

Injury Mechanisms in Frontal Plane Corner Impacts

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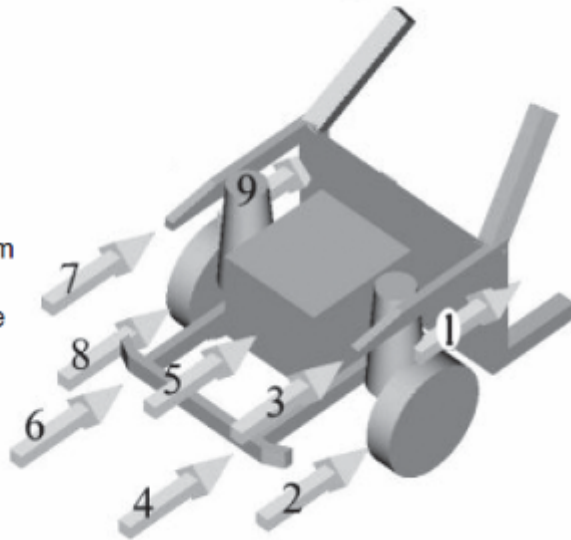
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Motivation For Study

Sweden: Lindquist, et.al., 2004, IJCrash

1. L side structure
2. L wheel
3. L shotgun beam
4. L longitudinal
5. Drive train
6. R. longitudinal
7. R. shotgun beam
8. R. wheel
9. R. side structure



Corner impacts 48% (29/61)
Belted Frontal Fatal Crashes

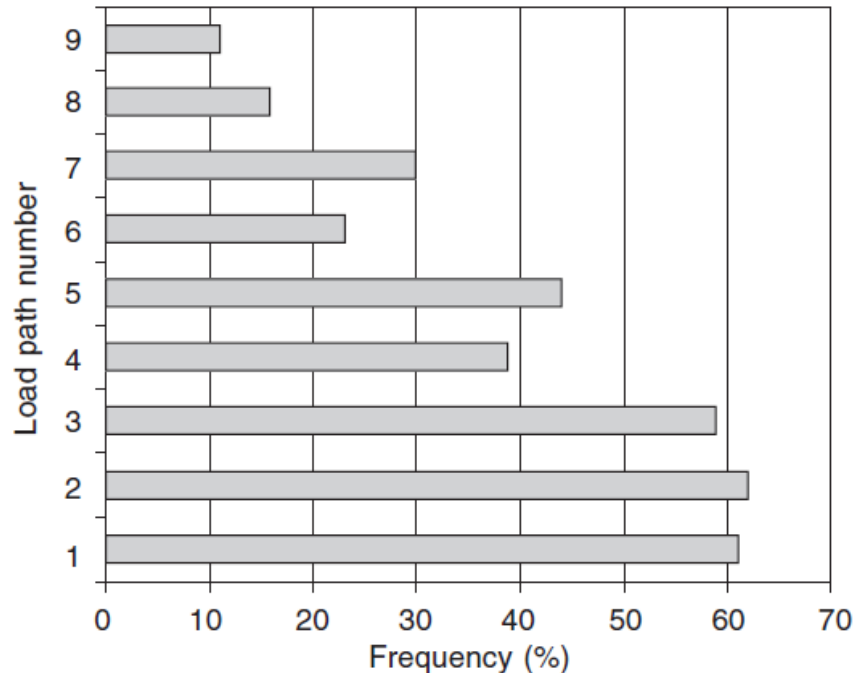


Figure 4b Frequency of front end load path usage in the 61 fatalities.

Crush and Extent



Crush



Extent

CDC-Code: Specific Longitudinal or Lateral Area

1 2 3 4 5 6 7
— — — — — — —

D

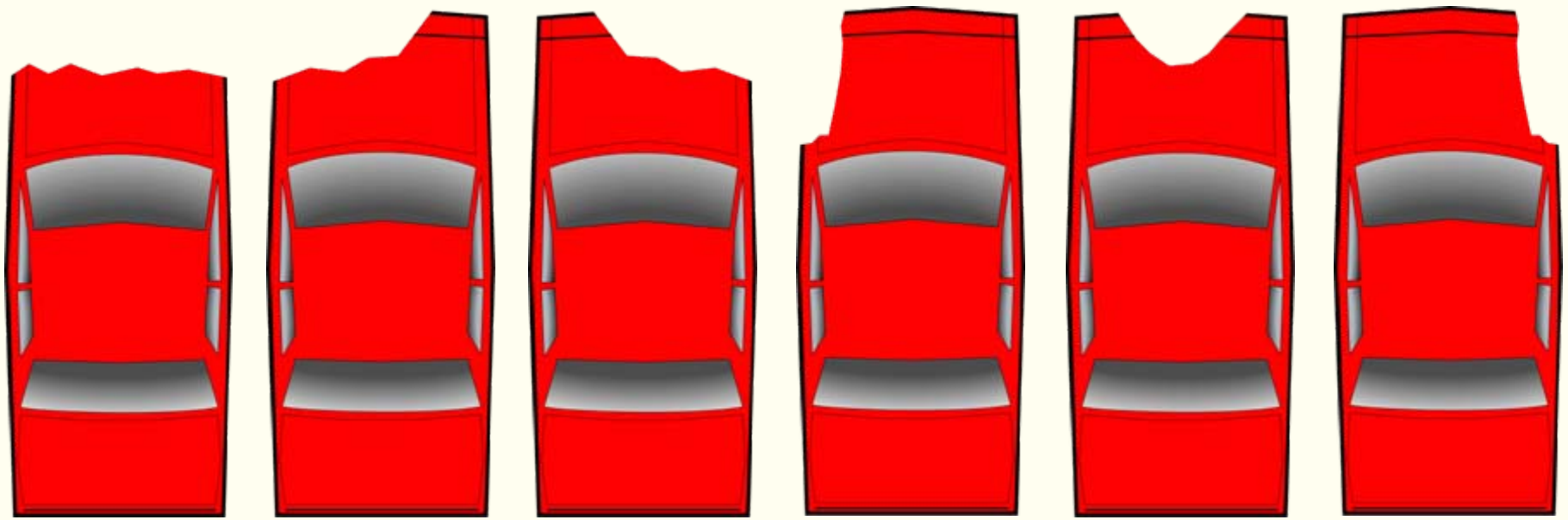
Y

Z

L

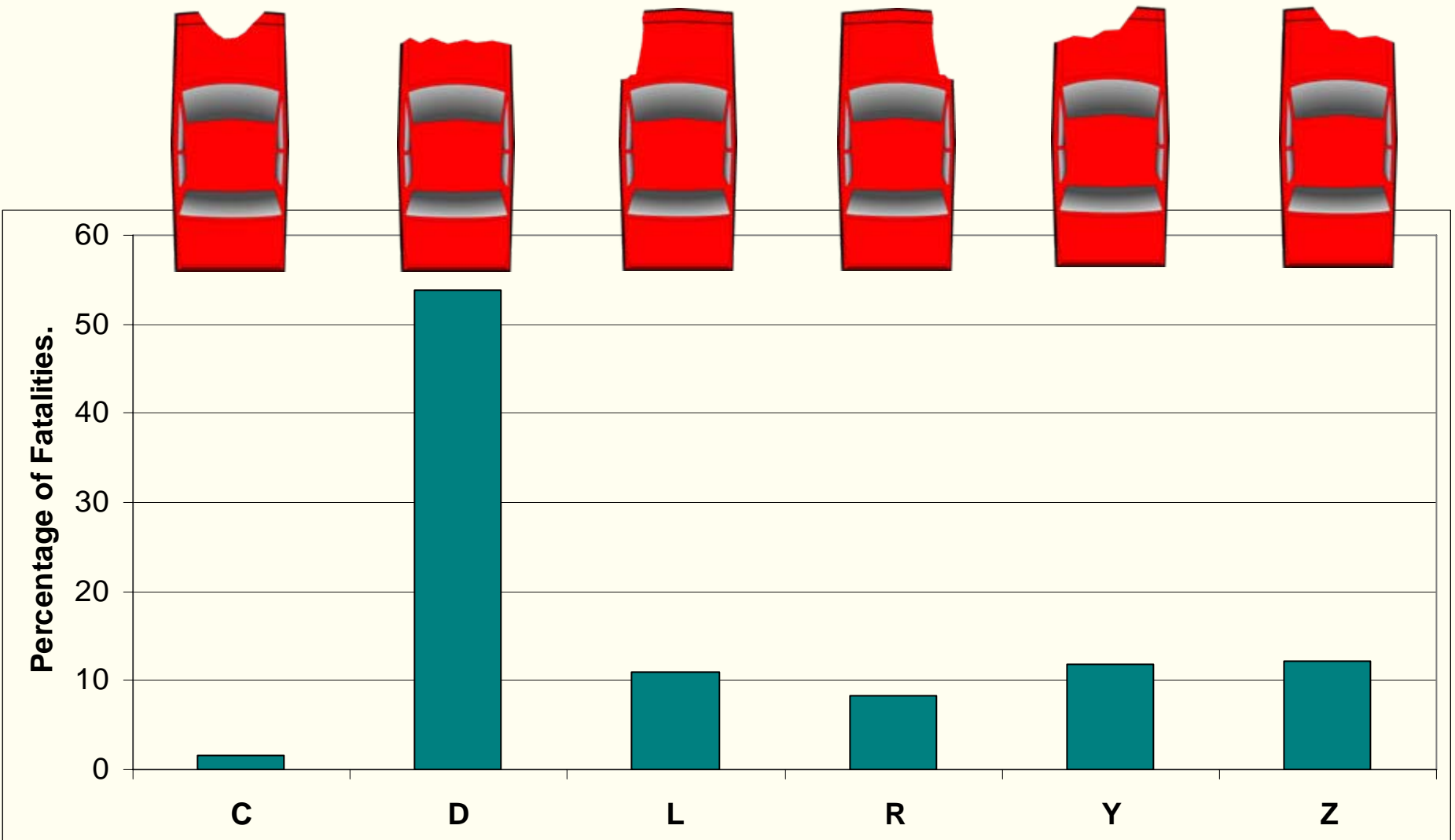
C

R



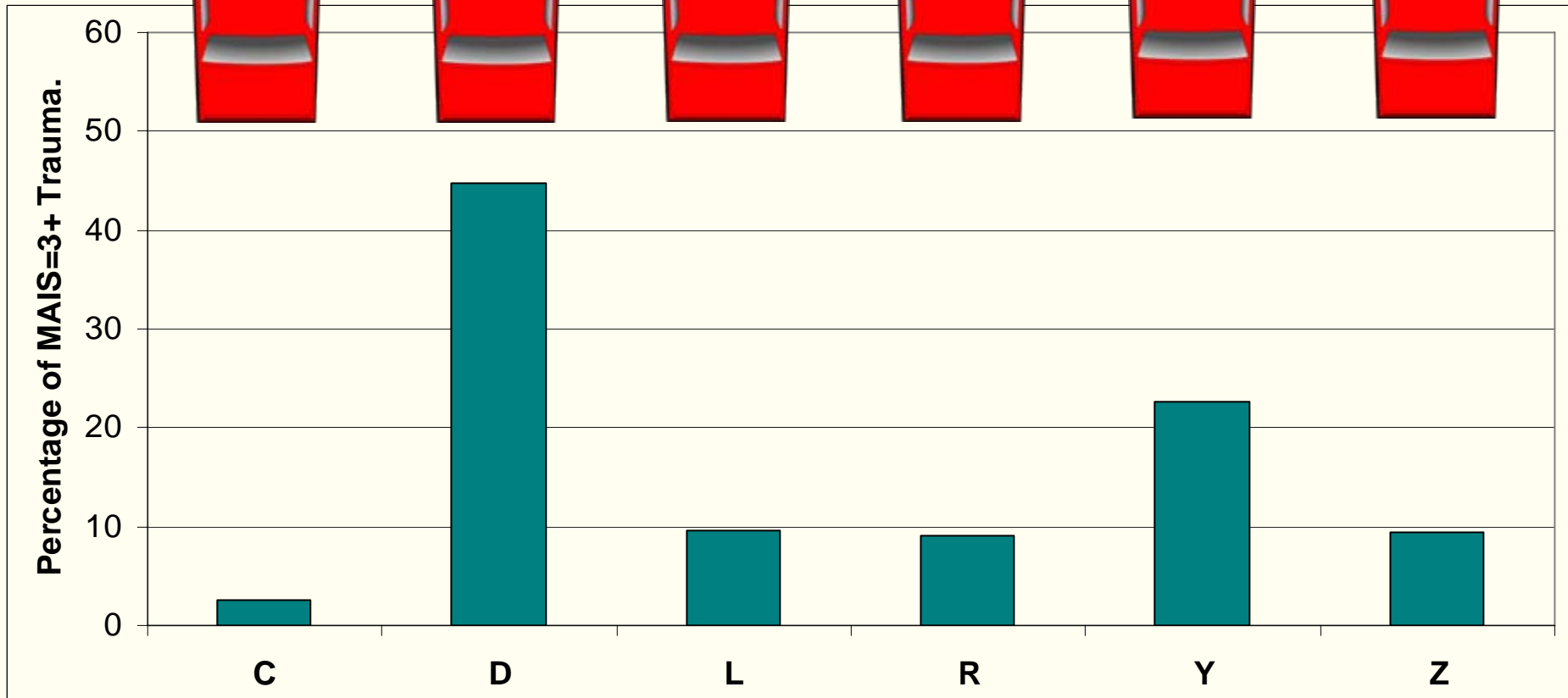
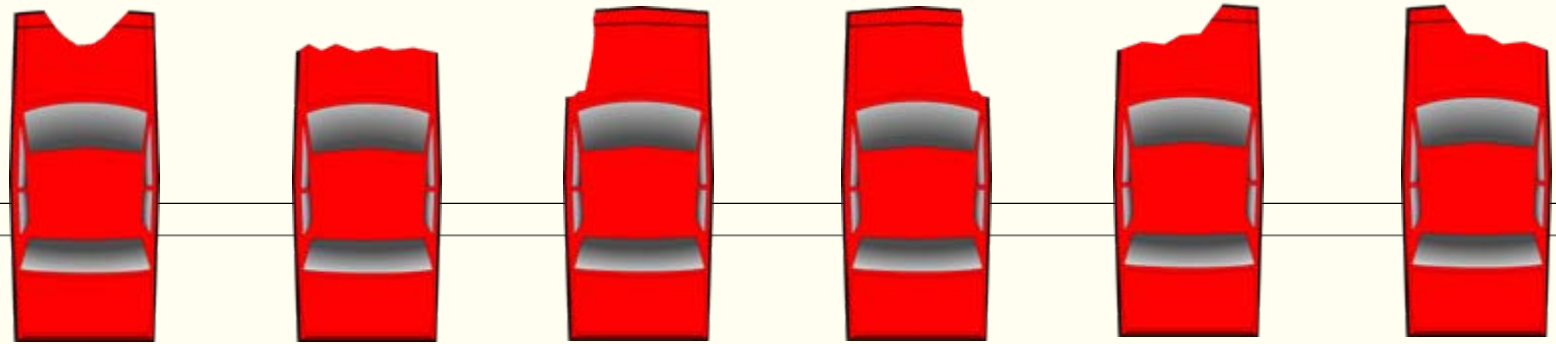
Fatalities in Frontal Impact by Crash Type

