OBLIQUE CRASHES IN CIREN

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National Highway Traffic Safety Administration
Objective

- Review newer oblique cases from CIREN
- Update prior field analysis on oblique crashes
  - Newer Case review
    - Crash Injury Research and Engineering Network (CIREN) cases
    - Revised criteria
      - Vehicles **must** have available AB at the driver position
        - Available steering wheel, roof rail and seat back ABs required
      - Right oblique (far side cases included)
      - AIS 2+
  - **Original NHTSA analysis with optimal restraint availability**
    - Original criteria (Rudd et al. 2011)
      - Belt restrained driver, AIS 3+ head, chest, KTH (2+ lower leg/ankle reviewed)
      - Frontal crash taxonomy used (Halloway 2011)
      - Over / underride excluded
NHTSA Oblique Crash Research

New case output
- 85 CIREN cases
  - Driver only
  - Left or right offset
  - 3 ABs available
  - AIS2+
- 68 cases (44 - left / 24 - right)
  - After override / underride filter applied
- 32 cases (Rudd 2011 criteria for LO)
  - 20 left offset / 12 right offset
    - Head AIS3+
    - Chest AIS3+
    - KTH 3+
      - Lower leg/foot/ankle 2+

No current cases were included in the original Rudd research
## New Cases - Optimal Restraint Availability

### 44 New Left Offset Cases / 24 Right Offset

<table>
<thead>
<tr>
<th></th>
<th>Left Offset</th>
<th>Right Offset</th>
</tr>
</thead>
<tbody>
<tr>
<td>% male</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td>Min age</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>Max age</td>
<td>90</td>
<td>81</td>
</tr>
<tr>
<td>Mean age</td>
<td>55</td>
<td>51</td>
</tr>
<tr>
<td>Min MAIS</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Max MAIS</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Mean MAIS</td>
<td>2.8</td>
<td>2.8</td>
</tr>
<tr>
<td>Min ISS</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Max ISS</td>
<td>41</td>
<td>26</td>
</tr>
<tr>
<td>Mean ISS</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>% fatal</td>
<td>7</td>
<td>0*</td>
</tr>
<tr>
<td>Mean Delta-v</td>
<td>49 kph</td>
<td>43.3 kph *</td>
</tr>
<tr>
<td></td>
<td>30.4 mph</td>
<td>26.9 mph</td>
</tr>
<tr>
<td>Model year or newer (50%+)</td>
<td>2007</td>
<td>2007</td>
</tr>
</tbody>
</table>
New Left Offset Injury Severity (n=44)

- AIS2+ Left Offset
- AIS3+ Left Offset

Percent of Cases

- Head
- Face
- Neck
- Chest
- Abdomen
- Spine
- UpExt
- LowExt

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New Left Offset Injury Severity and Air Bag Deployment

Steering wheel AB (SW) only (n=24)
SW/Curtain/Seat AB (n=17)

- SW AB AIS2+
- SW AB AIS3+
- SW/Curtain/Seat AB AIS2+
- SW/Curtain/Seat AB AIS3+
- Steering wheel AB (SW) only (n=24)
- SW/Curtain/Seat AB (n=17)

Other Case Deployments
- 1- SW/Curtain (AIS2 LE)
- 1- Curtain only (AIS2 Chest/Spine)
- 1- No AB (AIS3 Chest/LE)
Injury Severity Left vs. Right Offset

- AIS2+ Left Offset
- AIS2+ Right Offset
- AIS3+ Left Offset
- AIS3+ Right Offset

Left Offset n=44
Right Offset n=24
None of the current cases were included in the original Rudd review.
Updated CIREN vs Rudd (2011)

- Head AIS 3+: Updated (15%), Original (20%)
- Chest AIS 3+: Updated (30%), Original (40%)
- KTH AIS 3+: Updated (60%), Original (60%)
- Leg/Foot AIS 2+: Updated (45%), Original (40%

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Left Offset and AB Deployment

- SW AB (n=9)
- SW/Curtain/Seat AB (n=10)

