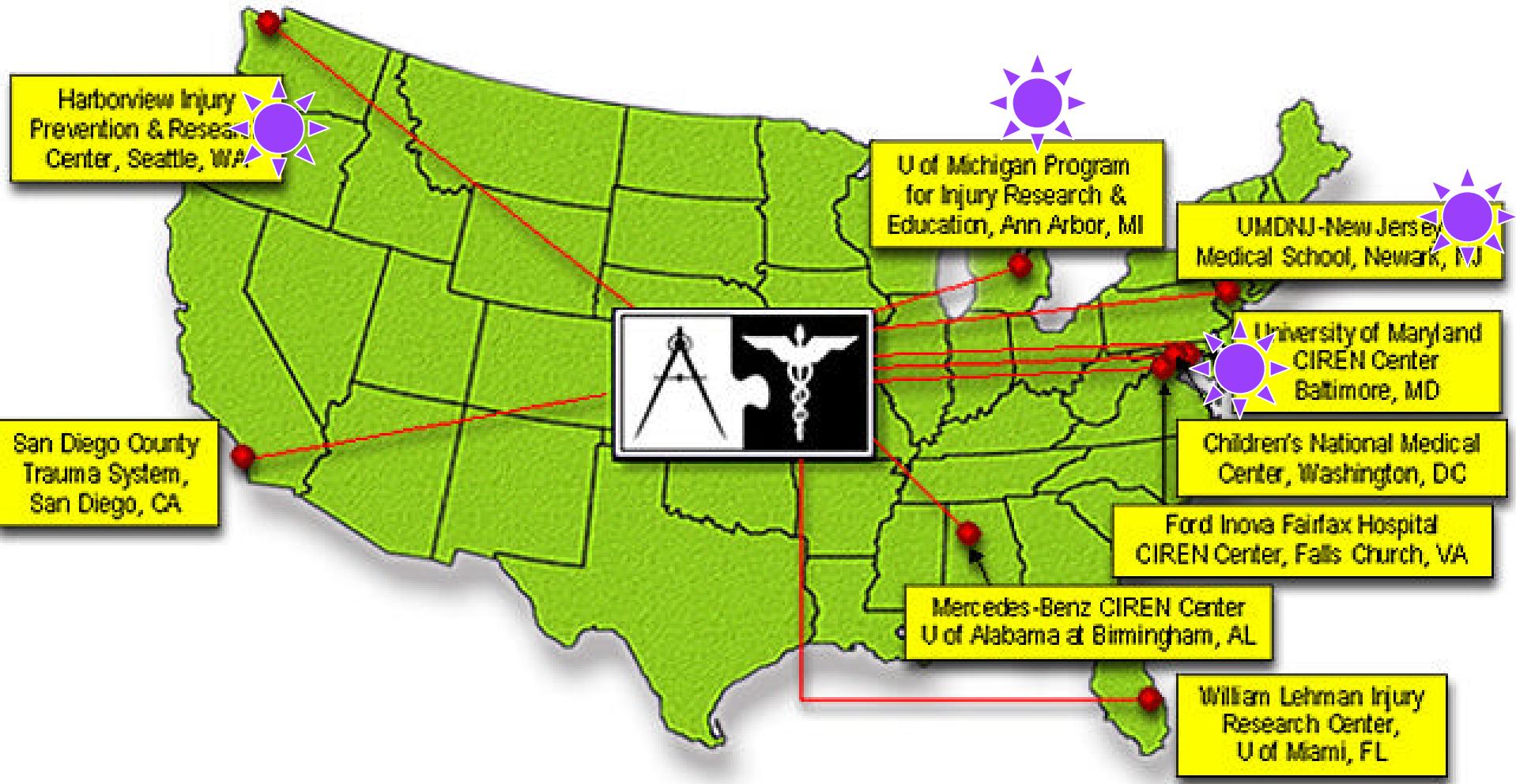




FACTORS INFLUENCING THE PATTERNS OF INJURIES AND OUTCOMES IN SEDAN VS SEDAN CRASHES COMPARED TO SPORT UTILITY, VAN, OR PICK-UP TRUCK VS SEDAN CRASHES

September 6, 2001





New Jersey Medical School-UMDNJ

Departments of Anatomy, Cell Biology and Injury Sciences and of Surgery

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The SUVT Problem

The introduction into the U.S. fleet of a high percent of large, heavy and bulky vehicles as represented by **sport utility vehicles, family vans and light pick-up trucks** produces crash incompatibilities when these impact sedans. SUVTs represent a threat to the ability of the present set of safety devices to continue to maintain a low injury, low complication and reduced mortality profile in SUVT-Sedan MVC's.

Study Inclusion Criteria

- driver or front seat passenger from frontal or lateral MVCs
- no rollovers, no rear end collisions
- no ejection of victim
- must be 16 years of age or older
- all cases obtained after informed consent with Certificate of Confidentiality

RESULTS

- 449 patients were analyzed
 - 331 frontal crash occupants
 - 174 with airbags
 - 156 no airbags
 - 1 unknown airbag status
 - 118 lateral crash occupants
- Of the 257 two-car crash occupants
 - 87 frontal & 33 lateral sedan vs. sedan
 - 62 frontal & 37 lateral sedan vs. SUVT
 - 25 frontal & 2 lateral SUVT vs. sedan
 - 7 frontal & 4 lateral SUVT vs. SUVT

Table IA: Frontal vs Lateral Crashes

category	N	Mean Delta V (kph)	Brain Injury Incidence (% TBI)	Mean GCS w TBI	Mean ISS
All Frontal	331	46.6 +/- 1.2 +++	44 ++	11.3+/-0.4 ++	21.7+/-0.9 +++
All Lateral	118	37.4 +/- 1.3	58	9.3+/-0.6	28.2+/-1.8
All Frontal 2-vehicle crashes	181	46.7+/-1.5 +++	43 +	11.4+/-0.5	21.5+/-1.2 +++
All Lateral 2-vehicle crashes	76	36.1+/-1.5	54	9.6+/-0.8	27.6+/-2.2

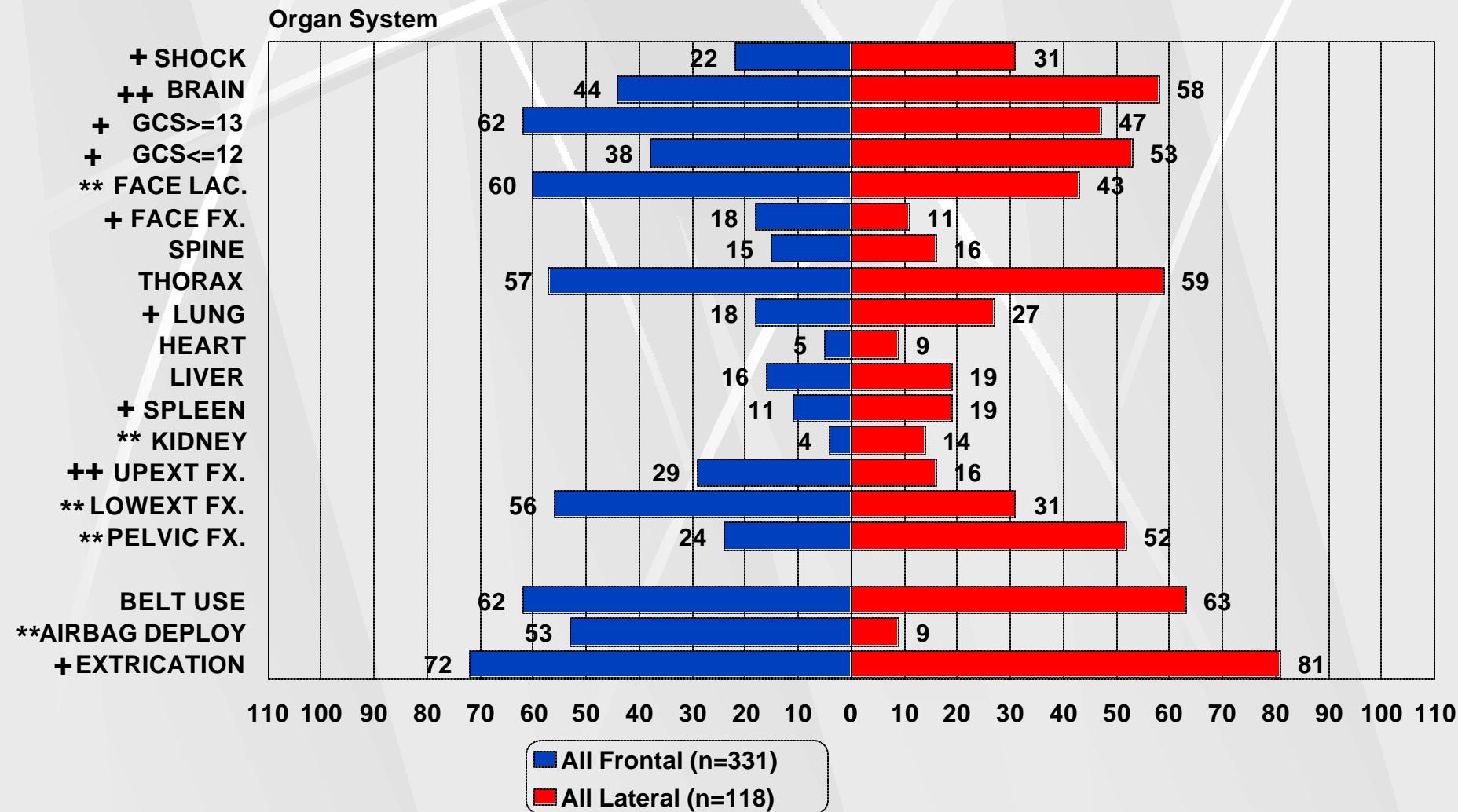
By t-test or Fisher exact: P-value: '+' < 0.05 '++' < 0.01 '+++' < 0.001

Table IB: Frontal Crashes: Airbags and Seatbelts

category	N	Mean Delta V (kph)	Brain Injury Incidence (% TBI)	Mean GCS w TBI	Mean ISS
All Frontal No-Airbag	156	47.4+/-1.7	43	10.5+/-0.6	24.6+/-1.1
All Frontal Airbag	174	45.9+/-1.6	45	12.1+/-0.5	19.1+/-1.3
Non-Belted Frontal No-Airbag	67	50.4+/-2.8	42	8.9+/-0.9	29.6+/-1.8
	89	45.3+/-2.0	44	+ 11.6+/-0.7	+++ 20.9+/-1.2
Non-Belted Frontal No-Airbag	67	50.4+/-2.8	42	8.9+/-0.9	29.6+/-1.8
	59	49.5+/-3.2	45	++ 12.5+/-0.8	+ 21.9+/-2.6
Non-Belted Frontal No-Airbag	67	50.4+/-2.8	42	8.9+/-0.9	29.6+/-1.8
	116	44.1+/-1.9	45	++ 11.9+/-0.6	+++ 17.8+/-1.5

