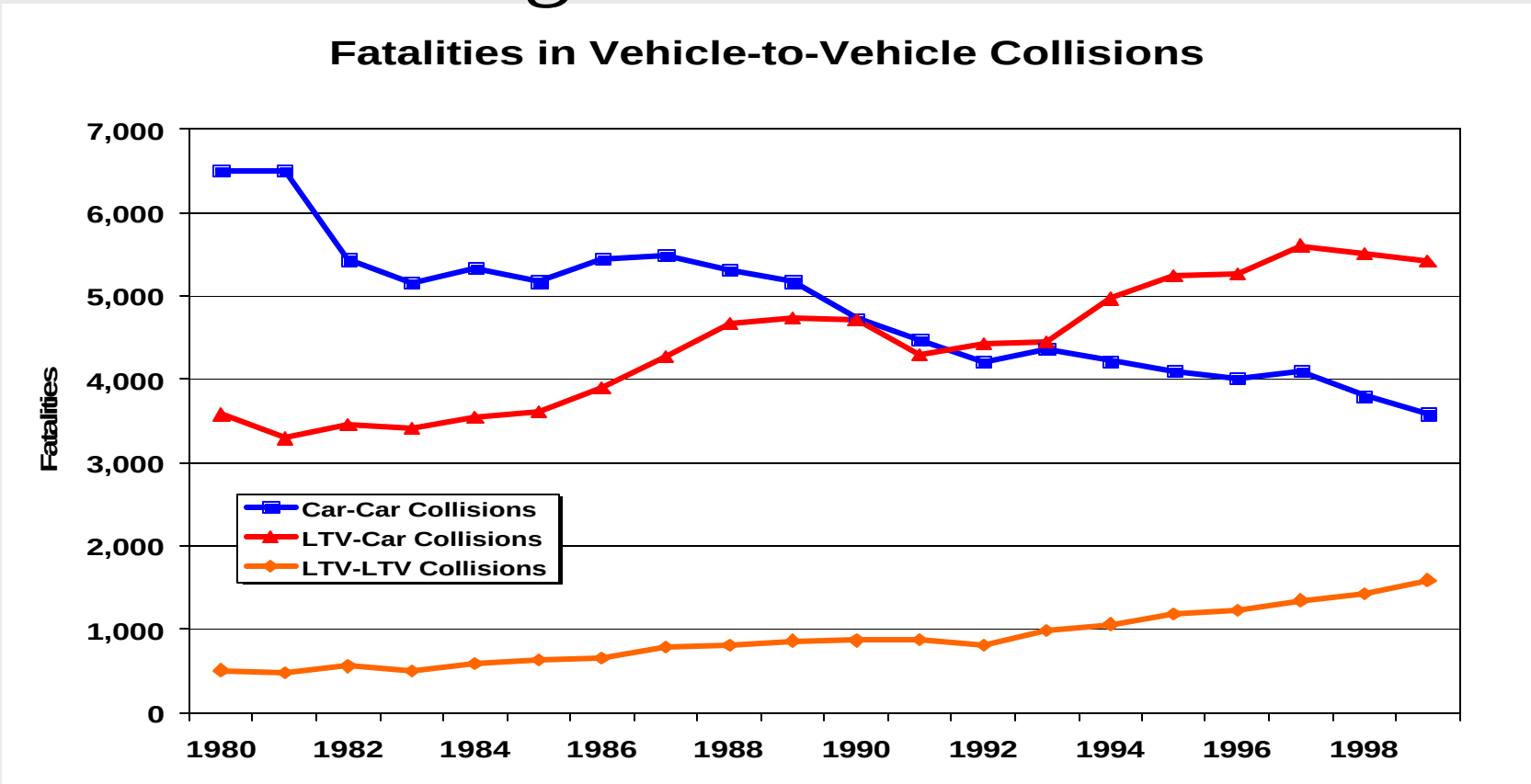
Increasing LTV-Car Fatalities

U.S. Sales and Registrations of Light Trucks and Vans



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

Increasing LTV-Car Fatalities



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

Seattle CIREN team research on incompatibility

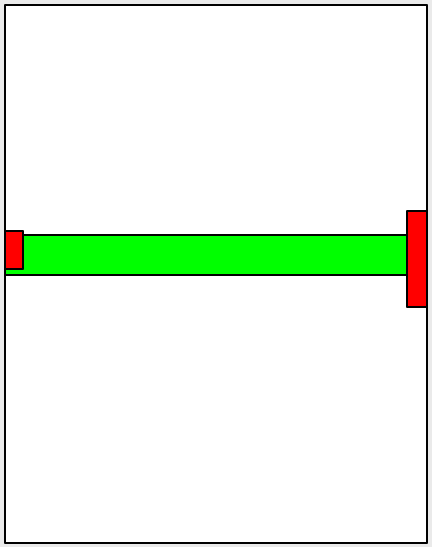
Current Publication submitted:

"Vehicle Mismatch: Injury Patterns and Severity", Acierno, Kaufman, Rivara, Grossman, Mock

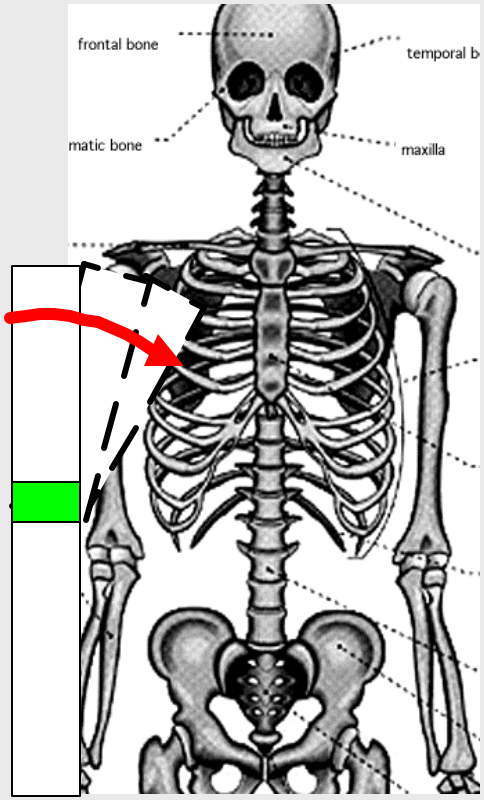
Reviewed and selected cases from 200 Seattle CIREN:

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

Side impacts with larger vehicles with lateral door support beams



Side View



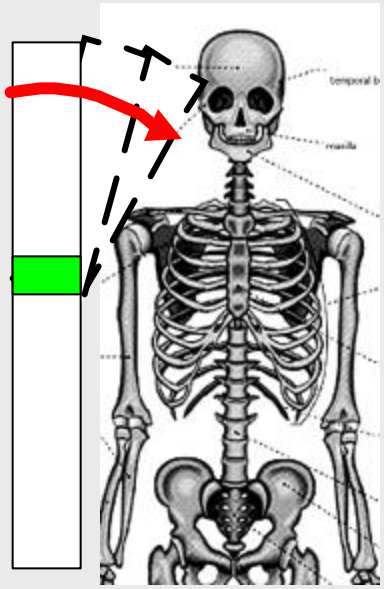
End View

Intrusion = Injury

Adults -Think Thorax!!

