

Ford Inova Fairfax Hospital CIREN Team

Ford Motor Company

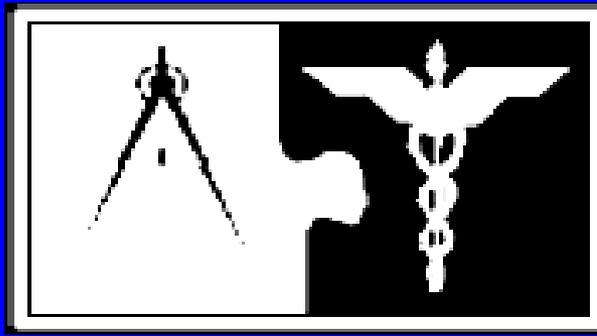


INOVA REGIONAL
TRAUMA CENTER

Team Members:

- Samir M. Fakhry, M.D., Principal Investigator
- Dorraine D. Watts, PhD, RN, Principal Investigator
- Christine Burke, CIREN Study Coordinator
- Colleen Gilmore, CIREN Research Associate
- Detective J.J. Banachoski, Fairfax County Police Accident
Reconstruction Unit
- Christopher Sherwood, Engineering, UVA





Case Studies in SUV Performance in Gross Size Mismatched Crashes

Rear Impact

Frontal Impact

Vehicle #1: 1993 Jeep Cherokee

Weight: 2928 Kg

Vehicle # 2: School Bus

Weight: >4536 Kg

Vehicle # 3: Tractor-Trailer

Weight: >4536 Kg



Occupants:

Left Front Seat: 48-year-old male

Right Front Seat: 12-year-old male

Right Rear Seat: 14-year-old male



Safety Systems: SB

(not airbag equipped)

Used in this crash:

Left Front Seat: 3-point belt

Right Front Seat: 3-point belt

Right Rear Seat: 3-point belt



Roadway: One-lane roadway
(off-ramp from interstate)

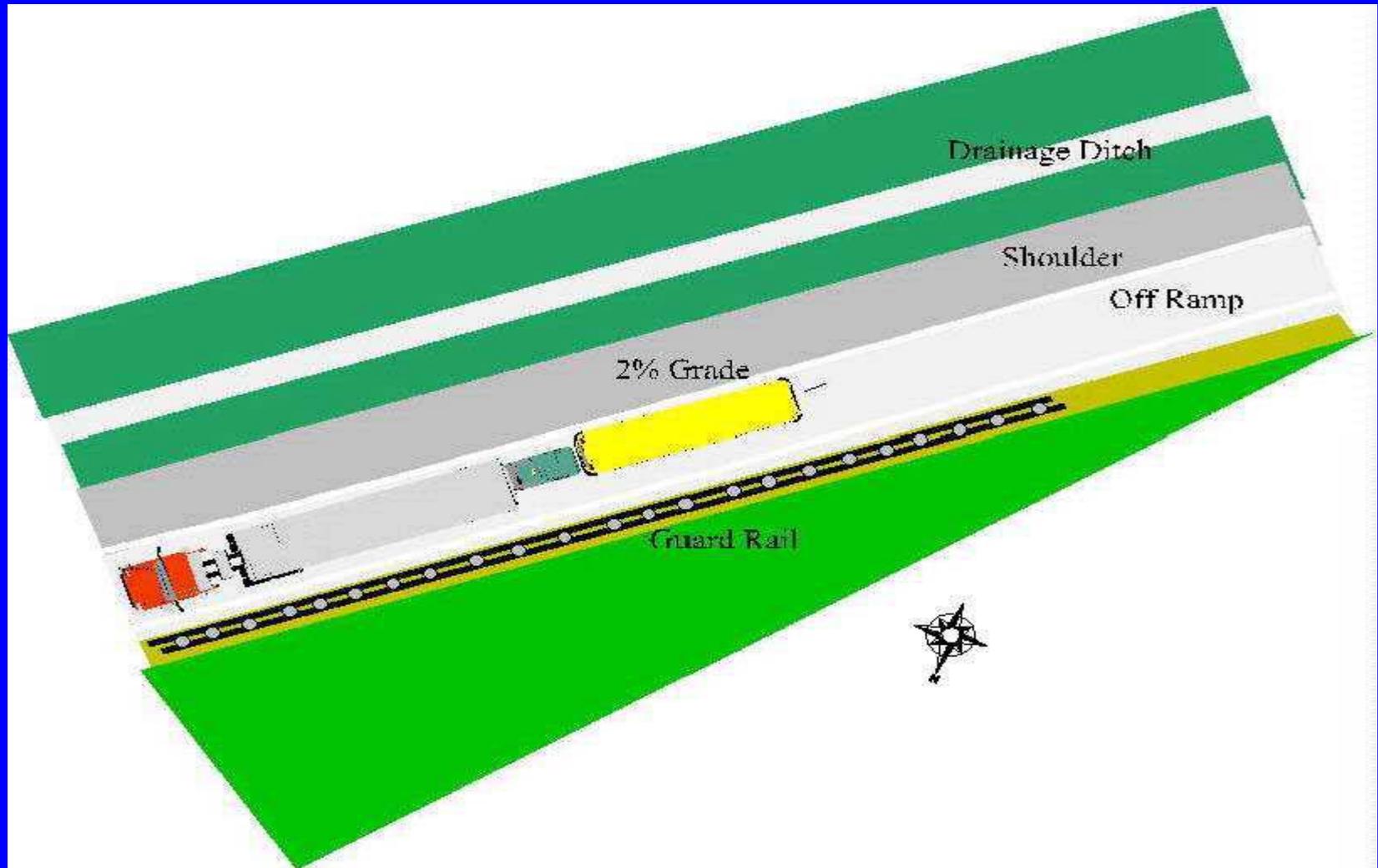
Posted Speed Limit: 55 MPH



Weather: Clear and Dry
Time: 7:28 am
Time of year: Spring



Scene



Ford Inova Fairfax Hospital CIREN Center

Primary Impact

Secondary Impact

PDOF	180°	0°
CDC	06BDAW6	12FDAW4
Max crush	38 cm	44 cm

Total ΔV	40 km/h	-46 km/h
Longitudinal ΔV	40 km/h	-46 km/h
Lateral ΔV	0 km/h	0 km/h



Scene



Ford Inova Fairfax Hospital CIREN Center

Scene



Ford Inova Fairfax Hospital CIREN Center

Scene



Ford Inova Fairfax Hospital CIREN Center

Scene



Ford Inova Fairfax Hospital CIREN Center

Scene



Ford Inova Fairfax Hospital CIREN Center

Scene



Ford Inova Fairfax Hospital CIREN Center

Overhead



Ford Inova Fairfax Hospital CIREN Center

Scene



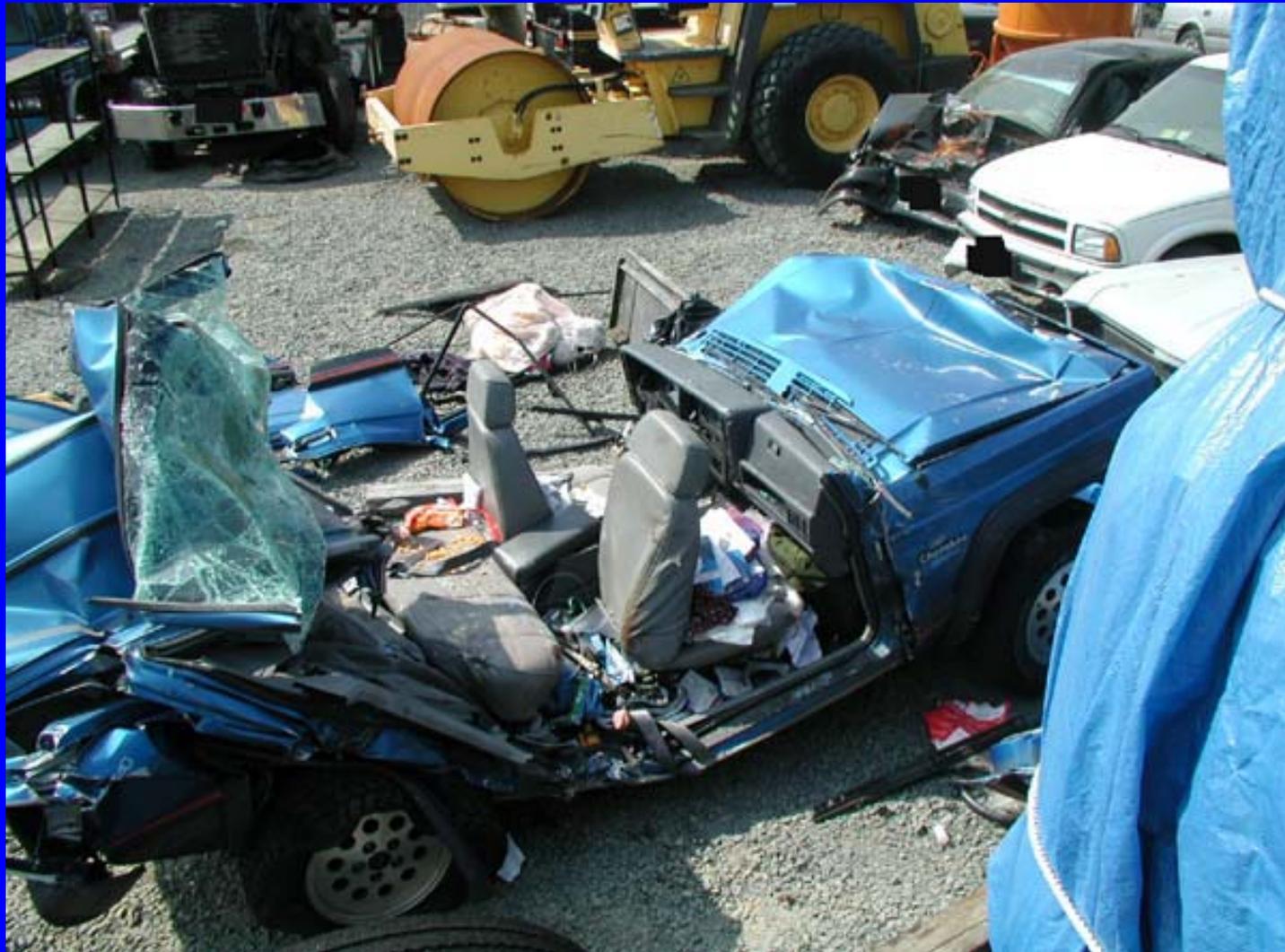
Ford Inova Fairfax Hospital CIREN Center

Look Back



Ford Inova Fairfax Hospital CIREN Center

Vehicle 1



Ford Inova Fairfax Hospital CIREN Center

Vehicle 1



Ford Inova Fairfax Hospital CIREN Center

Vehicle 1



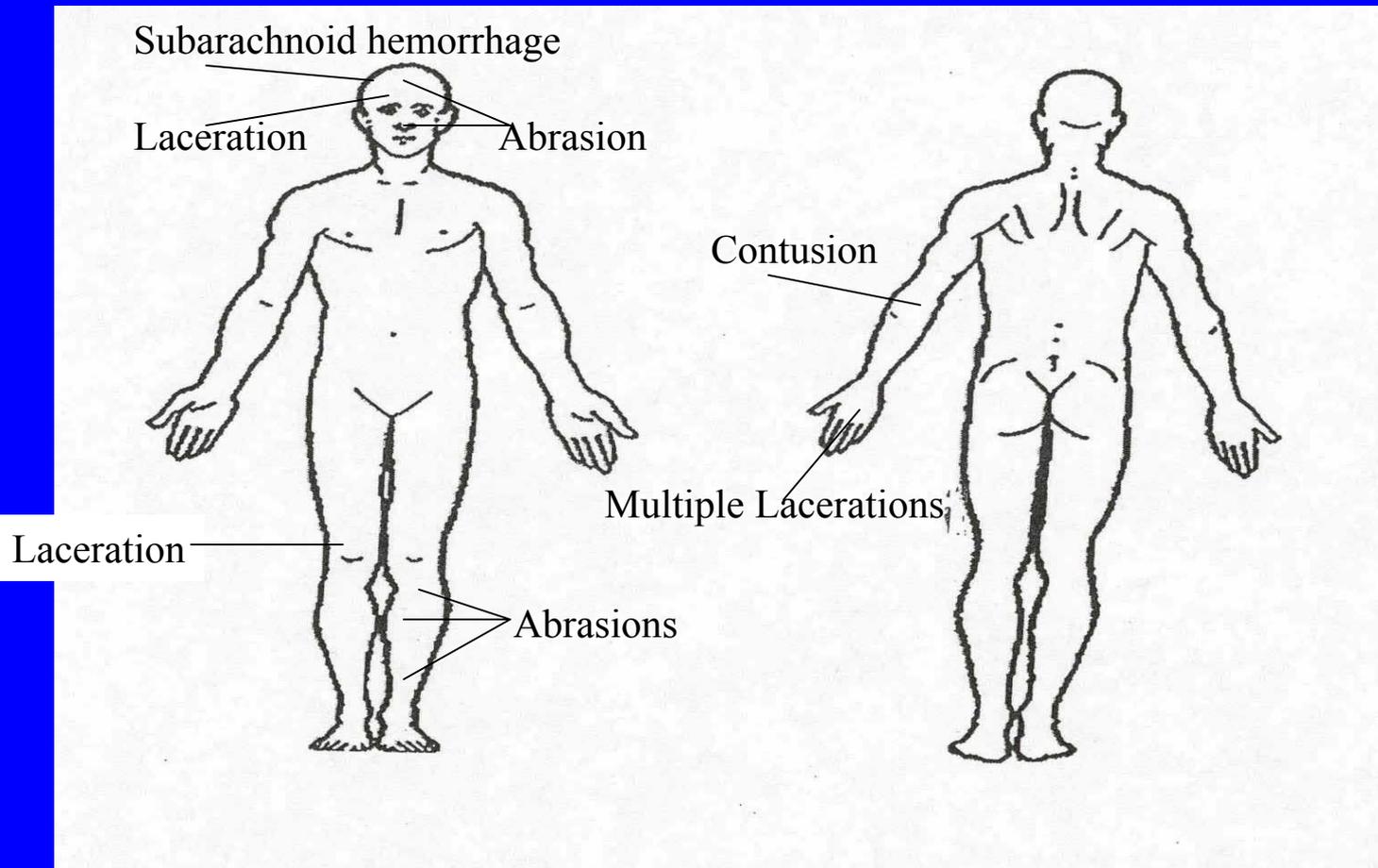
Ford Inova Fairfax Hospital CIREN Center

Heavy Rescue Personnel Summary

- The 3 occupants were still restrained, awake and oriented.
- The windshield as well as all 4 doors and the roof required removal to access the patients.
- A chain was attached to the rear of the case vehicle for a “reversed dash rollup.”
- The steering wheel was removed, which was not bent and the column intact.
- Total extrication time was 35 minutes.