By t-test or Fisher exact: P-value: '+' < 0.05 '++' < 0.01 '+++' < 0.001

All Frontal Cases vs. All Lateral Cases

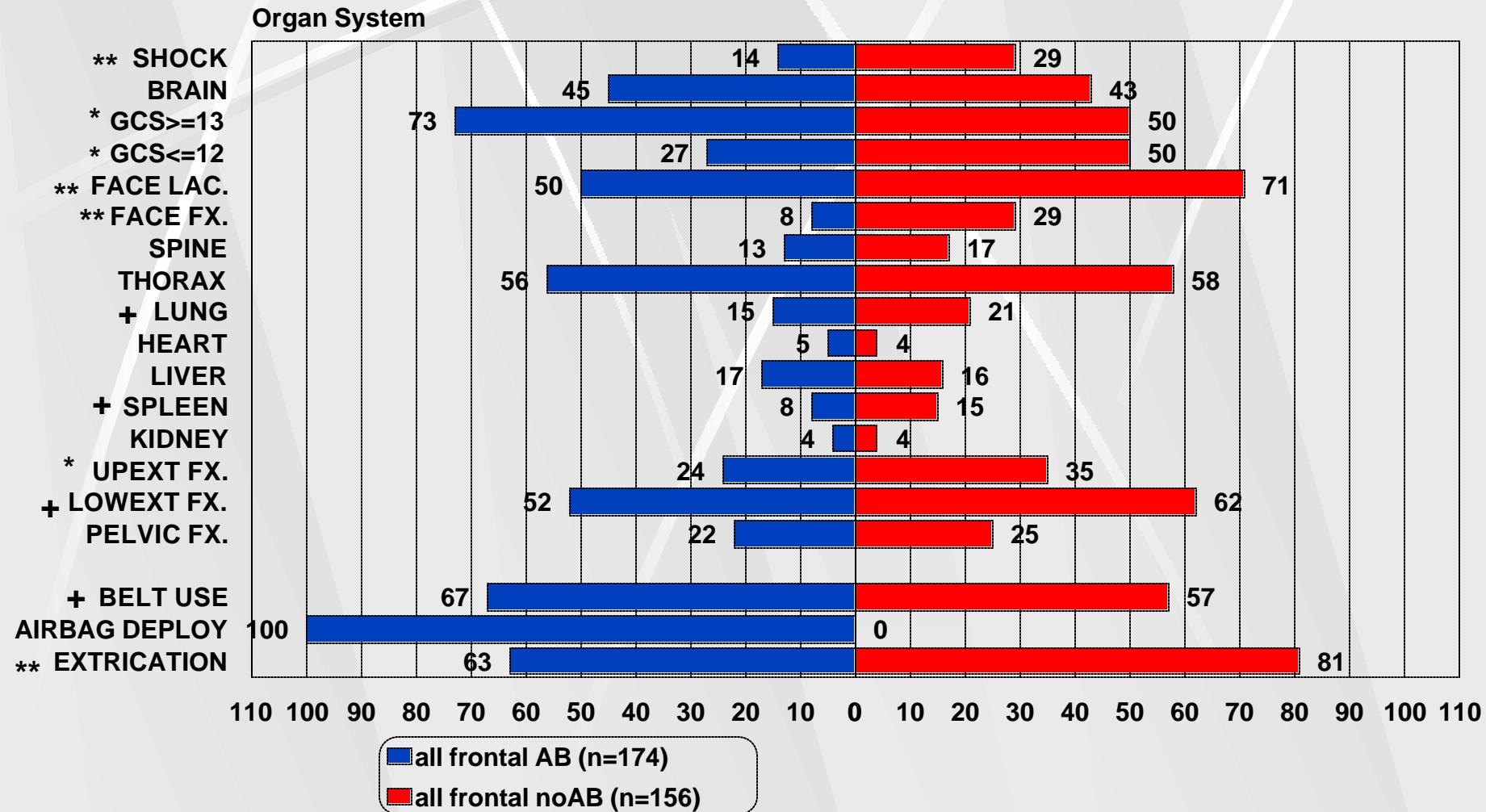


+ = p<0.05

** = p<0.001

++ = p<0.005

All Frontal Airbag vs. All Frontal No Airbag



+ = $p < 0.05$ ** = $p < 0.001$

* = $p < 0.01$

Case Presentation

Sedan vs Sedan

Left Lateral Crash

Left lateral motor vehicle crash

V1 = 1991 Toyota Corolla DX 4 door sedan (1057 kg), failed to observe stop sign and attempted left turn against traffic.

V2 = 1990 Lincoln Mark VII 2 door (1718 kg), travelling eastbound in travel lane.

Case Occupant (V1)

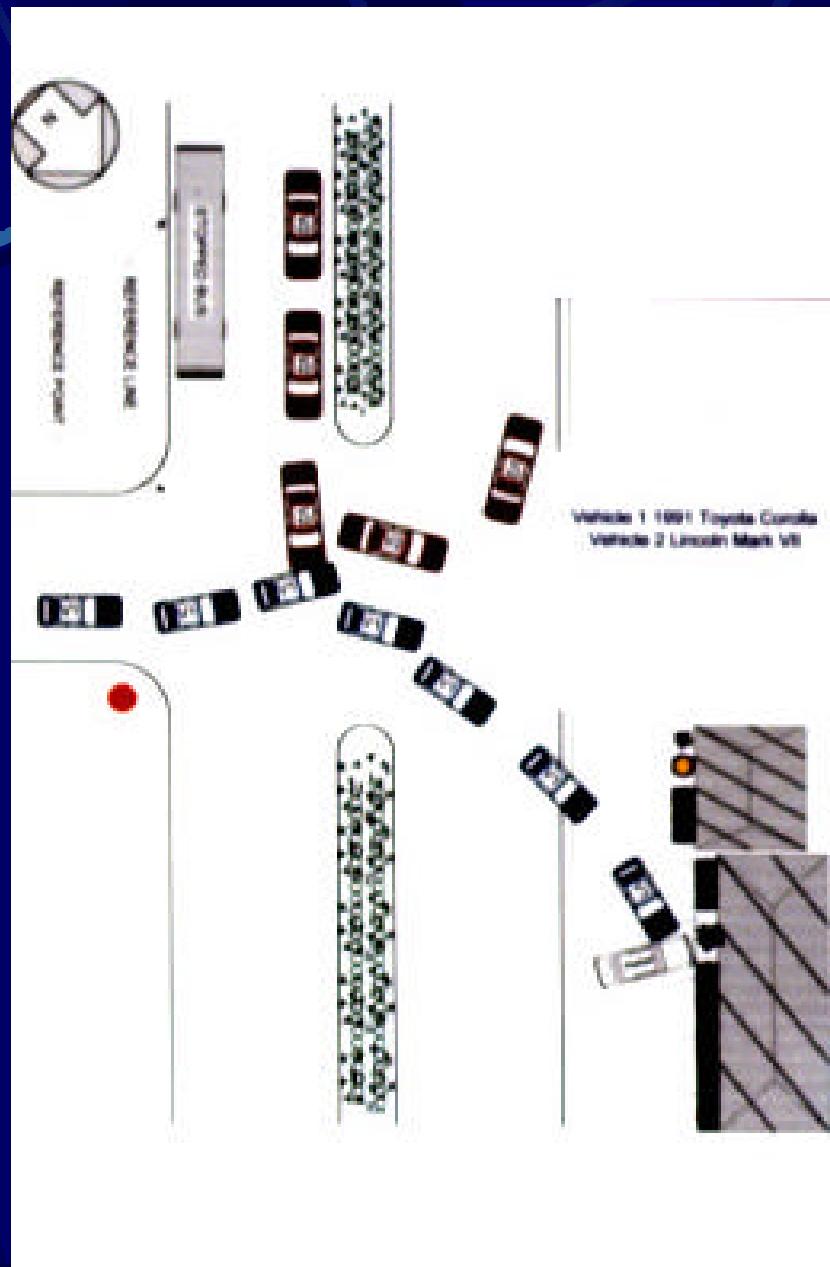
- 36 year old female restrained driver
- Weight = 45 kg (100 lbs)
- Height = 155 cm (5' 1")

Crash Scene

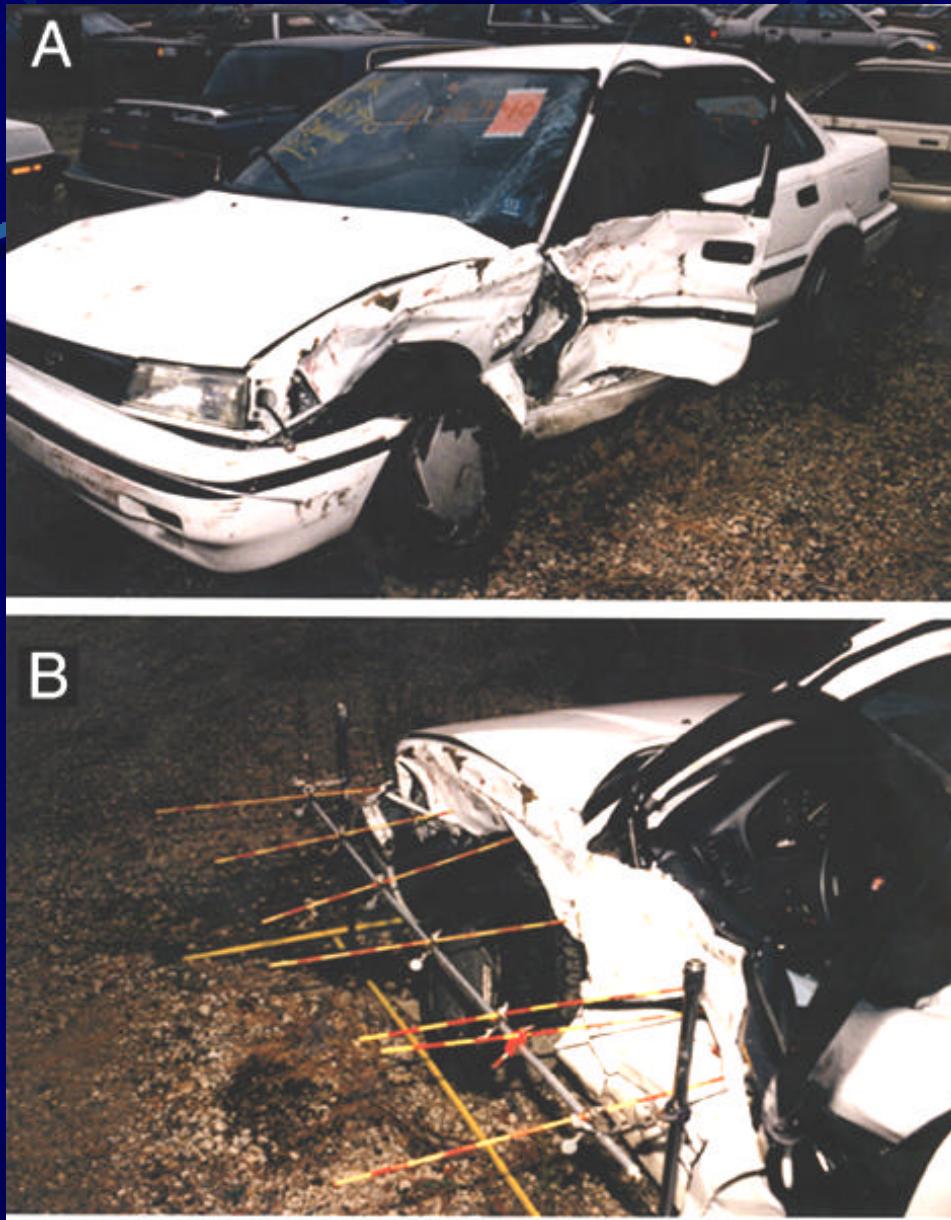
- 4-lane divided urban roadway at its intersection with a commercial driveway
- Speed limit = 64 km/h (40 mph)
- Roadway dry, free of defects
- Positive 4% grade in eastbound direction
- Visibility for both V1 and V2 limited by stopped urban transit bus

Reconstruction Data (V1)

- Left lateral collision
- CDC = 09LYEW2
- PDOF = 270 degrees
- Delta V = 29 kph (16.3 mph)
- Max Crush = 14 cm at C2
- Estimated speed V1 = 32-40 kph (20-25 mph)
- Estimated speed V2 = 64-72 kph (38-44 mph)







Left lateral motor vehicle crash vs Sedan – Case Occupant (V1) Injury List

INJURY	SOURCE	INTRUSION (cm)
Loss of consciousness < 1 hr	Left window/frame	0
Left forehead abrasion	Left window/frame	0
Left forehead contusion	Left window/frame	0
Left pneumothorax	Left armrest/hardware	18 cm
Left inferior pubic rami fracture	Left armrest/hardware	18 cm
Left anterior and posterior acetabular column fracture	Left armrest/hardware	18 cm
Left anterior and posterior acetabular wall fracture	Left armrest/hardware	18 cm
Left iliac wing fracture	Left armrest/hardware	18 cm
Obturator branch of left internal iliac artery laceration	Left armrest/hardware	18 cm
Retroperitoneal hematoma	Left armrest/hardware	18 cm
Pubic symphysis diastasis	Left armrest/hardware	18 cm

Case Presentation

Sedan vs Van

Left Lateral Crash

Left lateral motor vehicle crash

V1 = 1997 Ford Taurus 2 door sedan (1497 kg), entered intersection from roadway with a posted stop sign.

V2 = 1989 Ford Econoline Van (2300 kg), travelling northbound in travel lane.