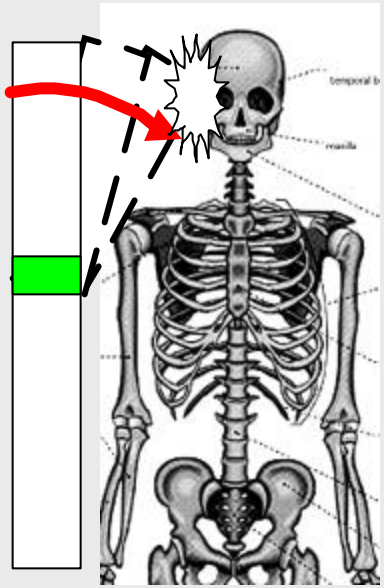
Children- Think head

This becomes head contacts for children

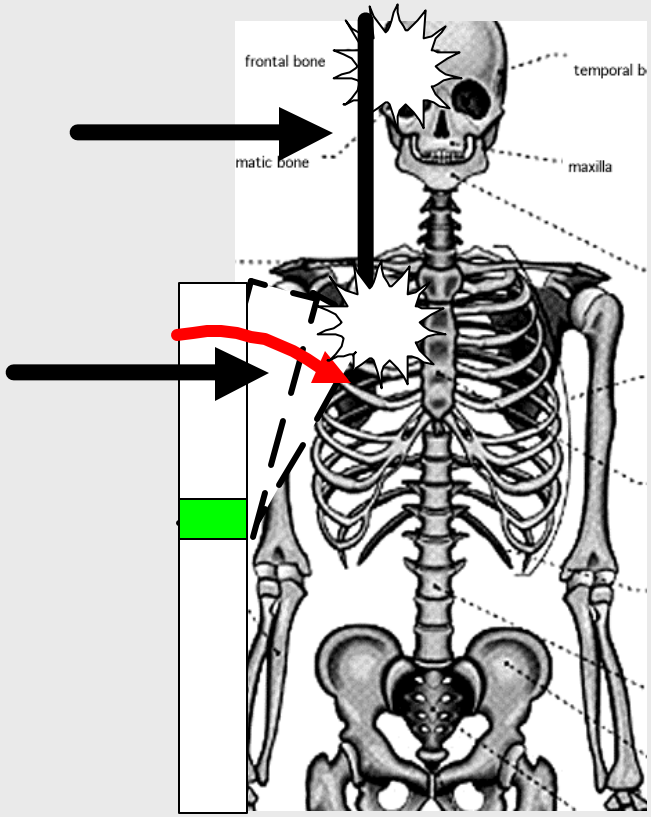


End View

Mismatch Side Impact Injury Patterns



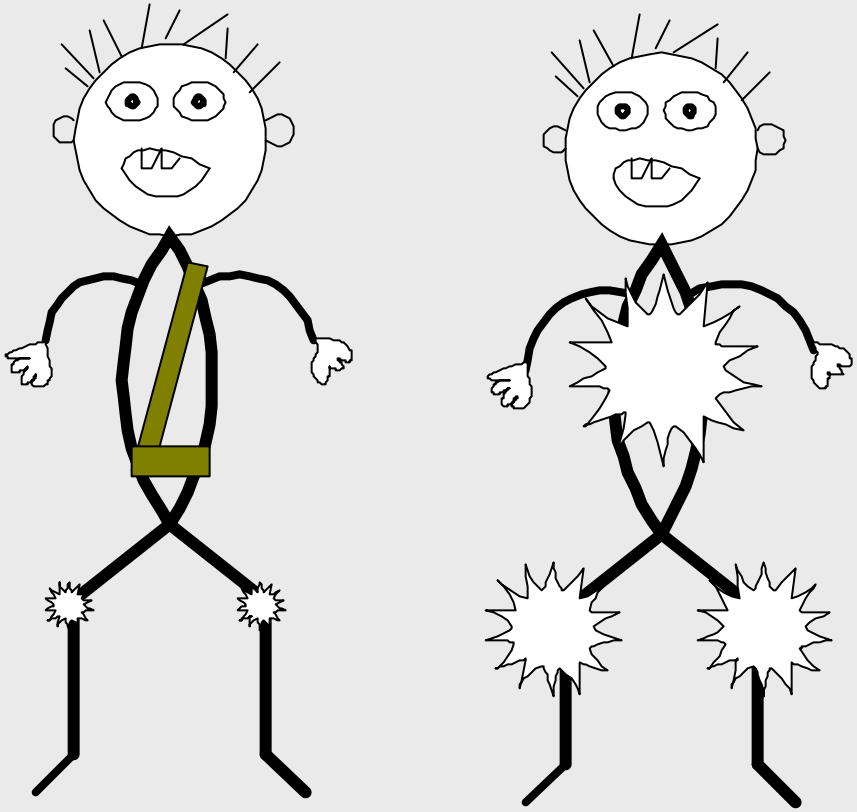
End View



End View

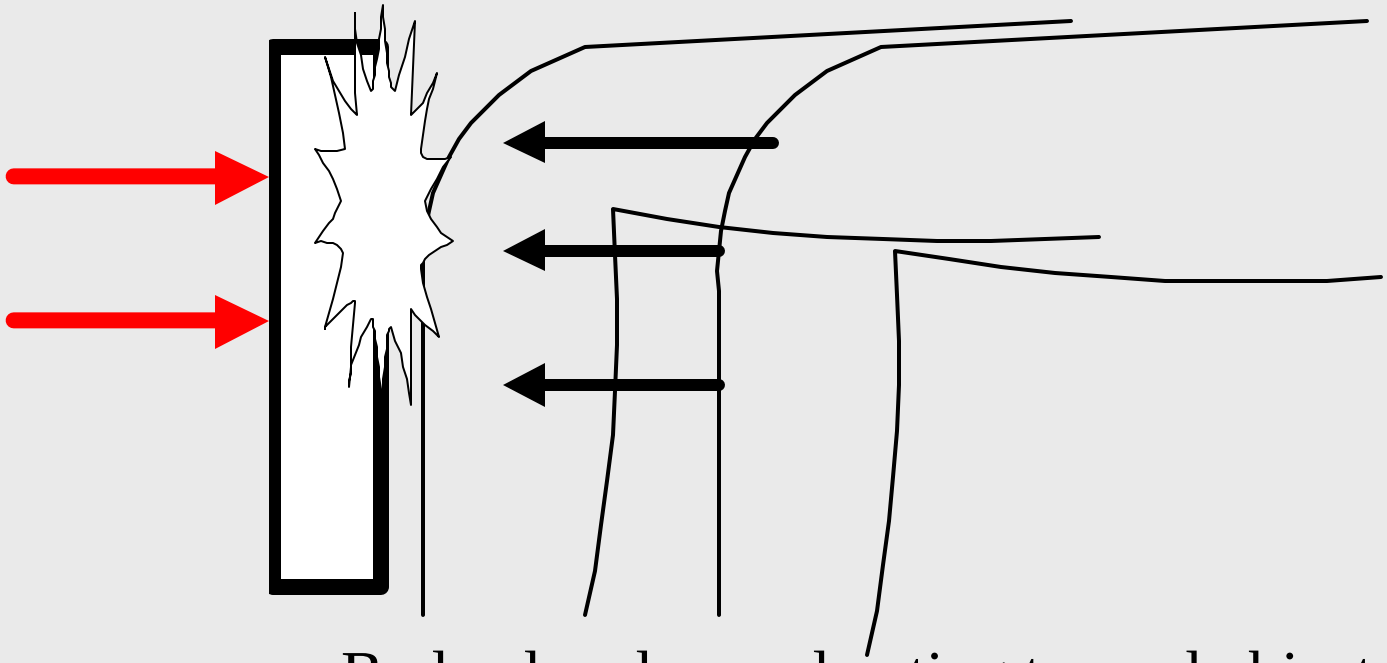
Frontal Impacts

Occupant energy distribution



Restrained vs. Intrusion or Unrestrained

Direct Contact Forces w/ Intrusion



- Body already accelerating toward object

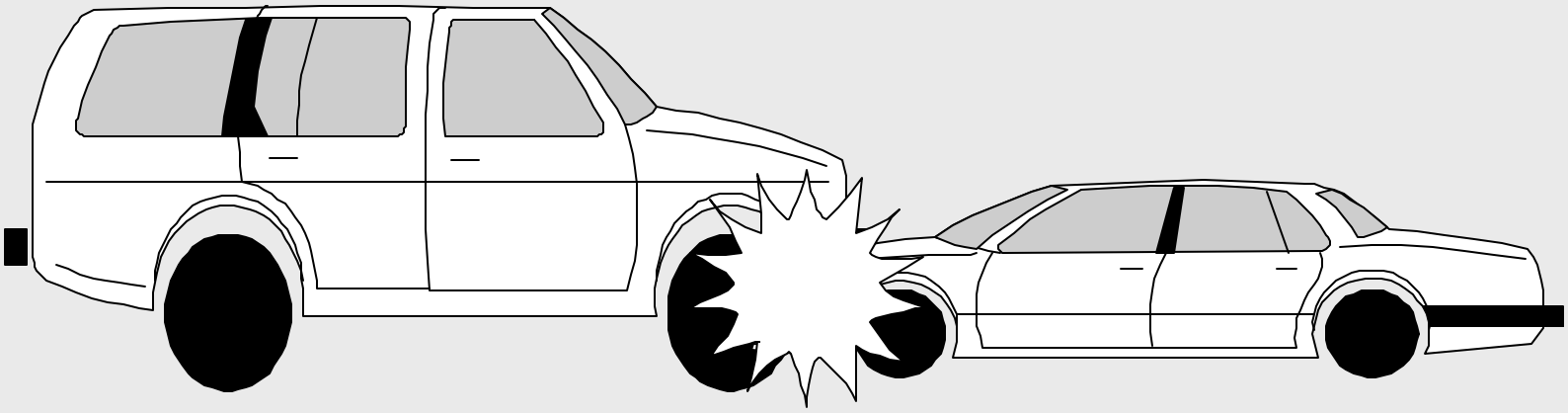
- Intrusion increases the forces loading on the lower extremities

