“Head Injury Mechanisms and Preventive Measures”

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Article in Press

Accident Analysis & Prevention

"Correlation of head injury to vehicle contact points using Crash Injury Research and Engineering Network"
R. Nirula, C. Mock, R. Kaufman et al.

- Identify mechanisms and contact sources producing critical/severe head injuries in MVC using the CIREN database.

- Predominant mechanism for critical head trauma occurred in lateral impacts, especially with the roof pillars, and in frontal impacts to M/H trucks.

Other research on head injury sources

Thomas, Loughborough University of Technology, *"The cause of head injuries in real world crashes"* 1991.

Sources: St. Wheel, Pillars, striking intruding object

Morris, Birmingham Univ., *"Head injuries in lateral impact collisions"* 1993.

Sources: 49% exterior sources: tree, poles, vehicle

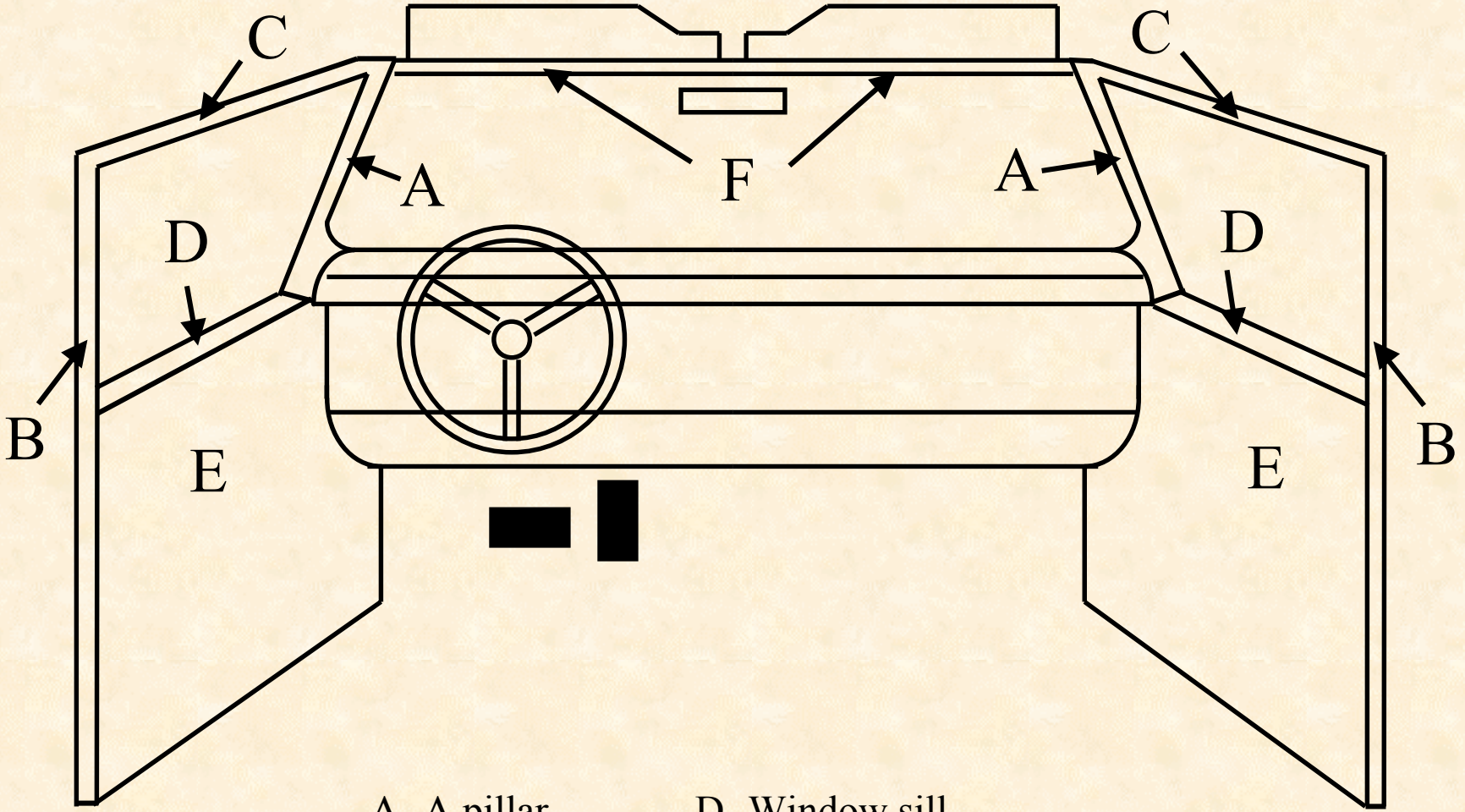
Gloyns, Vehicle Safety Consultants, *"Mechanisms and patterns of head injuries in fatal frontal and side impacts"* 1994.

