The Hidden Mechanism in Side Impact Crashes

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HARBORVIEW INJURY PREVENTION AND RESEARCH CENTER

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Various geometric shapes of interior door panel designs

Photos of interior door panel types, one separate, one installed in vehicle

Door Panel Geometry

Armrest with the panel extended downward

Door Panel Geometry

Protruding armrests

Door Panel Geometry

Long armrest across door

Intruding corner edges may result in injuries

Door Panel Geometry

Stiff door handles

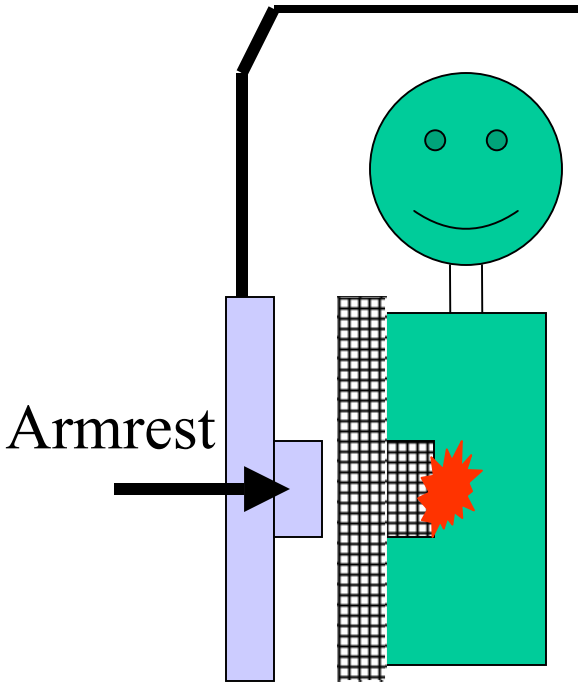
Door Panel Geometry

Flat door handles and no armrest

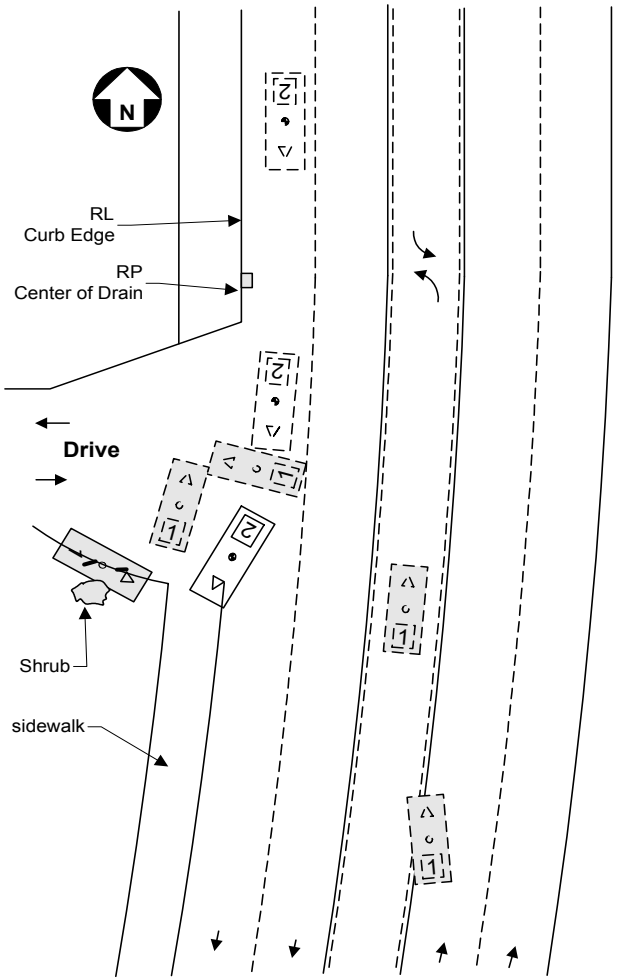
Abdominal Injuries Observed

- Side impacts appear to increase the risk of abdominal injuries

- The stiffness and geometry of the door panels along with the protruding components, such as the armrest appear to become forced into the abdomen of the occupant.



Abdominal injury case review



1990's sedan

Front Right Pass.

