



# Chest/Abdominal Injuries in Side Crashes

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## Topic

- Restrained Occupants in Far-side Crashes
- Chest/Abdominal Injuries from 3-point Belts



## Research Approach

- Identify Injury Distributions with NASS/CDS 1988-97 Data
- Identify Typical Injury Mechanisms with WLIRC 1994-98 Data

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# NASS/CDS Data

Combined Years  
1988-1997



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## Harm Distribution Front Occupants in Side Crashes

| <b>Position</b> | <b>Frequency</b> | <b>Harm</b> |
|-----------------|------------------|-------------|
| Near            | 66%              | 71.5%       |
| Far             | 34%              | 28.5%       |

NASS/CDS 1988-1997

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## AIS 3+ Distribution Front Occupants in Side Crashes Restrained Occupants

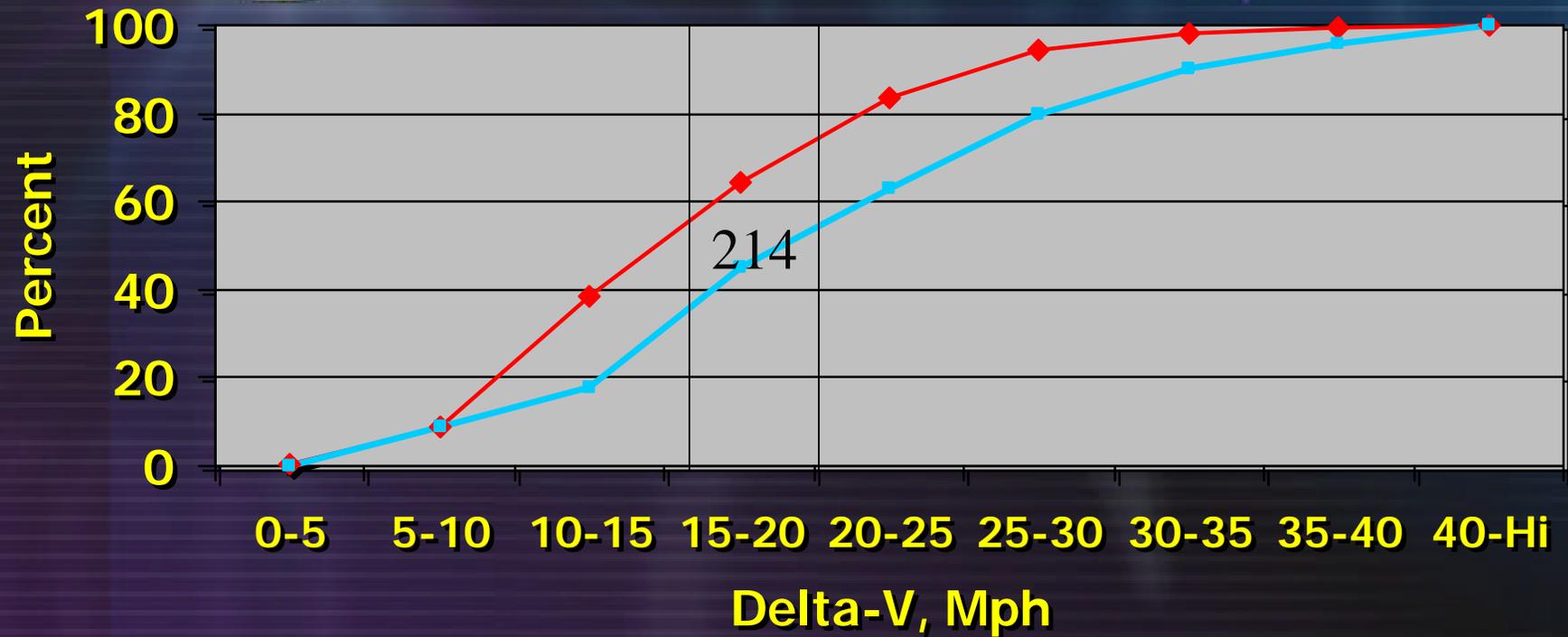
| <b>Position</b> | <b>Frequency</b> | <b>AIS 3+</b> |
|-----------------|------------------|---------------|
| Near            | 66%              | 70.0%         |
| Far             | 34%              | 30.0%         |

