CRASH DYNAMICS 101

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DISCLOSURE

MOTOR VEHICLE CRASHES ARE….

The Most Preventable Predominant Cause of Traumatic Death and Critical Injury!

TRAFFIC SAFETY FACTS

In 2019, there were an estimated :

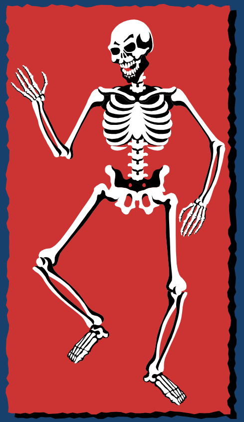
- 6,756,000 police-reported traffic crashes
- 36,096 people were killed
- 2,740,000 people were injured

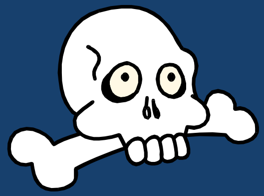
https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813209

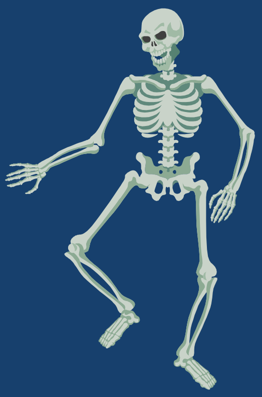
TRAFFIC SAFETY FACTS

On average,

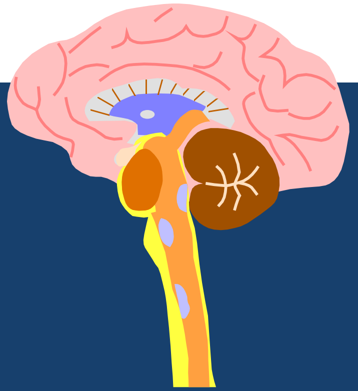
one person is killed in a car crash every 15 minutes



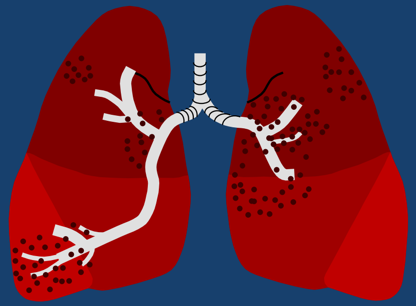


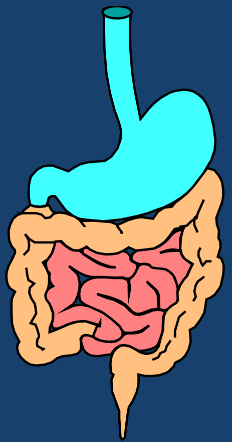


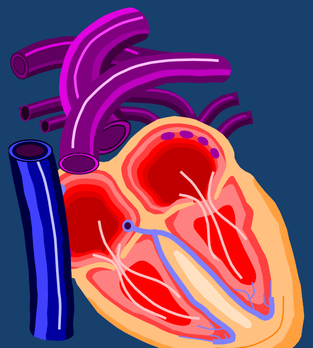
MOTOR VEHICLE CRASHES



- Injury-Specific Mortality
  - Head: 48%
  - "Internal": 37%
  - Spinal fracture: 8%
  - Extremity fracture: 2%
  - All other: 5%







Crash Dynamics 101

CRASH DYNAMICS 101

- Law of inertia
- Principle direction of force (PDOF)
- Delta V
- Intrusion
- Seatbelts
- Airbags

CRASH DYNAMICS 101

- **Law of inertia**
- Principle direction of force (PDOF)
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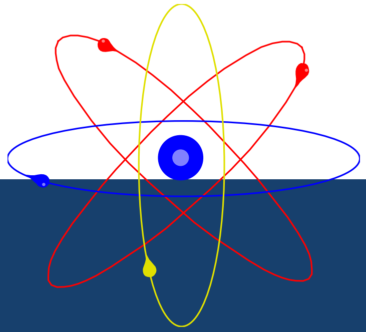
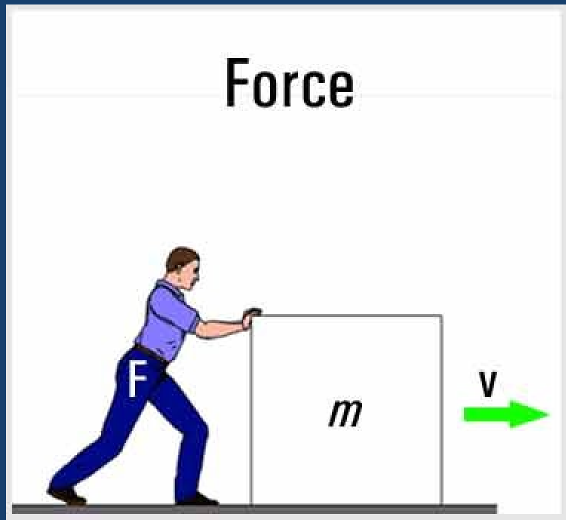
CRASH DYNAMICS 101



Newton's First Law of Motion…..

An object in motion remains in motion unless acted upon by an external force



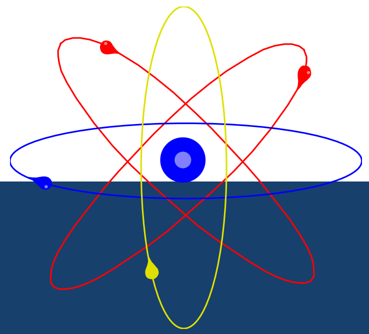
CRASH DYNAMICS 101

- Three “collisions”
  - Vehicle
  - Body
  - Organ systems

CRASH DYNAMICS 101

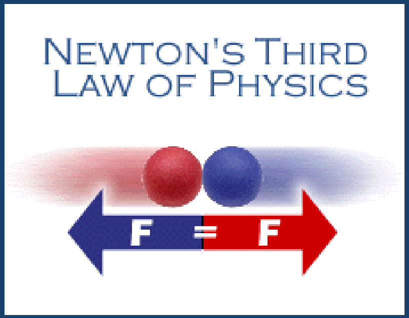
- Law of inertia
- **Principle direction of force (PDOF)**
- Delta V
- Intrusion
- Seatbelts
- Airbags

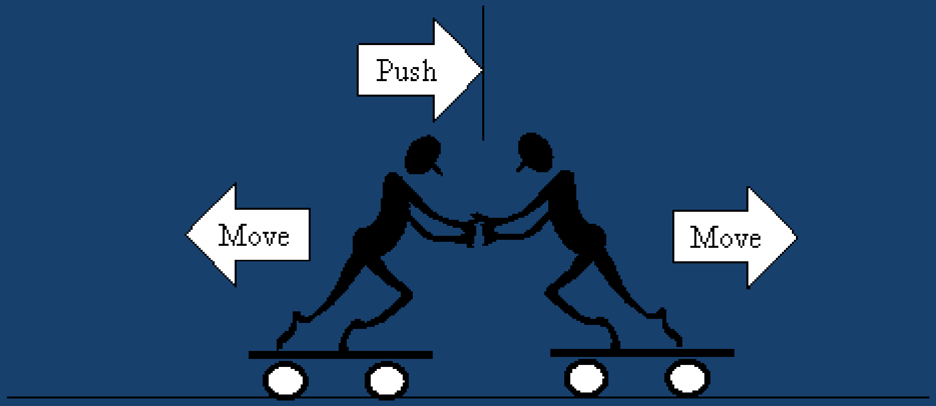
PDOF



Newton’s Third Law of Motion…..

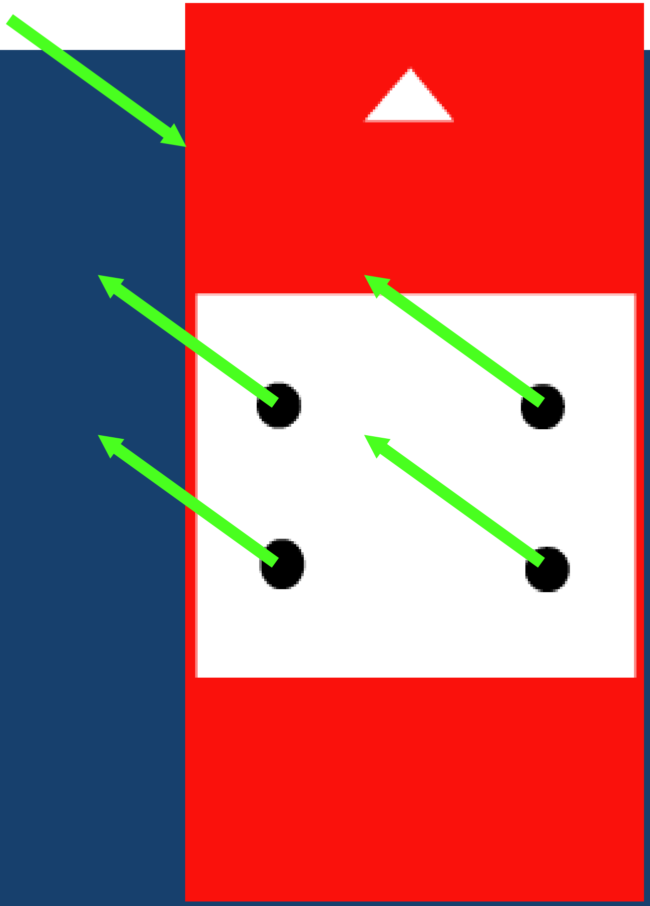
For every action (force) in nature, there is an *equal* and *opposite* reaction





PDOF

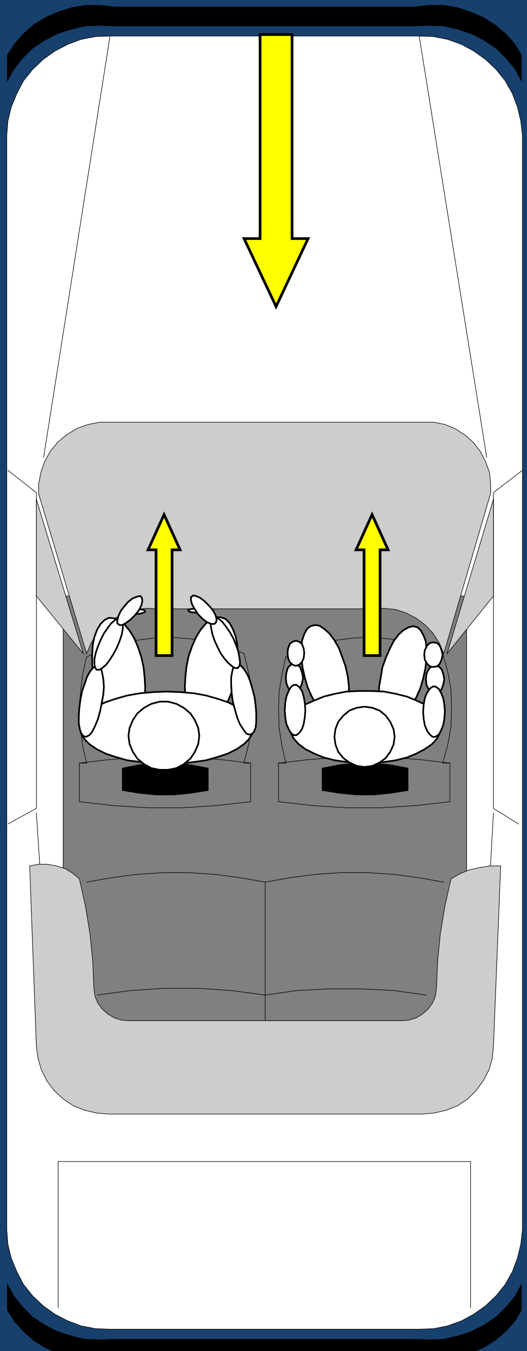
Direction of Force



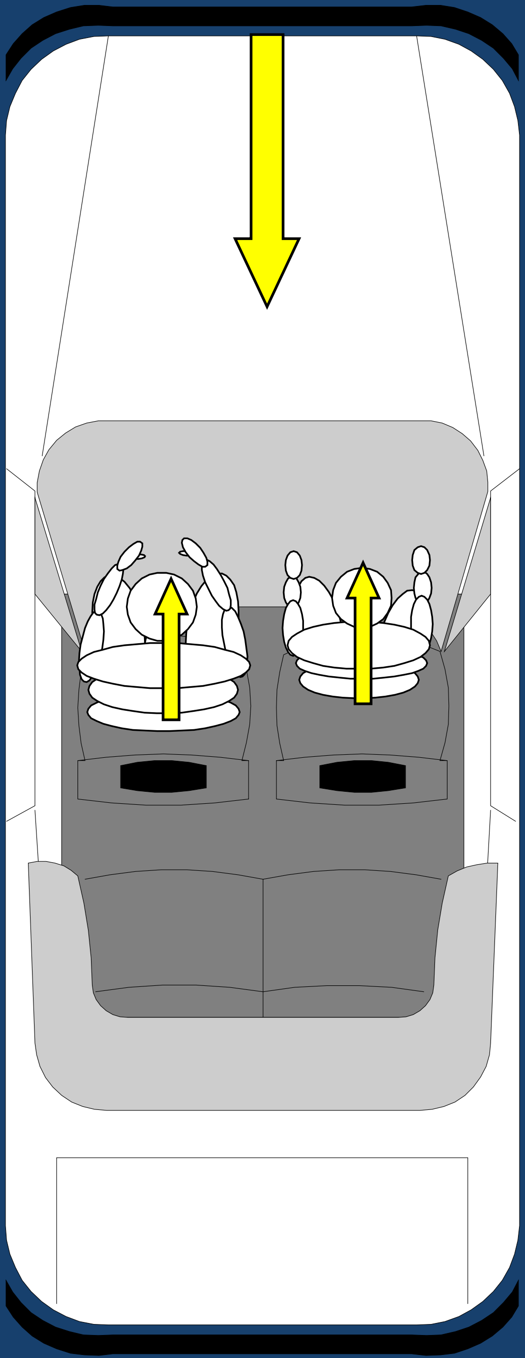
Occupant Response is <u>equal</u> and <u>opposite</u> to the PDOF

Zero PDOF

In a full frontal crash

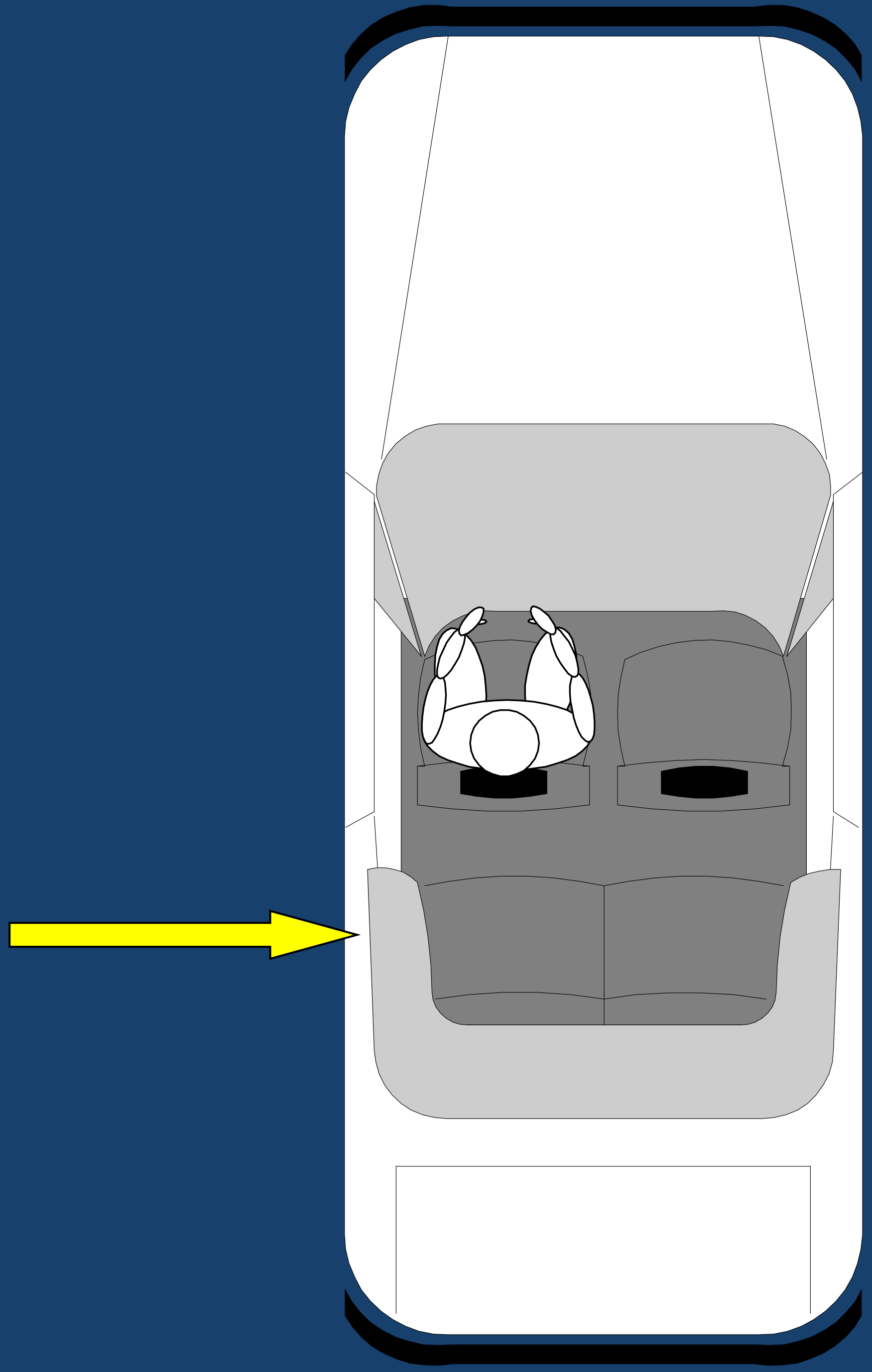


Occupants move opposite and parallel

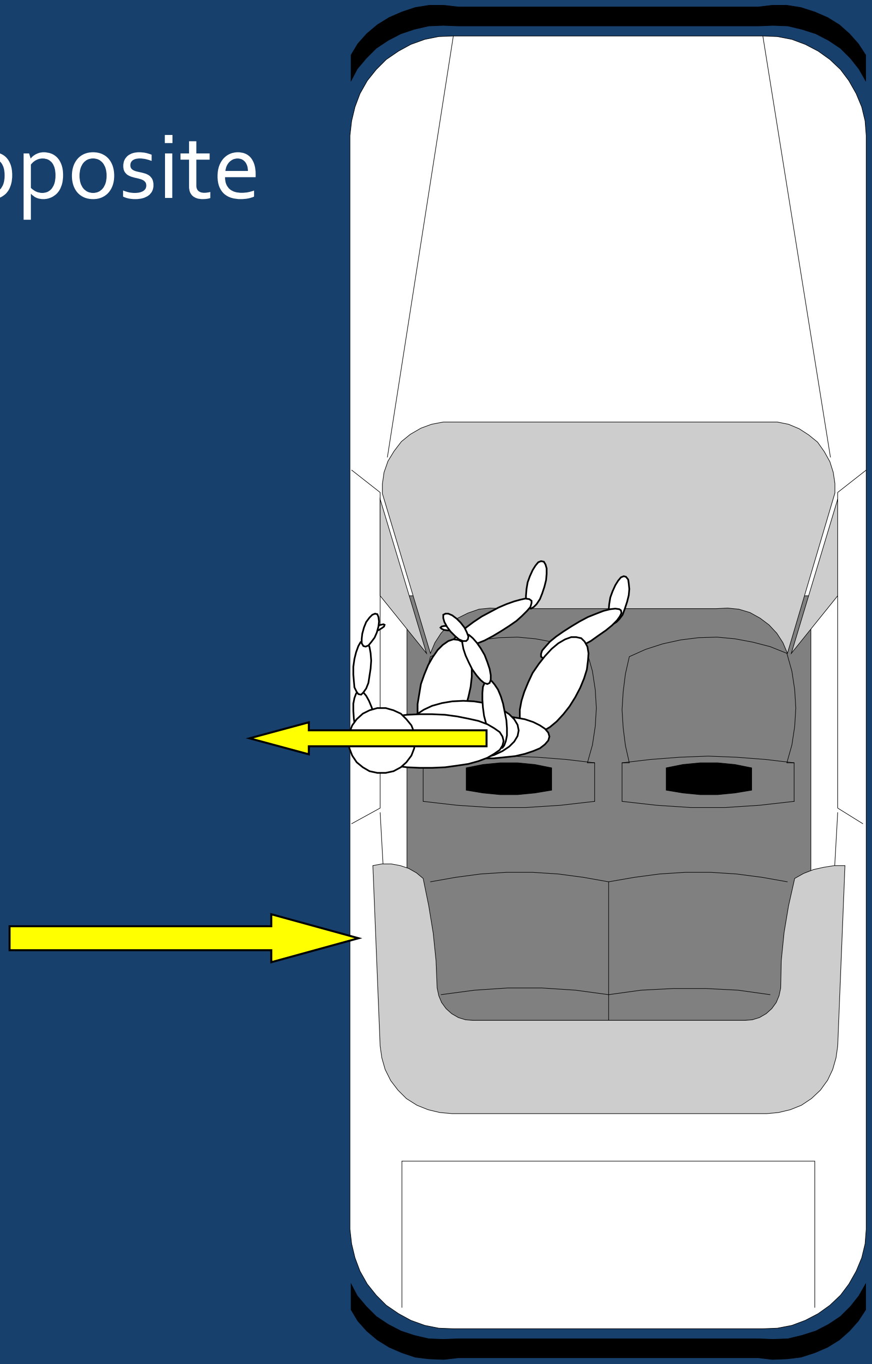


90º PDOF

In a full lateral crash



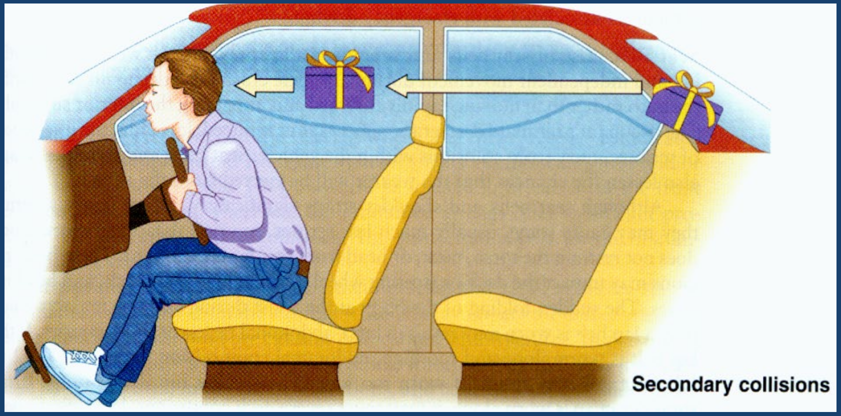
Occupants move opposite and parallel



PDOF

….which tells us the patient's

- likely path of travel
- side of body likely injured
- the parts of the vehicle that are likely injury sources
- the direction from which unsecured cargo and/or unrestrained occupants may have struck the patient