NASS Data 2000-2005 Frontal 11, 12, 1 o'clock



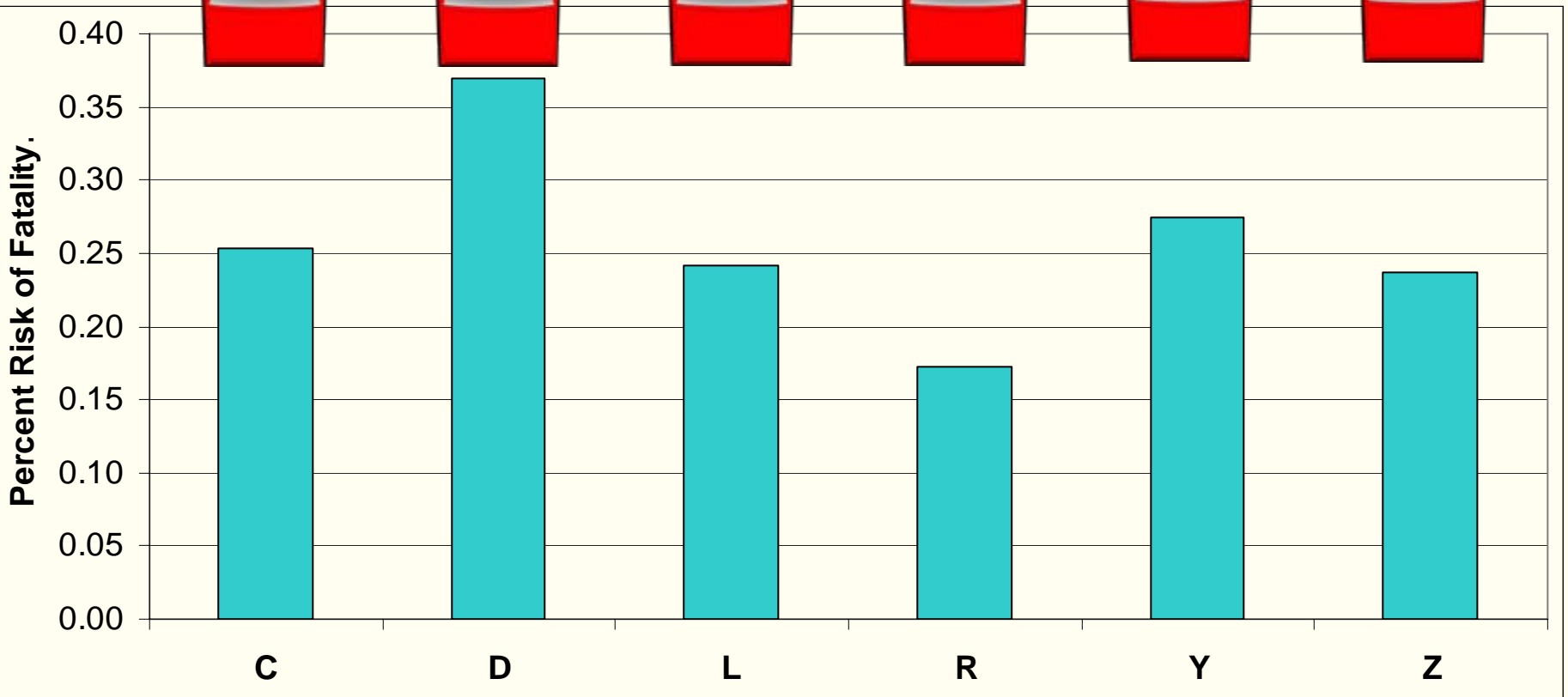
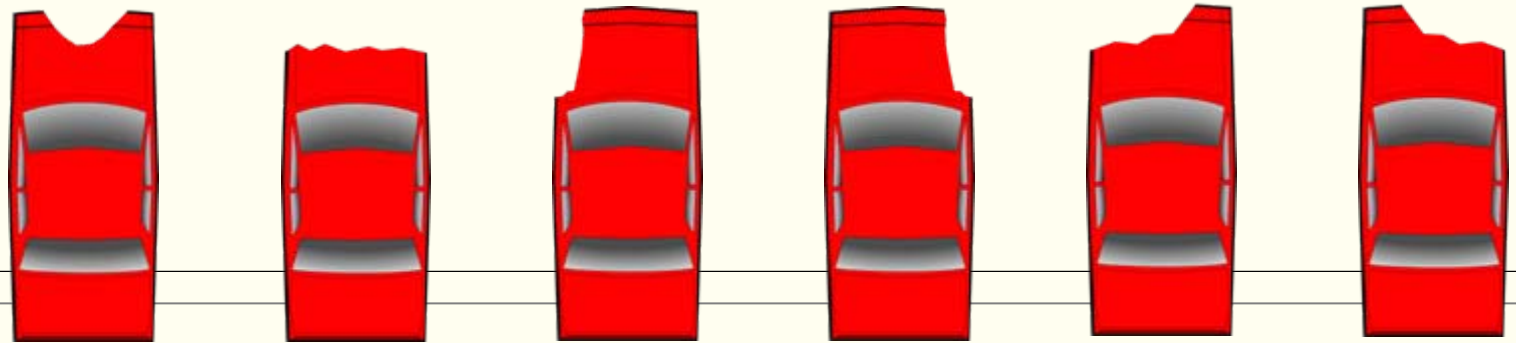
MAIS=3+ Trauma in Frontal Impact by Crash Type

NASS Data 2000-2005 Frontal 11, 12, 1 o'clock



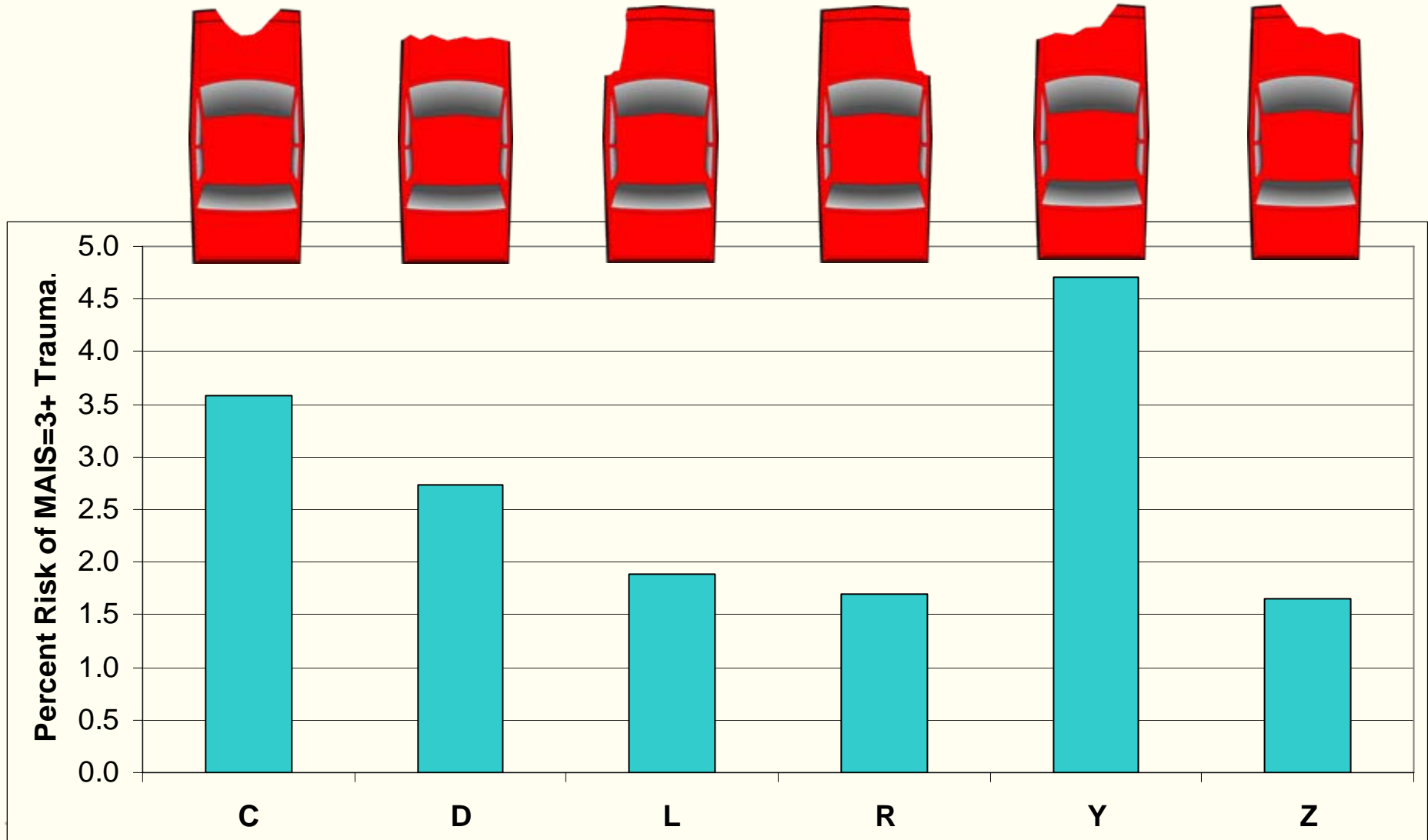
Percent Risk of Fatality in Frontal Impact by Crash Type

NASS Data 2000-2005 Frontal 11, 12, 1 o'clock



Percent Risk of MAIS=3+ Trauma in Frontal Impact by Crash Type

NASS Data 2000-2005 Frontal 11, 12, 1 o'clock



Selection Criteria for CIREN Case

- Case occupant: driver or right front passenger
- Severe Injury: AIS=3+ or 2 AIS=2
- PDOF range: 340 to 0 (left); 0 to 30 (right) degrees
- Vehicle damage did not involve loading of the longitudinal structural members along the X-axis
- No other end or side-plane impacts with an extent zone at least two
- No roll-over event
- The object contacted was another vehicle, a pole or a tree

