Occupant Injury Patterns in Side Pole Crashes

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Narrow-Object Side Impacts

- Single vehicle crash
- Potential for severe trauma
- Greater / concentrated levels of intrusion
- Ways to reduce injury?
- What can side airbags do?
Narrow-Object Side Impacts
CIREN Analysis

- Query CIREN database
- Near side 8-10 or 2-4 pole/tree crashes
- Apply Biomechanics Tab coding
- Characterize Injury Patterns
NASS Data

Narrow-object versus Car-to-car

Occupants < 40 years old

Percent AIS=3+ Injuries

Delta-V (km/h)
Narrow Object Side Impacts
CIREN Case Analysis

- 49 analyzed
- Of the 49:
  - 25 males, 24 females
  - 15 age 10-18 YO; 34 age 19-63 YO
  - 35 drivers; 14 passengers
  - Belt use: 38 yes, 11 no
- CIREN inclusion
  - Late-model vehicles 1990 – 2004
  - AIS=3+ or multiple AIS=2 injuries
Narrow-Object CIREN Cases

<table>
<thead>
<tr>
<th>Delta-V km/h</th>
<th>Number of Cases</th>
</tr>
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<tbody>
<tr>
<td>&lt; 24</td>
<td>4</td>
</tr>
<tr>
<td>24-32</td>
<td>12</td>
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<td>33-40</td>
<td>14</td>
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<tr>
<td>41-48</td>
<td>12</td>
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<td>&gt; 48</td>
<td>6</td>
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</tbody>
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WWISCONSIN
WISCONSIN
CIREN
CCIREN CENTER
MILWAUKEE, WISCONSIN
Narrow-Object CIREN Cases

Number of Cases by Vehicle Model Year

- 1990
- 1991
- 1992
- 1993
- 1994
- 1995
- 1996
- 1997
- 1998
- 1999
- 2000
- 2001
- 2002
- 2003
- 2004

The chart shows the number of cases for each vehicle model year from 1990 to 2004.
Narrow Object Side Impacts
CIREN Case Analysis

- 26 of 49 with Thorax Injury
- 26 of 49 with Head Injury
- 17 of 49 with Pelvic Injury
- 16 of 49 with Lower Extremity Injury
- 12 of 49 with Abdomen Injury
- 5 of 49 with Cervical Spine Injury
- 4 of 49 with Upper Extremity Injury
Narrow Object Side Impacts
CIREN Case Analysis
Number of Occupants with Trauma to Body Region
Narrow Object Side Impacts
CIREN Case Analysis
Number of Occupants with Associated Head Trauma
Narrow Object Side Impacts
CIREN Case Analysis
Number of Occupants with Associated Lo Extremity Trauma

- Head
- C-spine
- Chest
- Abdomen
- Pelvis
- Lo Extr
Narrow Object Side Impact Location

Class 1
Forward of 25 cm

Class 2
25 cm Forward
Center of Wheelbase

Class 3
25 cm Rearward

Class 4
Rearward of 25 cm
Narrow Object Side Impact Location

17 Total Class 1 Cases
Percent of occupants with injury

- Head
- Chest
- Abdomen
- Pelvis
- Lo Extr

Class 1
Narrow Object Side Impact Location

18 Total Class 1 Cases
Percent of occupants with injury

- Head
- Chest
- Abdomen
- Pelvis
- Lo Extr

Class 2
Narrow Object Side Impact Location

11 Total Class 1 Cases
Percent of occupants with injury

- Head
- Chest
- Abdomen
- Pelvis
- Lo Extr

Class 3

0 20 40 60 80
Narrow Object Side Impact Location

Less than 5 cases

Class 4
Head Trauma in Narrow Object Side Impacts
CIREN Case Analysis

26 of 49 cases had Head injury
- 10 had skull fractures; 8 were skull base
- 17 had hemorrhage; subdural, subarachnoid...
- 4 had LOC; 3 had DAI
- 4 had isolated head injuries
- 19 had associated chest trauma
- 8 had associated abdomen trauma
- 5 had associated C-spine trauma
- 9 had associated pelvis trauma
- 4 had associated low extremity trauma
Head Trauma in Narrow Object Side Impacts
CIREN Case Analysis
Percent of Head-Injured Occupants with Associated Trauma

![Bar chart showing percentage of head-injured occupants with associated trauma by body region.](chart_image)
Head Trauma in Narrow Object Side Impacts
Involved Physical Component using Bio-Tab