Driver



Driver

Occupant Data

Age:	48	Weight:	210 lbs
Gender:	Male	Height:	5'11"
Restraint:	Restrained		
Airbag:	Not Deployed		
Clothing:	Suit pants/jacket/shirt/flat shoes		
Eyewear:	Sunglasses		



Driver

Pre-Hospital Summary:

- Upon arrival the patient was alert and oriented with a GCS of 15.
- Examination was significant for facial lacerations
- Vital signs were stable and he was transported to the trauma center by ground.



Driver

Arrival Data:

	<u>Scene</u>	<u>ED</u>
BP:	147/100	165/78
Pulse:	64	65
Respiration:	18	18
GCS:	15	15
BAC:	n/a	0
Drug Screen:	n/a	None performed

Past Medical History:

Hypertension



Driver

Hospital Summary:

- Upon arrival in the emergency department the patient was alert and oriented with a GCS of 15.
- Evaluation was significant for a ½- cm laceration just superior to his right eyebrow, abrasions on the bridge of his nose, contusion of his left elbow, laceration of his left hand, laceration on his right knee and abrasion to the left lower leg.
- CT scan of his head identified a right-sided subarachnoid hemorrhage.
- He progressed well and was discharged home on HD# 2.



Driver

Other Hospital Data:

Time to first OR:	N/A
Hospital LOS:	2
ICU LOS:	0
Ventilator Days:	0
Disposition:	Home
Hospital Charge:	\$3,637



Driver

Facial abrasions

Facial lacerations



Driver

Facial abrasions

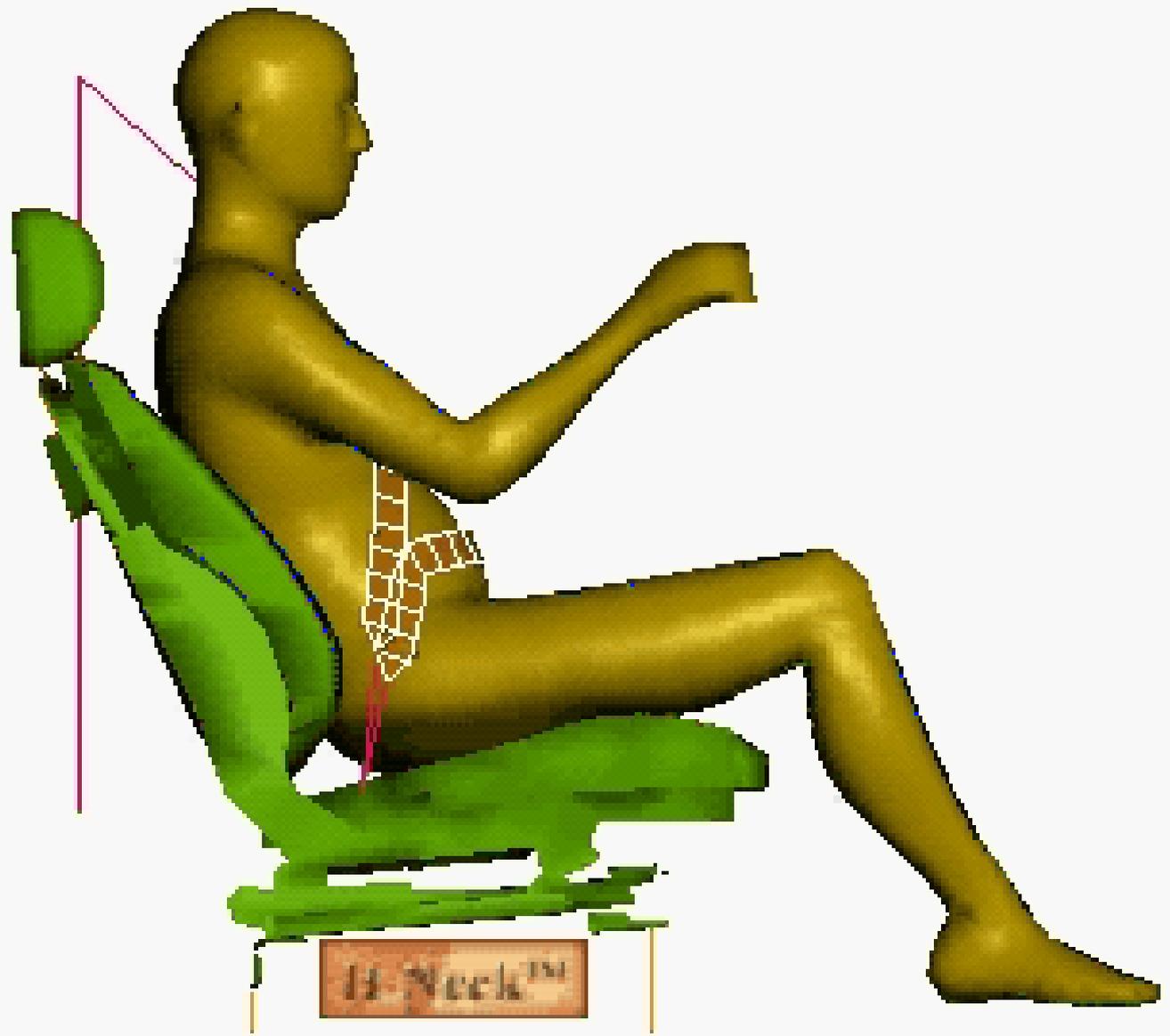
Facial lacerations



Driver

Left elbow contusion





Driver

Hand lacerations



Ford Inova Fairfax Hospital CIREN Center

Driver

Right Knee laceration



Ford Inova Fairfax Hospital CIREN Center

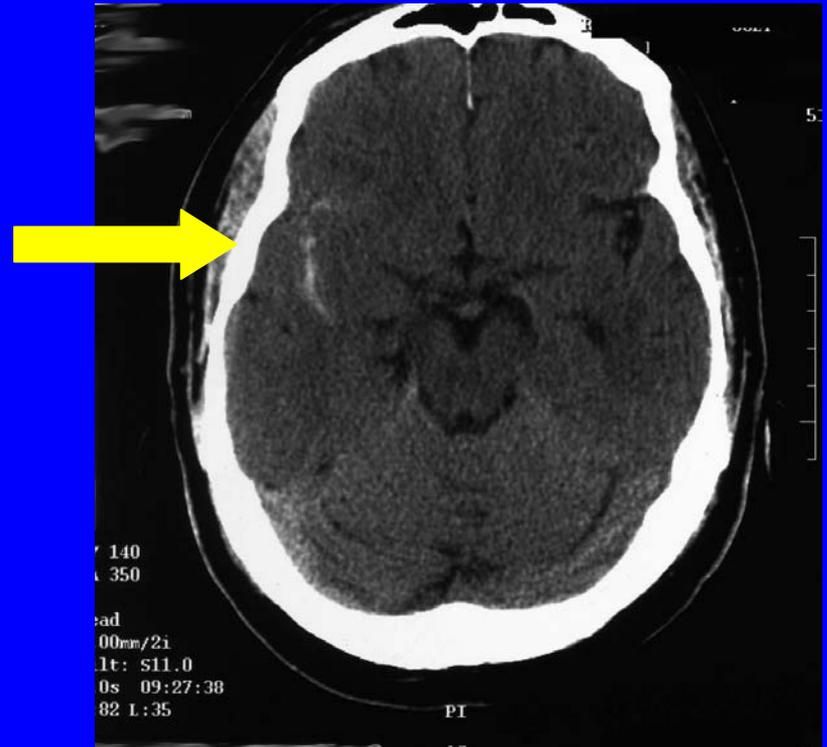
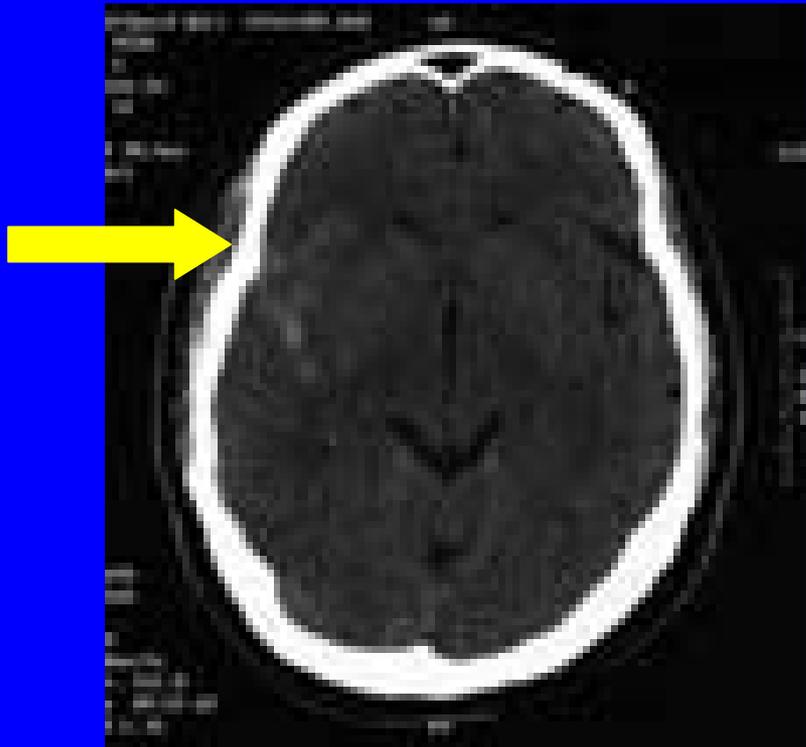
Driver

Left lower leg abrasions



Driver

Subarachnoid Hemorrhage



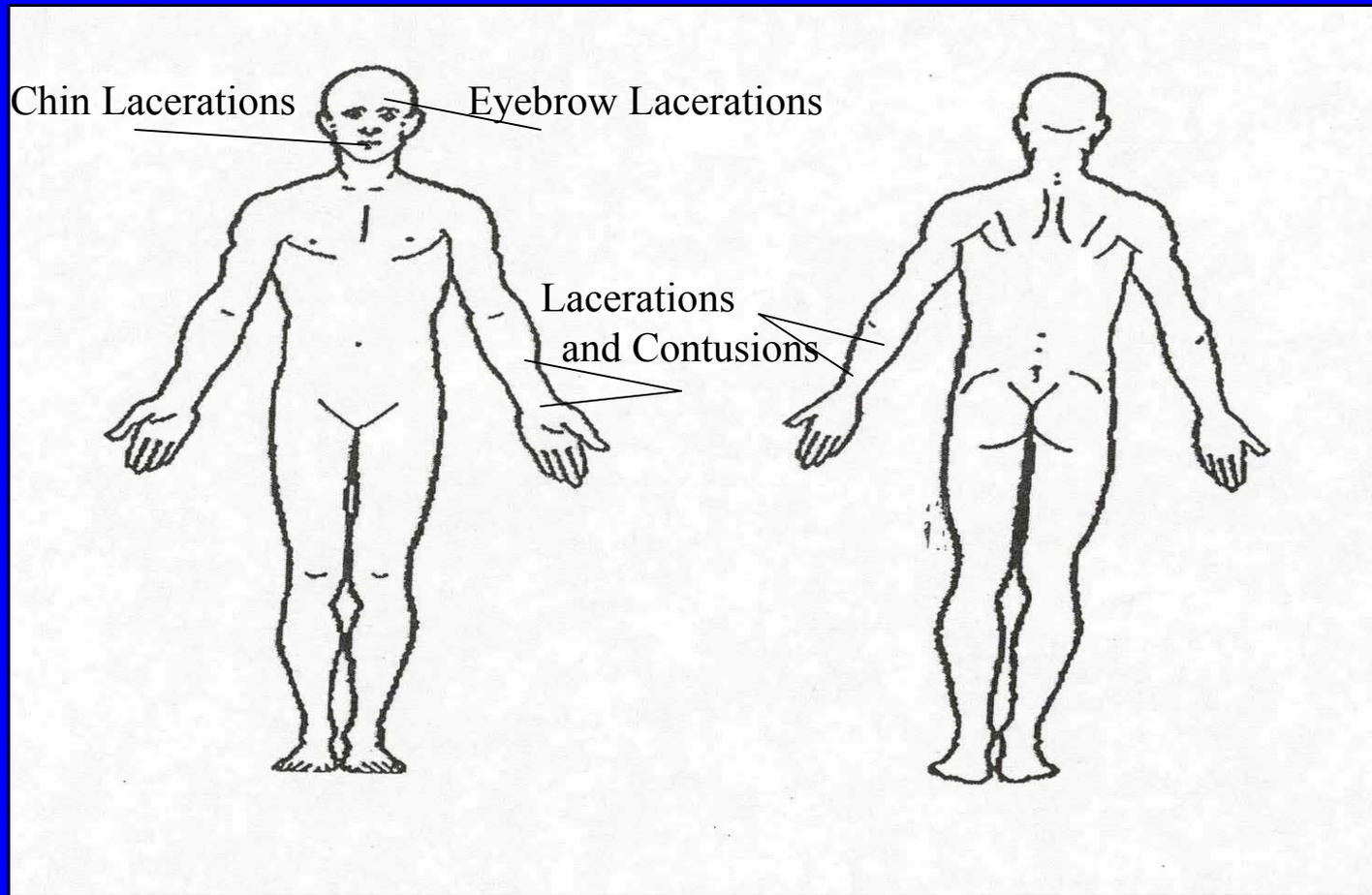
Driver

Injuries (ICD)	AIS Severity	Info Source	Aspect (R,L,bilat,etc)	Contact Area (door, seat,etc)	Mechanism (direct,etc)	Confid. Level	Rank
LOC	160202.2	Report	Whole region	Steering wheel rim	Direct	Certain	2
Subarachnoid hemorrhage (852.00)	140466.3	CT	Right	Steering wheel rim	Direct	Certain	1
Facial abrasions – forehead (910.0)	290202.1	Exam	Right	Steering wheel rim	Direct	Certain	6
Facial abrasion – nose (910.0)	290202.1	Exam	Center	Sunglasses	Direct	Possible	6
Facial lacerations (873.42)	290602.1	Exam	Right	Steering wheel rim	Direct	Certain	3
Elbow contusion (923.1)	790402.1	Exam	Left	B-pillar	Direct	Possible	7
Hand laceration (884.0)	790600.1	Exam	Left	Unknown	Unknown	Unk	4
Knee laceration (894.0)	890600.1	Exam	Right	Knee bolster	Direct	Certain	5
Lower leg abrasions (916.0)	890202.1	Exam	Left	Knee bolster	Direct	Certain	8

Annotation: Hand laceration – unknown – due to the diffuse and varied injury it is suspected that he may have contacted multiple components.



