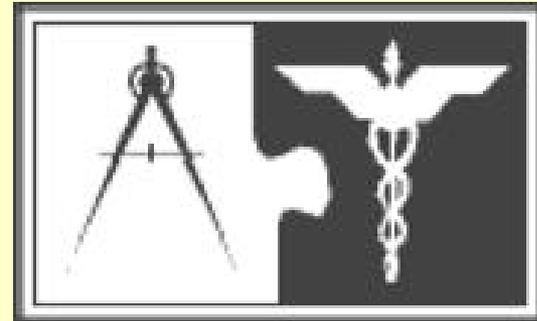


SUVS involving: Rollovers, Frontal Offsets and Corner Impacts called FLEES.

Presenters:

Rob Kaufman B.Sc.

Dr. Charles Mock Ph.D.



CIREN Seattle

HARBORVIEW
MEDICAL
CENTER
INJURY PREVENTION
AND RESEARCH CENTER

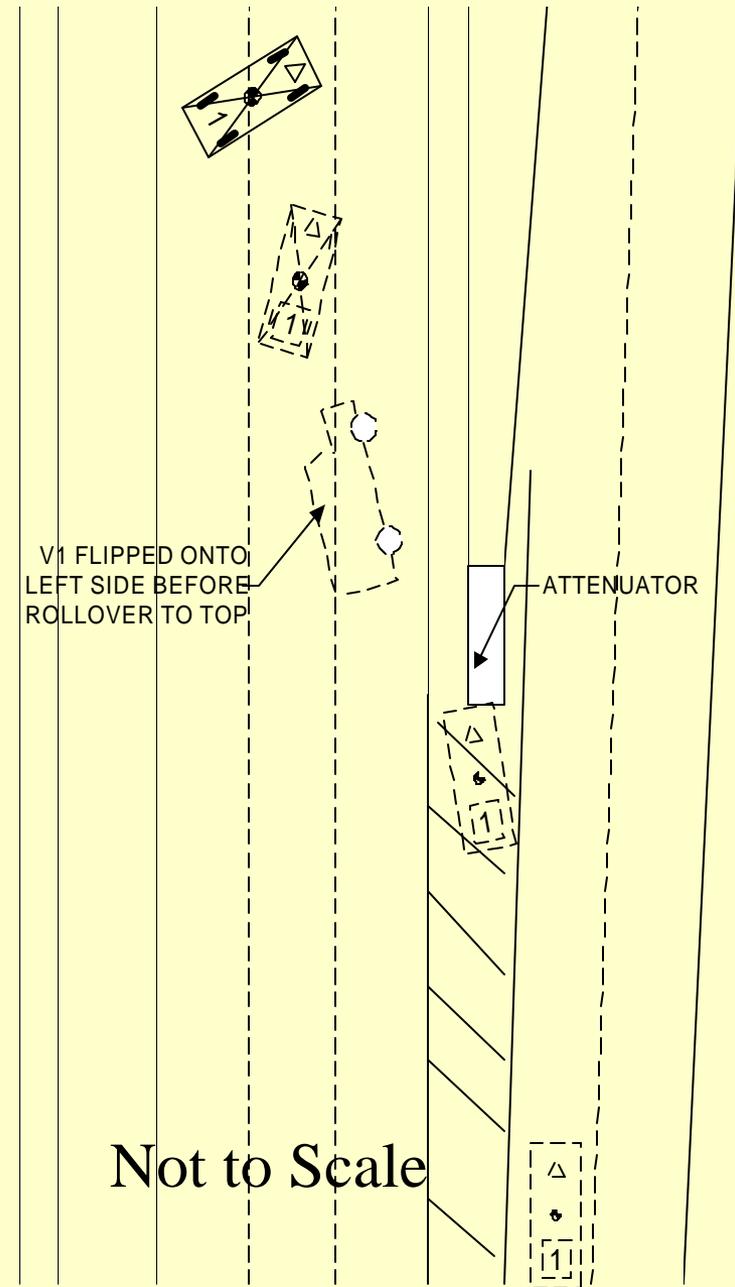
A graphic element of the Harborview Medical Center logo, showing a stylized building with three columns and a curved roof, with two hands holding it.

SUV Rollover



90's GMC
Yukon

Subject
Unbelted Driver
(4 others declined)





Impact Attenuator - 12FZEW1

Delta V = 10 mph BE

Max Crush = 20 cm @ C6

Rollover - 00TDDO4

Max Crush = 31 cm of Driver Seat Area





Intrusions

Row	Position	Area	Intruded Component	Intrusion	Magnitude	Crush Direction
Front Seat	Left	Interior	Windshield header	32	>= 30 to < 46 cms	Vertical
Front Seat	Left	Interior	A (A1/A2)-pillar	34	>= 30 to < 46 cms	Vertical
Front Seat	Left	Interior	Windshield	32	>= 30 to < 46 cms	Vertical
Front Seat	Left	Interior	Roof (or convertible top)	36	>= 30 to < 46 cms	Vertical
Front Seat	Left	Interior	Roof side rail	32	>= 30 to < 46 cms	Vertical
Front Seat	Middle	Interior	Windshield	24	>= 15 to < 30 cms	Vertical
Front Seat	Right	Interior	Windshield	19	>= 15 to < 30 cms	Vertical
Front Seat	Right	Interior	Windshield header	20	>= 15 to < 30 cms	Vertical
Front Seat	Right	Interior	Roof (or convertible top)	16	>= 15 to < 30 cms	Vertical
Front Seat	Middle	Interior	Windshield header	28	>= 15 to < 30 cms	Vertical
Front Seat	Middle	Interior	Roof (or convertible top)	26	>= 15 to < 30 cms	Vertical
Front Seat	Right	Interior	A (A1/A2)-pillar	23	>= 15 to < 30 cms	Vertical
Front Seat	Right	Interior	Roof side rail	13	>= 8 to < 15 cms	Vertical
Second Seat	Right	Interior	Roof (or convertible top)	9	>= 8 to < 15 cms	Vertical



Subject Driver

30's Male

No Belts used

No airbag

Injuries

Head - Concussion + LOC

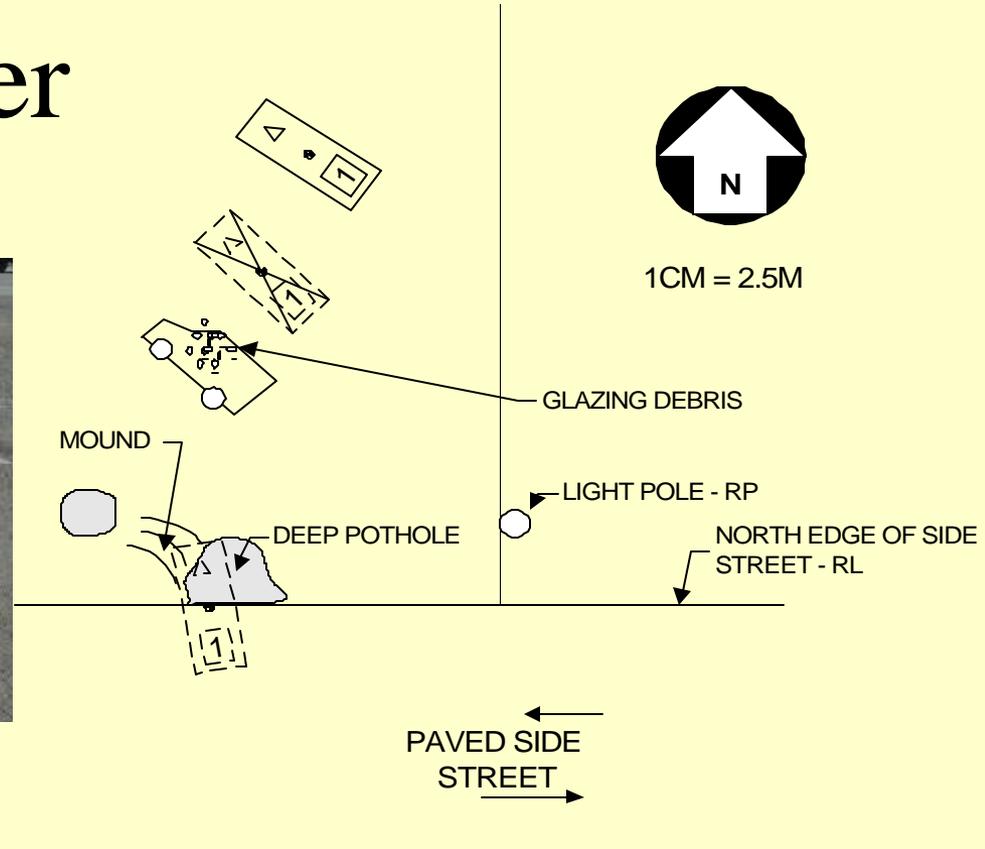
Face - R facial contusion

Abd. - Hematuria/blood in urine
(kidney/bladder contusion?)



Three unbelted back seat occupants - no serious injuries

SUV Rollover



Late Model Chevrolet Blazer

Subject - Front Right Passenger

Five total occupants in vehicle who all belted



Single Rollover Event
Four quarters

CDC = 00TDDO5

Max Crush = 38 cm
@ Right
windshield header



Intrusions



Row	Position	Area	Intruded Component	Comparison	Intruded	Intrusion	Magnitude	Crush Direction
Front Seat	Right	Interior	Windshield header	102	62	40	≥ 30 to < 46 cms	Vertical
Front Seat	Right	Interior	Roof (or convertible top)	110	68	42	≥ 30 to < 46 cms	Vertical
Front Seat	Right	Interior	A (A1/A2)-pillar	102	62	40	≥ 30 to < 46 cms	Vertical
Front Seat	Right	Interior	Roof side rail	103	64	39	≥ 30 to < 46 cms	Vertical
Front Seat	Middle	Interior	Windshield	25	0	25	≥ 15 to < 30 cms	Vertical
Front Seat	Right	Interior	Windshield	25	0	25	≥ 15 to < 30 cms	Vertical
Front Seat	Right	Interior	B-pillar	102	87	15	≥ 15 to < 30 cms	Vertical
Front Seat	Middle	Interior	Windshield header	33	12	21	≥ 15 to < 30 cms	Vertical
Second Seat	Right	Interior	Roof (or convertible top)	110	95	15	≥ 15 to < 30 cms	Vertical
Front Seat	Middle	Interior	Roof (or convertible top)	110	86	24	≥ 15 to < 30 cms	Vertical
Front Seat	Left	Interior	Roof (or convertible top)	110	101	9	≥ 8 to < 15 cms	Vertical
Second Seat	Right	Interior	Roof side rail	103	94	9	≥ 8 to < 15 cms	Vertical
Front Seat	Left	Interior	Windshield	25	20	5	≥ 3 to < 8 cms	Vertical
Second Seat	Middle	Interior	Roof (or convertible top)	110	104	6	≥ 3 to < 8 cms	Vertical
Front Seat	Left	Interior	Windshield header	33	29	4	≥ 3 to < 8 cms	Vertical