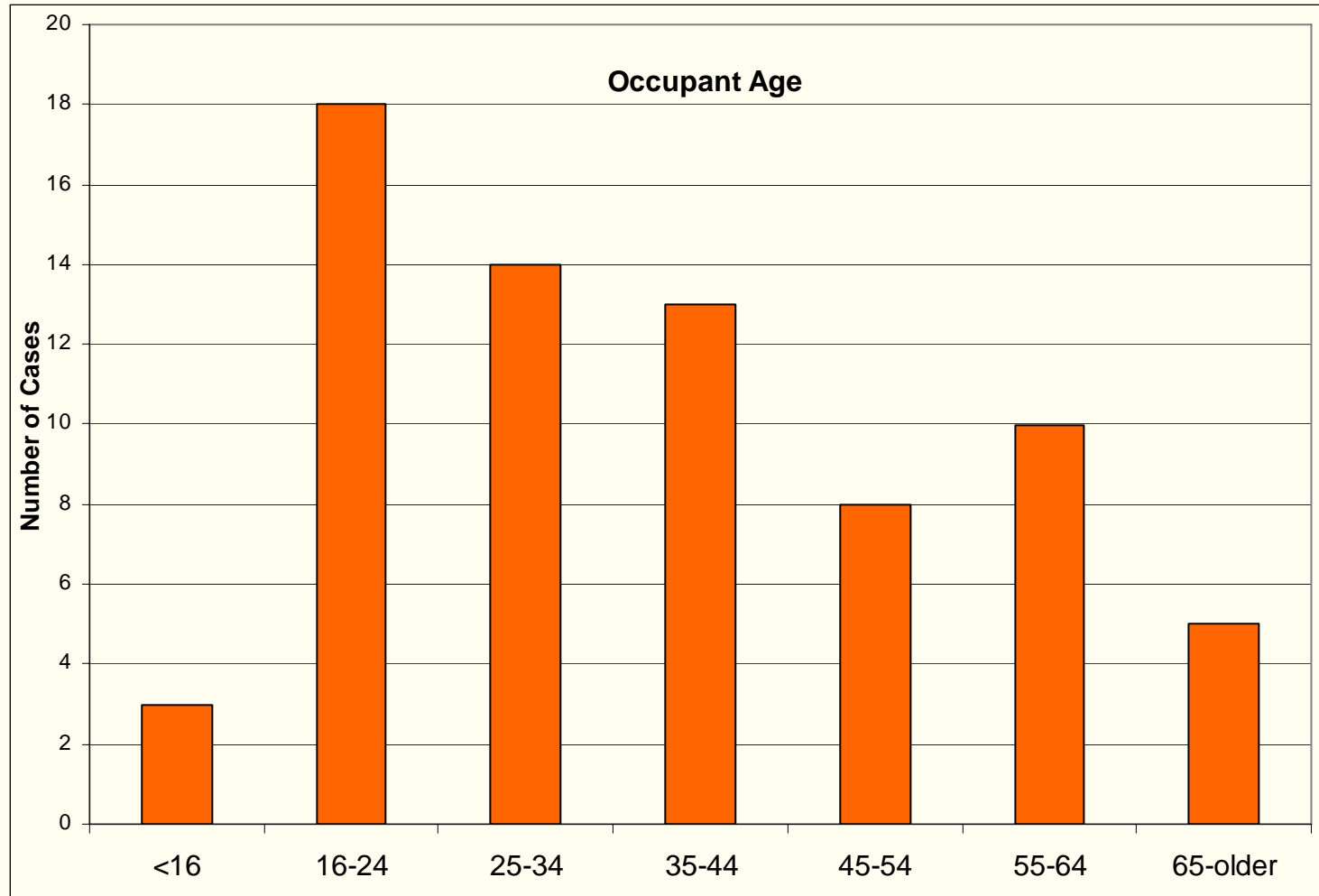
CDC-Code FLEE or FREE Crashes: CIREN Analysis

71 cases analyzed

Of the 71:

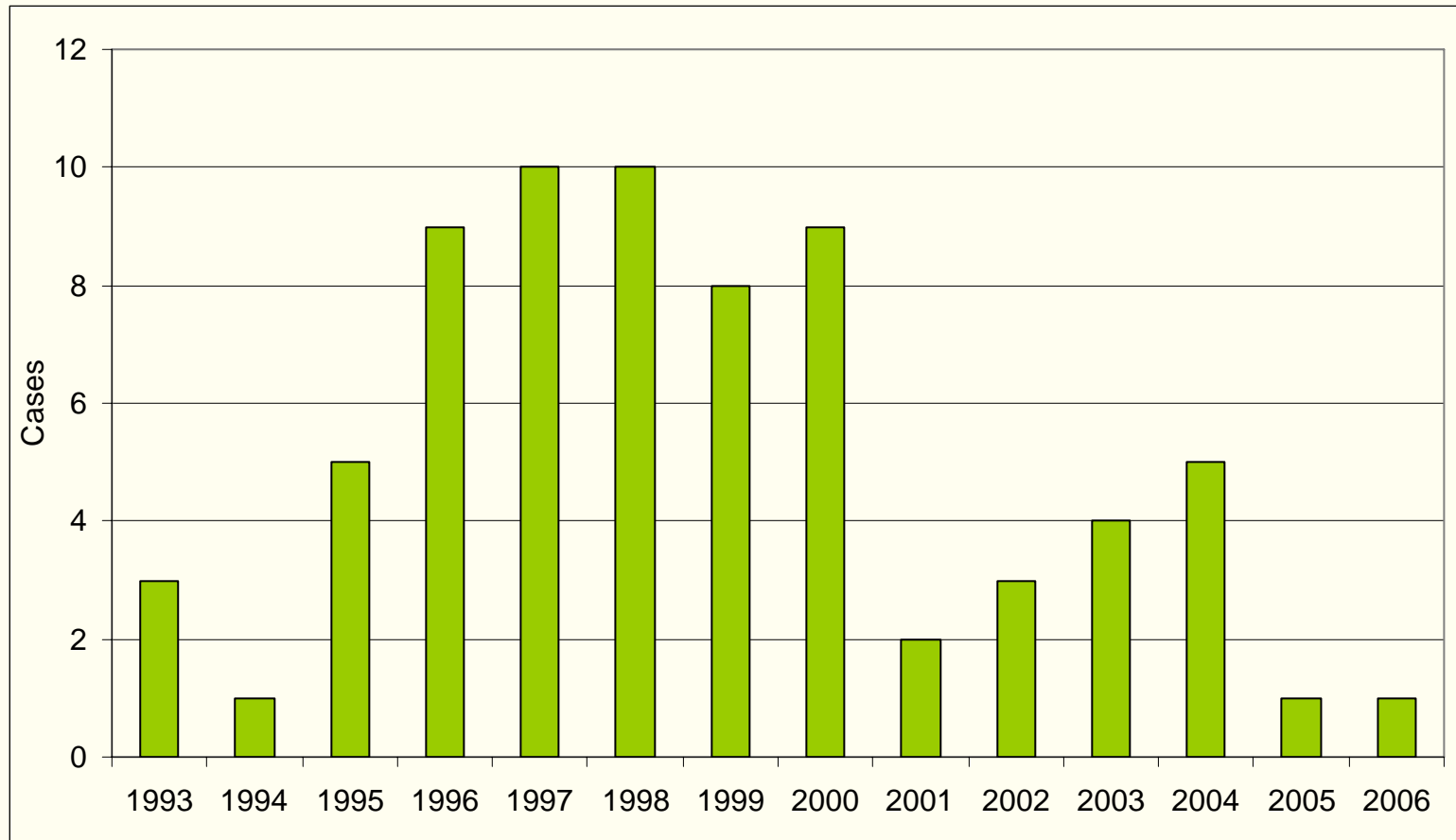
- ≡ 50 drivers, 21 passengers
- ≡ 44 Males; 27 Females
- ≡ 32 from 16-34 yrs; 15 from 55-older
- ≡ 51 belted (72%)
- ≡ 70 (99%) airbag deployed

