# Injuries to Restrained Occupants in Far-side Crashes

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# Research Approach

- Identify injury distributions with NASS/CDS 1988-98 data
- Conduct crash tests to evaluate occupant motion in a vehicle-to-vehicle far-side crash mode

# Harm Distribution Front Occupants in Side Crashes

| Position | Frequency | Harm |
|---|---|---|
| Near | 66% | 71.5% |
| Far | 34% | 28.5% |
| | | |
| Ratio | 1.9 | 2.5 |

NASS/CDS 1988-1997

# NASS/CDS Data

Combined Years

1988-1998

# AIS 3+ Injuring Contacts-
## Far-side Crashes, NASS/CDS

| Injuring Contact | No |
|---|---|
| Far Side Interior | 245 |
| Safety Belt | 75 |
| Roof | 57 |

# AIS 3+ Injuring Contacts-
## Far-side Crashes, NASS/CDS

| Injuring Contact | No | Unwgt |
|---|---|---|
| Far Side Interior | 245 | 32% |
| Safety Belt | 75 | 10% |
| Roof | 57 | 7% |

# AIS 3+ Injuring Contacts-
## Far-side Crashes, NASS/CDS

| Injuring Contact | No | Unwgt | Wgt |
|---|---|---|---|
| Far Side Interior | 245 | 32% | 27% |
| Safety Belt | 75 | 10% | 21% |
| Roof | 57 | 7% | 12% |

# AIS 3+ Injuring Contacts-
## Far-side Crashes, NASS/CDS

| Injuring Contact | No | Unwgt | Wgt | Ave Wgt |
|---|---|---|---|---|
| Far Side Interior | 245 | 32% | 27% | 70 |
| Safety Belt | 75 | 10% | 21% | 178 |
| Roof | 57 | 7% | 12% | 137 |

# Major Injuring Contacts

- Far Side Interior
- Seatbelt

# Most Frequent AIS 3+ Injury Combinations – Far Side Crashes

| Body Region | Contact | Weighted Percent | Crash Severity |
|---|---|---|---|
| Trunk | Safety Belt | 21% | Low |
| Trunk | Far Side Interior | 12% | High |
| Head | Far Side Interior | 11% | High |
| Head/Spine | Roof | 13% | Mod |

# The Research Question

- What is causing the injuries?
  - o Head to Opposite Side at Hi Severity
  - o Trunk to Seat Belt at Low Severity