Lap/Shoulder belt

Elderly Female

Map indicates path of travel of case vehicle

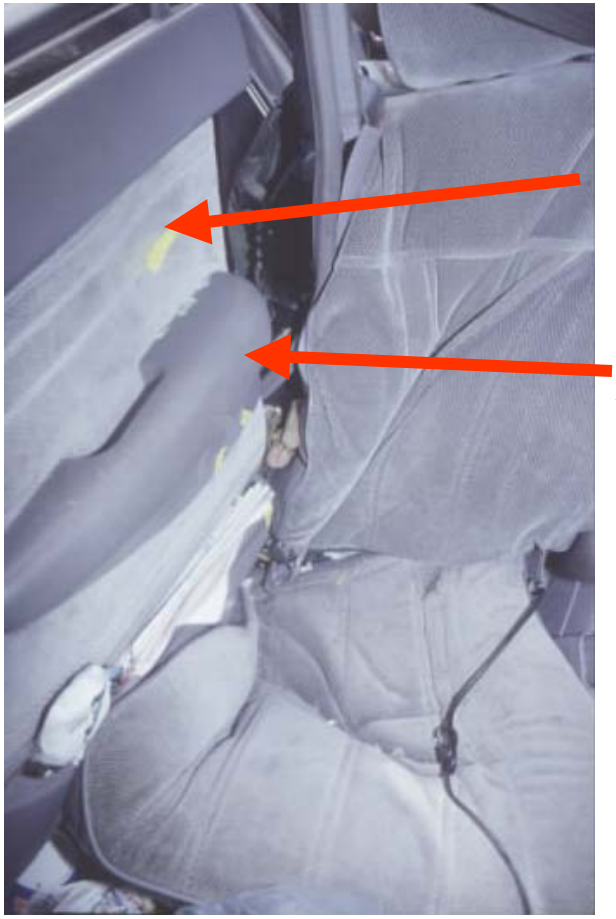
Abdominal injury case review

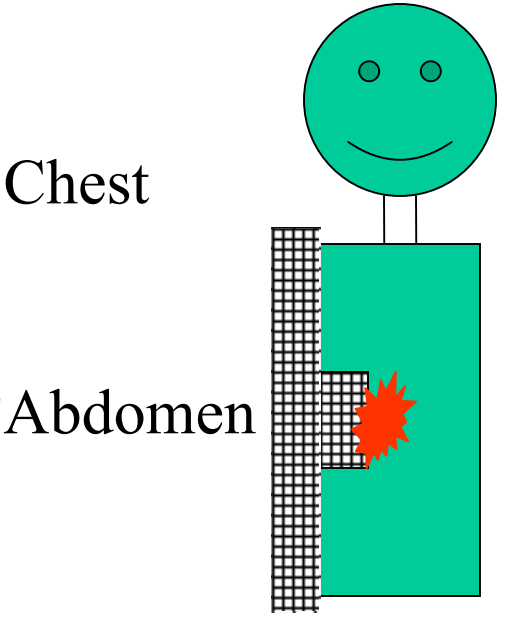
Injuries associated with stiff armrest:

R kidney laceration

Liver laceration

Other: Splenic laceration, Flail chest , ruptured aorta

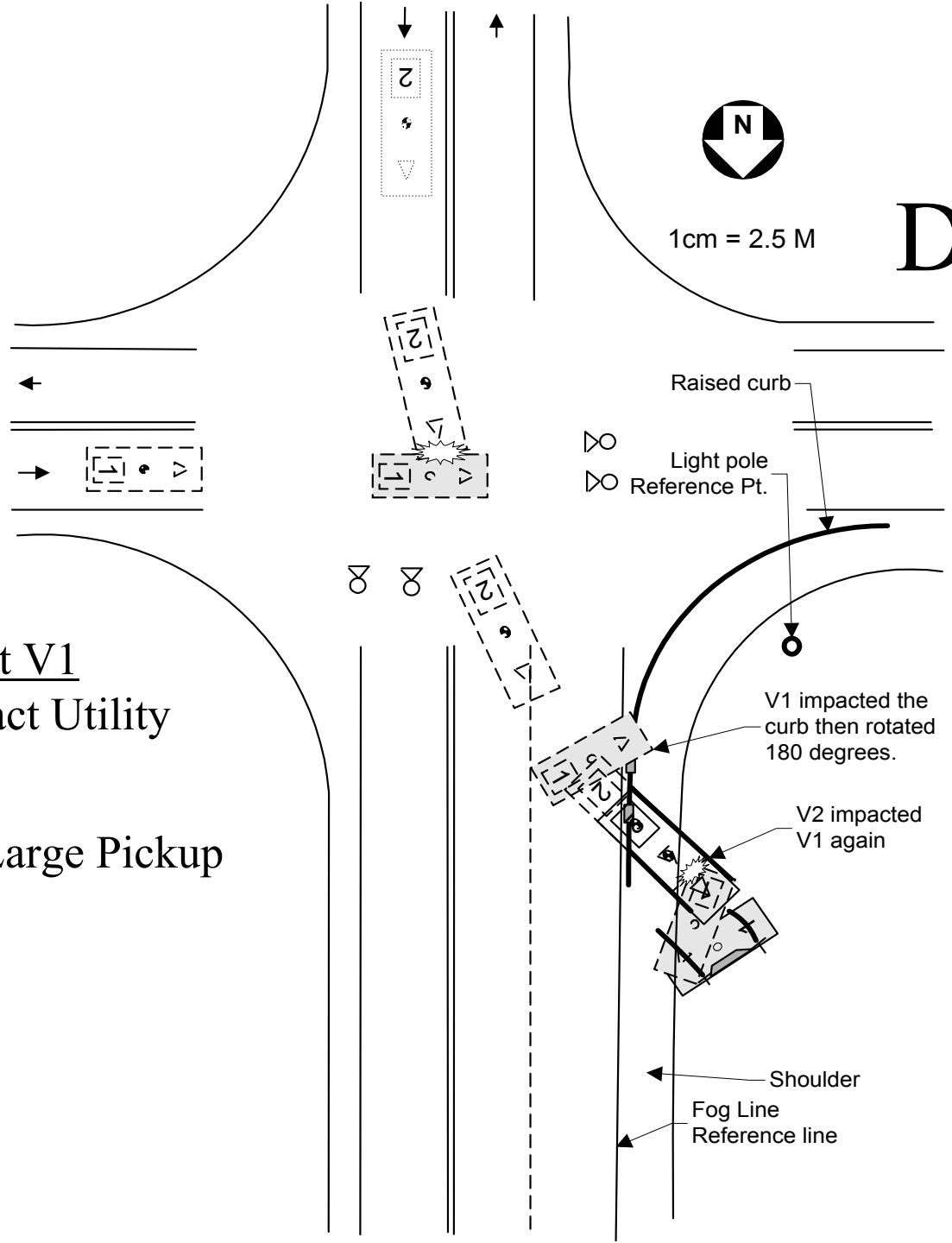




Abdominal Armrest Injury Case Review

Late model compact utility – post crash

Scene Diagram



Subject V1
Compact Utility

V2
1986 Large Pickup

Vehicle Damage

Door Extrication - low profile

Delta V = 15 mph

PDOF = -80

Demographic - Interior Contacts

Driver

Near side
FMVSS 214
Unrestrained

30’s - Female

Photo interior of vehicle (perspective from passenger side facing driver side) post-crash