CIREN Analysis: 71 Corner Impacts



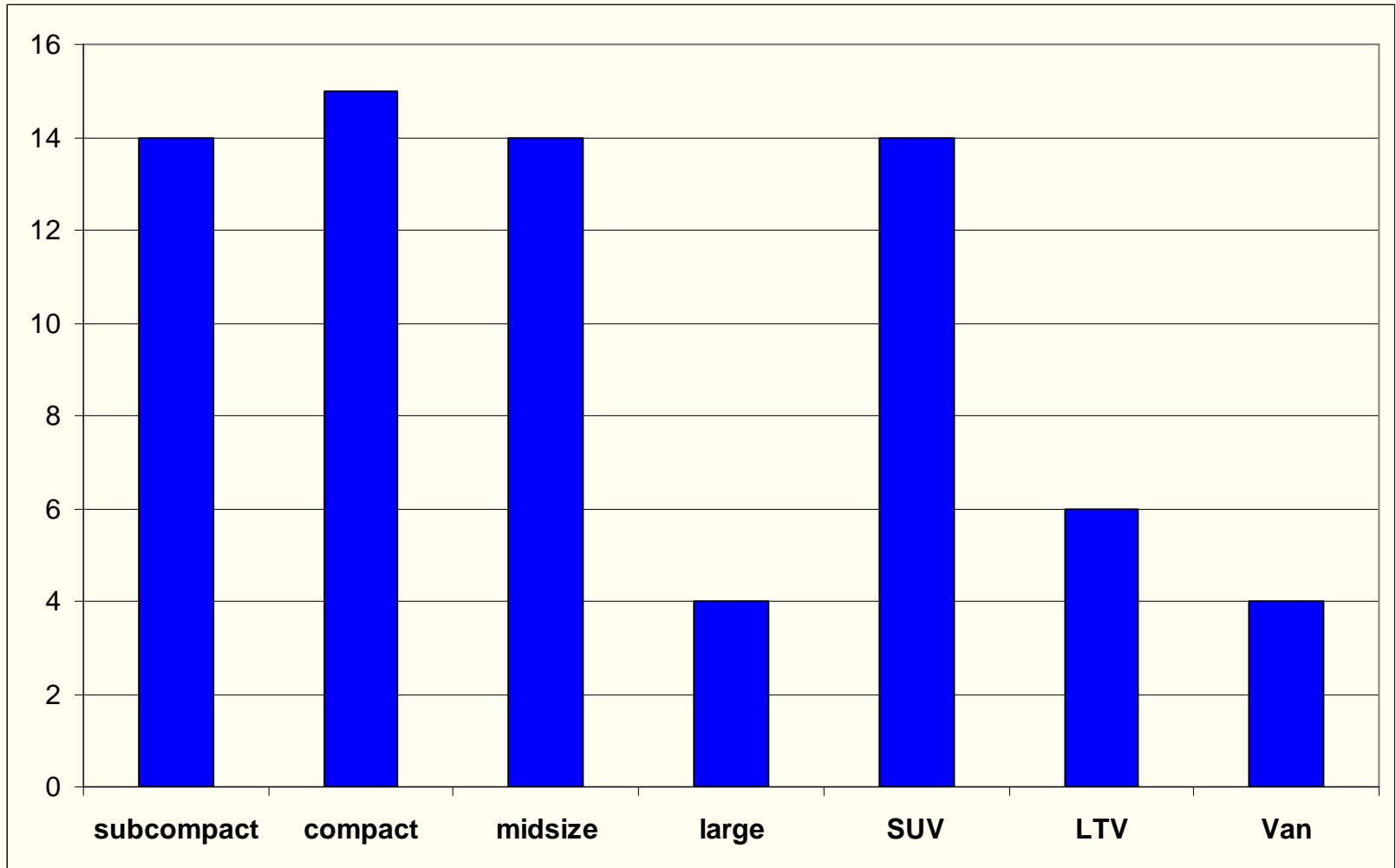
CIREN Analysis: 71 Corner Impacts

Vehicle Model Year



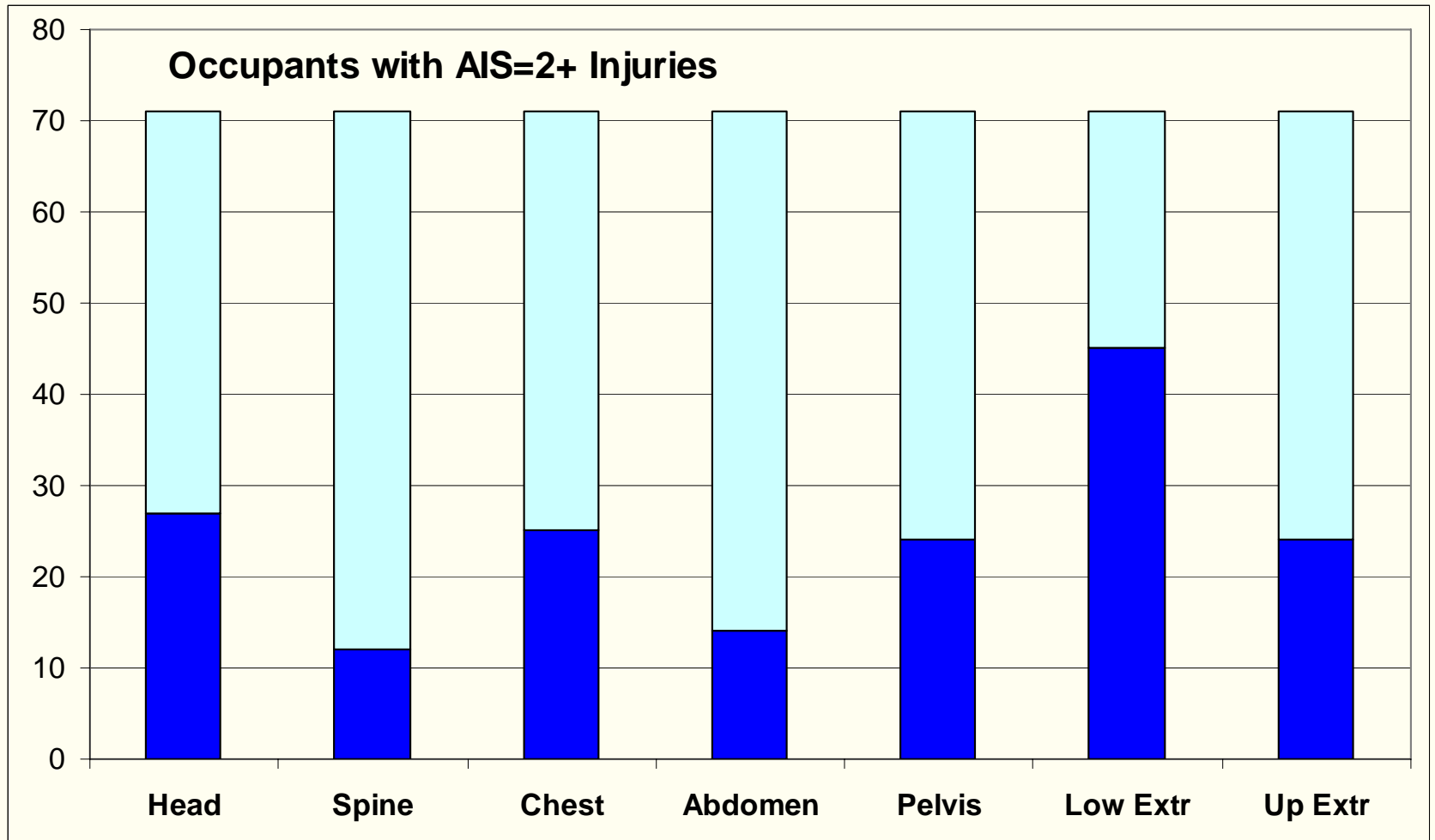
CIREN Analysis: 71 Corner Impacts

Vehicle Type



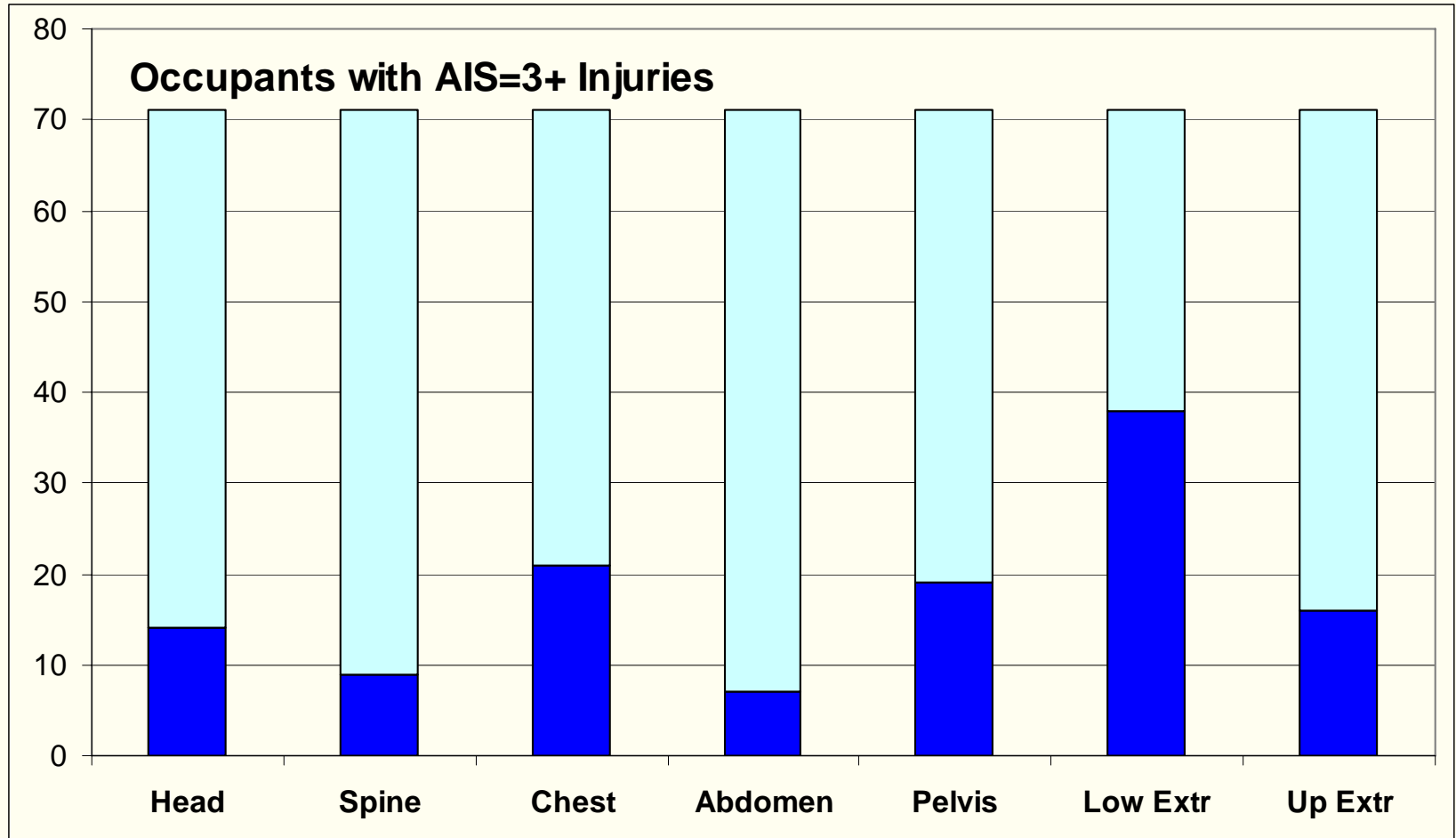
CIREN Analysis: 71 Corner Impacts

Occupant Injuries

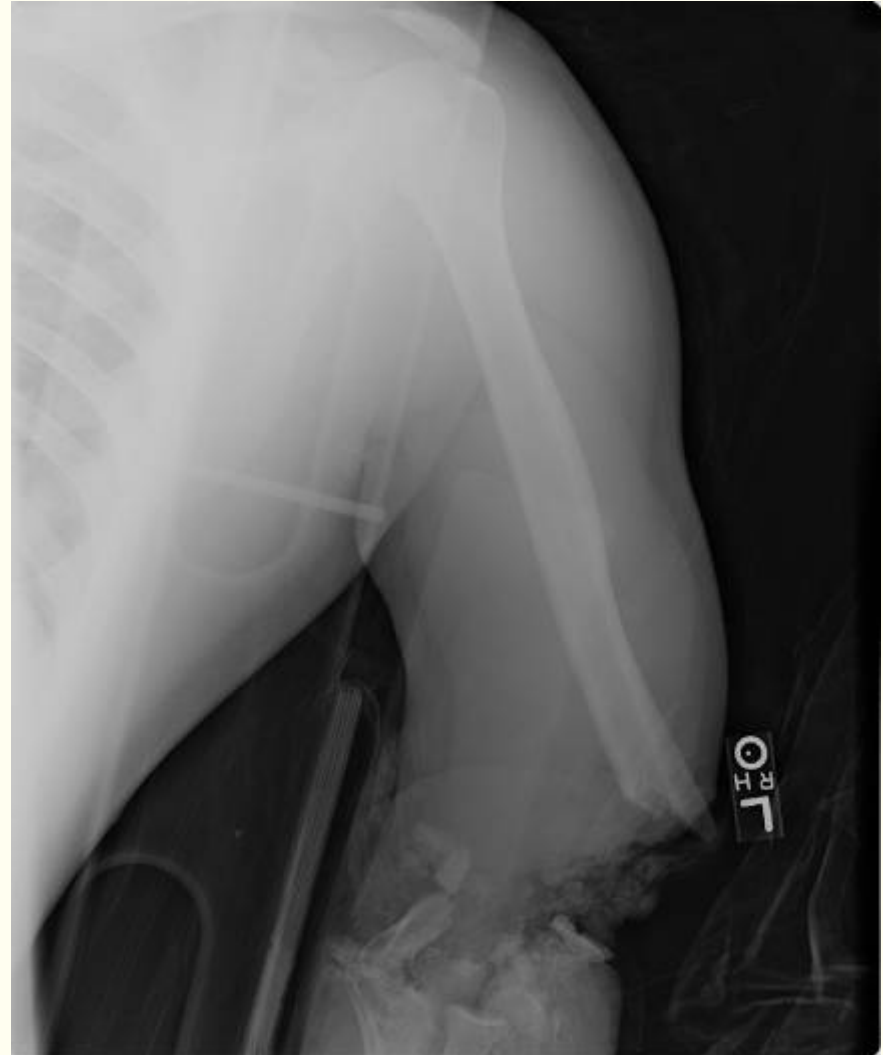


CIREN Analysis: 71 Corner Impacts

Occupant Injuries



Examples of Extremity Trauma: AIS=3

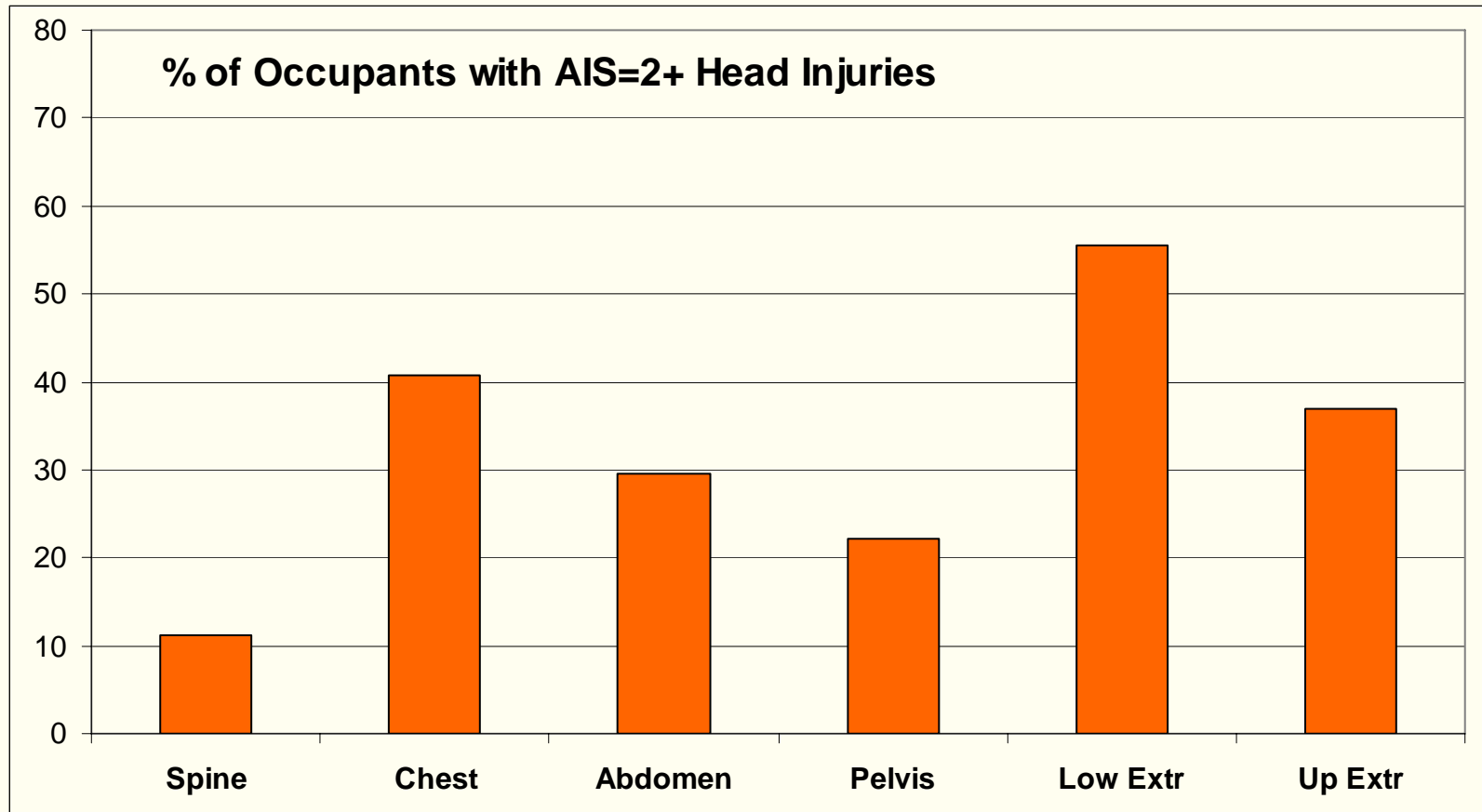


71 CIREN Corner Impacts: Head Trauma

- 12 LOC or Concussion AIS=2+
- 5 hematoma/hemorrhage AIS=3
- 2 Basilar skull fractures AIS=3
- 3 Cerebrum contusion AIS=3
- 1 DAI AIS=5
- 2 Brain Stem Lac or Head crush AIS=6