Sources: Frontal impacts, loading of skull was usually transmitted via the facial bones.

Reference: SAE Highway Vehicle Safety Database, 916006, 1993-13-0003, 1994-13-0009

Critical Head Injury Mechanisms
Seattle CIREN Case Reviews

Direct contact source for critical head injuries



A- A pillar

B- B pillar

C- Roof side rail

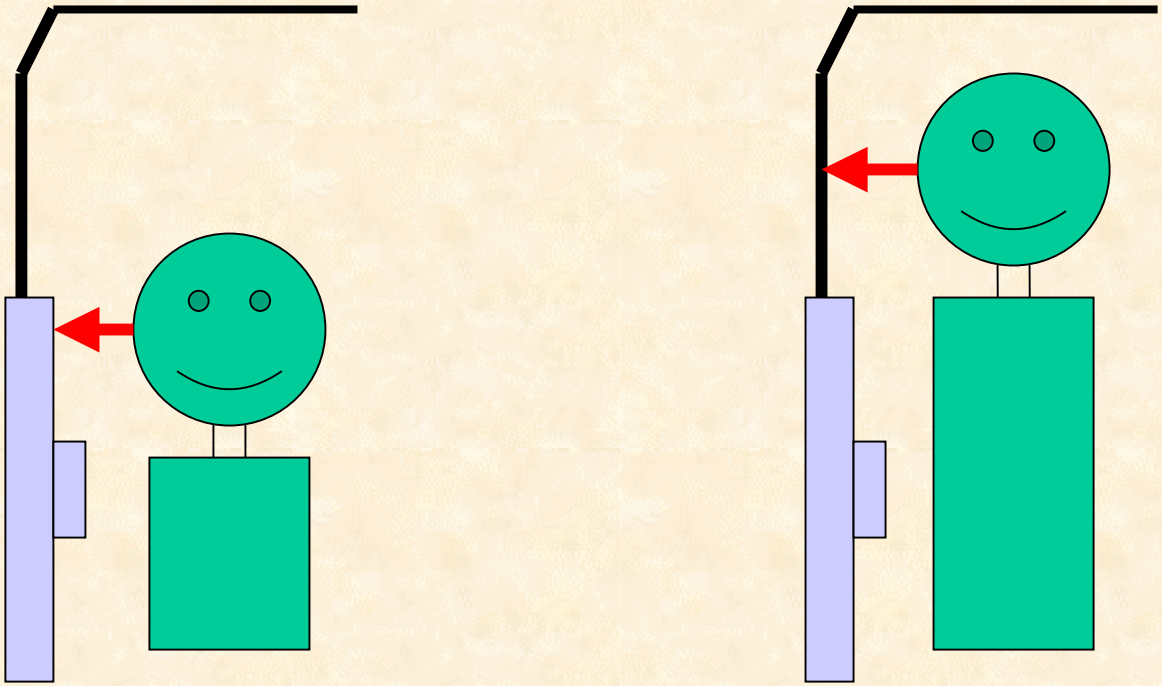
D- Window sill

E- Door panel

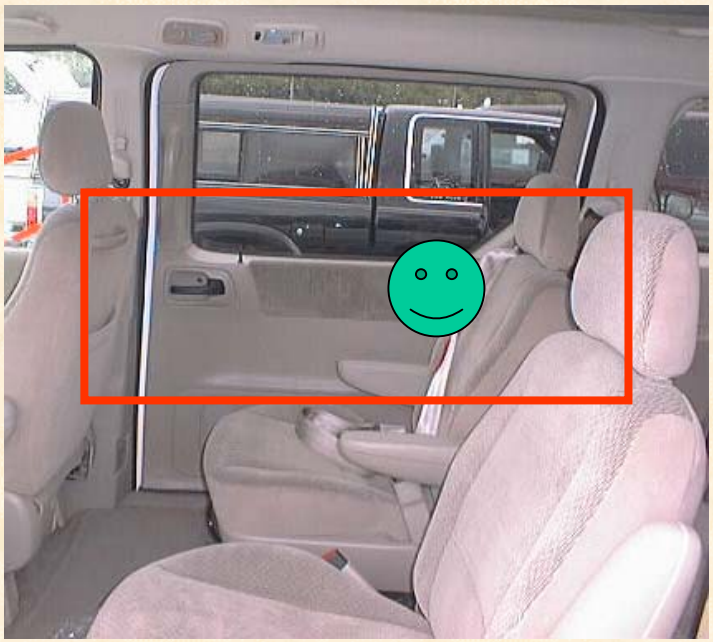
F- Windshield Header

Lateral impact head contacts

Remember that children are exposed to more surface area for head contact in crashes.



Children that are seated in vehicles expose themselves to more surface area for head contacts



Adults head contacts will occur to the greenhouse structure (roof and roof pillars)

Critical Head Injuries - Child Side Impacts

90's Ford Sedan

20 mph Delta V

PDOF = 60

Struck by large pickup

Young Boy

Back right seat - fully restrained

Sleeping with head against door

Critical Head Injuries - Child Side Impacts

40 cm of intrusion at door panel, window sill