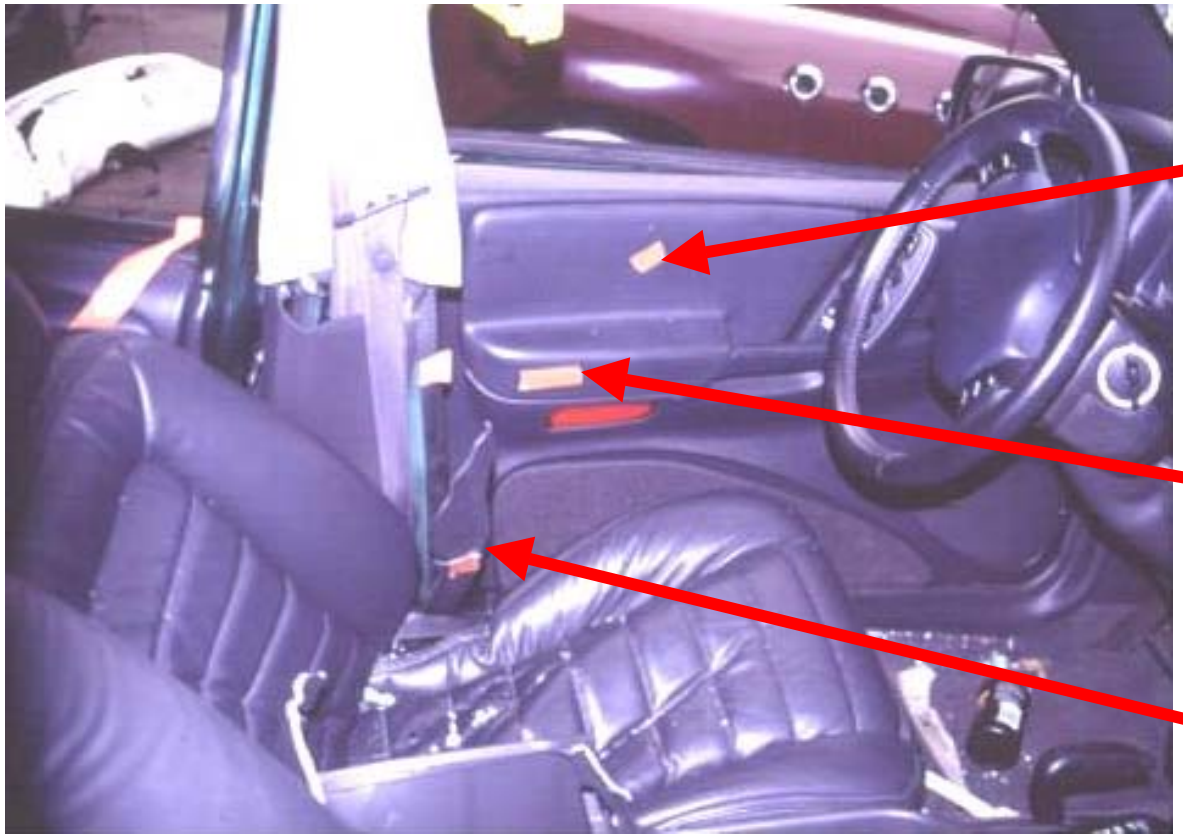
Intrusions

Left B pillar - 22cm - Lat

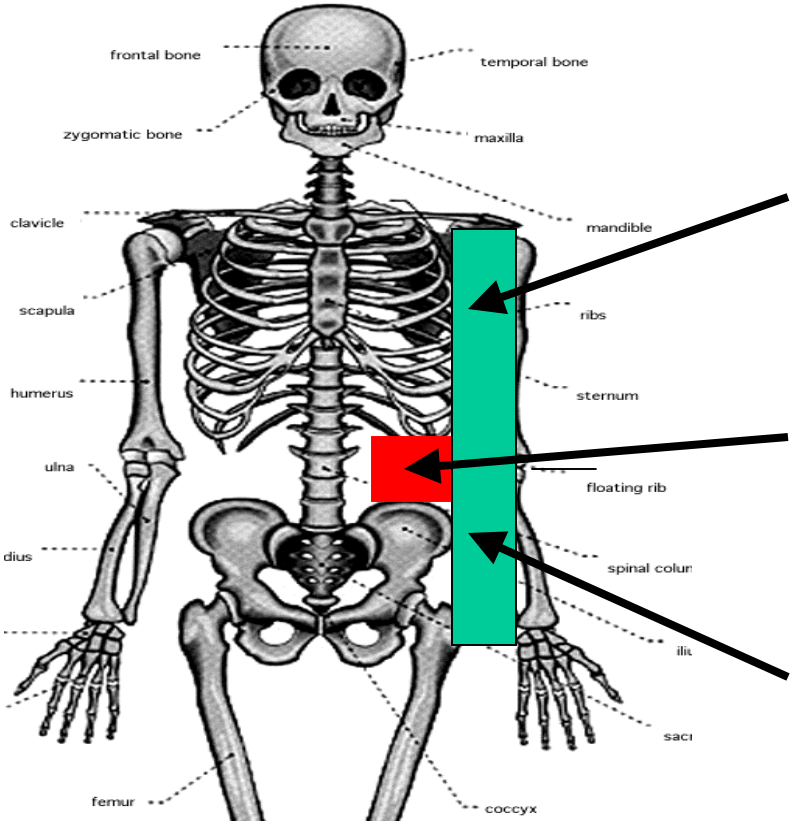
Driver Door - 16cm - Lat

Roof rail - 12cm - Lat

Occupant Contacts to Interior



Injury Contacts Observation Summary



L Ribs Fx's w/ hemothorax

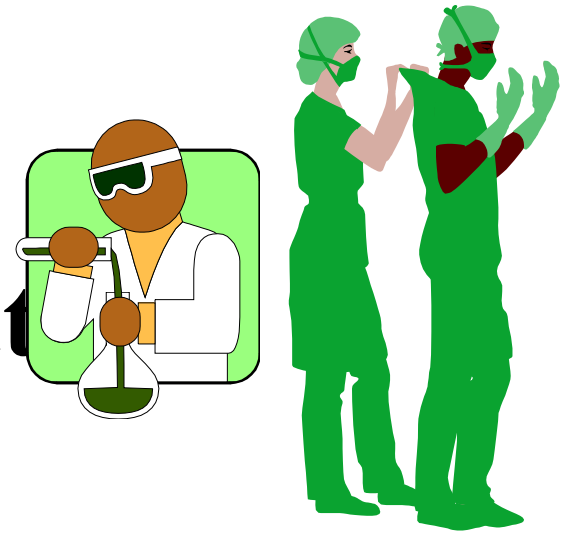
Splenic lacerations

L liver laceration

L iliac wing fracture

L pubic ring fracture

From CIREN's Real World Laborat



These cases raised questions about the association of door geometry and armrest stiffness with the likelihood of chest and abdominal injuries