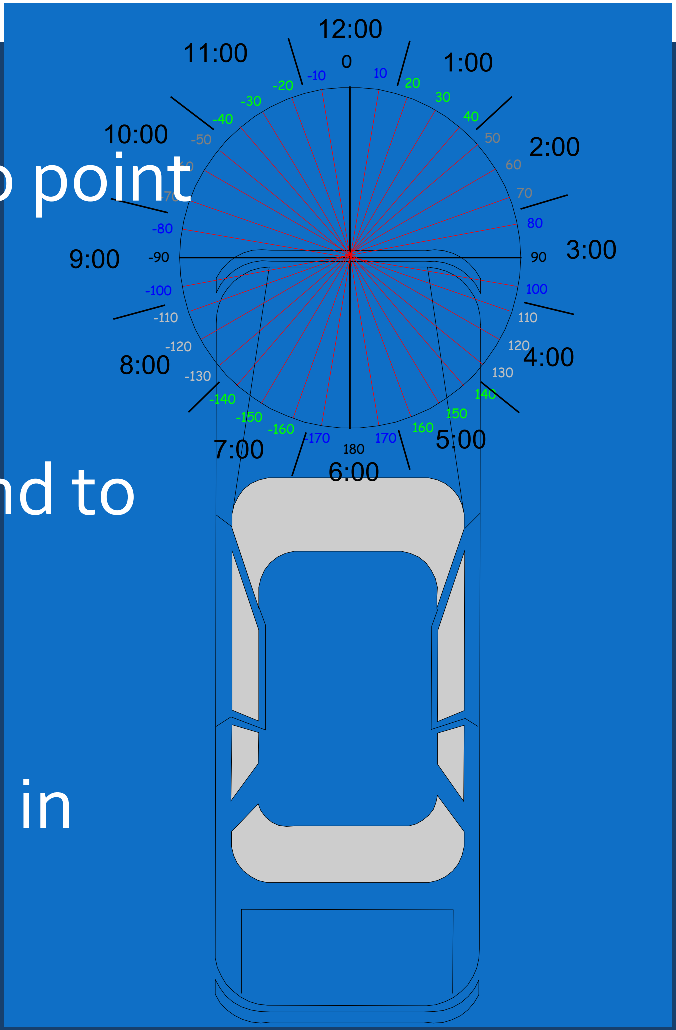
PDOF

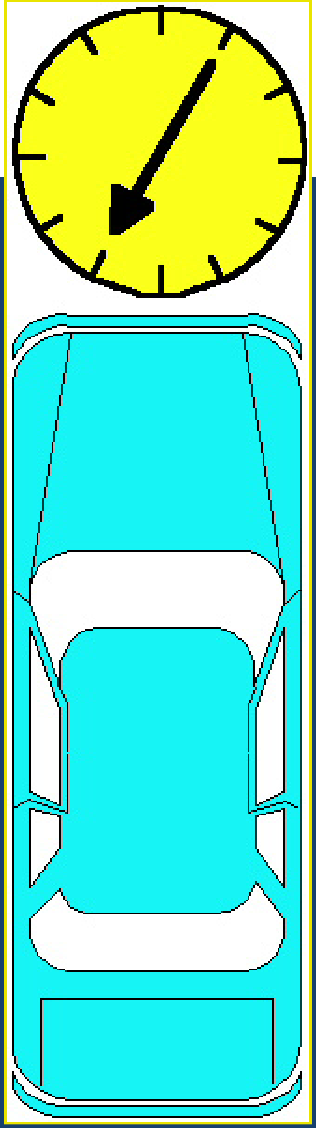
- The “Superman” technique

if you could grab a piece of the vehicle with one finger and pull in one direction, what direction would you pull in order to restore the car to its original shape?

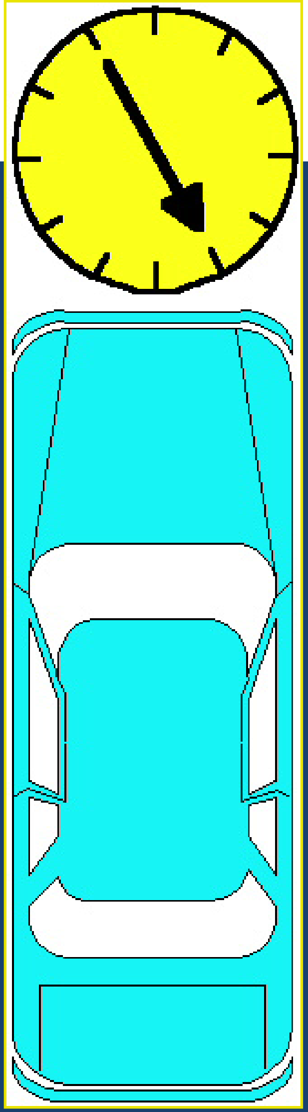
PDOF

- Applied to point of impact
- Correspond to clock face
- Measured in degrees





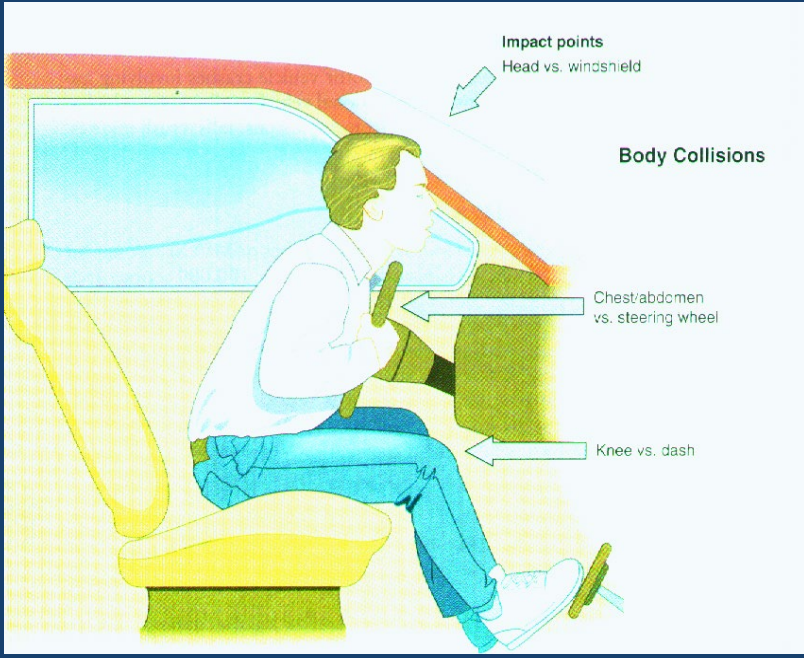
1 O'clock



11 O'clock

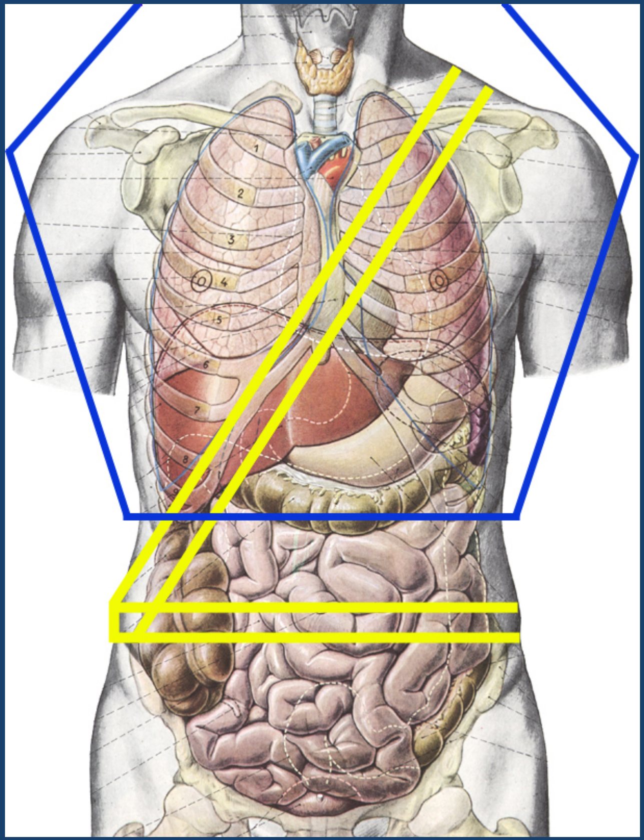
FRONTAL COLLISIONS

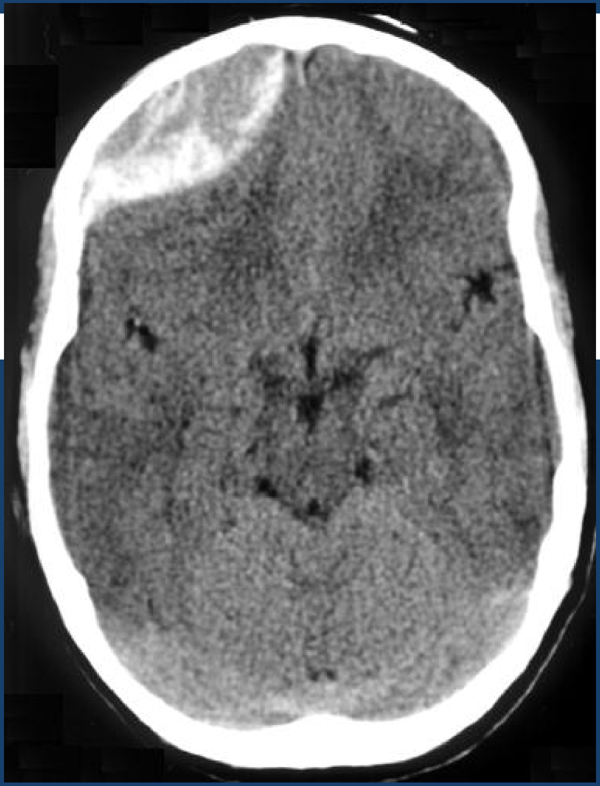
- 32%
- Unrestrained occupants
  - continue to move forward as the vehicle comes to an abrupt stop
  - forward motion is arrested as the patient connects with the stationary vehicle
  - initial impact point is often the lower extremities
  - as the body continues moving
    - the head, cervical spine and torso impact on the windshield and steering column

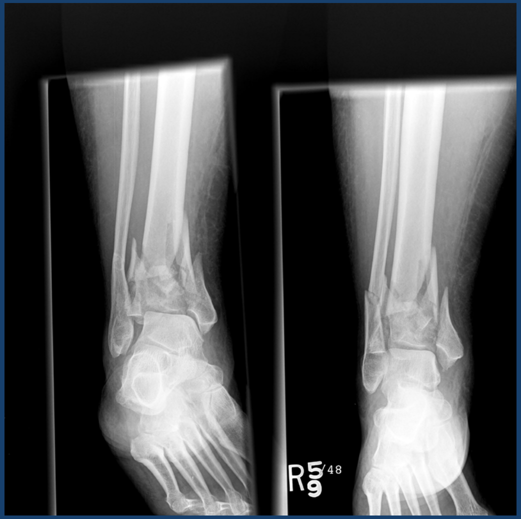


FRONTAL COLLISIONS

- Restrained occupants
  - Lateral rib fractures
    - Visceral injuries evenly distributed
    - Lung, liver, spleen
  - Intestinal and solid organ - seatbelt
  - Pelvic fractures
    - open book, posterior hip dislocation





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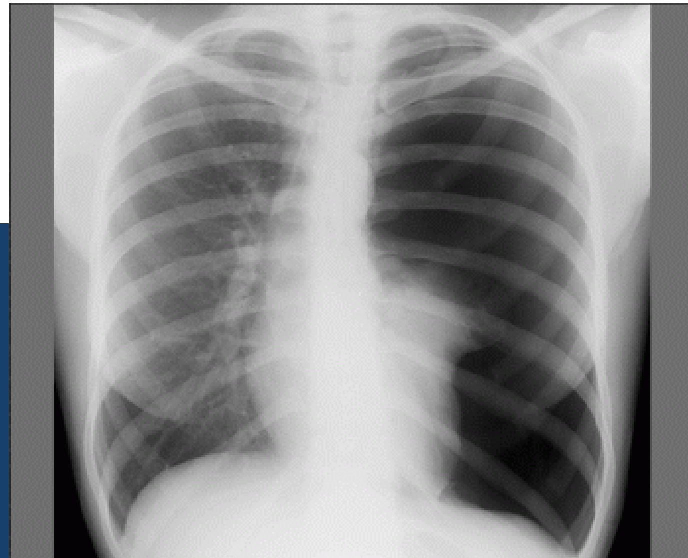
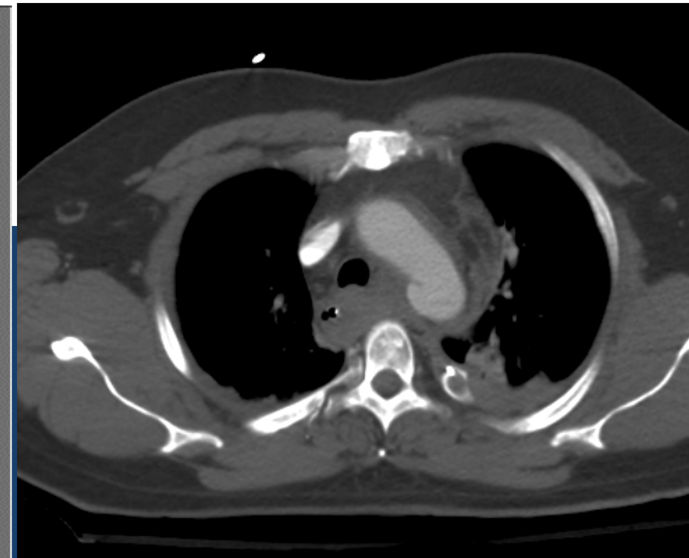
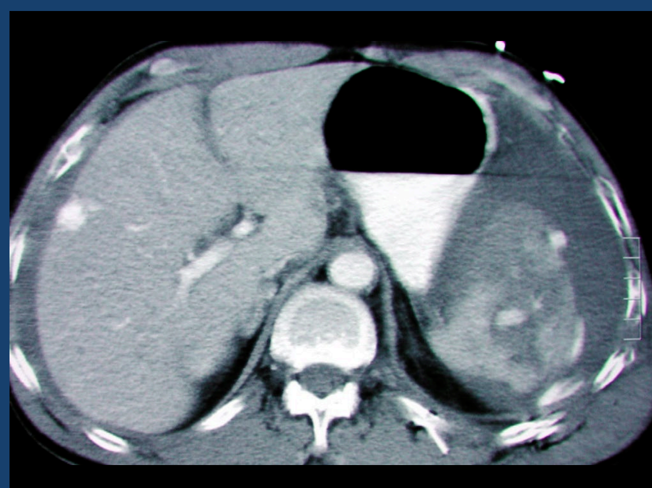
LATERAL COLLISIONS

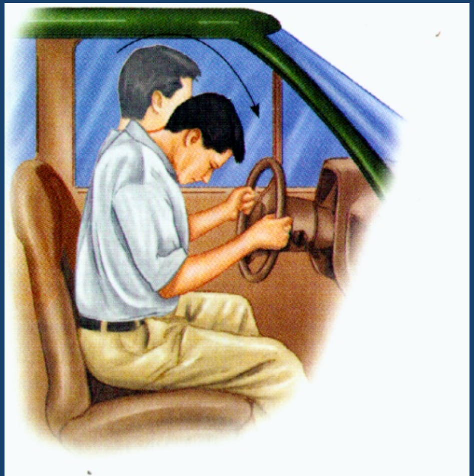
- 15% of crashes, but 22% of deaths
- Injuries often due to intrusion
- “Struck side” injuries
- Risk of chest, neck and head injuries increases with height of striking object


REAR COLLISIONS

- 9%
- Typically, impacted vehicle is stationary
- Seat propels the occupant forward
- Injuries
  - Hyperextension and hyperflexion of C-spine

a. Victim moves ahead while head remains stationary. Head rotates backward. Neck extends.



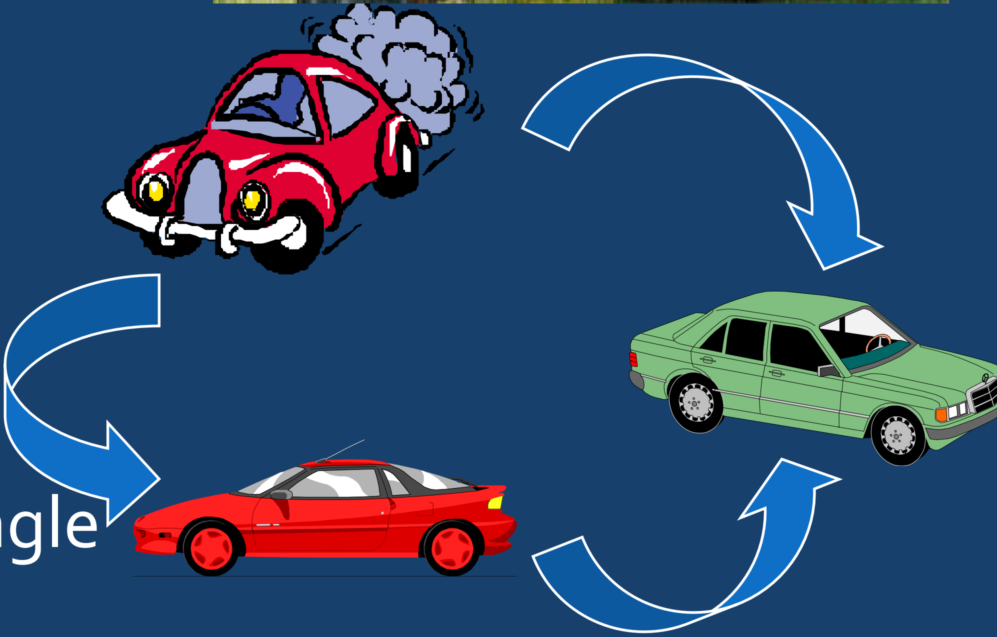
b. Head snaps forward. Head rotates forward. Neck flexes.

ROLLOVER COLLISIONS

- 6%
- No predictable injury patterns
- Multiple points of impact
- High incidence of lethal injuries
  - Less injury with restraints
- 25 times more likely to be killed if ejected

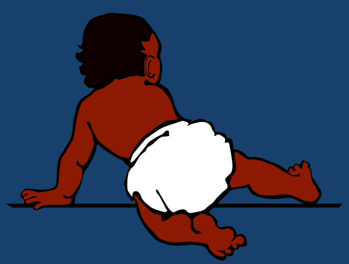
ROTATIONAL COLLISION

- 38%
- Forward motion is converted to spinning motion
- Typically secondary impact
- Vehicle struck at oblique angle

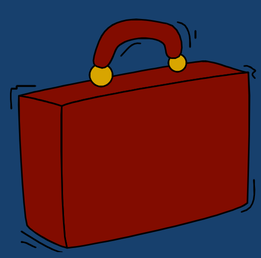


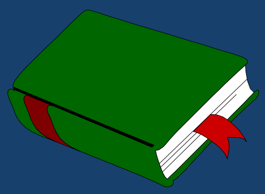
PDOF

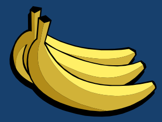
- The other occupants in the vehicle (injured or not) often interact during the crash sequence and can be the source of a patients injury



- Unsecured cargo is also a potential injury source







CRASH DYNAMICS 101

- Law of inertia
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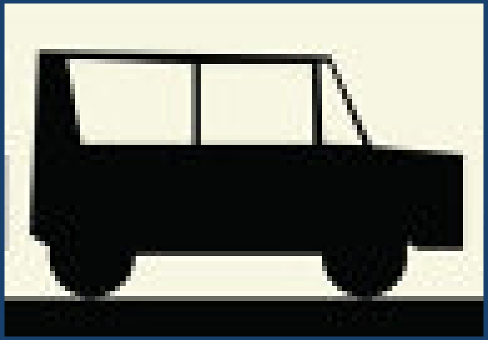
- **Delta V**
- Intrusion
- Seatbelts
- Airbags

DELTA V

- The speed change that the vehicle experiences as a result of the impact

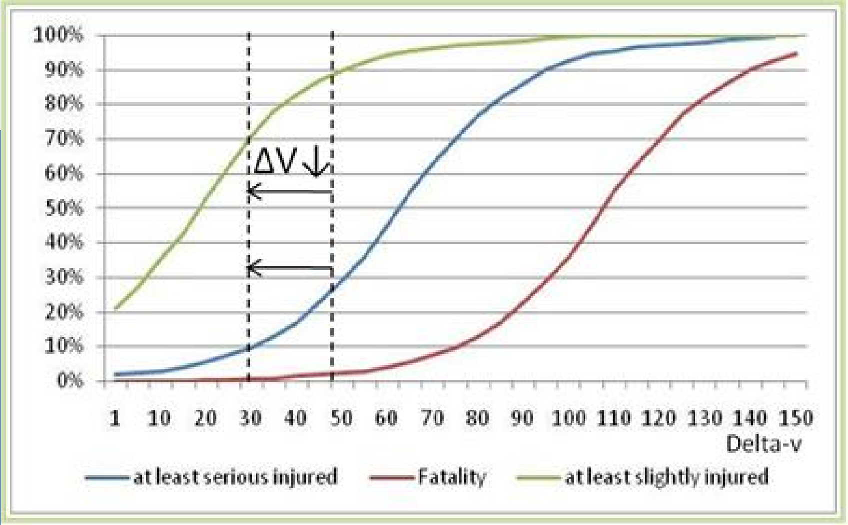
- Three factors
  - Speed
  - Impact configuration
  - Mass ratios

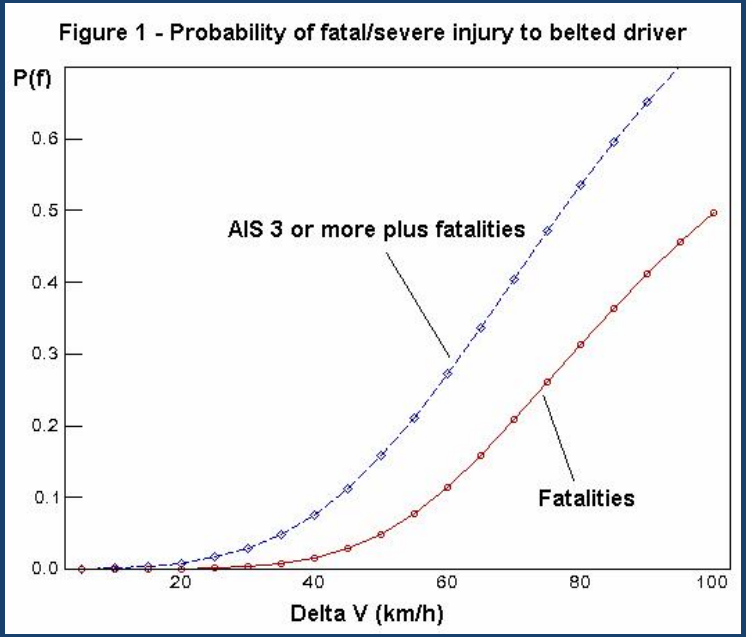


DELTA V

- Delta v is the accepted measure of the absolute severity of the impact and the degree of energy transferred to the vehicle

- Delta v correlates well with serious injury and fatality rates.