Critical Head Injuries - Child Case reviews

Head Injury Summary

Brain injury - AIS = 5

Critical Head Injuries - Adult Case reviews

LMY Chrysler large sedan

Delta V = 25 mph

PDOF = 95

Critical Head Injuries - Adult Case reviews

Subject Right Front Passenger

Adult Male

Lap/Shoulder restraint used

Severe crush

Intrusion at legs and B pillar

External right scalp avulsion

Critical Head Injuries - Adult Case reviews

Critical Head Injuries - Adult Case reviews

- Bilateral intra-cranial hemorrhage and subarachnoid hemorrhage

- Left temporal contusion with shear - AIS 5

Head Injury Sources - SeattleCIREN

Plane	AIS	Source
Front	5	A pillar
Front	5	Airbag
Front	5	Windshield Header
Front	4	Airbag/Steering rim
Front	6	Unknown/noncontact
Side	4	B pillar
Side	5	B pillar
Side	6	Light pole
Side	5	Window Frame
Side	4	C pillar
Side	4	B pillar
Side	5	Window Sill
Side	5	B pillar
Side	4	Tree
Side	5	Roof side rail

1/3 involve the A & B Pillars

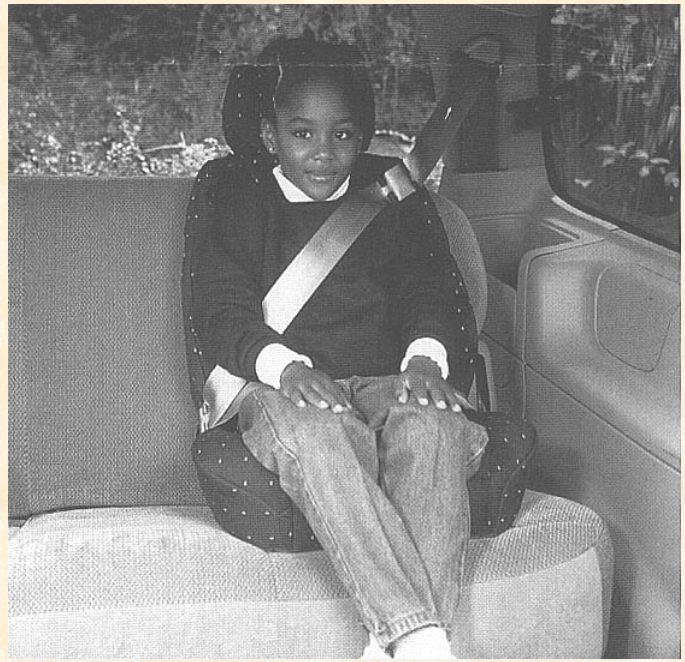
2/3 involve roof pillars and the greenhouse structure