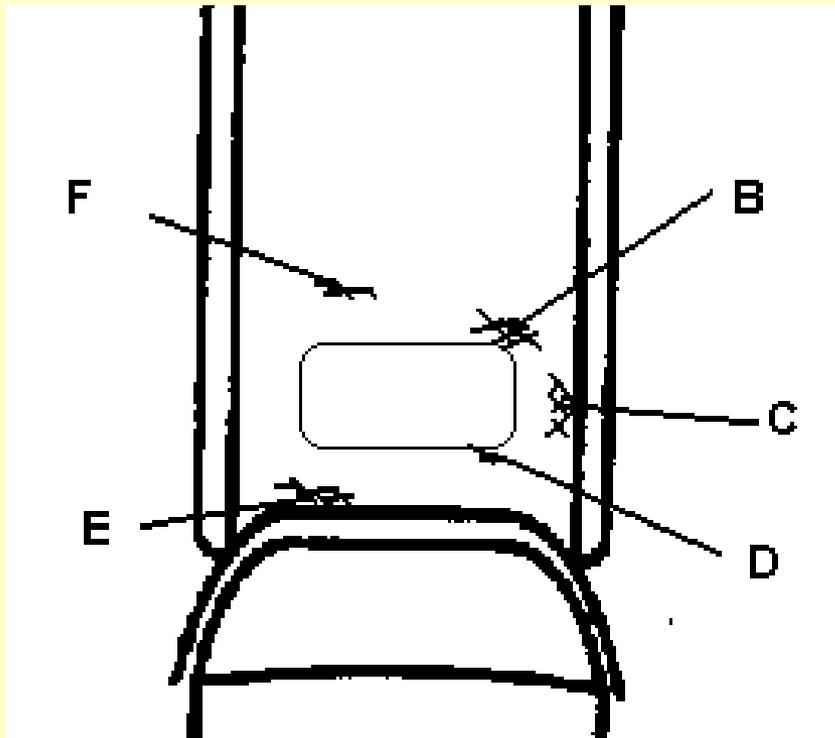


Subject Front Right Passenger
20's Male

Restraint: Lap/Shoulder belt

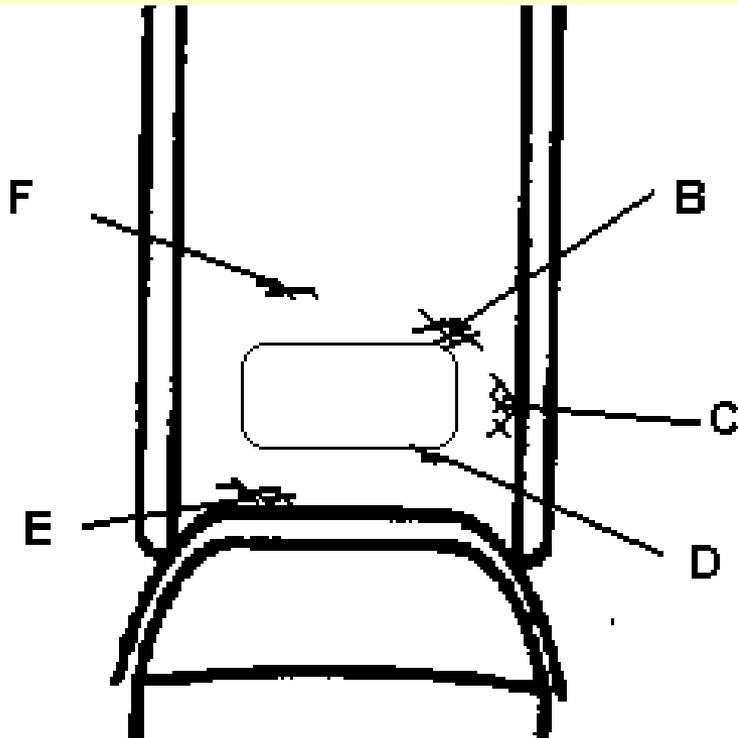
Max Roof Intrusion location

Contacts



Contact	Area	Component	Occ #	Body Region	Evidence	Confidence
A	Front	Sunvisor	2	Head	Transfer (Specify)	PROBABLE
B	Roof	Roof or convertible top	2	Head	Hair	CERTAIN
C	Roof	Roof right side rail	2	Head	Hair	CERTAIN
D	Roof	Roof or convertible top	2	Unknown	Scatched	UNKNOWN
E	Roof	Roof or convertible top	1	Lower Arm - Unknown	Scuffed	POSSIBLE
F	Roof	Roof or convertible top	3	Unknown	Scuffed	PROBABLE

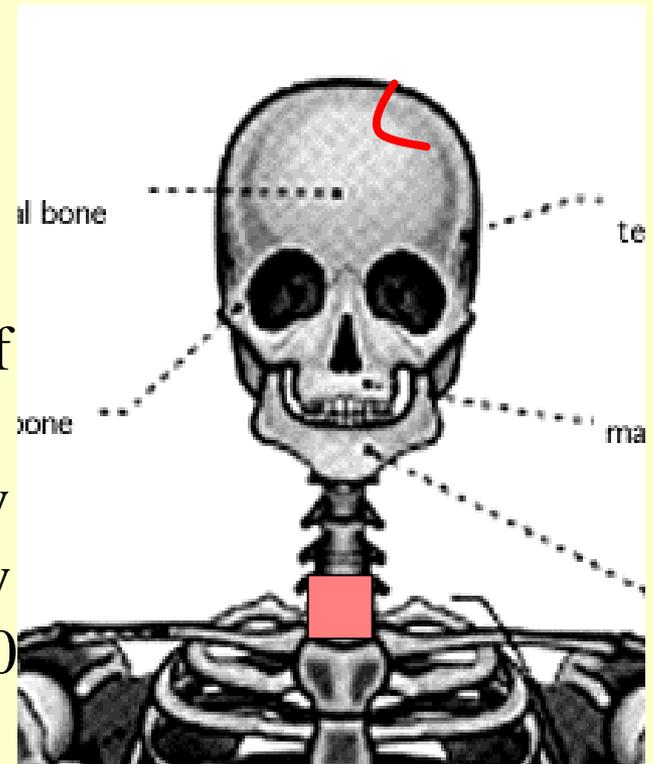
Contacts



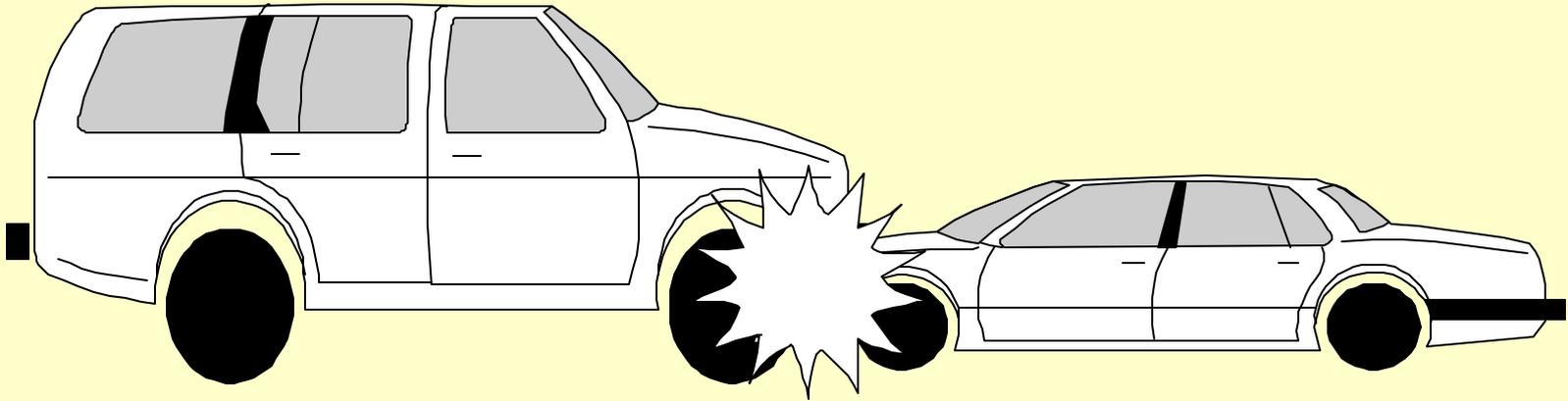
Contact	Area	Component	Occ #	Body Region	Evidence	Confidence
A	Front	Sunvisor	2	Head	Transfer (Specify)	PROBABLE
B	Roof	Roof or convertible top	2	Head	Hair	CERTAIN
C	Roof	Roof right side rail	2	Head	Hair	CERTAIN
D	Roof	Roof or convertible top	2	Unknown	Scatched	UNKNOWN
E	Roof	Roof or convertible top	1	Lower Arm - Unknown	Scuffed	POSSIBLE
F	Roof	Roof or convertible top	3	Unknown	Scuffed	PROBABLE

