Injuries Due to Vehicle Mismatch: Implications for Prevention and for Medical Care – Seattle CIREN

Presenters: Charles Mock, MD, PhD, FACS
Rob Kaufman, BS Crash Investigator

CIREN Seattle
Seattle CIREN team research on incompatibility

Current Publication:


Reviewed and selected cases from CIREN network:

1. Side Impacts (Passenger vehicle struck by LTV)
2. Frontal Impacts (Passenger vehicle)
3. Frontal Impacts (LTV)
Increasing LTV Sales/Registrations

NHTSA’s Research Program For Vehicle Aggressivity and Fleet Compatibility - Hollowell, Summers, Prasad.
Increasing LTV-Car Fatalities
NHTSA research paper#307-Summers, Hollowell, Prasad
Side impact standard improvements (SS214)

Use of side impact beams in doors
Protection from side impact beams

- Minimal intrusion
- No injury
- Delta V = 12 mph
- 01RYEW2

Striking vehicle
Larger Vehicle and Side Impacts

Light Truck Vehicles vs. Passenger Vehicles

Some bumper heights/frames are overriding the side impact supports
Side impacts with larger vehicles with lateral door support beams
Intrusion = Injury

Adults - Think Thorax!!

Children - Think head
This becomes head contacts for children
Mismatch Side Impact
Injury Patterns
LTV Front into Side Passenger Vehicle

<table>
<thead>
<tr>
<th>Body Part</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>HEAD</td>
<td>47%</td>
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<tr>
<td>CHEST</td>
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<td>EXTREMITIES</td>
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AIS ≥ 2
Frontal Impacts
Occupant energy distribution

Restrained vs. INTRUSION or Unrestrained
Direct Contact Forces w/ Intrusion

- Body already accelerating toward object
- Intrusion increases the forces loading on the lower extremities
Left mid-shaft femur fracture due to override impact and intrusion to instrument panel.
Offset Frontal Impacts with Vehicle Mismatch
SUV-LTV vs. Sedan

Obvious mismatch in bumper frame heights
SUV-Truck vs. Sedan

Override impact creates significant intrusion of instrument panel/hood

- SUV bumper into grill of sedan
- Sedan bumper into front tire/axle
SUV-Truck vs. Sedan

Longitudinal intrusion is created and impacts the head, chest and lower extremities.
Front Passenger Vehicle into Front LTV

FRONT PV

<table>
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<th>AIS Percentage</th>
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<td>EXTREMITIES</td>
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AIS ≥ 2
SUV-Truck vs. Sedan

Passenger bumper frame impacts the SUV tires and axle which become forced into the floor and toe pans
Front LTV into passenger vehicle

6 cases - all PVs had at least one fatality

AIS \geq 2

Conclusions
- The foot position (eversion/inversion v neutral) should be considered as another variable in estimation of compressive impact force tolerance
- Toe pan intrusion is directly related to fractures of the foot
Side Impact Vehicle Mismatch
Case Reviews
Side Impact - Vehicle Mismatch

- Front Seat Passenger
- Elderly person
- Lap/Shoulder belt
- Struck by a large pickup
- Lateral Direction of Force
Upper door panel intrusion
Override of support beams

Toyota Corolla struck by large pickup truck
Upper door panel intrusion
Case review
Injuries

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<th>Region</th>
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<td>3</td>
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<td>2</td>
<td>Abdomen</td>
</tr>
<tr>
<td>2</td>
<td>Abdomen</td>
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ISS = 29
CIREN Case Review

90’s Ford

20 mph Delta V

PDOF = 60

Struck by large pickup
Critical Head Injuries
Side Impact Case review

Child

Back right seat - fully restrained

Sleeping with head against door
40 cm of intrusion at door panel, window sill

Deformation from head contact
Head Injury Summary
- Serious Brain Injury, AIS = 5

40 cm of intrusion at door panel, window sill

Deformation from head contact
Frontal Offset Case Review
SUV vs. Minivan

V1 - 80’s SUV

Subject V3 - 90’s Van

Posted Speed limit = 30 mph
SUV vs. Minivan

90’s Van
Delta V = 27 mph

Offset = 63%
Demographics/Intrusions

Driver - Mid 30’s Female.

Restraints:
- Lap/shoulder belt
- Airbag

Deployment

Driver Area Intrusions
- Toe pan: 45 cm
- Instr. Panel: 42 cm
- A pillar: 52 cm
- Windshield: 24 cm
- Kick panel: 18 cm
- Steering col.: 15 cm
Driver Contacts

INJURIES
Left Mid-shaft Femur Fx
Right Mid-shaft Femur Fx

Both Knees contacted into bolster area with severe intrusion
Subject Driver
50’s Female
Manual Lap/shoulder belt
Deployed Frontal and Side airbags
Impact to front left tire
55 cm (21”) longitudinal intrusion of toe pan
Injury summary

**Right Foot**
- Multiple fractures to the foot and ankle

**Left Foot**
- Multiple fractures to the foot and ankle
Vehicle Mismatch Impacts

Preventive Measures
documented from CIREN research
Side impact with child in booster seats

Minimal Head Injury

Head positioned above door interior
Side Airbags Provide Head and Chest Protection
Mismatch side impact assessment of injury severity and mechanism

Children - Head injury mechanism

Adults - Head and Chest Mechanisms

Intrusion = Injury
Mismatch Frontal Impact Assessment for Injury Severity

LTV toe pan intrusion and lower extremity (foot) fractures/injuries

PV instrument panel intrusion and chest and lower extremity injuries
Thank you