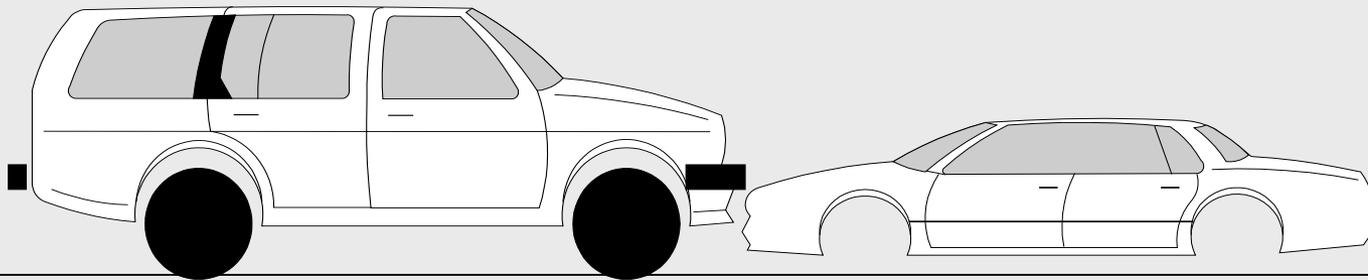


# Crash Injury Mechanisms in Vehicle Mismatch Collisions



Presenters: Kaufman, Mock, Henley, Tencer,

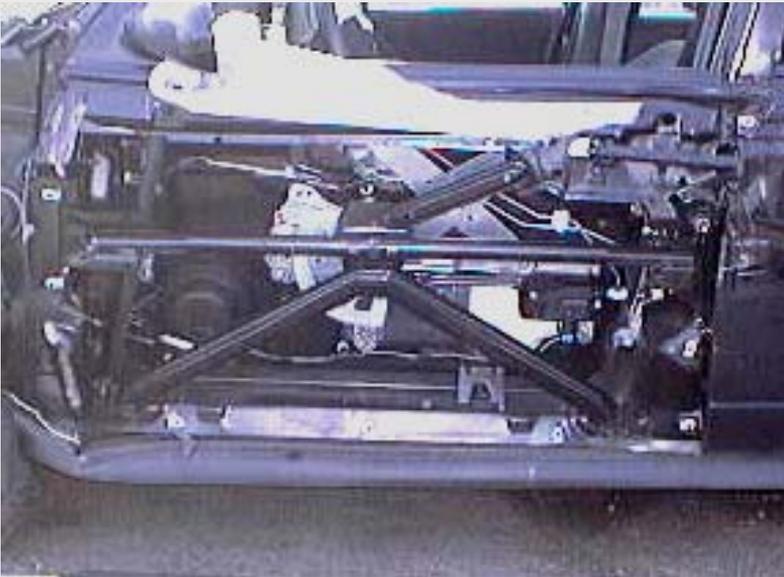


CIREN Seattle

HARBORVIEW INJURY PREVENTION  
AND RESEARCH CENTER



# Side impact standard improvements (SS214)



Use of side impact beams in doors

# Protection from side impact beams

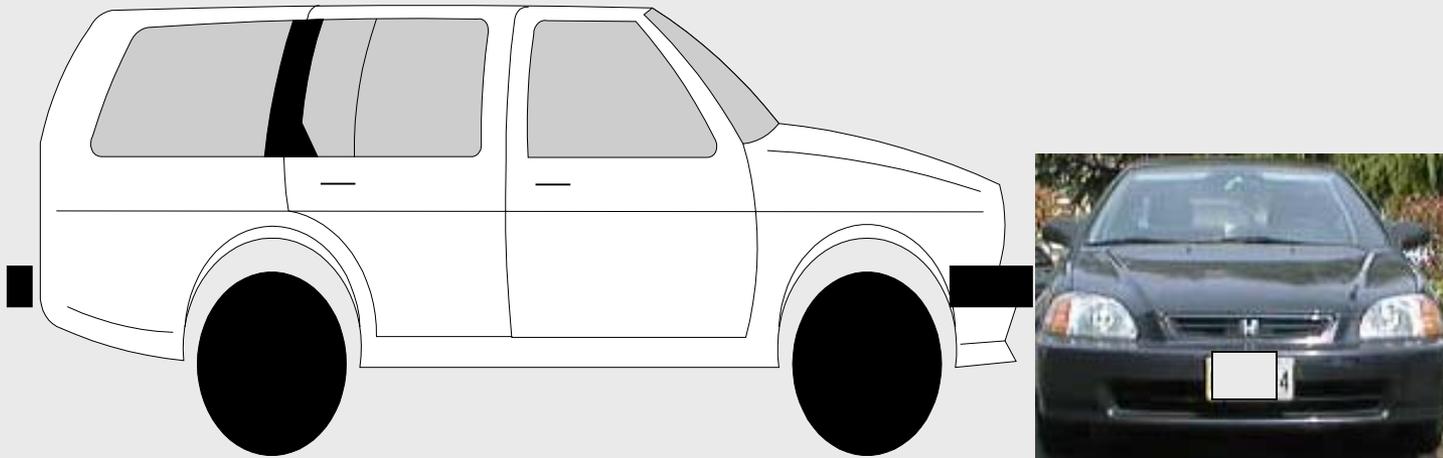


- Minimal intrusion
- No injury
- Delta V = 12 mph
- 01RYEW2



Striking vehicle

# Larger Vehicle and Side Impacts



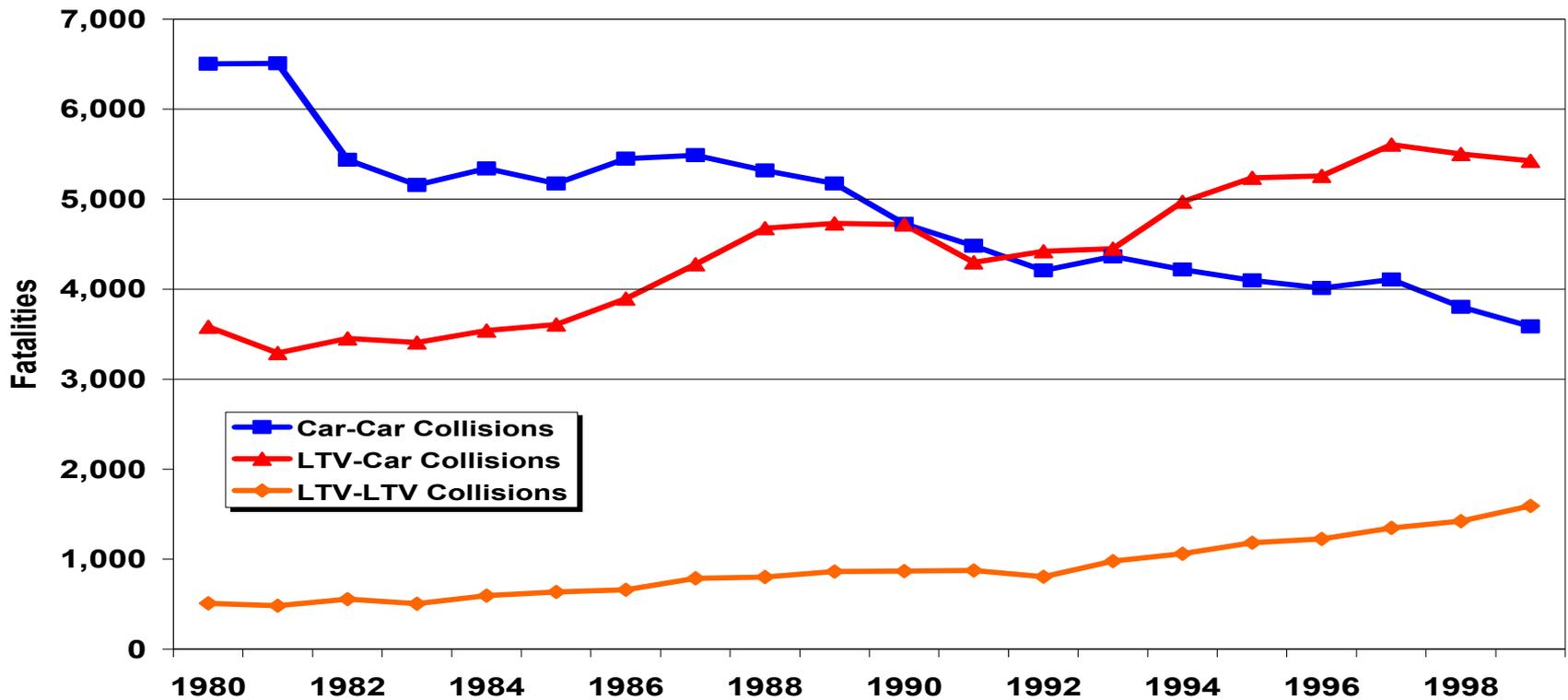
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Subdivisions vs. compact/economical