- Examine NHTSA Crash Test Data
  - x One far side test at 90 degrees

# Crash Test - Far-Side Dummy

**Delta -V**
**18 kph**

**PDOF**
**9 O'clock**
**(90 degrees)**

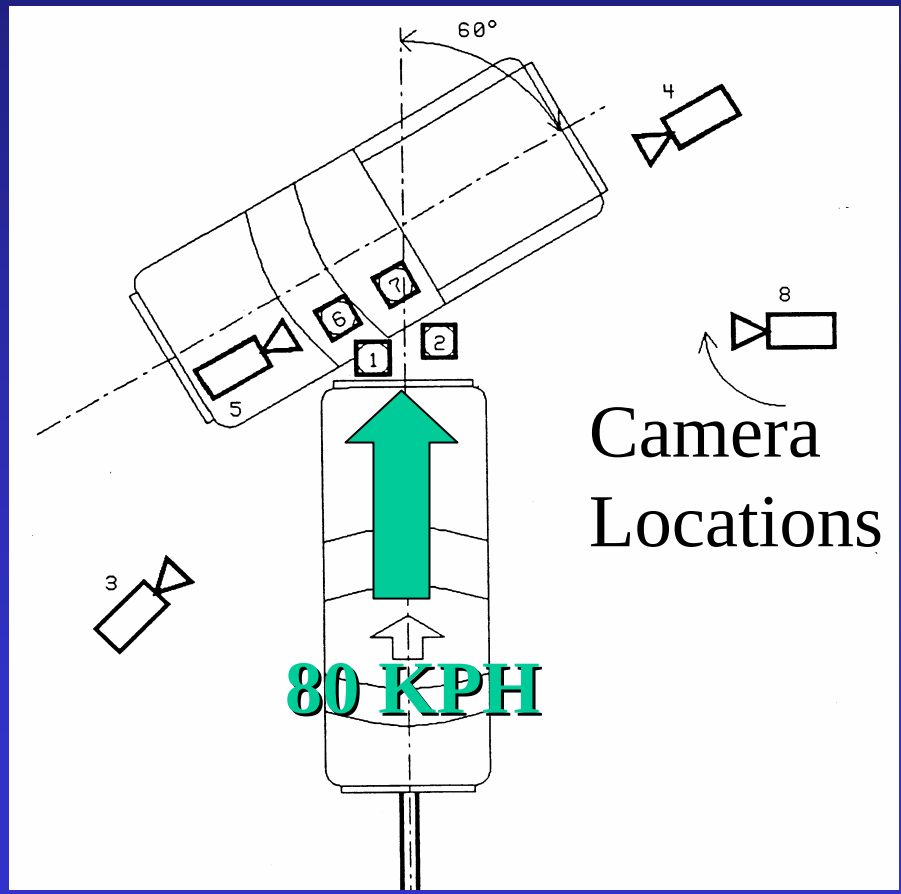
# Observations

- Shoulder belt ineffective in 90 degree opposite-side crashes
- Lap belt loading may be through soft tissue

# Research Questions for Crash Testing

- How effective is the shoulder belt in side crashes other than 90 degrees?
- Do different belt latch rings make a difference?