NASS/CDS 1988-1997

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# Severity - Side Impact



◆ Near Side    ■ Far Side Restrained

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# Injured Body Regions Far-side Crashes, NASS/CDS

| Body Region     | All<br>Percent | Drivers<br>Percent | RF Pass.<br>Percent |
|-----------------|----------------|--------------------|---------------------|
| Head            | 38.2           | 40.0               | 27.2                |
| Trunk           | 48.0           | 45.5               | 64.5                |
| Spine           | 2.2            | 2.5                | 0.0                 |
| Lower Extremity | 5.9            | 6.2                | 3.3                 |
| Upper Extremity | 5.6            | 5.7                | 5.1                 |

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## General Observations – Far Side Impacts

Drivers Get Head and Chest/Abdomen Injuries

Right Passengers are Less Likely to Get Head Injuries (Protected by the Driver)

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## Injuring Contacts- Weighted Data Far-side Crashes, NASS/CDS

| <b>Injuring Contact</b> | <b>All<br/>Percent</b> | <b>Drivers<br/>Percent</b> |
|-------------------------|------------------------|----------------------------|
| Right Side Interior     | 26.7                   | 30.5                       |
| Seat Belt               | 20.8                   | 22.6                       |
| Roof                    | 12.2                   | 13.1                       |
| All Other               | 8.7                    | 8.2                        |
| Seat                    | 7.5                    | 3.5                        |
| Left Side Interior      | 7.2                    | 8                          |
| Non Contact             | 6.4                    | 6                          |
| Dashboard               | 5.2                    | 4.3                        |
| Other Occupant          | 2.9                    | 1.4                        |
| Steering System         | 2.4                    | 2.4                        |



## Injuring Contacts- Weighted Data Far-side Crashes, NASS/CDS

| <b>Injuring Contact</b> | <b>Occupants<br/>Number</b> | <b>Average<br/>Weight</b> |
|-------------------------|-----------------------------|---------------------------|
| Right Side Interior     | 239                         | 72                        |
| Left Side Interior      | 45                          | 64                        |
| Seat Belt               | 75                          | 145                       |
| Non Contact             | 88                          | 36                        |
| Other Occupant          | 58                          | 32                        |
| Dashboard               | 55                          | 96                        |
| Roof                    | 57                          | 127                       |
| Seat                    | 43                          | 341                       |
| Steering System         | 27                          | 140                       |
| All Other               | 90                          | 54                        |
| Raw N (AIS)             | 777                         |                           |
| Raw N (MAIS)            | 287                         |                           |

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# Major Injuring Contacts

- Opposite Side Interior
- Seatbelt



# Crash Test – Far-Side Dummy

Delta V: 18 kph

PDOF: 9 O'clock





## Observations

- Shoulder Belt Ineffective in Opposite-Side Crashes
- Lap Belt Loading Increases
- Belt Abdominal Loading May Be Through Soft Tissue



# William Lehman Injury Research Data – Far-side Cases

13 Cases with AIS 3+ Injuries

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# WLIRC Far Side Cases



| Number   | Rest. | Occ Loc | Lat Dv | MAIS | Fatal | Max Injury    | Contact         |
|----------|-------|---------|--------|------|-------|---------------|-----------------|
| 98-005S  | L&S   | Left    | 10.4   | 3    | No    | Cervical cord | Non-contact     |
| 97-020KL | L&S   | Left    | 11.4   | 5    | No    | Brain         | R Side Interior |
| 98-006BL | L&S   | Left    | 12.5   | 4    | Yes   | Brain         | Pass. Air Bag   |
| 96-020EL | S     | Left    | 12.8   | 4    | No    | Liver         | Belt            |
| 96-041JL | S     | Left    | 12.8   | 3    | No    | Liver         | Belt            |
| 97-044FL | L&S   | Right   | 15.4   | 3    | No    | Spleen        | Belt            |
| 98-025AL | L&S   | Left    | 18.5   | 5    | Yes   | Liver         | Belt            |
| 94-L016J | L&S   | Left    | 39.5   | 5    | Yes   | Brain         | R Side Interior |
| 98-011S  | L&S   | Right   | 48     | 5    | Yes   | Brain         | Unknown         |
| 97-019S  | L&S   | Left    | 49.8   | 5    | Yes   | Brain         | Other Vehicle   |
| 98-004S  | S     | Left    | 72.2   | 4    | No    | Liver/Spleen  | Belt            |
| 97-038S  | L&S   | Right   | 71.8   | 5    | Yes   | Brain         | L Side Interior |

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Lateral Delta-V in km/hr

# WLIRC Far Side Cases



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|----------|-------|---------|--------|------|-------|---------------|-----------------|
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Lateral Delta-V in km/hr