Injuries

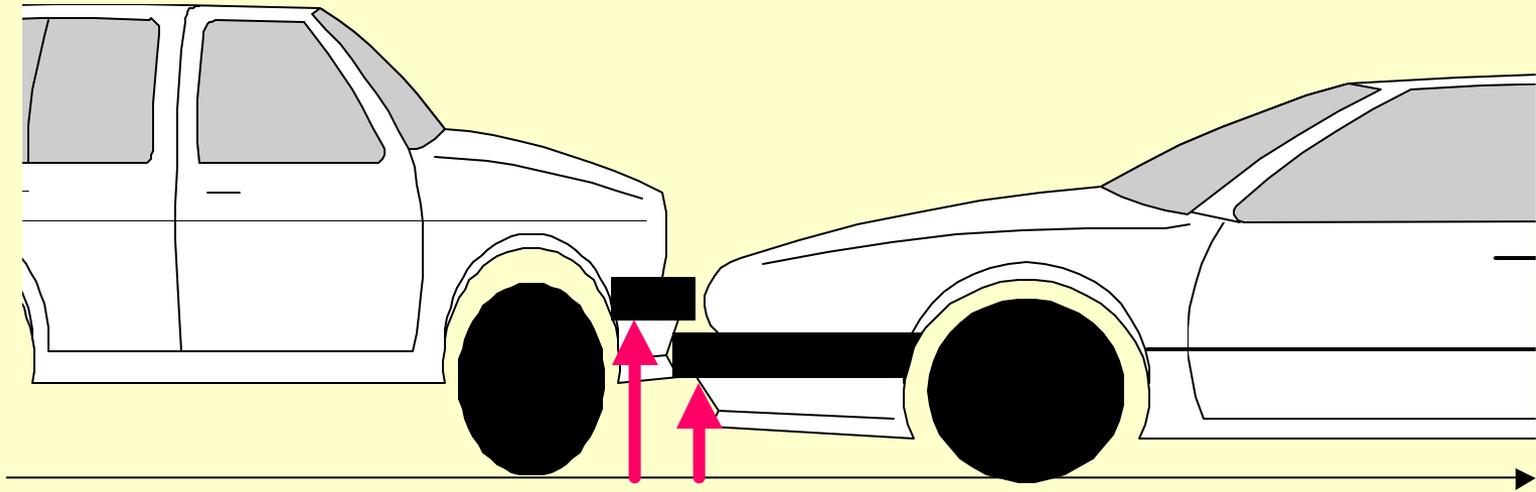
AIS	Region	Injury
3	Spine	R C5 pedicle fx, R C5 laminar, R inf facet fx C5 w/ cord contusion @ base of C4-C5
2	Spine	C5 nerve root injury
1	Spine	C5 nerve root injury
2	Head	Crown of L scalp 10 cm lac, complex
1	Face	1" central chin lac



Offset Frontal Impacts into SUVs



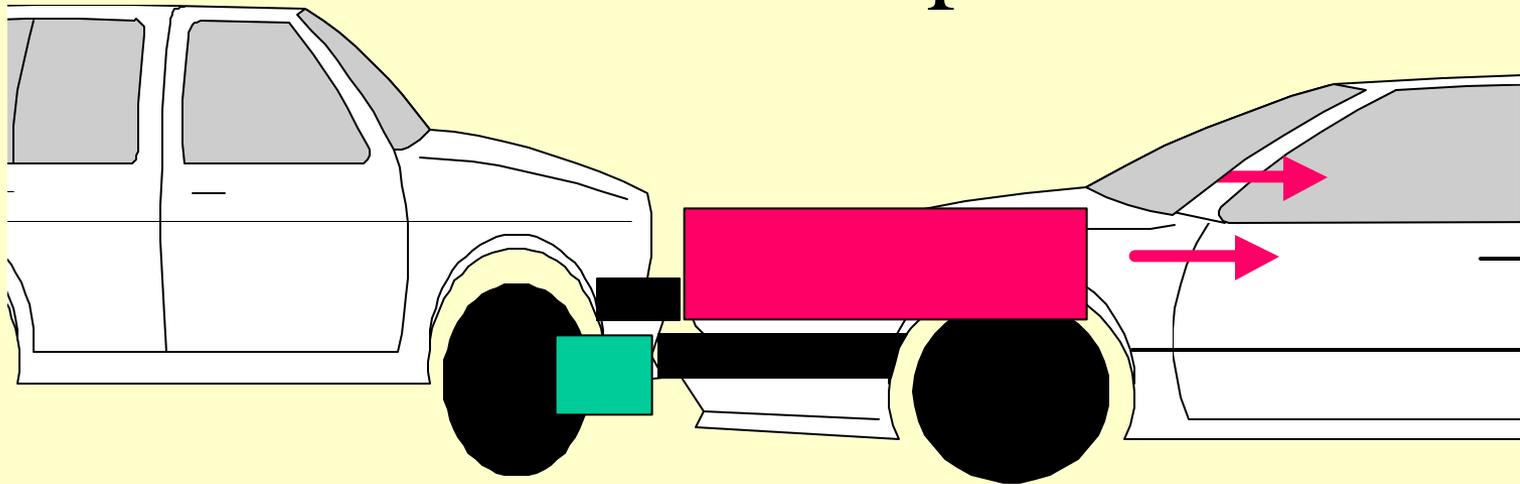
SUV vs. Sedan



Obvious mismatch in bumper heights

SUV vs. Sedan

Override impact creates significant intrusion of instrument panel/hood



■ SUV bumper into grill of sedan

■ Sedan bumper into front tire/axle

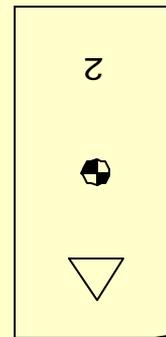
SUV vs. Mid-Size



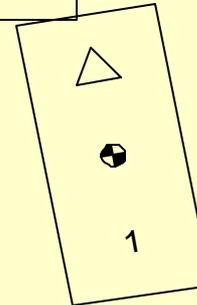
Subject driver pre-impact view

Posted speed limit - 30 mph

Driver V1 drifted straight, not negotiating the curve to the left



90's Ford
Explorer



90's
Mercedes
190E

SUV vs. Mid-Size



90's Mercedes
190E

Delta V = 25 mph

Offset = 51%

Demographics / Intrusions

Subject Driver:

60's Female

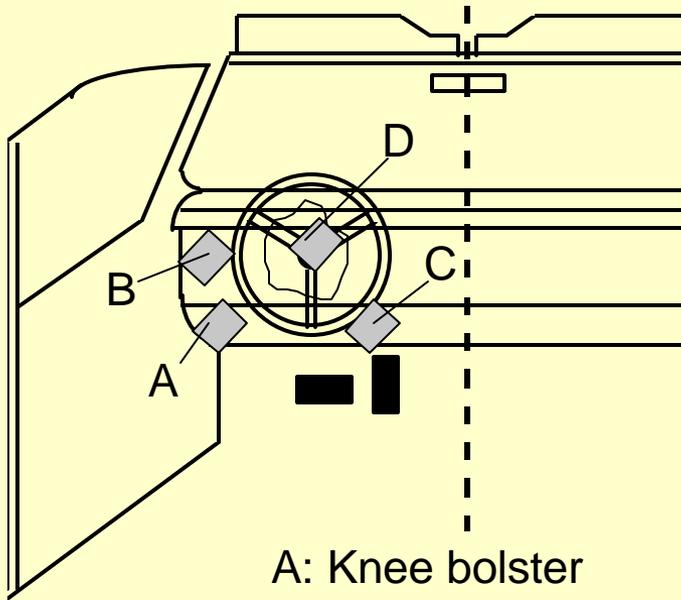
Restraints: Lap/Shoulder
belt w/ air bag deployment

Major Driver area Intrusions

Knee bolster	- 21 cm
Left Instr. Panel	- 20 cm
Hood/windshield	- 20 cm
A pillar	- 17 cm
Toe pan	- 13 cm
Steering assembly	- 10 cm