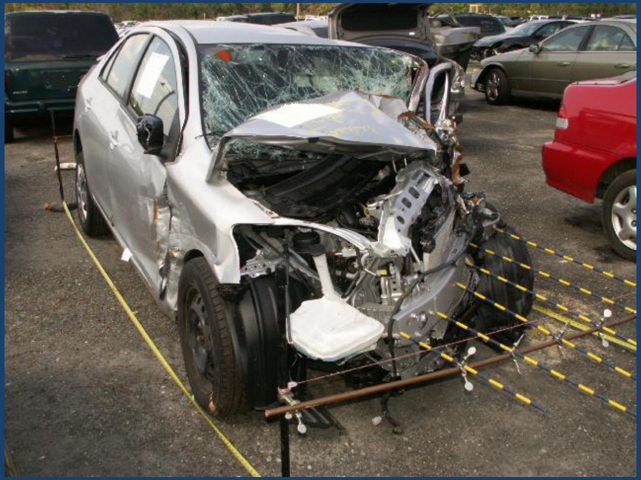




DELTA V

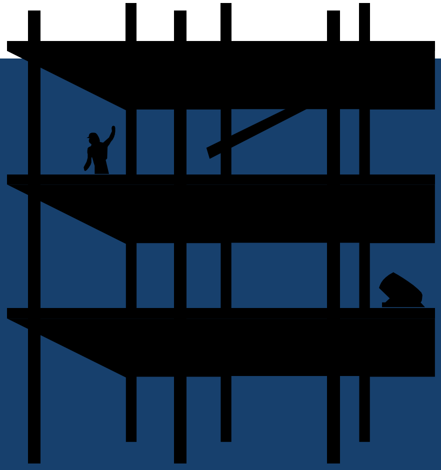
- Deformation gives an indication of the amount of energy dissipated in a crash

- Deformation determines "delta v"



DELTA V

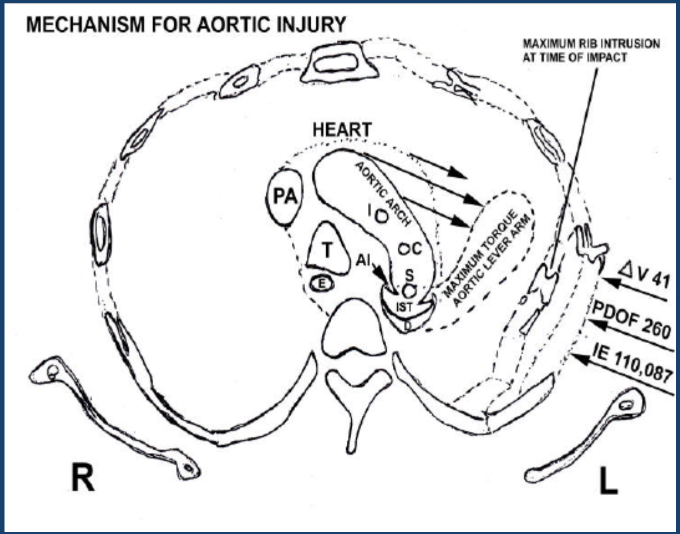
10 mph	3.5 feet
15 mph	7.5 feet
20 mph	13 feet - 1 story
25 mph	21 feet - 2 stories
30 mph	30 feet - 2.5 stories
35 mph	41 feet - 3.5 stories
40 mph	54 feet - 4.5 stories

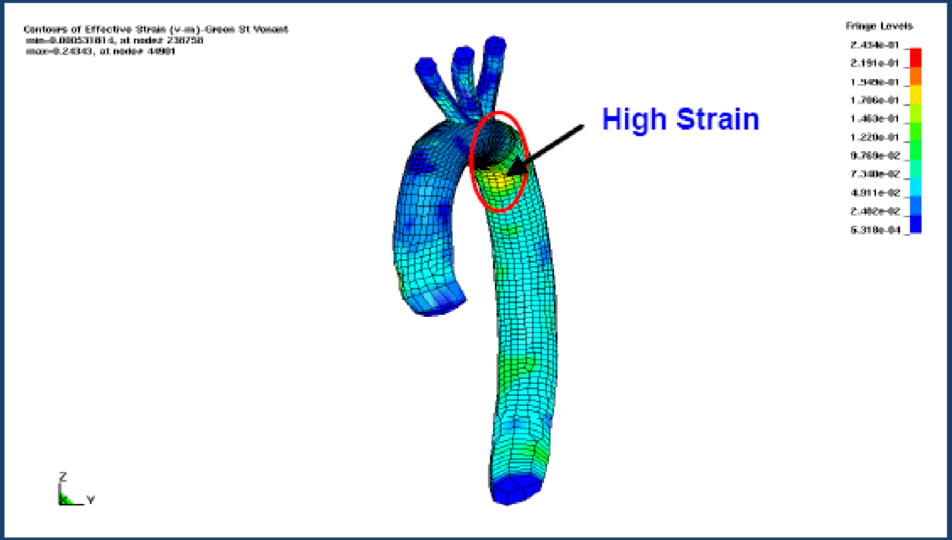


DELTA V

- Delta V also predicts degree of **acceleration/deceleration**

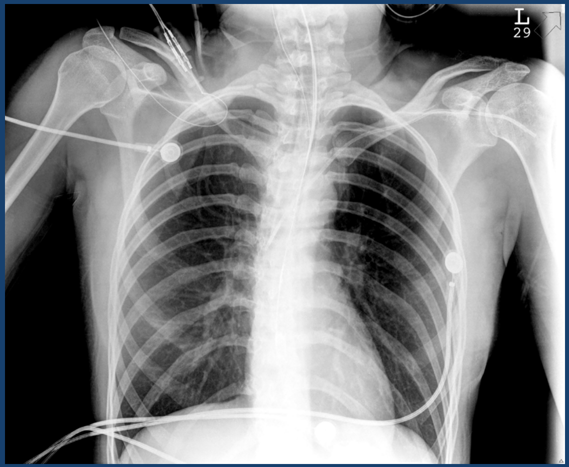
- Injuries occur when differential movement occurs between adjacent structures
  - Organs move and tear at areas of attachment

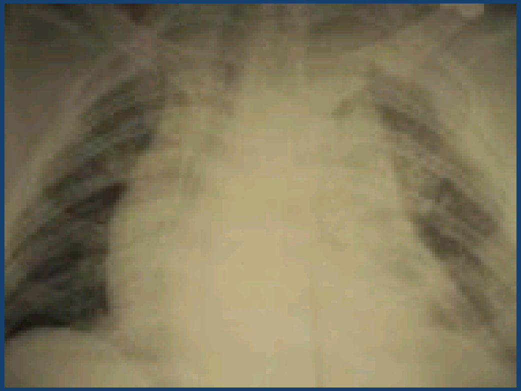




DELTA V

- The distal aorta is anchored to the thoracic spine and decelerates much more quickly than the relatively mobile aortic arch.
- Shear forces are generated in the aorta by the continuing forward motion of the arch in respect to the distal thoracic aorta.



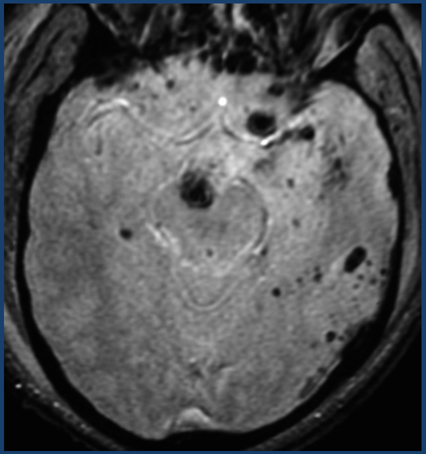


Widened mediastinum from TAR

DELTA V

Deceleration/acceleration injuries

- Similar situations occur at
  - the renal pedicle
  - the junction of the cervical with the thoracic spine
  - between the white and grey matter within the brain



CRASH DYNAMICS 101

- Law of inertia
- Principle direction of force (PDOF)
- Delta V
- **Intrusion**
- Seatbelts
- Airbags

INTRUSION

- Intrusion into a vehicle indicates the transfer of energy <u>between vehicle and occupant</u>

INTRUSION

Minor - Frontal

- No intrusion

Moderate - Frontal

- Minimal intrusion; typically limited to floor/toepan

Minor - Lateral

- 4 inches or less of door intrusion

Moderate - Lateral

- 4-6 inches of door intrusion

INTRUSION

Severe - Frontal

- Dash, floor, & steering column intrusion common

Severe - Lateral

- More than 6 inches of door intrusion
- Seat cushion & seat backrest deformation common

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SEATBELTS

- Occupant slows with the vehicle
- Designed to have the occupant "ride down" the crash
- Distributes forces over several points

SEATBELTS

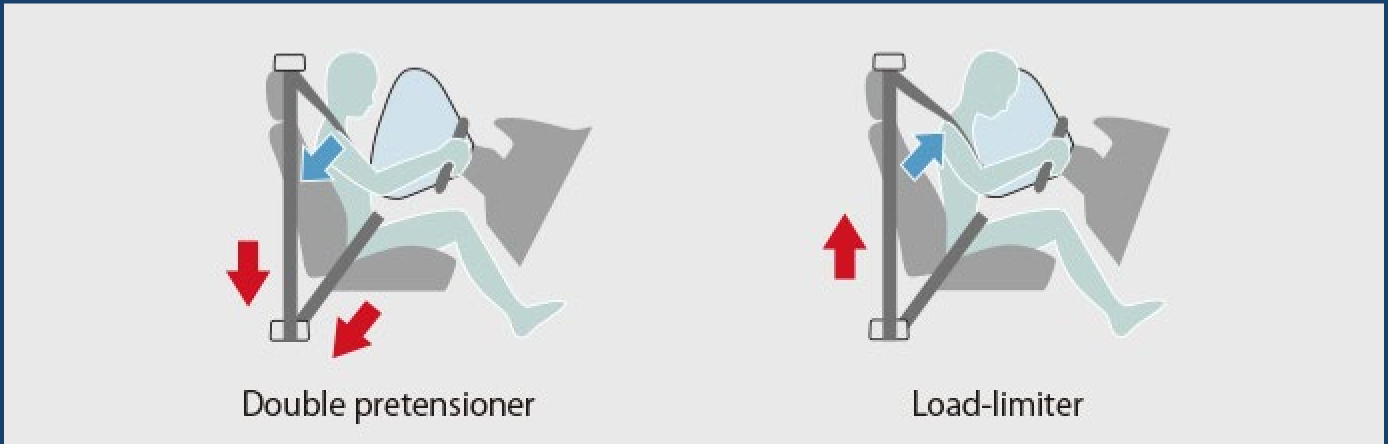
D-RINGS

SEATBELTS

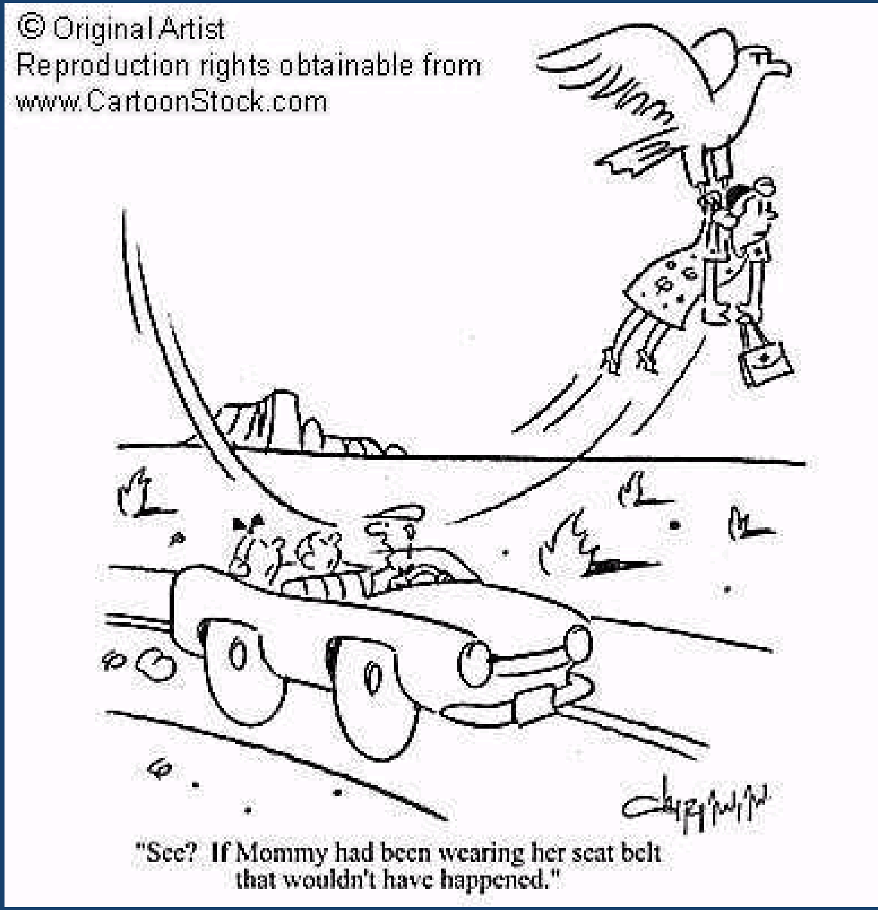
CONTINUOUS LOOPS

SEATBELTS

- Pretensioners
- Load Limiters



SEATBELTS



"OF COURSE I WAS WEARING MY SEATBELT, OFFICER!"

SEATBELTS

Post-crash

belt “locked” in extended mode - will not retract

SEATBELTS

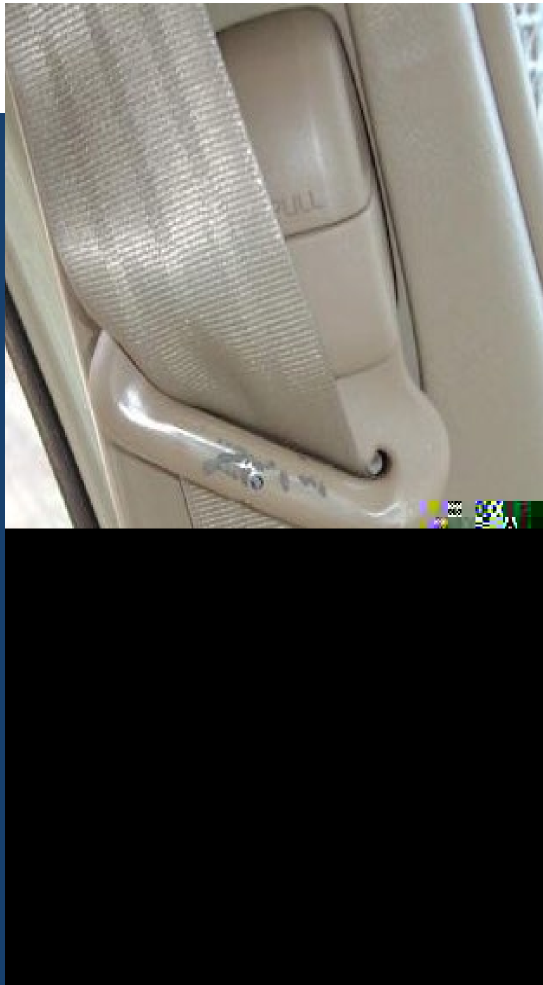
Post-crash

belt “locked” in retracted mode - will not extend

SEATBELTS

POST-CRASH WEBBING CUT

SEATBELTS



WEBBING MARKS

SEATBELTS

Upper SW rim deformation is "usually" indicative of a belted driver

SEATBELTS

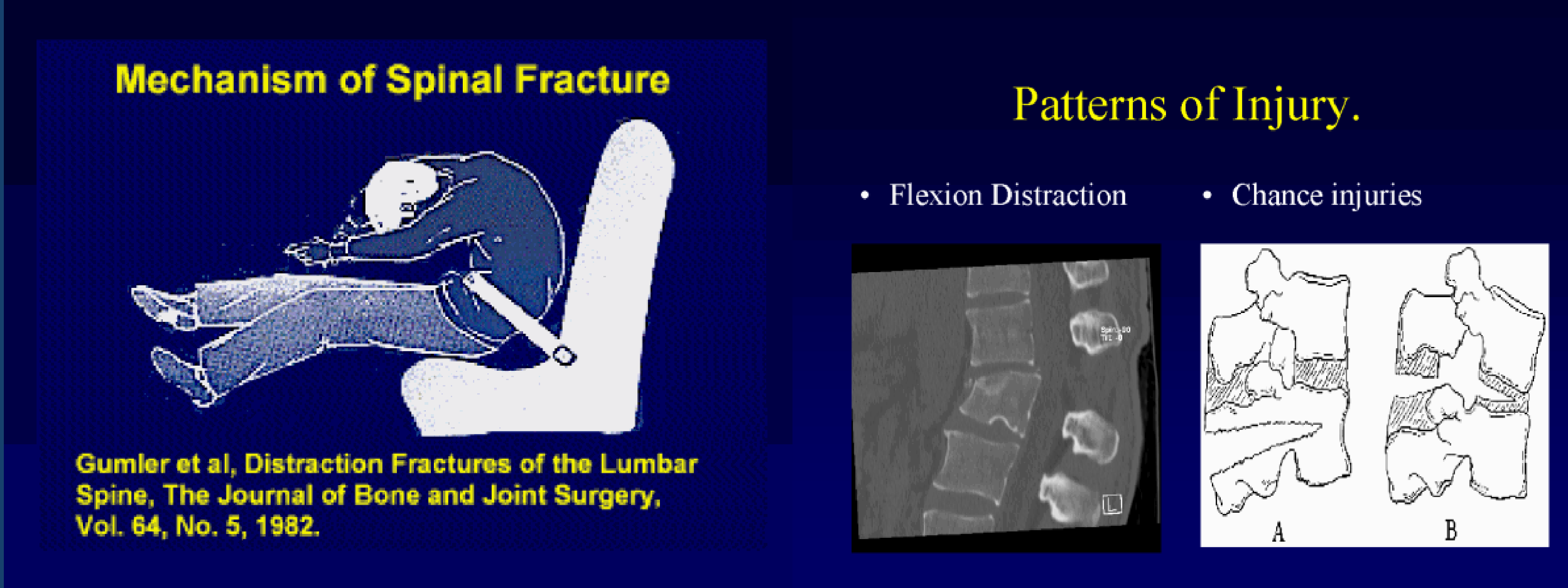
Upper and lower SW rim deformation tends to occur in higher severity crashes and can be either be a belted or unbelted driver

The Living Proof

SEATBELTS

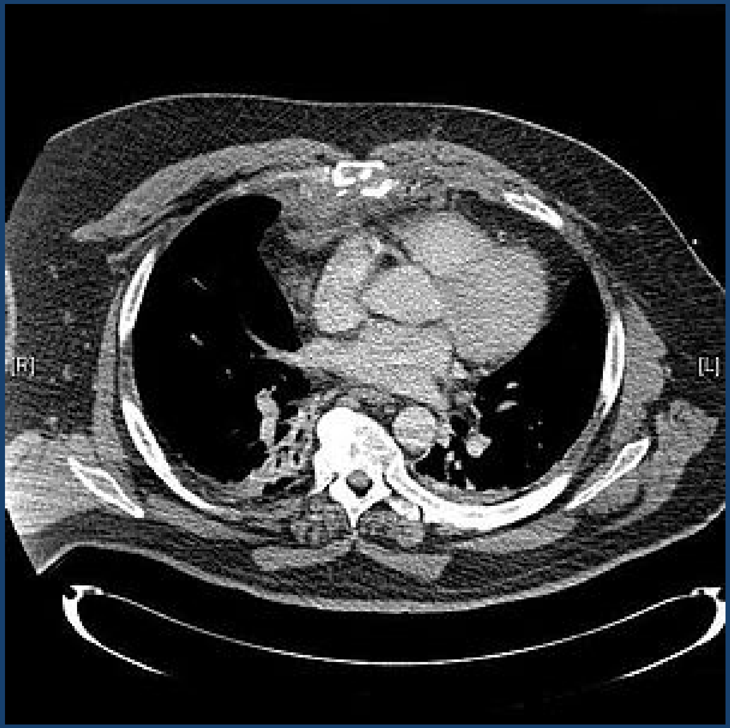
- Shoulder and Lap belts MUST be worn together
  - Specific injury patterns if worn separately
    - Lap belt only
      - Body folds forward & upper body impacts dash or steering wheel.
      - Facial, head, neck, abdomen, or lumbar injuries
    - Shoulder belt only
      - Severe neck injuries
      - Lose protection against other injuries