## WLIRC Case

Far Side Passenger with Spleen Injury  
Belt Induced

Case 97-044FL

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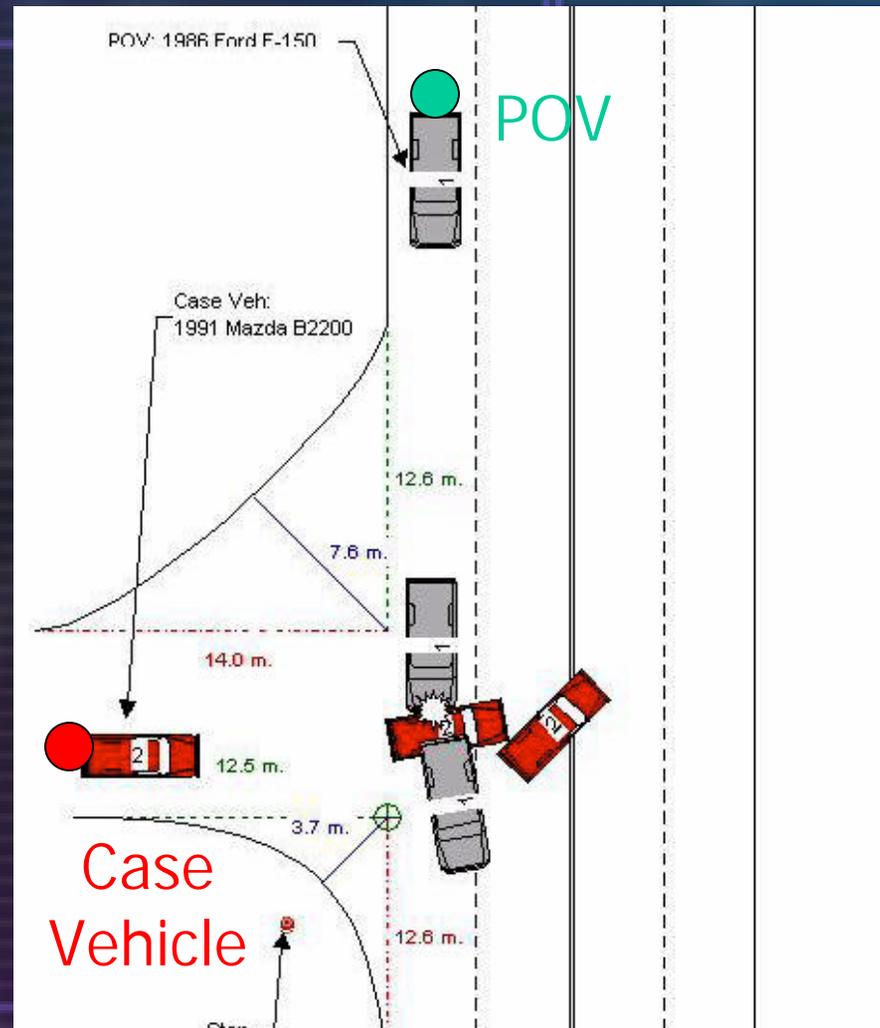
# Scene Diagram

Crash: Truck-to-Truck  
- Side Impact

PDOF: 10 o'clock

Long DV: 13 kph

Lat. DV: 15.4 kph



Case 97-044FL



## Crash Data - Far Side Passenger

Female Front Right Passenger; 62 YO; 66" Tall; 125 Lbs

Case Veh: - '91 Mazda 2200

POV: '86 Ford F-150

PDOF: 10 o'clock

DV: 20 kph

Crush: 250 mm.