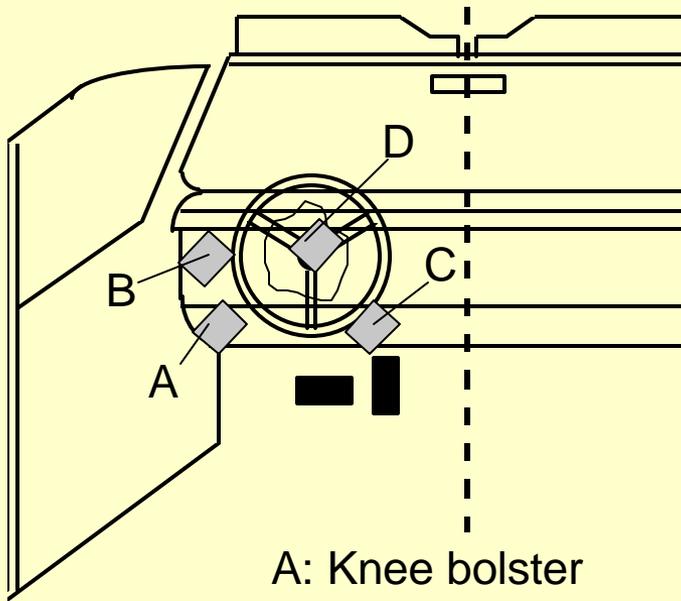
Interior Contacts



- A: Knee bolster
- B: L inst panel
- C: L inst panel
- D: Airbag



Interior Contacts

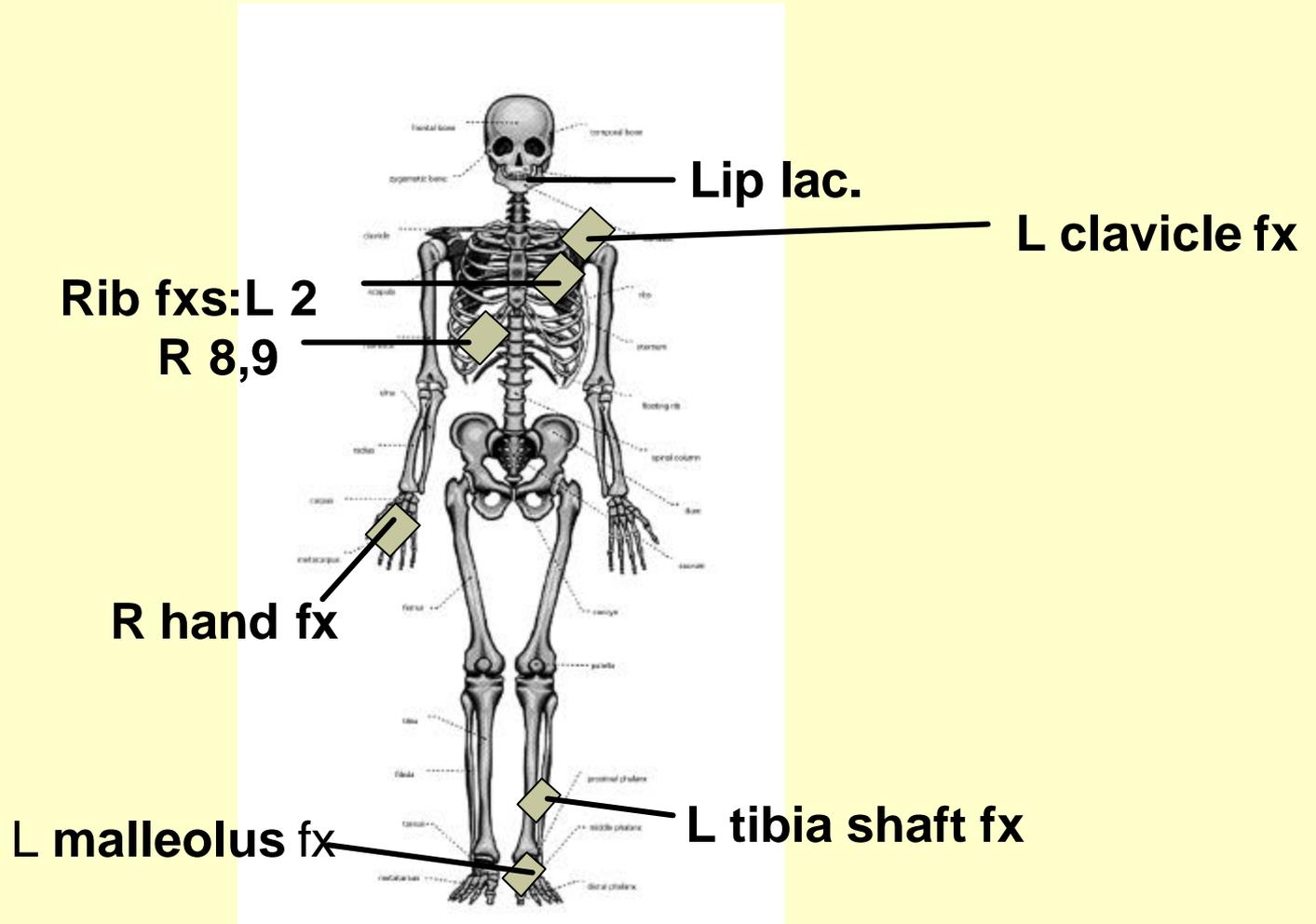


- A: Knee bolster
- B: L inst panel
- C: L inst panel
- D: Airbag



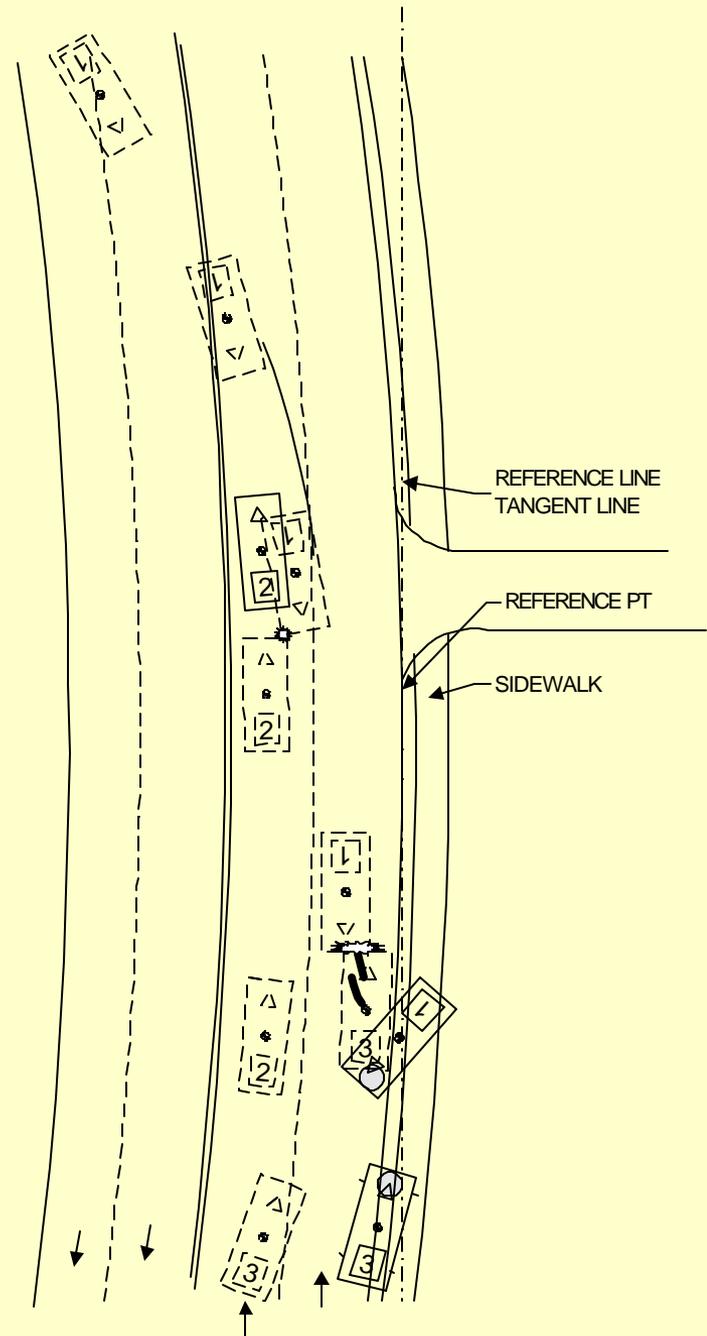
Airbag - Lipstick

Injury summary

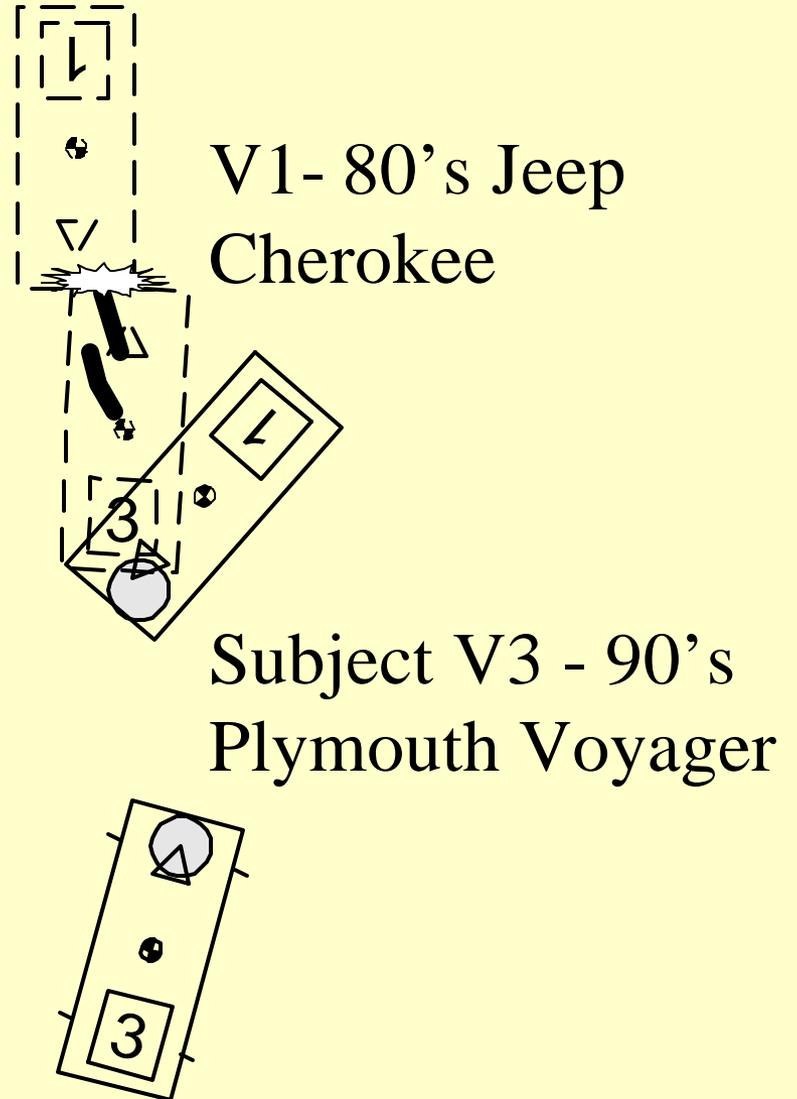


SUV vs. Minivan

Posted Speed limit = 30 mph



SUV vs. Minivan



SUV vs. Minivan



90's Plymouth Voyager

Delta V = 27 mph



Offset = 63%

Demographics/Intrusions

Driver - 30's Female

Restraints:

_____Lap/shoulder belt

Airbag

Deployment

Driver Area Intrusions

Toe pan = 45 cm

Instr.Panel = 42 cm

A pillar = 52 cm

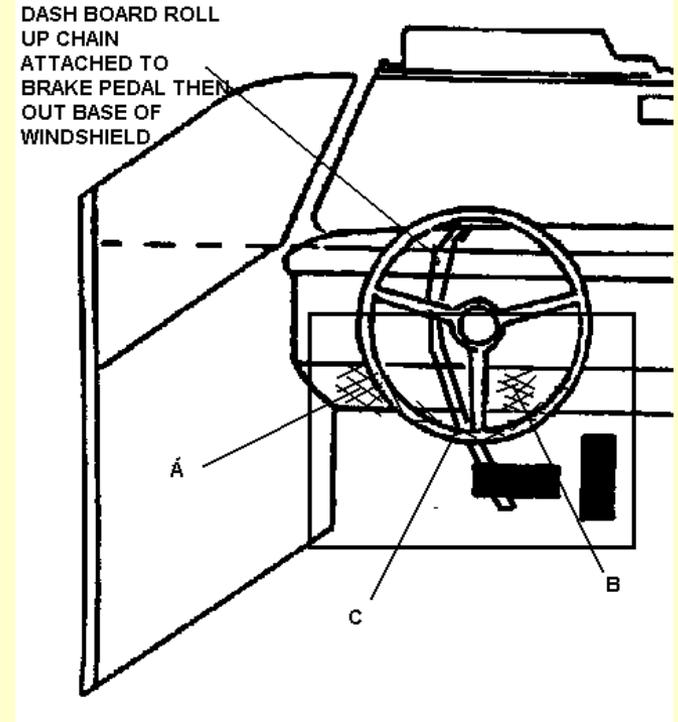
Windshield = 24 cm

Kick panel = 18 cm

Steering col. = 15 cm



Driver Entrapment



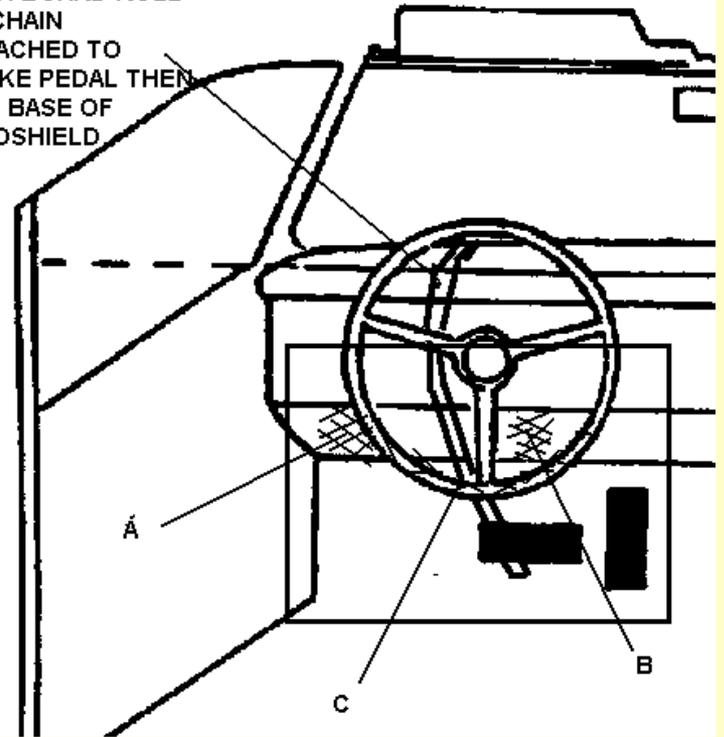
Dashboard Rollup

Dashboard on top of legs with both mid-shaft femurs fx'd

Driver Contacts



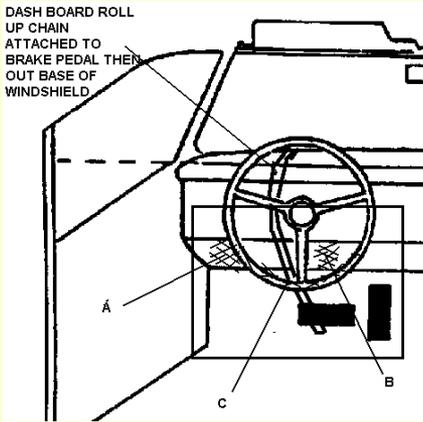
DASH BOARD ROLL
UP CHAIN
ATTACHED TO
BRAKE PEDAL THEN
OUT BASE OF
WINDSHIELD



Both Knees contacted into bolster area

Steering Rim Deformity

DASH BOARD ROLL
UP CHAIN
ATTACHED TO
BRAKE PEDAL THEN
OUT BASE OF
WINDSHIELD



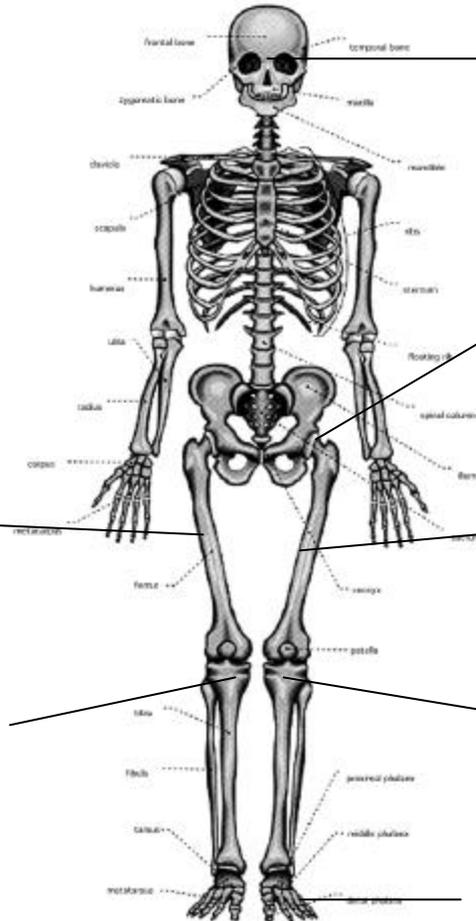
Injury Summary

Driver - 30's Female

ISS = 10

**Right Midshaft
Femur Fx**

**Right Tibial
Plateau
Comminuted Fx**



**Minor chin
and cheek
abrasions**

**Left intertrochanteric
hip fx**

**Left Midshaft Femur
Fx**

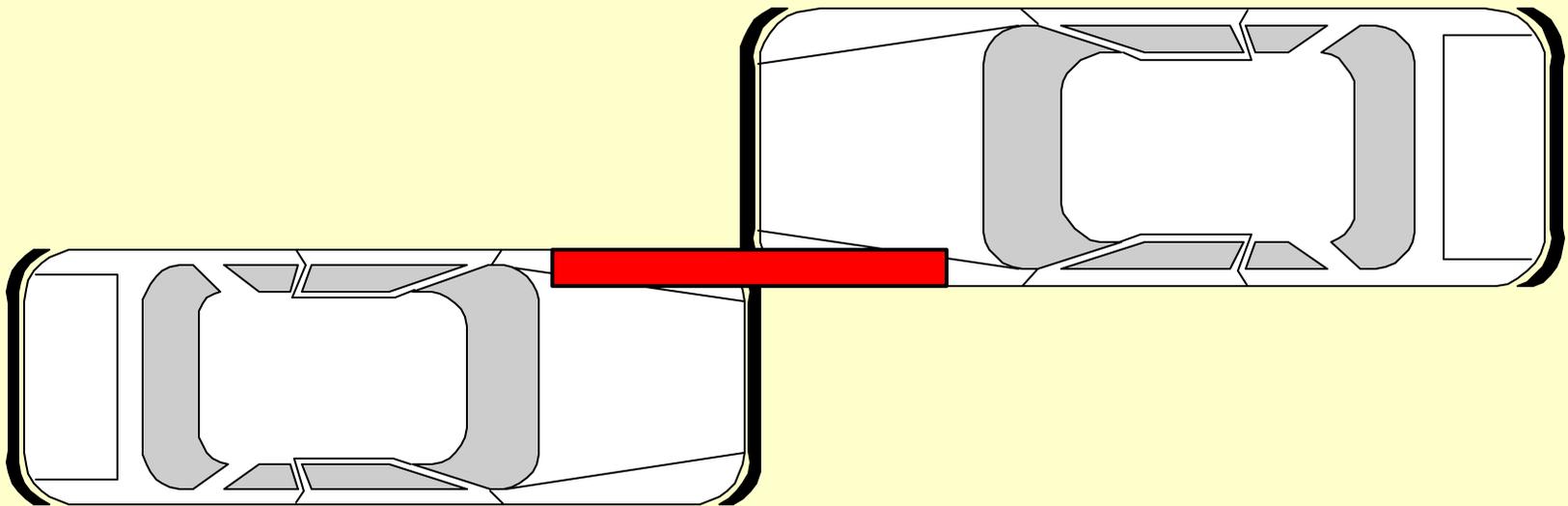
**Left Tibial Plateau
Comminuted Fx**

Left third toe fx

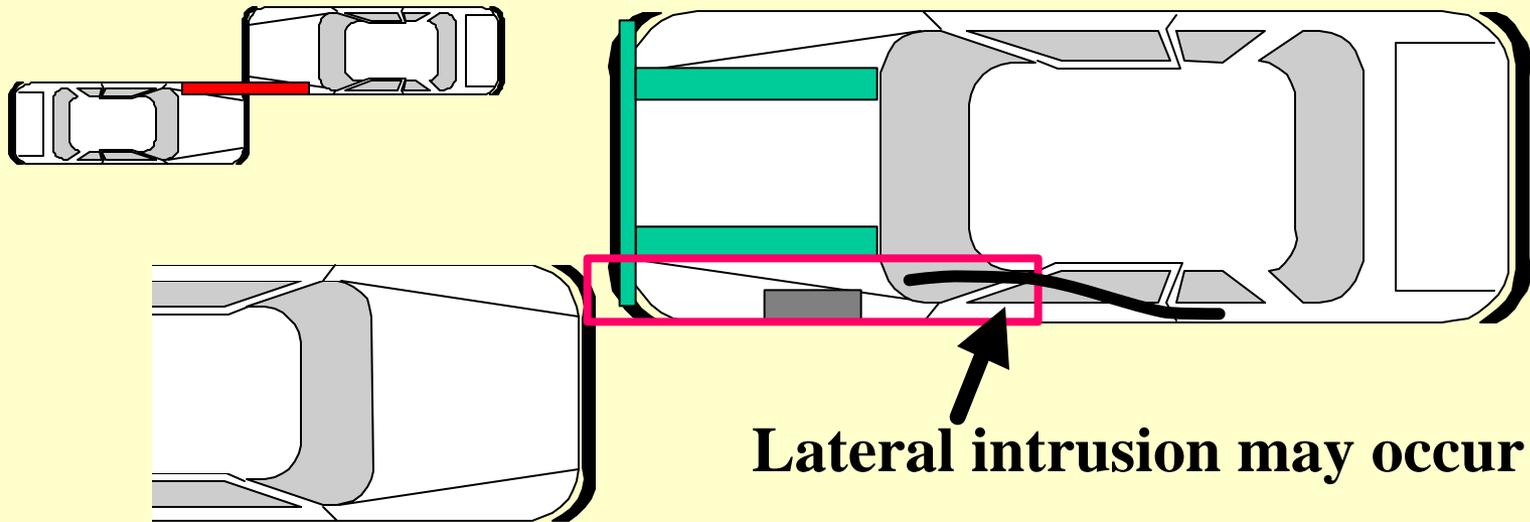
Injury Summary

	AIS
<u>Face</u>	
Multiple abrasions and contusions	1
<u>Lower Extremity</u>	
L: Midshaft femur fx	3
Intertrochanteric hip fx	3
R: Midshaft femur fx	3
Bilat: Tibial plateau fx, comminuted	3
L third toe fx	1
	MAIS 3
	ISS 10