Preventive Measures for Head Injury

Frontal Airbags

Children in Booster seats

Minimal Head Injury



Head positioned above door interior

NASCAR Helmets

Race track crash occurs at 80-100 Gs.
100 Gs to 160lbs man = 16,000 lbs on top

BeadALL liner - special foam layer, poly

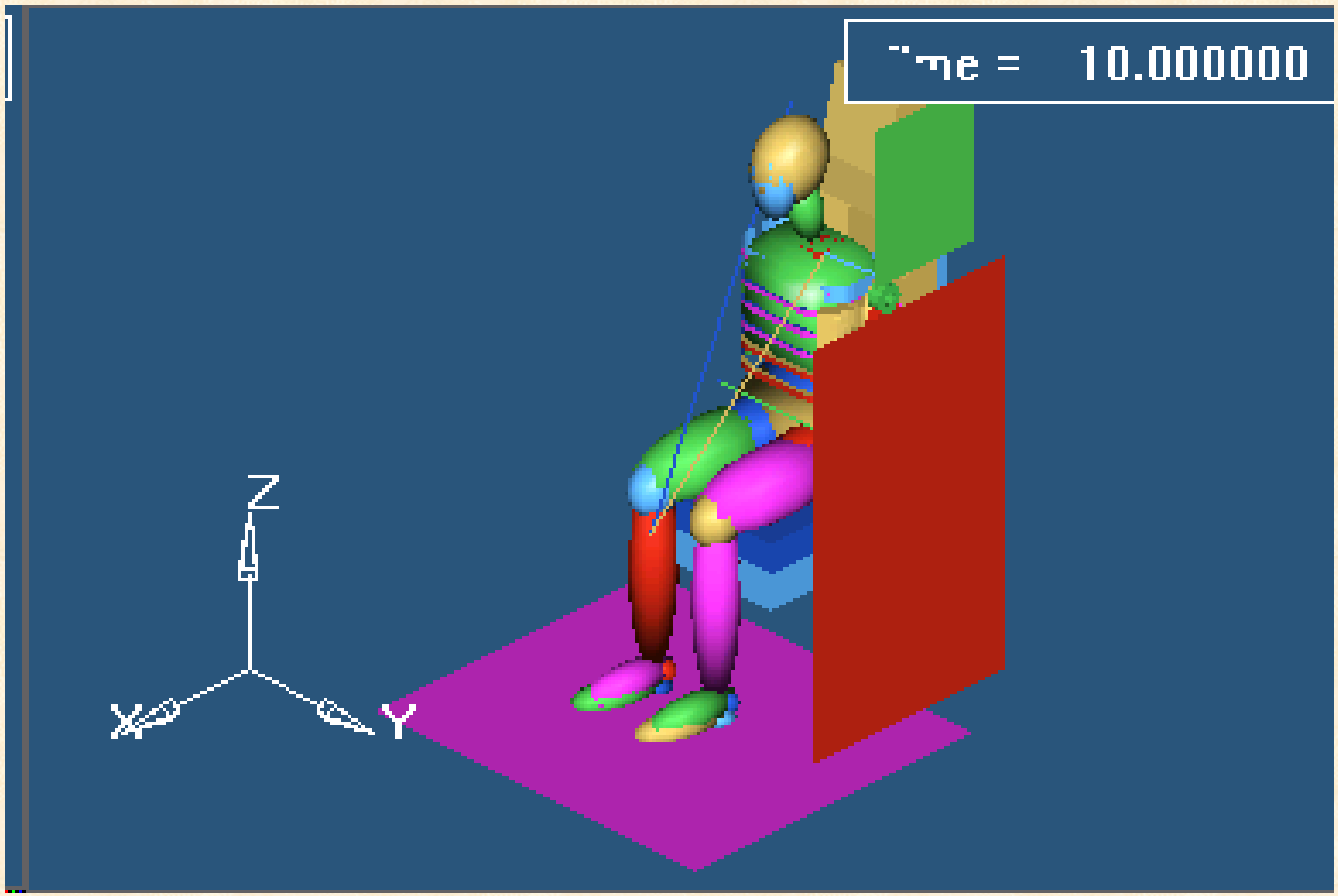
<u>Impact resistance test</u>

- If the peak acceleration impacting the metal head exceeds a magnitude of force equal or above 300G's, it is rejected.