Pre-crash

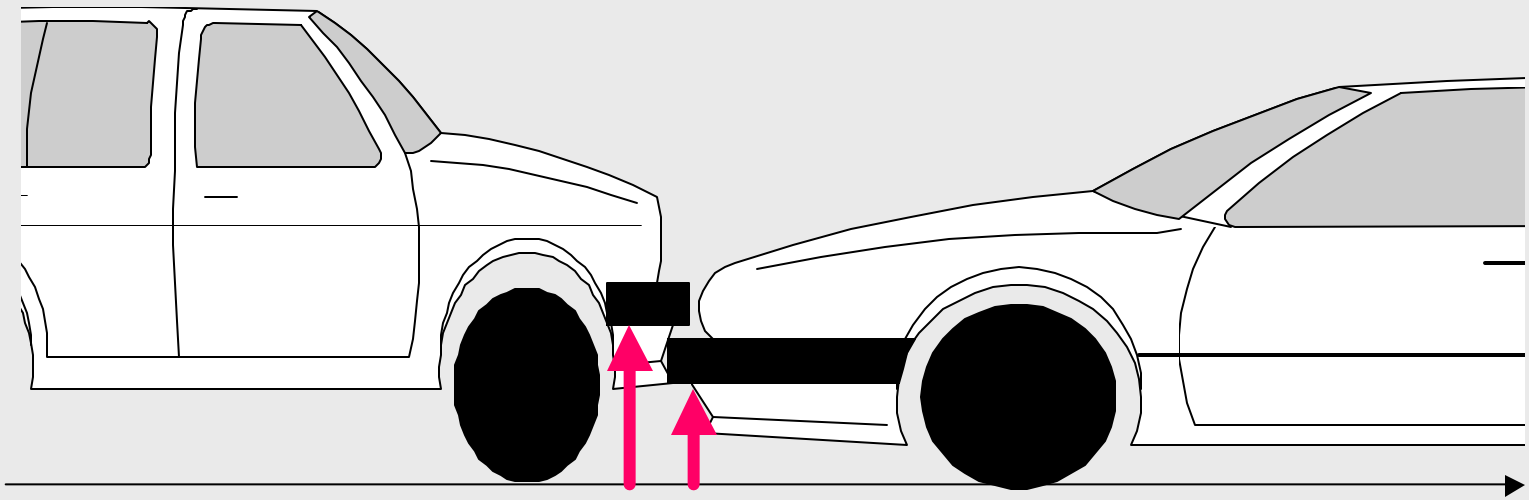
Post-crash

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

Offset Frontal Impacts with Vehicle Mismatch



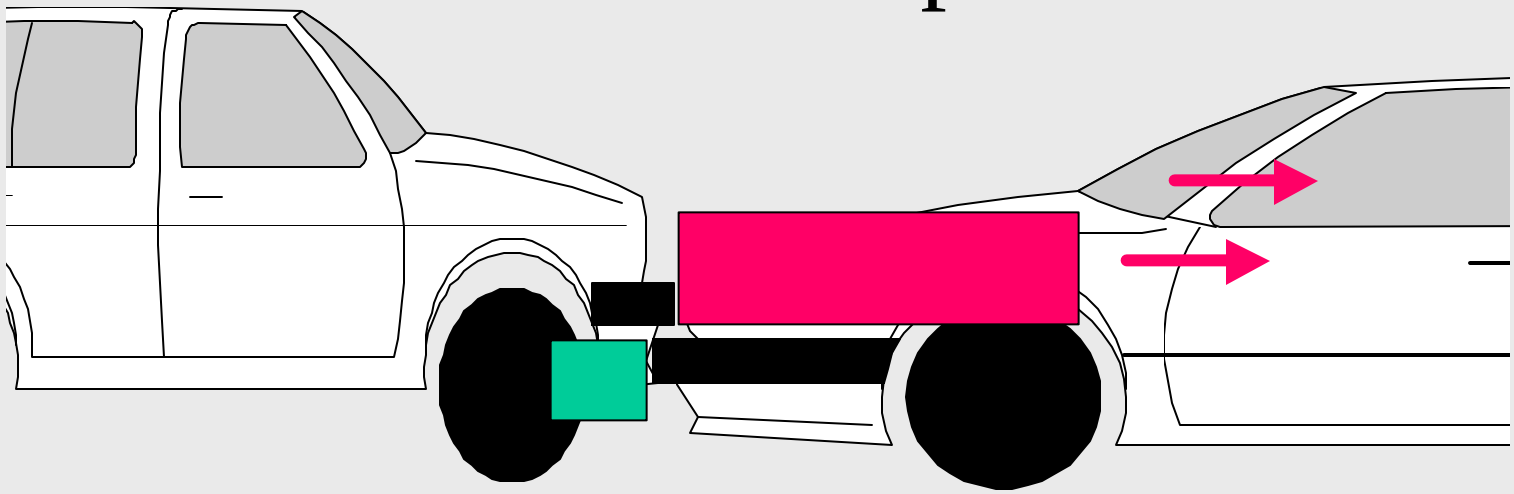
SUV-Truck vs. Sedan



Obvious mismatch in bumper heights, or bumper frame

SUV-Truck vs. Sedan

Override impact creates significant intrusion of instrument panel/hood

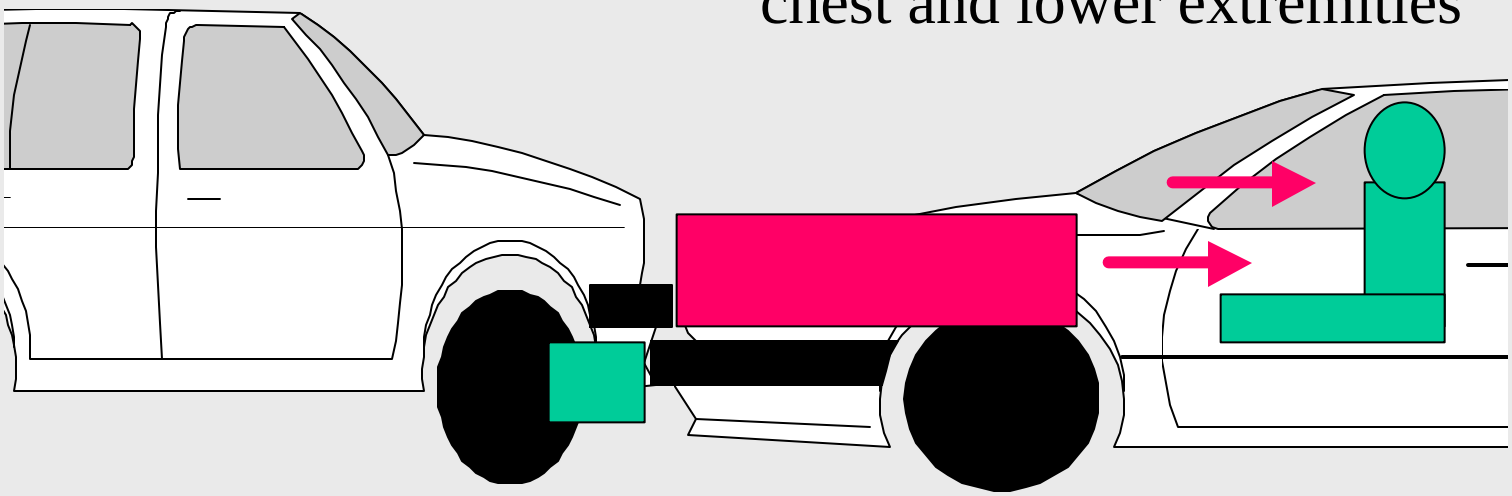


SUV bumper into grill of sedan

Sedan bumper into front tire/axle

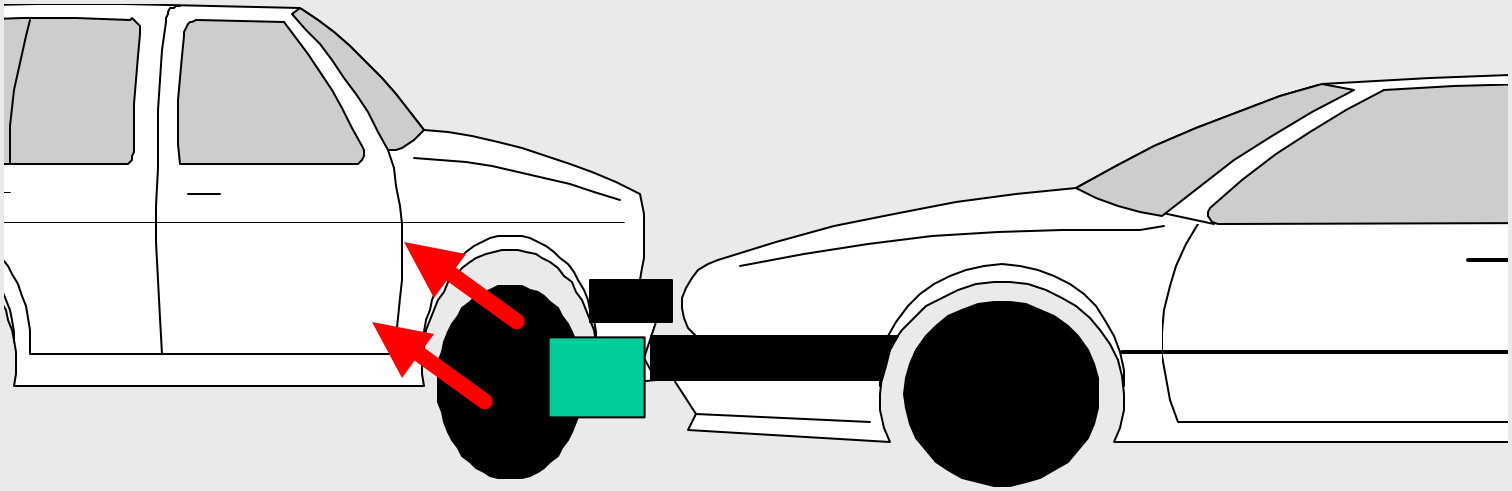
SUV-Truck vs. Sedan

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



SUV-Truck vs. Sedan

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



Side Impact Vehicle Mismatch Case Reviews

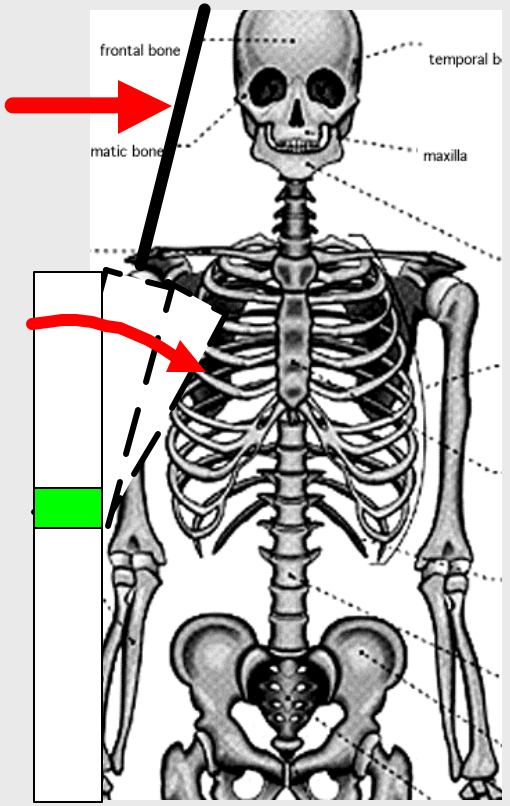
Side Impact - Vehicle Mismatch

- 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

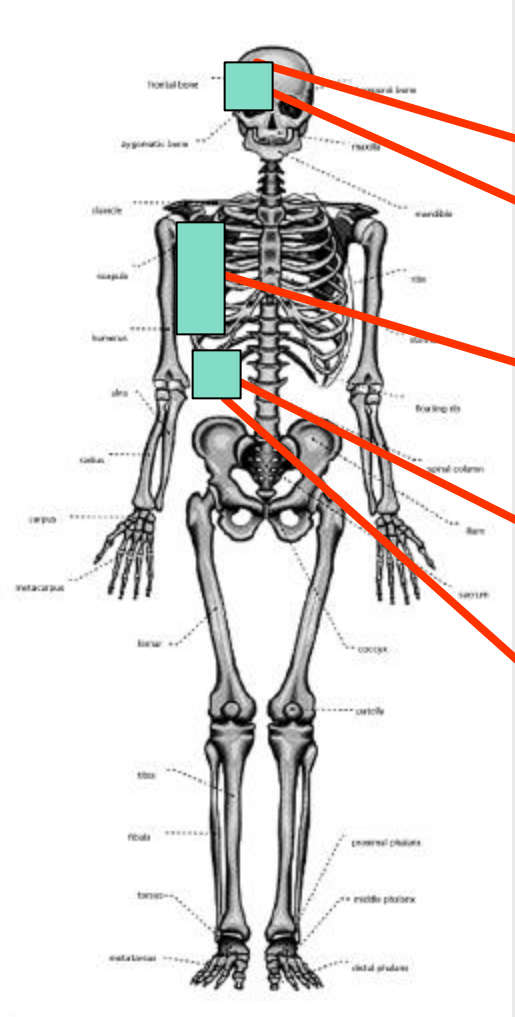
Toyota Corolla struck by large F250 pickup truck