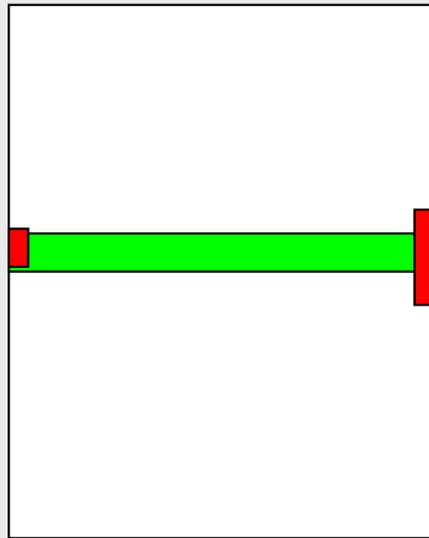
Some bumper heights are overriding the side impact supports

# Increasing LTV-Car Fatalities

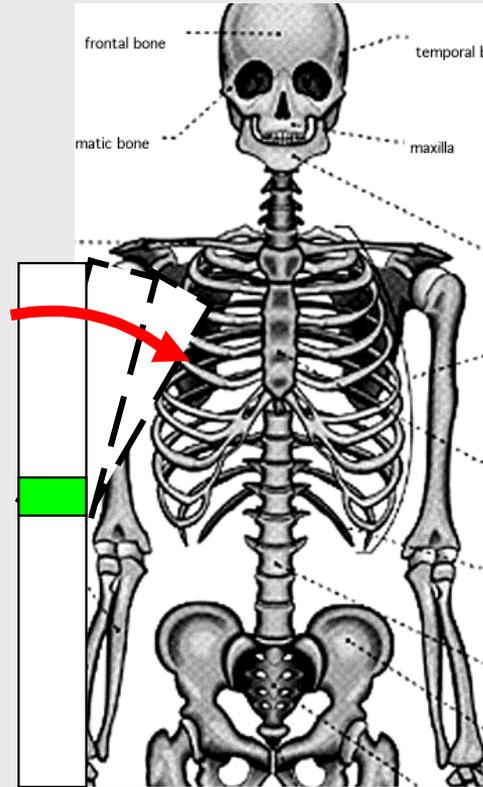
## Fatalities in Vehicle-to-Vehicle Collisions



# Side impacts with larger vehicles with lateral door support beams



Side View



End View

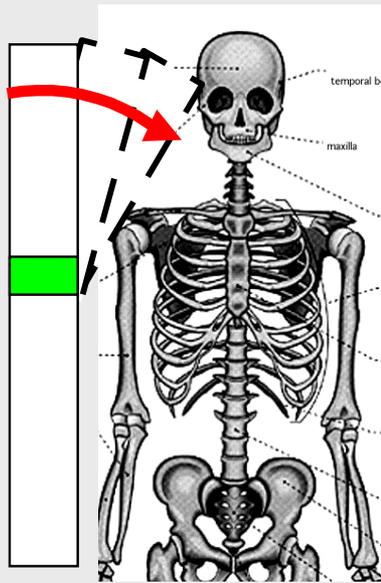
# Intrusion = Injury



Adults -Think  
Thorax!!