MADYMO Simulations

- Roof pillars and side rails are very stiff
- Would slight change in pillar stiffness reduce the severity of head injuries, or HIC?
- Add-on padding, or changes in original design, might minimize head injury severity
  - less expensive than airbag technology

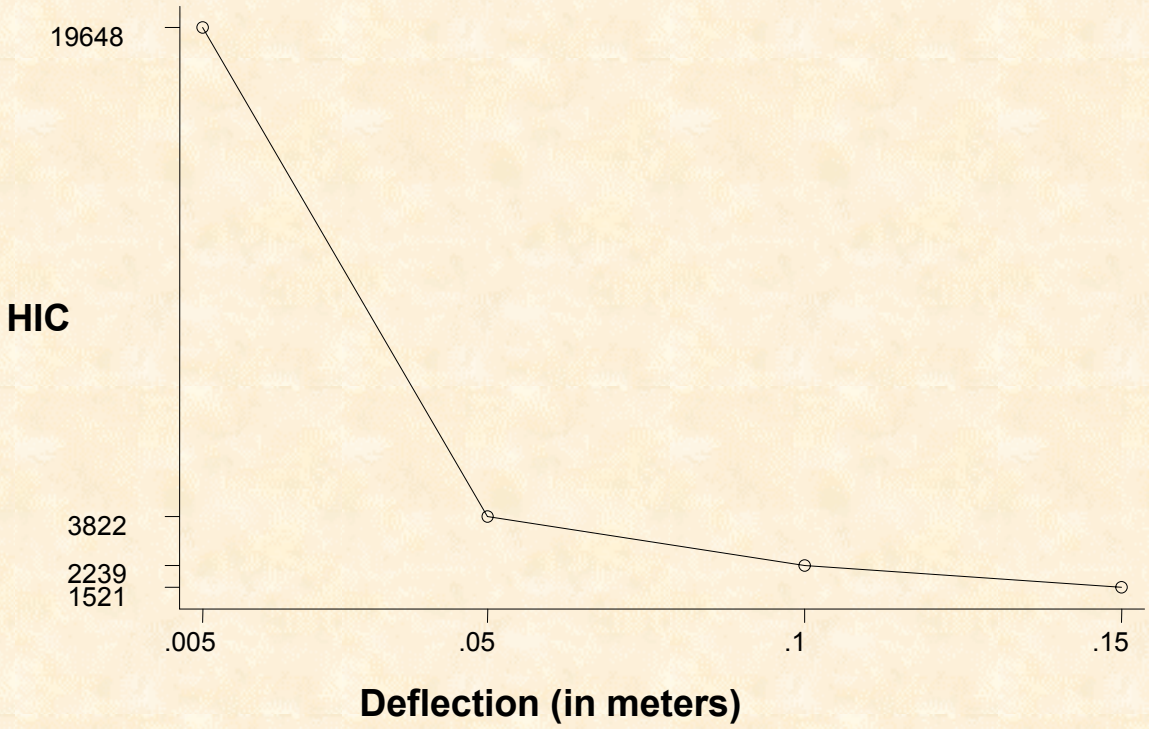
MADYMO
Head impact with pillar



- Used BIOSID in MADYMO

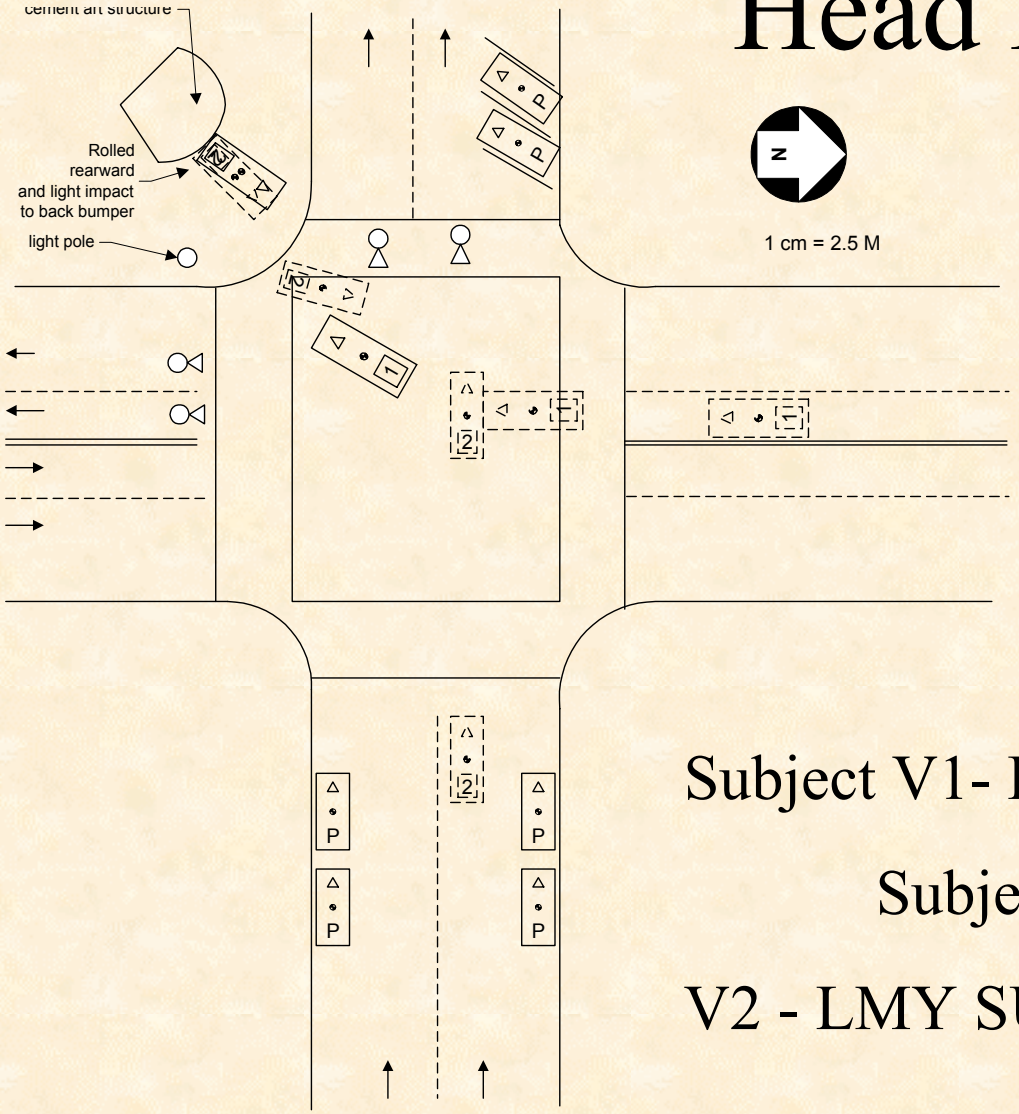
- Arbitrary Force of 20000N

- HIC based on frontal impact and linear measurement excluding rotational acceleration