Upper door panel intrusion Case review



End View

Injuries



AIS	Region
2	Head
3	Head
4	Chest
2	Abdomen
2	Abdomen

ISS = 29

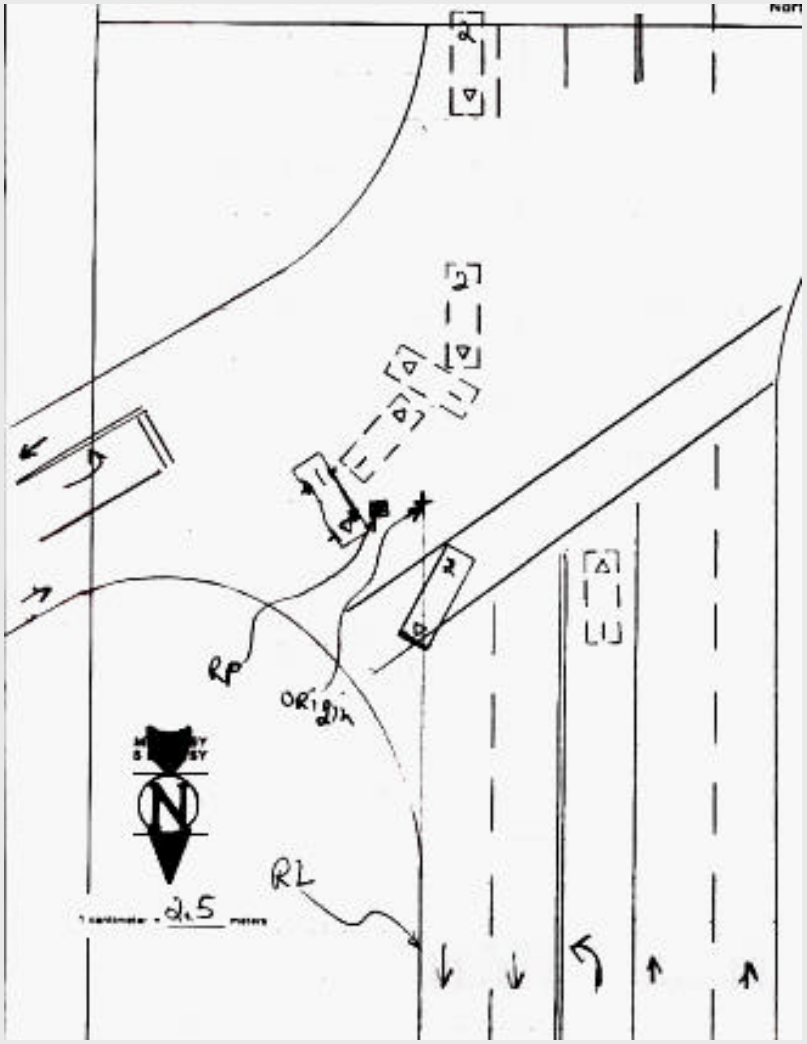
CIREN Case Review

90’s Ford

20 mph Delta V

PDOF = 60

Struck by large pickup

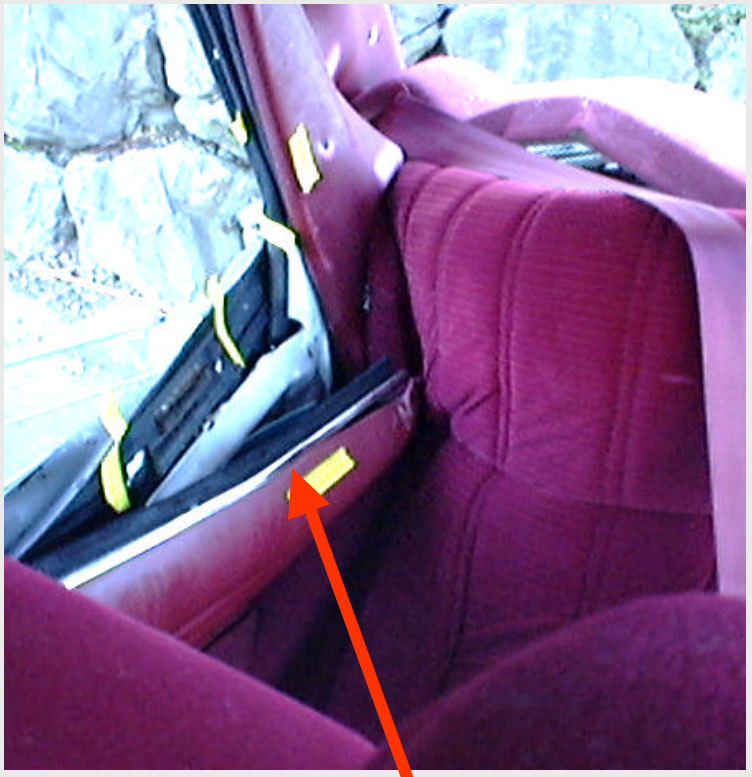


Critical Head Injuries
Side Impact Case review

Child

Back right seat - fully restrained

Sleeping with head against door

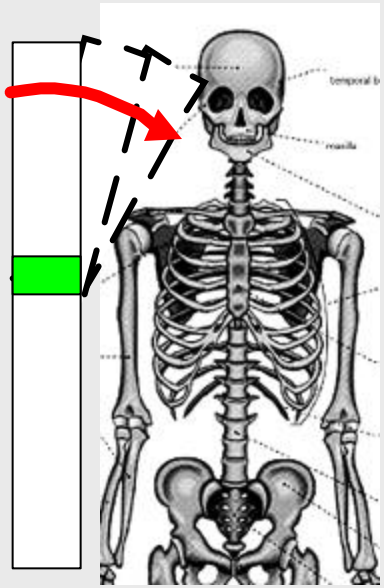


40 cm of intrusion at door panel, window sill

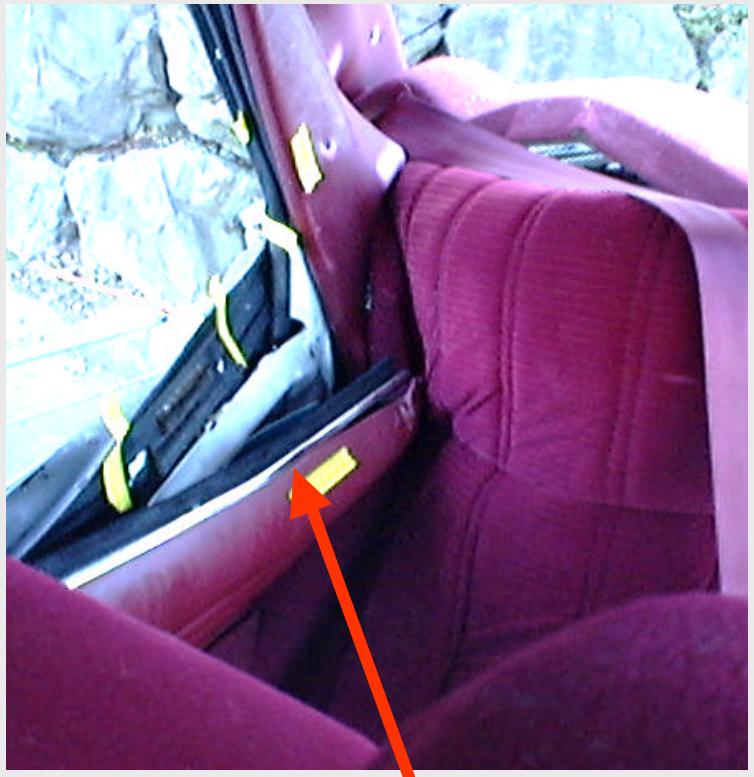
Deformation from head contact