Case Occupant (V1)

- 78 year old female unrestrained driver
- Weight = 70 kg (154 lbs)
- Height = 163 cm (5' 4")

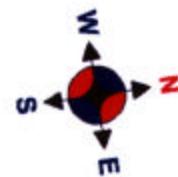
Crash Scene

- 2-lane urban intersection controlled by stop sign in one direction only
- Speed limit = 72 km/h (45 mph)
- Roadway dry, straight, free of defects
- Daylight conditions

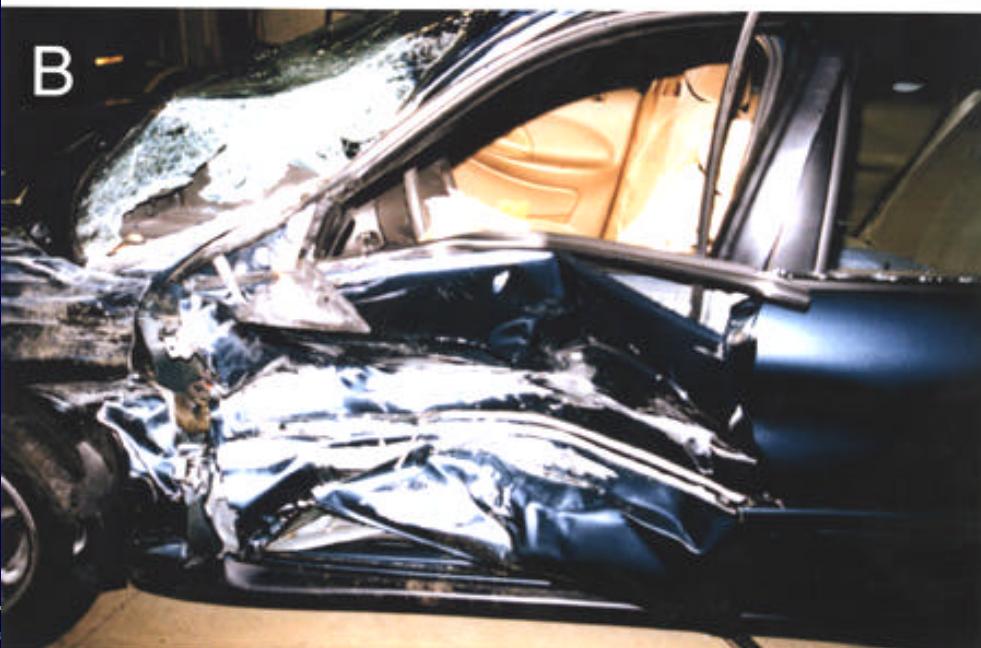
Reconstruction Data (V1)

- Left lateral collision
- CDC = 10LYAW3
- PDOF = 305 degrees
- Delta V = 22 kph (13.8 mph)
- Max Crush = 28 cm at C3
- Estimated speed V1 = 16-24 kph (10-15 mph)
- Estimated speed V2 = 72-81 kph (45-51 mph)

VEHICLES:
V1 - 1997 FORD TAURUS GL
V2 - 1989 FORD ECONOLINE VAN









Left lateral motor vehicle crash vs Van – Case Occupant (V1) Injury List

INJURY	SOURCE	INTRUSION (cm)
Loss of consciousness < 1 hr	Left A pillar	12 cm
Left temporo-parietal scalp laceration	Left A pillar	12 cm
Bilateral subdural hematomas (temporo-parietal)	Left A pillar	12 cm
Bilateral subarachnoid hemorrhages	Left A pillar	12 cm
Right lateral chest wall abrasions	airbag	N/A
Left pneumothorax	Left door panel	17 cm
Left rib fractures (III-VII)	Left door panel	17 cm
Splenic laceration < 3 cm	Left door panel	17 cm
Sternum fracture	airbag	N/A
Bilateral ventricular wall contusions	airbag	N/A
Right lateral abdominal wall abrasions	airbag	N/A

Simple Closed

Comminuted Closed

Simple Open

Comminuted Open

Segmental Bone Loss

Soft Tissue Loss

Nerve Injury

Fracture Site

Amputation Site

Rib Fx T6 Left

A.

Simple Closed

New

List

Show

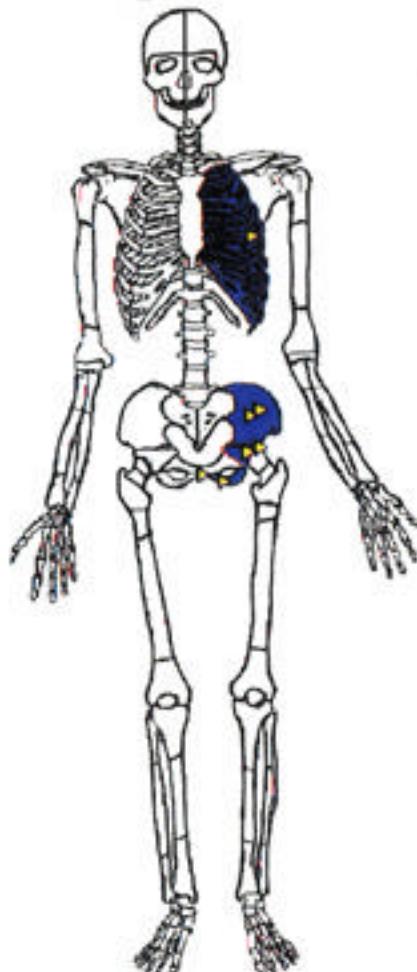
Print

File

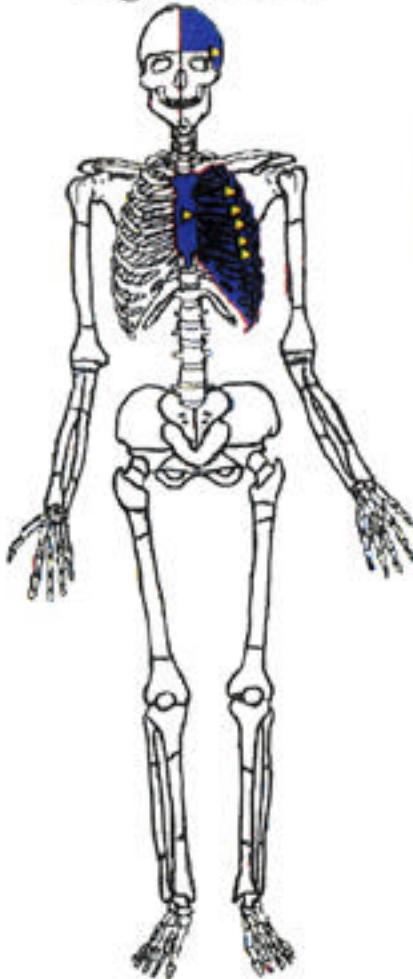
Amend

Delete

A. 36 yr old female
weight 45 kg
height 5 ft 1 in



B. 70 yr old female
weight 70 kg
height 5 ft 4 in



Rib Fx T3 Left
Rib Fx T4 Left
Rib Fx T5 Left
Rib Fx T6 Left
Rib Fx T7 Left

B.

Sprain	
Shoulder	R L
Elbow	R L
Wrist	R L
Hip	R L
Knee	R L
Ankle	R L

Ligament Disruption	
Shoulder	R L
Elbow	R L
Wrist	R L
Hip	R L
Knee	R L
Ankle	R L
Pubis	

Sacroiliac	
------------	--

Dislocation	
Shoulder	R L
Elbow	R L
Wrist	R L
Hip	R L
Knee	R L
Ankle	R L
Pubis	

Sacroiliac	
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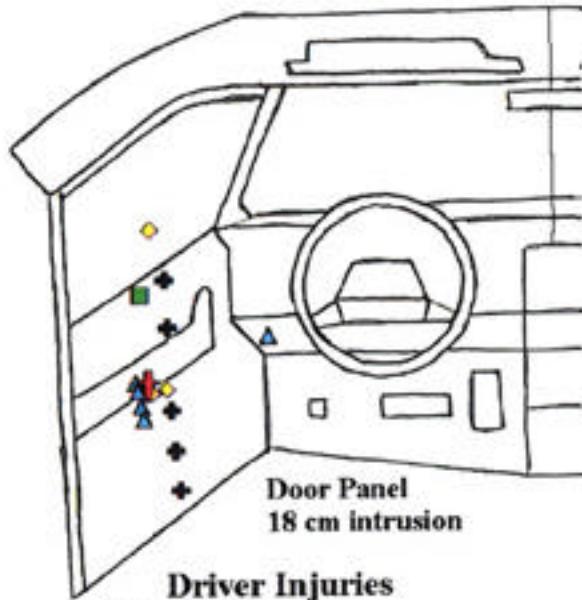
A. Driver: Sedan vs. Sedan B. Driver: Sedan vs. SUV

Abrasion
Contusion
Laceration
Fracture
Open Fracture
Organ Injury
Brain Injury
Airbag Injury
Intrusion
2 Door Sedan
4 Door Sedan
Hatchback
Station Wagon
Light Truck
Other
Airbag Equipped
Driver
Passenger
Airbag Deployed
Driver
Passenger
1997 Side Impact
Restrained
Frontal Crash
Lateral Crash
Extrication
Ejection
Compartment Intrusion

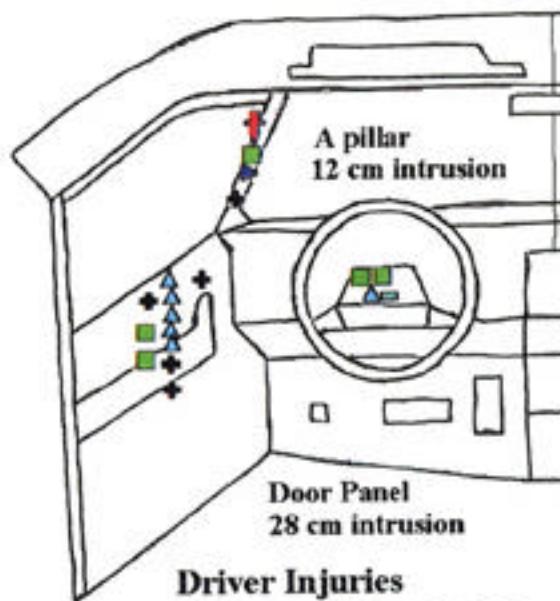
Organ Injury

[New](#)
[List](#)
[Show](#)
[Print](#)
[File](#)
[Amend](#)
[Delete](#)

A. Sedan vs. Sedan 1990 Toyota Corolla



B. Sedan vs. SUVT 1997 Ford Taurus


[Clear Relations](#)
[Clear Selections](#)

Case Presentation

Sedan vs SUV

Frontal Crash

(Vehicle 1)

Frontal motor vehicle crash

V1 = 1994 Nissan Sentra 4 door sedan (1114 kg), crossed into oncoming traffic lanes.

V2 = 1997 Jeep Grand Cherokee 4 door SUV (1850 kg), travelling northbound in travel lane.

Case Occupant (V1)

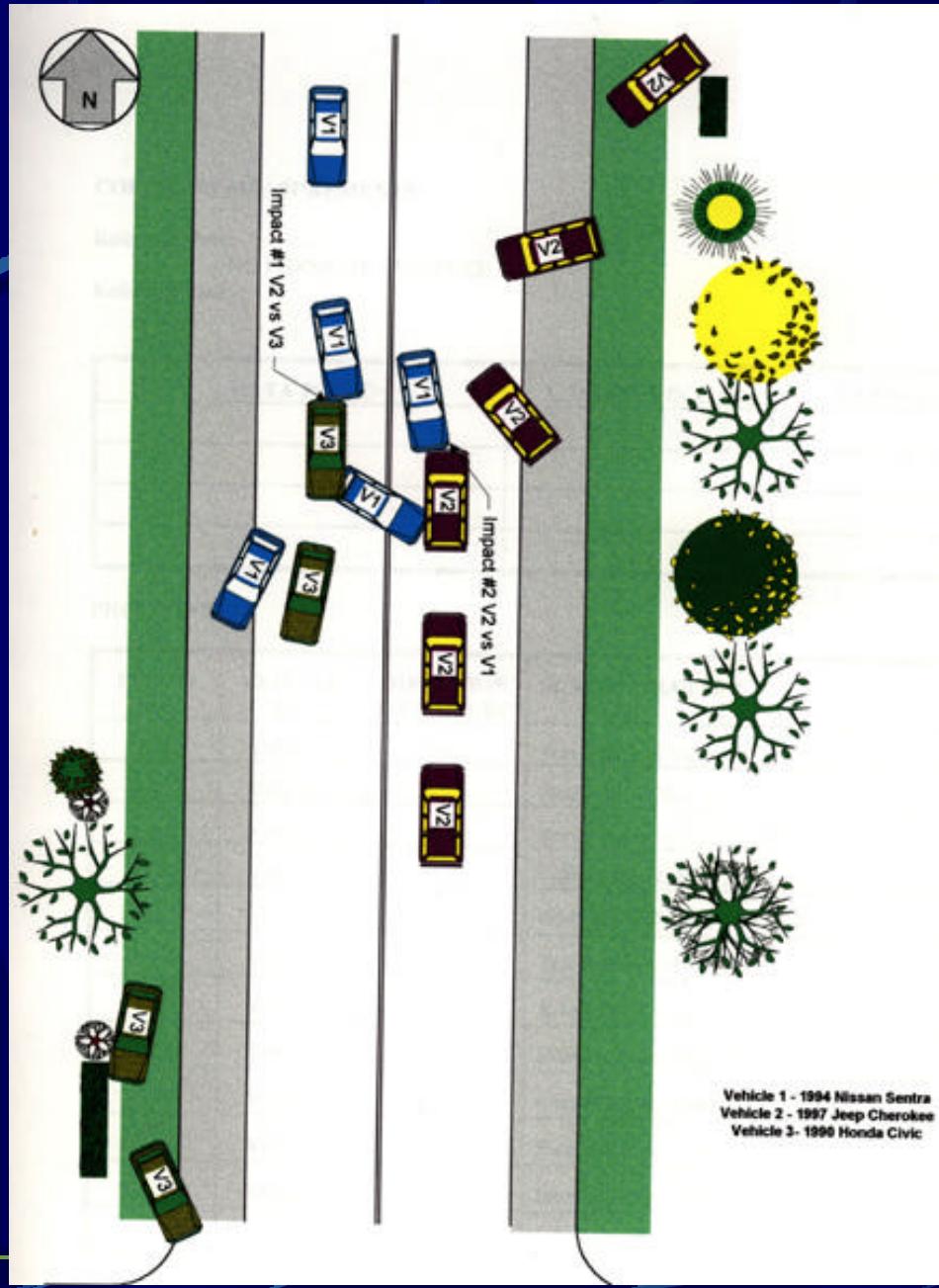
- 37 year old male unrestrained driver
- Weight = 67 kg (148 lbs)
- Height = 180 cm (5' 11")