Right Front Seat Passenger



Right Front Seat Passenger

Occupant Data

Age: 11 Weight: 110 lbs
Gender: Male Height: 5'

Restraint: Restrained
Airbag: Not Deployed

Clothing: Pants/Shirt/High top sneakers

Eyewear: None



Right Front Seat Passenger

Pre-Hospital Summary:

- The patient was alert and oriented with a GCS of 15.
- Evaluation was significant for a laceration above the left eye and blood from the nares.
- His vital signs were stable and he was transported to the trauma center by air.



Right Front Seat Passenger

Arrival Data:

	<u>Scene</u>	<u>ED</u>
BP:	118/76	137/73
Pulse:	82	92
Respiration:	n/a	25
GCS:	15	15
BAC:	n/a	None Performed
Drug Screen:	n/a	None Performed

Past Medical History:

None



Right Front Seat Passenger

Hospital Summary:

- Upon arrival in the emergency department his vital signs were stable, and a GCS of 15.
- Physical examination was significant for a small laceration over the left eyebrow and chin and some upper arm contusions and lacerations.
- Radiographic examination did not reveal any additional traumatic injuries.
- The head CT was negative though the patient's clinical picture was consistent with a concussion.
- He was admitted overnight for observation and discharged home on HD # 2.



Right Front Seat Passenger

Other Hospital Data:

Time of first OR:	N/A
Hospital LOS:	2
ICU LOS:	0
Ventilator Days:	0
Disposition:	Home
Hospital Charges:	\$3,086



Right Front Seat Passenger

Facial lacerations
and abrasions



Ford Inova Fairfax Hospital CIREN Center

Right Front Seat Passenger

Facial lacerations
and abrasions



Right Front Seat Passenger

Facial lacerations



Ford Inova Fairfax Hospital CIREN Center

Right Front Seat Passenger

Facial lacerations
and abrasions



Ford Inova Fairfax Hospital CIREN Center

Right Front Seat Passenger

Left hand lacerations



Right Front Seat Passenger

Left arm lacerations
and contusions

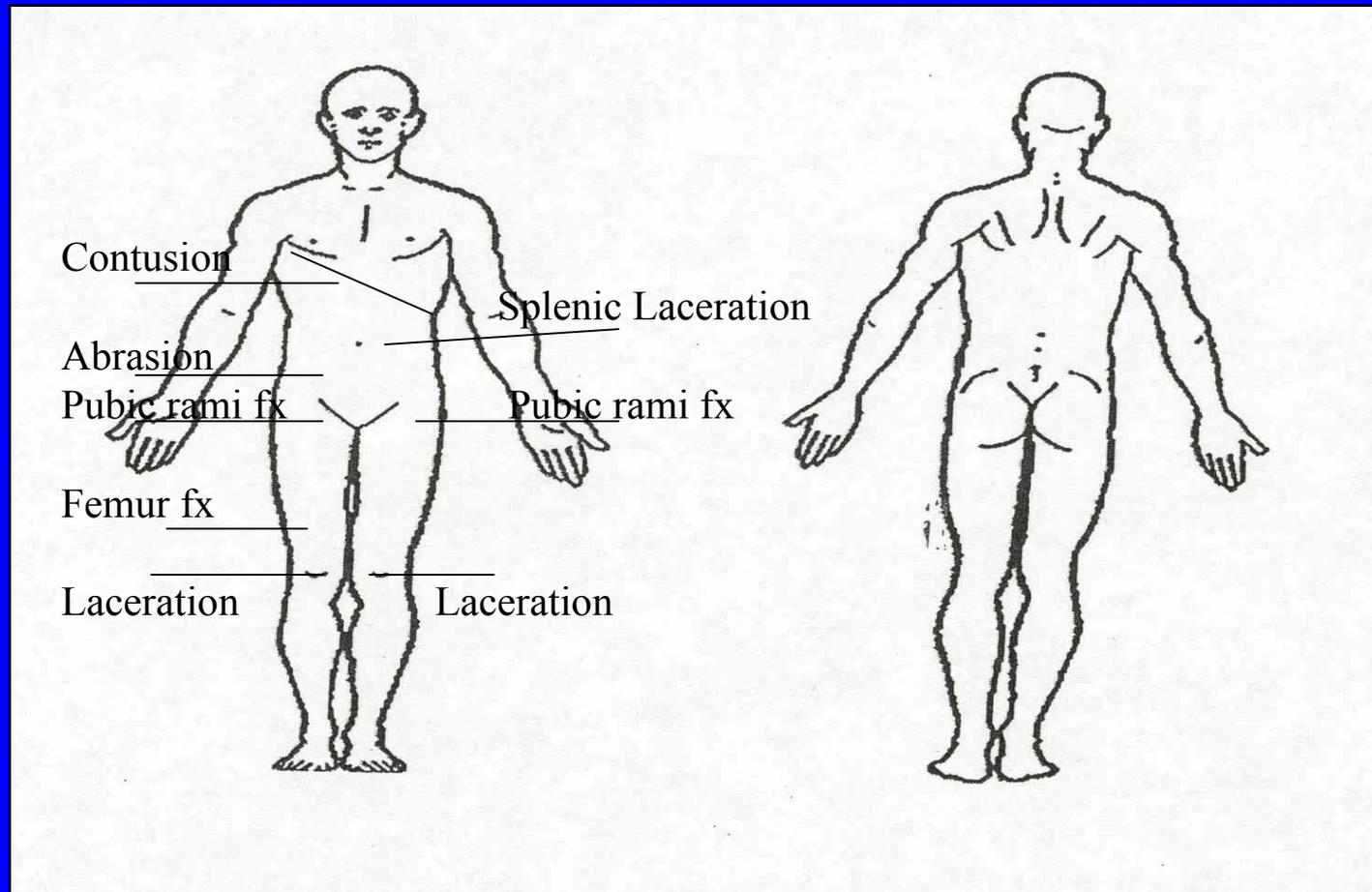


Right Front Seat Passenger

Injuries (ICD)	AIS Severity	Info Source	Aspect (R,L,bilat,etc)	Contact Area (door, seat,etc)	Mechanism (direct,etc)	Confid. Level	Rank
Concussion (850.1)	161000.2	Exam	Whole region	Headliner	Direct	Possible	1
Eyebrow laceration - 2x3 cm (873.42)	290602.1	Exam	Left	Unknown	Unknown	Unknown	2
Chin laceration – 1cm (873.44)	290602.1	Exam	Left	Unknown	Unknown	Unknown	3
Upper extremity contusion (923.02)	790402.1	Exam	Left	Add on – cell phone jack	Direct	Possible	5
Upper extremity laceration (882.00)	790602.1	Exam	Left	Add-on – cell phone jack	Direct	Possible	4



Right Rear Seat Passenger



Right Rear Seat Passenger

Occupant Data

Age: 14 Weight: 134 lbs

Gender: Male Height: 5'4"

Restraint: Restrained

Airbag front: N/A

Clothing: Shorts/T-shirt/Shirt/Low top sneakers

Eyewear: None



Right Rear Seat Passenger

Pre-Hospital Summary:

- The patient was alert and oriented with a GCS of 15.
- The right foot was noted to be trapped underneath the front passenger seat and he complained of right leg pain.
- His vital signs were stable and he was transported to the trauma center by air.



Right Rear Seat Passenger

Arrival Data:

	<u>Scene</u>	<u>ED</u>
BP:	130/90	136/81
Pulse:	100	109
Respiration:	20	23
GCS:	15	15
BAC:	n/a	None Performed
Drug Screen:	n/a	None Performed

Past Medical History:

None



Right Rear Seat Passenger

Hospital Summary:

- Upon arrival in the emergency department he was electively intubated for temporary reduction of the femur fracture and to facilitate operative therapy.
- Evaluation was significant for a displaced right femoral shaft fracture, superior and left inferior pubic rami fracture, left sacral ala fracture, SI joint separation, grade I splenic laceration, 1-cm thigh laceration, 1.5-cm patella laceration, seatbelt contusions and abrasions.
- He was admitted to the pediatric ICU where he remained for 4 days.
- Duplex study revealed no arterial injury in the right thigh.



Right Rear Seat Passenger

Hospital Summary:

- He underwent ORIF of the right femur fracture with IM nailing. Estimated blood loss was 300 ml.
- On HD #2 his hematocrit fell to 18% and then to 13.6%.
- He received 2 units of pRBCs, his hematocrit rose to 25.8%.
- A repeat abdominal CT revealed only a slight increase in the pelvic fluid and no change in the spleen.
- On HD #3 his hematocrit fell to 20.6% and to 16.7% on HD #4.
- He received 2 units of pRBCs, his hematocrit rose to 27.7%.
- A repeat abdominal CT revealed no evidence of intraperitoneal or retroperitoneal pelvic bleeding.
- He progressed well and was discharged home on HD #8.



Right Rear Seat Passenger

Other Hospital Data:

Time to first OR:	HD # 1
Hospital LOS:	8
ICU LOS:	4
Ventilator Days:	1
Disposition:	Home
Hospital Charge:	\$38,705



Right Rear Seat Passenger

Right femur fracture
Right thigh laceration
Right knee laceration



Right Rear Seat Passenger

Right thigh
laceration



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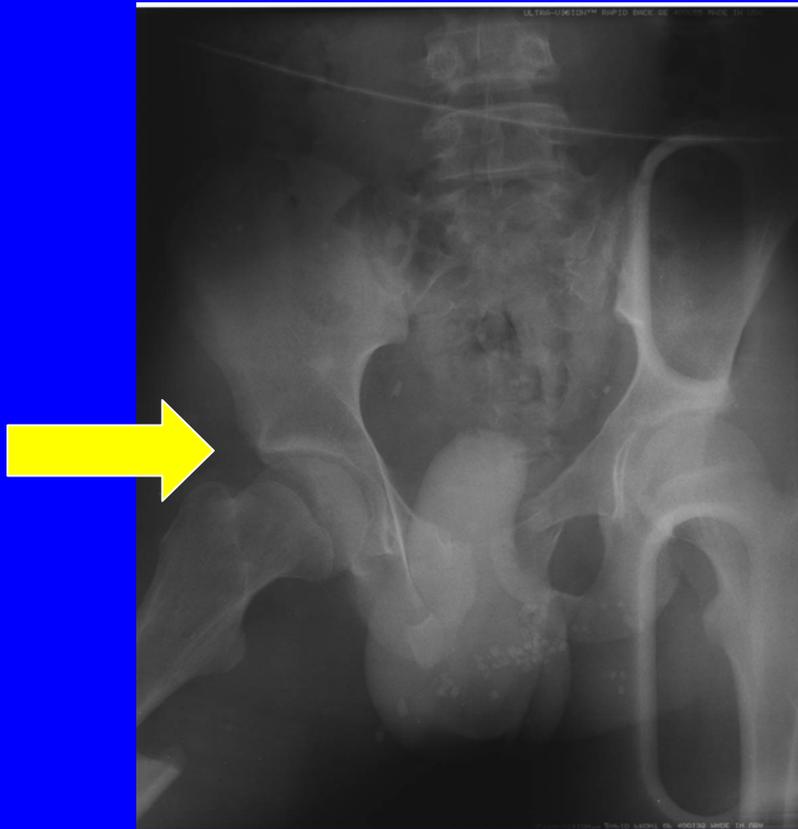
Right Rear Seat Passenger

Abdominal
abrasion



Right Rear Seat Passenger

Pelvic fracture



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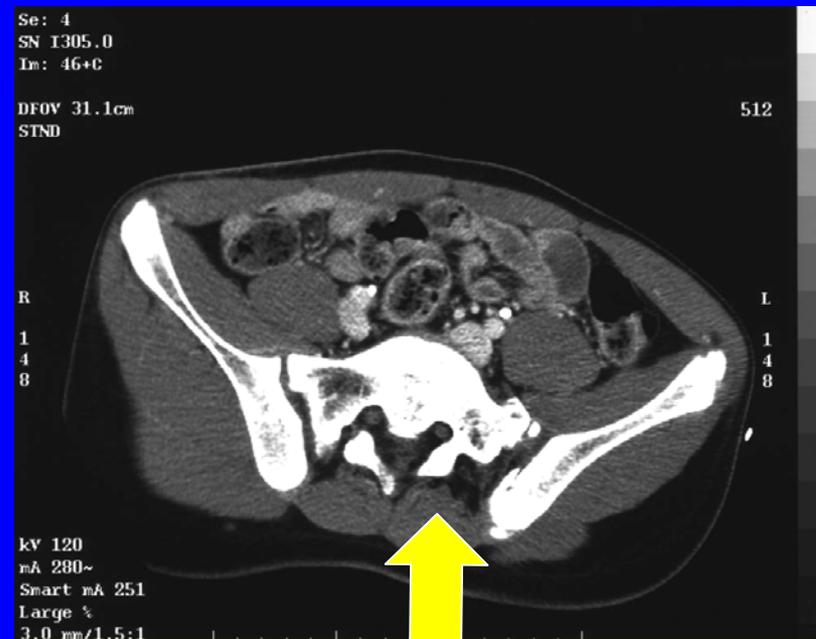
Right Rear Seat Passenger

Pelvic fracture



Right Rear Seat Passenger

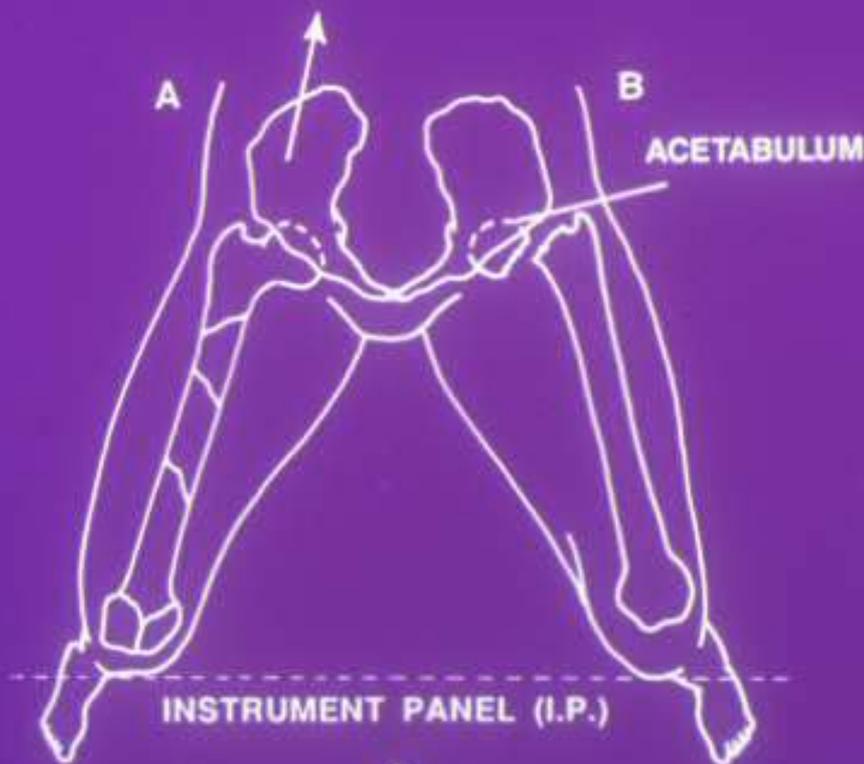
Sacral ala fracture w/ SI joint separation