Children- Think head

# This becomes head contacts for children

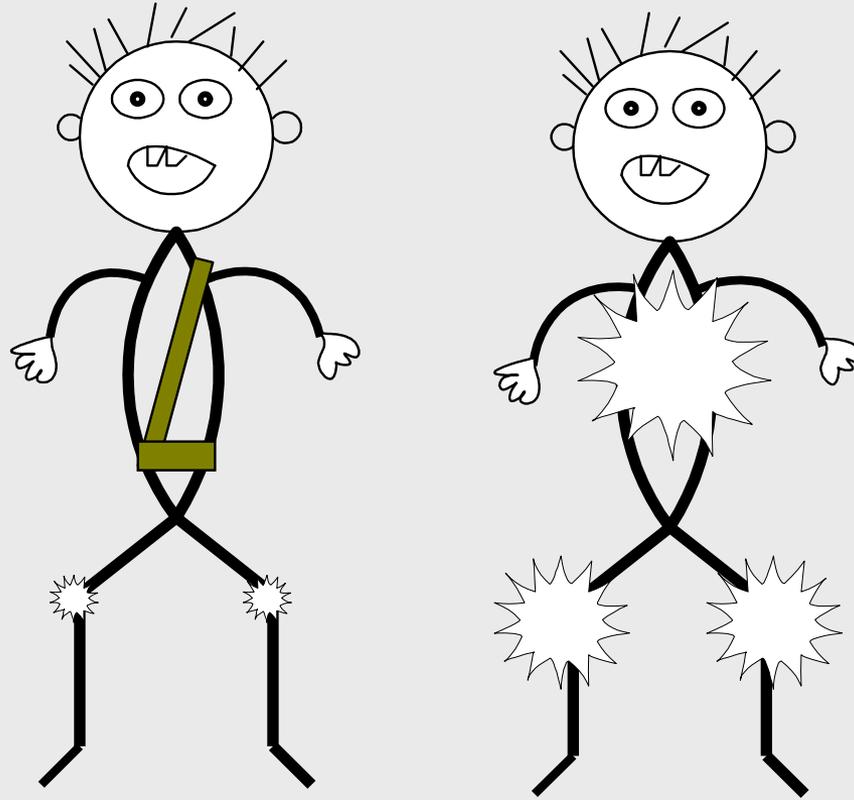


**End View**



# Frontal Impacts

# Occupant energy distribution

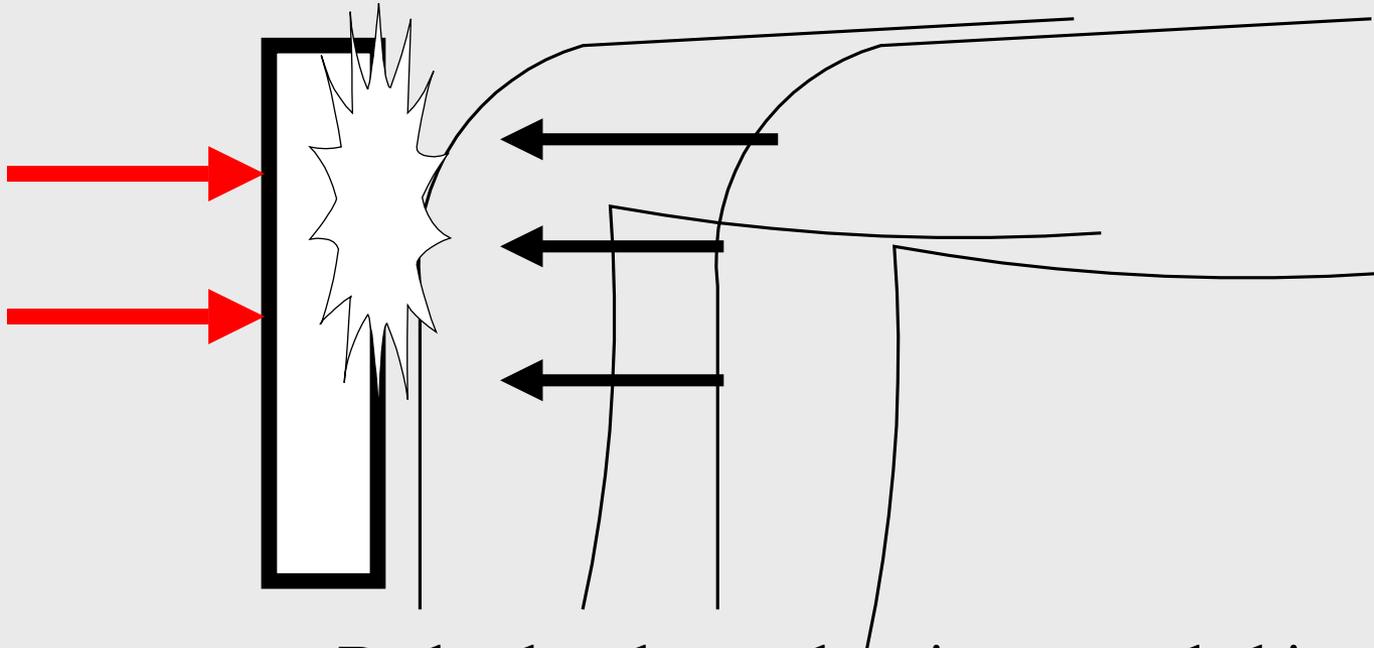


Restrained

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

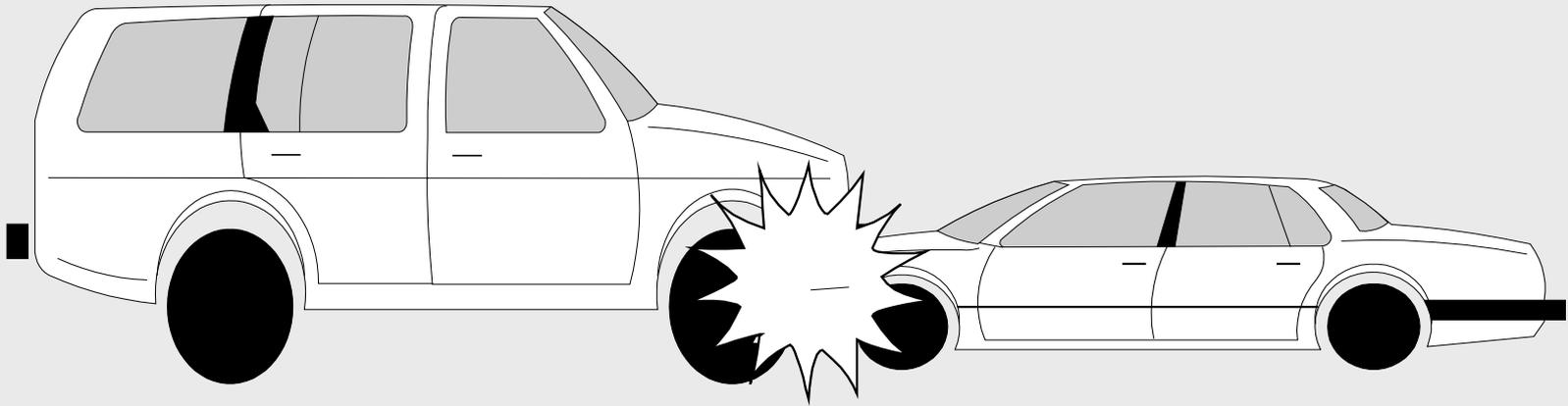


Post-crash

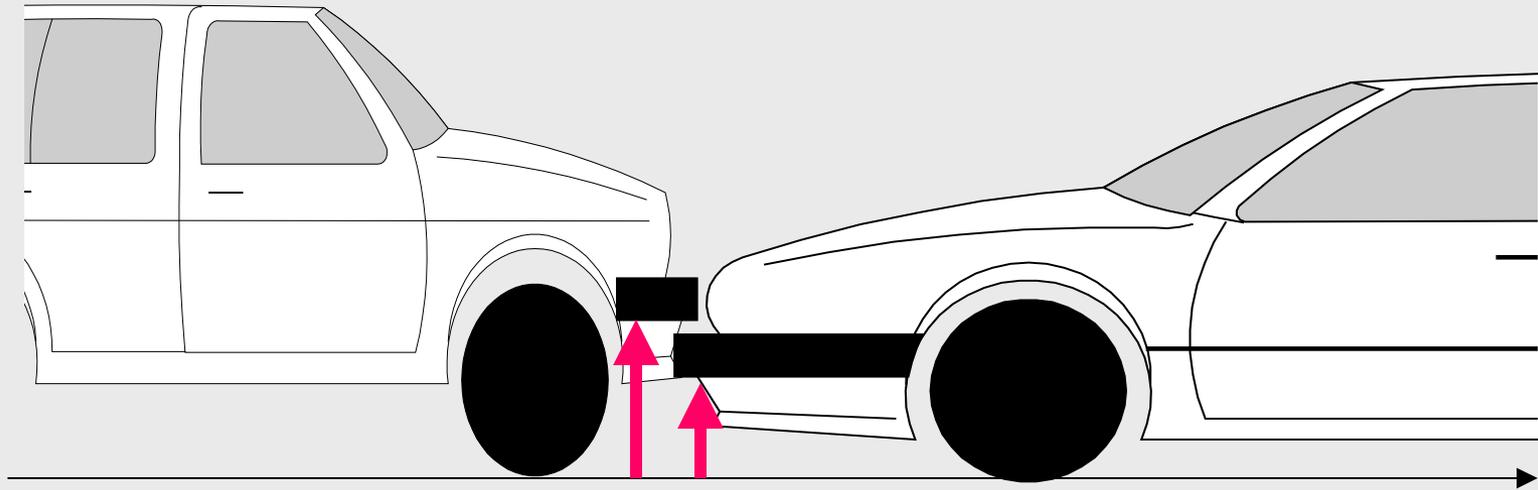


Left mid-shaft femur fracture due to override impact and intrusion to instrument panel