FLEE Head-on or Corner to Corner Impacts

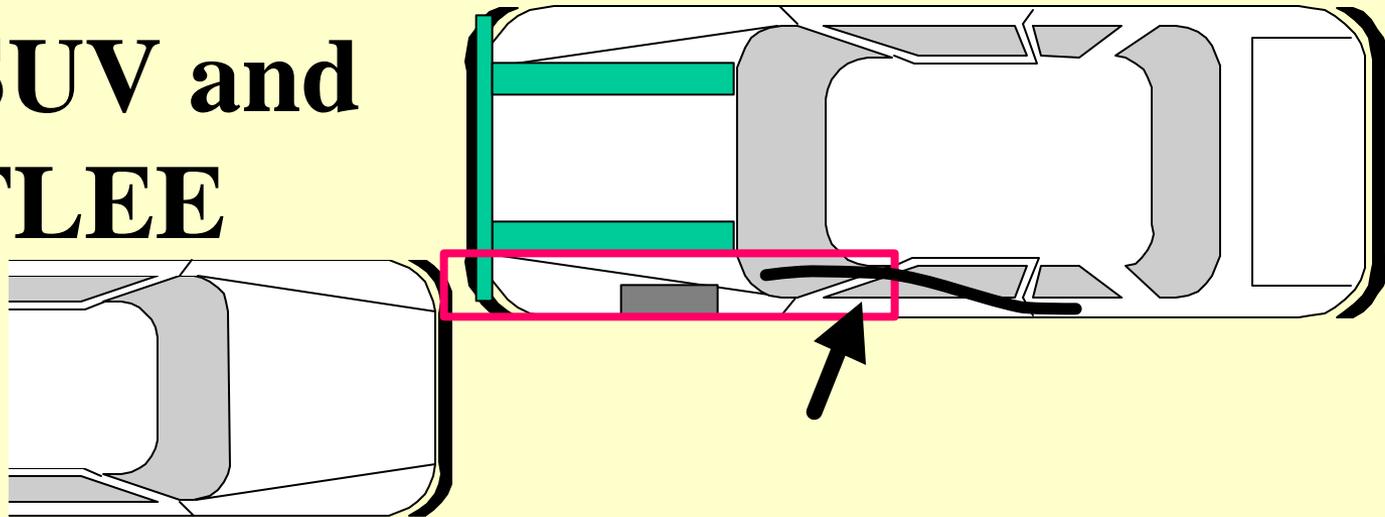


FLEE Offset Impacts

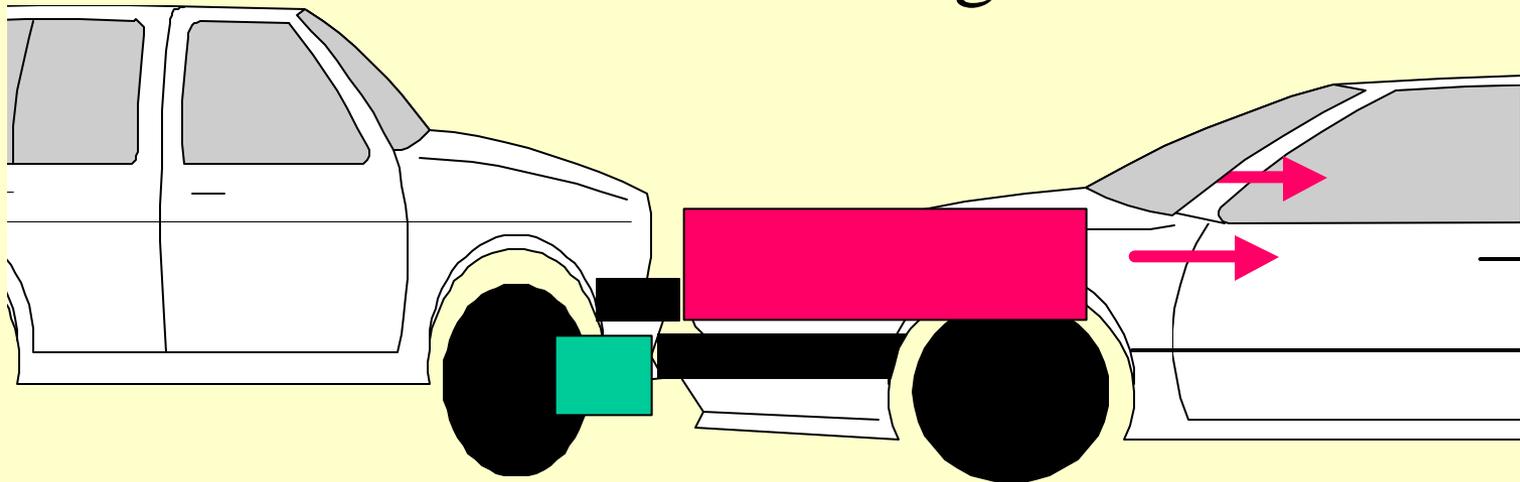


- **Frame rail gets partial hit, or even missed**
- **Bumper frame doesn't extend to corner with any support**
- **With hollow fender well the impact will make contact into the wheel/axle and at the base of A pillar**
- **Longitudinal intrusion of toe pan, instrument panel, steering column, with even lateral intrusion of door and floor panels.**