Head Injury Summary

- Serious Brain Injury, AIS = 5



End View

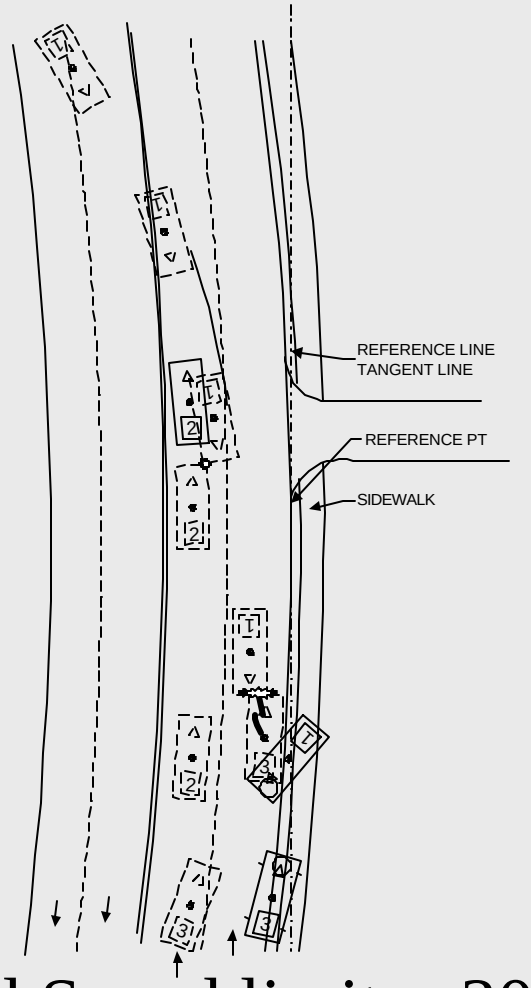


40 cm of intrusion at door panel, window sill

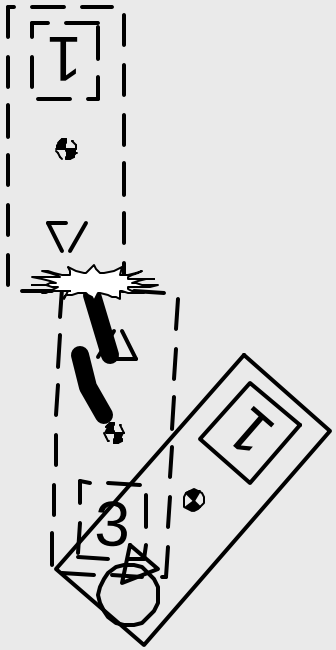
Deformation from head contact

Frontal Offset Case Review

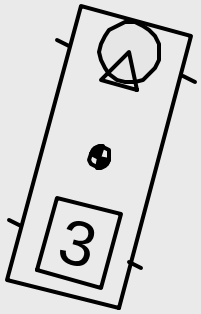
SUV vs. Minivan



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%

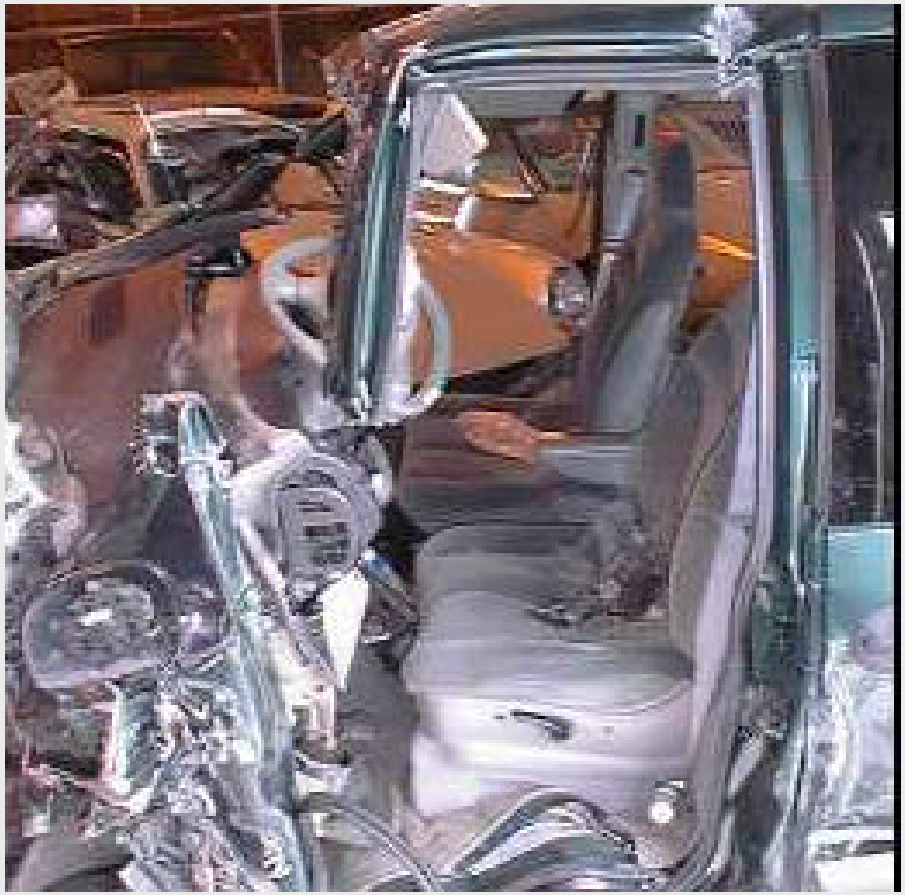
Demographics/Intrusions

<u>Driver</u> - Mid 30's Female.

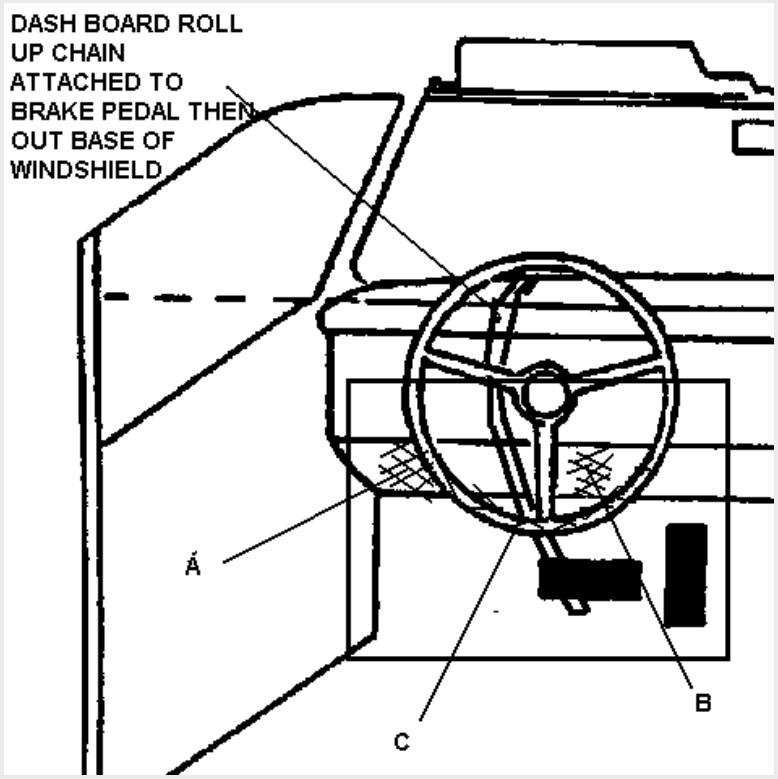
<u>Restraints:</u>
Lap/shoulder belt
Airbag
Deployment