# Offset Frontal Impacts with Vehicle Mismatch



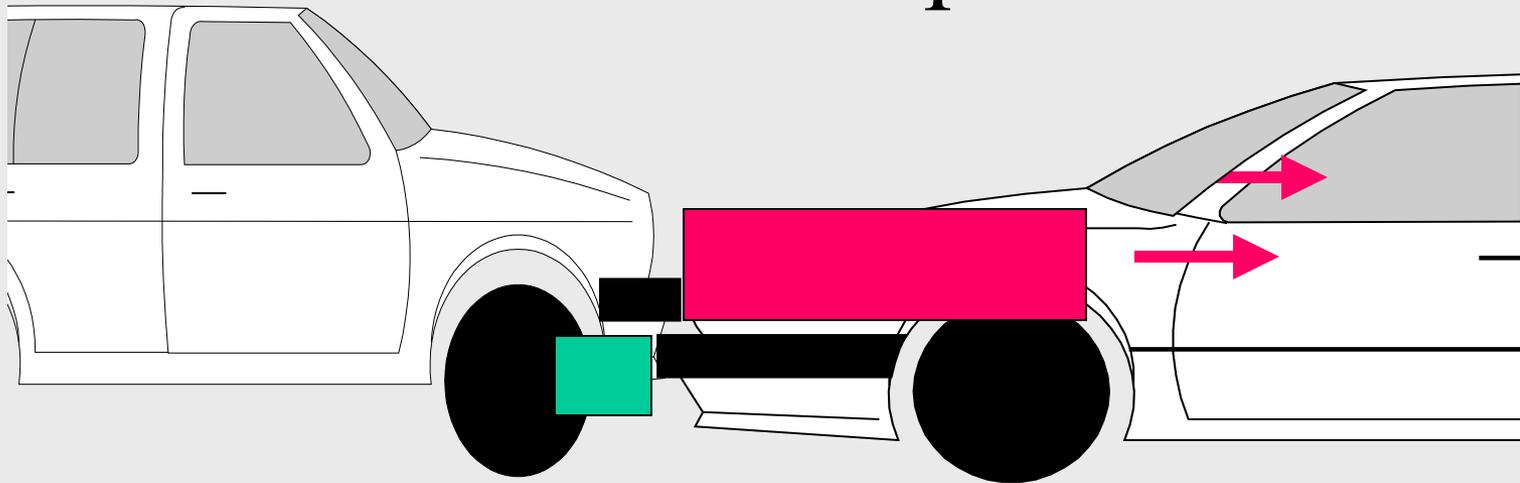
# SUV-Truck vs. Sedan



Obvious mismatch in bumper heights,  
or bumper frame

# SUV-Truck vs. Sedan

Override impact creates significant intrusion of instrument panel/hood

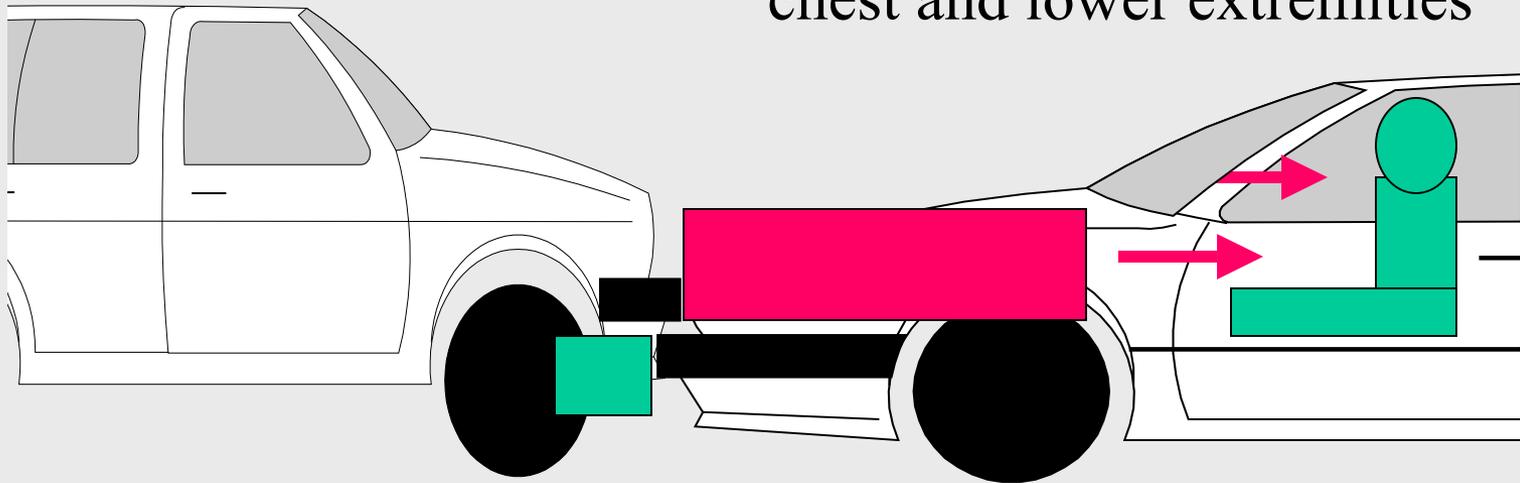


 SUV bumper into grill of sedan

 Sedan bumper into front tire/axle

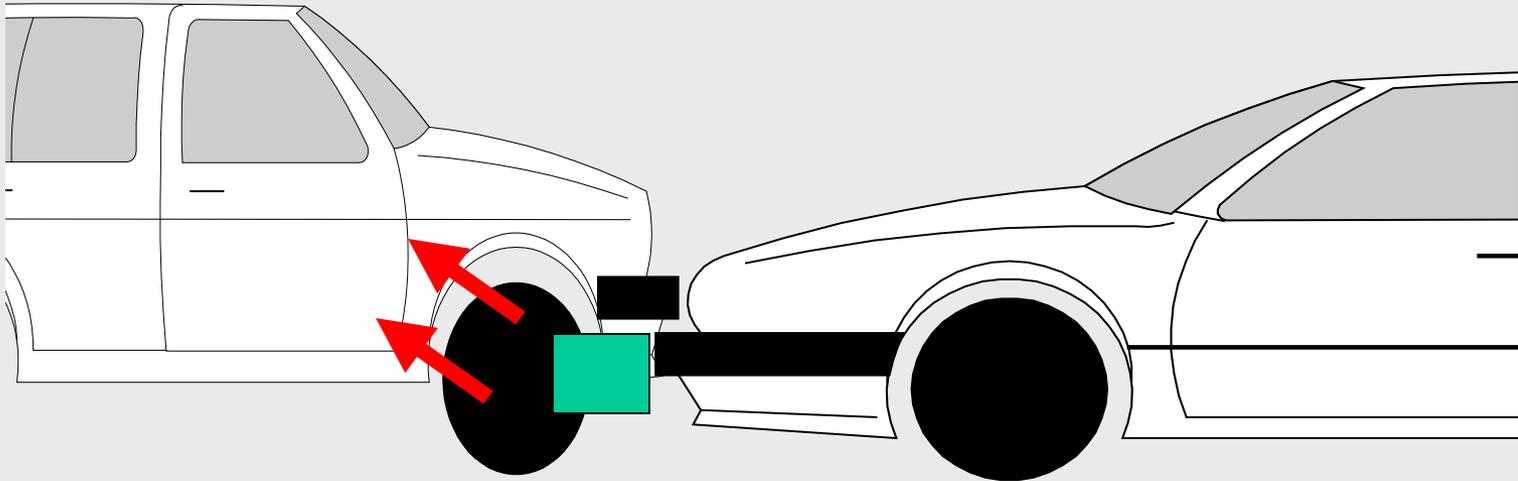
# SUV-Truck vs. Sedan

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

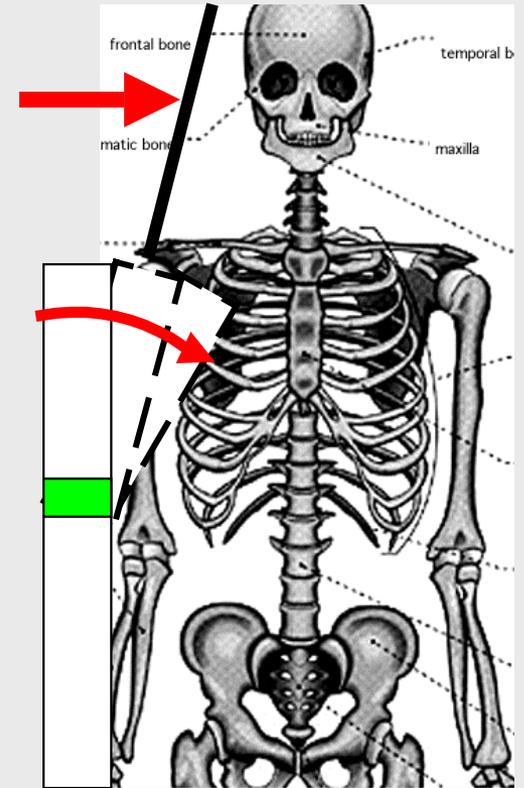
# Upper door panel intrusion Override of support beams