SUV and FLEE



SEVERE COMBO of
Longitudinal and Lateral

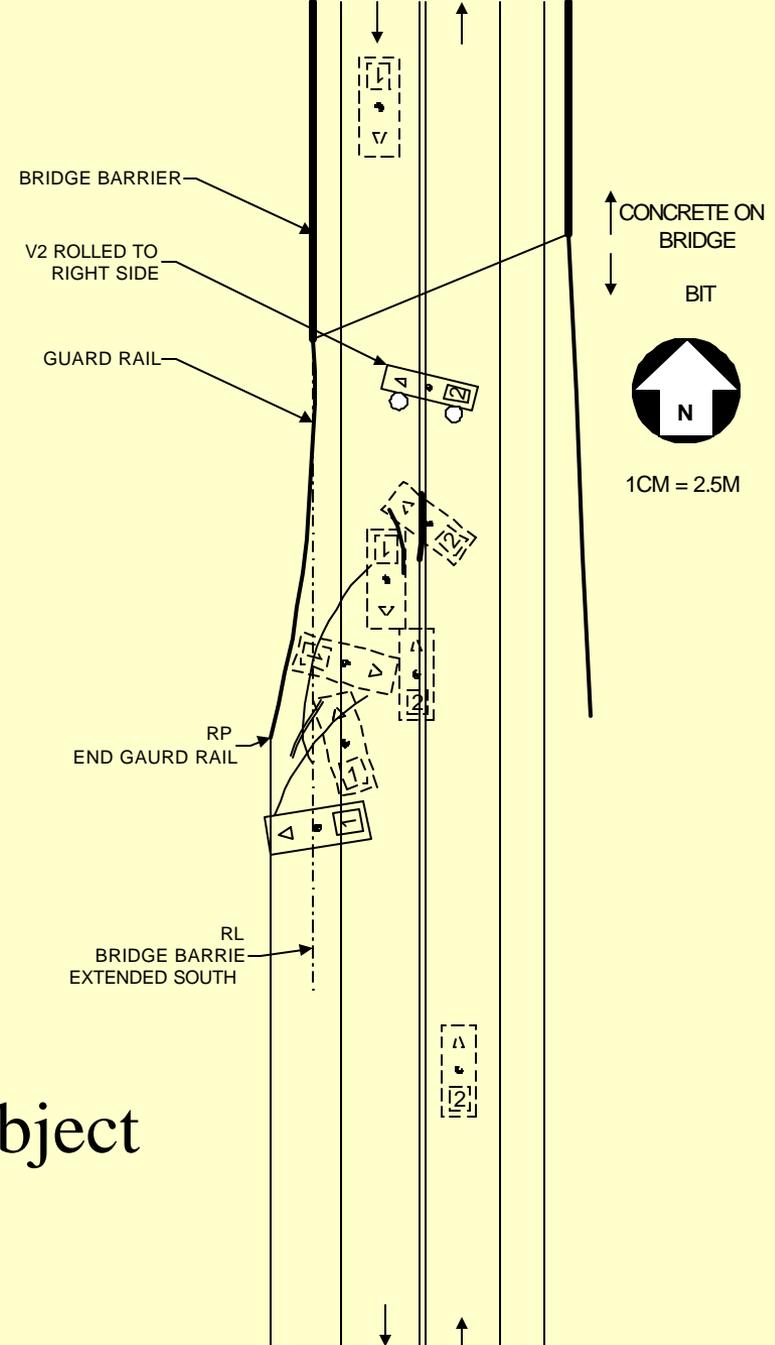


Offset FLEE into an SUV

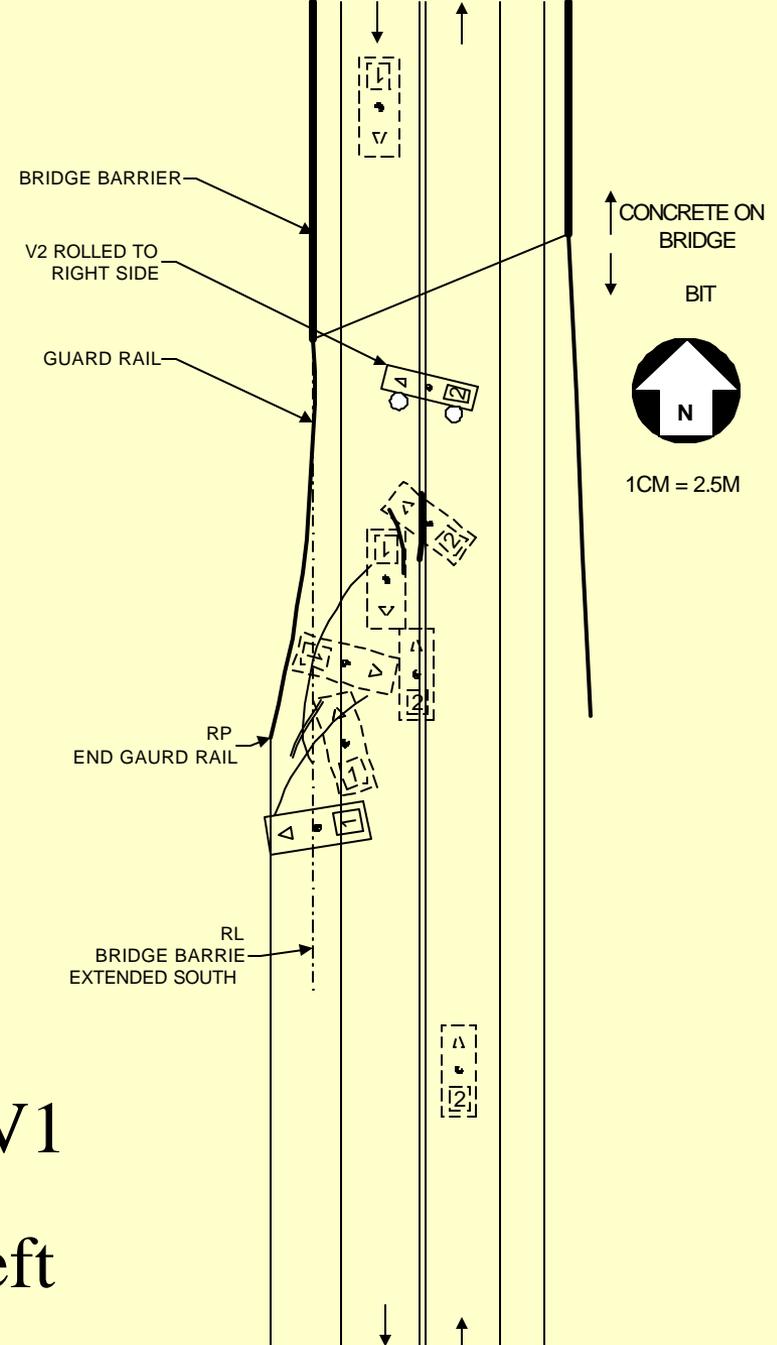


V1 - 90's Plymouth Breeze - Subject

V2 - 80's Chevrolet Blazer



Offset FLEE into an SUV



Three case subjects enrolled in V1
Driver, Front Right, 2nd Seat Left

Damage



CDC - 12FLEE9

Smash Missing vehicle

Delta V = 20 mph

Database - Severe



I n t r u s i o n s



Row	Position	Intruded Component	Intrusion	Magnitude	Crush Direction
Front Seat	Left	Side panel - forward of the A1	32	≥ 30 to < 46 cms	Lateral
Front Seat	Left	Instrument panel left	28	≥ 15 to < 30 cms	Longitudinal
Front Seat	Middle	Instrument panel center	15	≥ 15 to < 30 cms	Longitudinal
Front Seat	Left	Side panel - forward of the A1	19	≥ 15 to < 30 cms	Longitudinal
Front Seat	Left	Roof (or convertible top)	26	≥ 15 to < 30 cms	Vertical
Second Seat	Left	Door panel (side)	27	≥ 15 to < 30 cms	Lateral
Front Seat	Left	Roof side rail	20	≥ 15 to < 30 cms	Lateral
Front Seat	Left	A (A1/A2)-pillar	23	≥ 15 to < 30 cms	Longitudinal
Second Seat	Left	B-pillar	16	≥ 15 to < 30 cms	Lateral
Front Seat	Left	Steering Assembly	15	≥ 15 to < 30 cms	Longitudinal
Front Seat	Left	Door panel (side)	14	≥ 8 to < 15 cms	Lateral
Second Seat	Left	Roof side rail	8	≥ 8 to < 15 cms	Lateral
Front Seat	Right	Instrument panel right	3	≥ 3 to < 8 cms	Longitudinal

Demographics

Driver: 20's Male - No belts, Deployed Airbag

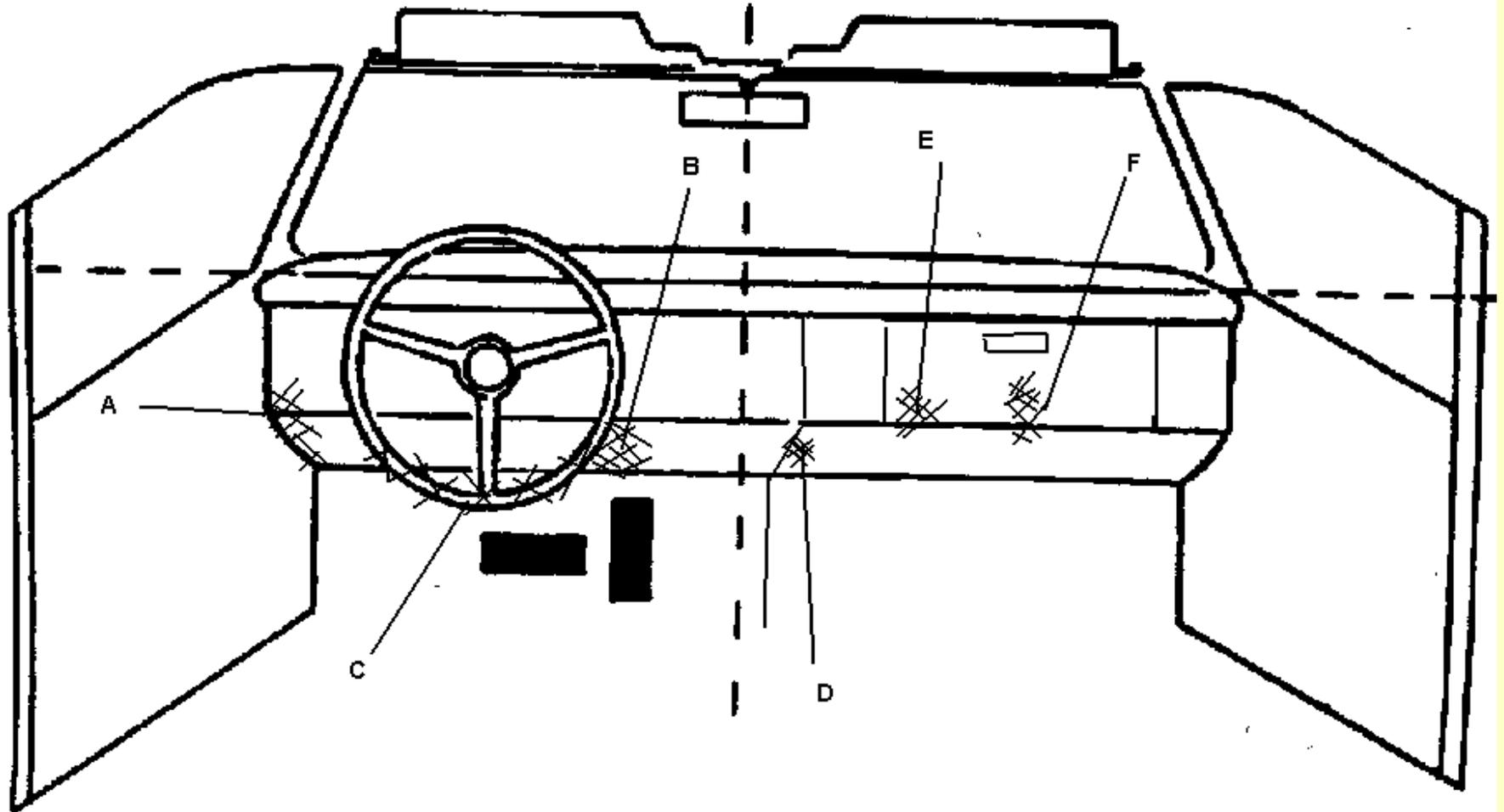
Front Right Pass: 20's Female

Lap/Shoulder belt w/ Airbag
7 months pregnant

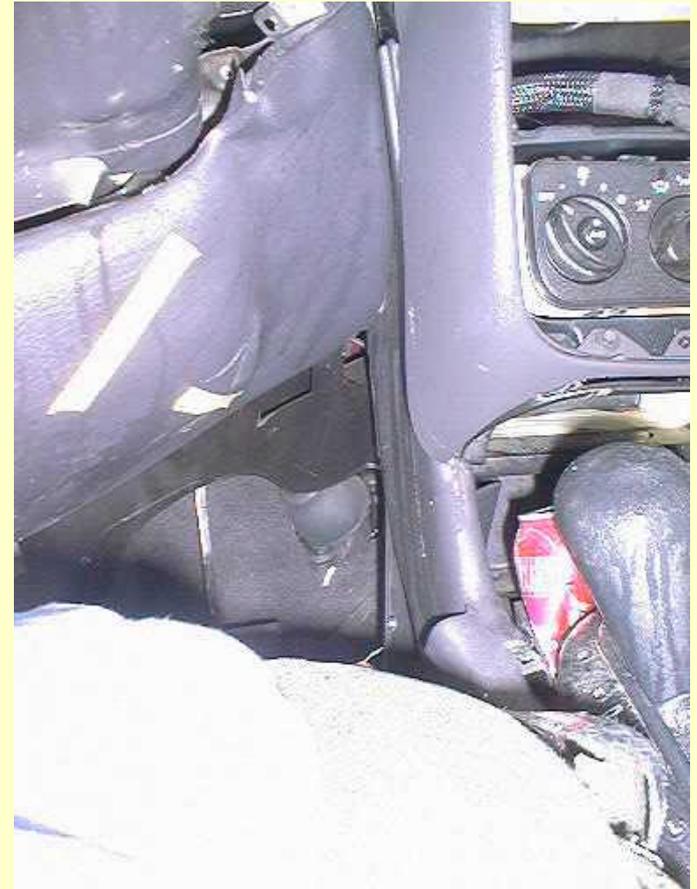
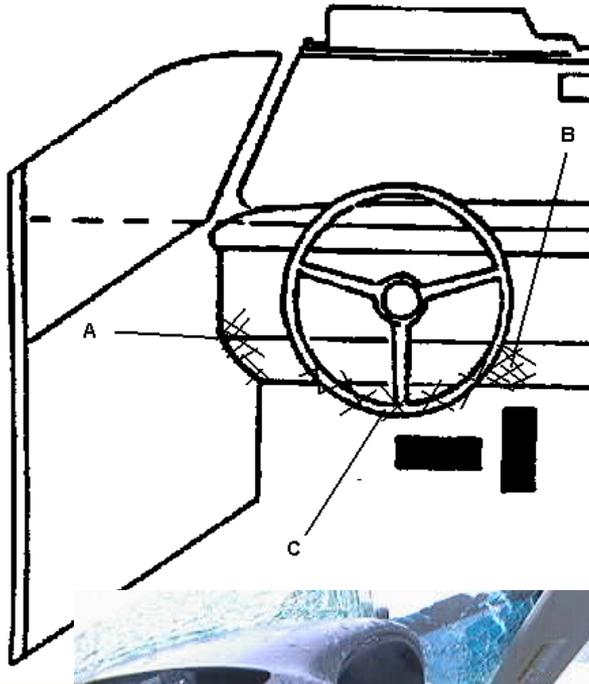
2nd Left Pass: 4-8yr. Male

Lap/Shoulder belt (no booster)