Right Rear Seat Passenger

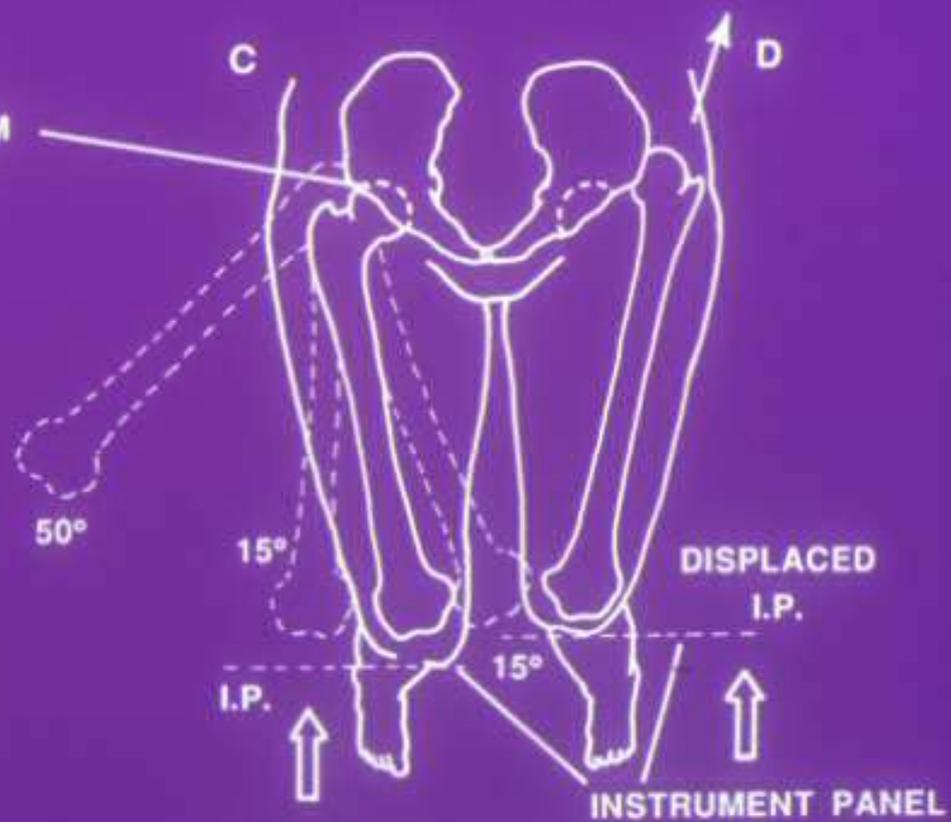
Grade I splenic laceration





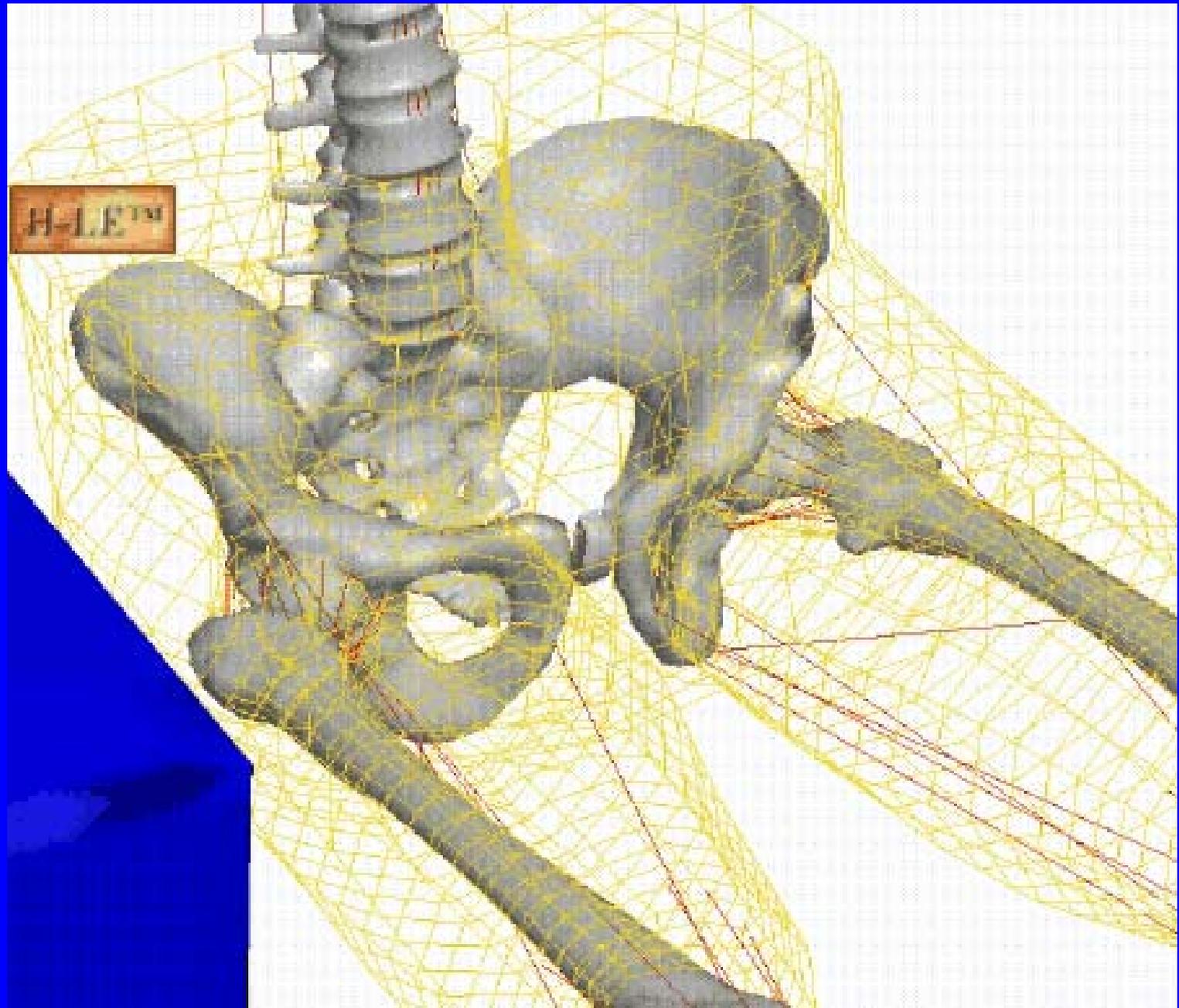
THIGH FLEXED AND ABDUCTED

- A** FRACTURE OF FEMORAL SHAFT AND/OR CONDYLAR FRACTURES
- B** DISLOCATION OF PROXIMAL FEMUR AND/OR SHEARED HEAD OF FEMUR



THIGH FLEXED AND ADDUCTED

- C** ACETABULAR FRACTURE OR
- D** POSTERIOR DISLOCATION OF FEMUR



Right Rear Seat Passenger

Injuries (ICD)	AIS Severity	Info Source	Aspect (R,L,bilat,etc)	Contact Area (door, seat,etc)	Mechanism (direct,etc)	Confid. Level	Rank
Abdominal abrasion (911.0)	590202.1	Exam	Right	Seatbelt	Direct	Certain	7
Grade I splenic laceration (865.02)	544222.2	CT	Left	Seatbelt	Indirect	Probable	4
Pelvic fracture (808.49)	852602.2	X-ray/ CT	Left	Back of front seat	Indirect	Probable	2
Sacral ala fracture w SI joint separation (839.42)	852800.3	CT	Left	Back of front seat	Indirect	Probable	3
Femoral shaft fracture (821.01)	851814.3	x-ray	Right	Jammed between seat and B-pillar	Direct	Certain	1
Thigh laceration 1-cm (890.0)	890602.1	Exam	Right	Release lever from front seat	Direct	Certain	5
Patella laceration 1.5 cm (891.0)	890602.1	Exam	Left	Rear of front seat	Direct	Probable	6



Side Impact



Ford Inova Fairfax Hospital CIREN Center

Vehicle #1: 1999 Chevrolet Yukon

Vehicle #2: 1986 International Dump Truck



Vehicle #1: Driver: Female, Age 30

Safety Systems available:

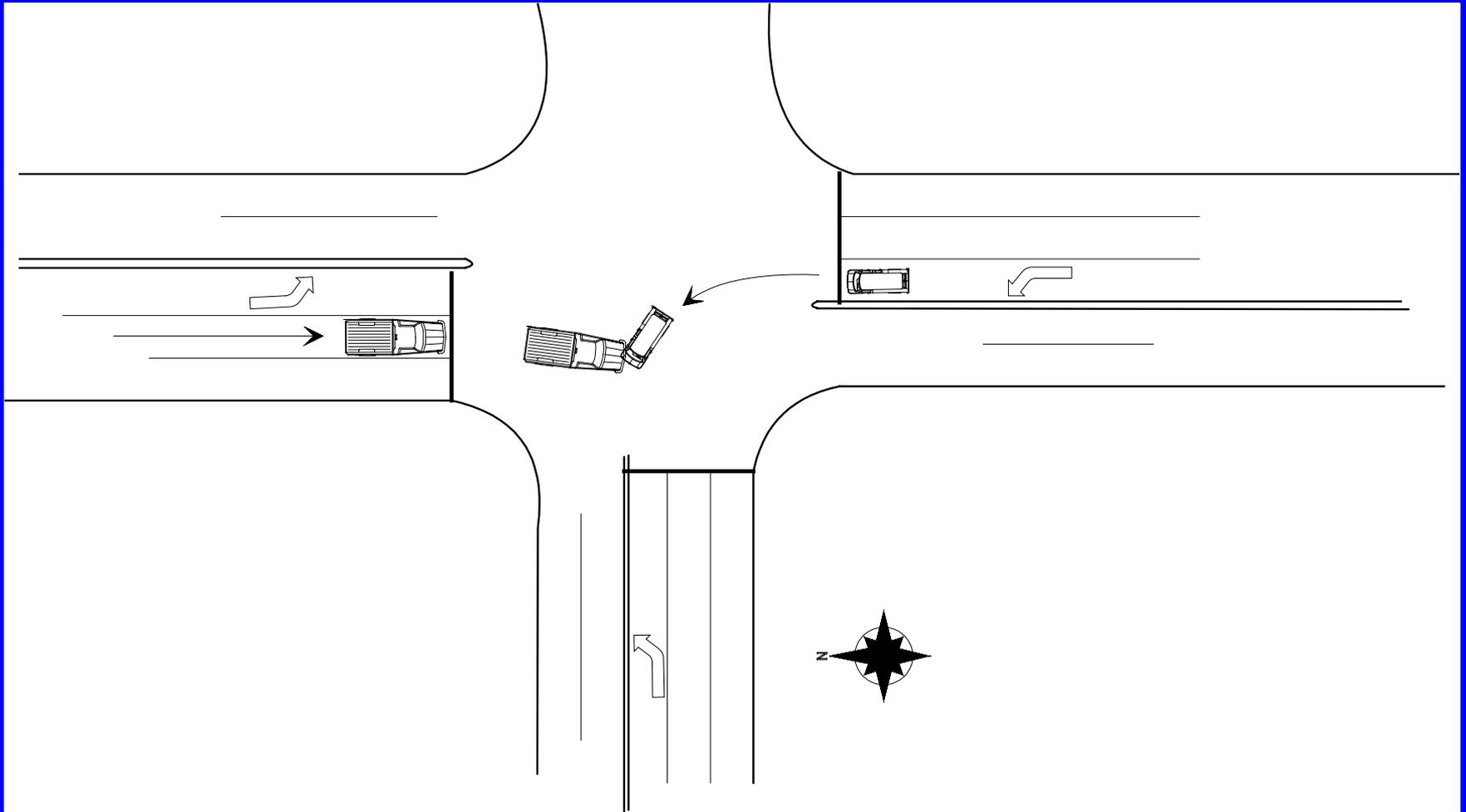
SB and AB

Used in this crash:

SB and AB



SCENE



Ford Inova Fairfax Hospital CIREN Center

Vehicle #1: Weight: 2417 Kg

PDOF: 60

Total ΔV : 41 km/h

Longitudinal: -21 km/h

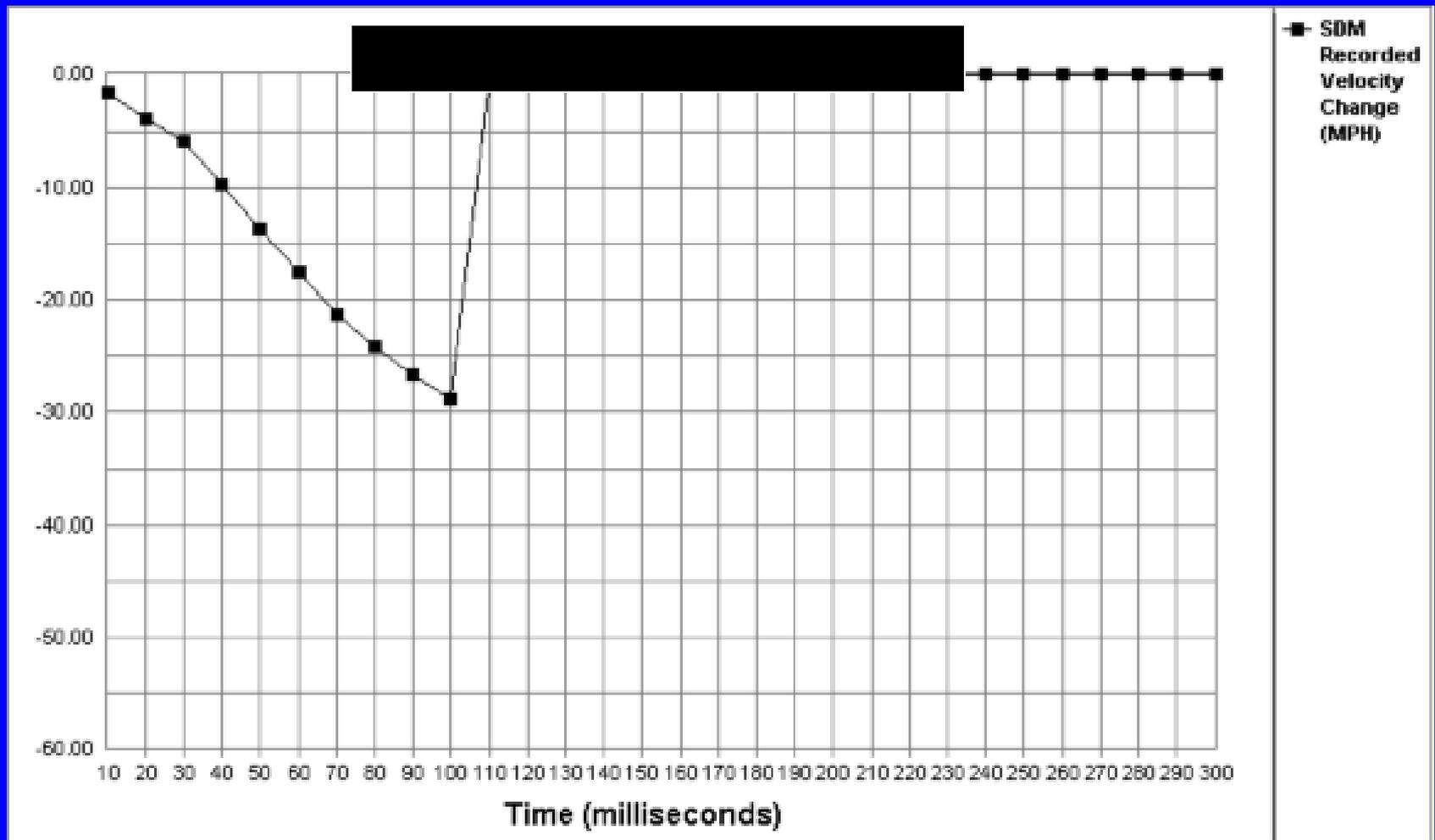
Latitudinal: -36 km/h

Vehicle #2: Weight: 9007 Kg

PDOF: 0



EVENT DATA RECORDER



EVENT DATA RECORDER

System Status At Deployment	
SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Passenger Front Air Bag Suppression Switch Circuit Status	ON
Ignition Cycles At Deployment	0
Ignition Cycles At Investigation	5970
Time From Algorithm Enable To Deployment Command (msec)	10
Time From Near Deployment To Deployment (msec)	0

Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-1.54	-3.95	-5.92	-9.65	-13.60	-17.55	-21.28	-24.13	-26.55	-28.74	0.00	0.00	0.00	0.00	0.00
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00



Scene



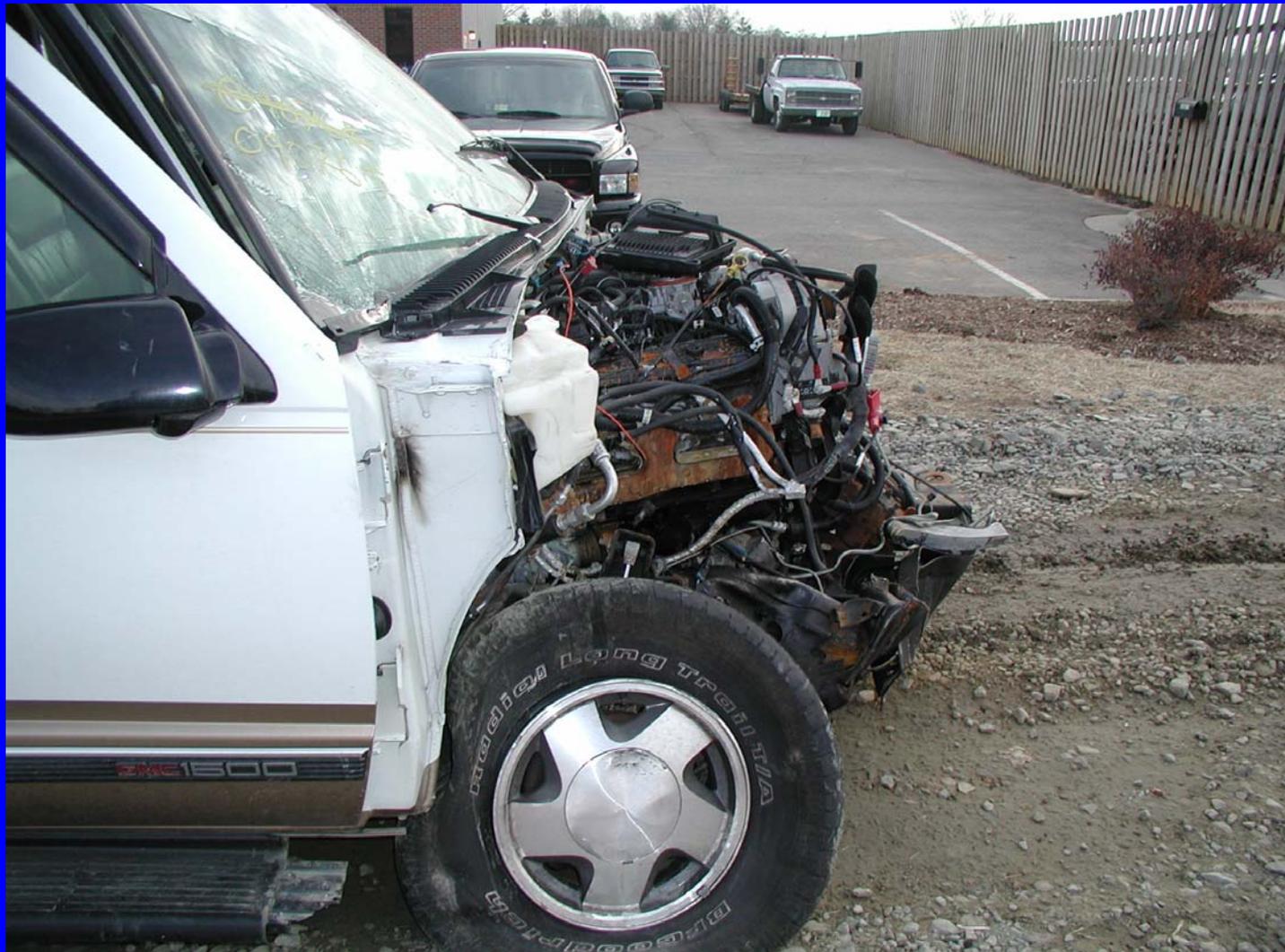
Ford Inova Fairfax Hospital CIREN Center

VEHICLE #1



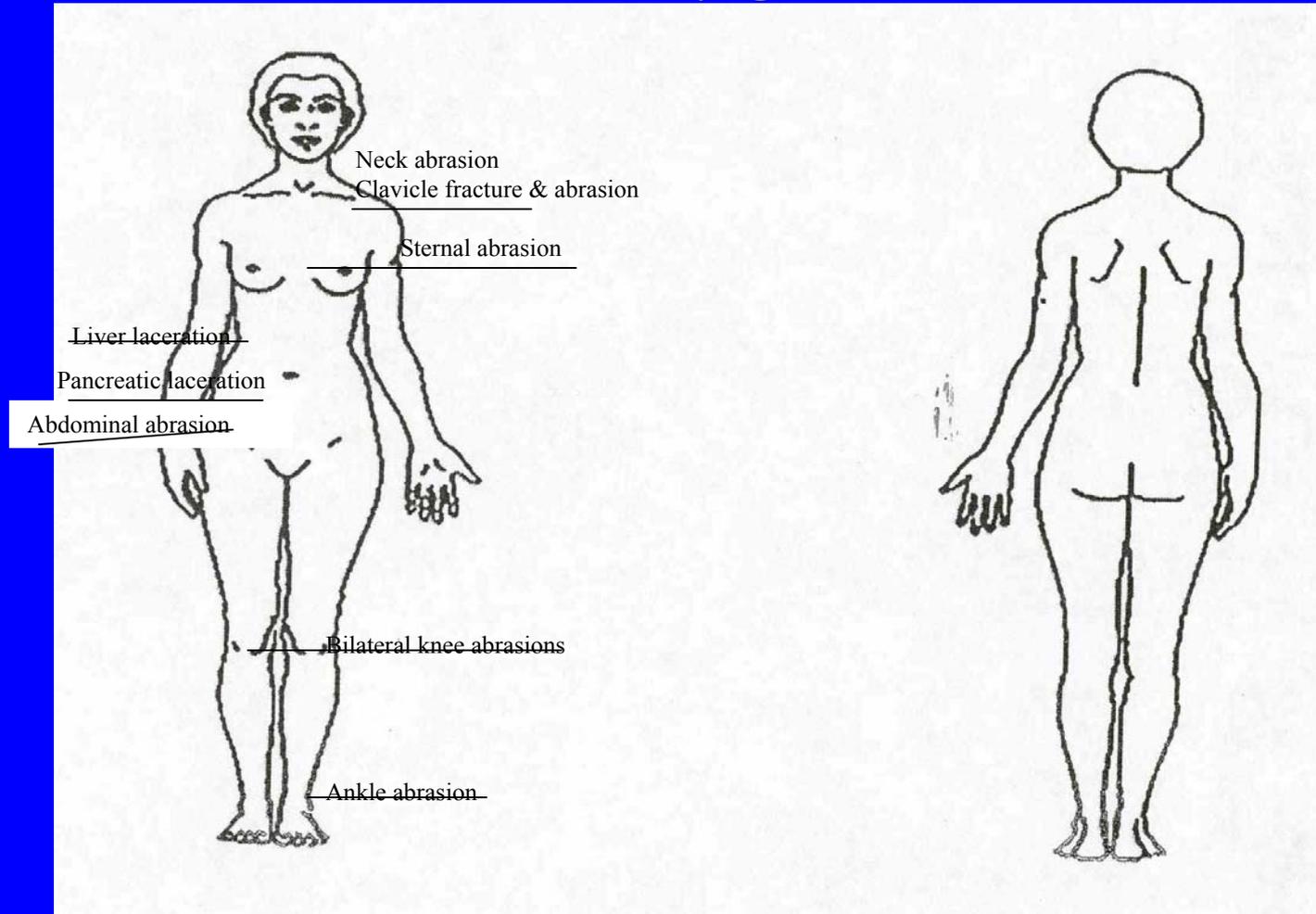
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VEHICLE #1



Ford Inova Fairfax Hospital CIREN Center

Driver



Driver

Occupant Data:

Age: **30** Weight: 145 lbs

Gender: Female Height: 5'6"

Restraint: **Belt**

Airbag front: Deployed

Clothing: Leggings/sweater/flat shoes

Eyewear: None



Driver

Pre-Hospital Summary:

- The patient was alert, oriented but amnestic to the event.
- She had extricated herself from the vehicle and was sitting on the curb upon arrival of pre-hospital personnel.
- Vital signs were stable and she was transported to the trauma center by ground.



Driver

Arrival Data:

	<u>Scene</u>	<u>ED</u>
BP:	120/80	127/56
Pulse:	92	72
Respiration:	18	18
GCS:	unk	15
BAC:	n/a	None performed
Drug Screen:	n/a	None performed

Past Medical History:

None



Driver

Hospital Summary:

- Evaluation in the emergency department was significant for abrasions to the left neck, clavicle, sternum, right upper abdomen, bilateral knees and left ankle.
- Radiologic examination revealed a grade II liver laceration, grade II pancreatic laceration and clavicle fracture.
- The liver and pancreatic lacerations were treated non-operatively and the patient was discharged home on hospital day # 4.



Driver

Other Hospital Data:

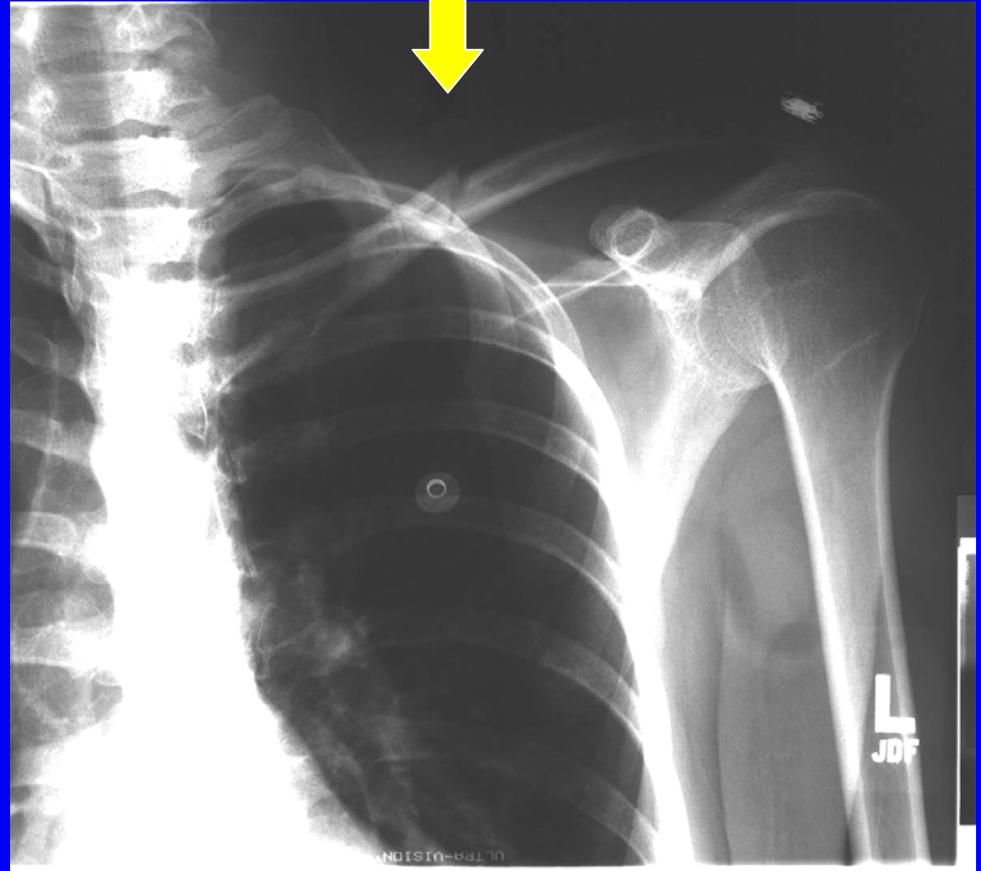
Time to first OR:	N/A
Hospital LOS:	4
ICU LOS:	0
Ventilator Days:	0
Disposition:	Home
Hospital Charges:	\$9,587