Pilot Phase
The Relationship of Chest/Abdominal Injuries to Interior Door Shape in Low Intrusion Side Impact Crashes

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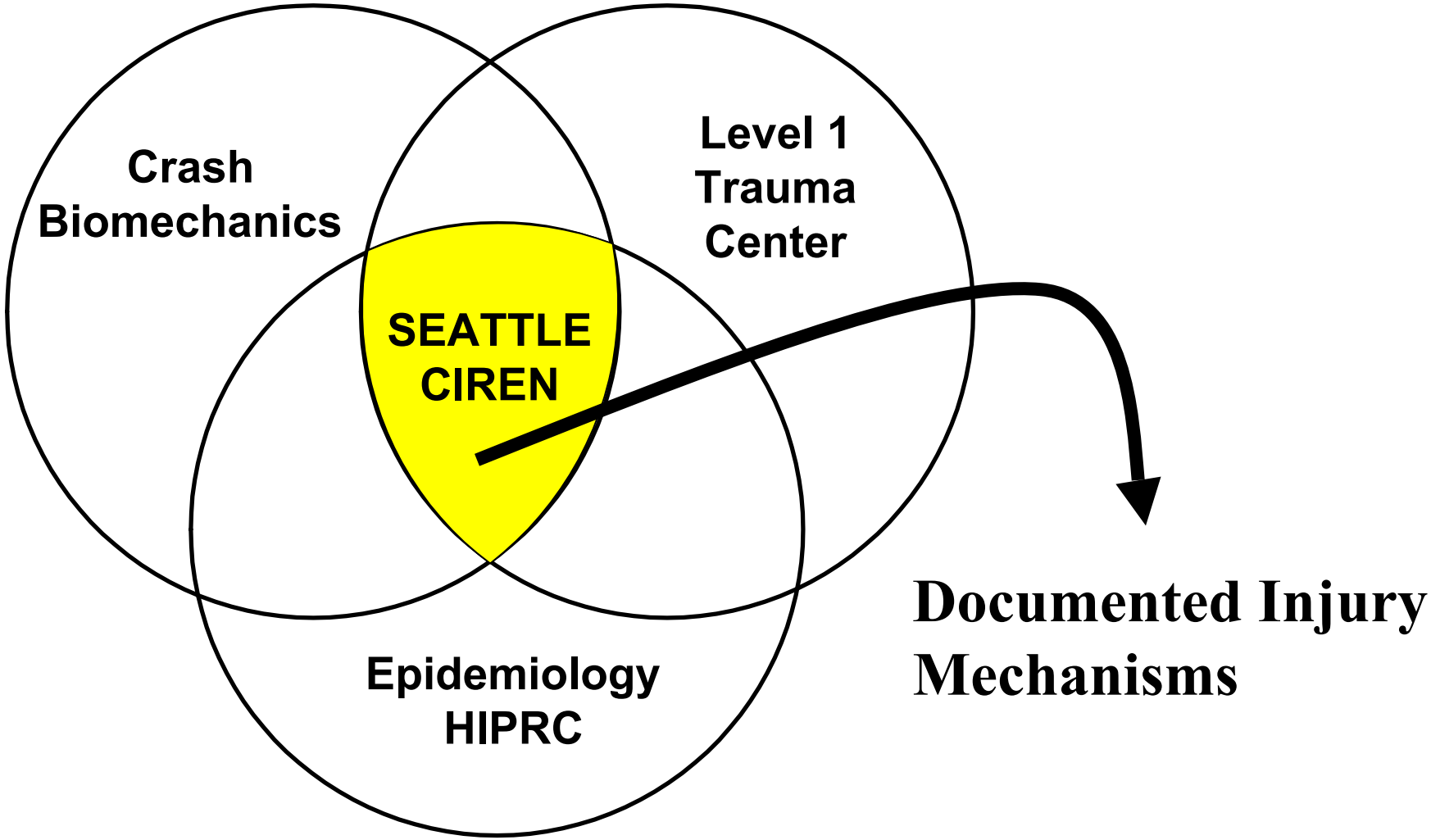
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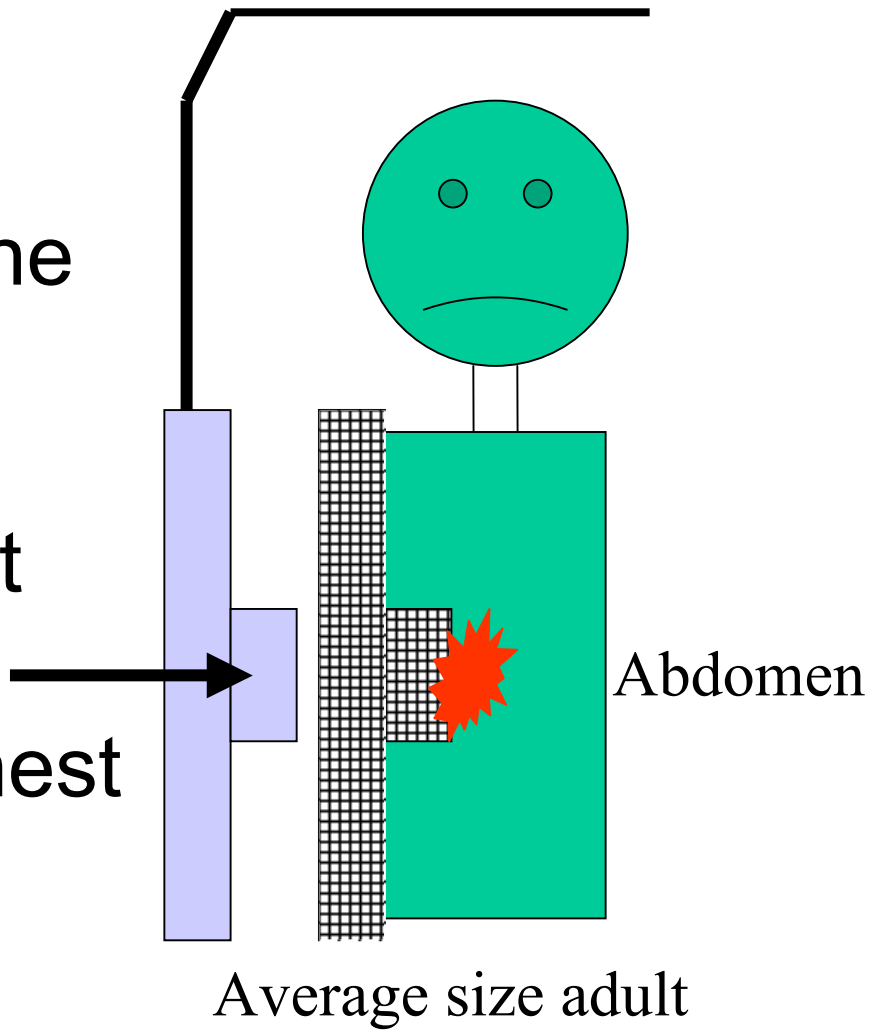
Epidemiology
HIPRC
Documented Injury
Mechanisms