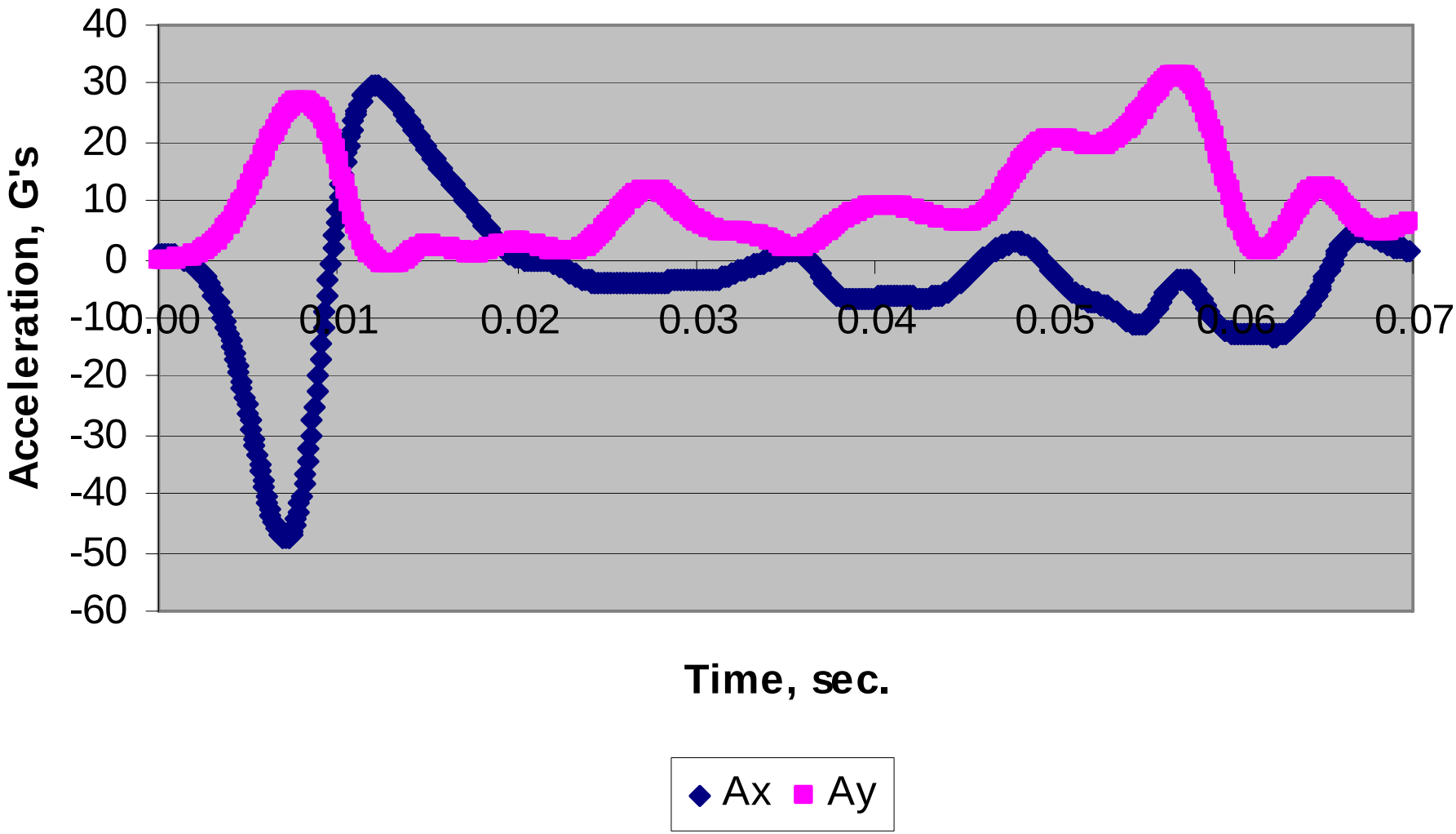
# Crash Configuration



# Far-side Crash Tests

- Side Impact – Chevrolet Caprice Bullet
  Chevrolet Pickup Target
- 80 kph, 60$^{o}$ Impact by Caprice
- No Occupant Compartment Intrusion

# Crash Pulse


40
30
20
10
0
-10
-20
-30
-40
-50
-60
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
Acceleration, G's
Time, sec.
Ax
Ay

# Belt Configurations Tested

- 1- Fixed Latch Ring – Dual Retractor
- 2- Low-Friction Latch Ring
- 3- Moderate Friction Latch Ring