Crash Scene

- 2-lane undivided urban roadway
- Speed limit = 56 km/h (35 mph)
- Roadway dry, straight and level
- Daylight conditions
- Estimated coefficient of friction=0.75

Reconstruction Data (V1)

- Frontal collision
- CDC = 12FDEW3
- PDOF = 350 degrees
- Delta V = 38.3 kph (21.7 mph)
- Max Crush = 56 cm at C1
- Estimated speed V1 = 72-80 kph (45-50 mph)
- Estimated speed V2 = 56-64 kph (35-40 mph)



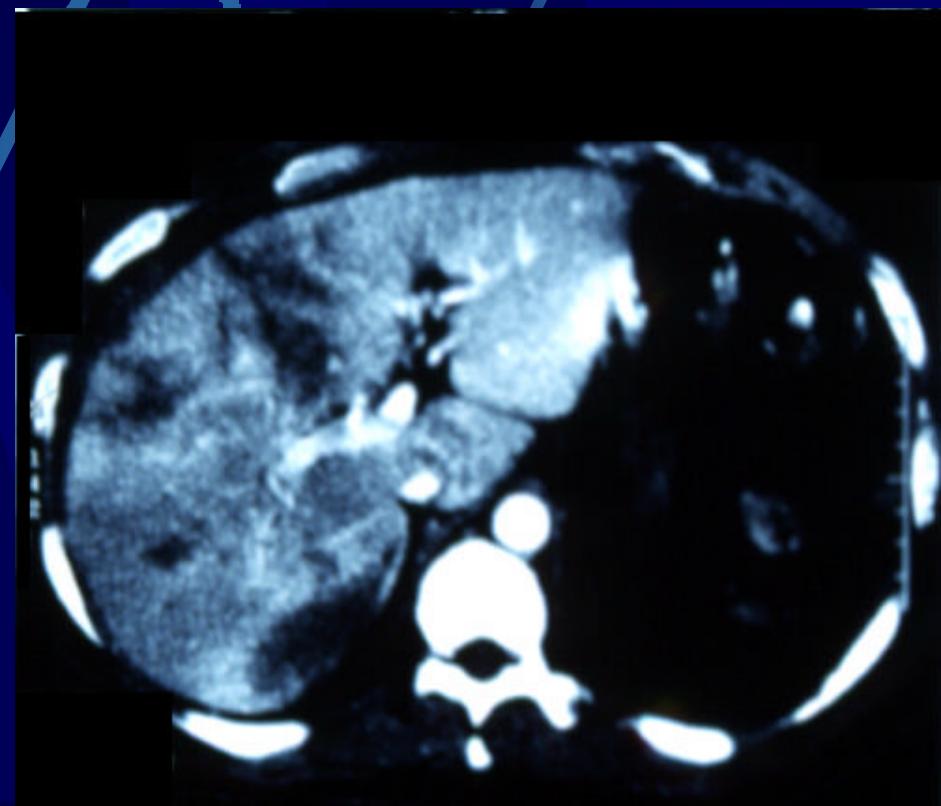
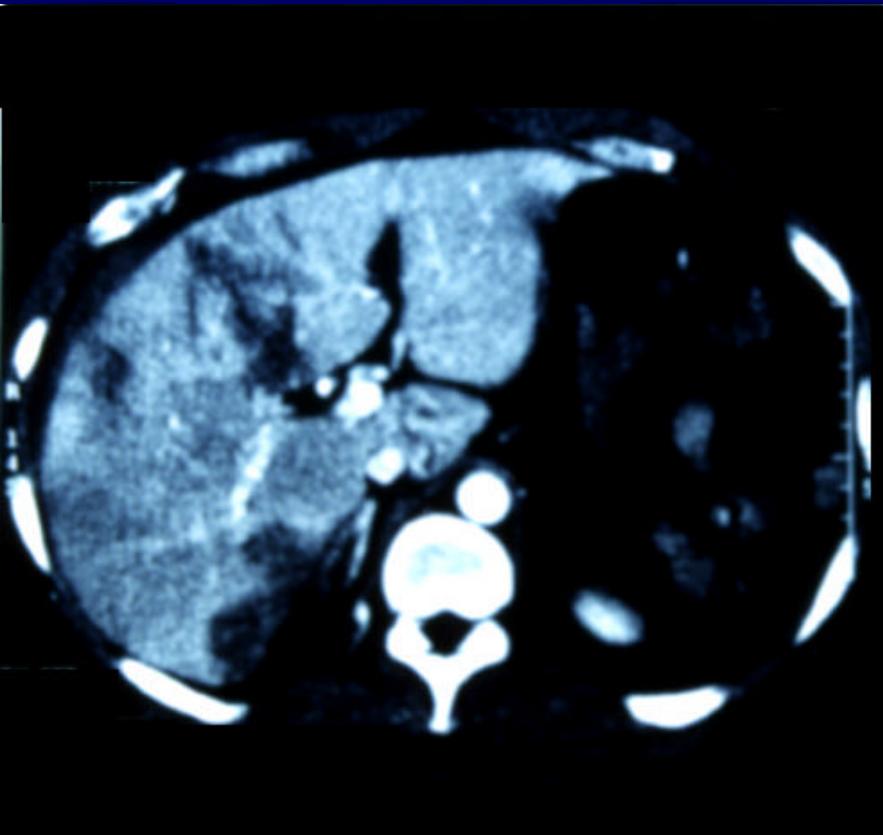






Frontal motor vehicle crash vs SUV – Case Occupant (V1) Injury List

INJURY	SOURCE	INTRUSION (cm)
Left chin laceration	airbag	N/A
Liver laceration Grade IV	Steering wheel	0
Left hepatic artery laceration	Steering wheel	0
Left portal vein fistula	Steering wheel	0
Left second metacarpal fracture	Instrument panel	0



viscera

● Gunshot Wound ● Shotgun Wound ● Blunt Trauma ● Laceration ● Stab Wound ● Injury Grade Severity 1 Severity 2 Severity 3 Severity 4 Severity 5 Severity 6 ● Complication Systemic Cardiopulmonary Pneumonitis Inflammation Obstruction Infarction Hemorrhage Infection Perforation Abcess Organ Failure Infectious Agents	<h3>Laceration</h3> <div style="display: flex; justify-content: space-between;"> New List Show Print File Amend Delete </div> <div style="margin-top: 10px;"> Name Last <input type="text"/> First <input type="text"/> Age <input type="text"/> Weight <input type="text"/> kg; Sex <input type="checkbox"/> M <input type="checkbox"/> F Race <input type="text"/> Height <input type="text"/> ft; <input type="text"/> in; Hospital ID <input type="text"/> Date MM <input type="text"/> DD <input type="text"/> YY <input type="text"/> Time HH <input type="text"/> MN <input type="text"/> Day <input type="text"/> File Date <input type="text"/> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> R L </div> <div style="text-align: center; margin-top: 20px;"> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> + + + + </div> <div style="background-color: #e64a89; color: white; padding: 10px; width: fit-content; margin-top: 20px;"> Time Series Rx Adv. </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> + + + + </div> <div style="display: flex; justify-content: space-between; margin-top: 10px;"> IV Laceration: Parenchymal disruption 25-50% of hepatic lobe 864.04 4 </div> <div style="margin-top: 10px; border: 1px solid black; padding: 5px; background-color: #f0f0f0;"> Thyrohyoid Membrane Larynx Cricothyroid Membrane Thyroid Gland Trachea First Rib Clavicle Apex of Lung Lung, Upper Lobe Right Lung, Middle Lobe Lung, Lower Lobe Superior Vena Cava Atrium Ventricle Ascending Aorta Pulmonary Artery Diaphragm Liver, Right Lobe Liver, Middle Lobe Liver, Left Lobe Esophagus Stomach, Antrum Stomach, Body Stomach, Cardia Stomach, Fundus Spleen Gall Bladder Proximal Jejunum Mid Jejunum Distal Ileum Cecum Appendix Ascending Colon Transverse Colon Descending Colon Sigmoid Colon Rectum Urinary Bladder Urethra Uterus Ovary Penis/Vagina Testis External Genitalia Nound Whole Body </div>
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Case Presentation

Sedan vs SUV

Frontal Crash

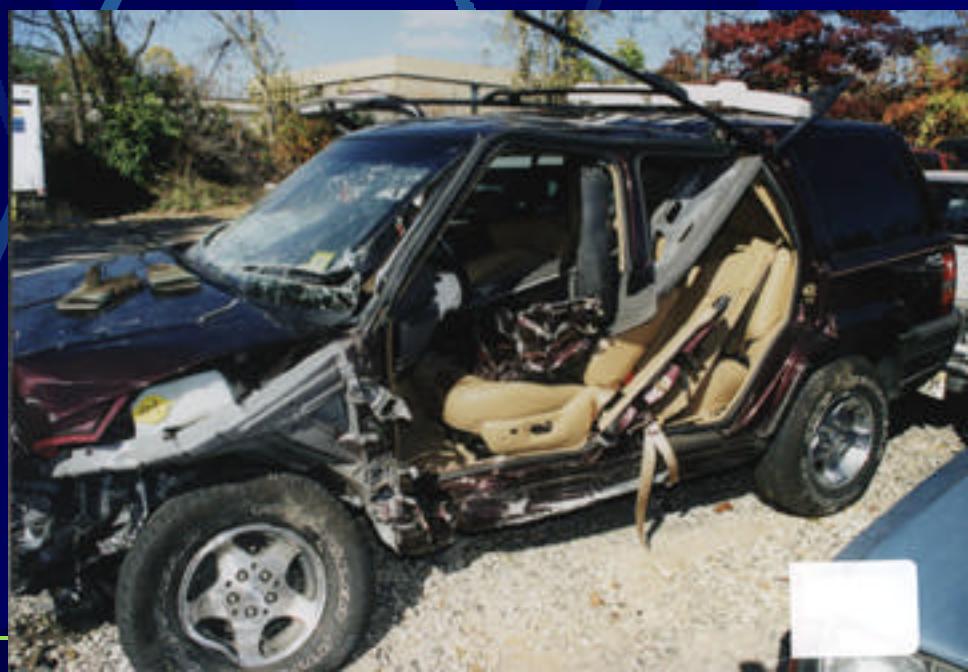
(Vehicle 2)

Case Occupant (V2)

- 38 year old male restrained driver
- Weight = 82 kg (180 lbs)
- Height = 178 cm (5' 10")

Reconstruction Data (V2)

- Frontal collision
- CDC = 12FLEE7
- PDOF = 355 degrees
- Delta V = 23.0 kph (14.3 mph)
- Max Crush = 128 cm at C1
- Estimated speed V1 = 56-64 kph (35-40 mph)
- Estimated speed V2 = 72-80 kph (45-50 mph)





Frontal motor vehicle crash

– Case Occupant (V2) Injury List

INJURY	SOURCE	INTRUSION (cm)
Loss of consciousness < 1 hr	airbag	N/A
Forehead abrasions	airbag	N/A
Right distal 1/3 fibula fracture	Brake pedal	15 cm displ.
Right distal 1/3 tibia fracture	Brake pedal	15 cm displ.
Left bimalleolar fibula fracture	Toe pan	22 cm