CIREN Analysis: 71 Corner Impacts

Trauma Associated with Head Injury

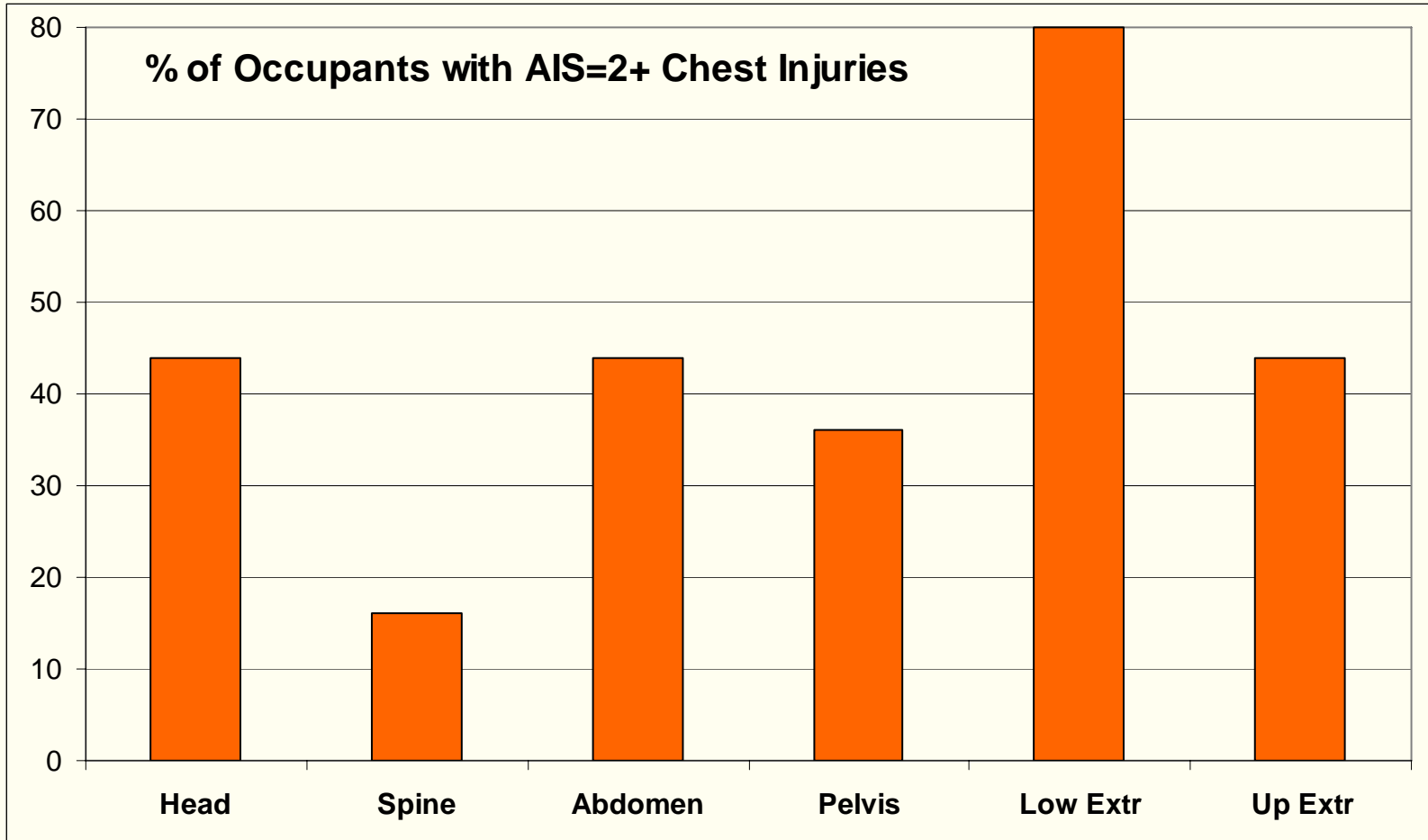


71 CIREN Corner Impacts : Chest Trauma

- 5 Aorta/Heart Laceration AIS=5+
- 17 Rib Fractures AIS=2+
- 9 Lung contusions AIS=3+

CIREN Analysis: 71 Corner Impacts

Trauma Associated with Chest Injury



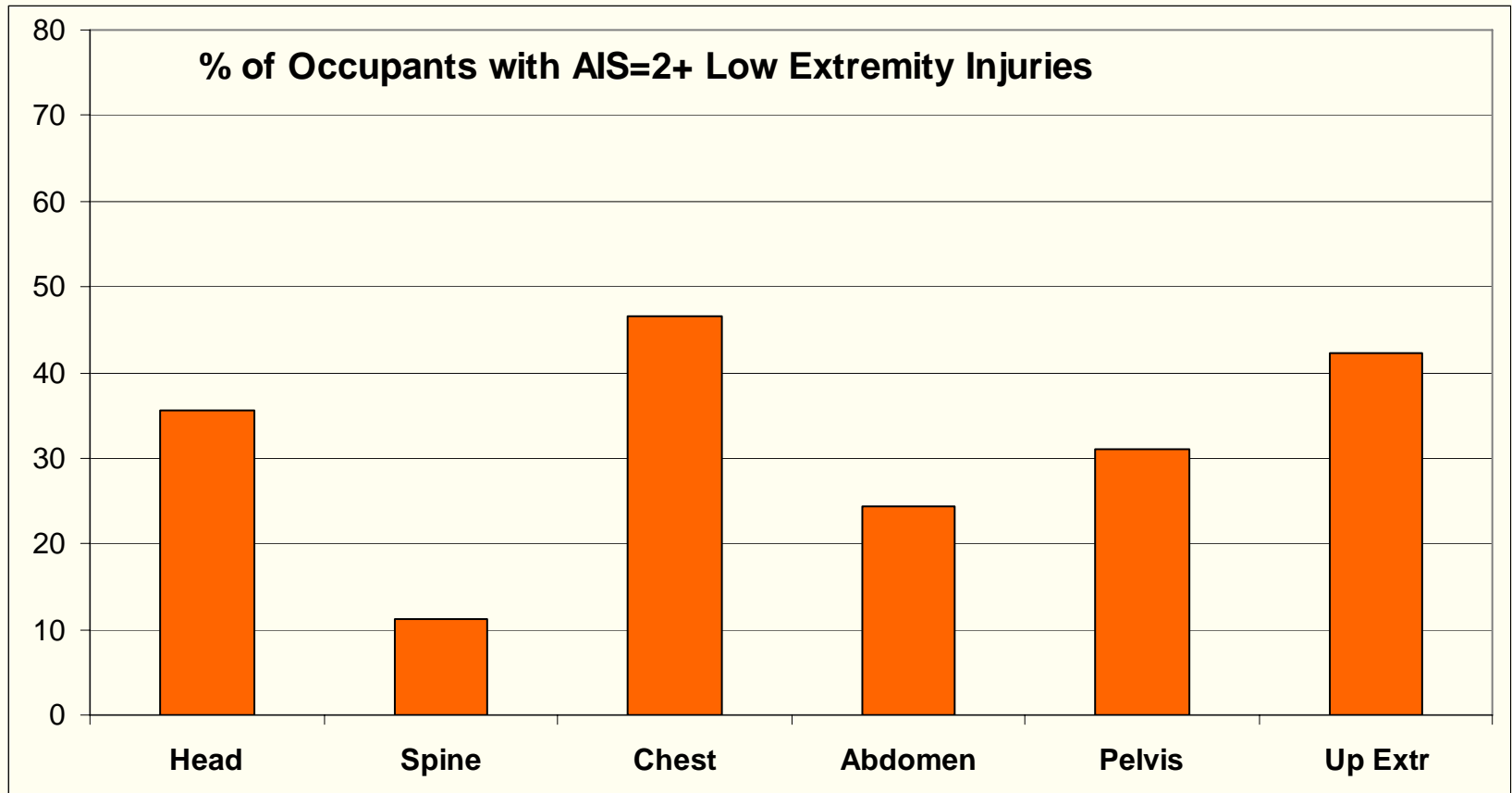
71 CIREN Corner Impacts : Lower Extremity Trauma

- 33 Femur Fractures AIS=3
- 22 Tibia/Fibula Fractures AIS=2 or 3
- 24 Pelvis Fracture or Crush AIS=2, 3, or 4

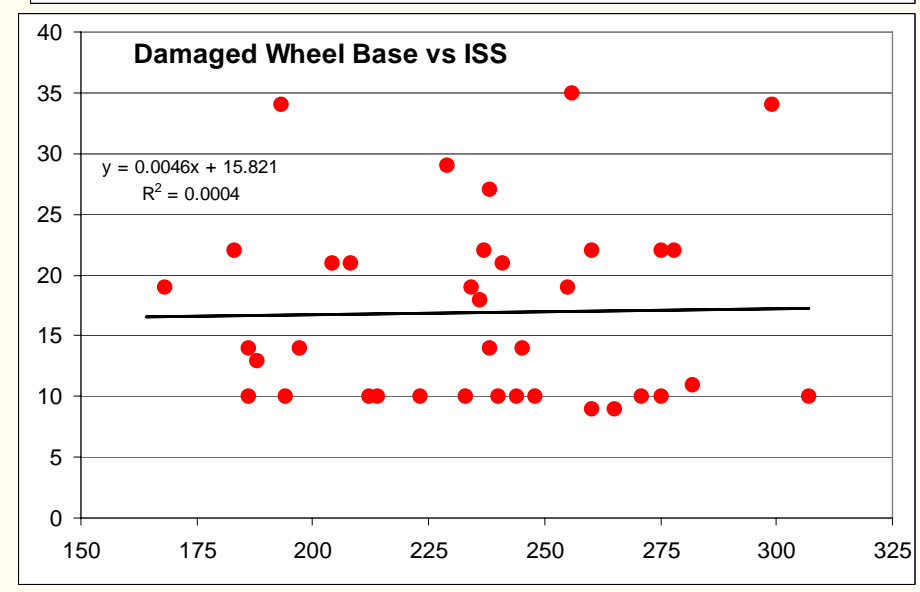
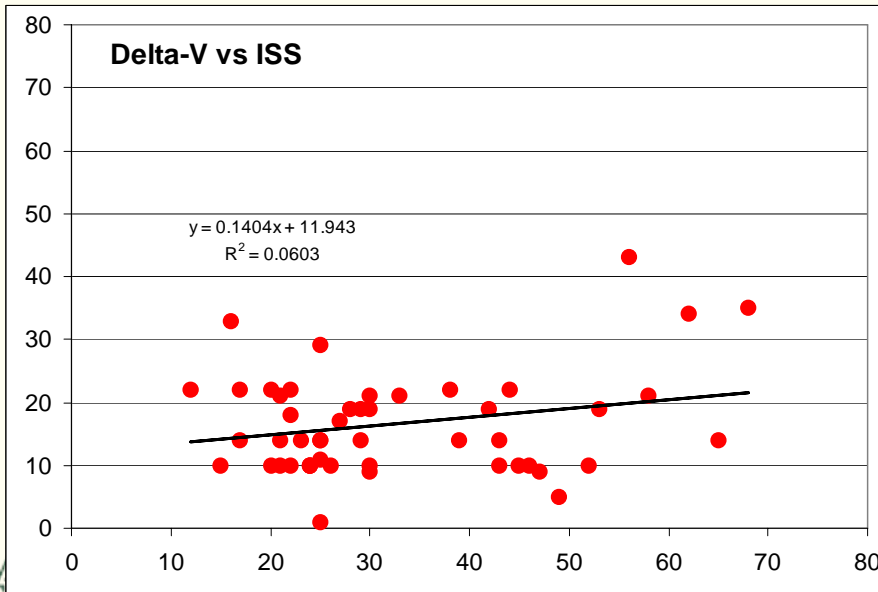
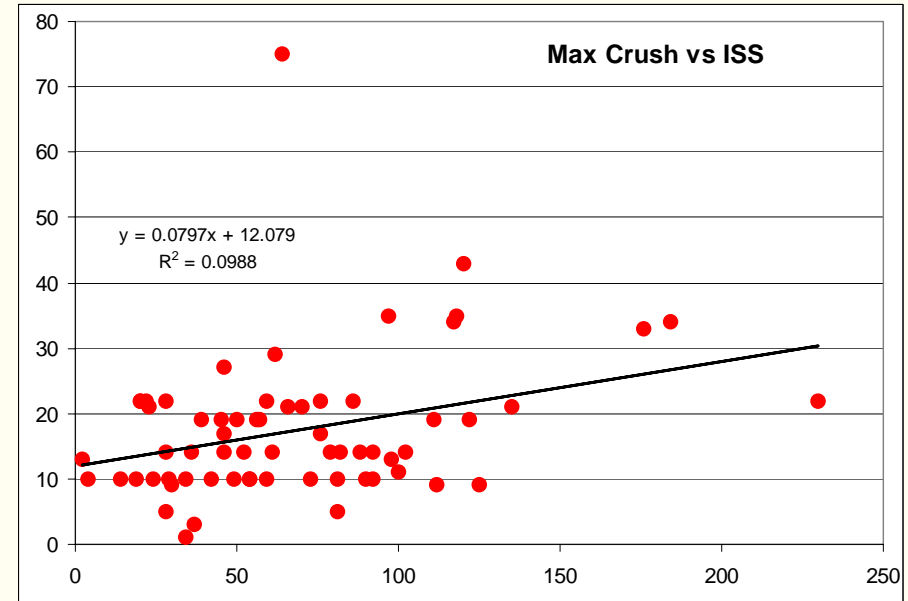
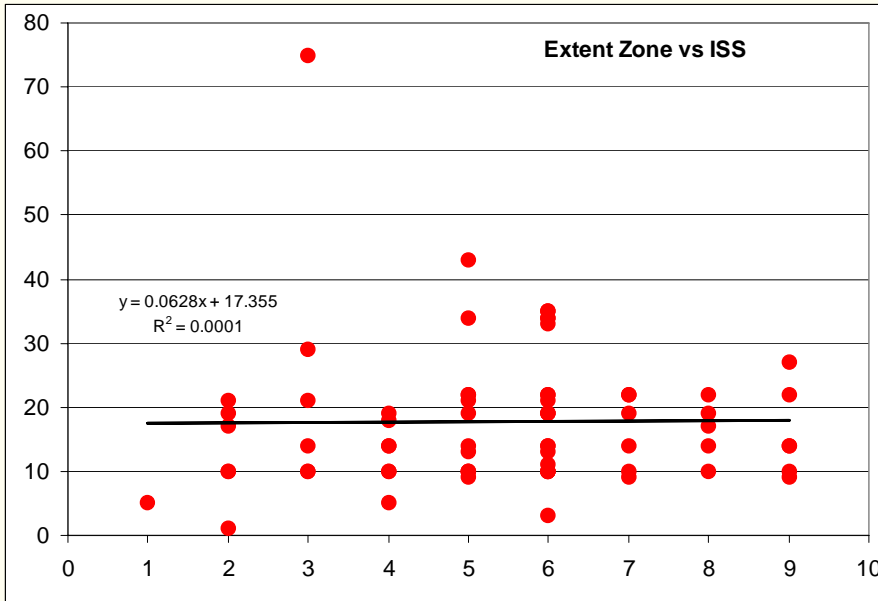