Toyota Corolla struck by large F250 pickup truck

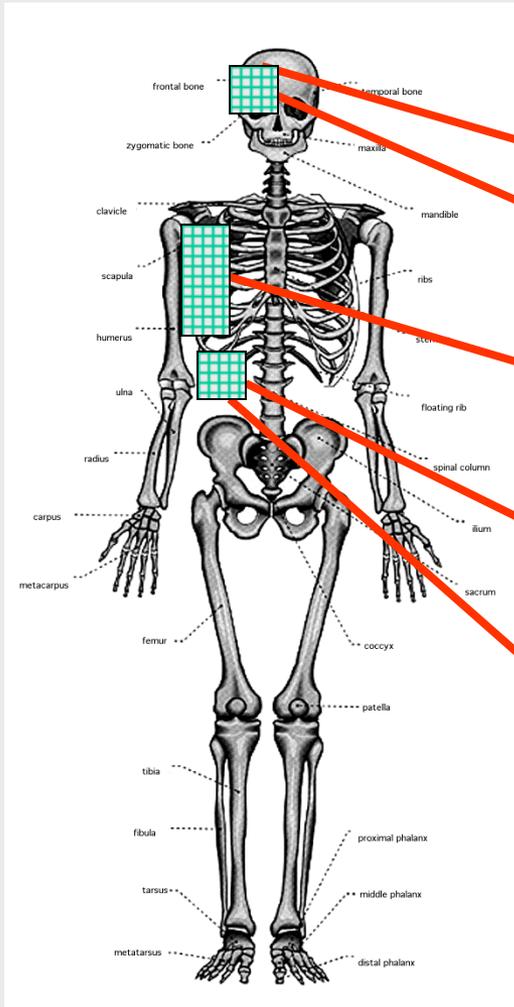
# Upper door panel intrusion

## Case review



End View

# Injuries



**AIS**

**Region**

**Injury**

2

Head

Scalp laceration

3

Head

R cerebral contusion

4

Chest

R Rib fxs with

R pneumothorax

2

Abdomen

R perinephric hematoma -  
small

2

Abdomen

Pancreas contusion

**ISS = 29**



# CIREN Case Review

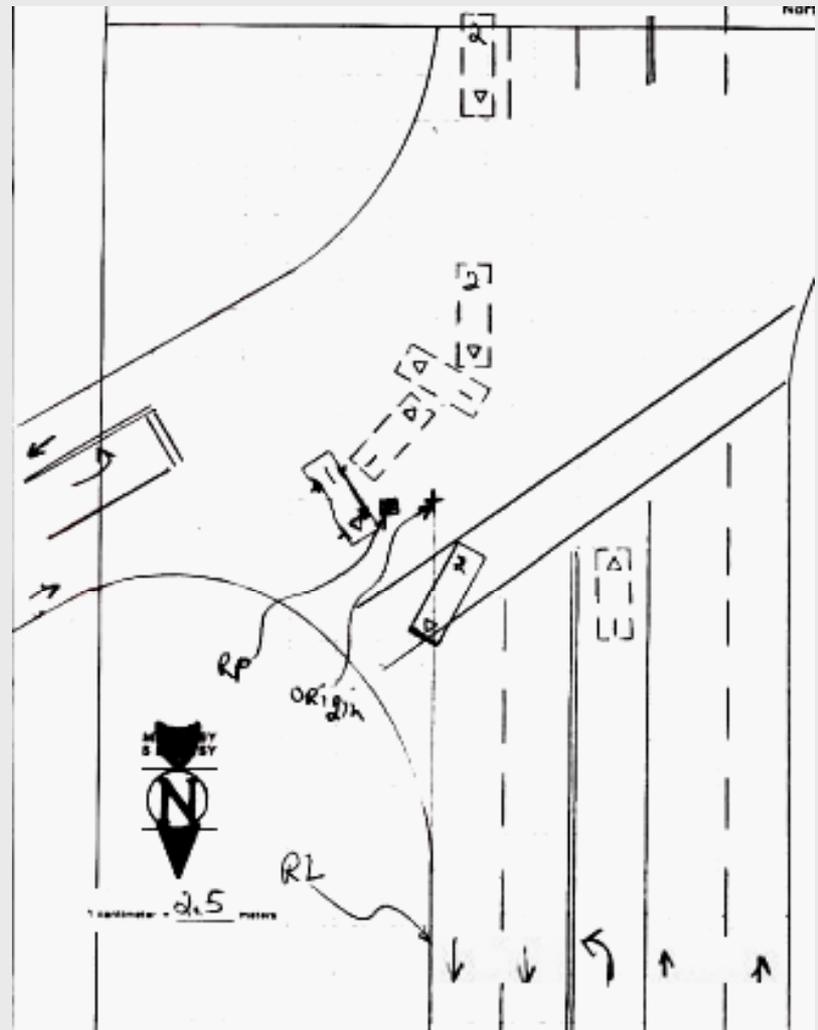


90's Ford

20 mph Delta V

PDOF = 60

Struck by large pickup



# Critical Head Injuries

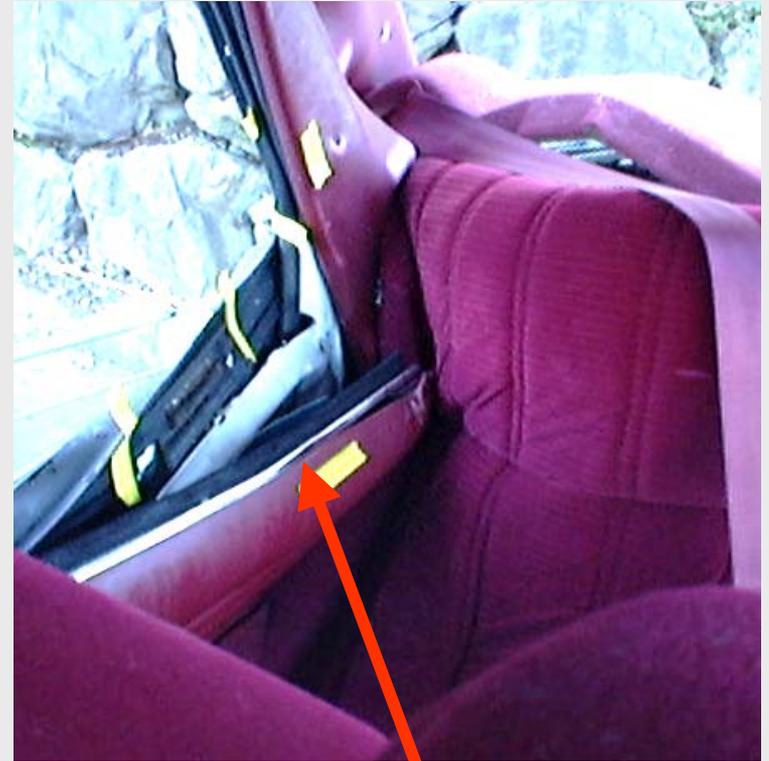