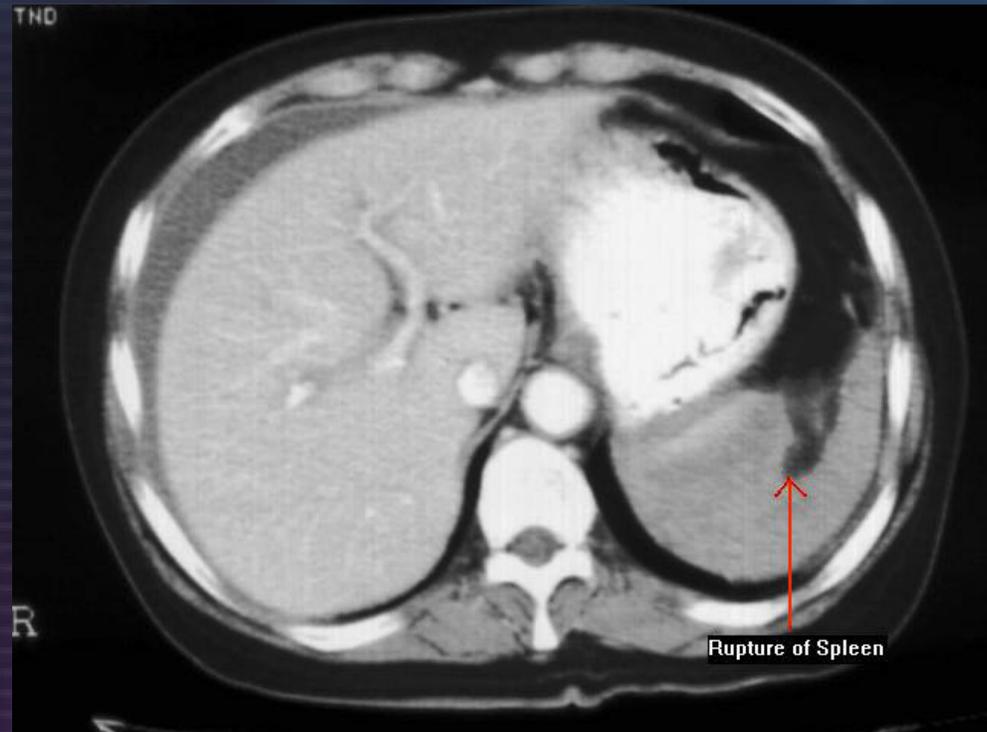
Case 97-044FL

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# Injury

- Belt Induced Injuries:  
AIS 3 - Spleen  
Other Injuries: None
- Trauma Criteria:  
Refused Acceptance  
by Other Hospital



Case 97-044FL

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# Vehicle Interior

Restraint: Lap & Shoulder Belt  
Evidence of Belt Use

Case 97-044FL



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# Safety Belt Floating Tongue

Floating Tongue May Permit  
Slack and Unfavorable Loading  
of Abdomen Soft Tissue



Case 97-044FL



# 10 O'clock Crash Belt with Floating Tongue



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## Observations

- Impact at Occupant Compartment
- No Injury to Driver (near-side)
- Spleen Injury to Passenger (far-side)
- Both Lateral and Longitudinal Component of Acceleration
- Occupant Motion Forward and Toward the Vehicle Centerline
- Shoulder Belt is Ineffective in This Crash Mode; Increased Lap Belt Loading

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Far Side Occupant Rear Seat Passenger  
Driver's Side (Left)  
Liver Injury - Belt Induced

Case 98-025AL

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# Scene Diagram

DV: 18.5 kph (est)