Initial Goal

To investigate the association of the geometry and stiffness of the interior surface of the vehicle's door with the potential for abdominal and chest injuries in near side impact collisions.

Background Observation

The interior shapes of the door panels have protruding components, such as the armrest that may intrude into the occupant's abdomen/chest during side impact.



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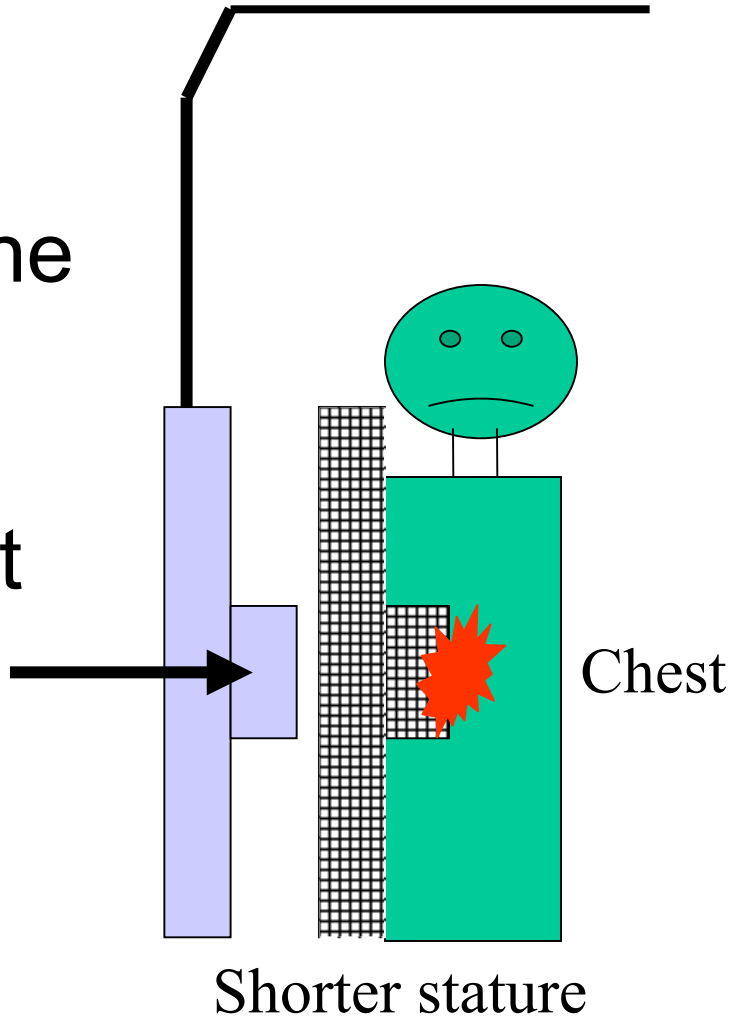