CIREN Analysis: 71 Corner Impacts

Trauma Associated with Low Extremity Injury

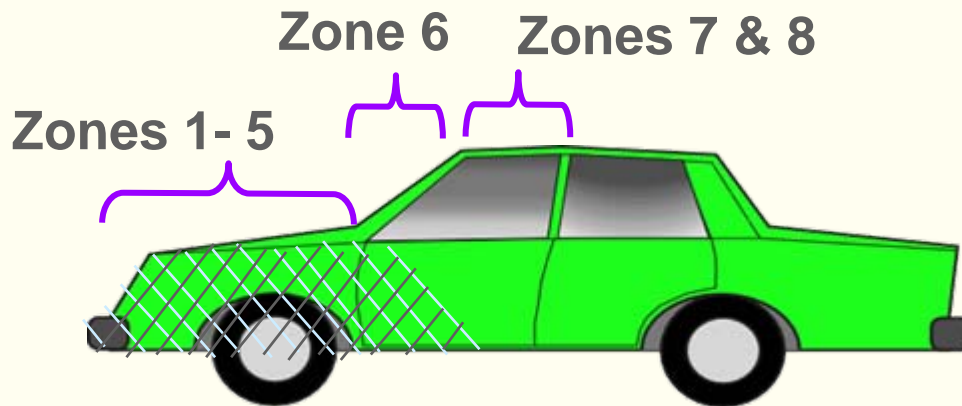
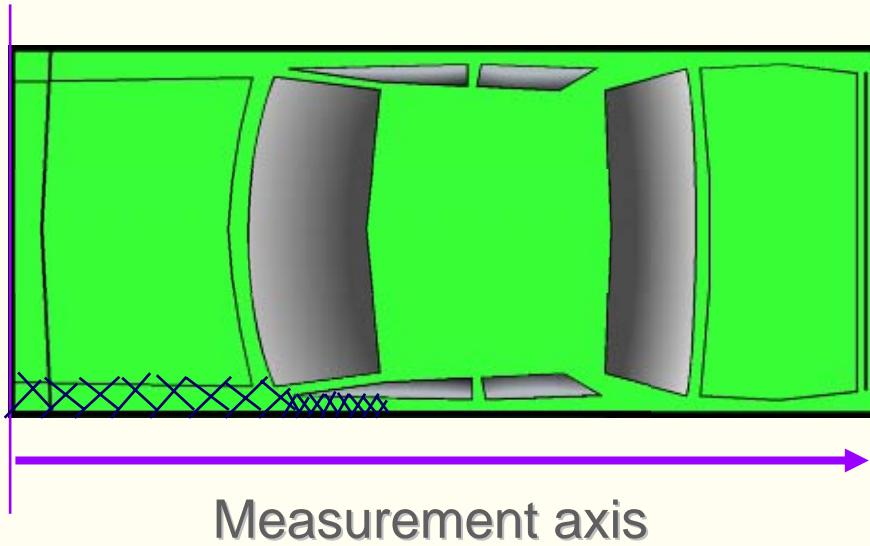


CIREN 71 Corner Impacts: Severity



Extent

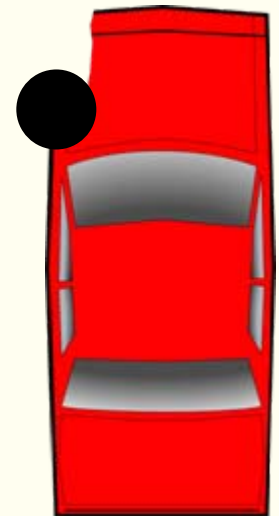
Front-end
plane



CIREN Analysis: 71 Corner Impacts

Front Tree/Pole Crashes

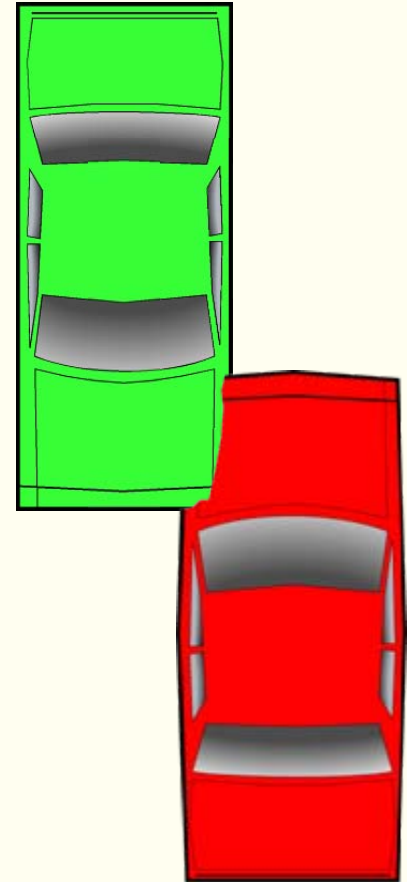
- 31 cases
- Extent Zone
 - Zone-2-5: 21 cases
 - Zone-6-9: 11 cases
- Average ISS = 18



CIREN Analysis: 71 Corner Impacts

Front-to-front Crashes – Matched Vehicles

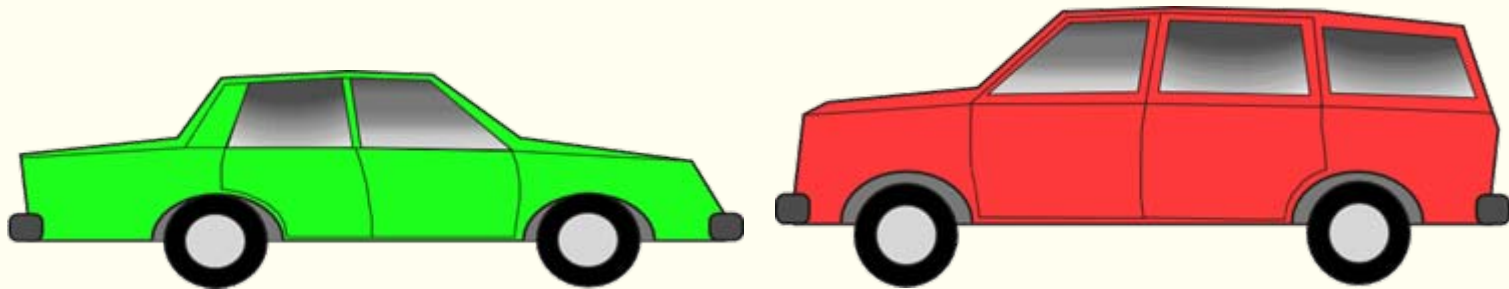
- 22 cases
- Extent Zone
 - Zone-2-5: 7 cases
 - Zone-6-9: 15 cases
- Average ISS = 18



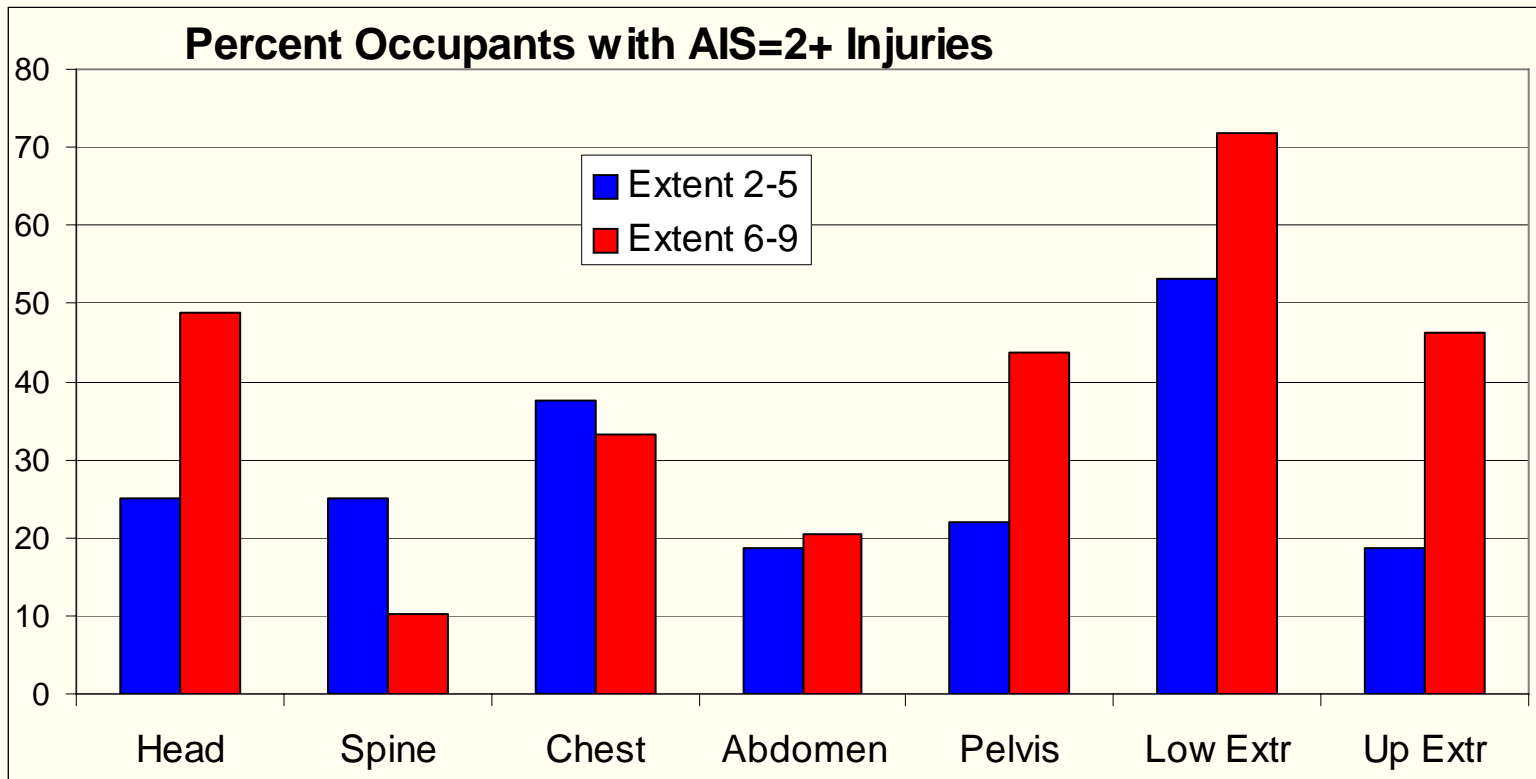
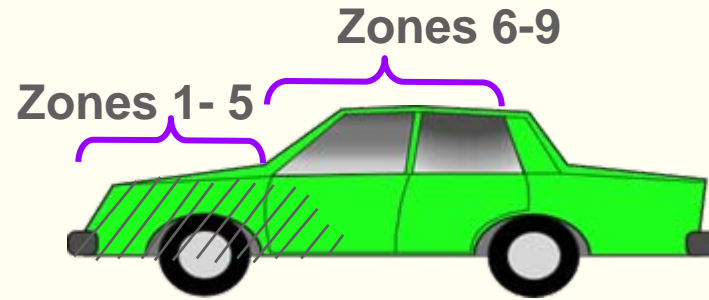
CIREN Analysis: 71 Corner Impacts