Percent of Cases:
- Head AIS 3+
- Chest AIS 3+
- KTH AIS 3+
- Leg/Foot AIS 2+

1 case w/ No AB deployments = Chest and Leg/Foot
Rudd Comparison with Right Offset

Right Offset vs. Left Offset

- **Head AIS 3+**
- **Chest AIS 3+**
- **KTH AIS 3+**
- **Leg/Foot AIS 2+**

- **Right Offset (n=12)**
- **Left Offset (n=20)**

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## Left Offset Case Examples

<table>
<thead>
<tr>
<th>Case Vehicle</th>
<th>2013 Chrysler 300</th>
<th>2010 Honda Accord</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belted driver</td>
<td>31 yo female</td>
<td>33 yo female</td>
</tr>
<tr>
<td>HT/WT</td>
<td>5'6” / 178 lbs.</td>
<td>5'7” / 126 lbs.</td>
</tr>
<tr>
<td>AB Deployment</td>
<td>SW/Curtain/Seat</td>
<td>SW/Curtain/Seat</td>
</tr>
<tr>
<td>MAIS</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>ISS</td>
<td>10</td>
<td>38</td>
</tr>
<tr>
<td>V2</td>
<td>2003 Nissan Maxima</td>
<td>2003 Dodge Durango</td>
</tr>
<tr>
<td>Delta-V</td>
<td>31.6 mph</td>
<td>23.6 mph (rated low)</td>
</tr>
</tbody>
</table>
### Left Offset Cases

<table>
<thead>
<tr>
<th>AISCODE</th>
<th>Description</th>
<th>Aspect</th>
</tr>
</thead>
<tbody>
<tr>
<td>4422045</td>
<td>Thoracic injury, pneumothorax, tension; massive air leak</td>
<td>Left</td>
</tr>
<tr>
<td>7527243</td>
<td>Ulna fracture, shaft, complex; comminuted; segmental, open</td>
<td>Left</td>
</tr>
<tr>
<td>8532713</td>
<td>Femur fracture, shaft, complex; comminuted; segmental; Winquist IV</td>
<td>Left</td>
</tr>
<tr>
<td>4414072</td>
<td>Lung, contusion, unilateral, minor; &lt;1 lobe</td>
<td>Left</td>
</tr>
<tr>
<td>4502022</td>
<td>Rib fracture or fractures, without flap, any location unilateral or bilateral, two ribs [OIS II]</td>
<td>Left; Posterior Rib; L Rib; 3 L Rib 1</td>
</tr>
<tr>
<td>5418222</td>
<td>Liver, laceration, simple capsular tears; &lt;=3cm parenchymal depth; &lt;=10cm long; minor; superficial [OIS II]</td>
<td>Right; Right Lobe</td>
</tr>
<tr>
<td>8562512</td>
<td>Acetabulum fracture, partial articular (involving one column)</td>
<td>Left</td>
</tr>
<tr>
<td>6502202</td>
<td>Vertebra, cervical spine, fracture with or without dislocation but no cord involvement, transverse process</td>
<td>Posterior/Back/Dorsal; Left Process; C7</td>
</tr>
<tr>
<td>6504202</td>
<td>Vertebra, thoracic spine, fracture with or without dislocation but no cord involvement, transverse process</td>
<td>Superior/Upper; Left Process; T3; T2</td>
</tr>
<tr>
<td>7521132</td>
<td>Ulna fracture, proximal (olecranon)</td>
<td>Right</td>
</tr>
<tr>
<td>7521512</td>
<td>Radius fracture, proximal, extra-articular; radial neck</td>
<td>Right</td>
</tr>
<tr>
<td>8575612</td>
<td>Cuneiform fracture, fracture line into one joint surface</td>
<td>Right</td>
</tr>
<tr>
<td>8576612</td>
<td>Cuboid fracture, fracture line into one joint surface</td>
<td>Right</td>
</tr>
<tr>
<td>8581532</td>
<td>Metatarsal fracture, one of four lateral metatarsals fracture, extra-articular or shaft</td>
<td>Right</td>
</tr>
<tr>
<td>2106201</td>
<td>Skin/subcutaneous/muscle, face, laceration, minor; superficial</td>
<td>Left Forehead; Left</td>
</tr>
<tr>
<td>7102021</td>
<td>Skin/subcutaneous/muscle, upper extremity, abrasion</td>
<td>Hand/Digits; Left</td>
</tr>
<tr>
<td>7106021</td>
<td>Skin/subcutaneous/muscle, upper extremity, laceration, minor; superficial</td>
<td>Forearm; Left</td>
</tr>
<tr>
<td>7723021</td>
<td>Elbow joint, dislocation, with radial head involvement [proximal radioulnar]</td>
<td>Left</td>
</tr>
</tbody>
</table>