- 3 point restraints
  - STILL get injuries!
    - Neck, clavicle, internal organs



- Lap belts only
  - Chance fractures
  - High association with pancreatic and small bowel injury

SEATBELT INJURIES



SEATBELT INJURIES

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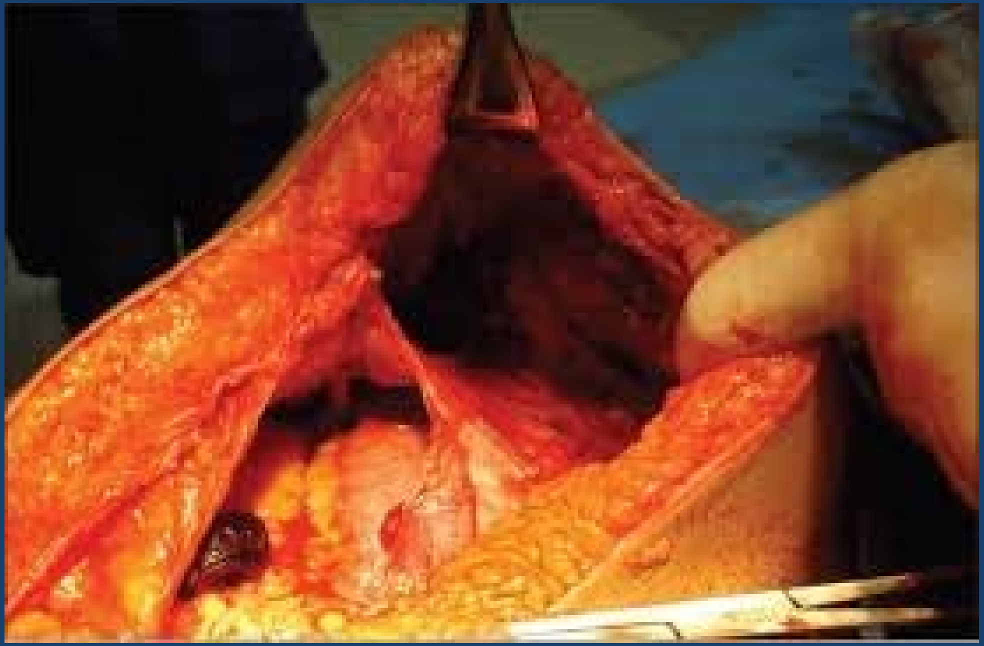
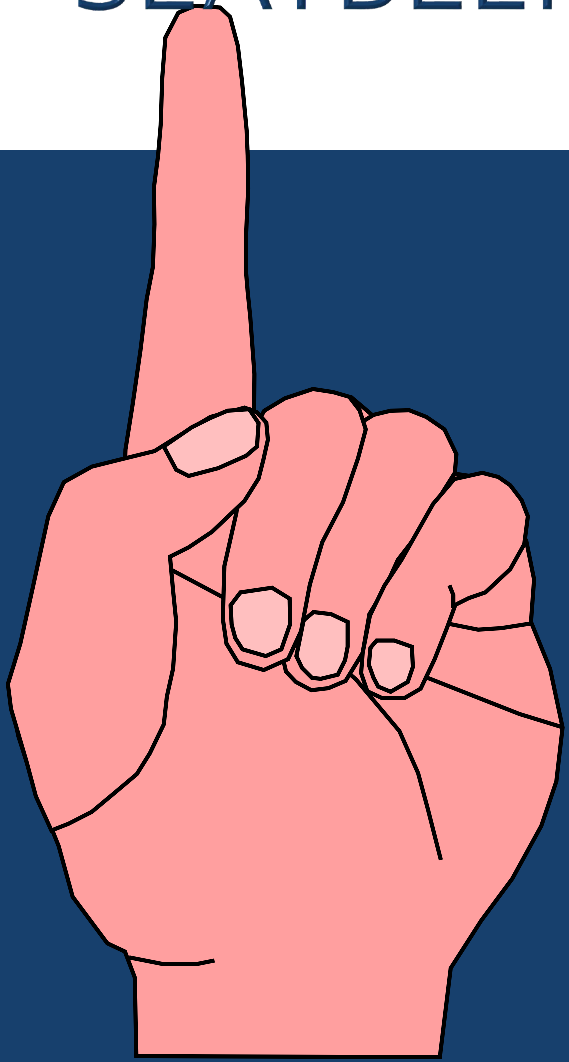


SEATBELTS



- Rule
  - belted occupants may still contact interior components in higher severity crashes
  - in general, belt restrained occupants fare well in most crashes
  - Seatbelts can CAUSE injuries
- Exceptions
  - serious injuries occur with
    - improperly belted
    - inappropriately belted
    - very young and the very old

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- **Airbags**

AIRBAGS

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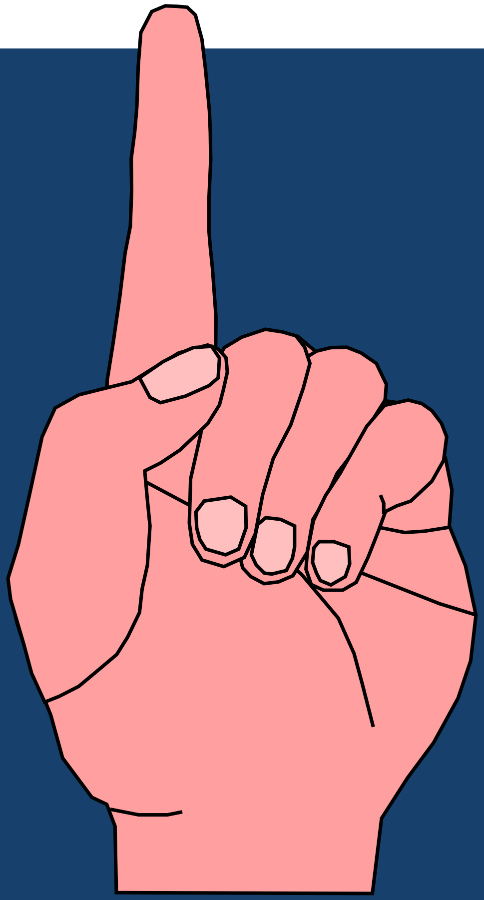


- Rule
  - airbag restrained occupants generally enjoy good protection from head to abdomen
- Exceptions
  - unbelted occupants can often miss or skip off the airbag (angled PDOFs)
  - airbag protected occupants lose protection after first severe impact
  - occupants who are OOP can sustain “inflation injuries”
    - flail chest, A-O separation, forearm fractures, brain injuries (angular acceleration)

2001 BMW X5

Side Impact into Pole

28.9 kph (18 mph)

AIRBAGS AND SEATBELTS

- *Air bag plus lap-shoulder belt* provided about 60% reduction in injury risk for serious injury
  - The estimated effectiveness of the air bag alone was 7%

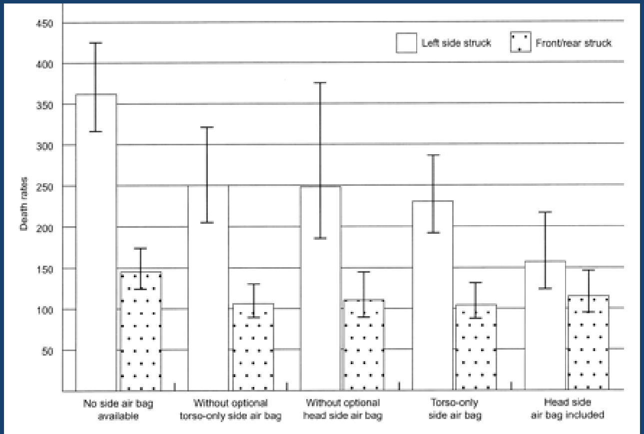
- The addition of an air bag to the lap-shoulder belt user increases head injury and chest injury protection, while increasing the risk of moderate and serious arm injury.
  - However, injuries to the head and chest pose much greater life-threatening risks than do arm injuries.

Third Report to Congress: Effectiveness of Occupant Protection Systems and Their Use. NHTSA. U. S. DoT.

AIRBAGS AND SEATBELTS

- Head and torso-protecting dual airbag systems are highly effective in reducing driver death or injury due to near side crashes

- Associated with a statistically significant reduction
  - 41.1% in the odds of death or injury across all body regions
  - 48.0% reduction in the odds of death or injury to the head, neck, face, chest and abdomen.

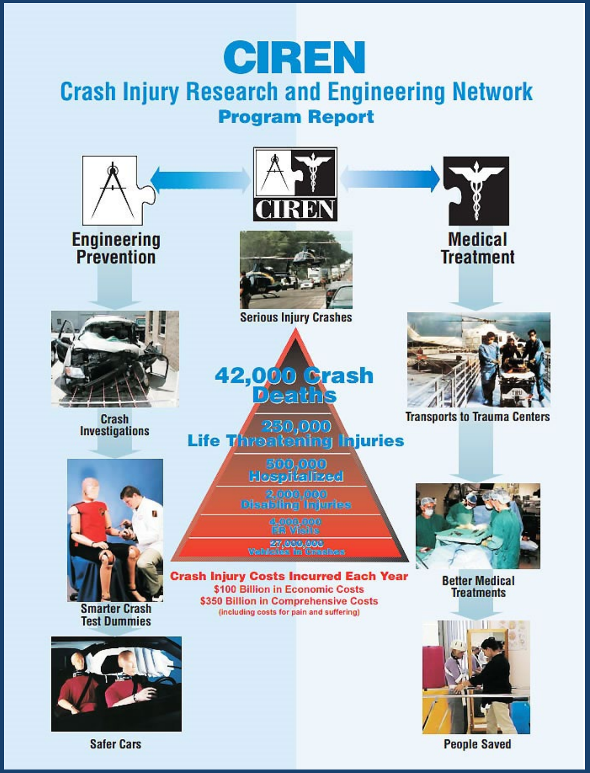


D'Elia A, Newstead S, Scully J. Evaluation of vehicle side airbag effectiveness in Victoria, Australia. 2013;54:67-72.

CIREN - CRASH INJURY RESEARCH ENGINEERING NETWORK

NHTSA

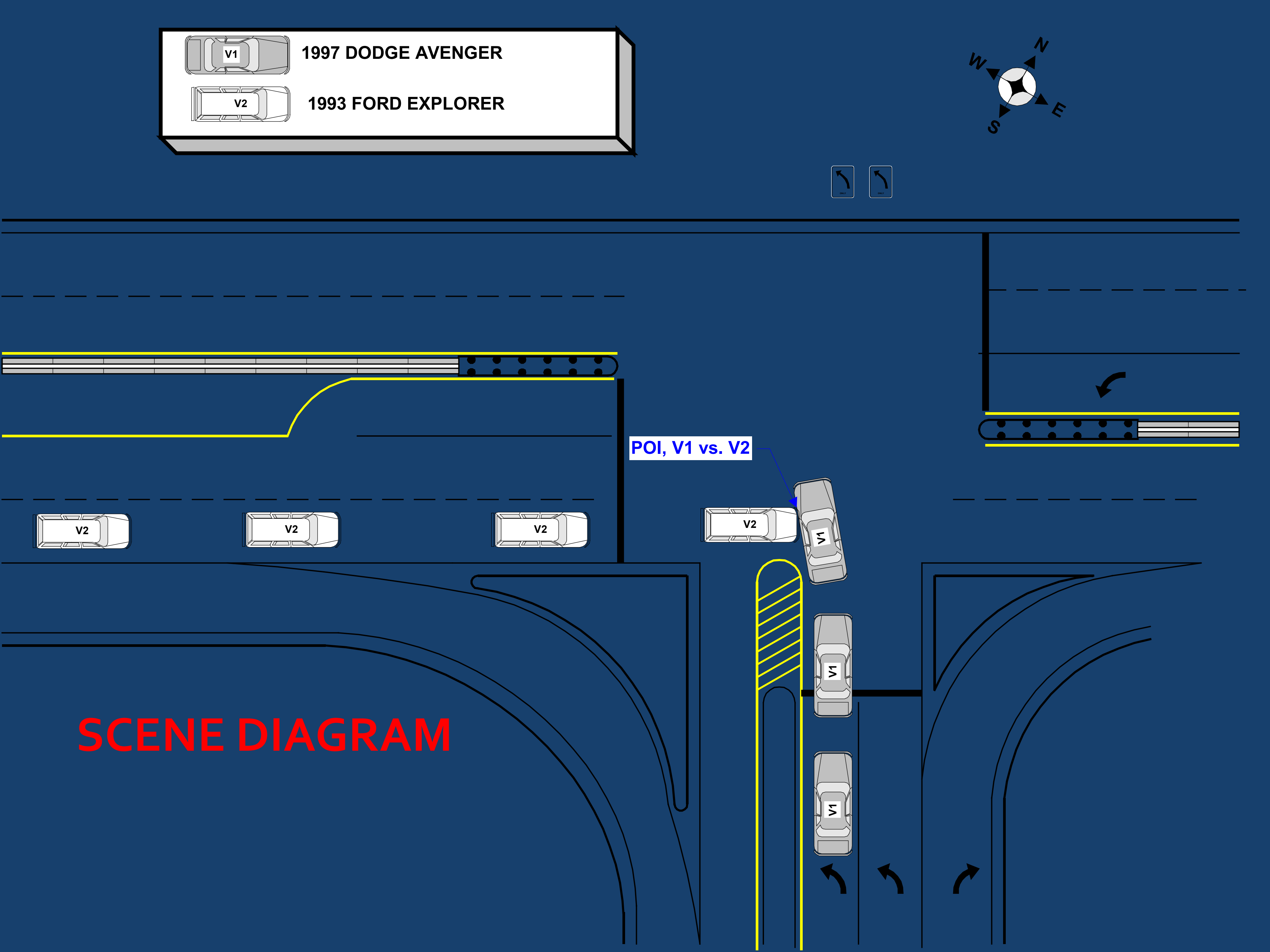
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION



CIREN CASE

- Type Of Crash: Side Swipe, Head-on (to case vehicle)
- Type Of Crash: Angle Crash
- Vehicles In Crash:
  - Case Vehicle: 1997 Dodge Avenger
  - 2nd Vehicle: 1993 Ford Explorer

This case was initiated in response to a report of a 19-year old female driver injured in a crash, who was admitted to a trauma center.



V1
1997 DODGE AVENGER
V2
1993 FORD EXPLORER
N
E
S
W
POI, V1 vs. V2
V2
V2
V2
V2
V1
V1
V1
SCENE DIAGRAM

Vehicle 1's Approach

Vehicle 1's POI

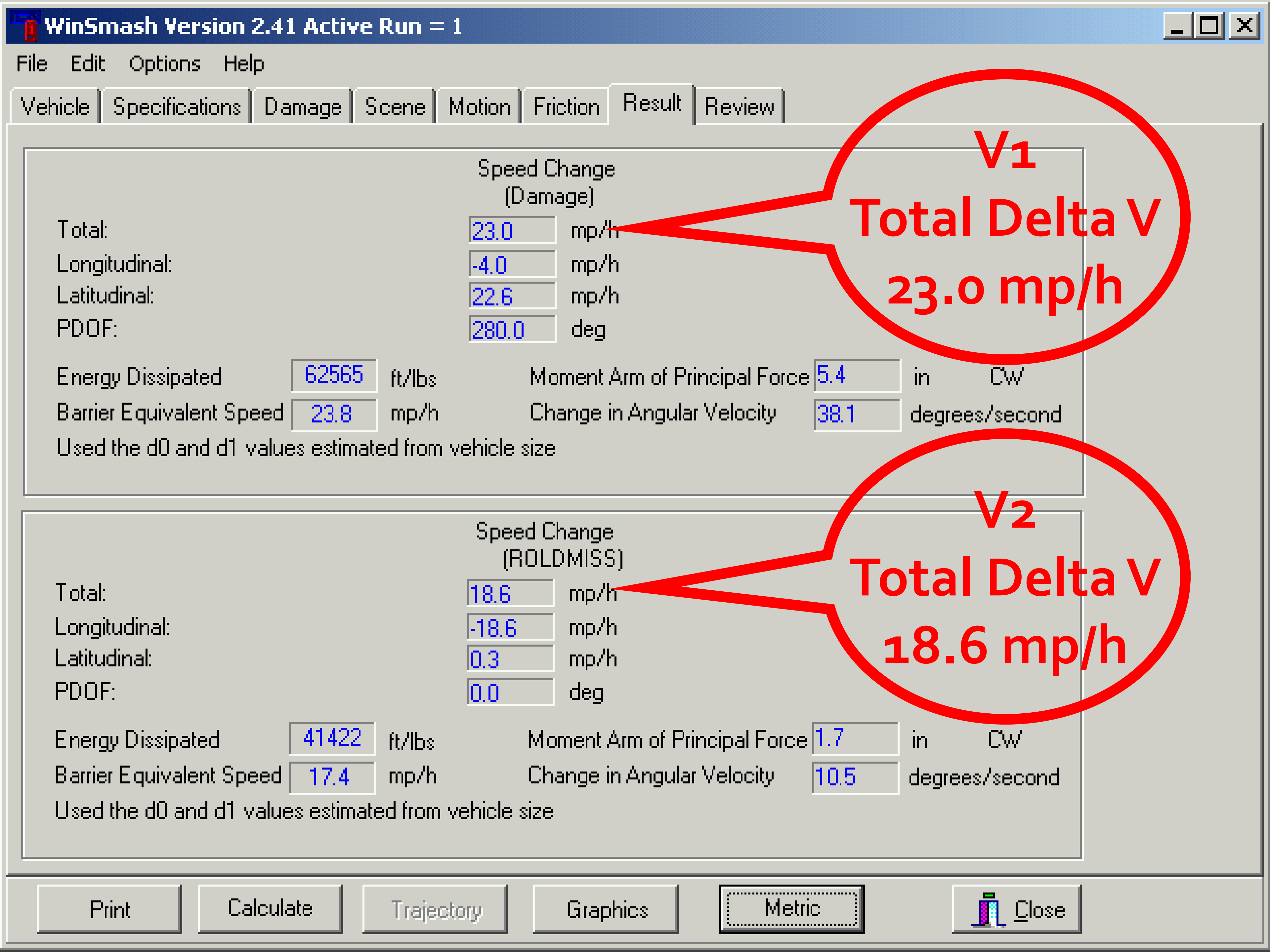
Vehicle 2's Approach

Vehicle 2's Approach & POI

Exemplar Vehicle

Vehicle 1 - Left Side

Vehicle 1 - Left Side


WinSmash Version 2.41 Active Run = 1
File Edit Options Help
Vehicle Specifications Damage Scene Motion Friction Result Review
Speed Change
(Damage)
Total: 23.0 mp/h
Longitudinal: -4.0 mp/h
Latitudinal: 22.6 mp/h
PDOF: 280.0 deg
Energy Dissipated 62565 ft/lbs
Barrier Equivalent Speed 23.8 mp/h
Moment Arm of Principal Force 5.4 in CW
Change in Angular Velocity 38.1 degrees/second
Used the d0 and d1 values estimated from vehicle size
V1
Total Delta V
23.0 mp/h
Speed Change
(ROLDMISS)
Total: 18.6 mp/h
Longitudinal: -18.6 mp/h
Latitudinal: 0.3 mp/h
PDOF: 0.0 deg
Energy Dissipated 41422 ft/lbs
Barrier Equivalent Speed 17.4 mp/h
Moment Arm of Principal Force 1.7 in CW
Change in Angular Velocity 10.5 degrees/second
Used the d0 and d1 values estimated from vehicle size
V2
Total Delta V
18.6 mp/h
Print
Calculate
Trajectory
Graphics
Metric
Close