Front-to-front Crashes – Mismatched Vehicles

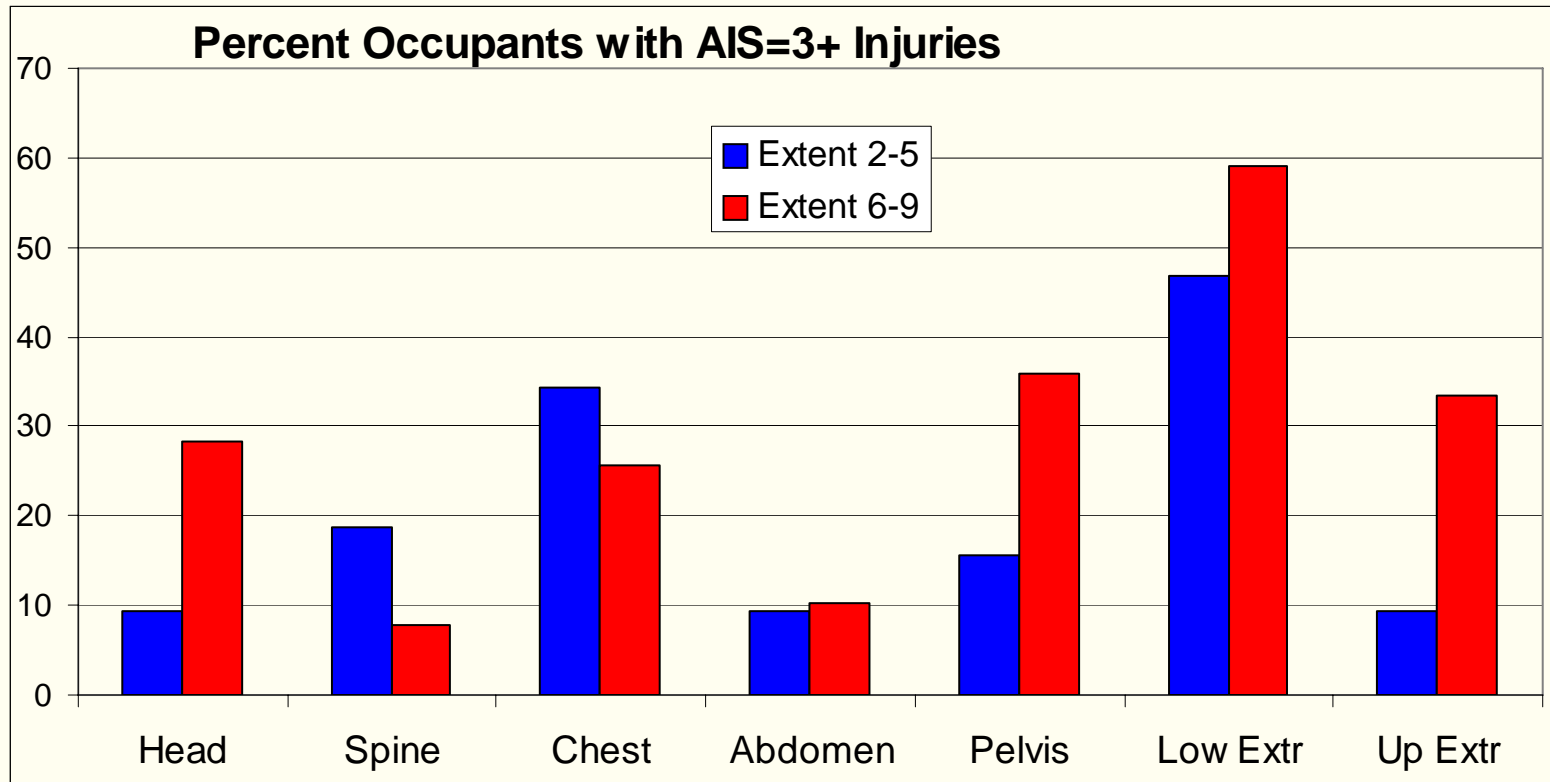
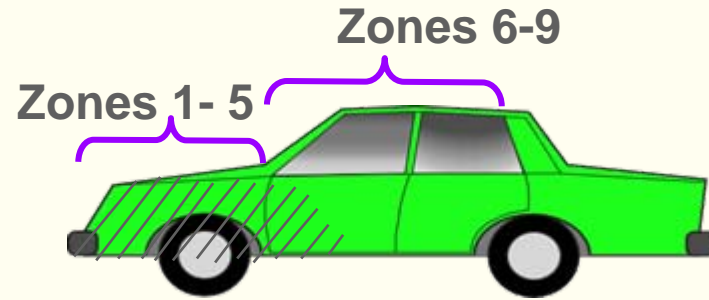
- 16 cases
- Extent Zone
 - Zone-2-5: 4 cases
 - Zone-6-9: 12 cases
- Average ISS = 24



CIREN Analysis: 71 Corner Impacts

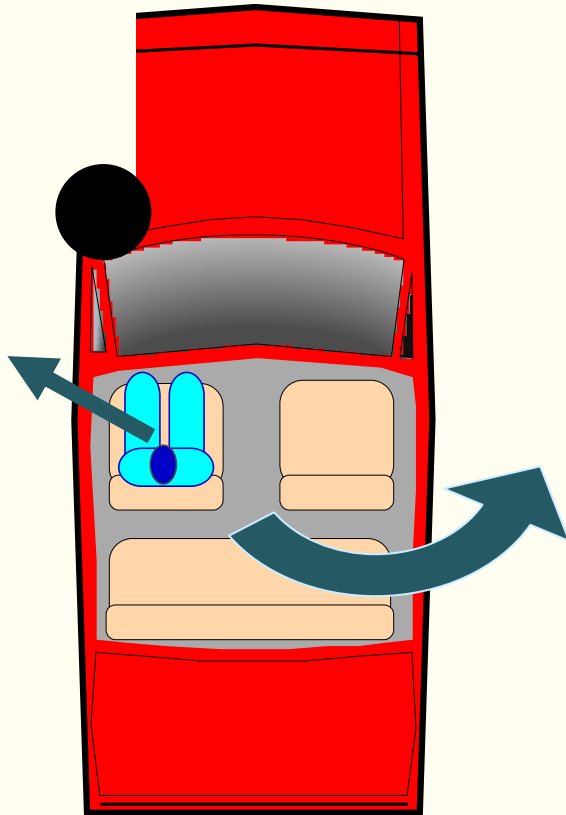


CIREN Analysis: 71 Corner Impacts



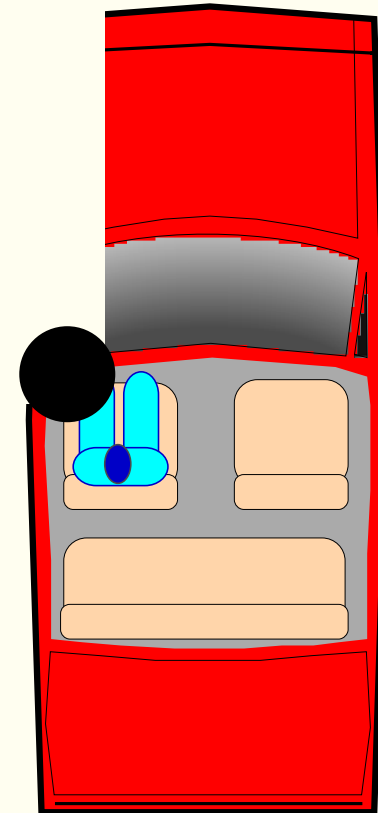
Injury Mechanism Theory: Corner Impacts

Extent Zone 1-5



Occupant
Side Impact

Extent Zone 6-9



Occupant
Frontal Impact

Conduct Corner Impact Crash Test



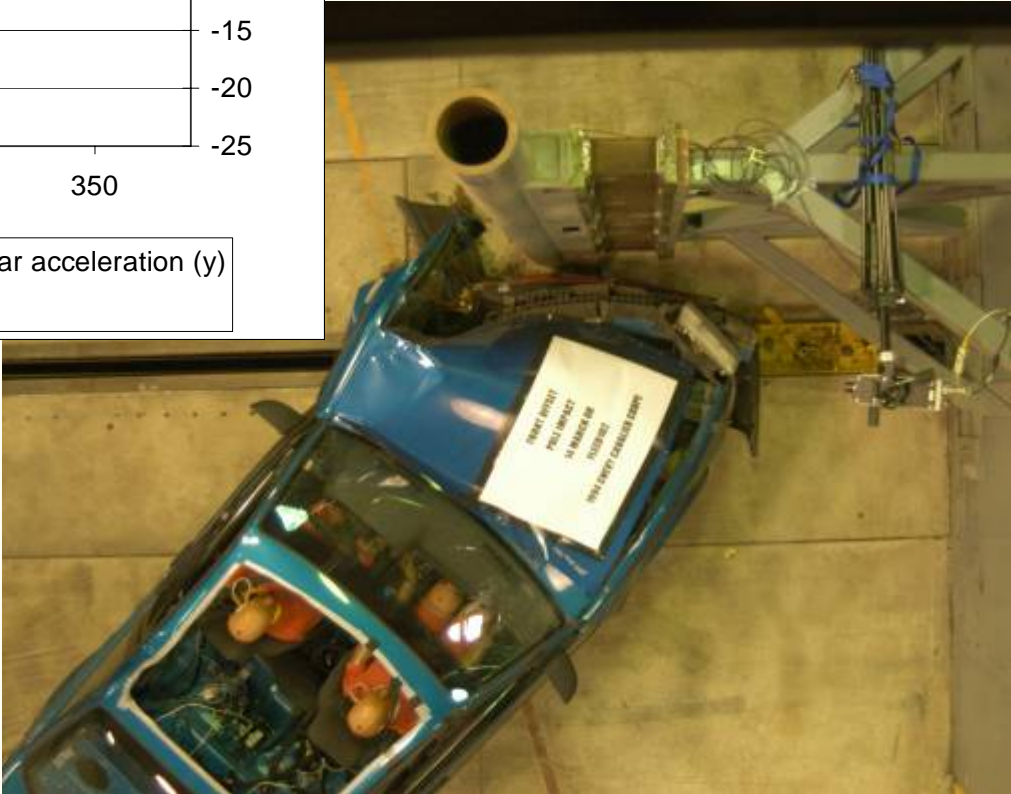
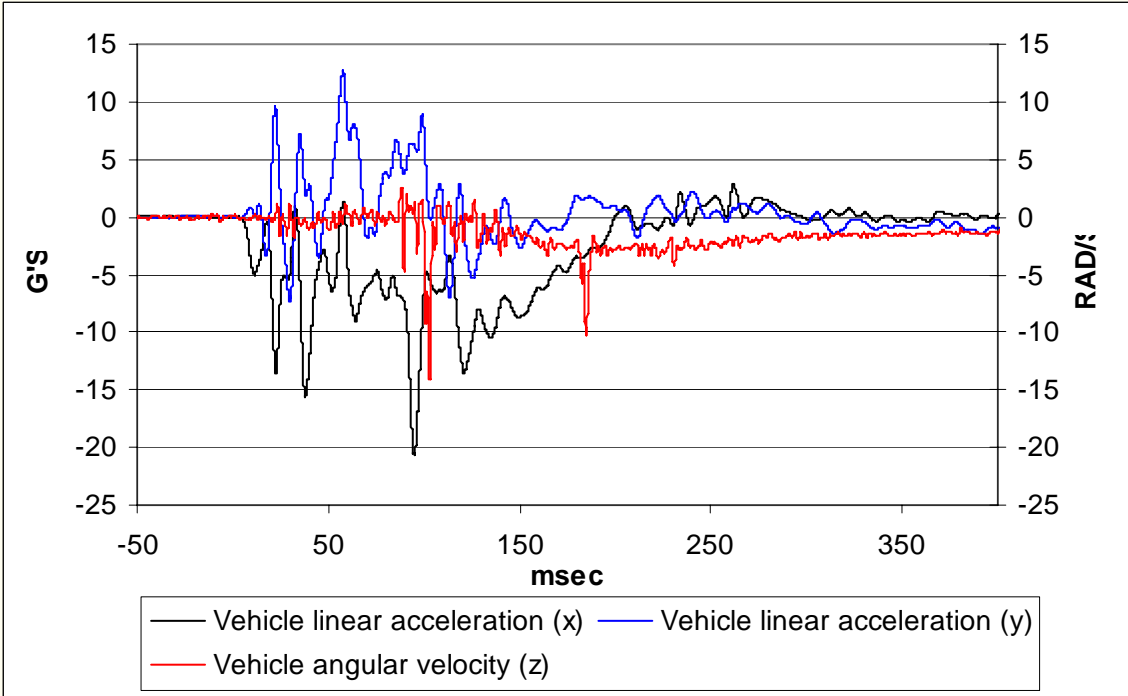
Corner Impact Crash Test Results