<u>Driver Area Intrusions</u>

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



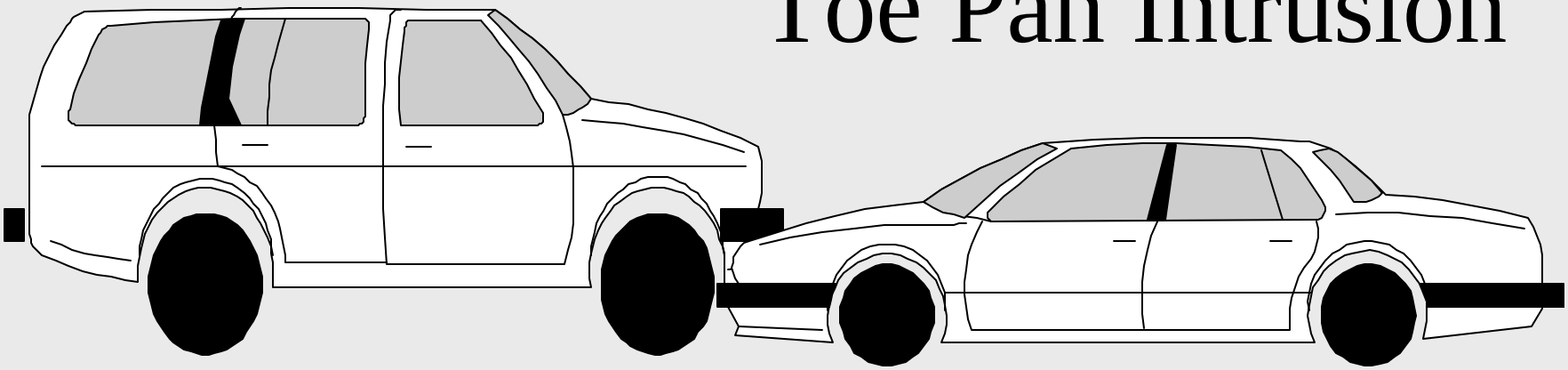
INJURIES

Left Mid-shaft Femur Fx

Right Mid-shaft Femur Fx

Both Knees contacted into bolster area

Offset Frontal Case Review
Toe Pan Intrusion



Late Model
Lincoln Navigator

Late 90’s compact
Driver fatally injured

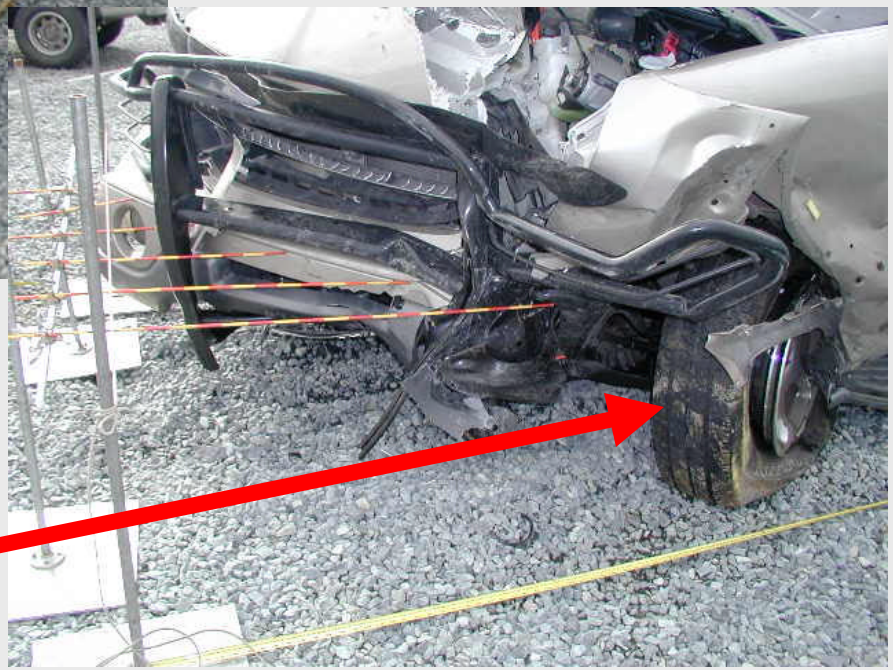
<u>Subject Driver</u>

50’s Female

Manual Lap/shoulder belt

Deployed Frontal and Side airbags

Delta V = 20 mph



Impact to front left tire

55 cm (21”) longitudinal intrusion of toe pan

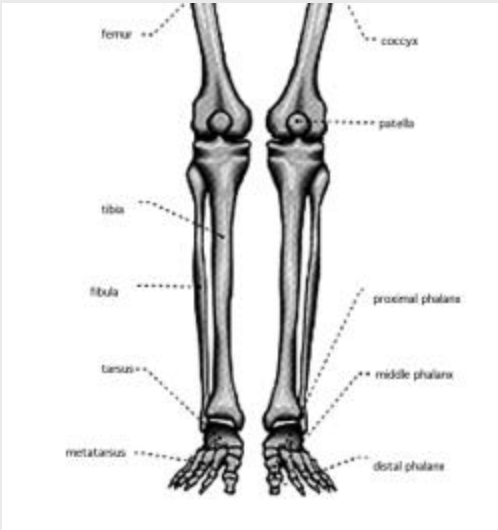
Injury summary

Right Foot

- Distal tibia Fx, comm.

- Distal fibula fx

- 1-5 metatarsals fx



Left Foot

- Cuboid fx

- Cuneiform fx (medial)