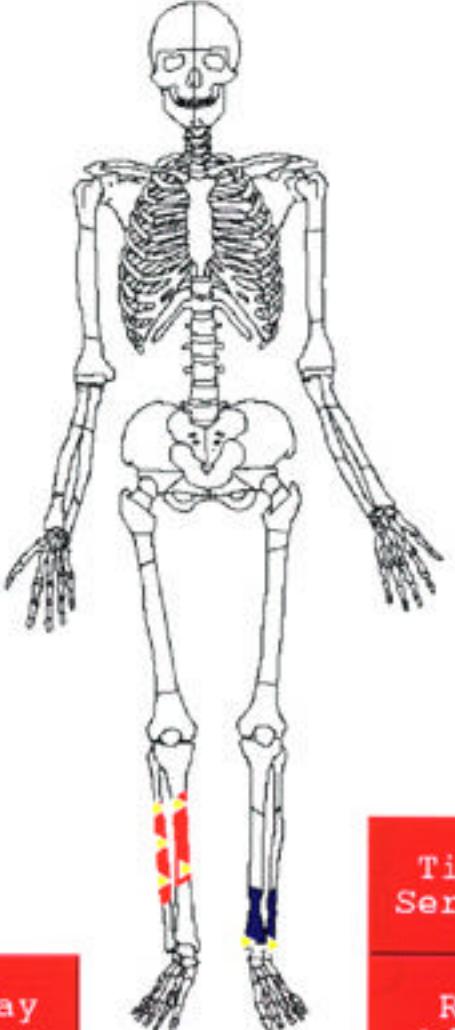
R



L



skel

Simple Closed Comminuted Closed Simple Open Comminuted Open Segmental Bone Loss Soft Tissue Loss Nerve Injury Fracture Site Amputation Site Lesion Excision Prostheses	Comminuted Open					
	New	List	Show	Print	File	Amend
	Name Last		First		Age	Weight
	Height		ft; in;		Hospital ID	kg; Sex
	Date MM		DD YY		Time HH	MM
					Day	File Date
	R	 <div style="position: absolute; bottom: 0; left: 0; width: 100%; height: 100%; background-color: black; opacity: 0.5;"></div>			L	
	R	<div style="position: absolute; bottom: 0; left: 0; width: 100%; height: 100%; background-color: black; opacity: 0.5;"></div>			L	
	R	<div style="position: absolute; bottom: 0; left: 0; width: 100%; height: 100%; background-color: black; opacity: 0.5;"></div>			L	
	Cervical Spine Thoracic Spine Lumbar Spine Sternum Skull Face Jaw Clavicle Scapula Ribs Proximal Humerus Midshaft Humerus Distal Humerus Elbow Proximal Radius/Ulna Midshaft Radius/Ulna Distal Radius/Ulna Hand Sacrum Ilium Pubic Ramus Ischium Acetabulum Femur Head Femur Neck Inter Troch. Femur Sub Troch. Femur Midshaft Femur Supra Condylar Femur Patella Proximal Tibia/Fibia Midshaft Tibia/Fibia Distal Tibia/Fibia Ankle Foot					
	Time Series Rx Adv.					
						

ME Case Presentation

Sedan vs SUV

Right Lateral Crash

Right lateral motor vehicle crash

V1 = 1991 Buick Skylark 4 door sedan (1299 kg), passing through intersection after reportedly failing to stop at red light.

V2 = 1996 Ford Explorer SUV (1775 kg), passed through intersection on green traffic signal.

Case Occupant (V1)

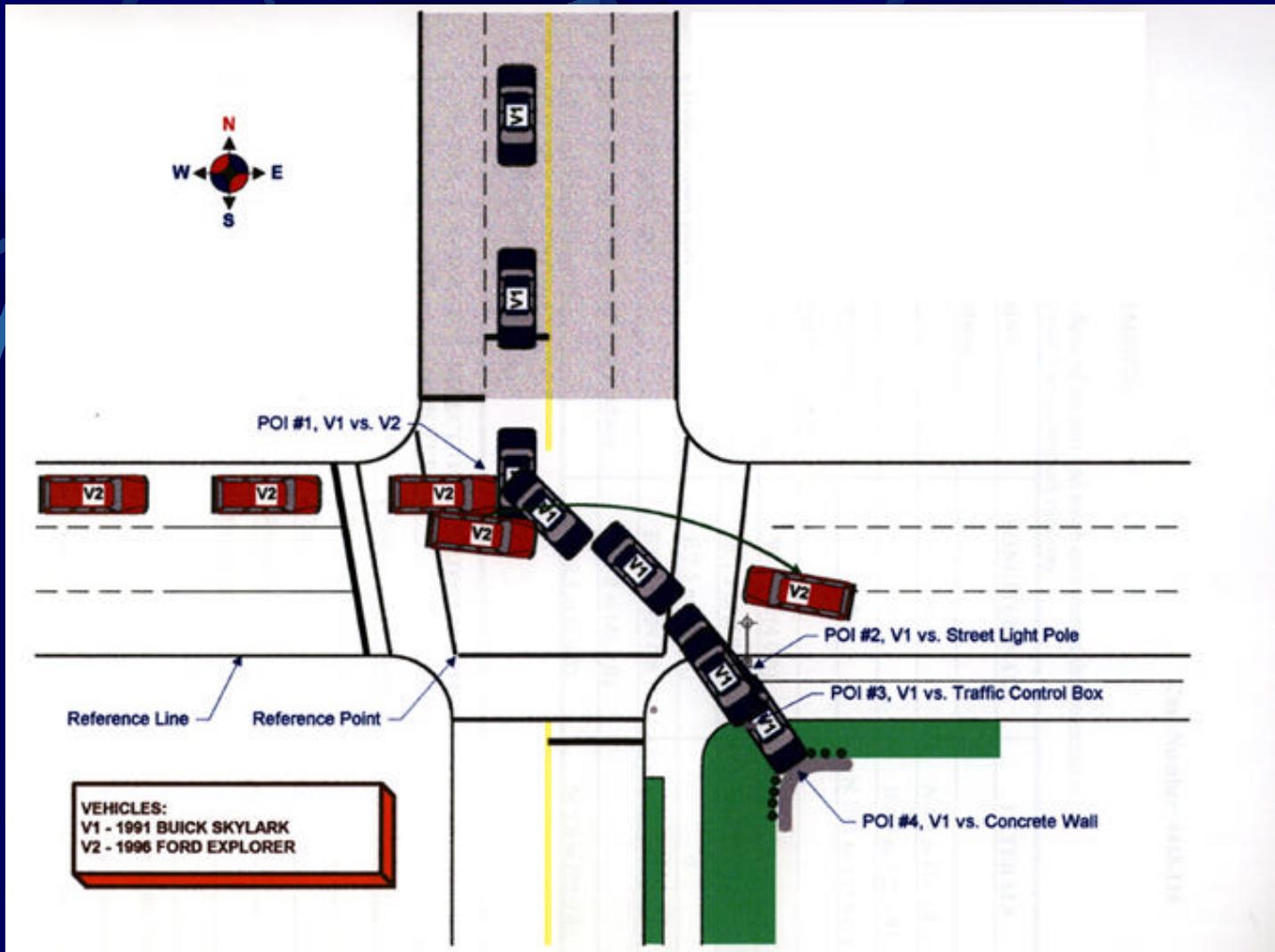
- 46 year old male unrestrained driver
- Weight = 116 kg (256 lbs)
- Height = 188 cm (6' 2")

Crash Scene

- 4-lane urban intersection controlled by a lighted traffic signal
- Speed limit = 64 km/h (40 mph)
- Roadway – wet, dark

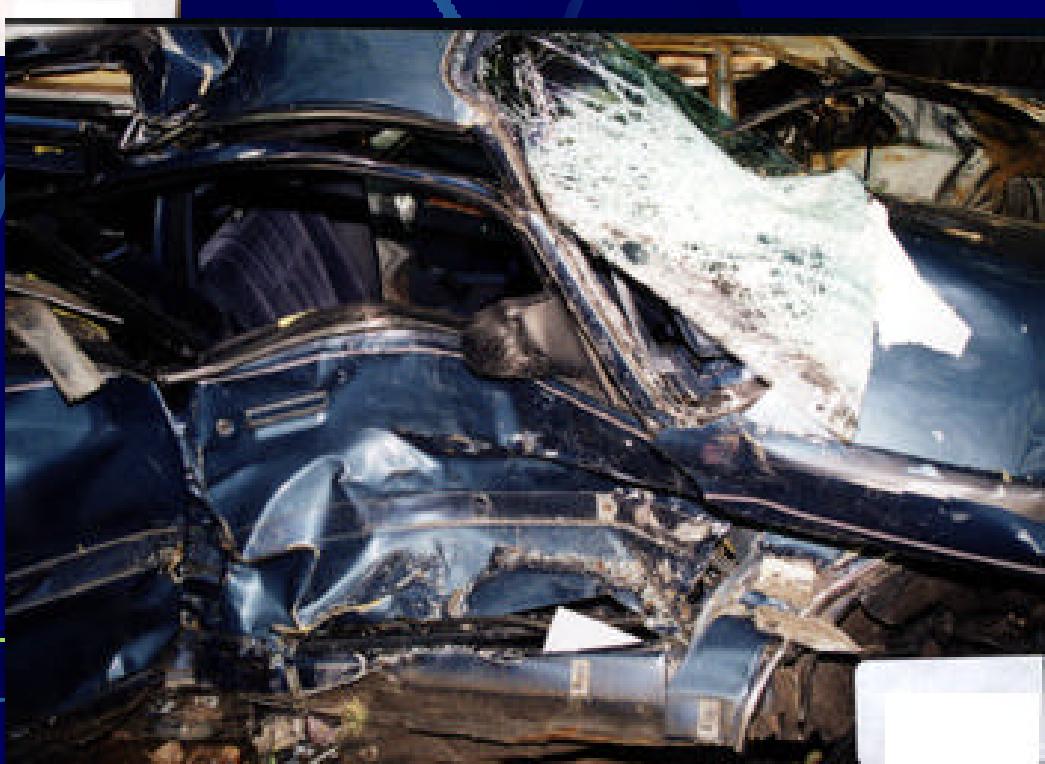
Reconstruction Data (V1)

- Right lateral collision
- CDC = 03RYAW6
- PDOF = 080 degrees
- Delta V = 58.8 kph (36.6 mph)
- Max Crush = 92 cm (12.2 in.) located 31 cm forward of C3
- Estimated speed V1 = 64-72 kph (40-45 mph)
- Estimated speed V2 = 81-88 kph (50-55 mph)