# Tested Belt Systems

Fixed

Low Friction

# Tested Belt Systems

Intermediate Friction

# Crash Test, Real Time

# Far Side Crash Test

**Fixed Latch Ring - Dual Retractors**

# Far Side Crash Test

**Moderate Friction Latch Ring**

# Far Side Crash Test

**Low  Friction Latch Ring**

# Head Excursion – Comparative Results


Fixed Ring

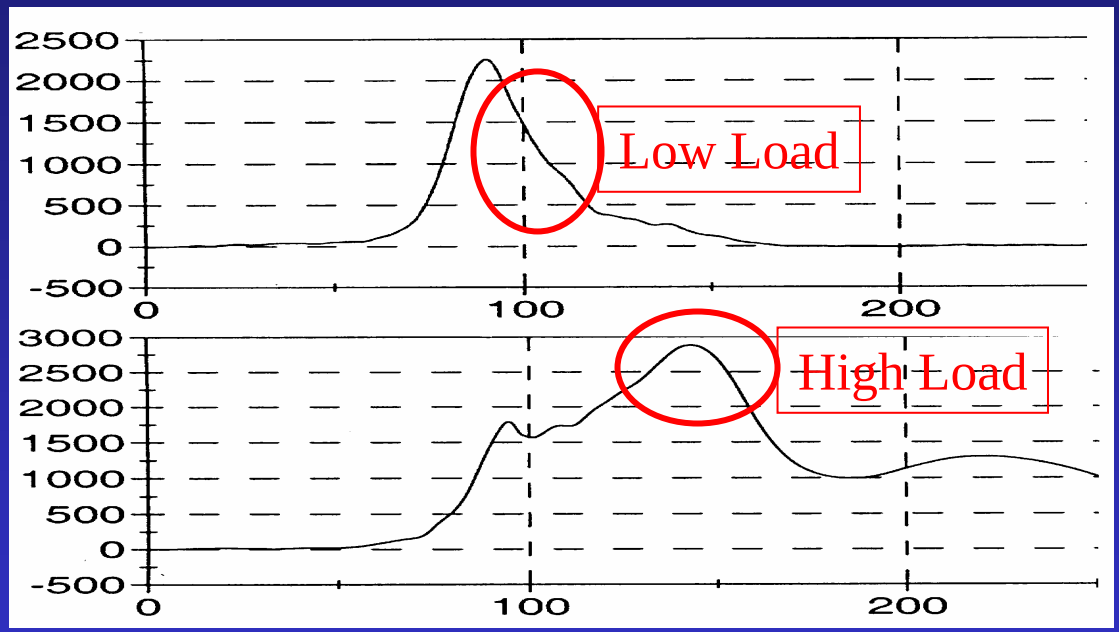

Moderate Friction Ring


Low Friction Ring

# Belt Loads – Far Side Crash

Shoulder Belt Force, N

Lap Belt Force, N



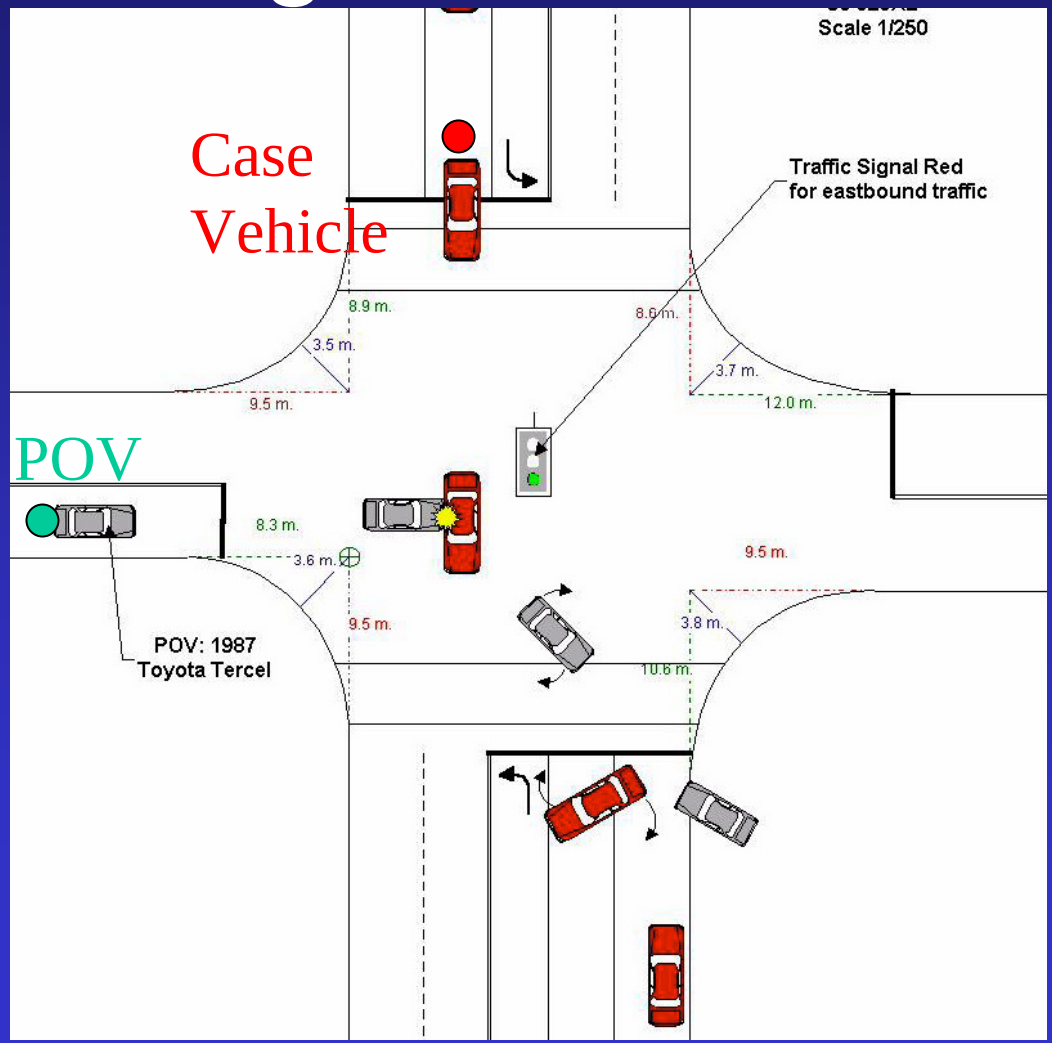

**Time, ms.**

# Illustrative Case---
# Far Side Occupant  Rear Seat)
# Liver Injury - Belt Induced

# Scene Diagram

- PDOF -2 o'clock
- Delta-V - 18.5 Kph (est)
- Restraints:

  Lap & Shoulder Belt
- Left Rear Passenger
- 12 year old female




Case 98-025AL

# Vehicle Damage

- Female Back Left Passenger; 12 YO; 6 Tall; 156 Lbs
- Veh. - ‘97 Lexus LS 400
- POV- ‘87 Toyota Tercel
- 2 o’clock,
  18.5 Kph
- 195 mm Crush

Case 98-025AL

# Vehicle Belt Configuration

- Trauma Criteria-

  No Indicators of Injury!