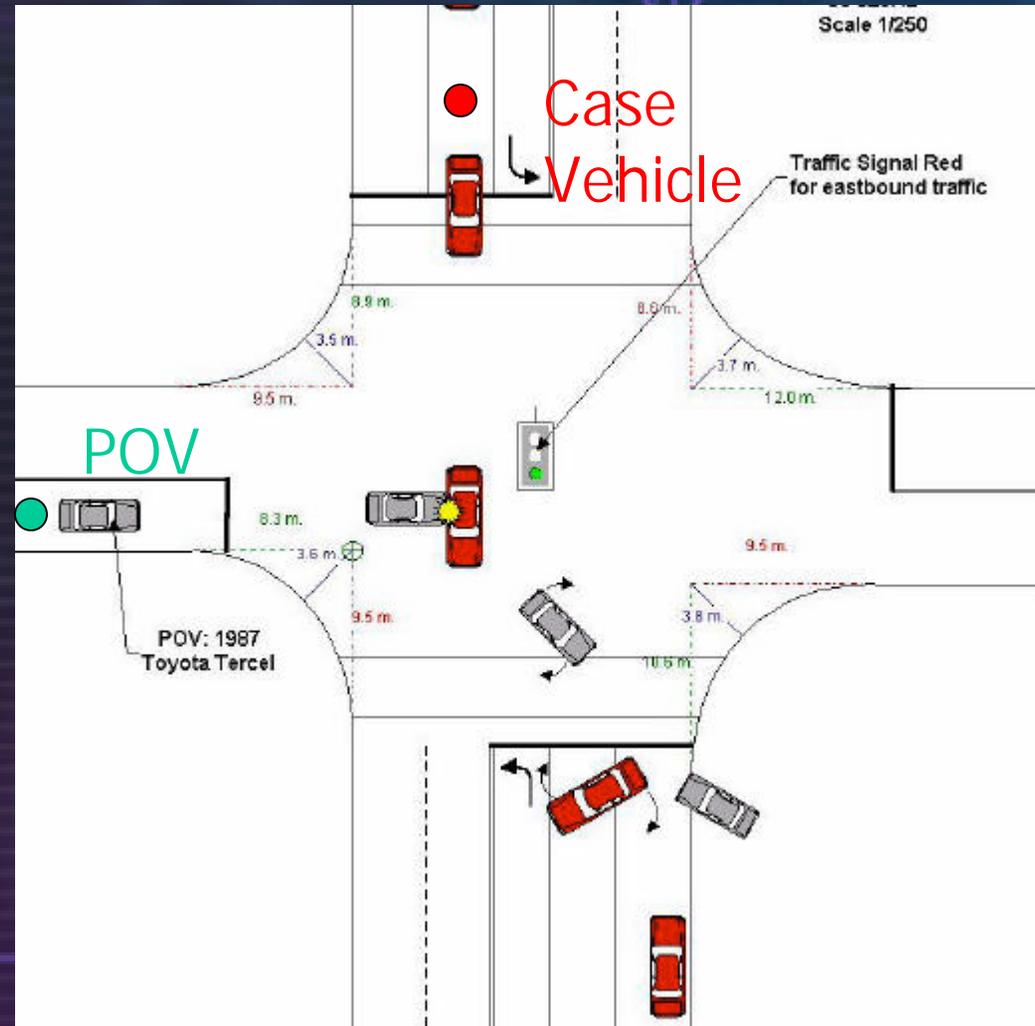
PDOF: 2 o'clock

Restraints:

- Lap & Shoulder Belt

Left Rear Passenger:

- 12 YO Female



Case 98-025AL



# Vehicle Damage

Female Back L. Pass; 12 YO; 65" Tall; 156 Lbs

Case Veh: '97 Lexus LS 400

POV: '87 Toyota Tercel

PDOF: 2 o'clock,

DV: 18.5 kph

Crush: 195 mm



Case 98-025AL

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# Vehicle Belt Configuration

- Trauma Criteria:
  - No Indicators of Injury!
- Restraint:
  - Lap & Shoulder Belt