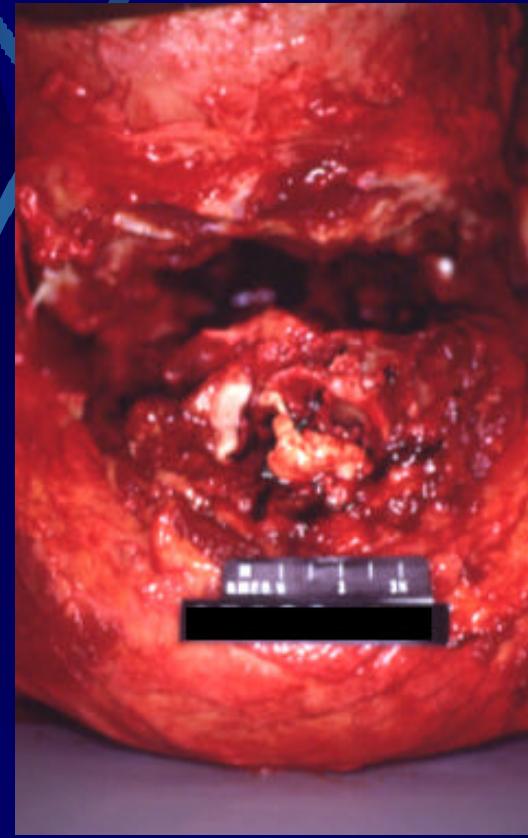


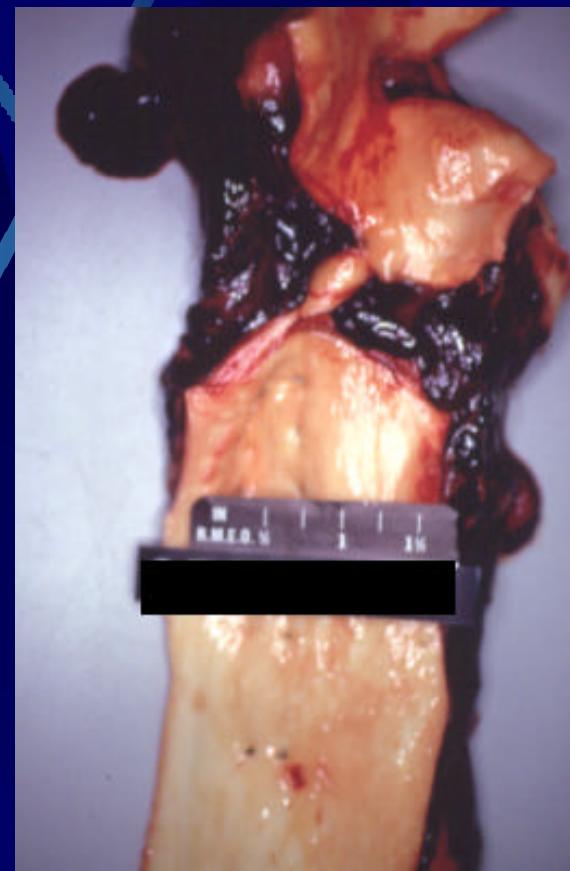
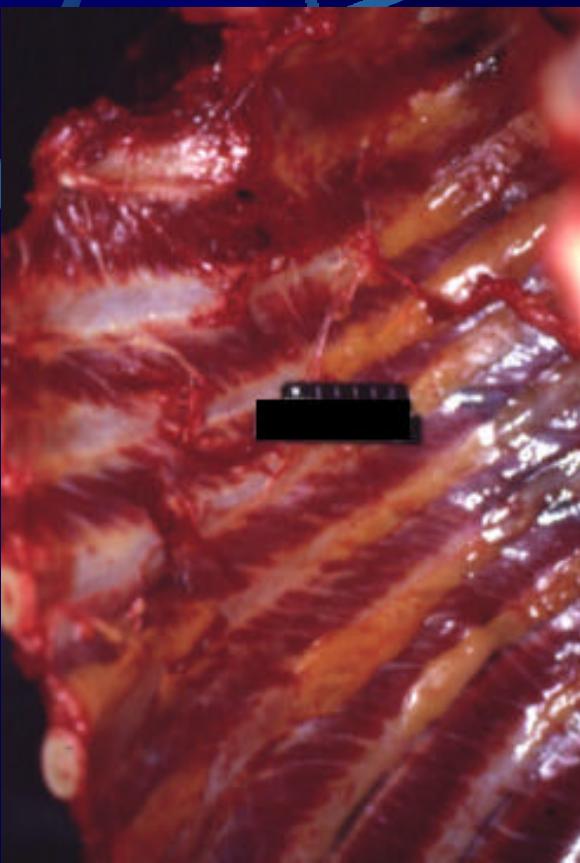
Right lateral motor vehicle crash vs SUV – Case Occupant (V1) Injury List

INJURY	SOURCE	INTRUSION (cm)
Subarachnoid hemorrhage (cerebellum)	Right front upper window frame	70 cm
Right jaw lacerations (2)	Right front window	70 cm
Right comminuted mandibular body fractures	Right front door panel	70 cm
Atlanta-occipital dislocation	Right front upper window frame	70 cm
C-spine C1 complete cord transection	Right front upper window frame	70 cm
Right rib fractures (II-V)	Right front door panel	70 cm
Thoracic aorta transection (100%, 3cm distal to the LSA)	Right front door panel	70 cm
Left hemothorax (750cc)	Right front door panel	70 cm

Right lateral motor vehicle crash vs SUV – Case Occupant (V1) Injury List, p. 2

INJURY	SOURCE	INTRUSION (cm)
Right vertebral artery laceration	Right front door panel	70 cm
Right upper extremity abrasions	Right front door panel	70 cm
Multiple liver lacerations	Right front door panel	70 cm
Bilateral pelvic abrasions (bilateral aspects)	unknown	N/A





spinal

Absent

Motor

Pin Prick

Light Touch

Impaired

Motor

Pin Prick

Light Touch

Gunshot Wound

Shotgun Wound

Stab Wound

Blunt Trauma

L	L	V1	R	R	R	L	L	L	T6	R	R	R
L	L	V2	R	R	R	L	L	L	T7	R	R	R
L	L	V3	R	R	R	L	L	L	T8	R	R	R
L	L	V4	R	R	R	L	L	L	T9	R	R	R
L	L	C1	R	R	R	L	L	L	T10	R	R	R
L	L	C2	R	R	R	L	L	L	T11	R	R	R
L	L	C3	R	R	R	L	L	L	T12	R	R	R
L	L	C4	R	R	R	L	L	L	L1	R	R	R
L	L	C5	R	R	R	L	L	L	L2	R	R	R
L	L	C6	R	R	R	L	L	L	L3	R	R	R
L	L	C7	R	R	R	L	L	L	L4	R	R	R
L	L	C8	R	R	R	L	L	L	L5	R	R	R
L	L	T1	R	R	R	L	L	L	S1	R	R	R
L	L	T2	R	R	R	L	L	L	S2	R	R	R
L	L	T3	R	R	R	L	L	L	S3	R	R	R
L	L	T4	R	R	R	L	L	L	S4	R	R	R
L	L	T5	R	R	R	L	L	L	S5	R	R	R

Absent Light Touch

New

List

Show

Print

File

Amend

Delete

Name Last	First	Age	46	Weight	120	kg; Sex	M	Race	W
Height	ft;	in;	Hospital ID	Trauma No	4448	SS#			
Date MM	DD	YY	Time HH	MM	Day	File Date			

R



L

L

EXAM NOT DONE
NORMAL EXAM

R



SENSORY SCORES R L TOTAL

Pin Prick 0 0 0

Light Touch 0 0 0

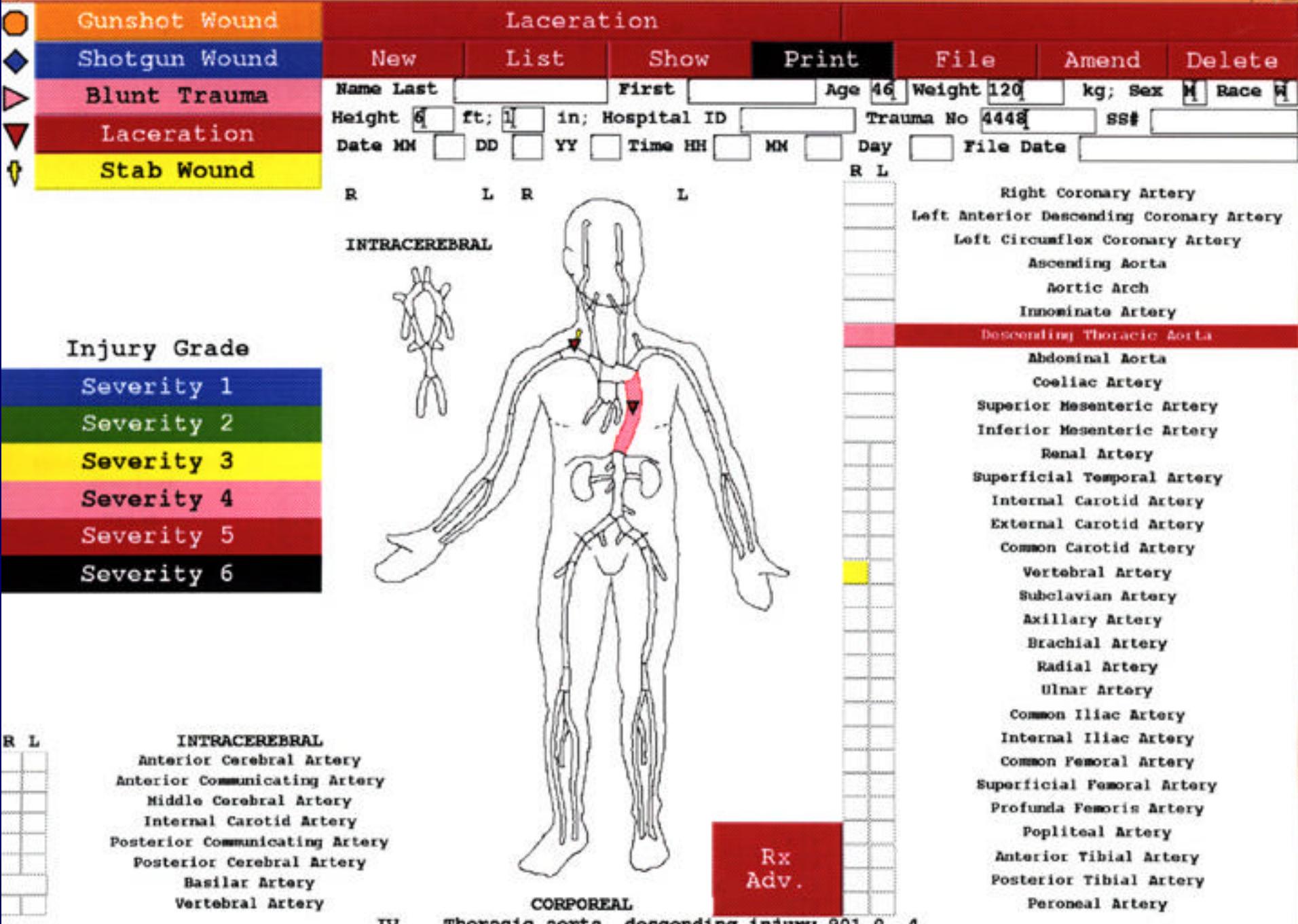
ANAL SENSATION YES NO

Blunt Injury : C1 : Complete Injury

C1 - C4 806.01

ASIA
MOTOR
SCORINGASIA
IMPAIRMENT
SCALEASIA
CLINICAL
SYNDROMESCNS
BRAIN
SYNDROMESCHRONIC
CONDITIONSRx
Adv.

Simple Closed		Fracture Site											
Comminuted Closed		New	List	Show	Print	File	Amend	Delete					
Simple Open		Name Last		First		Age 46	Weight 120	kg; Sex M Race W					
Comminuted Open		Height 6 ft; 1 in;		Hospital ID		Trauma No 4448		SS#					
Segmental Bone Loss		Date MM	DD	YY	Time HH	MN	Day	File Date					
Soft Tissue Loss		R		L	R	R	L						
Nerve Injury		Cervical Spine											
Fracture Site		Thoracic Spine											
Amputation Site		Lumbar Spine											
Lesion Excision		Sternum											
Prostheses		Skull											
Cervical C1 Fracture		Face											
Rib Fx T2 Right		Jaw											
Rib Fx T3 Right		Clavicle											
Rib Fx T4 Right		Scapula											
Rib Fx T5 Right		Ribs											
Sprain/Soft Tissue		Proximal Humerus											
Shoulder		R	L	Midshaft Humerus									
Elbow		R	L	Distal Humerus									
Wrist		R	L	Elbow									
Hip		R	L	Proximal Radius/Ulna									
Knee		R	L	Midshaft Radius/Ulna									
Ankle		R	L	Distal Radius/Ulna									
Ligament Disruption		Hand											
Shoulder		R	L	Sacrum									
Elbow		R	L	Ilium									
Wrist		R	L	Pubic Ramus									
Hip		R	L	Ischium									
Knee		R	L	Acetabulum									
Ankle		R	L	Femur Head									
Pubis		Femur Neck											
Sacroiliac		R	L	Inter Troch. Femur									
Dislocation		Sub Troch. Femur											
Jaw		R	L	Midshaft Femur									
Shoulder		R	L	Supra Condylar Femur									
Elbow		R	L	Patella									
Wrist		R	L	Proximal Tibia/Fibia									
Hip		R	L	Midshaft Tibia/Fibia									
Knee		R	L	Distal Tibia/Fibia									
Ankle		R	L	Ankle									
Pubis		Foot											
Sacroiliac		R	L										
X-Ray Image													
<table border="1"> <tr><td colspan="2">Time Series</td></tr> <tr><td colspan="2">Rx Adv.</td></tr> </table>										Time Series		Rx Adv.	
Time Series													
Rx Adv.													