Exemplar Interior

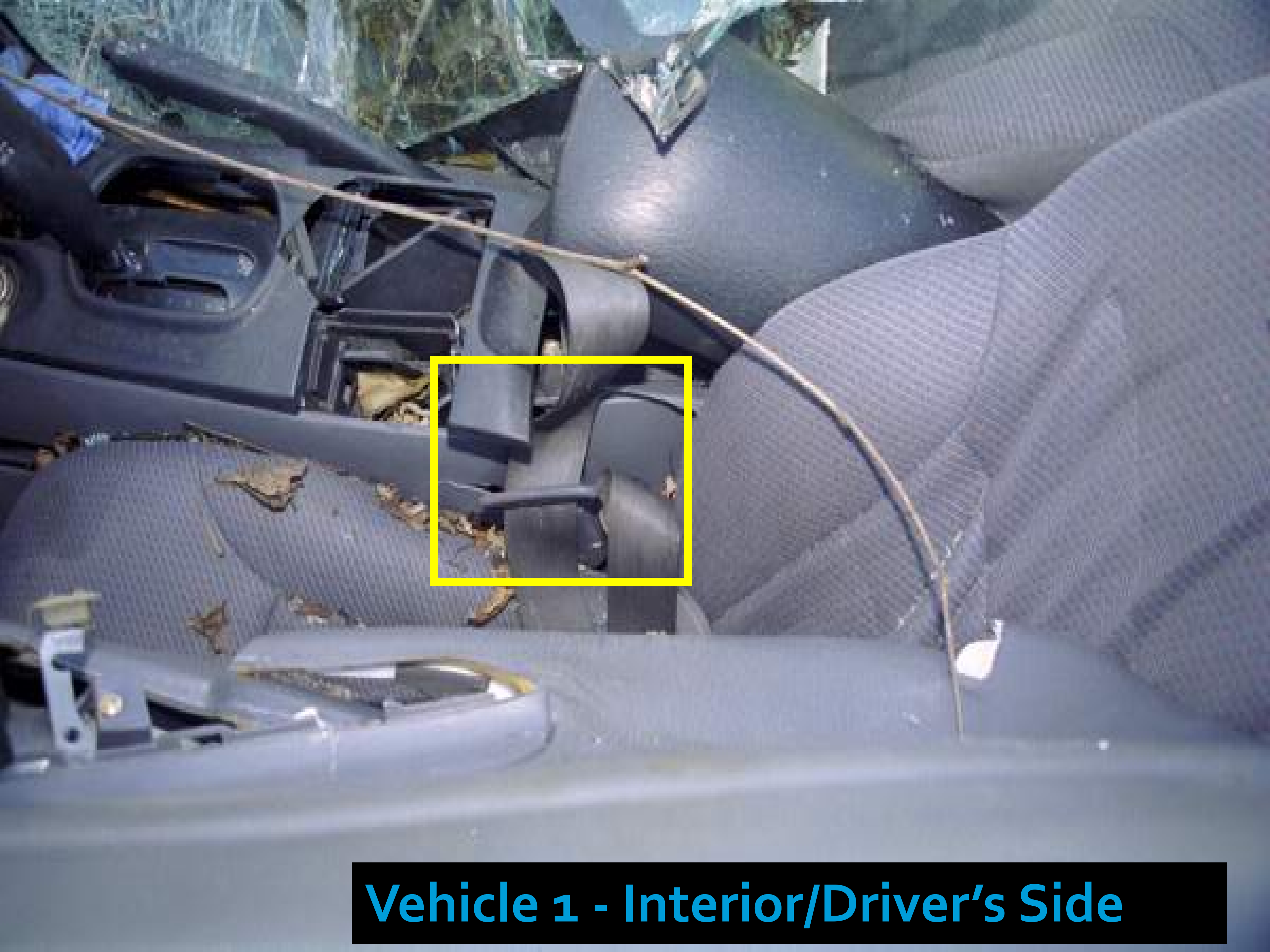
Exemplar Interior

Exemplar Interior

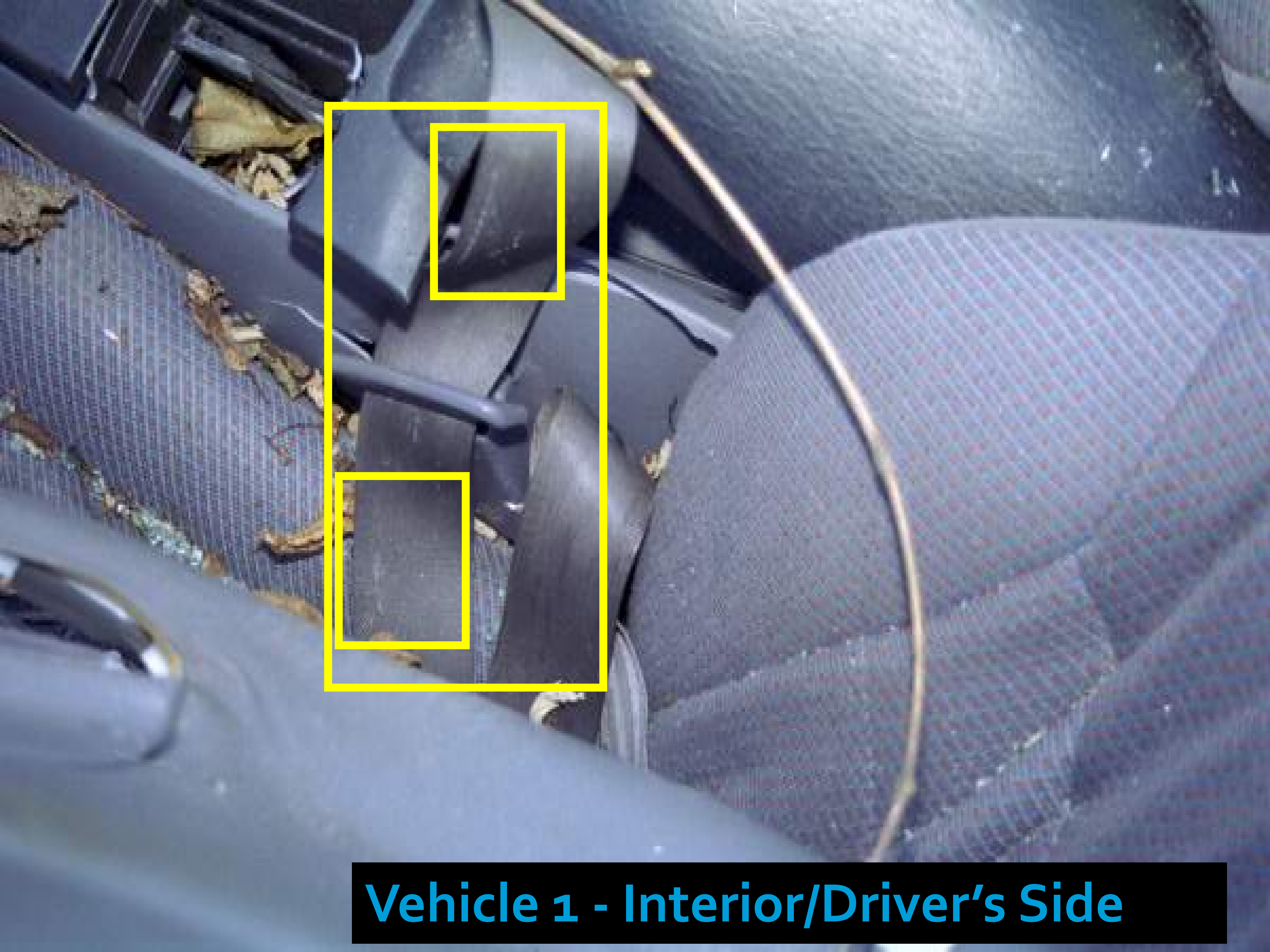
Vehicle 1 - Interior/Driver's Side

Vehicle 1 - Interior/Driver's Side

Vehicle 1 - Interior/Driver’s Side



Vehicle 1 - Interior/Driver's Side



Vehicle 1 - Interior/Driver's Side

Vehicle 1 - Interior/Driver's Side

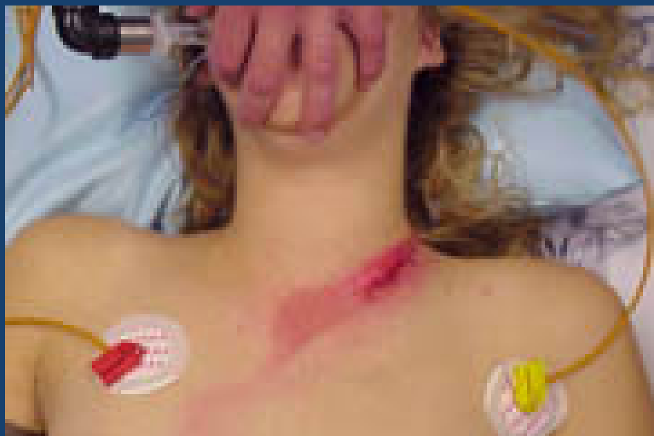
Vehicle 1 - Interior/Driver's Side

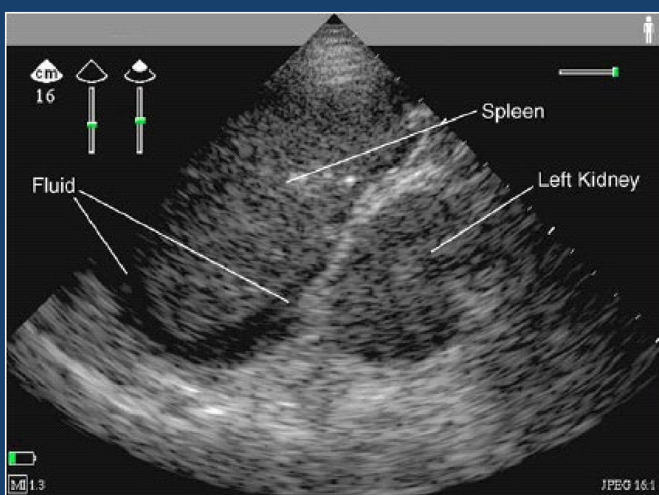
INTRUSIONS

Row	Position	Intruded Component	Intrusion	Crush Direction
Front	Left	Door Panel (front)	34 cm	Lateral
Front	Left	Door Panel (back)	29 cm	Lateral
Front	Left	Front Seat Back	13 cm	Lateral
Front	Left	“B” Pillar	10 cm	Lateral
Front	Left	Instrument Panel	11 cm	Lateral
Front	Left	“A” Pillar	9 cm	Lateral
Front	Left	Sill	8 cm	Lateral
Front	Right	Center Console	8 cm	Lateral
Front	Left	Kick Panel	5 cm	Lateral
2nd Seat	Left	Side panel	5 cm	Lateral

CIREN CASE

- Patient brought to STC and underwent evaluation.
- Initial VS
  - HR=108 BP=108/50 RR=23
- GCS=15
- FAST exam positive
- CXR negative
- Secondary survey revealed…




cm
16
Spleen
Fluid
Left Kidney
MI 1.3
JPEG 16:1

CIREN CASE

- Patient taken for splenic embolization
- To OR on HD #2 for ORIF of pelvis
- Patient was d/ced home on HD#4/POD#2

CIREN CASE REVIEW

EXPEDITED REVIEW V1.0

3-C5-2021-107

CIREN case(s) - 107

Review Date 05/27/2021

Enrolling center: UMB

Reviewing center: Emory

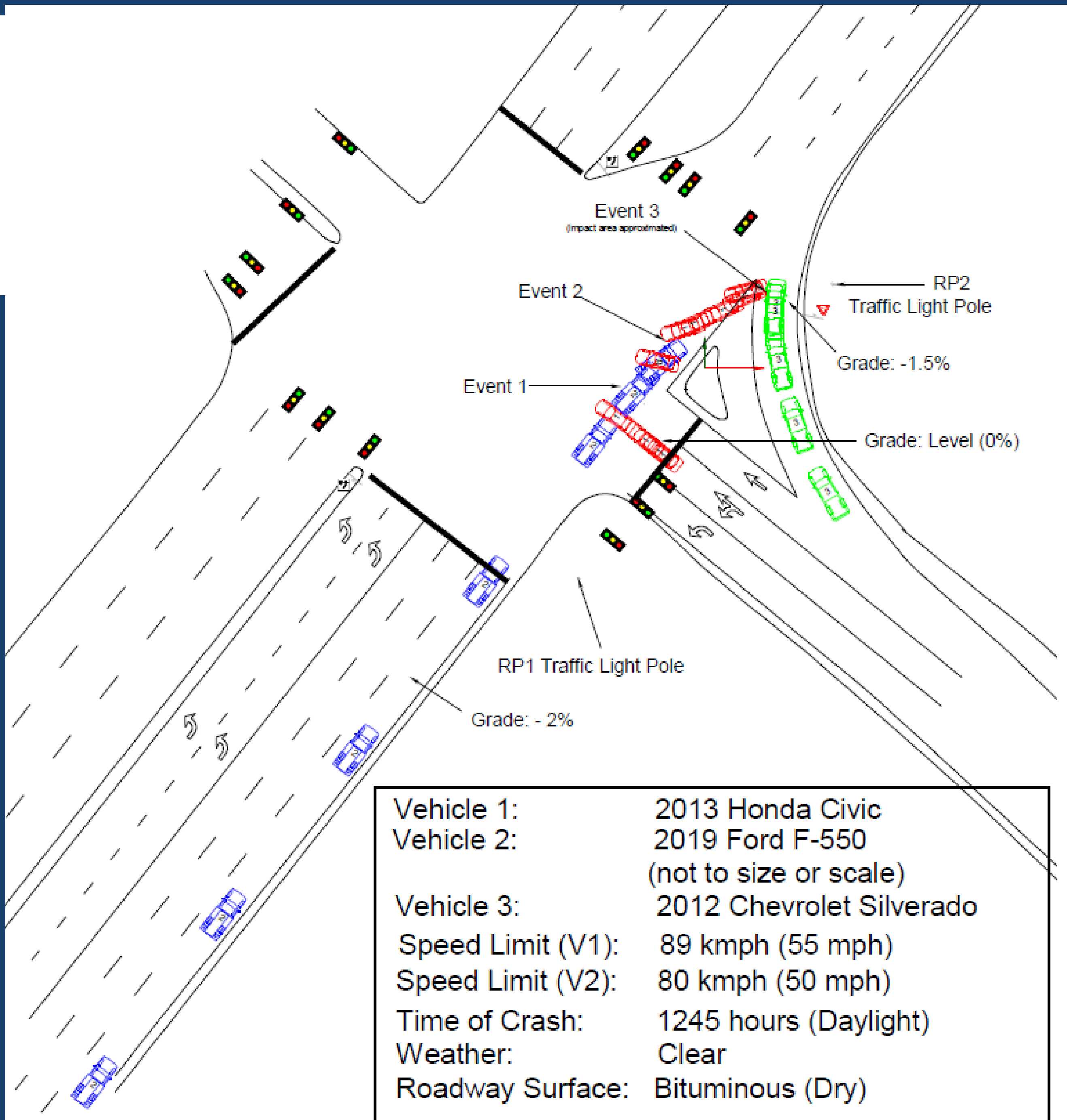
CASE SUMMARY

Case Vehicle	
Model year	2013
Make	Honda
Model	Civic
Body type	Four-door sedan
Sister/clone?	No

Inclusion Criteria/Type	
Crash type	Near side impact (primary)
Restraint	Belted Air Bags Deployed: DAB, SAB & CAB

Occupant	
Age	25
Gender	Female
Height	163 cm (64 in.)
Weight	59 kg (130 lbs.)
BMI	22.2
Seating position	Driver
MAIS	3
Clothing	Shirt, long pants, sneakers, earrings, necklace, ring
PMHx	None

SCENE



Vehicle 1:	2013 Honda Civic
Vehicle 2:	2019 Ford F-550 (not to size or scale)
Vehicle 3:	2012 Chevrolet Silverado
Speed Limit (V1):	89 kmph (55 mph)
Speed Limit (V2):	80 kmph (50 mph)
Time of Crash:	1245 hours (Daylight)
Weather:	Clear
Roadway Surface:	Bituminous (Dry)

SCENE IMAGES (V1 OVERALL VIEW)

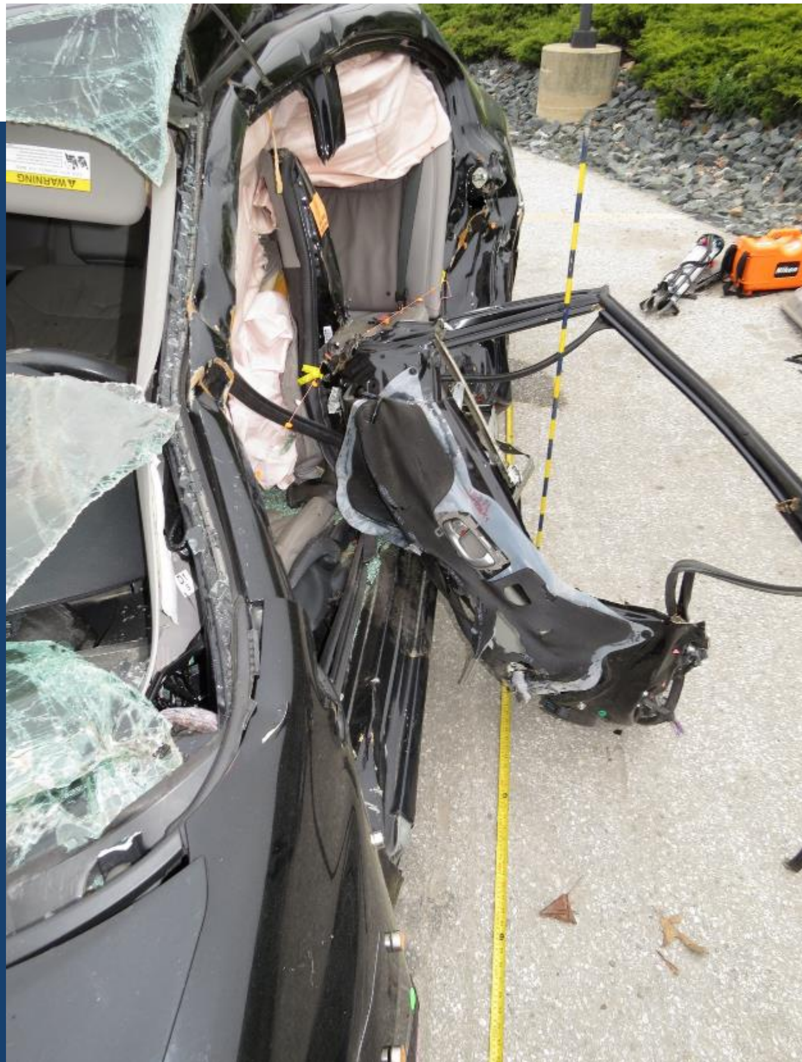
SCENE IMAGES (V1 IMPACT AREA)

CRASH OVERVIEW

Event	CDC	PDOF	Rank	Speed Change (ΔV or BES)	Max crush & location
1	10LYAW3	CISS: 290 EDR: 292	1	BES = 55 kmph (34 mph) EDR (long.) = -17 kmph (-11 mph) @ 137.5 ms EDR (lat.) = 43 kmph (27 mph) @ 130 ms	46 cm @ C4
2	06LYES1	CISS: 190 EDR: NR	-	DV = Unknown (sideswiping) EDR = Not Reported	Minor scraping @ LF fender / wheel
3	06BYEW1	CISS: 190 EDR: 188	2	DV = Unknown (not measured) EDR (long.) = 12 kmph (7 mph) @ 145 ms EDR (lat.) = 2 kmph (1 mph) @ 77.5 ms	Minor deformation at back left bumper