- Restraint:

  Lap & Shoulder Belt

Case 98-025AL

# Liver and Injuries

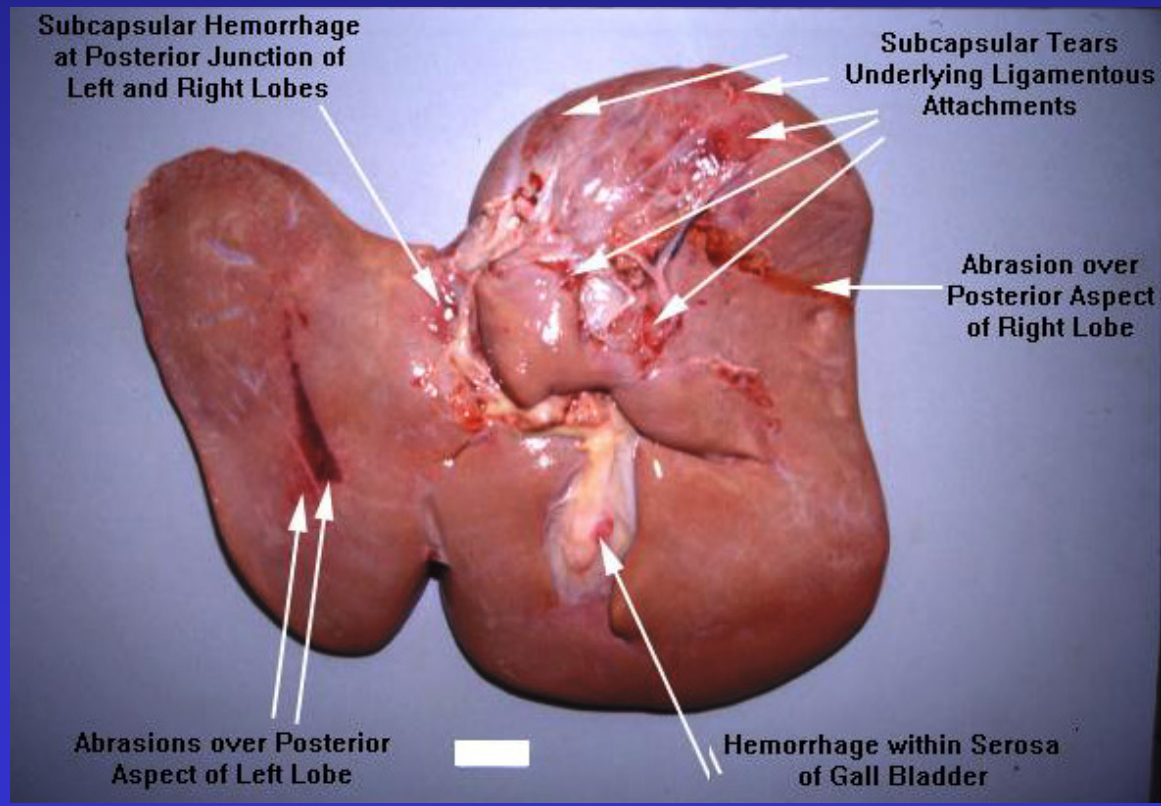
- **Belt Induced Injuries**:

  AIS 5 - Liver

  AIS 4 - Lungs

  AIS 3 - Heart
- **Other Injuries:**

  none




Case 98-025AL

# Observations Liver Injury Case

- Impact at occupant compartment; low delta-V
- No injury significant injury to near side rear seat occupant
- Undetected liver injury to far-side rear occupant
- Shoulder belt is ineffective in this crash mode; Increased lap belt loading