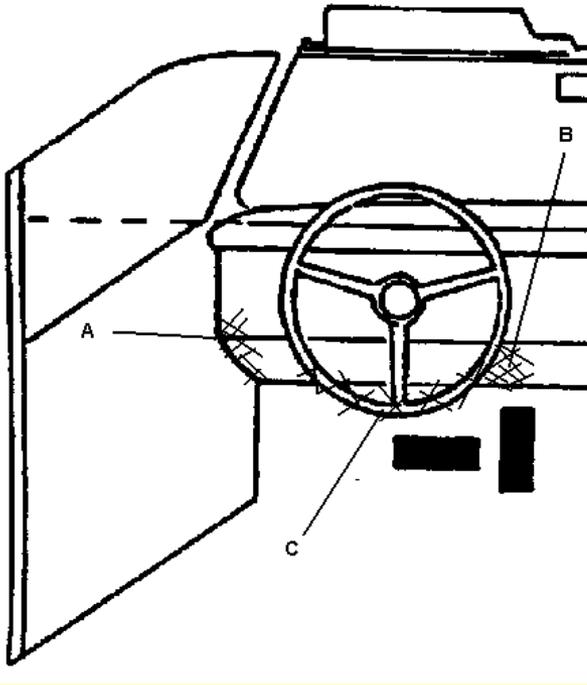
Front Seating Area Contacts



Driver Contacts

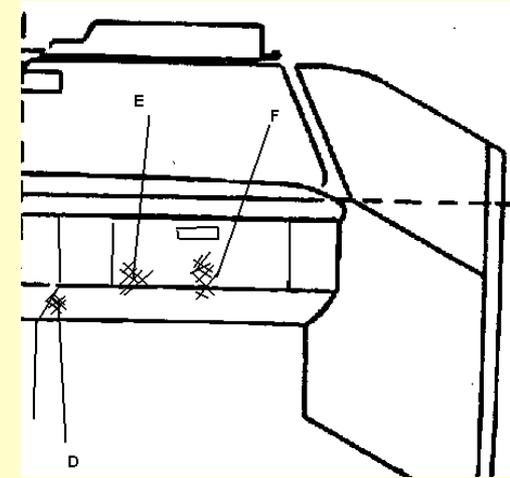


Driver Contacts

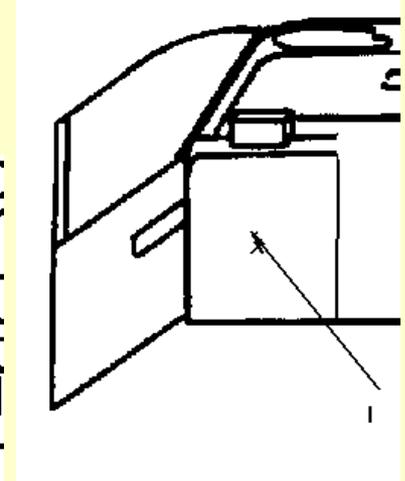
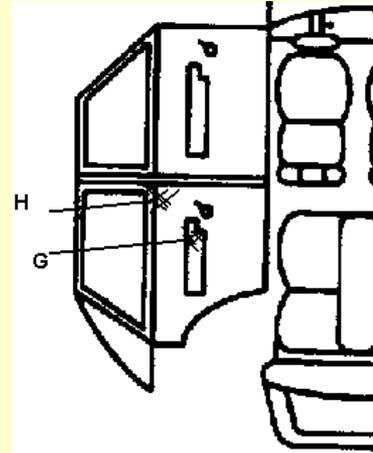


Driver door remove by Ecrew.

Front Right Passenger Contacts



Seat 21 Contacts



Driver Injury Summary

AIS	Region	Description
3	Head	minor TBI/concussion w/deficits
3	Low Ext	L transverse/posterior wall acetabular Fx with sciatic nerve contusion
2		L hip dislocation
2	Abdomen	L perinephric hematoma (Grade I)
1		Multiple minor contusions

*Minor contusions, lacerations, and scratches also on Head,
Thorax and Upper Extremities*

ISS = 22

Injury Summary - F.R. Pass

<u>AIS</u>	<u>Region</u>	<u>Description</u>
2	Head	+ LOC/concussion
1	Upper Ext	L upper arm contusion
1		L upper arm abrasion
1	Abdomen	Inferior lower abdomen contusions
1	Thorax	L chest wall contusions
1		L breast contusion

ISS = 6

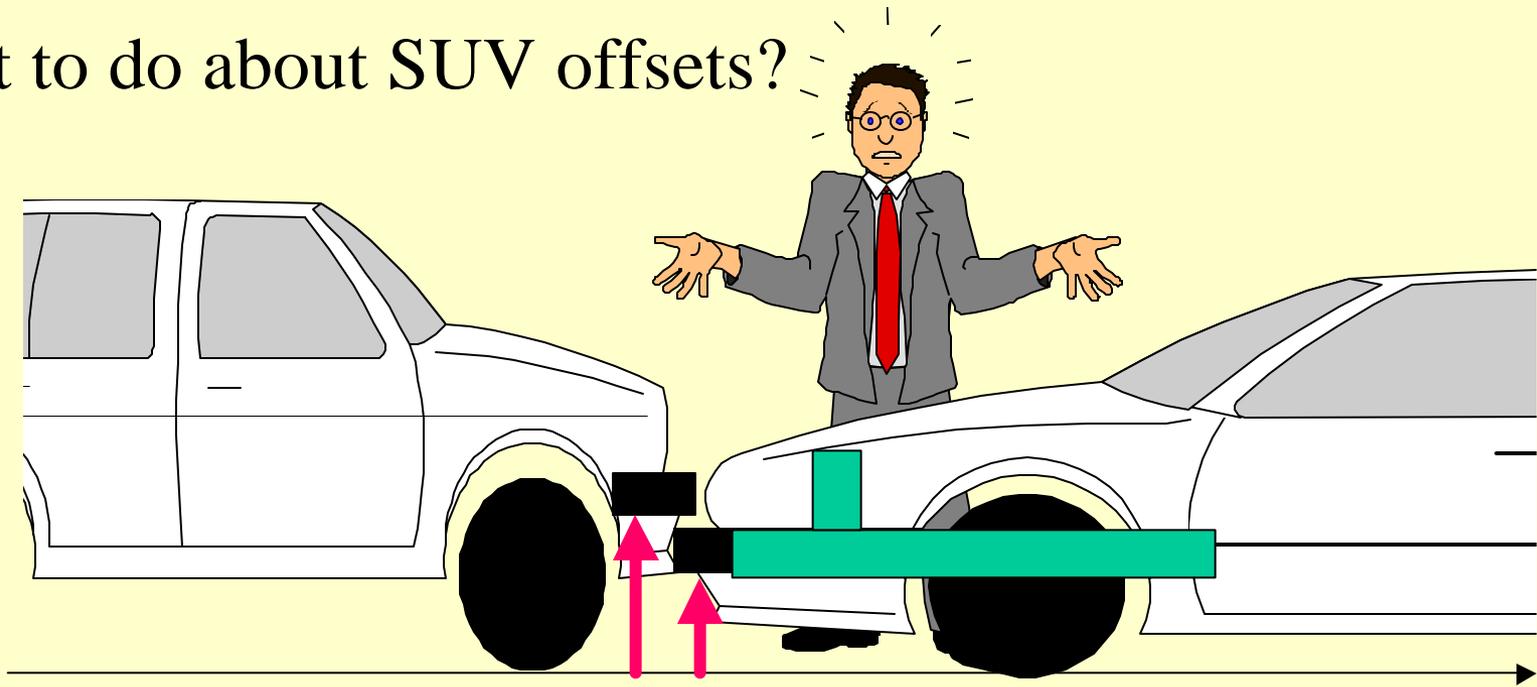
Back Right Passenger Injury Summary

<u>AIS</u>	<u>Region</u>	<u>Description</u>
2	Head	10 cm crown head lac (stapled)
1	Neck	L neck abrasions
1	Lower Ext	B knee contusions
1		L lower thigh contusion
1	Upper Ext	L elbow contusion
1		L 4th finger/nailbed contusion

ISS = 5

Conclusion

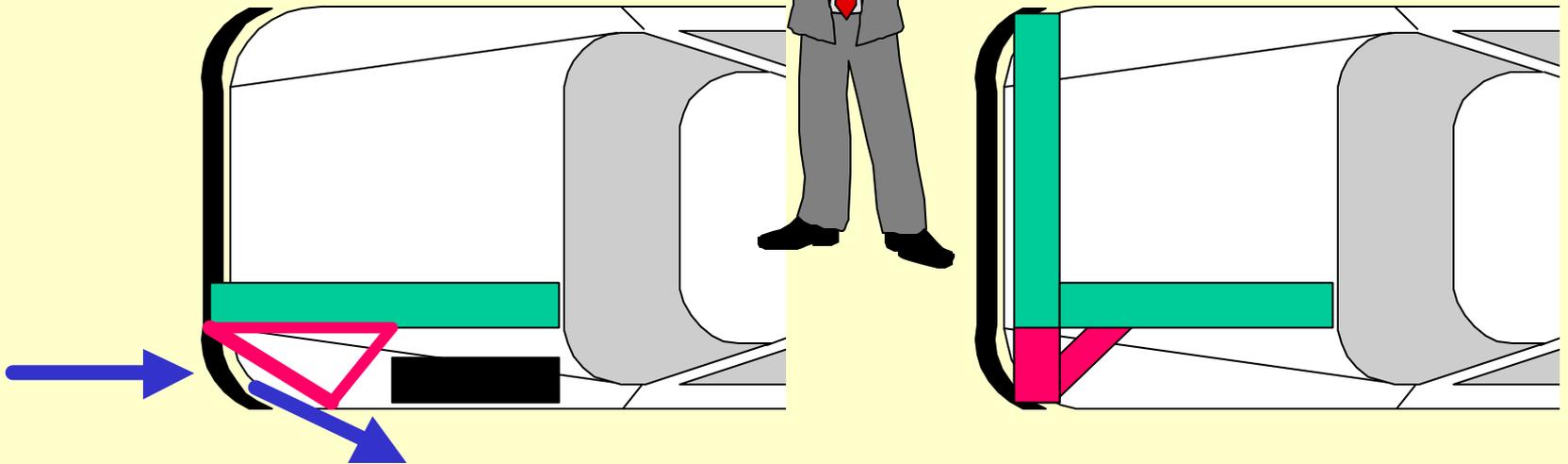
What to do about SUV offsets?



Rather than lower the support on the SUV create a vertical component on the frame rail of the sedan?

Conclusion

What about the FLEEs?



Need to brace and deflect the impact or extend the bumper support to the corner

Case Reviews Conclusion

A frontal offset impact into an SUV can create significant intrusion of the hood, and instrument panel area of compact sedans/others and increases injury severity to the lower extremities and thorax.

Offset FLEE impacts can be very severe, and could create a lateral component of intrusion along with rotation to the vehicle where both could exhibit an additional occupant contact which increases the injury severity.

The combination of an SUV with an offset FLEE can be severe or even fatal.