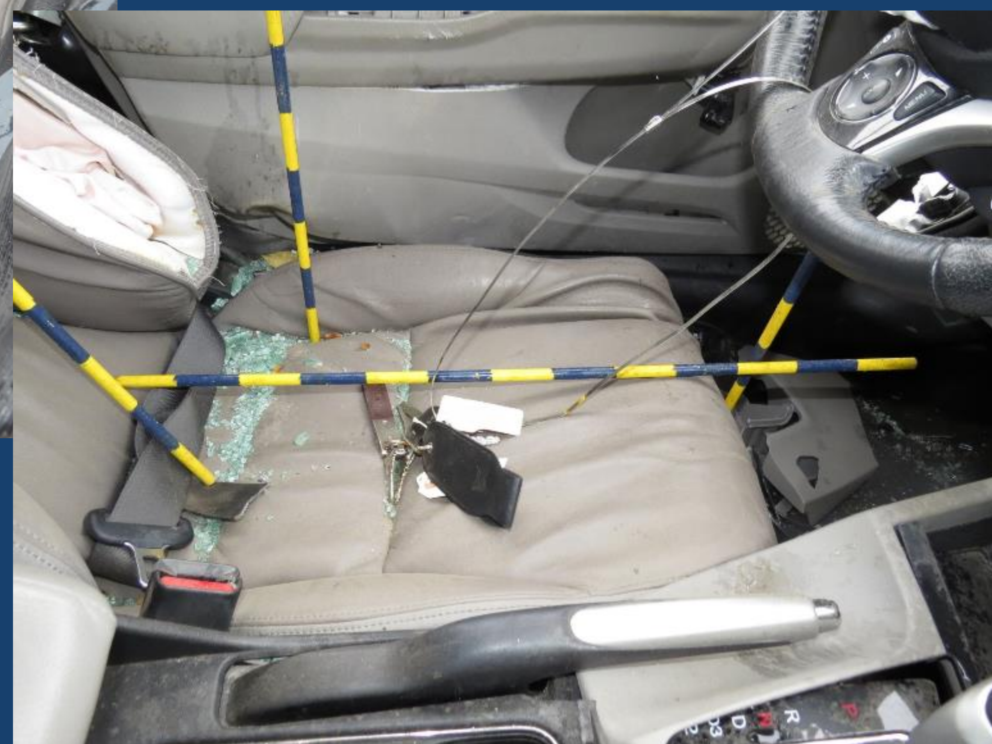
- EDR obtained – Yes

EVENT 1: 10LYAW3 – RANK 1

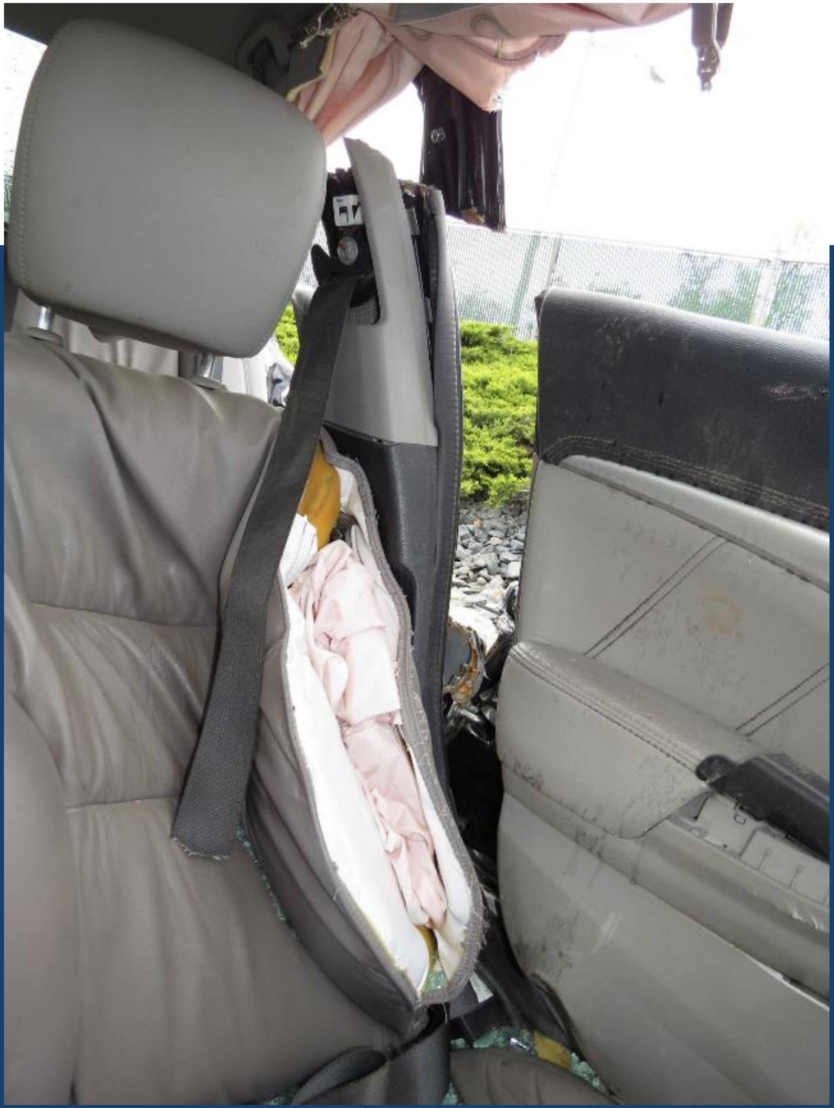


EVENT 2: 06LYES1 – RANK 3

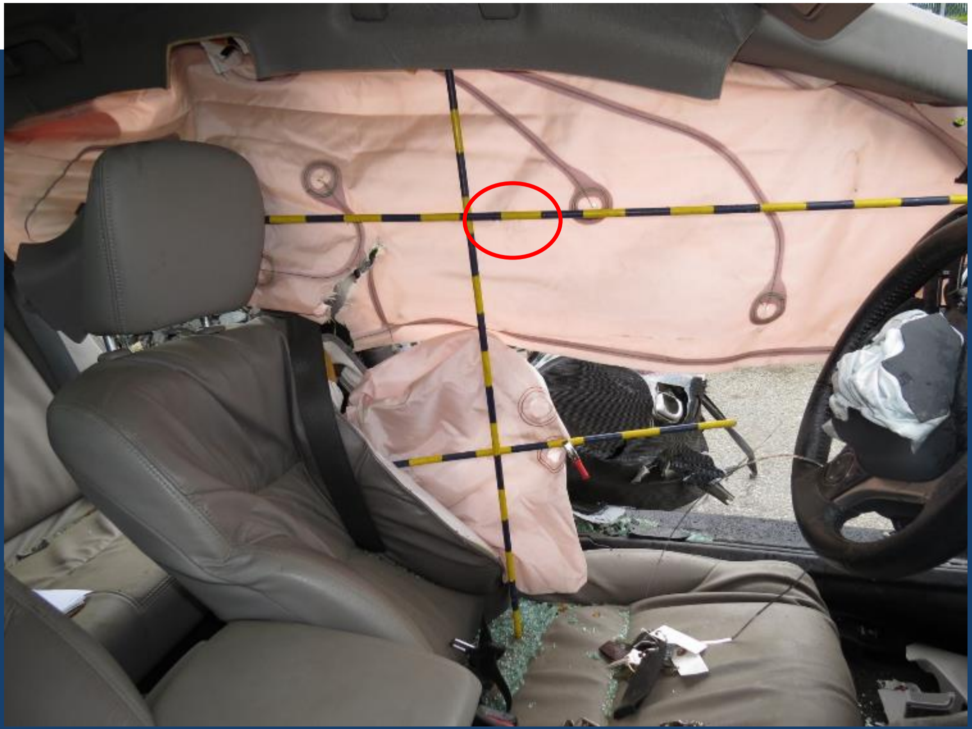
SEAT PAN



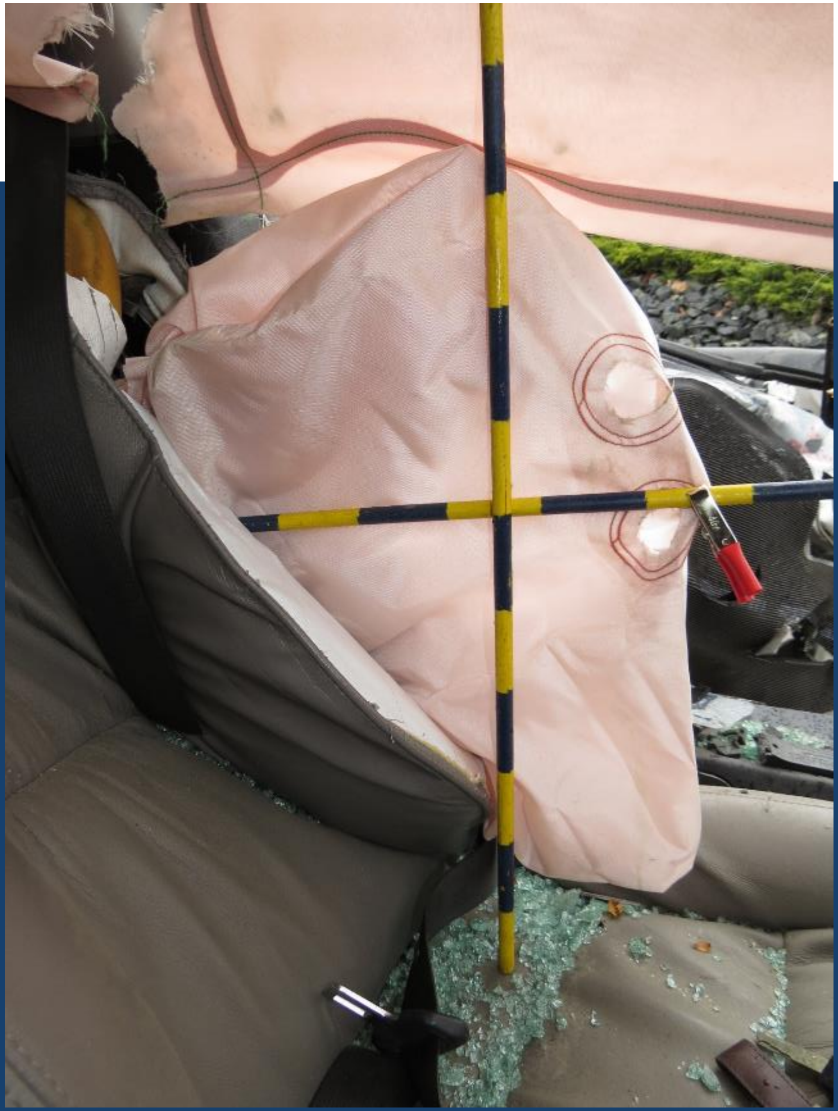
BELT RESTRAINT

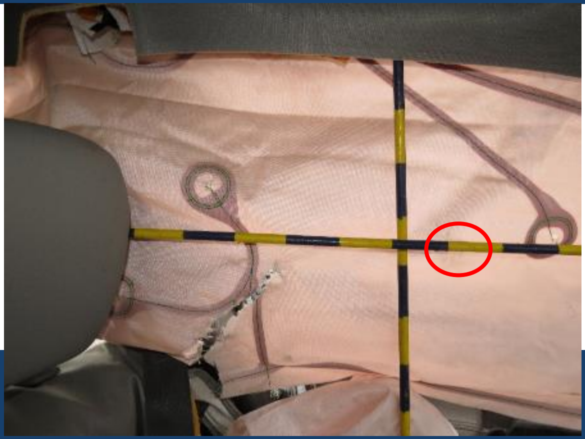


AIRBAGS



AIRBAGS

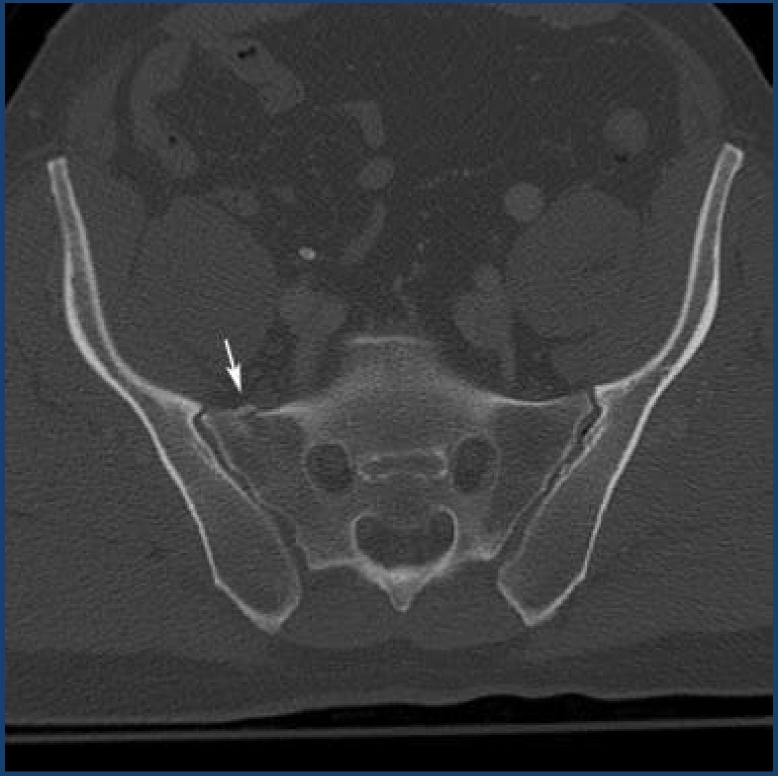




TRAUMA ADMISSION

Occupant Condition on Arrival	
Overall	Stable
GCS	15
Blood pressure	105/59
Temperature	Unknown
Pulse	Unknown
Respiration rate	20
Alcohol	Negative
Drugs	Negative

- L hip contusion
- R thigh contusion
- L left abrasion (lateral, approx. 3cm)
- Nose abrasion



CIREN CASE

Vehicle: 2002 Volkswagen Jetta vs. Utility Pole (37 cm)
(4-door sedan)

Case Occupant: 32 year old male driver
70 in / 178 cm Driver 220 lbs. / 100 kg

Seating: Driver's seat was found in the mid-to-forward seat track position, while the seat backrest was upright (reclined by EMS post crash).

CIREN CASE

Total Delta V: 117 km/h (72.7 mph)

Very High

CDC: 12FZEW6

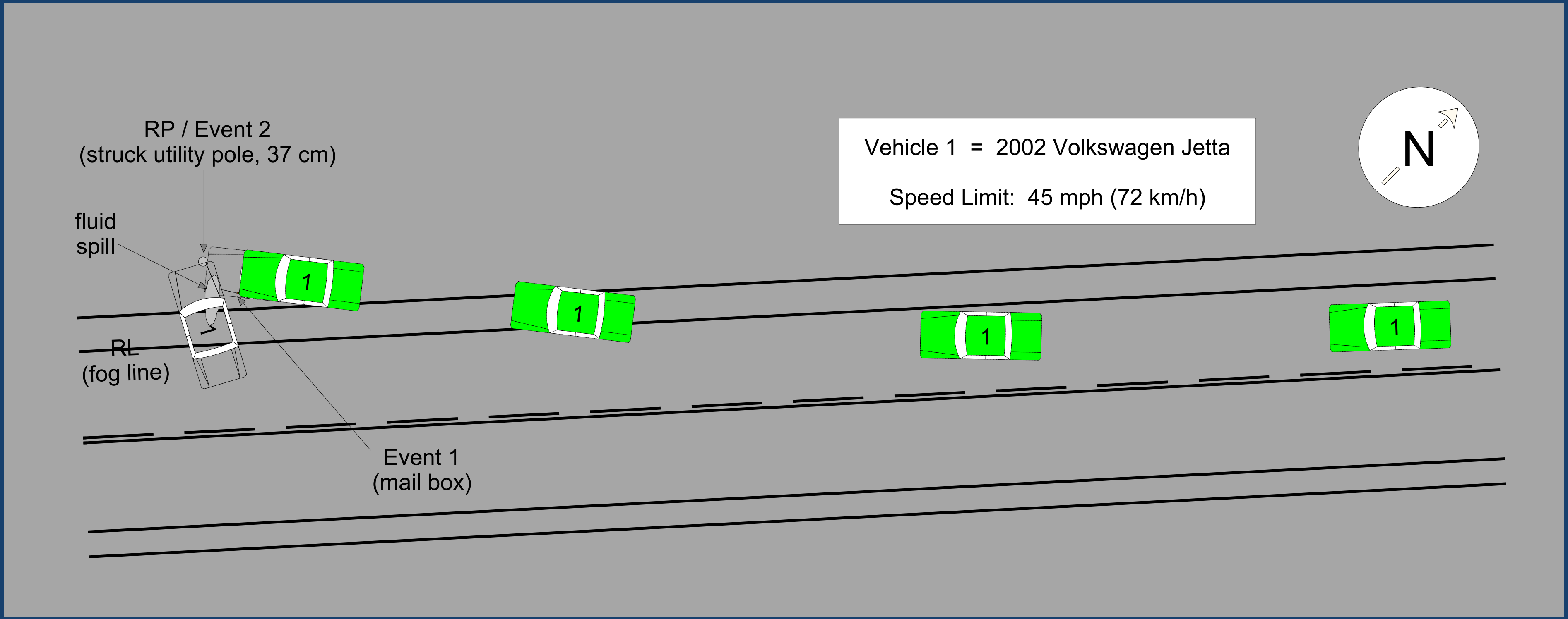
PDOF: 0 degrees

Max. Crush: 114 cm (44.9 in) @ C3

FIELD SUMMARY

Total Delta V:	117 km/h (72.7 mph) Very High		
CDC:	12FZEW6		
PDOF:	0 degrees		
Max. Crush:	114 cm (44.9 in) @ C3		
Intrusions:	Instr. Panel Lf.	32 cm (12.6 in)	Longitudinal
(Driver's area)	Instr. Panel Ctr.	32 cm (12.6 in)	Lateral
	Center Console	20 cm (8.0 in)	Lateral
	Toe Pan	8 cm (3.1 in)	Longitudinal

CIREN CASE



RP / Event 2
(struck utility pole, 37 cm)
fluid
spill
RL
(fog line)
Event 1
(mail box)
Vehicle 1 = 2002 Volkswagen Jetta
Speed Limit: 45 mph (72 km/h)
N
1
1
1
1

Vehicle 1 Approach

Impact

Rest

Look Back

Vehicle 1 Exemplar

Vehicle 1 Exemplar

V1
Exterior

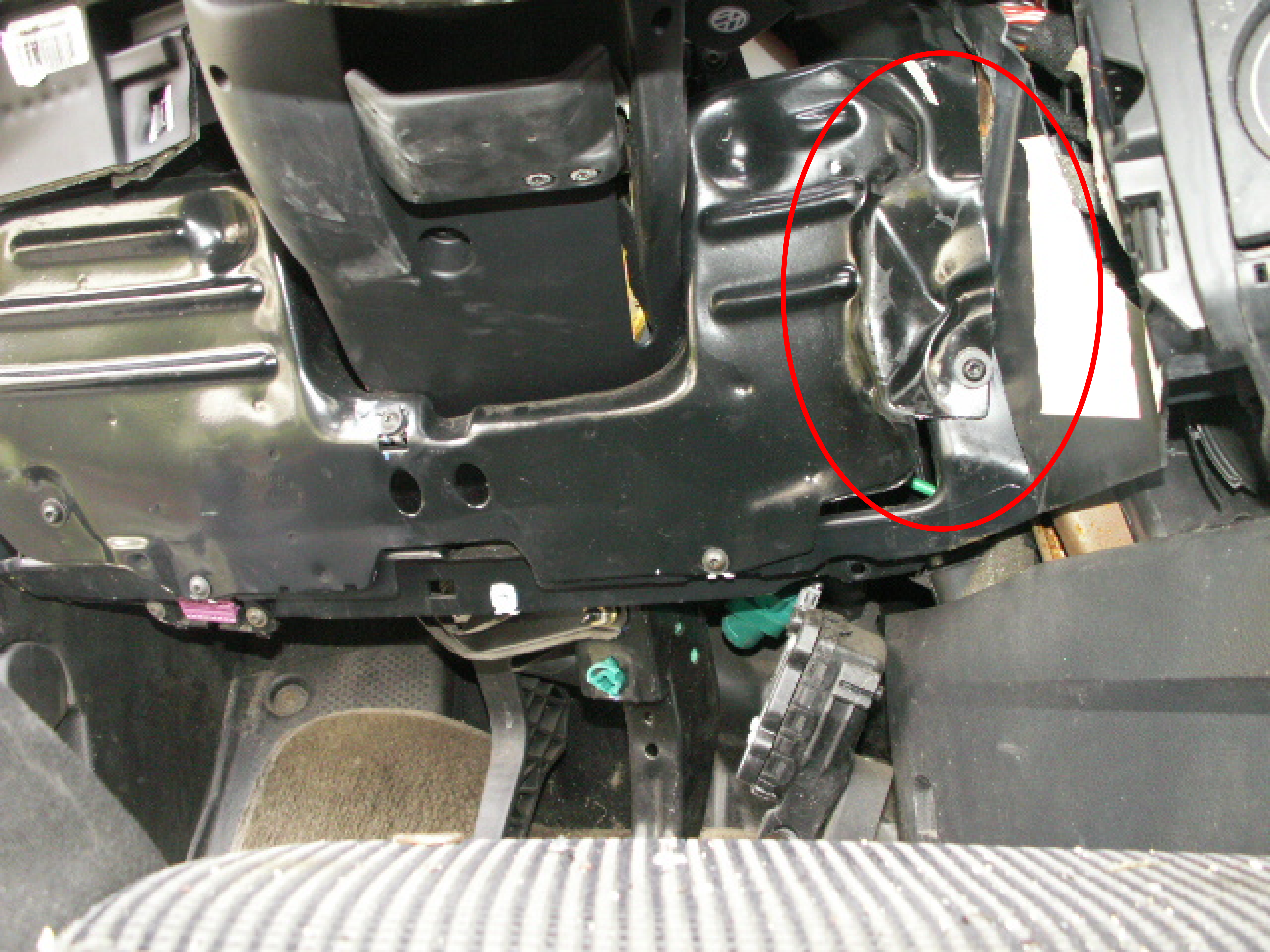
Vehicle 1 Exemplar

Vehicle 1 Exemplar

V1
Interior


WARNING

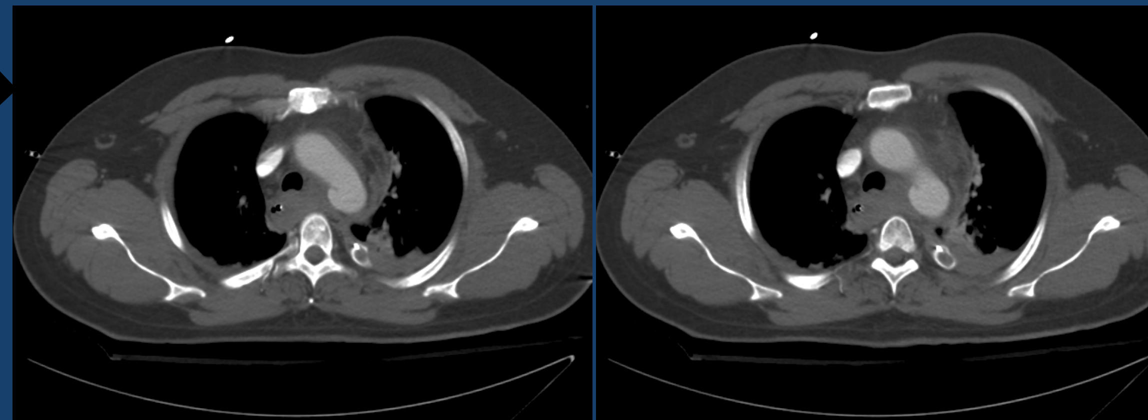

ESP
AC

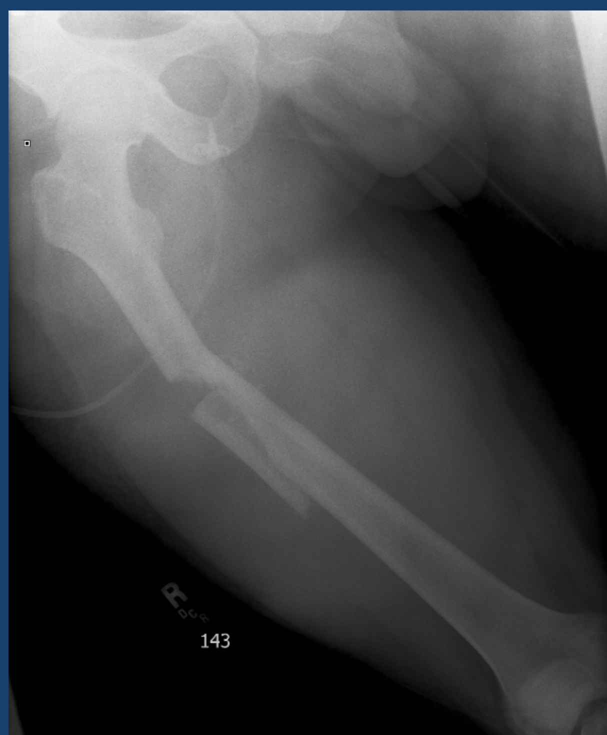


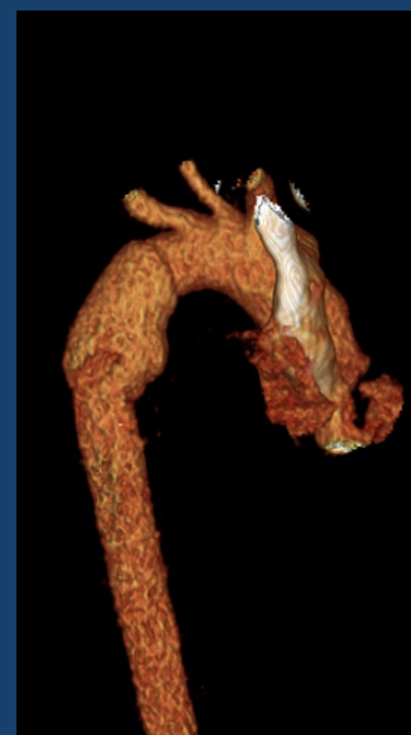
Final View

CIREN CASE

- Patient brought to STC and underwent evaluation
- Initial VS
  - HR=130 BP=80/42 RR=35 GCS=14
- Positive FAST
- Patient is taken emergently to the OR.
  - Liver injury found.
  - Mesentery and small bowel injuries repaired.
  - Abdomen is packed and left open.