ME Case Presentation

Sedan vs SUV

Left Lateral Crash

Left lateral motor vehicle crash

V1 = 1985 Oldsmobile Cutlass Ciera 4 door sedan (1257 kg), passing through intersection on green light

V2 = 1994 Nissan Pathfinder SUV (1762 kg), passed through intersection on red traffic signal

Case Occupant (V1)

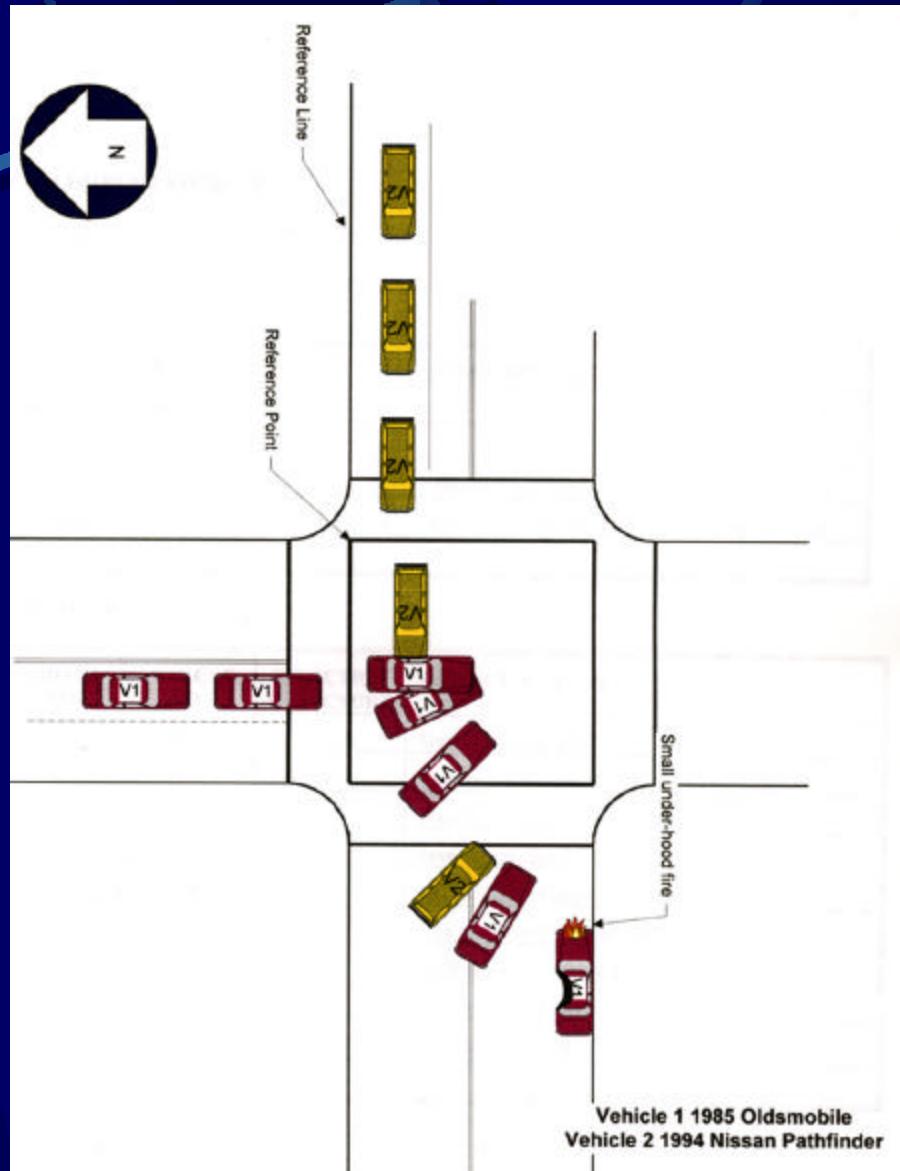
- 35 year old female unrestrained driver
- Weight = 99 kg (218 lbs)
- Height = 178 cm (5' 10")

Crash Scene

- 4-lane urban intersection controlled by a lighted traffic signal
- Roadway level and straight
- Speed limit = 56 km/h (35 mph)
- Roadway – asphalt, dry, free of defects
- Coefficient of friction – 0.70

Reconstruction Data (V1)

- Left lateral collision
- CDC = 09LYAW5
- PDOF = 260 degrees
- Delta V = 47 kph (29 mph)
- Max Crush = 89 cm at C3
- Estimated speed V1 = 32-40 kph (20-25 mph)
- Estimated speed V2 = 48-56 kph (30-35 mph)



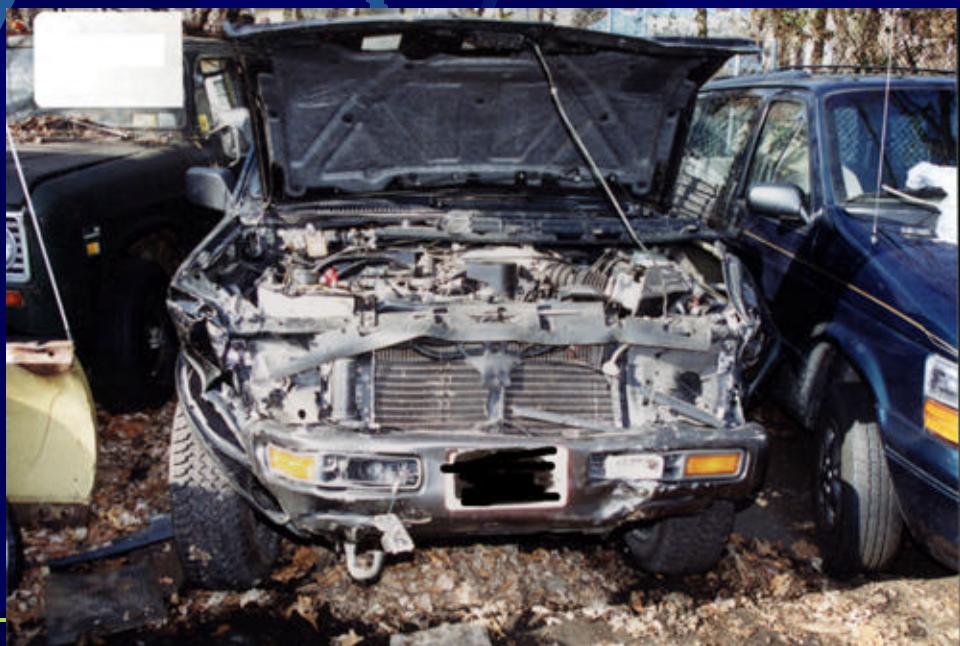






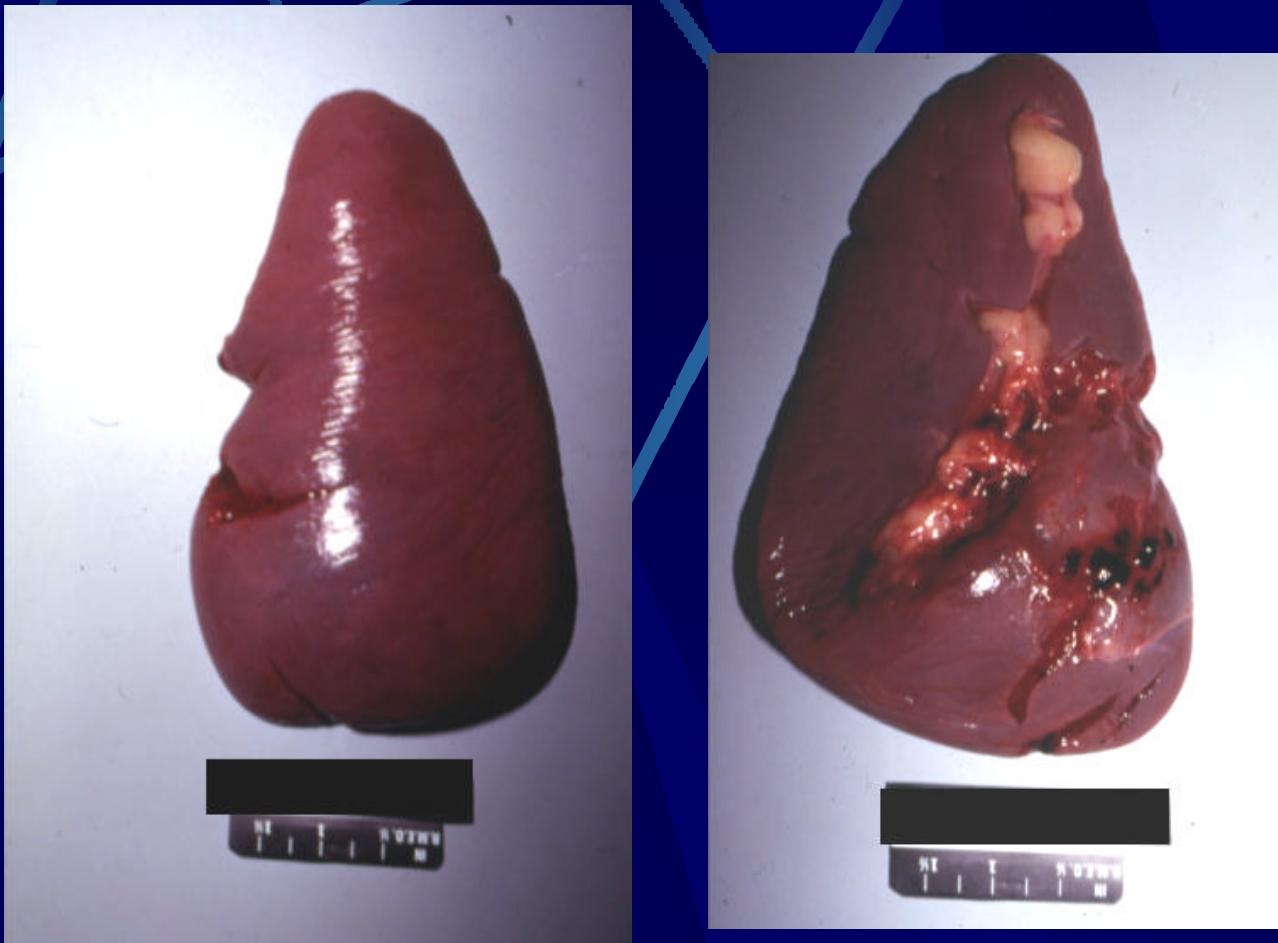


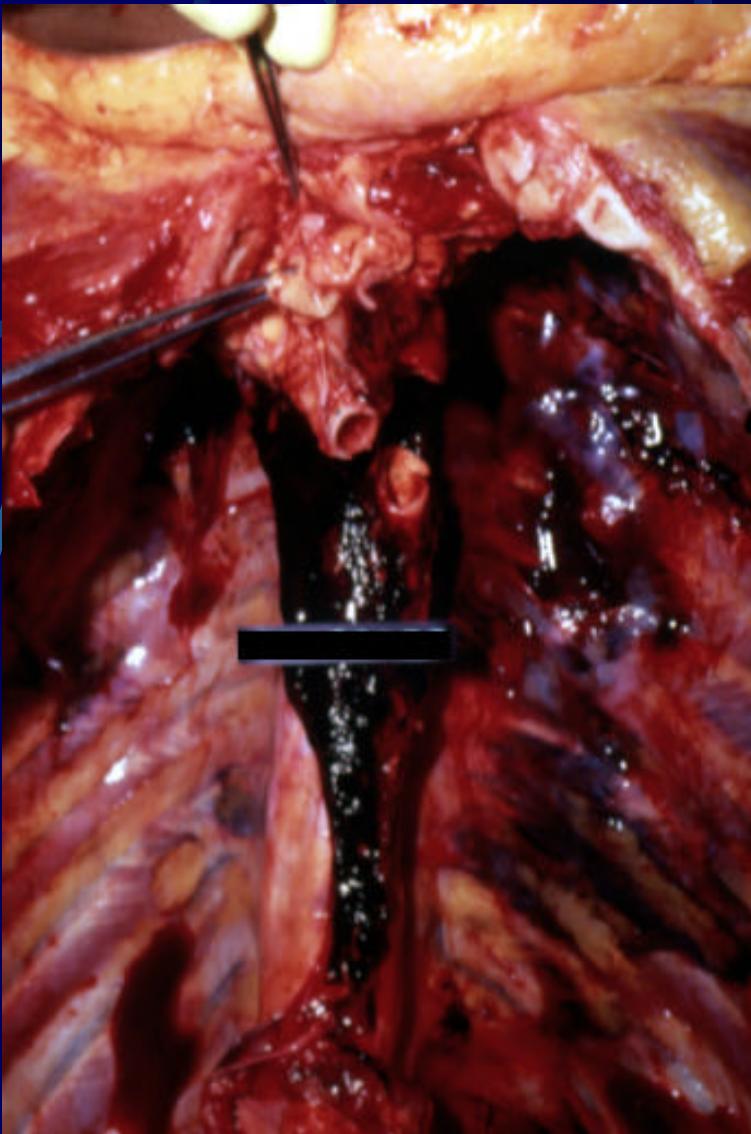




Left lateral motor vehicle crash vs SUV – Case Occupant (V1) Injury List

INJURY	SOURCE	INTRUSION (cm)
Bilateral subarachnoid hemorrhages	B-pillar	38 cm
Bilateral rib fractures	Door panel	29 cm
Bilateral pulmonary contusions	Door panel	29 cm
Bilateral pulmonary lacerations	Door panel	29 cm
Thoracic aorta transection	Door panel	29 cm
Splenic lacerations	Door panel	29 cm
Hemoperitoneum	Door panel	29 cm
Left shoulder lacerations	Door panel	29 cm
Left knee laceration	Lower door panel	29 cm
Left lower leg abrasions	Lower door panel	29 cm

