Crash Injury Mechanisms in Vehicle Mismatch Collisions

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CIREN Seattle
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

Subdivisions vs. compact/economical

Some bumper heights are overriding the side impact supports.
Increasing LTV-Car Fatalities

U.S. Sales and Registrations of Light Trucks and Vans

NHTSA’s Research Program For Vehicle Aggressivity and Fleet Compatibility - Hollowell, Summers, Prasad.
Increasing LTV-Car Fatalities

NHTSA’s Research Program For Vehicle Aggressivity and Fleet Compatibility - Hollowell, Summers, Prasad.
Seattle CIREN team research on incompatibility

Current Publication submitted:
“Vehicle Mismatch: Injury Patterns and Severity”, Acierbo, Kaufman, Rivara, Grossman, Mock

Reviewed and selected cases from 200 Seattle CIREN:
1. Side Impacts (Passenger vehicle struck by LTV)
2. Frontal Impacts (Passenger vehicle)
3. Frontal Impacts (LTV)
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
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-Truck vs. Sedan

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

Passenger bumper frame impacts the SUV tires and axle which become forced into the floor and toe pans.
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 F250 pickup truck
Upper door panel intrusion
Case review

End View
## Injuries

<table>
<thead>
<tr>
<th>AIS</th>
<th>Region</th>
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<tbody>
<tr>
<td>2</td>
<td>Head</td>
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<tr>
<td>3</td>
<td>Head</td>
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<td>4</td>
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<td>2</td>
<td>Abdomen</td>
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<td>2</td>
<td>Abdomen</td>
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</tbody>
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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
Offset Frontal Case Review
Toe Pan Intrusion

Late Model
Lincoln Navigator

Late 90’s compact
Driver fatally injured

Subject Driver
50’s Female
Manual Lap/shoulder belt
Deployed Frontal and Side airbags
Delta $V = 20$ mph

Impact to front left tire
55 cm (21”) longitudinal intrusion of toe pan
Injury summary

Right Foot
- Distal tibia Fx, comm.
- Distal fibula fx
- 1-5 metatarsals fx

Left Foot
- Cuboid fx
- Cuneiform fx (medial)
- 1,2,3,5 metatarsal fx
- L great toe proximal phalynx fx
The Next Step

• Confirmatory Study of Injury Patterns using CDS Data
  – Evaluate Frontal and Side Impact Patterns
    • PV struck by PV
    • PV struck by LTV
    • LTV struck by PV
Frontal Crashes

Injury Severity in Frontal Crashes

- Died
- Upper AIS >2
- Lower AIS >2
- Abd AIS >2
- Thorax AIS >2
- Head AIS >2
- ISS >16
- ISS >8

Percent of Crashes

PV vs. PV  
n=9691

PV vs. LTV  
n=4132

LTV vs. PV  
n=3792
Side Crashes

Injury Severity in Side Crashes

- Died
- Upper AIS >2
- Lower AIS >2
- Abd AIS >2
- Thorax AIS >2
- Head AIS >2
- ISS >16
- ISS >8

Percent of Crashes

PV vs. PV n=3269
PV vs. LTV n=1775
LTV vs. PV n=833
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 Protection
Utilize CIREN case studies to evaluate side impact federal safety standards.
Require more door frame support to match with the growing fleet of SUV/Trucks on the road today
What to do about mismatch bumper frame heights?

Create a vertical component on the frame rail ends of the sedan or spoiler frame on LTV’s

Further examine CIREN data to provide input for SS
Toe Pan intrusion to SUV/Trucks

Better reinforcement behind wheel wells to prevent toe pan intrusion from front tires

Lower bumper frame to match passenger cars
Thank you