Driver



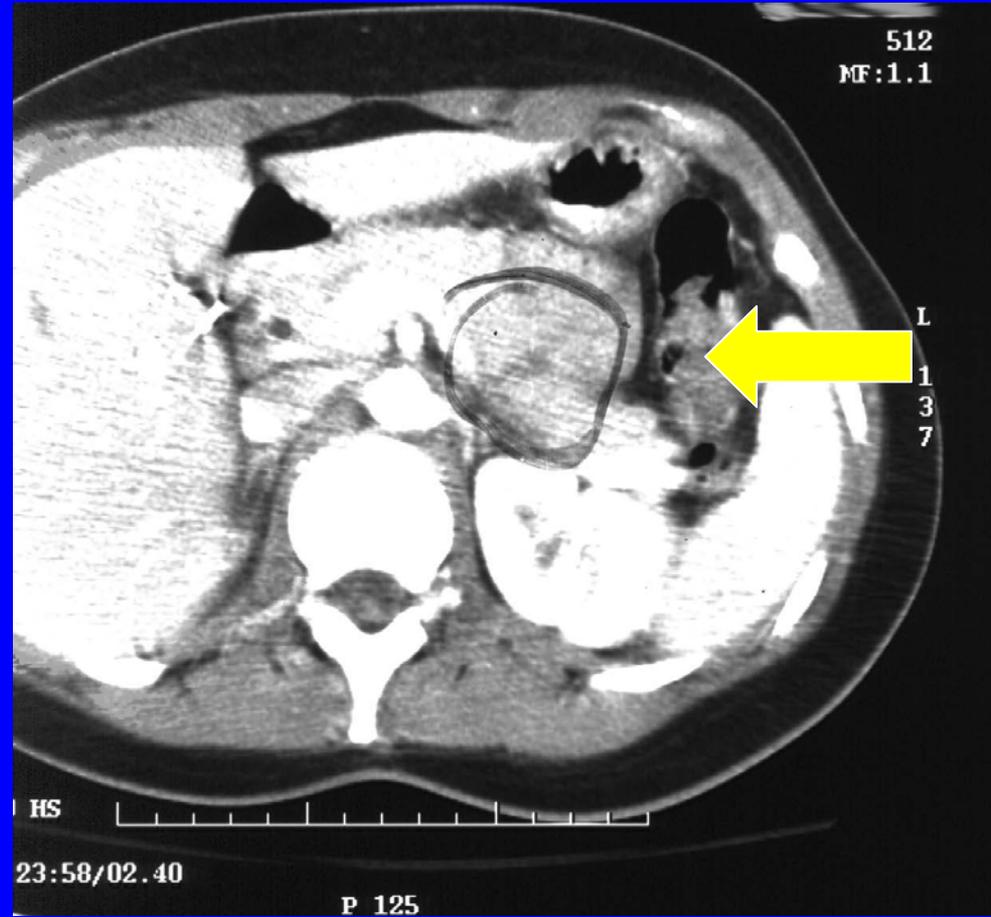
Clavicle fracture



Ford Inova Fairfax Hospital CIREN Center

Driver

Pancreatic laceration -
grade II



Driver

Liver laceration -
grade III



Driver

Injuries (ICD)	AIS Severity	Info Source	Aspect (R,L,bilat,etc)	Contact Area (door, seat,etc)	Mechanism (direct,etc)	Confid. Level	Rank
Grade III liver lacerations x3 (864.03)	541822.2	CT	N/A	Unknown	Unknown	Unknown	1
Grade III pancreatic laceration (863.84)	542824.3	CT	N/A	Unknown	Unknown	Unknown	2
Clavicle fracture (810.02)	752200.2	x-ray	Left	Seatbelt	Direct	Certain	3
Clavicle abrasion (912.0)	790202.1	Exam	Left	Seatbelt	Direct	Certain	4
Neck abrasion (910.0)	390202.1	Exam	Left	Seatbelt	Direct	Certain	5
Sternum abrasion (919.0)	490202.1	Exam	N/a	Seatbelt	Direct	Certain	6
Abdominal abrasion (911.0)	590202.1	Exam	Right	Seatbelt	Direct	Certain	7
Knee abrasion (916.0)	890202.1	Exam	Bilateral	Knee bolster	Direct	Certain	8
Ankle abrasion (916.0)	890202.1	Exam	Left	Foot pedal	Direct	Certain	9



Non-Horizontal Impact

Vehicle # 1: 2000 Nissan Frontier
Weight: 1672 kg

Vehicle # 2: 1999 Tow Truck
Weight: >4536 kg

Vehicle # 3: 1992 Chevrolet Camero
Weight: 1501 kg



Vehicle #1: Driver: Male, Age 46

Safety Systems Available: AB and SB

Safety Systems Used: AB and SB



Roadway:

4-lane highway divided by
a grassy median

Posted Speed Limit:

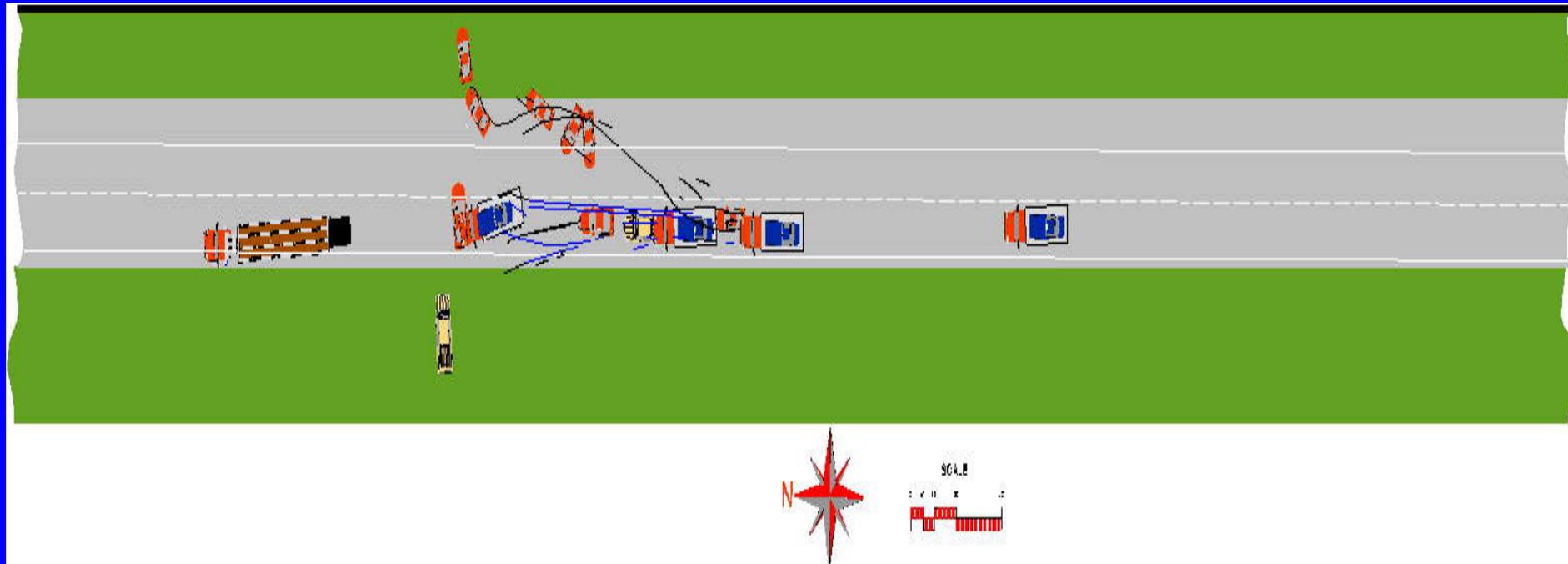
50 MPH



Weather: Clear
Time: 15:00 p.m.
Time of year: Summer

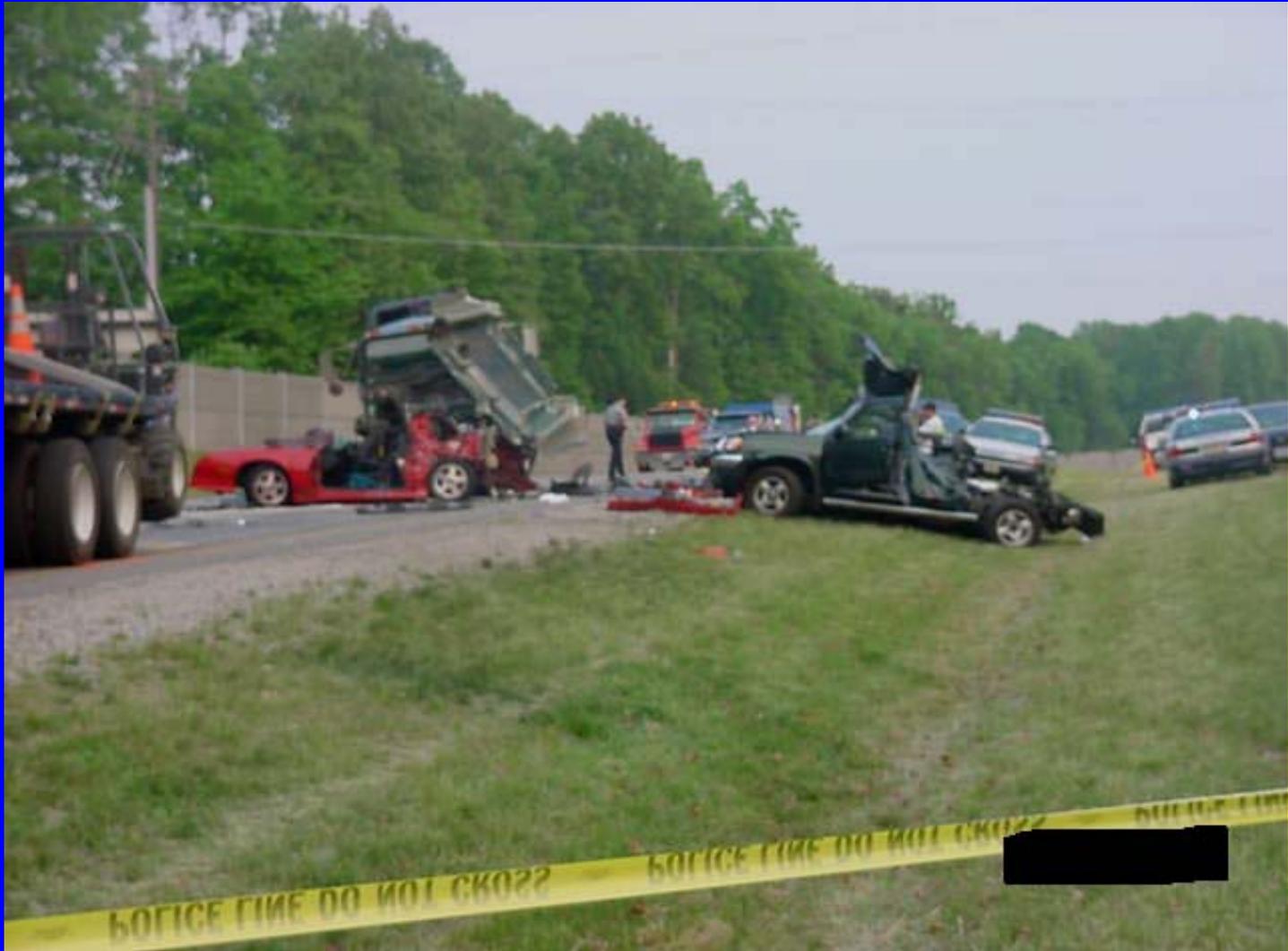


Scene Diagram



Ford Inova Fairfax Hospital CIREN Center

Scene



Ford Inova Fairfax Hospital CIREN Center

Scene



Ford Inova Fairfax Hospital CIREN Center

Scene



Ford Inova Fairfax Hospital CIREN Center

Scene



Ford Inova Fairfax Hospital CIREN Center



Event 1

Impact with Tow Truck

CDC: 00BDHW9
PDOF: Non-horizontal



Event 1 Damage - Case Vehicle



Ford Inova Fairfax Hospital CIREN Center

Event 2

Impact with Chevrolet Camaro

CDC: 01FREE8
PDOF: 20 degrees

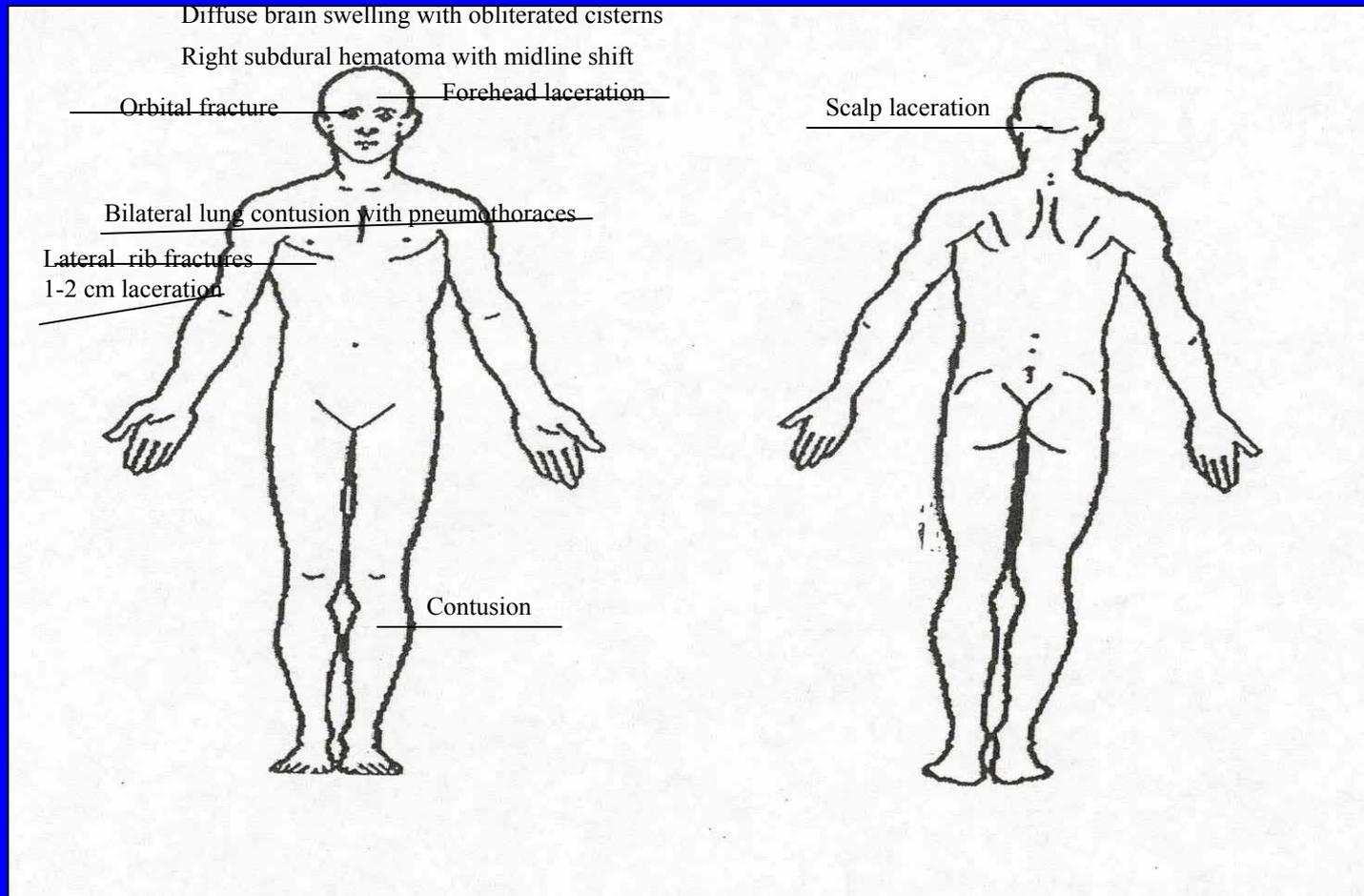


Event 2 Damage - Case Vehicle



Ford Inova Fairfax Hospital CIREN Center

Driver



Driver

Occupant Data:

Age:	46	Weight:	163 lbs
Gender:	Male	Height:	unknown
Restraint:	Restrained		
Airbag front:	Deployed		
Clothing:	Unknown		
Eyewear:	Unknown		



Driver

Pre-Hospital Summary:

- Upon arrival of pre-hospital personnel the driver was still belted. He was unconscious with agonal respirations.
- The driver side door was open and the driver's legs were hanging out of the door, the torso was leaning toward the passenger side.
- Visual examination revealed a laceration over the left eye, which was bandaged. His right pupil was fixed and dilated and the driver was posturing.
- He was backboarded, C-collar placed, oxygenated with BVM and IV fluids administered. Transport by air to the trauma center was requested.
- The driver became difficult to ventilate with BVM and his oxygen saturation levels dropped to the 50s. Endotracheal intubation was attempted, which was unsuccessful x 2 and the decision was made to perform a cricothyrotomy. During transport the driver's status remained unchanged.



Driver

Arrival Data:

	<u>Scene</u>	<u>ED</u>
BP:	98/64	86/45
Pulse:	82	118
Respiration:	12	Ventilated
GCS:	3	3
BAC:	n/a	0
Drug Screen:	n/a	None Detected

Past Medical History: None



Driver

Case Summary:

- 46-year-old, 163 lbs, Asian male, restrained driver of 2000 Nissan Frontier.
 - Upon arrival in the ED the patient's right pupil was dilated and non-reactive. He had clear lung sounds bilaterally with crepitus and chest tubes were placed bilaterally.
 - He was taken immediately for a head CT which revealed a large right subdural hematoma causing a shift to the midline to the left. Diffuse brain swelling and intraparenchymal hematoma. The cisterns were obliterated. During this period the patient also dilated his left pupil.
 - He immediately was transported to the OR for right-sided decompressive craniotomy and placement of a cranial pressure monitor.
 - Post-operatively the left pupil returned to normal. He then was taken to the Trauma ICU.
 - Despite all attempts the patient expired early the next morning following his crash. (Family refused autopsy)
-



Driver

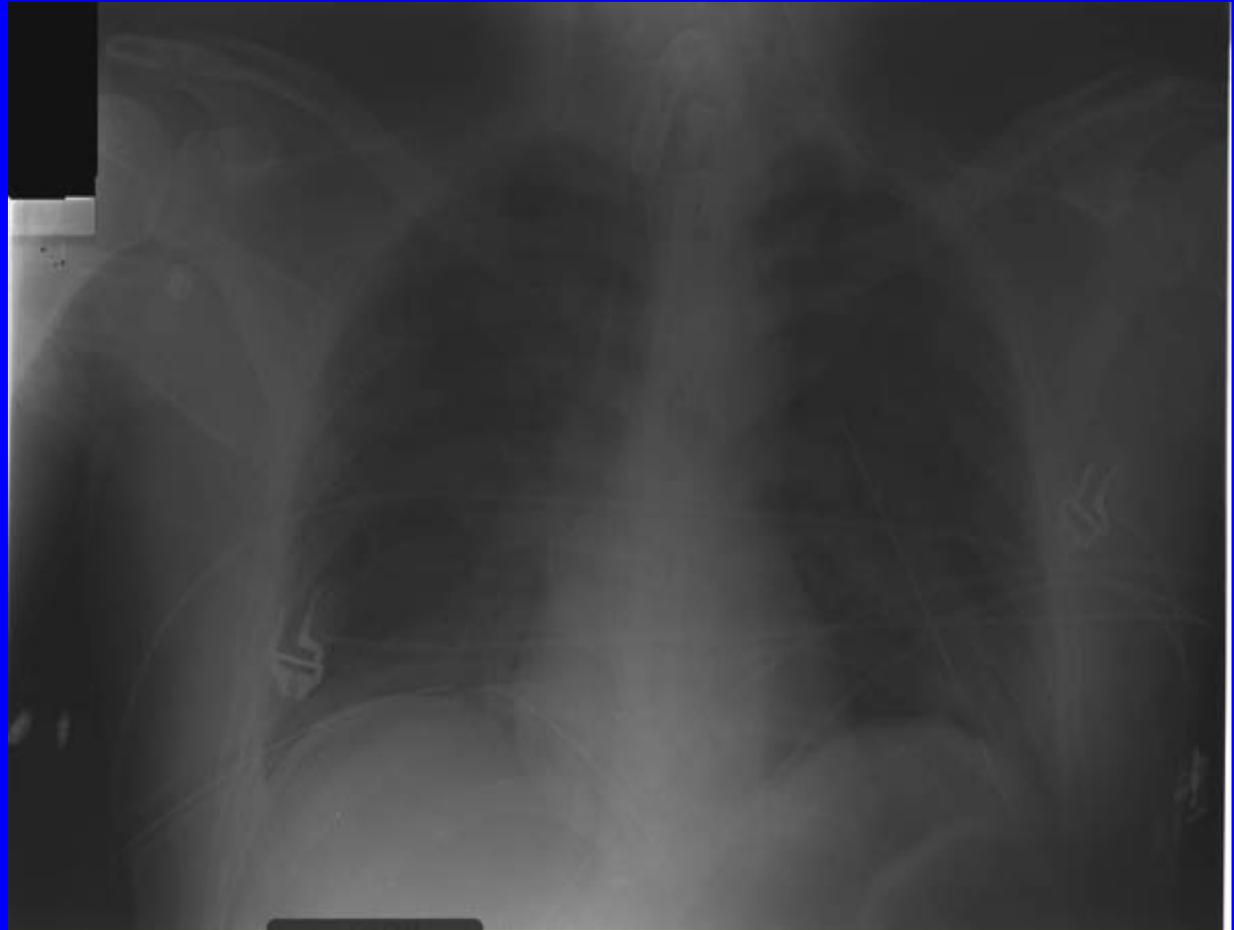
Other Hospital Data:

Date of first OR:	HD#1
Hospital LOS:	1
ICU LOS:	1
Ventilator Days:	1
Disposition:	Morgue
Hospital Charges:	\$19,428



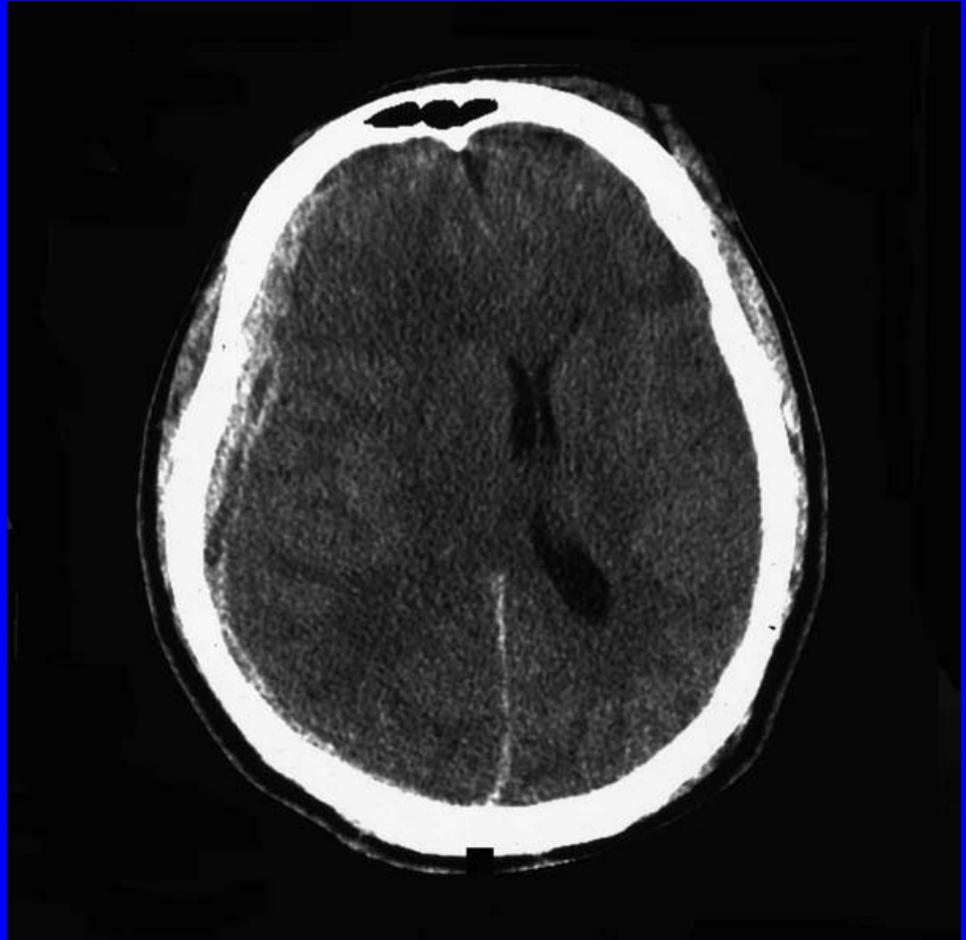
Driver

Bilateral lung
contusion with
pneumothoraces
and right-sided
lateral rib fractures