143



CIREN CASE

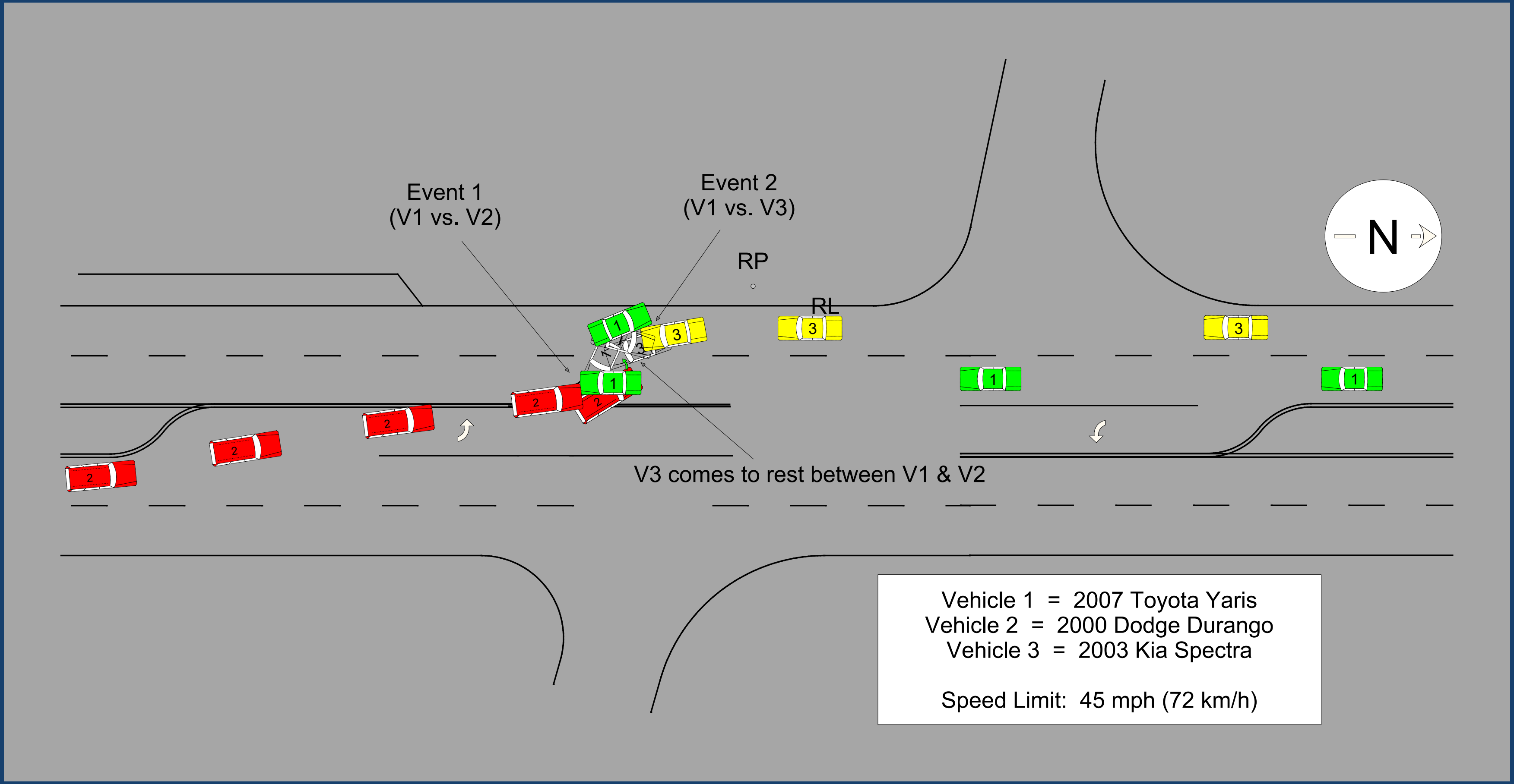
- Taken back to OR on HD #2 and unpacked and closed.
- TEVAR done on HD#2 and an IM nail of his R femur on HD#3.
- Patient was ultimately d/ced to rehab on HD#16

CIREN CASE

Total Delta V:	72 km/h (44.7 mph)
CDC:	12FYAW6
PDOF:	350 degrees
Max. Crush:	71 cm (28.0 in) @ C2 (A-pillar engaged at glazing level)

Intrusions:	Toe Pan	13 cm (5.1 in)	Longitudinal
	Instr. Panel	30 cm (11.8 in)	Longitudinal
	A-Pillar	23 cm (9.1 in)	Longitudinal
	Steering	20 cm (8.0 in)	Longitudinal

CIREN CASE


Event 1
(V1 vs. V2)
Event 2
(V1 vs. V3)
RP
RL
N
V3 comes to rest between V1 & V2
Vehicle 1 = 2007 Toyota Yaris
Vehicle 2 = 2000 Dodge Durango
Vehicle 3 = 2003 Kia Spectra
Speed Limit: 45 mph (72 km/h)

Vehicle 1 Approach

Impact Area

Rest

Look Back

Vehicle 2 Approach

Impact Area

Vehicle 2 Exemplar

V2
Exterior


DODGE
4X4


IP
NO vin

Vehicle 1 Exemplar

Vehicle 1 Exemplar


V1
Exterior


CIVIC
EX


TOYOTA

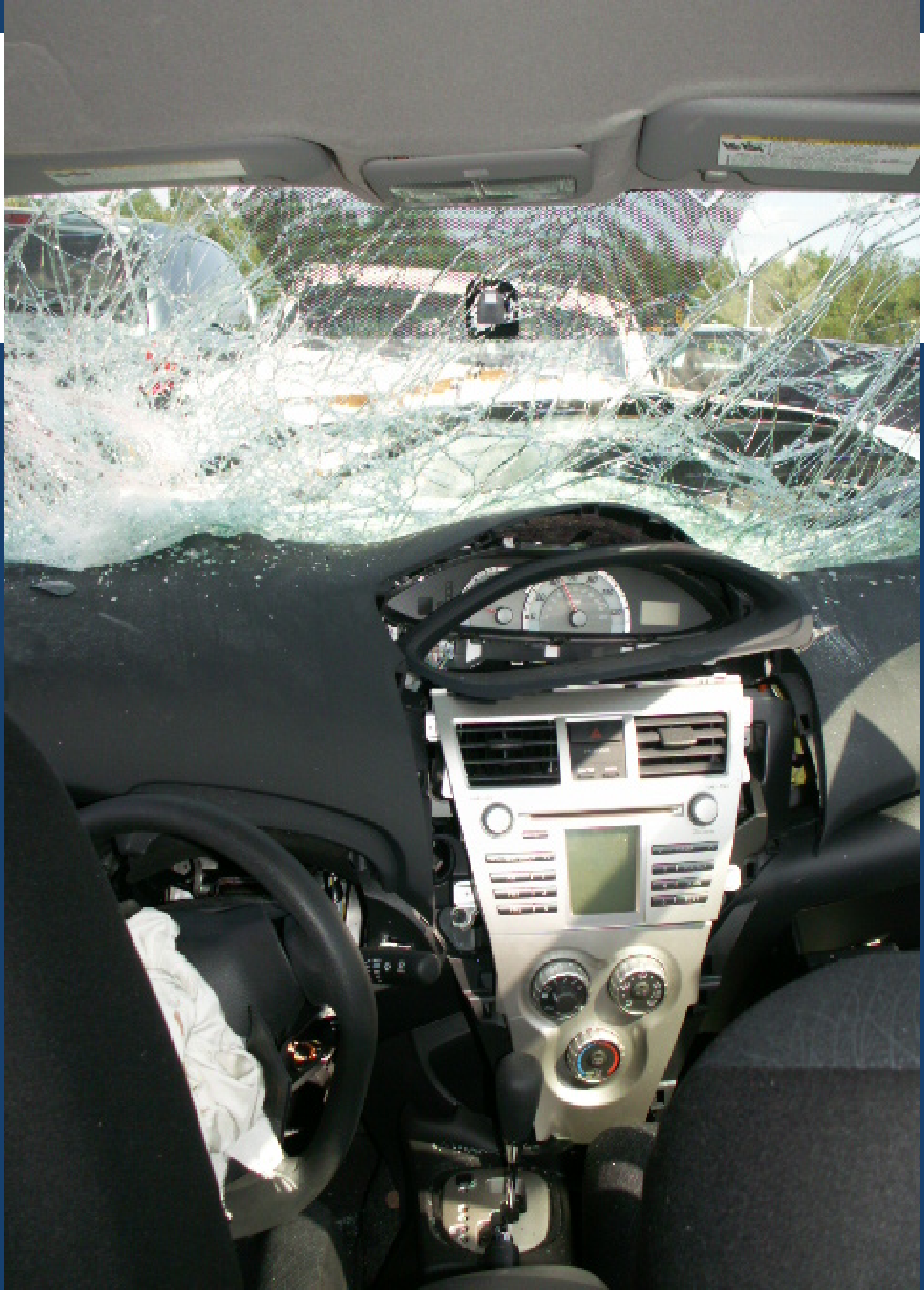

Vehicle 1
Exemplar

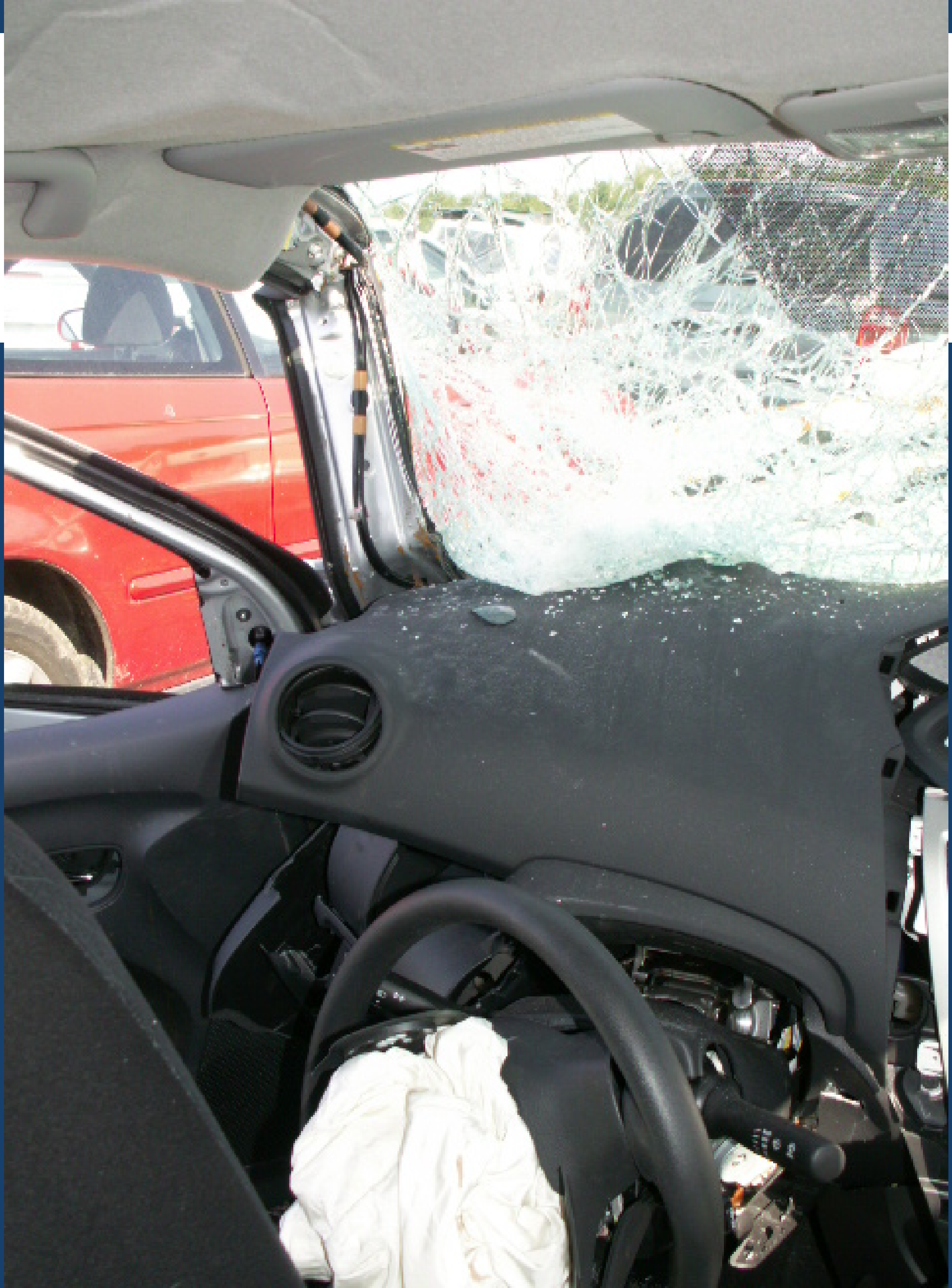
Vehicle 1 Exemplar


Vehicle 1
Exemplar

V1 Interior


P
R
N
D
3
2
L
0 1 2 3 4 5 6 7 8
0 20 40 60 80 100 120
MPH
km/h
0 20 40 60 80 100 120 140 160 180 200



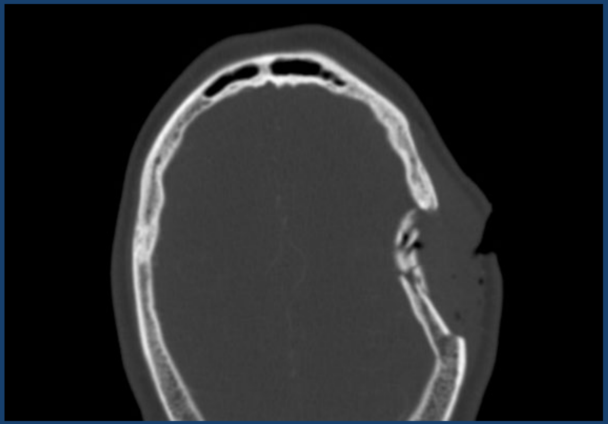
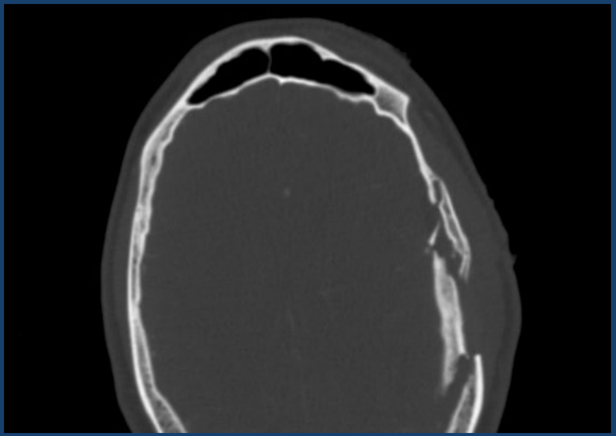



0 1 2 3 4

Final View

CIREN CASE

- Intubated in the field
- Patient brought to STC and underwent evaluation
- Initial VS
  - HR=124 BP=96/62 RR=bagged
- GCS=4T

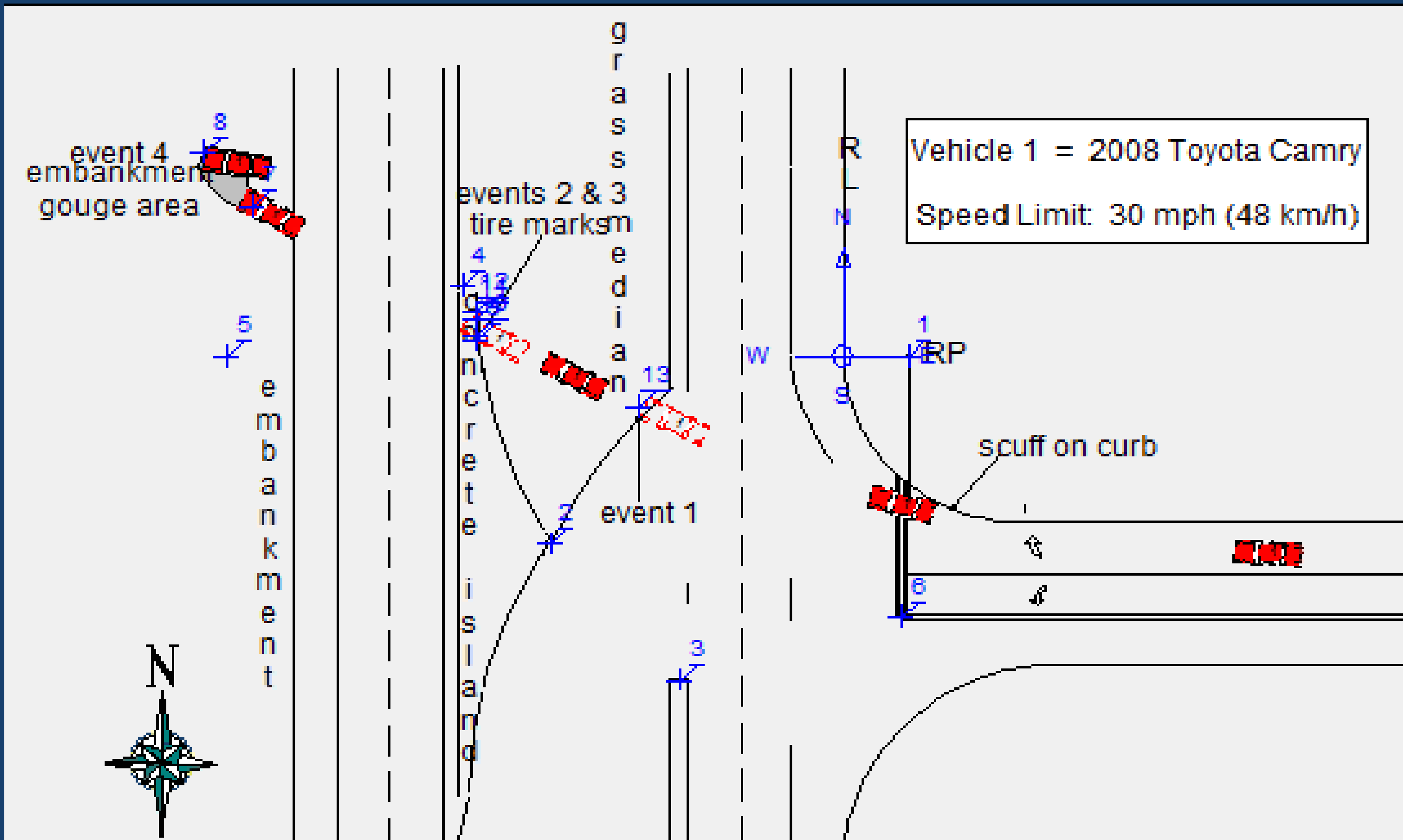





CIREN CASE

- The patient was brought emergently to the OR for craniectomy.
- On HD#2, he underwent external fixation of his R tibial plateau and L arm.
- On HD#7, he underwent ORIF of his R tibial plateau
- Patient remained in the ICU and was ultimately d/ced on HD#29 in a vegetative state.