### 2013 Chrysler 300 AIS3+

<table>
<thead>
<tr>
<th>AISCODE</th>
<th>Description</th>
<th>Aspect</th>
</tr>
</thead>
<tbody>
<tr>
<td>8532513</td>
<td>Femur fracture, shaft, simple; spiral; oblique; transverse; Winquist I</td>
<td>Left</td>
</tr>
<tr>
<td>8542712</td>
<td>Tibia fracture, shaft, complex; comminuted; segmental; Winquist IV</td>
<td>Right</td>
</tr>
<tr>
<td>8544712</td>
<td>Fibula [malleoli] fracture, above joint [suprasynodesmatic]; isolated shaft, head or neck; Weber C</td>
<td>Right</td>
</tr>
<tr>
<td>7523512</td>
<td>Radius fracture, distal, extra-articular [includes styloid]</td>
<td>Left</td>
</tr>
<tr>
<td>7524612</td>
<td>Carpus fracture, bone other than scaphoid</td>
<td>Left</td>
</tr>
<tr>
<td>8572522</td>
<td>Talus fracture, extra-articular; talus neck, open</td>
<td>Right</td>
</tr>
<tr>
<td>8102021</td>
<td>Skin/subcutaneous/muscle, lower extremity, abrasion</td>
<td>Knee; Right</td>
</tr>
</tbody>
</table>

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Left Offset Cases

Chest AIS3+ - 2010 Honda Accord

- Large left side pneumothorax (3) and posterior lung contusion (2).
- Left 1<sup>st</sup> and 3<sup>rd</sup> rib fractures (2)
  - Involved physical component (IPC) = Thoracic belt
Left Offset Cases

KTH AIS3+

2010 Honda Accord
• Left femur shaft fracture (3)
• Left posterior column acetabular fracture (2)
  - IPC = Lower instrument panel
Left Offset Cases

2013 Chrysler 300
- Left femur shaft fracture (3)
  - IPC=Lower instrument panel
2013 Chrysler 300

- Right tibia/fibula shaft fracture
  - IPC = Lower IP & Pedal
- Right talar neck fracture (open)
  - IPC = Pedal

2010 Honda Accord

- Right cuboid articular fracture
- Right cuneiform fractures (med/lat)
- Right 2nd metacarpal fracture
  - IPC = Floor pan
Other Significant Injury

2010 Honda Accord

- Right ulna fracture (2)
- Right radial neck fracture (2)
- Right radial head dislocation
  - IPC = Left IP
- Left ulna fracture (3)
  - IPC = UFQ Door
  - IPC = Left IP
- Liver capsule laceration (2)
  - IPC = Thoracic belt
Conclusions – CIREN Cases

New case review

- AIS3+ injury is highest in lower extremity, chest and spine for the newest left offset cases
- AIS3+ injury is highest in lower extremity, chest and upper extremity in the newest left offset cases with SW/Curtain/Seat air bag deployment
- AIS3+ injury is higher in chest, abdomen, face and neck for right offset vs. left offset crashes

Rudd 2011 comparison

- New cases indicate decrease injury frequency with the exception of AIS2 lower leg injury
- Air Bag coverage / deployment appears most effective for head injury reduction
- Right offset indicates a large increase in chest injury compared to left offset
Thank You

Questions -