## Side Impact Case review



Child

Back right seat - fully restrained

Sleeping with head against door

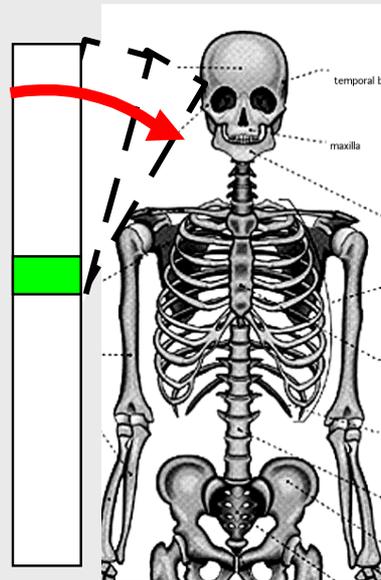


40 cm of intrusion at door panel, window sill

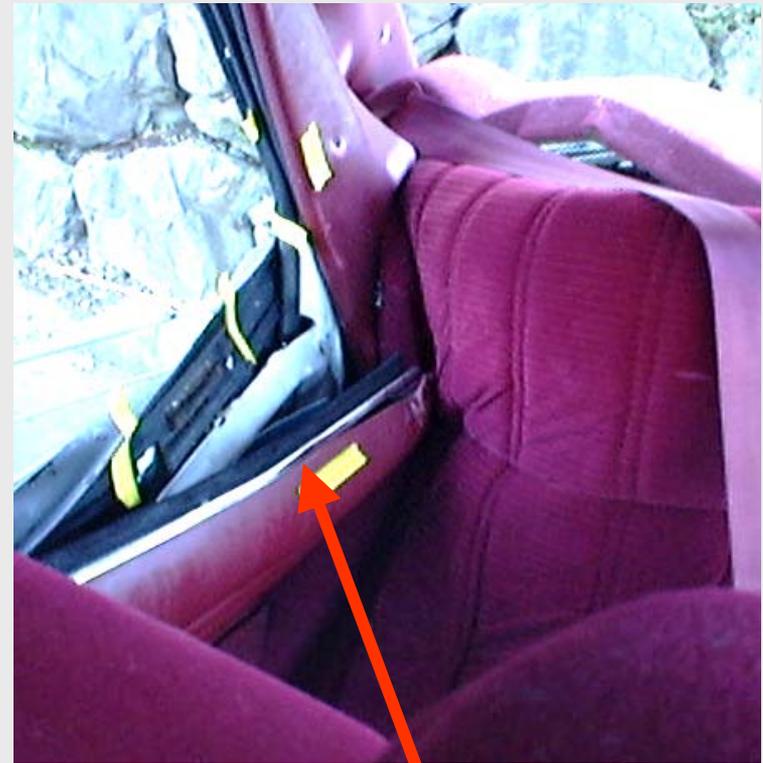
Deformation from head contact

## Head Injury Summary

- Serious Brain Injury, AIS = 5



**End View**

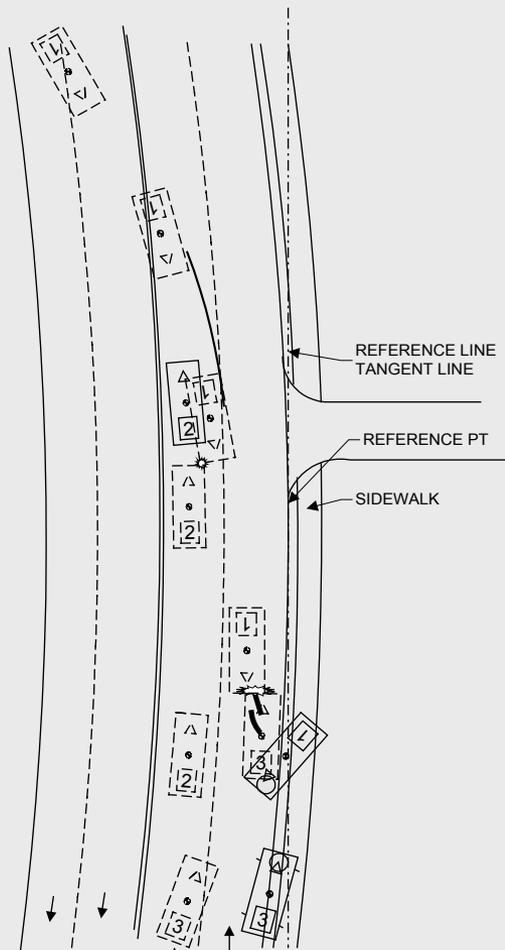


40 cm of intrusion at door panel, window sill

Deformation from head contact

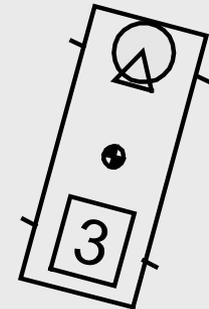
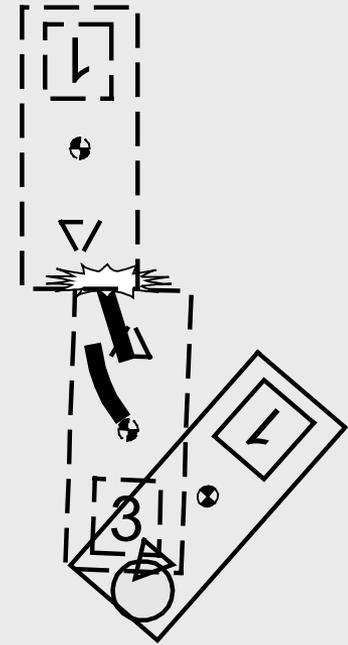
# Frontal Offset Case Review

