THE NEED TO CONTROL BELT ROUTING FOR SILVER NCAP RATINGS

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Presentation Outline

• Relevant changes in NCAP 2011 upgrade
• Research purpose
• Main study results
• Conclusion/Recommendations
Relevant 2011 NCAP changes

1. Used chest **deflection** rather than **acceleration** to measure injury risk
Relevant 2011 NCAP changes

1. Used chest **deflection** rather than **acceleration** to measure injury risk

Hybrid III Chest Calibration

Dummy should be used in a way consistent with its calibration
1. Used chest **deflection** rather than **acceleration** to measure injury risk

Would you expect the same deflection response for an impact higher on the chest?
Relevant 2011 NCAP changes

1. Used chest **deflection** rather than **acceleration** to measure injury risk

2. Used **deflection** injury risk for **35 year old male**
Relevant 2011 NCAP changes

1. Used chest compression rather than acceleration to measure injury risk
2. Used deflection injury risk for 35 year old male
3. For the right front passenger – Replaced 50% Male (mid position) with 5% Female (full forward)
Relevant 2011 NCAP changes

1. Used chest compression rather than acceleration to measure injury risk
2. Used chest injury risk for 35 year old male
3. For the right front passenger – Replaced 50% Male (mid position) with 5% Female (full forward)
4. Test procedure has no specification on control of belt routing or D-ring location!!
Consequence of no D-ring Specification

- 2001-2005 NCAP (50% Dummy RFP) 18% D-ring in Highest Location
- 82% in Mid or Lowest Location

Belt mid-shoulder

2001-05 NCAP D-ring in Mid Location – 80+%
Consequence of no D-ring Specification

• 2001-2005 NCAP (50% Dummy RFP) 18% D-ring in Highest Location
  82% in Mid or Lowest Location

• 2013-2017 NCAP (5% Dummy RFP) 92% in Highest Location

2001-05 NCAP D-ring in Mid Location – 80+%  2013-17 NCAP D-ring in Highest Location – 90+%
Consequence of no D-ring Specification

- 2001-2005 NCAP (50% Dummy RFP) 18% D-ring in Highest Location
  82% in Mid or Lowest Location

Belt Crossover Locations
Yr. 2011 NCAP Tests

2001-05 NCAP D-ring in Mid Location – 80+%
Research Objectives

• In an earlier paper, (ESV 13-0064) the authors proposed a “Silver Rating”.

• The “Silver Rating” increased the weight of the chest injury measurement
  • based on the higher frequency and risk of death for seniors with chest injuries.
Vulnerability of seniors to chest injury

Belted Front Outboard Chest Injury Rates (AIS >= .3) in Frontal Crashes

GAD1 = "F"
- No Rollover
- No Significant Secondary Impact (No Secondary Damage Extent >=2)

Occupant Age

Chest Injury Risk

Crash Severity

Mean UnweightedDV in Brackets
- 45 - 54 mph (69 KPH)
- 52 KPH (40 KPH)
- 54 KPH (44 KPH)
Research Objectives

• In an earlier paper, (ESV 13-0064) the authors proposed a “Silver Rating”.
• The “Silver Rating” increased the weight of the chest injury measurement.
  • based on the higher frequency and risk of death for seniors with chest injuries
• Therefore, the accuracy of the chest injury measurement became more important!!!
Research Question

In the NCAP frontal test how do variations in belt positioning across the chest from different D-ring positions influence the Hybrid III 5th female chest injury measurements?
Differences in shoulder belt routing
Right front passenger Hybrid III 5th female dummy in forwardmost seat position

**D-ring full up**

- Belt on Neck
- Center chest sensor

**D-ring full down**

- 64 mm
- Belt Overlays Sensor
Differences in shoulder belt routing
Right front passenger Hybrid III 5th female dummy in forwardmost seat position

**D-ring full up**

- NCAP Test
- Belt on Neck
- Center chest sensor

**D-ring full down**

- Our Retest to NCAP
- 64 mm
- Belt Overlays Sensor
Differences in shoulder belt routing
Right front passenger Hybrid III 5th female dummy in forwardmost seat position

D-ring full up
D-ring full down

Crash test chest deflection: 11.8 mm (from NCAP test)

Center chest sensor

Belt overlays sensor 64 mm

Belt overlays sensor
Differences in shoulder belt routing
Right front passenger Hybrid III 5th female dummy in forwardmost seat position

D-ring full up
Crash test chest deflection: 11.8 mm (from NCAP test)

D-ring full down
34.5 mm (Our repeat NCAP Test)

Center chest sensor
Belt overlays sensor 64 mm
Full vehicle test chest deflection comparison
Right front passenger Hybrid III 5th female dummy in forwardmost seat position

- D-ring Full Up: 11.8 mm
- D-ring Full Down: 34.5 mm
Age related chest injury risks
NCAP tests with D-ring full up and full down

- D-ring Full Up: 11.8 mm

<table>
<thead>
<tr>
<th>AIS 3+ Chest Injury Risk</th>
<th>Mid Aged Male</th>
<th>Older Female</th>
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<tr>
<td>0%</td>
<td>0.6%</td>
<td>0.6%</td>
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Age related chest injury risks
NCAP tests with D-ring full up and full down

D-ring Full Up: 11.8 mm
D-ring Full Down: 34.5 mm

- Mid Aged Male: 0.6% (D-ring Full Up), 15% (D-ring Full Down)
- Older Female: 0.6% (both conditions)
Age related chest injury risks
NCAP tests with D-ring full up and full down

<table>
<thead>
<tr>
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<th>D-ring Full Up</th>
<th>D-ring Full Down</th>
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<tbody>
<tr>
<td>Mid Aged Male</td>
<td>15%</td>
<td>0.6%</td>
</tr>
<tr>
<td>Older Female</td>
<td>45%</td>
<td>34.5 mm</td>
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</table>
Observations

• NCAP 2011+ ratings use chest deflection measurements
  • Protocol does not control of shoulder belt routing
  • HIII-5F dummy chest deflection measures are highly sensitive to routing

• In ~90% of NCAP tests, the belt is high above the HIII-5F center chest sensor
Observations

This study’s test results with D-ring full down

• The belt is 62 mm lower - across the center chest sensor
• Measured 22.7 mm additional deflection
• Measured a **25 times** increase in chest injury risk (NHTSA Risk)
• **Older female** chest injury risk increased **75 times** (Prasad Risk)
Sled Test Results for 5% Female with RibEye

NHTSA NCAP Sled Test (D-ring Full-up)
- Central Deflection Gage
- RibEye LEDs

Graph indicating measurements of chest deflection over time.
Ribeye useful for assessing asymmetry of belt routing on chest

RibEye may be Useful in Controlling Belt Position – See Paper for Other Tests
Conclusions/Recommendations

• NCAP chest ratings are highly dependent on shoulder belt routing relative to the chest sensor
• Better control of belt routing is necessary for NCAP comparative evaluations to be meaningful
• Especially important when considering *Silver NCAP* (chest injury risks are 4-5 times greater than for younger occupants)

• See paper for other test results!
Conclusions/Recommendations

• NCAP chest ratings are highly dependent on shoulder belt routing relative to the chest sensor
• Better control of belt routing is necessary for NCAP comparative evaluations to be meaningful
• Especially important when considering Silver NCAP (chest injury risks are 4-5 times greater than for younger occupants)
• A dummy landmark-based belt positioning procedure should be developed
  • Provide better control of belt routing relative to the dummy’s chest sensor
Acknowledgement

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