Pilot Phase Methods: NASS

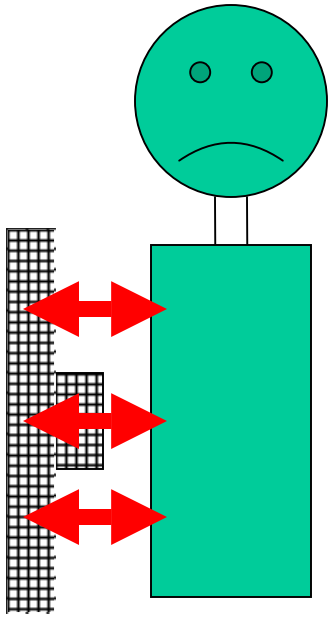
- Analyze side impact crashes for probability of chest or abdominal injury based on make and models
- Variables
  - Near sided - lateral PDOF
  - Intrusion - Magnitudes
  - AIS

Pilot Phase
Methods - Biomechanical

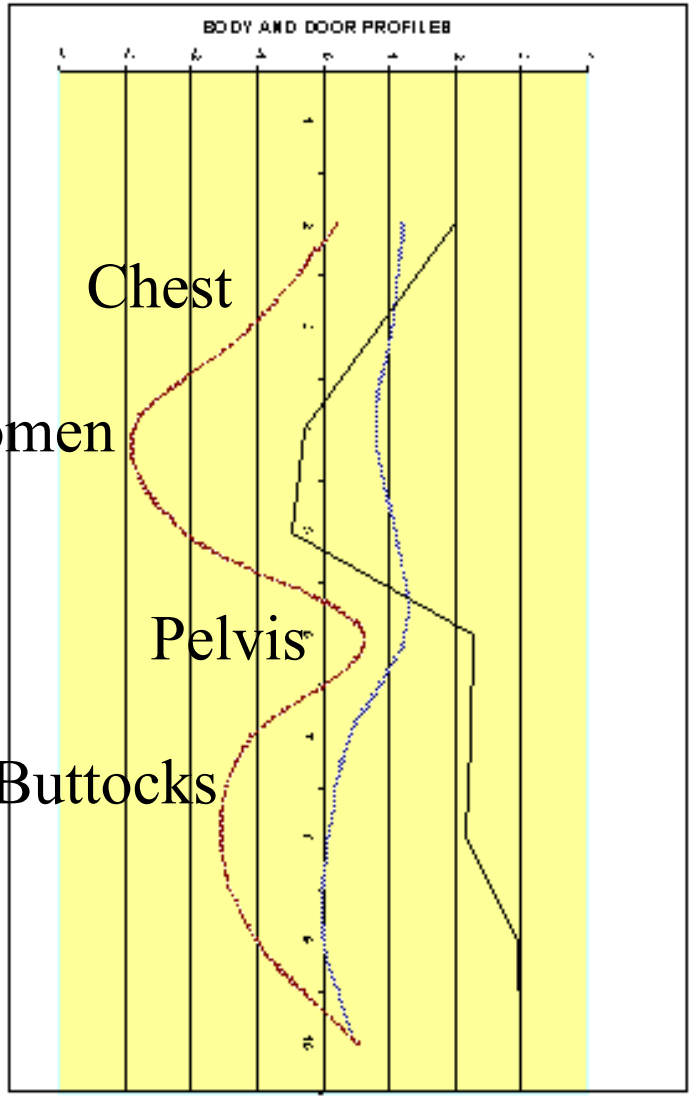
- Selected some high and low frequency models from the data analysis team's list
- Purchased whole doors from salvage yards to bring back to the lab

Pilot Phase
Initial Methods: Biomechanical

- Solve the contact problem between the door and the occupant, accounting for the geometry and stiffness of each, to determine the protrusion into the occupant's side as a measure of injury potential (estimated for 5 g collision with minimal intrusion)



Pilot Phase
Body and Door Profile



Door shape

Body Contour

Deformed Body Shape

Abdominal Deformation = 3.65”

The Next Phase - Chest/Abdominal Injuries in Side Impacts

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Hypotheses

- Soft doors with stiff interior protrusions (armrests) create more severe injuries than flat doors of uniform stiffness?