Case 98-025AL



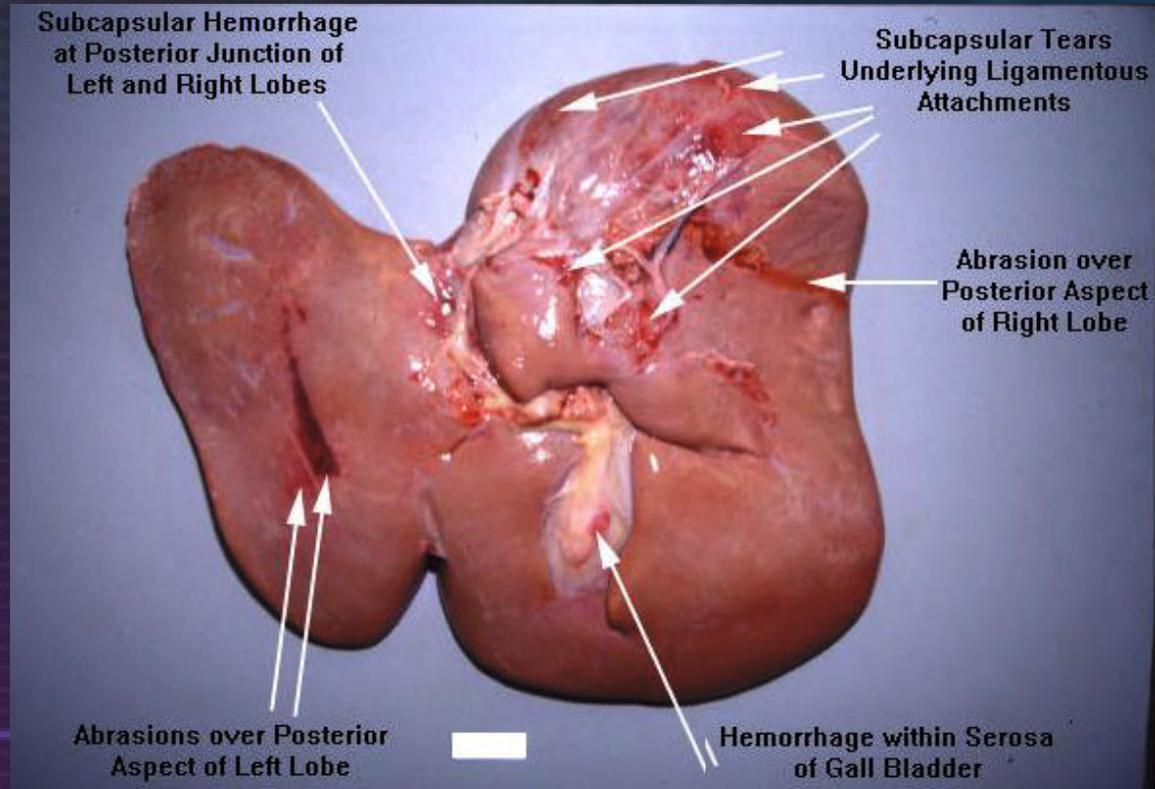
# Liver and Injuries

## Belt Induced Injuries:

- AIS 5 - Liver
- AIS 4 - Lungs