Crash test video

Corner Impact Crash Test Results

Crash test video

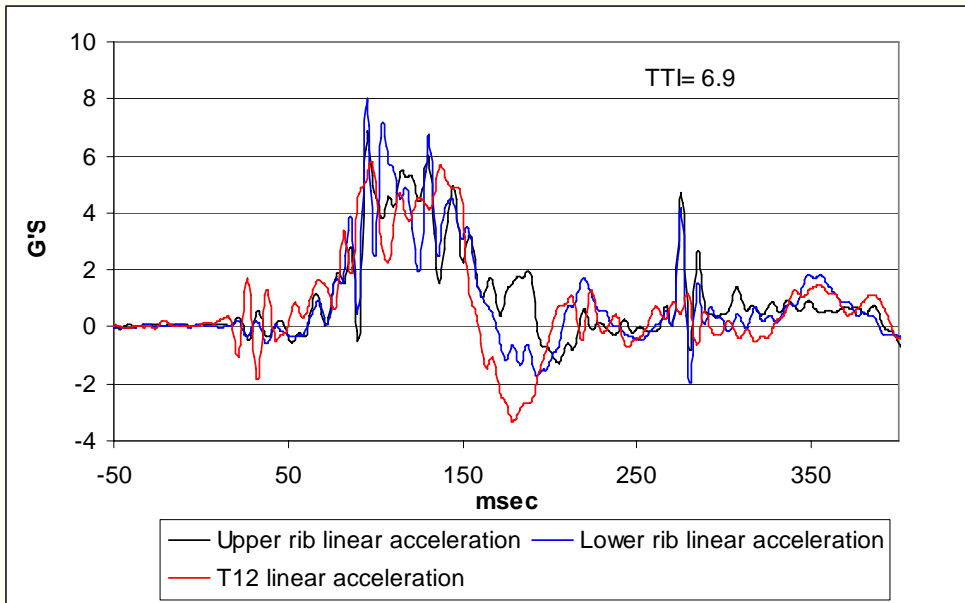
Corner Impact Crash Test Result



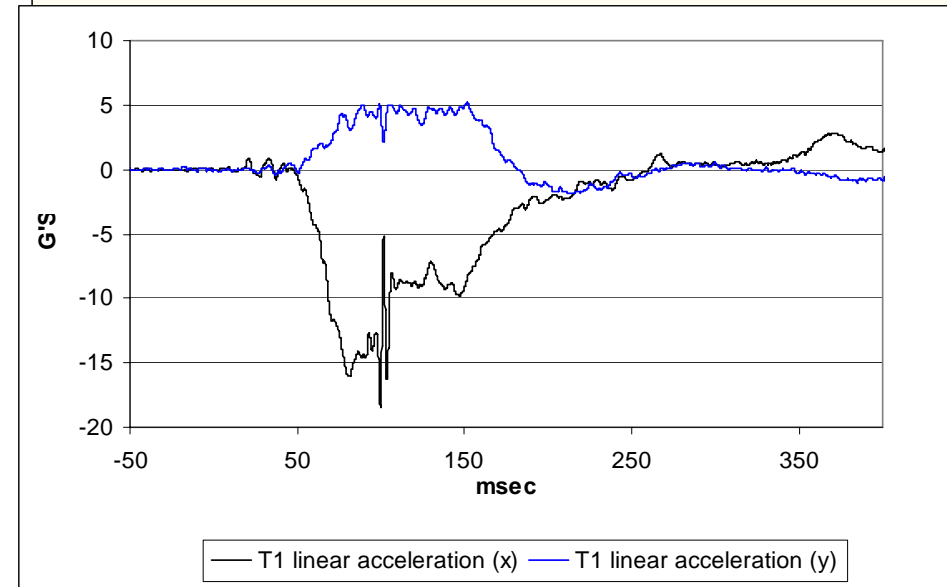
Extent zone = 4

Corner Impact Crash Test Results

Driver Response



Passenger Response

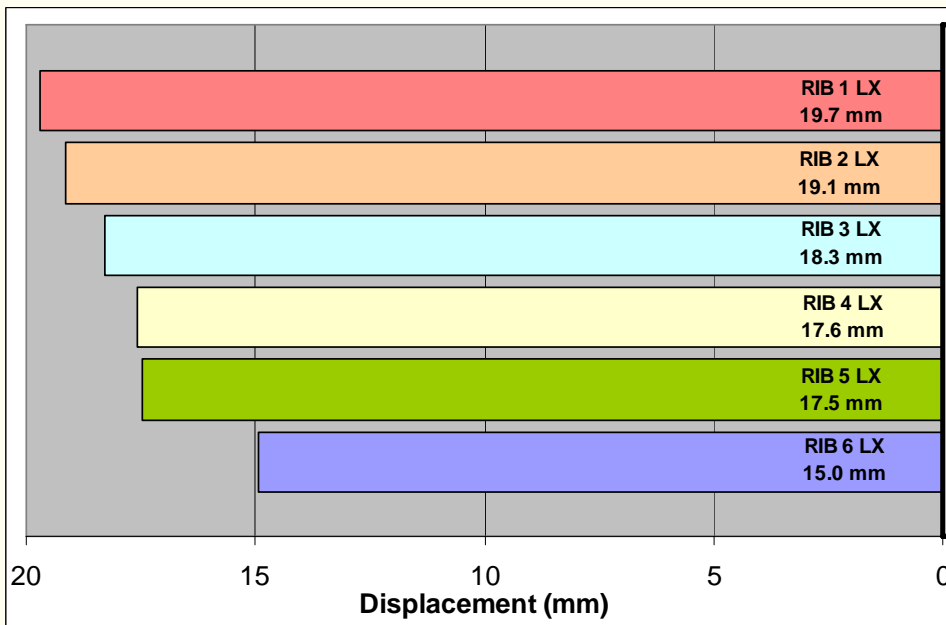


Corner Impact Crash Test Results

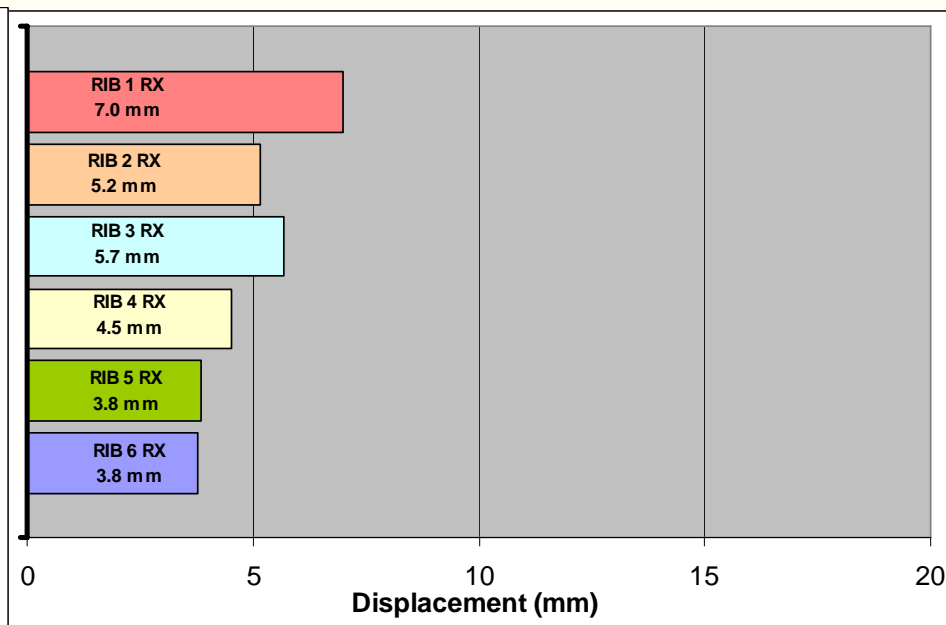
Passenger Chest Deflections
RibEye® Instrumentation
Front-to-Back Deflections



LEFT CHEST



RIGHT CHEST



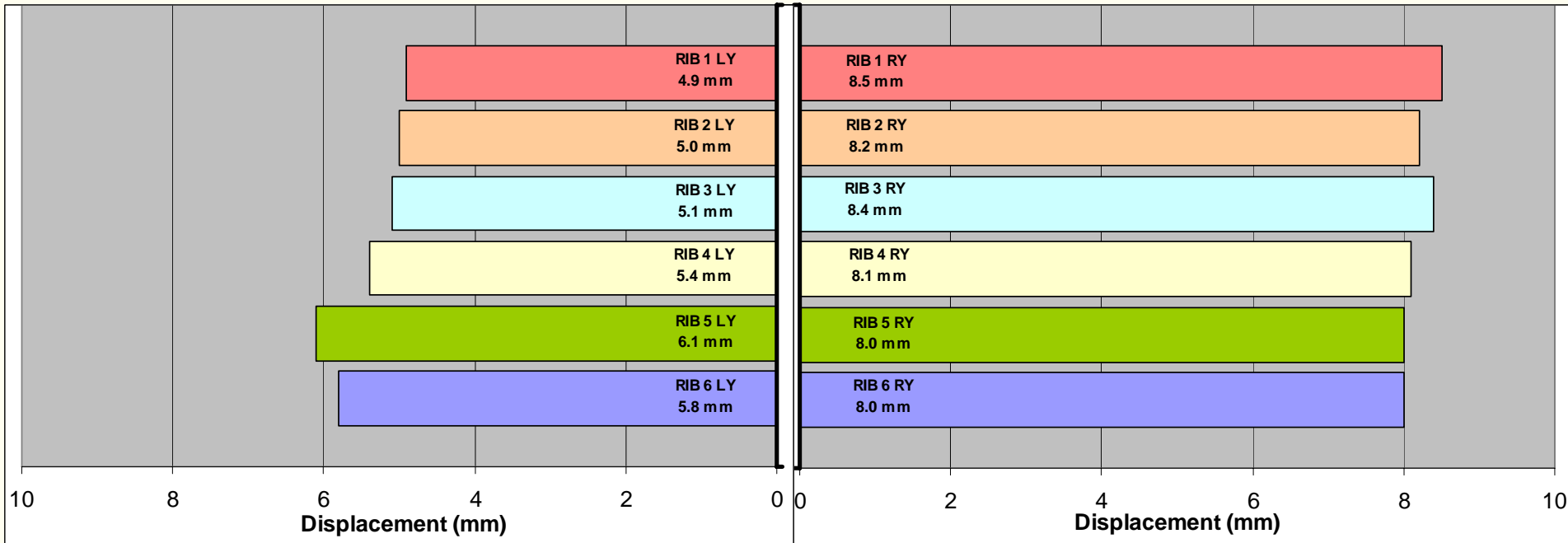
Corner Impact Crash Test Results

Passenger Chest Deflections
RibEye® Instrumentation
Left-to-Right Deflections



LEFT CHEST

RIGHT CHEST



Summary: 71 Corner Impact Crashes

- Frontal corner impacts a significant percentage of fatalities/severe trauma
- Severe lower extremity trauma with chest and pelvis trauma
- Impact type matters
 - ⌘ Tree/pole or Matched vehicles: ISS=18
 - ⌘ Mismatched vehicles: ISS=24
- Delta-V, crush measures not good predictors of trauma severity
- Extent zone crush may cause different occupant kinematics and interaction with airbag
- Recommend vehicle structural inspection with crush measures

Acknowledgment

This research was supported in part by

US Dept. of Transportation NHTSA,

Dept. of Veterans Affairs Medical Research