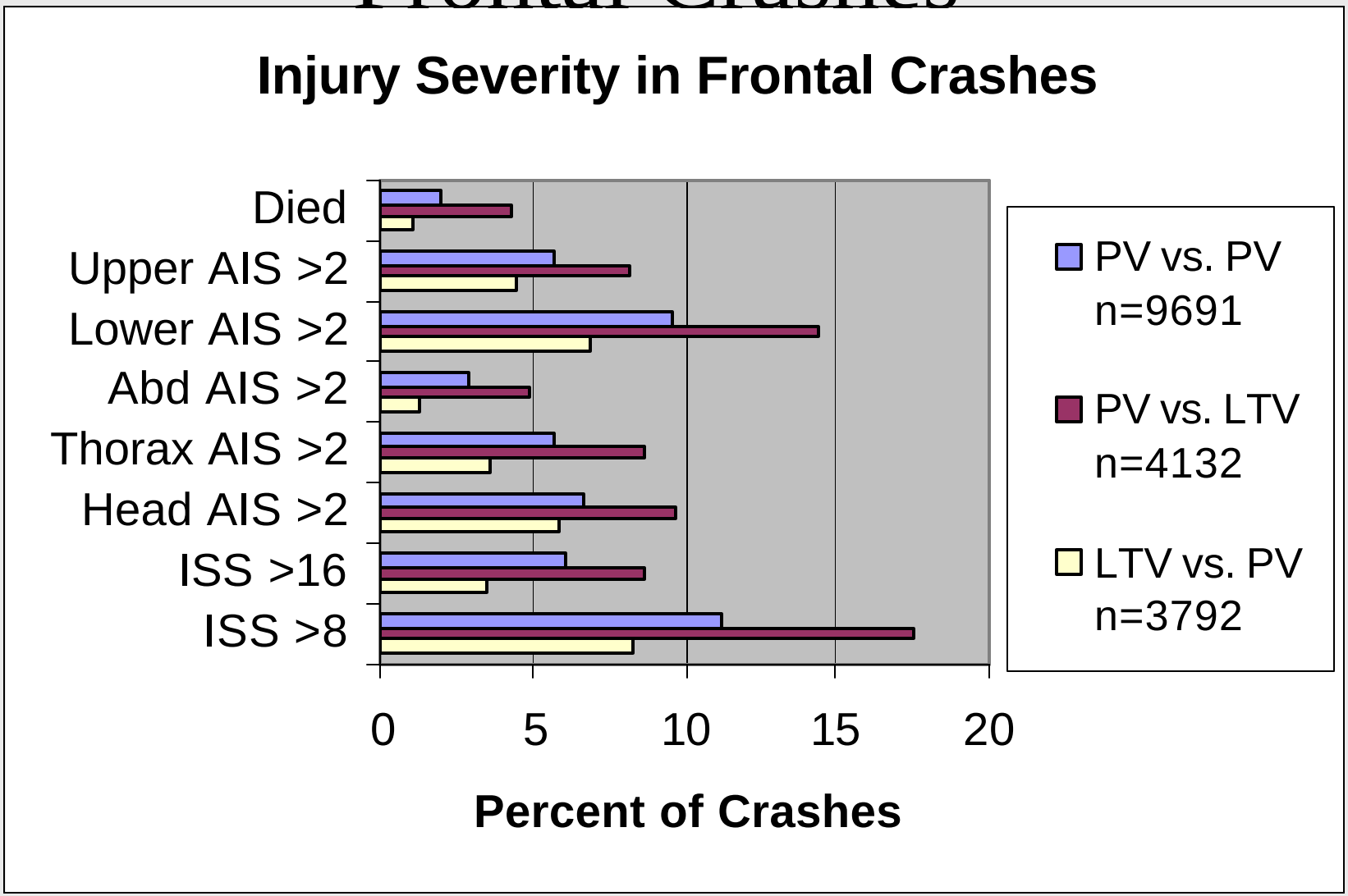
- 1,2,3,5 metatarsal fx

- L great toe proximal phalynx fx

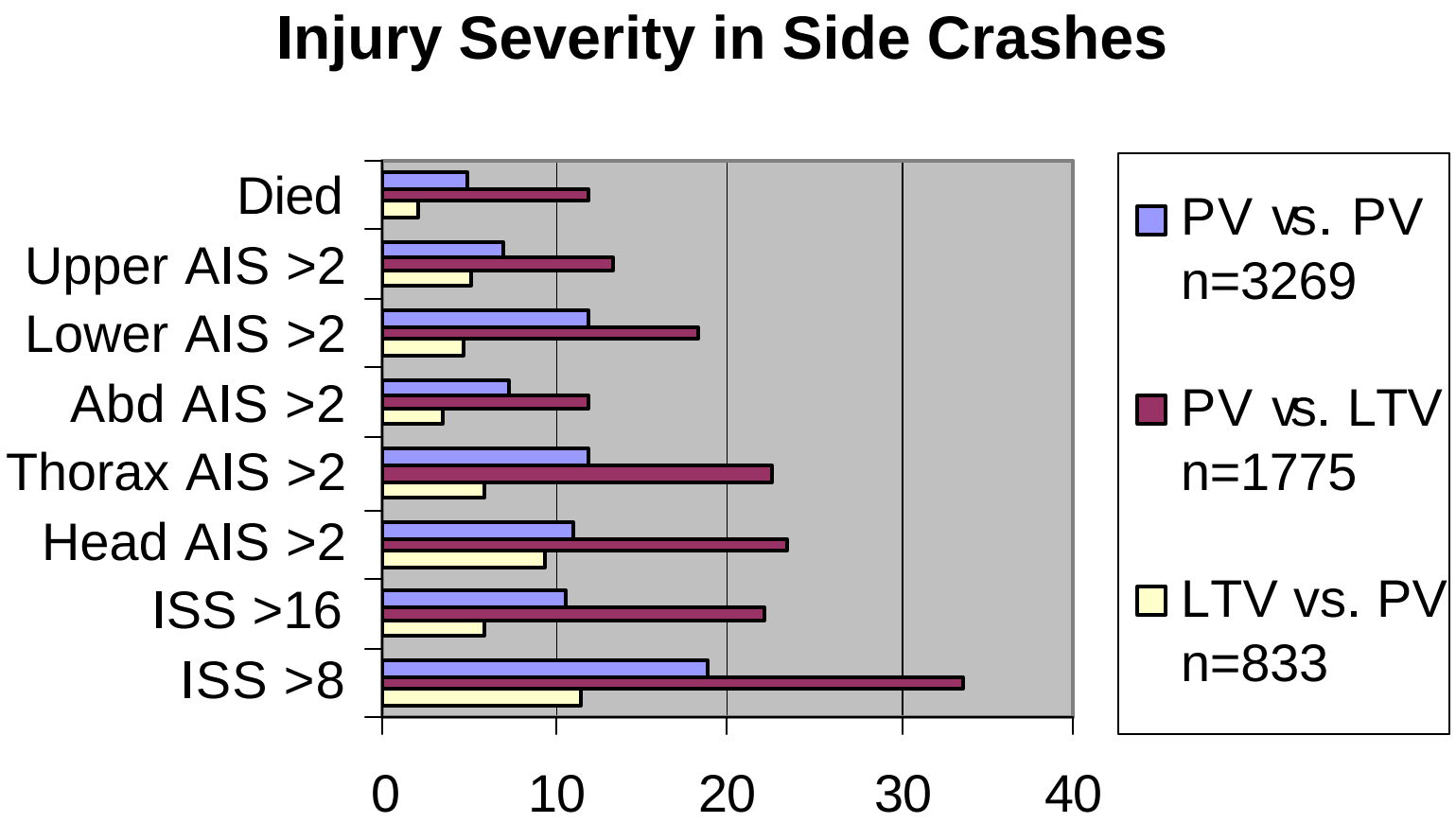
The Next Step

- Confirmatory Study of Injury Patterns using CDS Data
  - Evaluate Frontal and Side Impact Patterns
    - PV struck by PV
    - PV struck by LTV
    - LTV struck by PV