- AIS 3 - Heart

## Other Injuries:

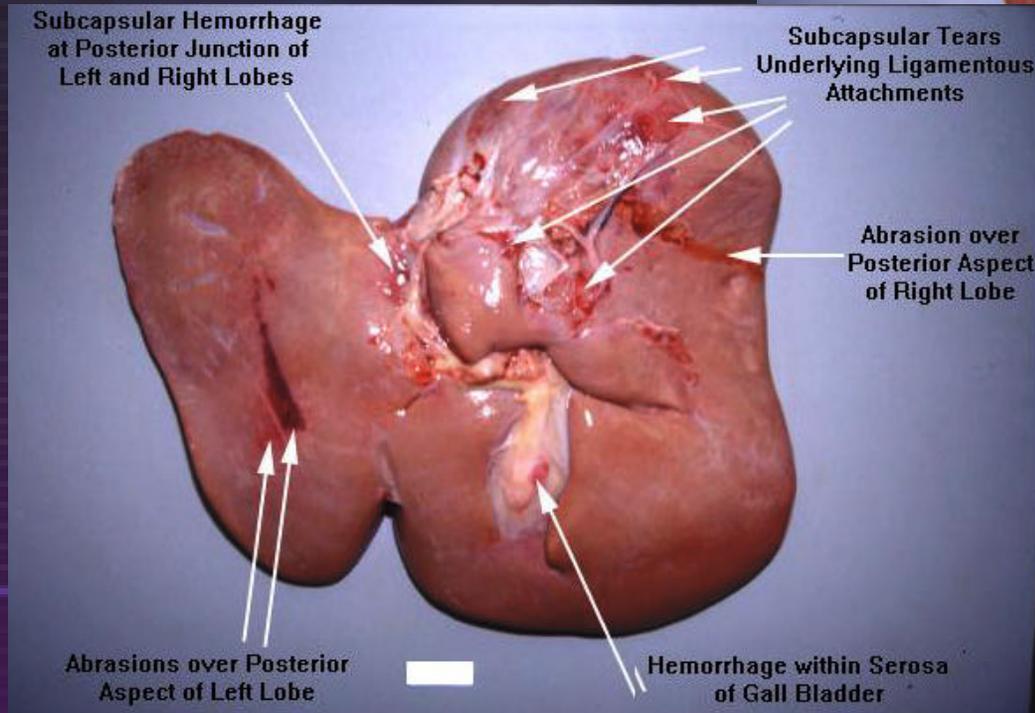
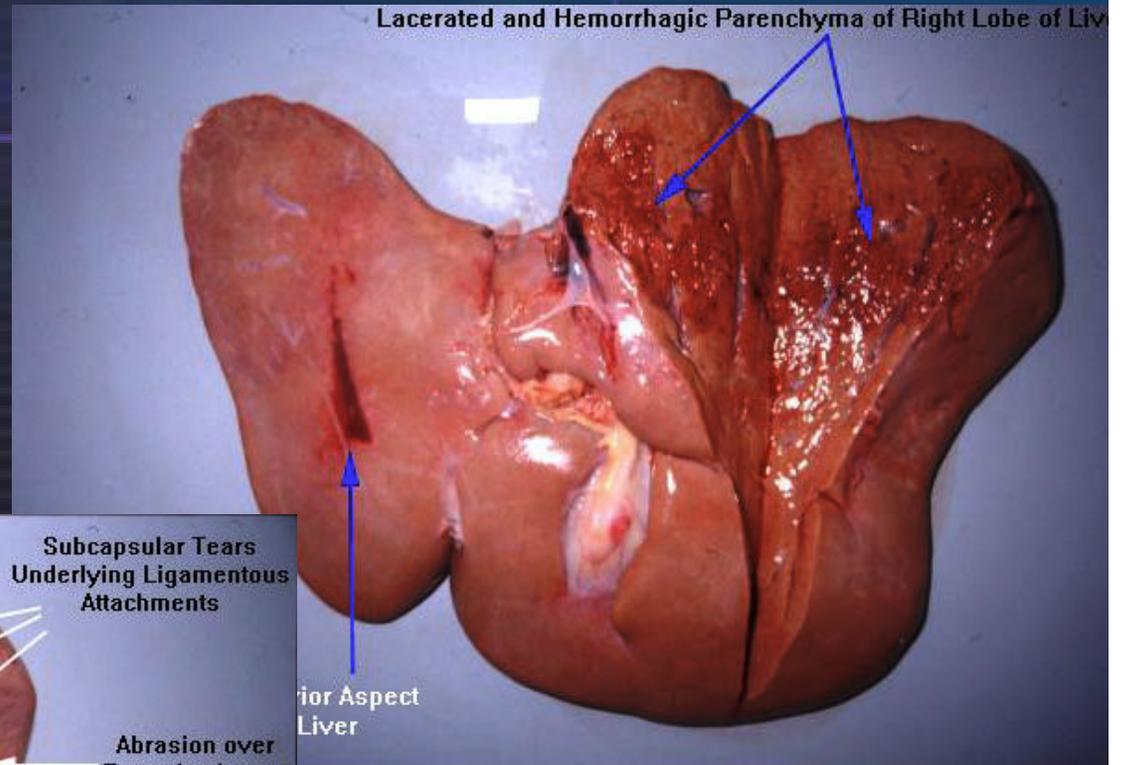
- None