# 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**

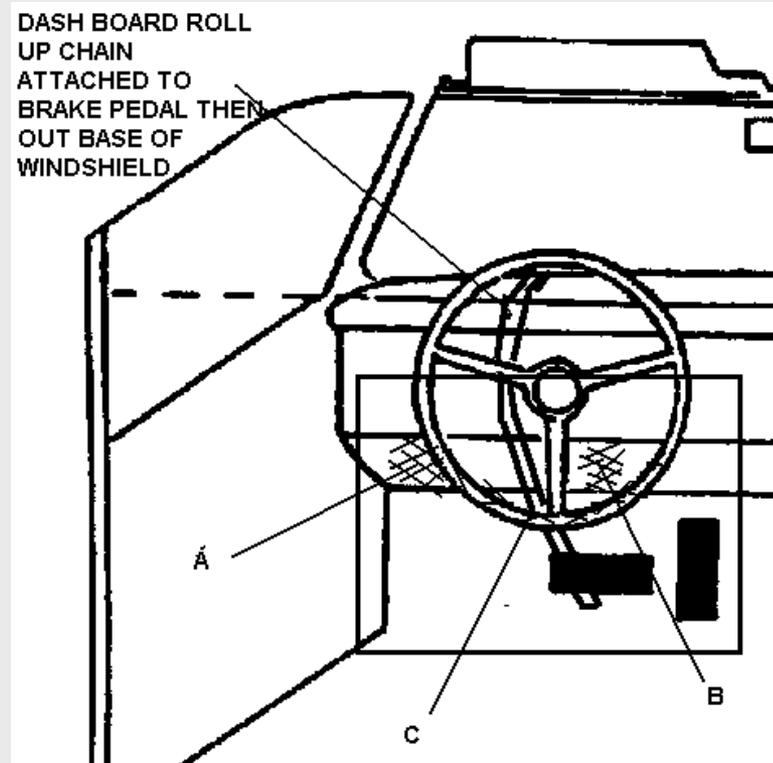
**Windshield = 24 cm**

**Kick panel = 18 cm**

**Steering col. = 15 cm**



# Driver Contacts

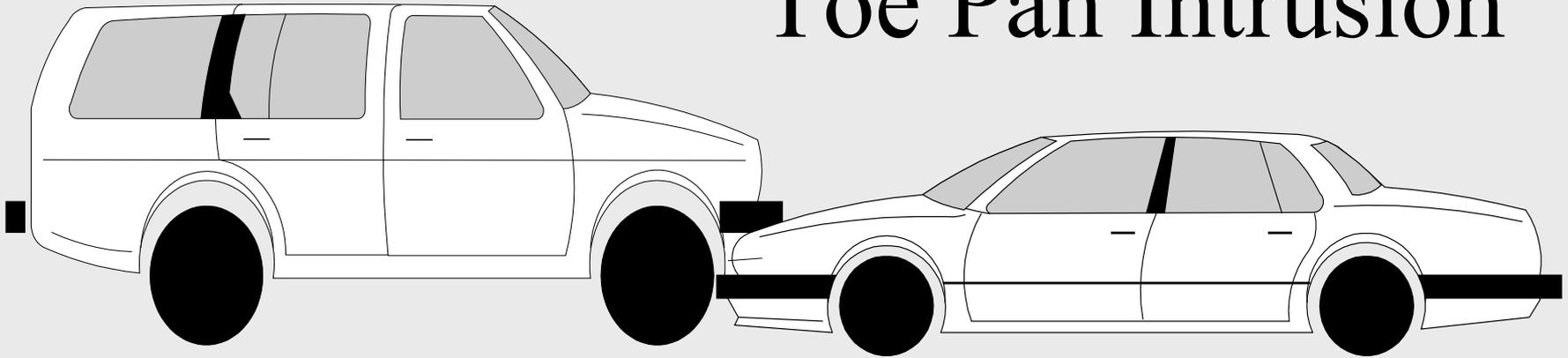


Both Knees contacted into bolster area

Steering Rim Deformity

# Offset Frontal Case Review

## Toe Pan Intrusion



Late Model

Lincoln Navigator

Late 90's compact  
Driver fatally injured

Subject Driver

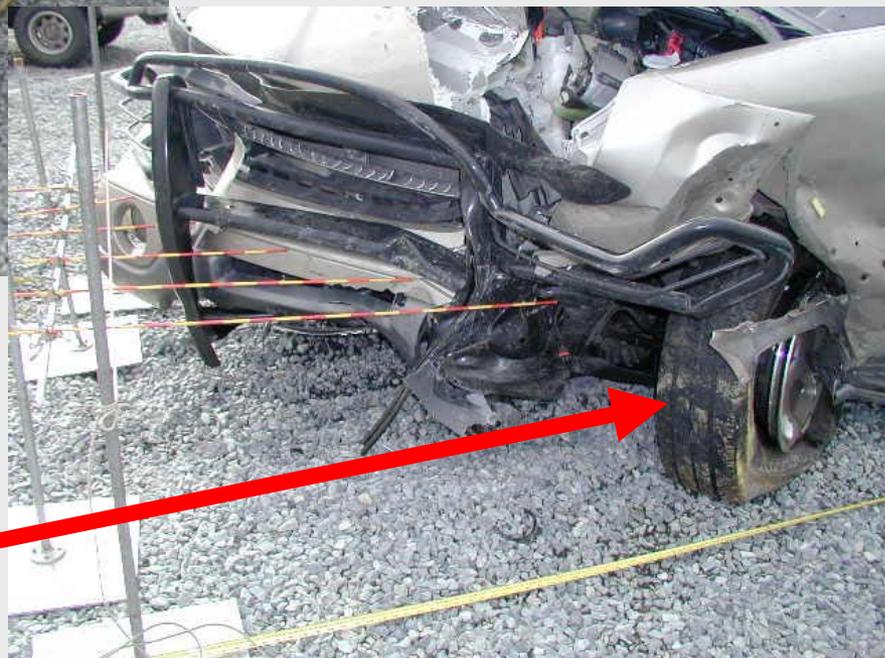
50's Female

Manual Lap/shoulder belt

Deployed Frontal and Side airbags



Delta V = 20 mph



Impact to front left tire

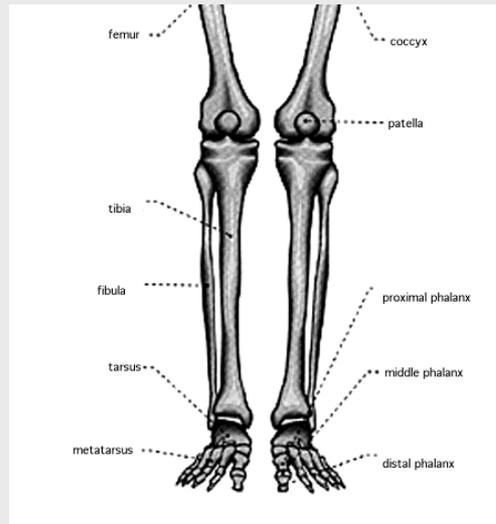


55 cm (21") longitudinal intrusion of toe pan

# 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

# **Vehicle Mismatch Impacts**

Preventive Measures