- Object intrusion location Class 2, 3
- 13 / 26 contacted object (pole, tree)
- 9 / 26 A-, B-pillar, or roof side rail
- 3 / 26 contacted door
Head Trauma in Narrow Object Side Impacts
Effect of Stature

- 3 with door contact
  - 11 year old male, 152 cm
  - 17 year old female, 160 cm
  - 18 year old male, 157 cm

- Small stature occupants
Head Trauma in Narrow Object Side Impacts
Involved Physical Component
Effect of Stature

- 9 with A-, B-Pillar, Roof Rail contact
  - 3 Roof side rail contact
    - Occupants 183, 185, 188 cm height
  - 4 B-pilar contact
    - Occupants 163, 168, 168, 183 cm height
    - Class 1, 2, 3, 4
    - PDOF; kinematics; seat position
  - 1 A-pillar contact
    - Occupant 196 cm; Class 1 impact
  - 1 Roof contact with intrusion
Head Trauma in Narrow Object Side Impacts
Involved Physical Component
Effect of Stature

- 13 with Pole / Tree contact
  - 3 in Class 1
    - Occupants 163, 168, 188 cm height
  - 7 in Class 2
    - Occupants 152 to 178 cm height
  - 3 in Class 3
    - Occupants 163, 165, 183 cm height
Chest Trauma in Narrow Object Side Impacts
CIREN Case Analysis

- 26 of 49 cases had Thorax injury
  - 17 had lung contusion
  - 19 had rib fractures
  - 4 had isolated thorax injuries
  - 19 had associated head trauma
  - 10 had associated abdomen trauma
  - 5 had associated C-spine trauma
  - 9 had associated pelvis trauma
  - 2 had associated low extremity trauma
Chest Trauma in Narrow Object Side Impacts
CIREN Case Analysis
Percent of Chest-Injured Occupants with Associated Trauma

- Chest only
- Head
- Abdomen
- Pelvis
- Lo Extr
Chest Trauma in Narrow Object Side Impacts
Involved Physical Component

- 25 / 26 contact with intruding door
- Object intrusion location Class 2, 3
- Oblique door load antero-lateral?
Chest Trauma in Narrow Object Side Impacts
CIREN Case Analysis

Torqued Seat  Class-2

- Multiple Rib Fractures
- Unilateral (left)
- With hemo-pneumothorax
- Spleen laceration
Chest Trauma in Narrow Object Side Impacts
CIREN Case Analysis

Torqued Seat  Class-2

Unilateral (left) rib fracture
Unilateral (left) lung contusion
With hemo-pneumothorax
Chest Trauma in Narrow Object Side Impacts
CIREN Case Analysis

Torqued Seat    Class-3

Unilateral (left)
Multiple rib fractures
Spleen laceration
Chest Trauma in Narrow Object Side Impacts
CIREN Case Analysis

Torqued Seat  Class-2

Unilateral (right) Rib Fractures
Right flail chest
With hemo-pneumothorax
Lung contusions
Liver laceration
Aortic injury
Chest Trauma in Narrow Object Side Impacts
CIREN Case Analysis SUMMARY

- Chest injuries associated with other injuries
  - Head predominantly
  - Abdomen
  - Less with pelvis
  - Not with low extremity

- Unilateral rib fractures
  - Torqued seatback in 11 / 15 cases
  - Oblique load to chest from door

- Object intrusion class 2 and 3
Narrow Object Side Impacts
CIREN Analysis: Side Airbags

- 2002, 45 km/h, 9-o’clock, class 1
  - Combo thorax-head bag
  - Lung contusions; pelvis fractures

- 2004, 24 km/h, 9-o’clock, class 3
  - Combo thorax-head bag
  - Spleen laceration AIS=3

- 2000, 34 km/h, 11-o’clock, class 1
  - Combo thorax-head bag
  - Bilateral femur fractures AIS=3
CIREN Case Example

- Right front passenger
- 22-year-old male
- 191 cm (6’ 3”), 102 kg (225 lb)
- Belted, right curtain and torso side air bags deployed
- MAIS = 5  Head, Chest Injuries
- ISS = 42
2001 Volkswagen

20 mph BES
2001 Volkswagen
2001 Volkswagen

Note: Case Occupant Seat Torqued
Case Occupant
Narrow Object Side Impacts
Summary of 49 CIREN Cases

- Location of impact influences injury patterns
- Head injuries influenced by stature
- Chest injuries influenced by oblique door loading
- Torqued seat may be indicator
- Limited data on side airbags
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