CIREN CASE

Case vehicle	2008 Toyota Camry
General crash type	Frontal
V2 / Object struck	Embankment
Time of crash	1023 hours
Weather / Environment	Clear & Dry


Vehicle 1 = 2008 Toyota Camry
Speed Limit: 30 mph (48 km/h)
event 4
embankment
gouge area
events 2 & 3
tire marks
grass median
concrete island
embankment
event 1
scuff on curb
RP
R
L
N
W
S
E
N
1
2
3
4
5
6
7
8
12
13



LE

CIREN CASE

- CDC: 12FDEW3
- Damage
  - DDL: 118 cm
  - Max crush: 46 cm @ C1
  - DSD: N/A
- Total DV (est.): 26 mph (42 km/h)

CIREN CASE

- Age: 41
- Ht/Wt/BMI/Seated Ht:

  -Ht= 5 ft 3 inches

  -Wt= 150 pounds

  -BMI= 26.6

  -Seated Ht= 61 cm
- Clothing: Dress, and regular shoes
- Indicated posture: Upright




CIREN CASE

- Belt status:

  No belt use

- Seat position/angle:

  Mid-to-Forward / Unknown, but suspected to be upright

- Pretensioner status:

  Retractor type actuated

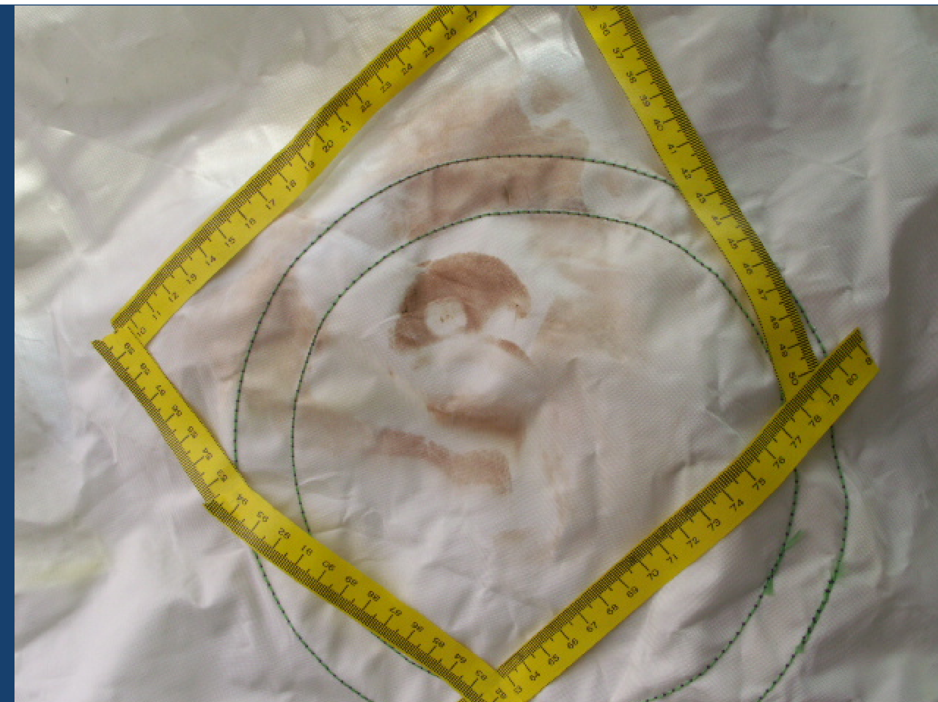
- Airbag status:

  Frontal and knee bolster air bags deployed

- Shear capsule status:

  Compressed

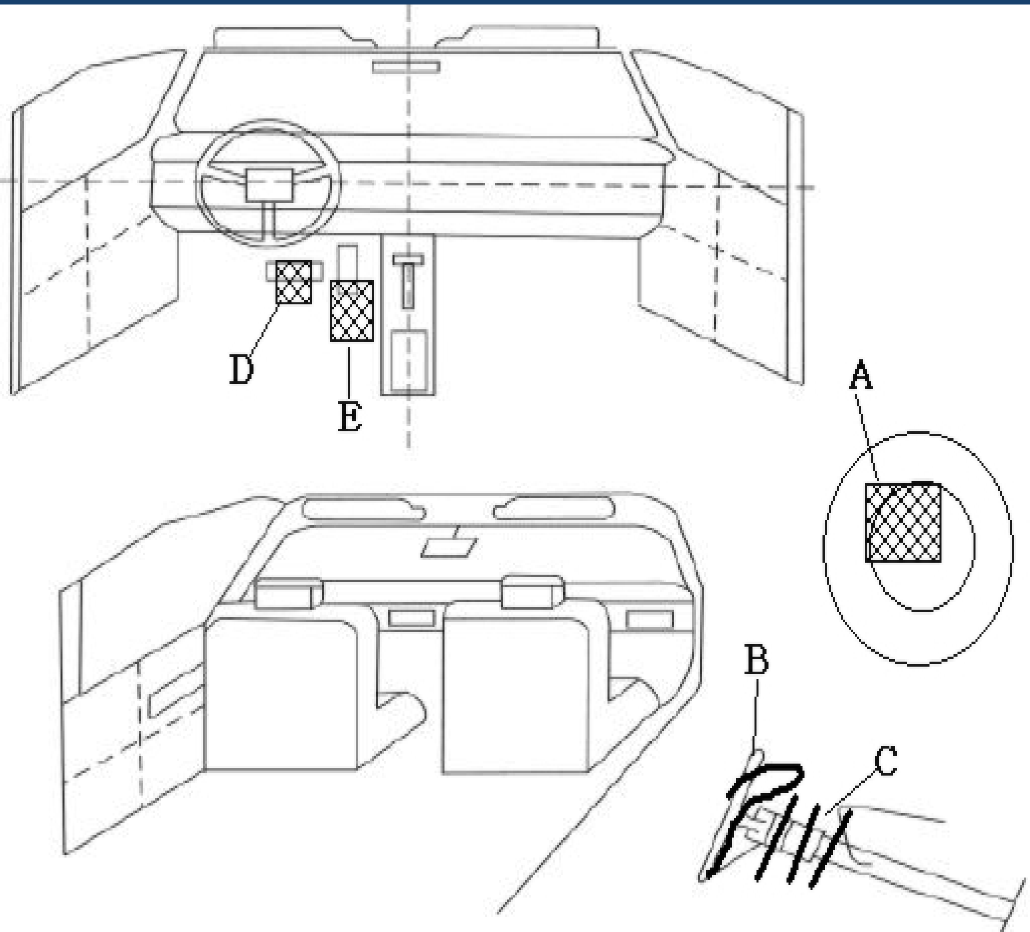

WARNING AVERTISSEMENT
EVEN WITH ADVANCED AIR BAGS

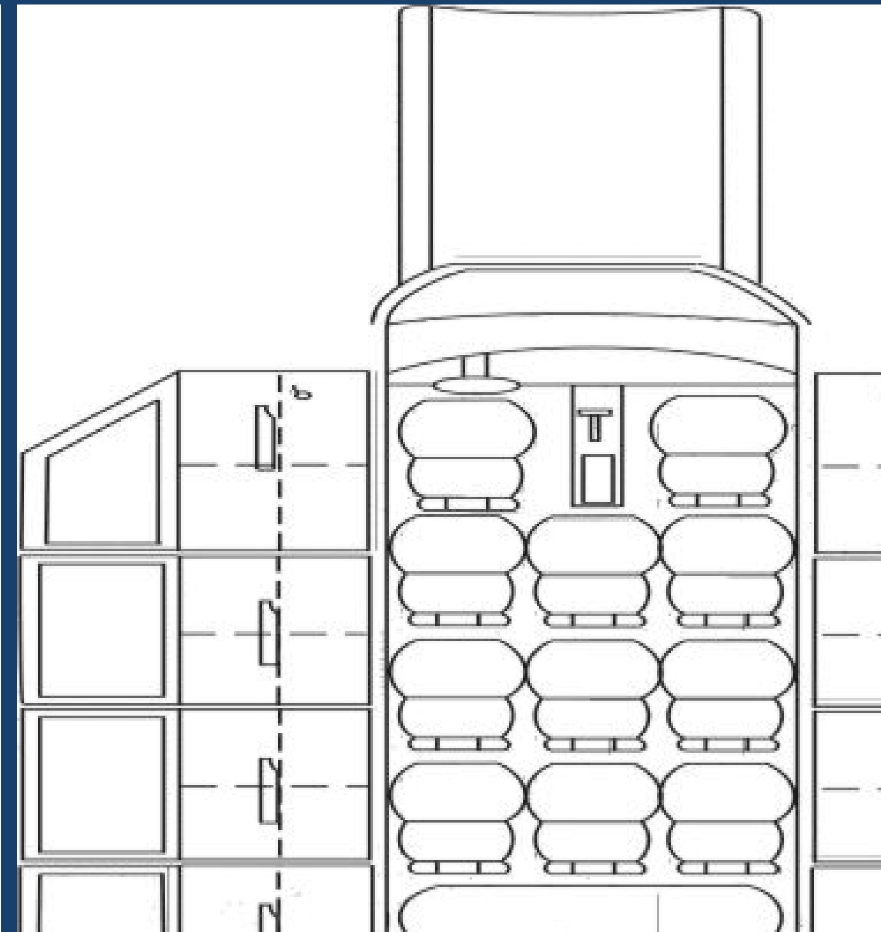



MODE

CONTACTS

	Contact	Area	Component	Occ #	Body Region	Evidence	Confidence
▶	A	Air Bag	Air bag-driver side	1	Face	Other (Specify)	Probable
	B	Front	Steering wheel rim	1	Chest	Bent	Certain
	C	Front	Steering wheel hub/spoke	1	Chest	Other (Specify)	Certain
	D	Floor	Foot controls including parking br.	1	Foot - Right	Other (Specify)	Possible
	E	Floor	Floor (including toe pan)	1	Foot - Right	Scuffed	Possible






95 96 97 98


95 96 97 98

CIREN CASE

- Admit condition: stable
- Admit vitals/LOC/GCS

    -BP= 102/38

    - Pulse= 123

    - Resp= 36

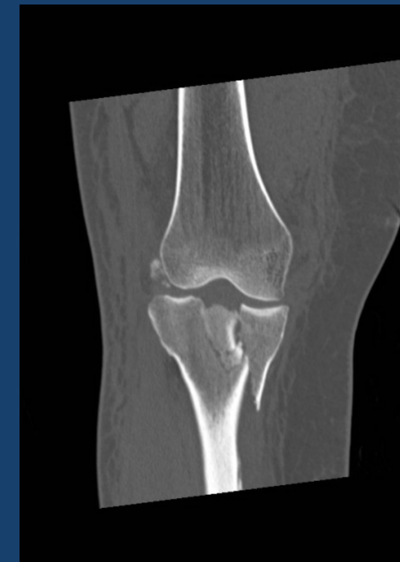
    - Temp= 98.4

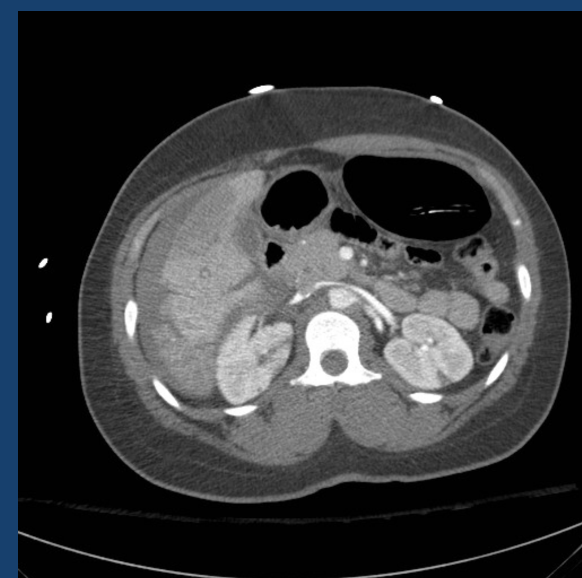
    - LOC= positive

    - GCS= 11
- Comorbidities

    - Hypertension
- Drug/ETOH status: alcohol – negative


R/11
143
right 11/143
CROSS TABLE

CROSS TABLE
L
143


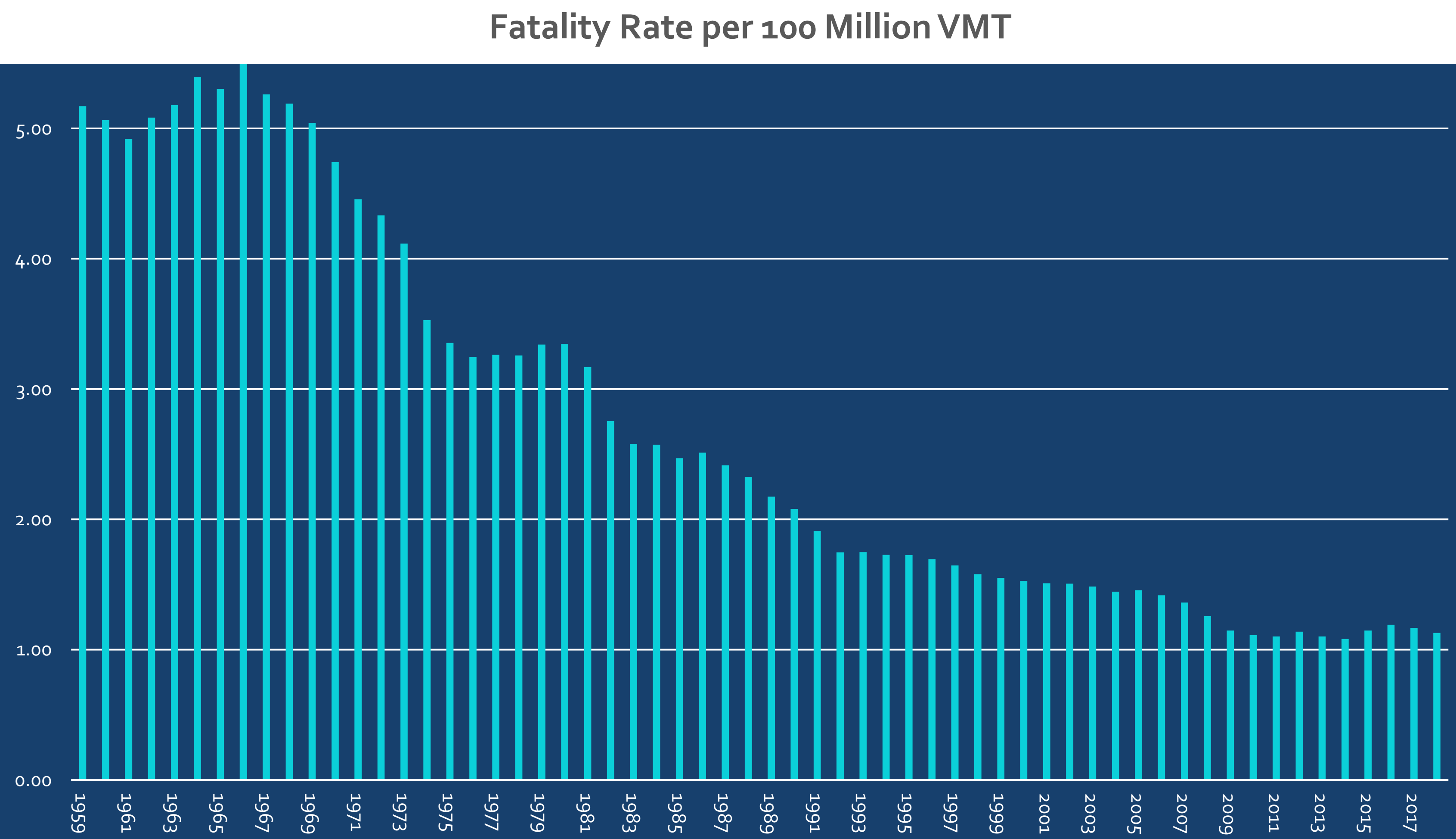



CIREN CASE

- Procedures
  - Day 1: Exploratory laparotomy, partial hepatectomy and splenectomy
  - Day 2: Ex fix of B/L LEs and unpacking/closure
  - Day 6: ORIF RLE

- Complications
  - Respiratory failure
  - Right atelectasis and pleural effusion
  - Right ankle osteomyelitis

"The greatest public health success story since the polio vaccine"



https://cdan.nhtsa.gov/tsftables/tsfar.htm#

Table 2

People Killed and Injured, and Fatality and Injury Rates per Population, Licensed Drivers, Registered Vehicles, and Vehicle Miles Traveled, 2010–2019

Year	Killed	Population	Fatality Rate per 100,000 Population	Licensed Drivers	Fatality Rate per 100,000 Licensed Drivers	Registered Motor Vehicles	Fatality Rate per 100,000 Registered Vehicles	VMT (millions)	Fatality Rate per 100 Million VMT
Killed									
2010	32,999	309,321,666	10.67	210,114,939	15.71	257,312,235	12.82	2,967,266	1.11
2011	32,479	311,556,874	10.42	211,874,649	15.33	265,043,362	12.25	2,945,194	1.10
2012	33,782	313,830,990	10.76	211,814,830	15.95	265,647,194	12.72	2,963,497	1.14
2013	32,893	315,993,715	10.41	212,159,728	15.50	269,294,302	12.21	2,982,941	1.10
2014	32,744	318,301,008	10.29	214,092,472	15.29	274,804,904	11.92	3,020,377	1.08
2015	35,484	320,635,163	11.07	218,084,465	16.27	281,312,446	12.61	3,089,841	1.15
2016	37,806	322,941,311	11.71	221,711,918	17.05	288,033,900	13.13	3,173,815	1.19
2017	37,473	324,985,539	11.53	225,346,257	16.63	290,335,891	12.91	3,210,248	1.17
2018	36,835	326,687,501	11.28	227,558,385	16.19	297,036,214	12.40	3,240,327	1.14
2019	36,096	328,239,523	11.00	228,679,719	15.78	299,267,114	12.06	3,261,772	1.11

https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812580

Table 1: Fatalities and Fatality Rate by Quarter, Full Year, and the Percentage Change From the Corresponding Quarter or Full Year in the Previous Year

Quarter	1st Quarter (Jan–Mar)	2nd Quarter (Apr–Jun)	3rd Quarter (Jul–Sep)	4th Quarter (Oct–Dec)	Total (Full Year)
Fatalities and Percentage Change in Fatalities for the Corresponding Quarter From the Prior Year					
2008	8,459 [-9.6%]	9,435 [-11.1%]	9,947 [-10.0%]	9,582 [-6.4%]	37,423 [-9.3%]
2009	7,552 [-10.7%]	8,975 [-4.9%]	9,104 [-8.5%]	8,252 [-13.9%]	33,883 [-9.5%]
2010	6,755 [-10.6%]	8,522 [-5.0%]	9,226 [+1.3%]	8,496 [+3.0%]	32,999 [-2.6%]
2011	6,726 [-0.4%]	8,227 [-3.5%]	8,984 [-2.6%]	8,542 [+0.5%]	32,479 [-1.6%]
2012	7,521 [+11.8%]	8,612 [+4.7%]	9,171 [+2.1%]	8,478 [-0.7%]	33,782 [+4.0%]
2013	7,166 [-4.7%]	8,207 [-4.7%]	9,024 [-1.6%]	8,496 [+0.2%]	32,893 [-2.6%]
2014	6,856 [-4.3%]	8,179 [-0.3%]	8,799 [-2.5%]	8,910 [+4.9%]	32,744 [-0.5%]
2015	7,370 [+7.5%]	8,823 [+7.9%]	9,805 [+11.4%]	9,486 [+6.5%]	35,484 [+8.4%]
2016	8,154 [+10.6%]	9,563 [+8.4%]	10,078 [+2.8%]	10,011 [+5.5%]	37,806 [+6.5%]
2017	8,301 [+1.8%]	9,460 [-1.1%]	10,081 [+0.0%]	9,631 [-3.8%]	37,473 [-0.9%]
2018	8,203 [-1.2%]	9,323 [-1.4%]	9,934 [-1.5%]	9,375 [-2.7%]	36,835 [-1.7%]
2019	7,816 [-4.7%]	9,172 [-1.6%]	9,953 [+0.2%]	9,155 [-2.3%]	36,096 [-2.0%]
2020†	*7,900 [+1.1%]*	*9,120 [-0.6%]*	*11,305 [+13.6%]*	*10,355 [+13.1%]*	*38,680 [+7.2%]*
Fatality Rate per 100 Million Vehicle Miles Traveled (VMT)					
2008	1.22	1.25	1.33	1.32	1.26
2009	1.09	1.16	1.17	1.12	1.15
2010	0.98	1.09	1.18	1.14	1.11
2011	0.98	1.09	1.18	1.17	1.10
2012	1.08	1.12	1.21	1.16	1.14
2013	1.04	1.07	1.17	1.16	1.10
2014	0.99	1.03	1.11	1.17	1.08
2015	1.03	1.08	1.20	1.21	1.15
2016	1.11	1.16	1.23	1.27	1.19
2017	1.12	1.13	1.21	1.20	1.17
2018	1.10	1.11	1.18	1.15	1.14
2019	1.05	1.08	1.17	1.12	1.11
2020†	*1.12*	*1.46*	*1.49*	*1.40*	*1.37*

Sources: Fatalities: 2008–2018 FARS Final File, 2019 FARS Annual Report File; VMT: FHWA December 2020 Traffic Volume Trends for 2019 and 2020

†2020 statistical projections and rates based on these projections.

Lives Saved by Restraint Use and 21-Year-Old Minimum Legal Drinking Age Laws, and Additional Lives That Would Have Been Saved at 100-Percent Seat Belt and Motorcycle Helment Use, 1975-2017							
	Lives Saved, Age 4 and Younger	Lives Saved, Age 5 and Older	Lives Saved, Age 13 and Older	Lives Saved, All Ages	Lives Saved	Additional Lives That Would Have Been Saved at 100 Percent Use	
Year	Child Restraints	Seat Belts	Frontal Air Bags	Motorcycle Helmets	Minimum Drinking Age Law*	Seat Belts	Motorcycle Helmets
2000	479	12,882	1,716	872	922	8,245	478
2001	388	13,295	1,978	947	927	8,016	558
2002	383	14,264	2,324	992	922	6,837	576
2003	447	15,095	2,519	1,173	918	6,151	651
2004	455	15,548	2,660	1,324	927	5,874	673
2005	424	15,688	2,752	1,554	882	5,667	731
2006	427	15,458	2,824	1,667	888	5,468	756
2007	388	15,223	2,800	1,788	831	5,048	805
2008	286	13,312	2,557	1,836	716	4,171	827
2009	307	12,757	2,481	1,486	636	3,690	733
2010	303	12,670	2,403	1,551	560	3,356	711
2011	262	12,071	2,341	1,622	543	3,396	707
2012	285	12,386	2,422	1,715	537	3,030	782
2013	263	12,644	2,398	1,640	507	2,771	717
2014	253	12,801	2,400	1,673	486	2,877	661
2015	273	14,062	2,597	1,800	542	2,715	742
2016	334	14,753	2,774	1,885	556	2,471	805
2017	325	14,955	2,790	1,872	538	2,549	749
Total	**11,606**	**374,276**	**50,457**	**45,746**	**31,959**	**386,719**	**34,044**

*Estimated reductions in deaths that resulted from the presence of laws establising a minimum legal age of 21 years for the consumption of alcoholic beverages.

https://cdan.nhtsa.gov/tsftables/Lives%20Saved.pdf

CRASH DYNAMICS 101

- There are 3 types of collisions that occur in each crash
- There are 5 major types of motor vehicle collisions
  - Each has distinct injury profiles
- PDOF, deformation, intrusion, and restraint systems can instruct us to occupant injury
- Understanding the crash can teach us about the injuries
- Understanding injuries can teach us about the crash

RIDING IN A CAR CONTINUES TO BE THE MOST DANGEROUS THING YOU DO ON A DAILY BASIS


Remember to buckle up and drive carefully!


Questions?