Case 98-025AL



# Undetected Liver Injury



Case 98-025AL

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# 10 O'clock Crash Lexus Belt



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## Observations

- Impact at Occupant Compartment; Low DV
- No Injury Significant Injury to Near-Side Rear Seat Occupant
- Undetected Liver Injury to Far-Side Rear Occupant
- Occupant Toward Opposite-Side of The Vehicle
- Shoulder Belt is Ineffective in This Crash Mode; Increased Lap Belt loading

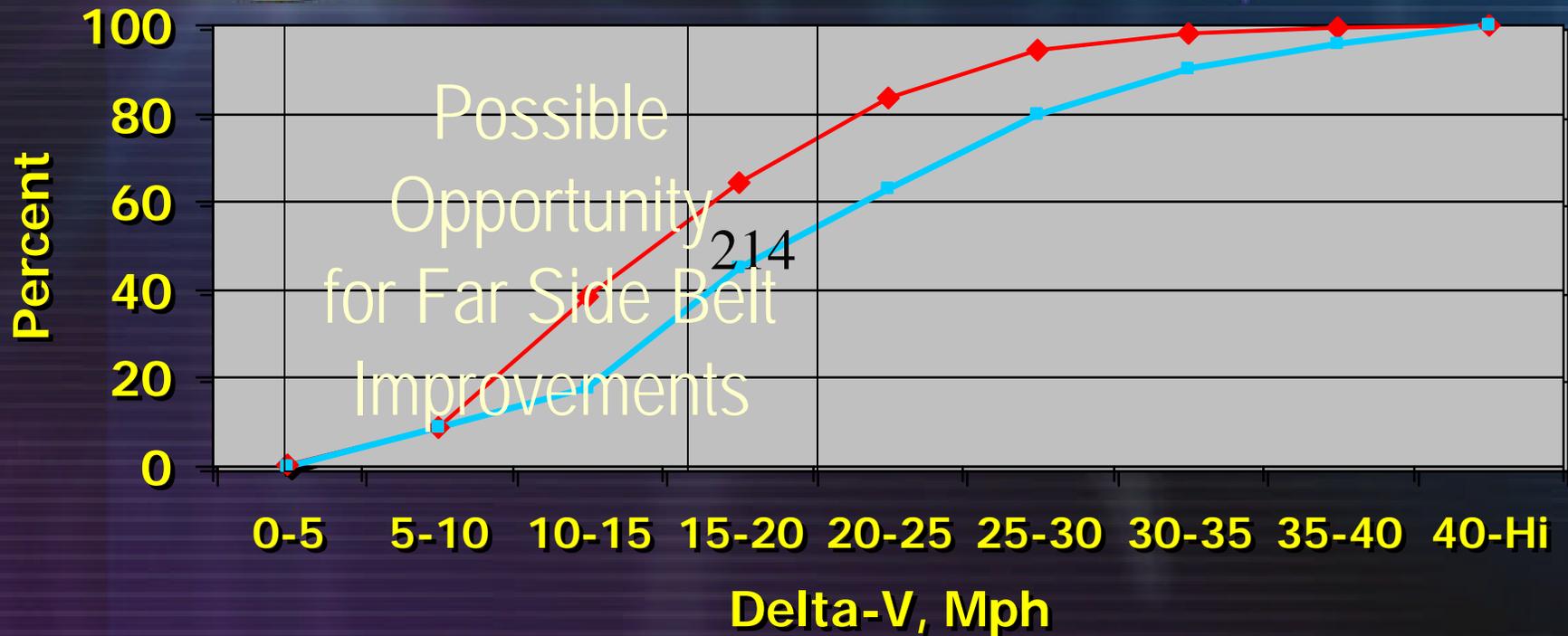


## Conclusions - Belted Occupants in Far Side Crashes

- Drivers & Passengers have different injury modes
- Passengers have fewer head injuries
- The Most Harmful Contacts are:
  - Opposite Side-Interior - 28.4%
  - Seatbelt - 20.8%
- The Shoulder Belt is ineffective in far-side crashes
- Seat Belt induced injuries occur in low speed crashes



# Severity - Side Impact

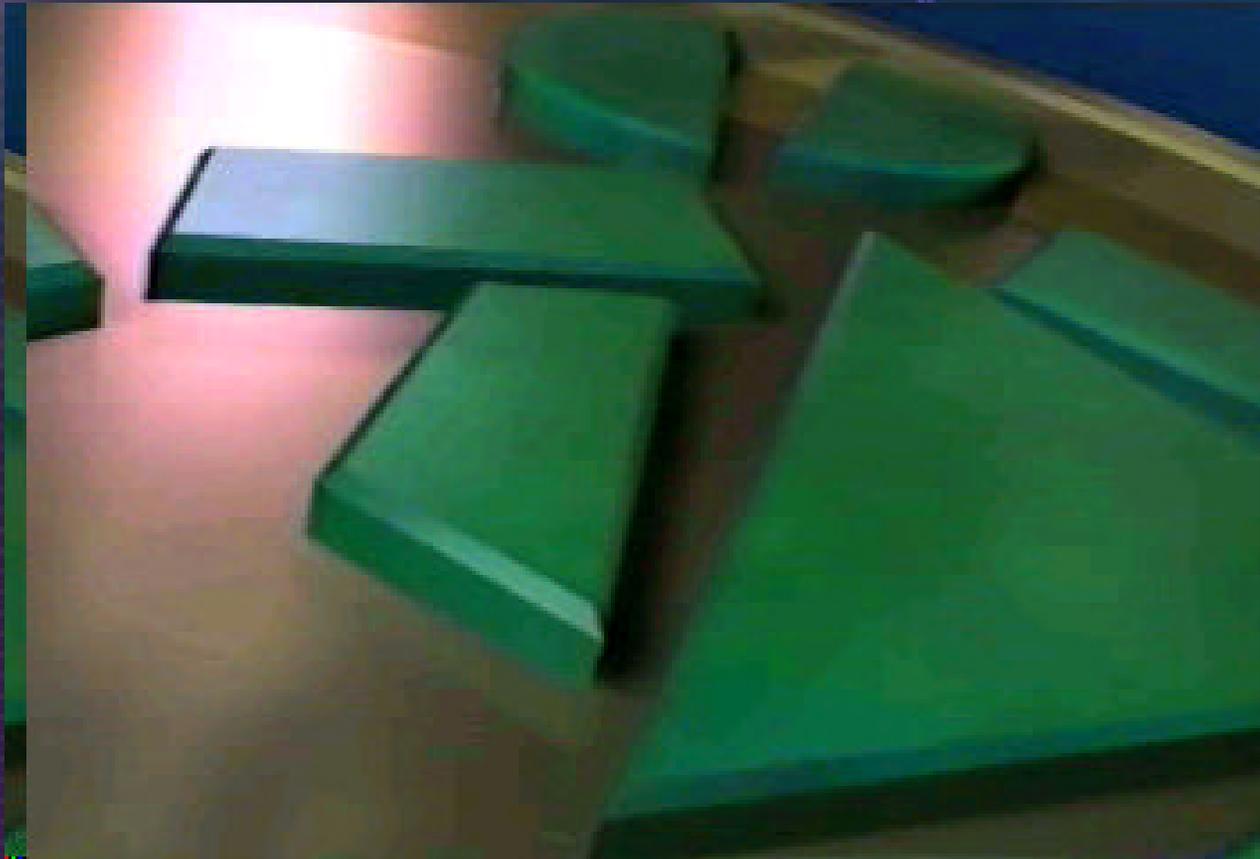


◆ Near Side — Far Side Restrained

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