Driver

Subdural hematoma
with midline shift &
obliterated cisterns



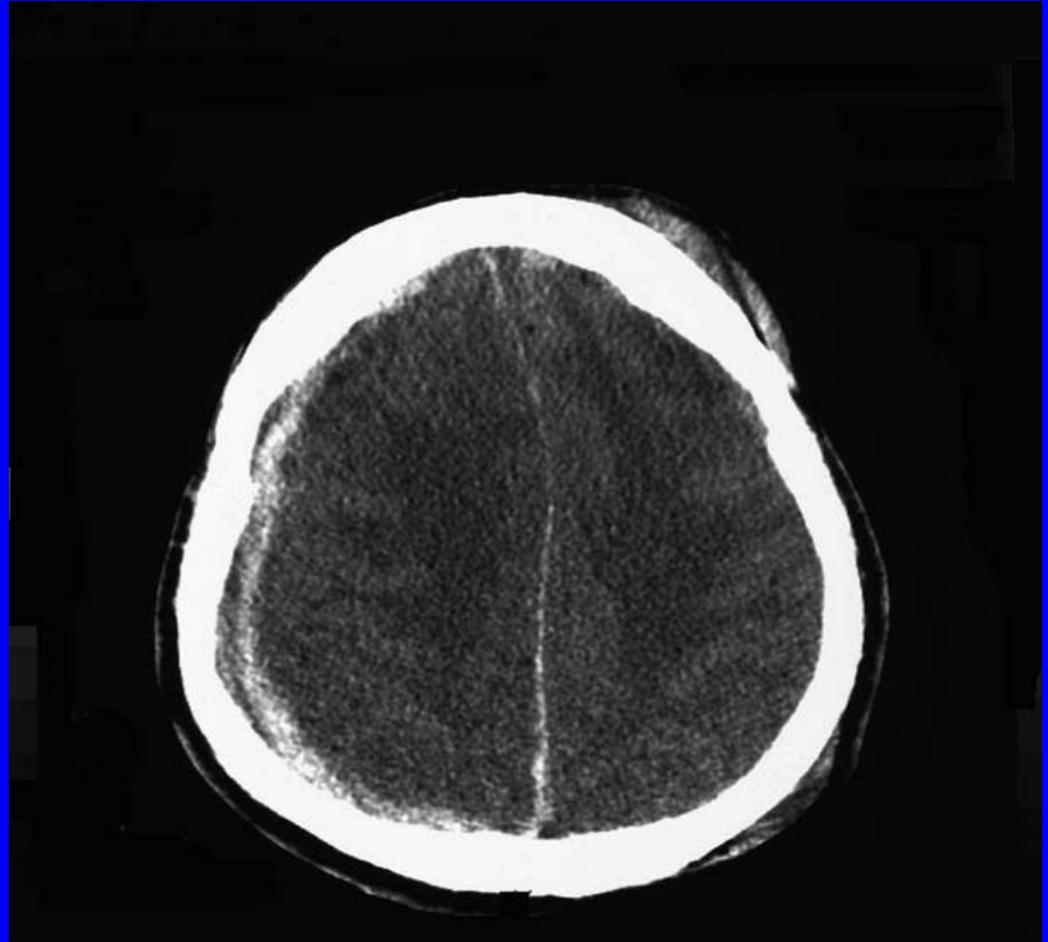
Driver

Subdural hematoma
with midline shift &
obliterated cisterns



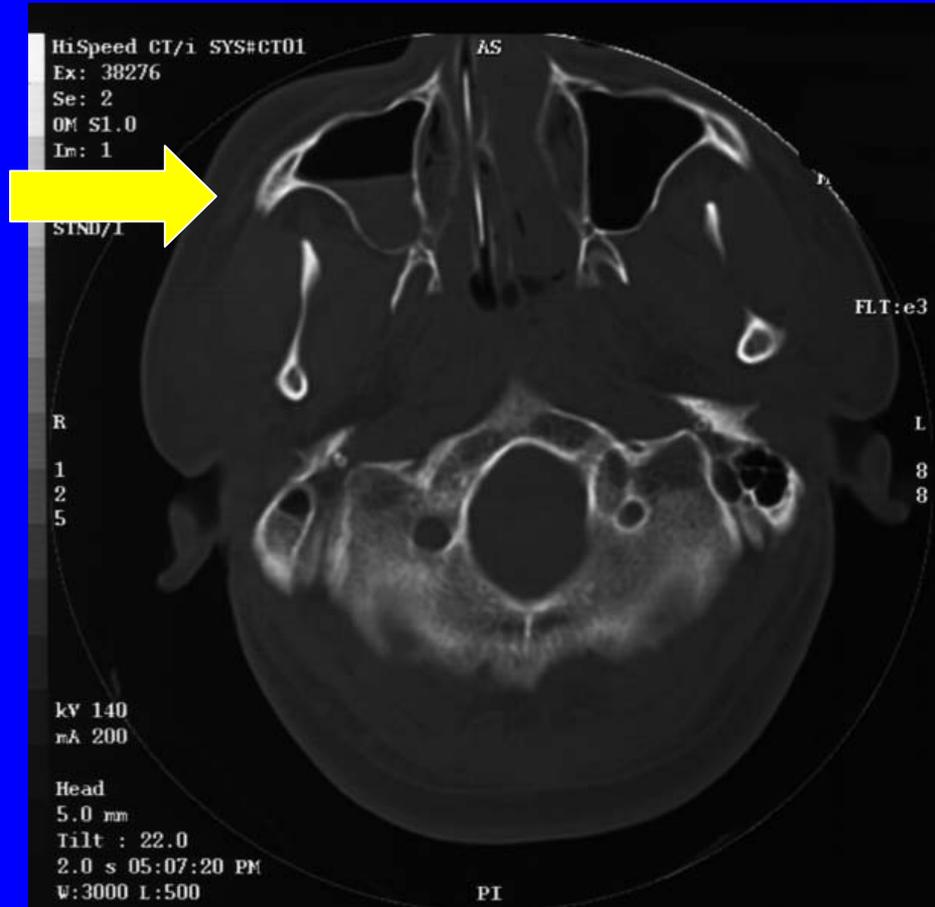
Driver

Subdural hematoma
with midline shift



Driver

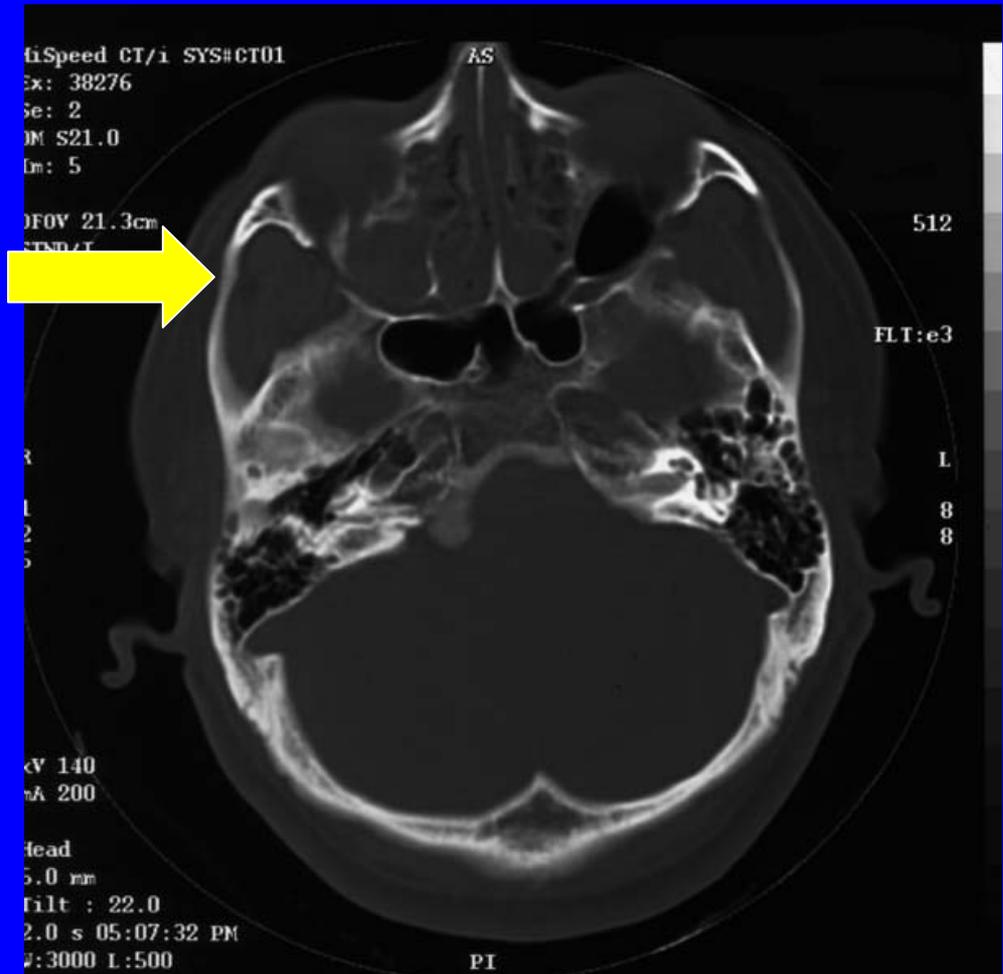
Fluid filled right maxillary sinus



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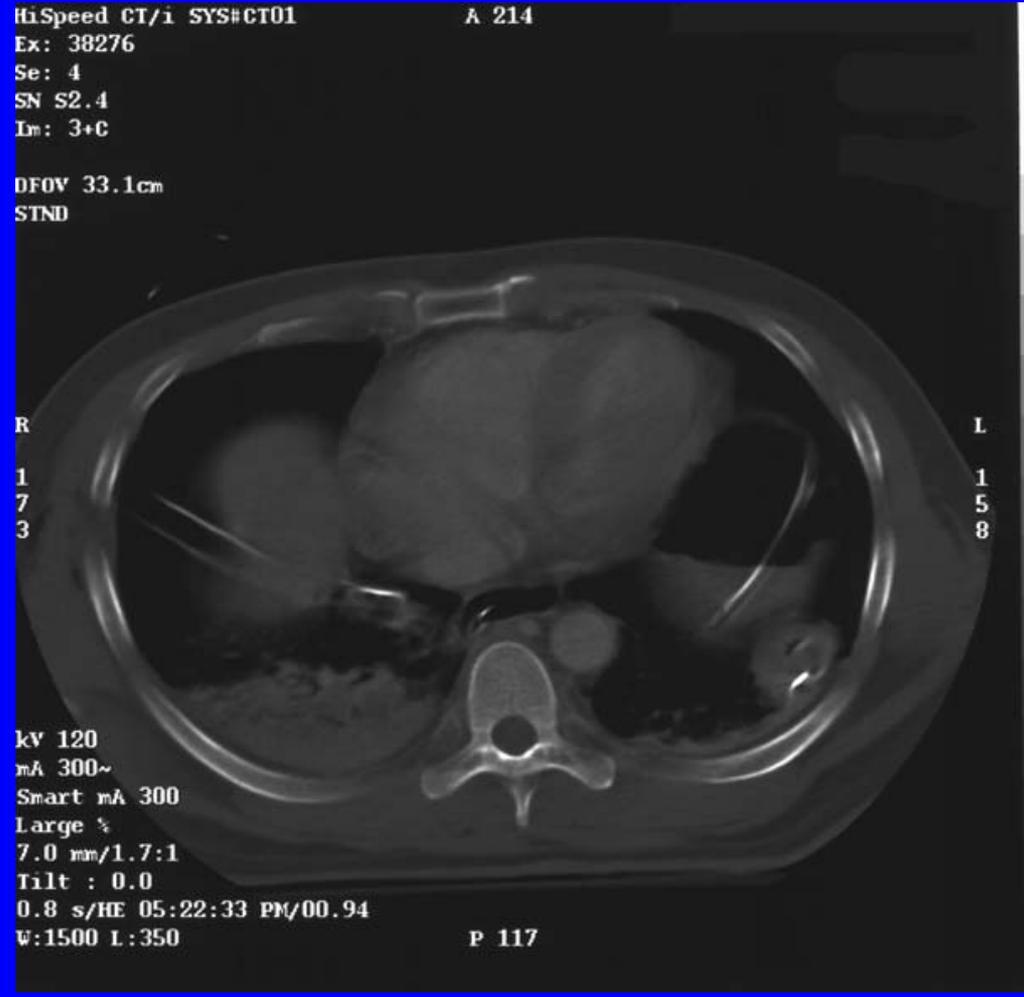
Driver

Right orbit fracture



Driver

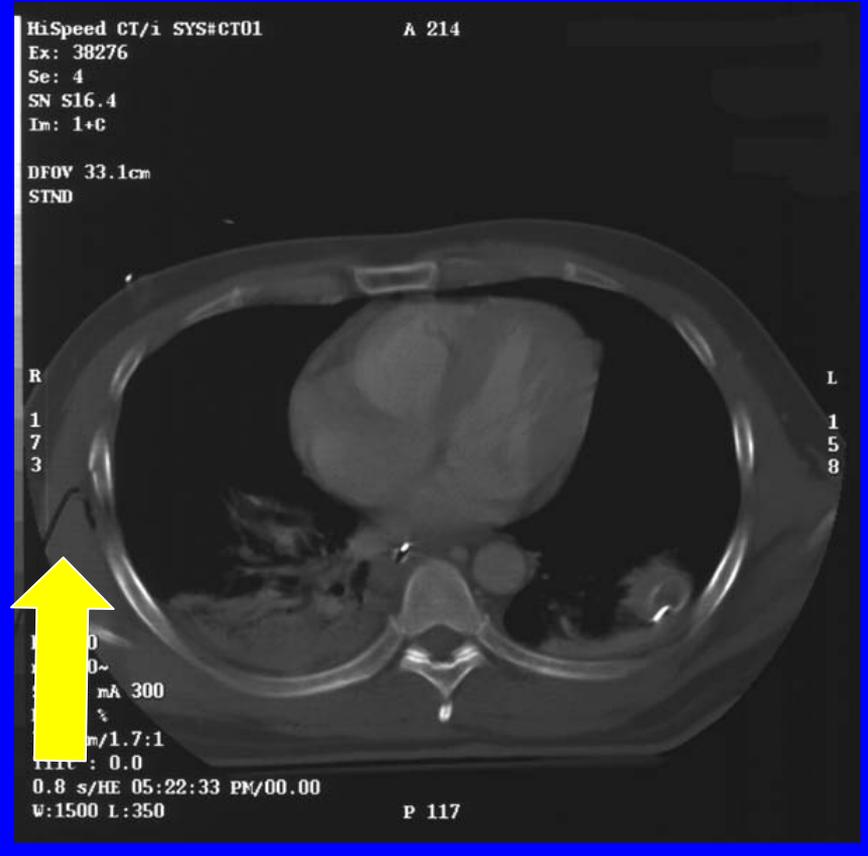
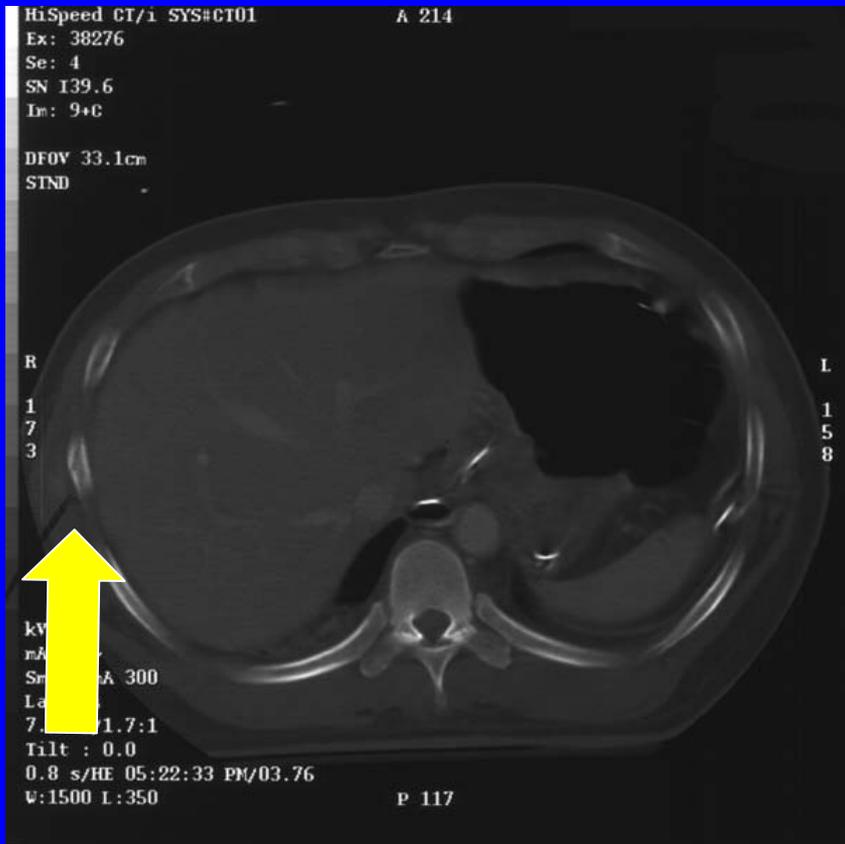
Bilateral lung contusion
and pneumothoraces



Ford Inova Fairfax Hospital CIREN Center

Driver

Right lateral rib fractures



Driver

Injuries (ICD)	AIS Severity	Info Source	Aspect (R,L,bilat,etc)	Contact Area (door, seat,etc)	Mechanism (direct,etc)	Confid. Level	Rank
Subdural hematoma w shift (852.25) Brain swelling with obliterated cisterns (853.05)	140656.5 140666.5	CT	Right				
Orbital fracture (802.6)	251202.2	CT	Right				
Forehead laceration (873.42)	290602.1	Exam	Left				
Scalp laceration (873.0)	190602.1	Exam	Center - posterior				
Pulmonary contusion w PTX (860.0)	441410.4	Exam	Right				
Pulmonary contusion w PTX (860.0)	441410.4	Exam	Left				
Rib fractures (unspecified #) (807.09)	450210.2	CT	Right - lateral				
Upper extremity laceration (880.03)	790602.1	Exam	Right				
Lower extremity contusion (916.1)	890402.1	Exam	Left				