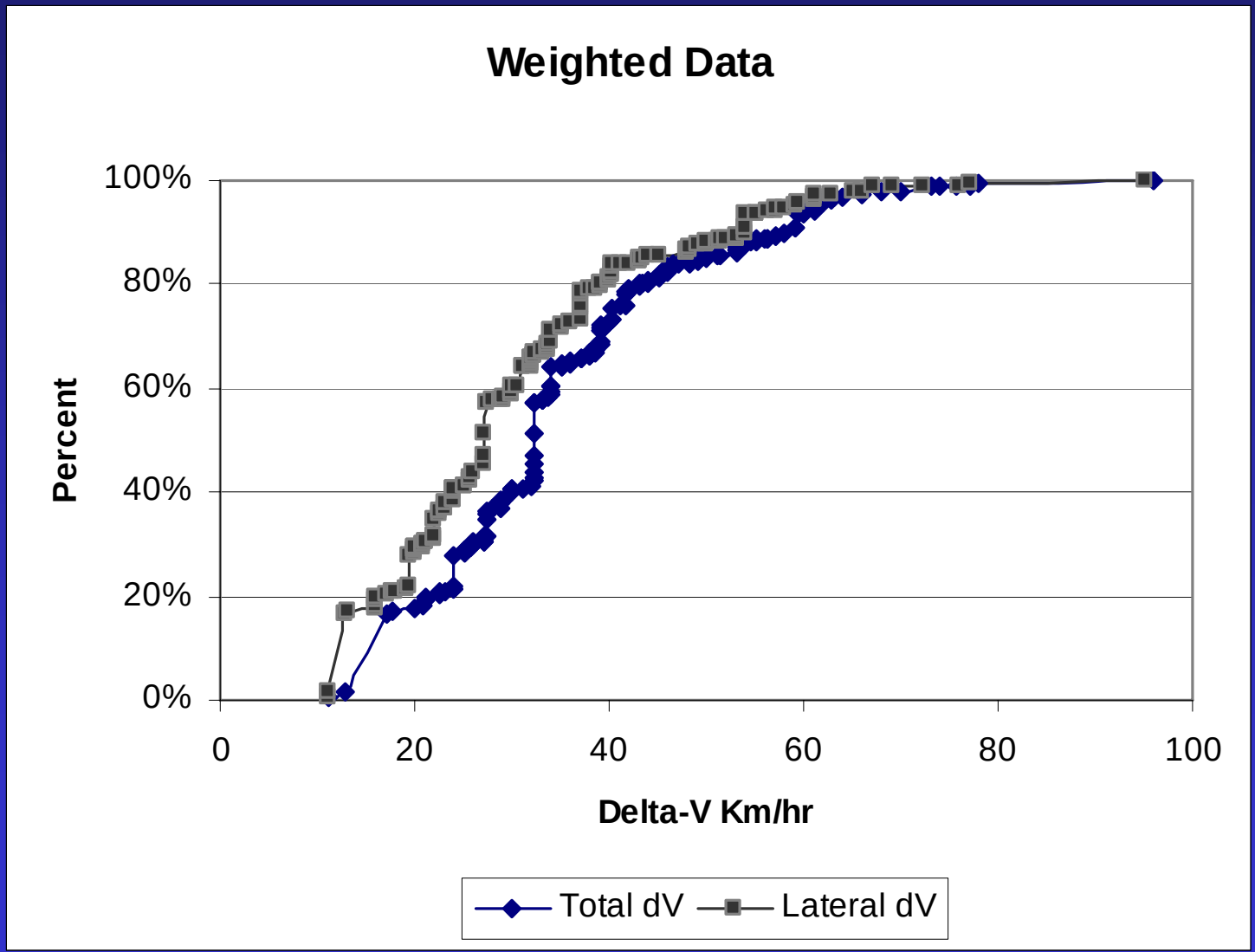
# Conclusions -
## Belted Occupants in Far Side Crashes

- The most harmful contacts are:
  - Opposite side interior - 26.9%
  - Seatbelt - 20.8%
  - Roof – 12.2%
- The shoulder belt is ineffective in the far-side crashes tested to date.
- Restraint achieved by abdominal loading by lap belt.
- Different latch ring designs influence the extent of head excursion.
- Other countermeasures may be required.

Thank you!!

# QUESTIONS?

# MAIS 3+ Injury Distribution by Delta-V



# Severity - Side Impact