documented from CIREN research

# Side impact with child in booster seats



Minimal  
Head  
Injury

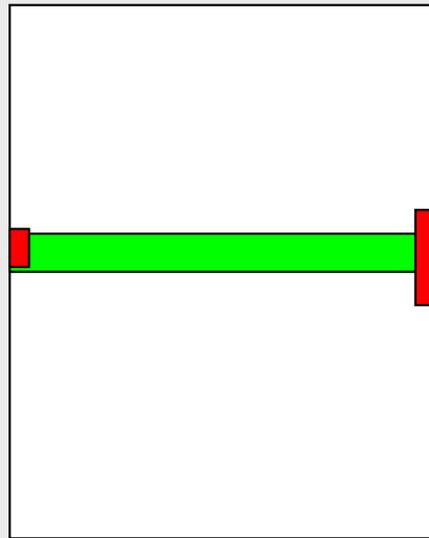


Head positioned  
above door interior

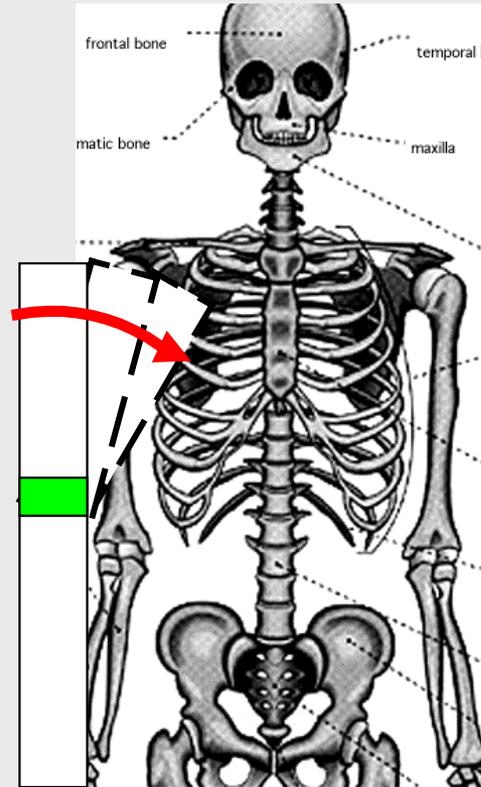


Side  
Airbags  
Provide  
Head  
Protection

Utilize CIREN case studies evaluate side impact federal safety standards

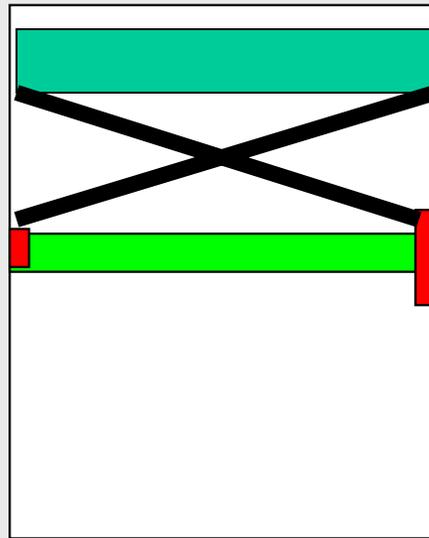


**Side View**

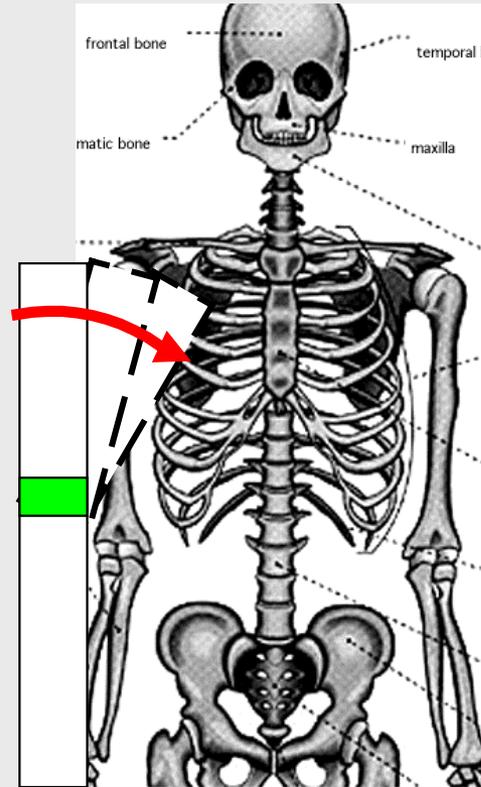


**End View**

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

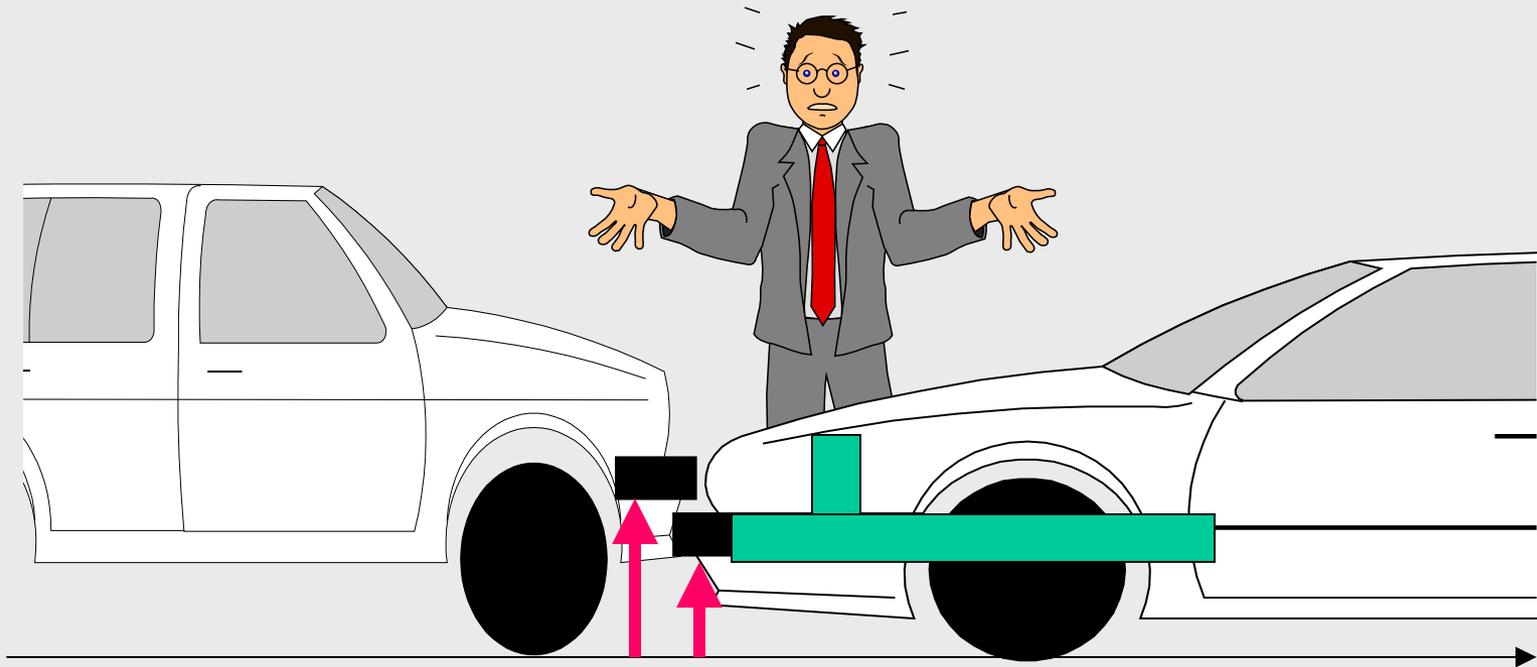


**Side View**



**End View**

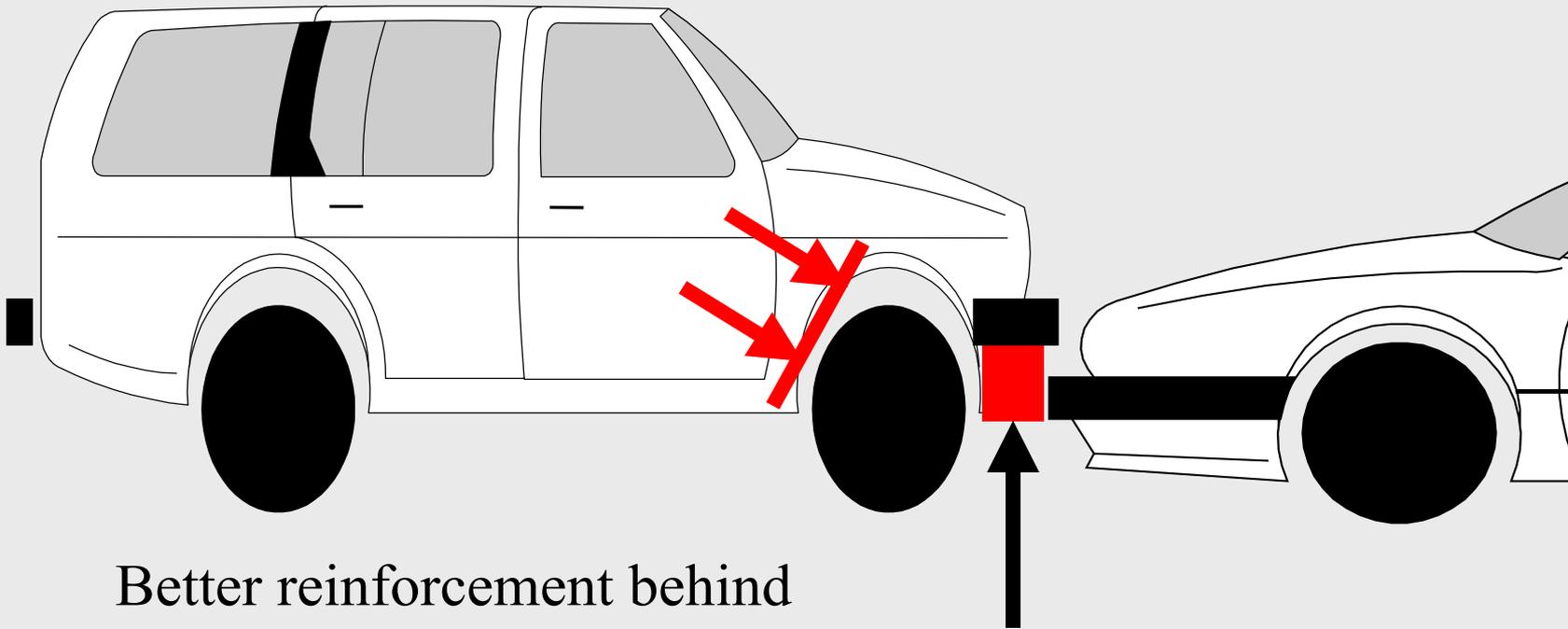
# What to do about mismatch bumper heights?



Create a vertical component on the frame rail of the sedan?

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