Frontal Crashes



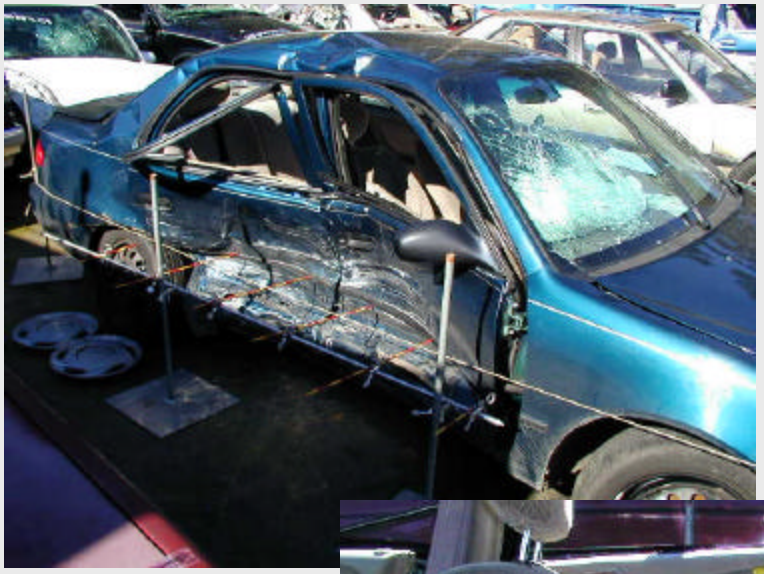
Side Crashes

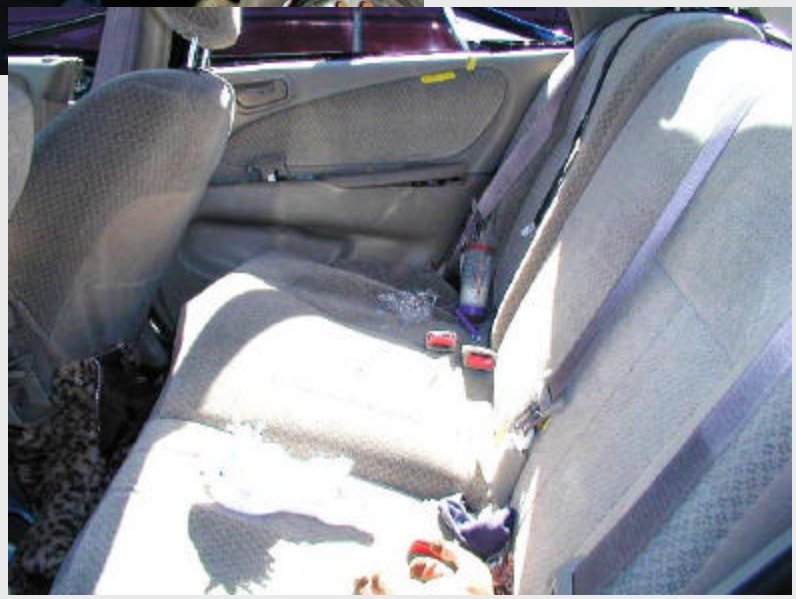


Vehicle Mismatch Impacts

Preventive Measures
documented from CIREN research

Side impact with child in booster seats



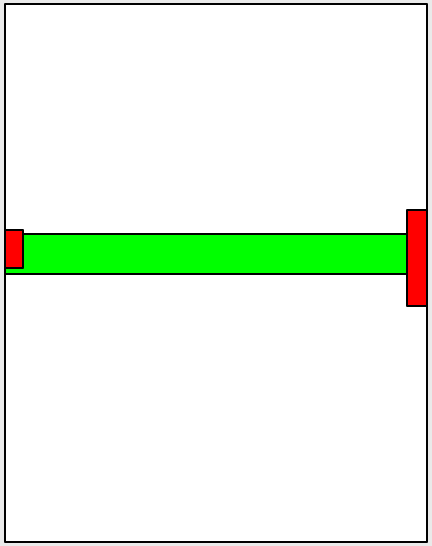


Minimal Head Injury

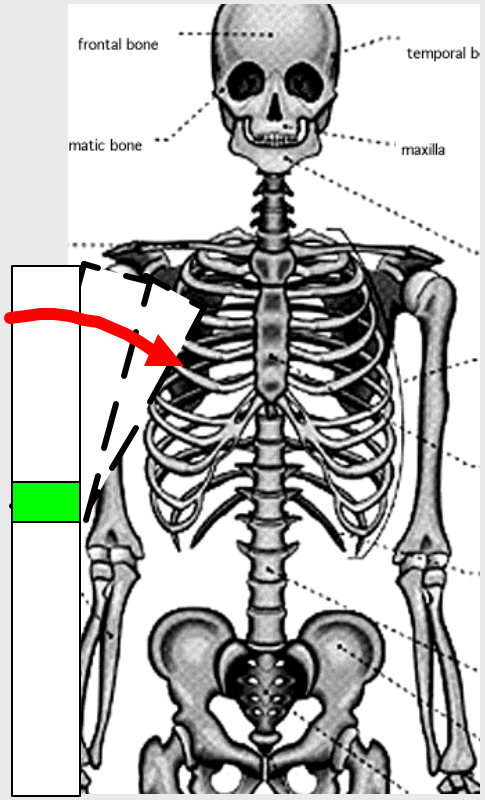
Head positioned above door interior

Side Airbags Provide Head Protection

Utilize CIREN case studies evaluate side impact federal safety standards

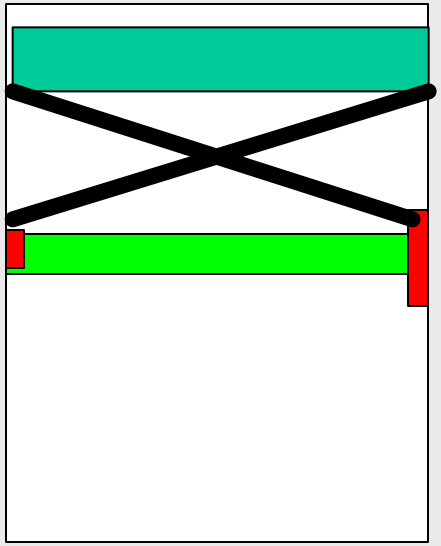


Side View

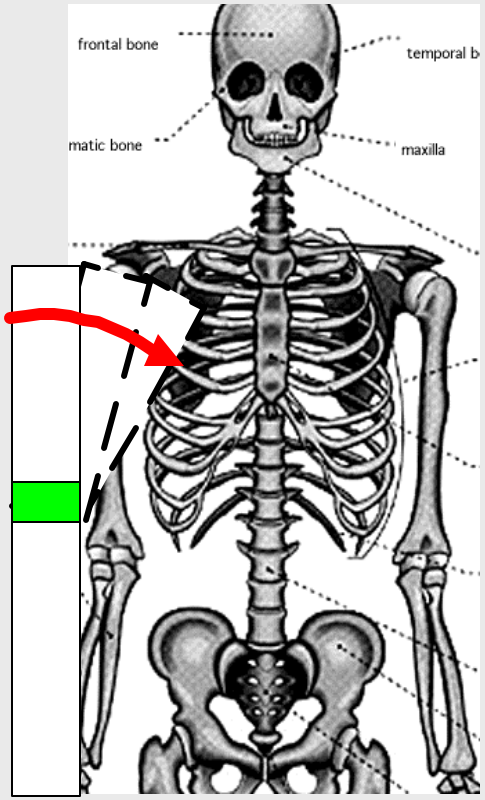


End View

Require more door frame support to match with the growing fleet of SUV/Trucks on the road today

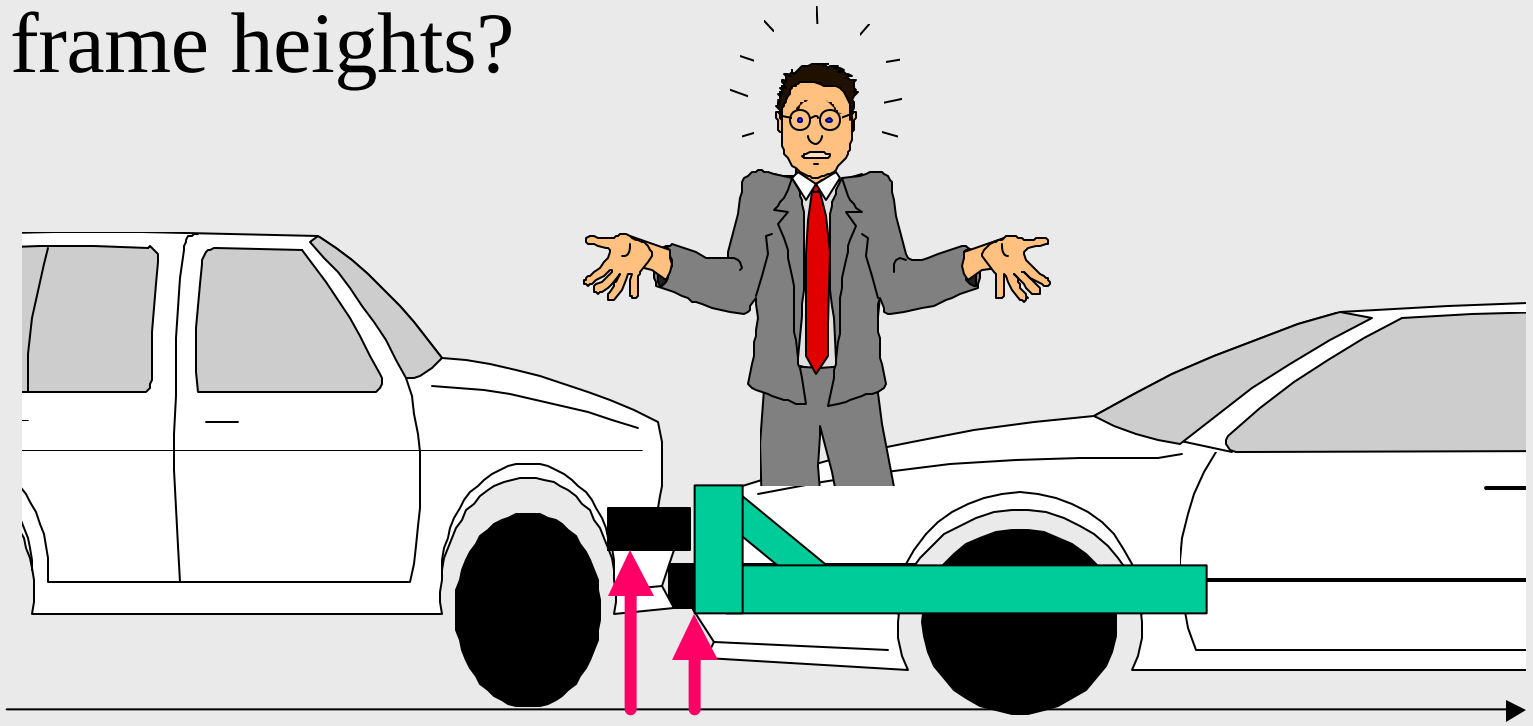


Side View



End View

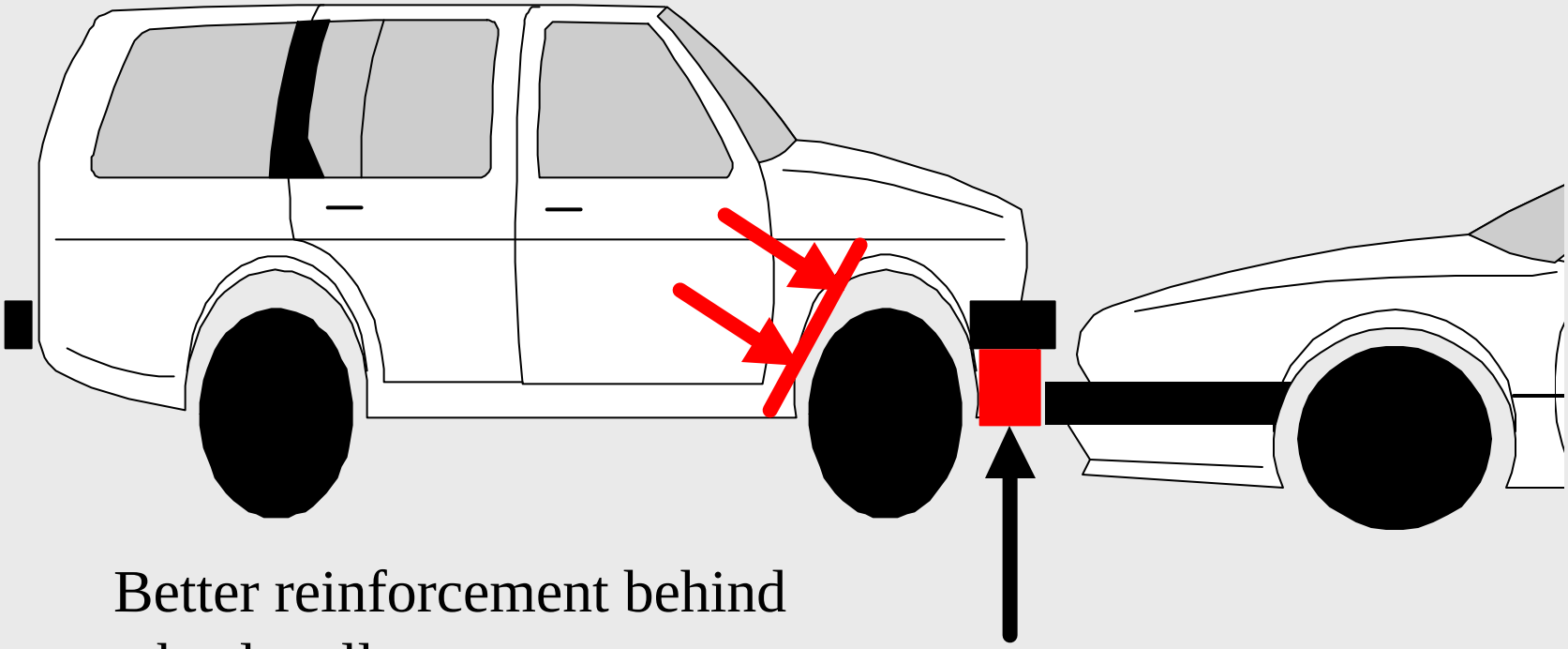
What to do about mismatch bumper frame heights?



Create a vertical component on the frame rail ends of the sedan or spoiler frame on LTV’s

Further examine CIREN data to provide input for SS

Toe Pan intrusion to SUV/Trucks



Better reinforcement behind wheel wells to prevent toe pan intrusion from front tires

Lower bumper frame to match passenger cars

Thank you