- Injuries will be more severe to persons of shorter stature, (since the protrusion (armrest) may contact the chest wall instead of the hip)?

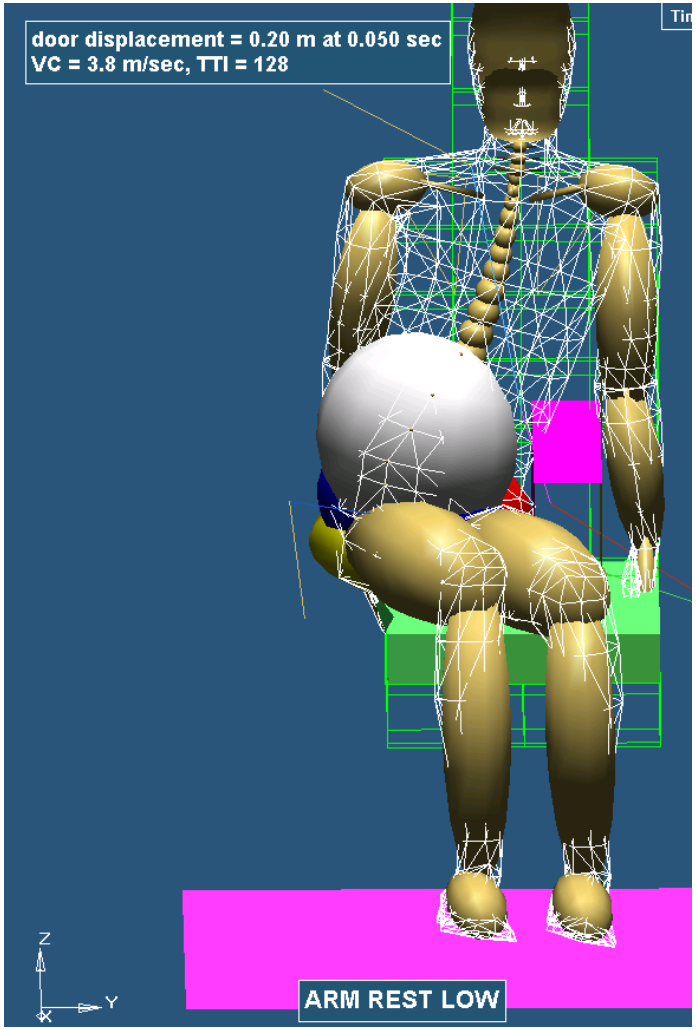
- Injury predictors based on displacement or intrusion (Cmax, VC) correlate better with actual injuries in cadavers than do injury predictors based on acceleration (such as TTI)?

Specific Aims

- Enhance our NASS based data of vehicle vs. frequency of injury, adding ’96, ‘02.
- Survey vehicles (post ‘97) to determine interior geometry of the door.
- Measure geometry and stiffness of a representative doors.
- Develop a MADYMO model of side impact using door data, test hypotheses.
- Compare model data with results of 24 high rate side impacts using the same door with cadavers.

Develop a MADYMO model of side impact

- Methods: 50th % human male, and the 5th % female models, door finite element object,
- Expected results: Test hypotheses regarding flat v. standard door, effects of occupant stature.
- Limitations: If during an impact the door exterior sheet metal was crushed, the door panel would be stiffer.



Goals

Use modeling and cadaveric testing to;

- Determine how actual vehicle doors with armrests, interact with occupants' bodies during a side impact
- Compare the injuries resulting from flat doors and actual doors with features such as arm rests
- Consider how persons of shorter stature (small women) are affected in side impacts with actual doors.
- Determine how well measured injury predictors used crash dummies correlate with injuries produced in cadavers impacting actual doors.

Test Cadaveric Specimens

Methods: Impact testing of 24 specimens, about 7 m/sec, sitting with arm rest high (contact above pelvis) or low (contact at pelvis)

Expected results: Injury AIS vs arm rest position, and AIS vs TTI, VC, Fmax, Cmax, energy, to determine best injury predictor

Limitations: Door is representative of a sample of doors tested, no consideration of role of side impact air bags.

CIREN Seattle Goals

CIREN Insight for CDC funded project - Propose better door panel design to minimize injury which in turn could reduce injury and **improve the crash test measures**, therefore costs to society.

Better Triage - Outreach efforts already underway to train EMS and ED staff to be aware of these potential side impact hidden mechanisms.

Thank you

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