Head protection w/Side Airbags

Side Airbag
Head Protection



Subject V1- LMY Mercedes Sedan

Subject - Front Right Passenger

V2 - LMY SUV

Subject Vehicle Damage

Right side direct lateral impact

Delta V Oldmiss = 18 mph

PDOF = 70

Extrication to door

Profile adjusted

Demographics/Contacts

Adult Female

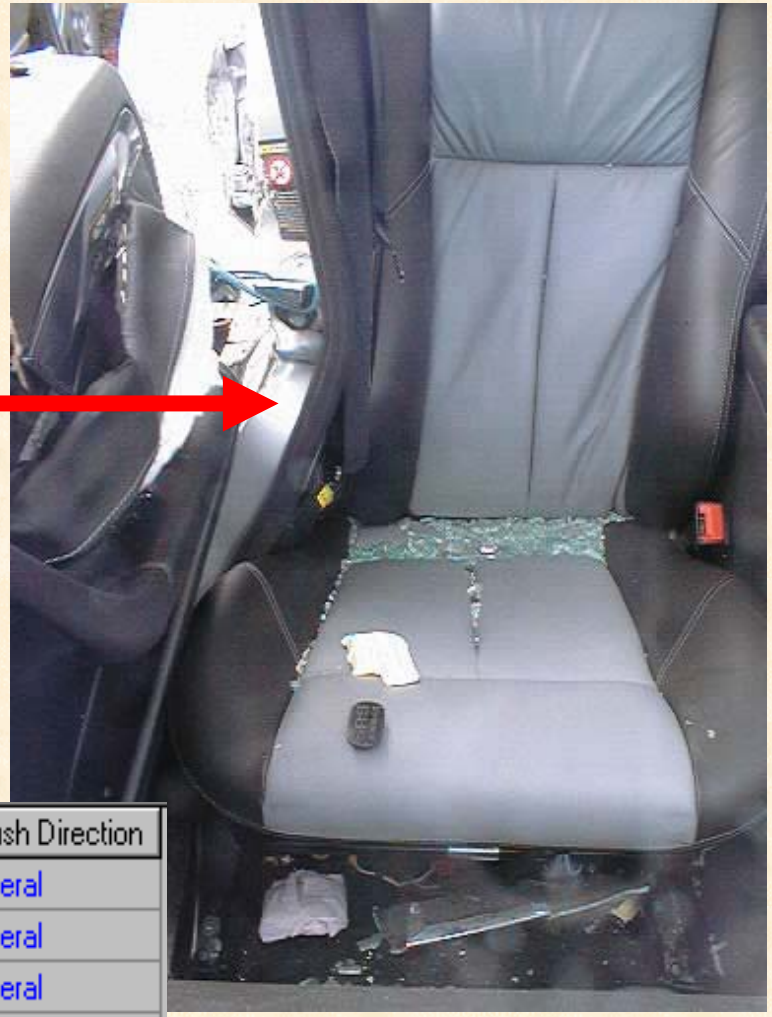
No Manual belts used

Side door airbag deployment

Lower door panel to lower chest/abdomen

Pelvis scuff to B pillar

Seatbelt locked in position by intrusion



Intrusions

	Row	Position	Intruded Component	Intrusion	Magnitude	Crush Direction
	Front Seat	Right	Door panel (side)	21	>= 15 to < 30 cms	Lateral
	Front Seat	Right	B-pillar	25	>= 15 to < 30 cms	Lateral
	Second Seat	Right	Window frame	17	>= 15 to < 30 cms	Lateral
	Second Seat	Right	Door panel (side)	19	>= 15 to < 30 cms	Lateral
	Front Seat	Right	Floor pan (includes sill)	10	>= 8 to < 15 cms	Lateral
	Second Seat	Right	Front seat back	10	>= 8 to < 15 cms	Longitudinal
	Front Seat	Right	Roof side rail	3	>= 3 to < 8 cms	Lateral
	Second Seat	Right	Floor pan (includes sill)	6	>= 3 to < 8 cms	Lateral
I	Second Seat	Right	Roof side rail	2	<= 2 cms	Lateral

Door Mount Side Airbag

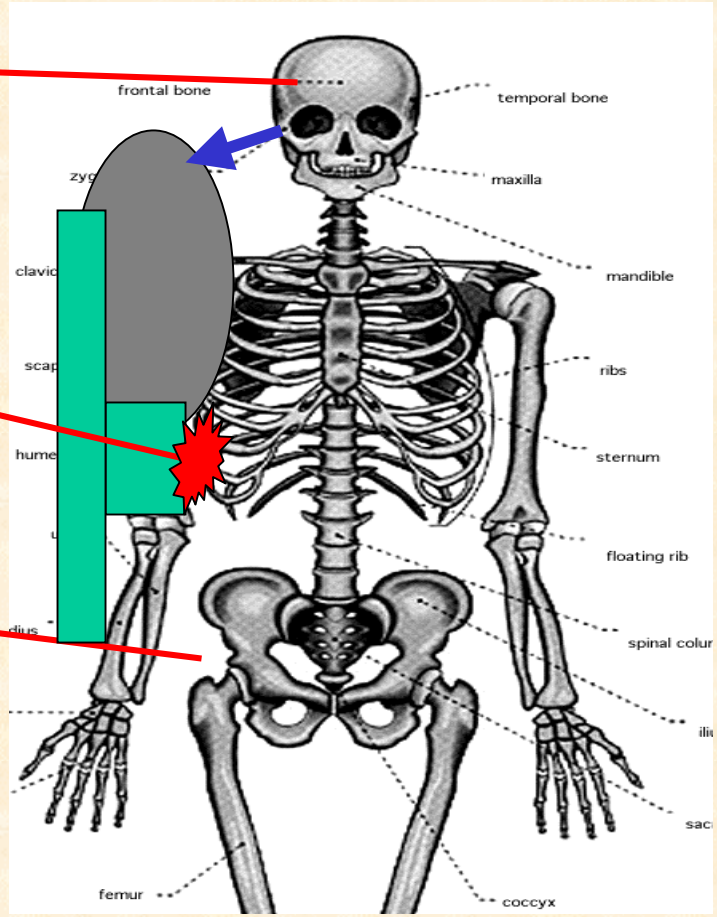
Main protection to upper thorax, but extends enough upward for some head protection

Injury Summary

Head - Slight LOC on scene
-Probable deceleration of head into side airbag.

Chest - R Rib fx 7-11
- Probable lower door panel intrusion

Pelvis - Right inferior pubic root, inferior rami and Zone I and II sacral fractures
- Probable B pillar intrusion



Upper chest and head appear to be protected by door mounted side impact airbag considering an SUV upper door impact.