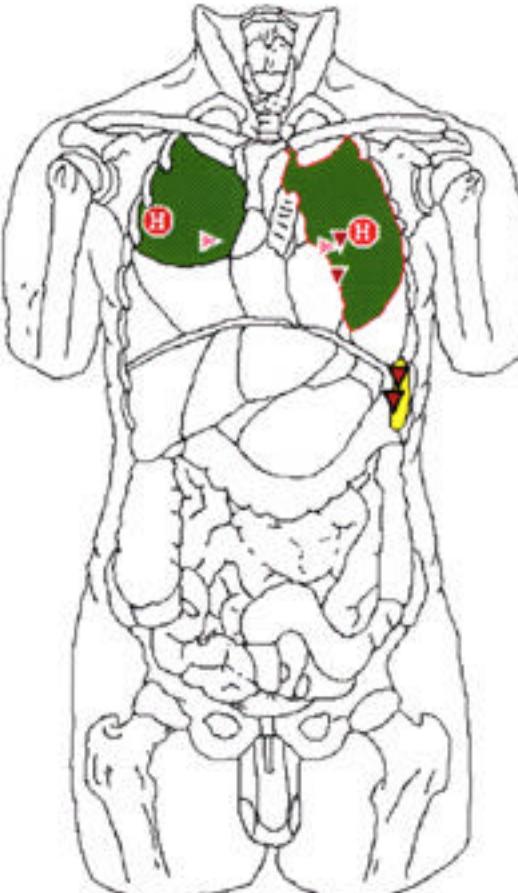
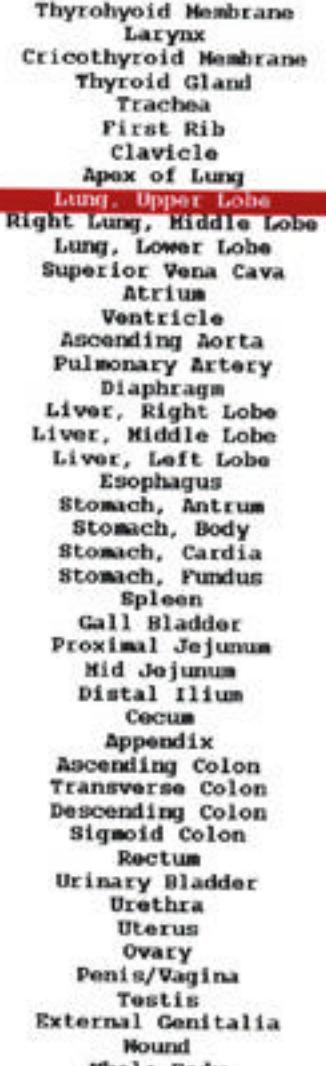




Thoracic aorta transection

Gunshot Wound
Shotgun Wound
Blunt Trauma
Laceration
Stab Wound
Injury Grade
Severity 1
Severity 2
Severity 3
Severity 4
Severity 5
Severity 6
Complication
Systemic
Cardiopulmonary
Pneumonitis
Inflammation
Obstruction
Infarction
Hemorrhage
Infection
Perforation
Abcess
Organ Failure
Infectious Agents

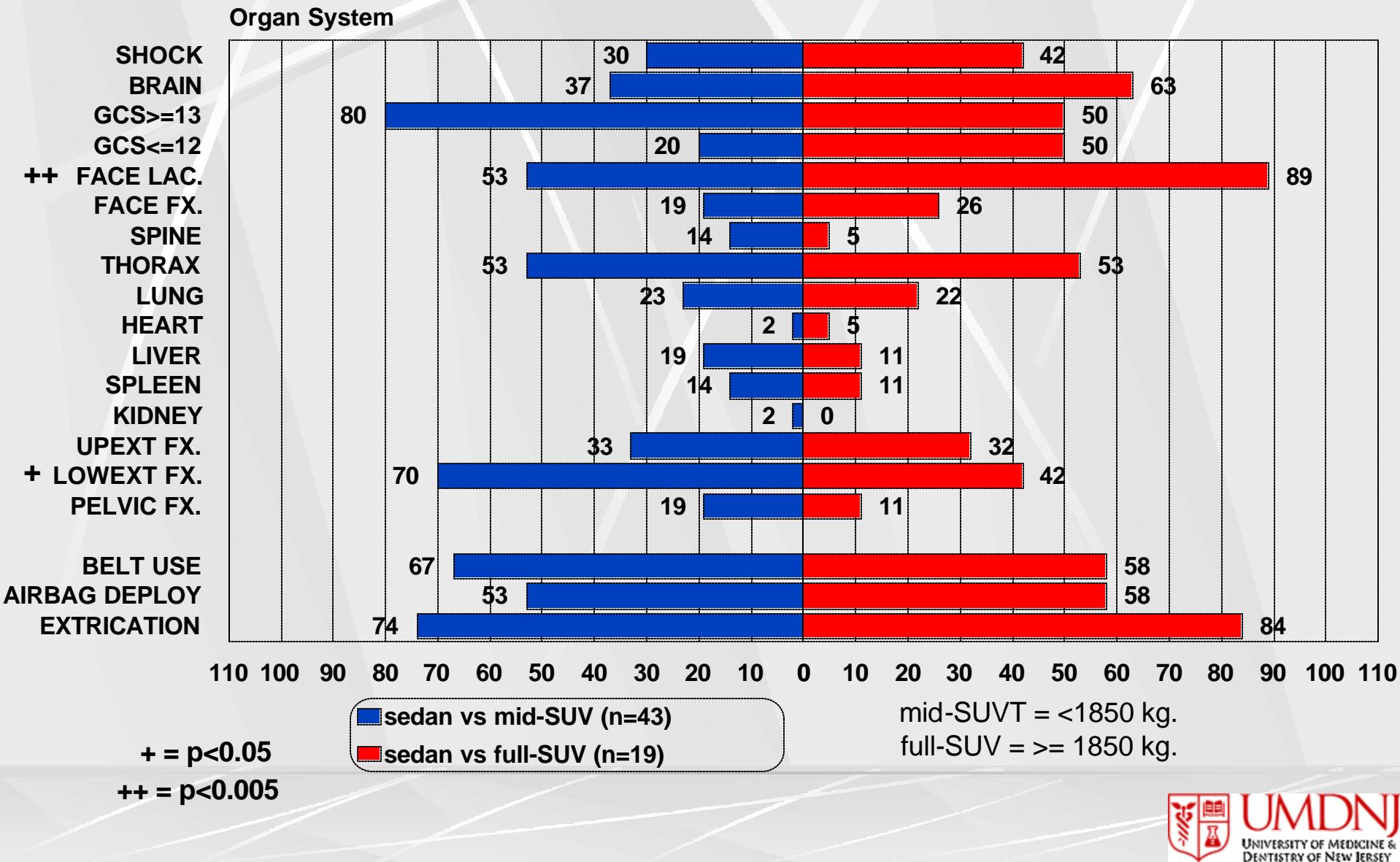
Viscera

Laceration		Print	File	Amend	Delete
New	List	Show			
Name Last <input type="text"/> First <input type="text"/> Age <input type="text"/> 35 Weight <input type="text"/> 105 kg; Sex <input checked="" type="checkbox"/> Race <input type="text"/> B		Age <input type="text"/> 35 Weight <input type="text"/> 105 kg; Sex <input checked="" type="checkbox"/> Race <input type="text"/> B			
Height <input type="text"/> ft; <input type="text"/> in; Hospital ID <input type="text"/>		Trauma No <input type="text"/> 4431 SS# <input type="text"/>			
Date MM <input type="text"/> DD <input type="text"/> YY <input type="text"/>	Time HH <input type="text"/> MM <input type="text"/>	Day <input type="text"/>	File Date <input type="text"/>		
					
R L					
R L					
					
Time Series					
Rx Adv.					

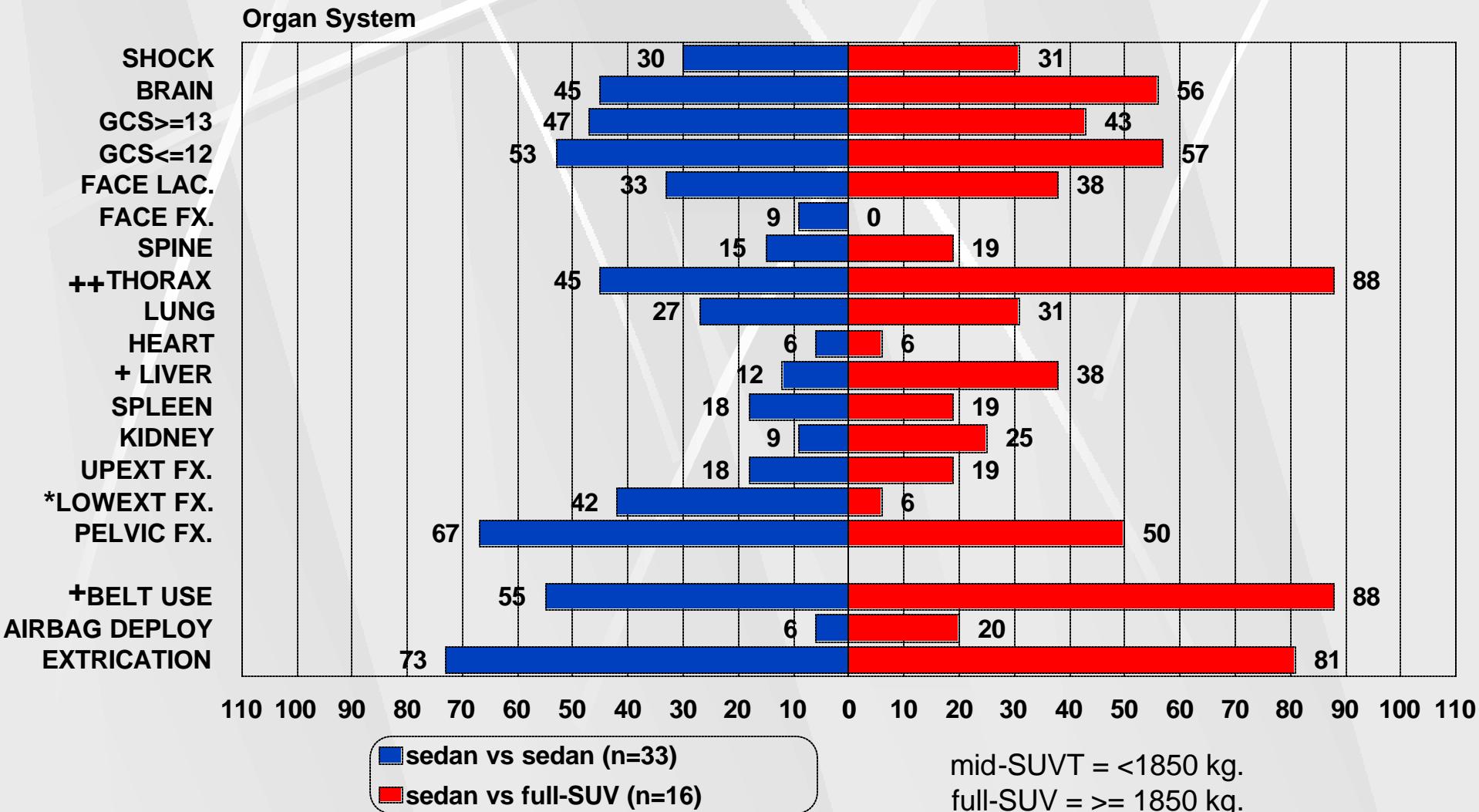
II Laceration: Hemothorax 860.2 3

Gunshot Wound		Laceration		decidate			
Shotgun Wound		New	List	Show	Print	File	Amend
Blunt Trauma		Name Last		First	Age 35	Weight 105	kg; Sex F Race B
Laceration		Height 5	ft; 9 in;	Hospital ID	Trauma No 4431	SS#	
Stab Wound		Date MM	DD	YY	Time HH	MM	Day R L File Date
R	L	R	L				
INTRACEREBRAL							
INTRACEREBRAL		<p>Right Coronary Artery Left Anterior Descending Coronary Artery Left Circumflex Coronary Artery Ascending Aorta Aortic Arch Innominate Artery Descending Thoracic Aorta Abdominal Aorta Coeliac Artery Superior Mesenteric Artery Inferior Mesenteric Artery Renal Artery Superficial Temporal Artery Internal Carotid Artery External Carotid Artery Common Carotid Artery Vertebral Artery Subclavian Artery Axillary Artery Brachial Artery Radial Artery Ulnar Artery Common Iliac Artery Internal Iliac Artery Common Femoral Artery Superficial Femoral Artery Profunda Femoris Artery Popliteal Artery Anterior Tibial Artery Posterior Tibial Artery Peroneal Artery</p>					
R L		<p>Anterior Cerebral Artery Anterior Communicating Artery Middle Cerebral Artery Internal Carotid Artery Posterior Communicating Artery Posterior Cerebral Artery Basilar Artery Vertebral Artery</p> <p>Rx Adv.</p>					
INTRACEREBRAL							
CORPOREAL							
IV Thoracic aorta, descending injury 901.0		4					

Frontal Sedan/Mid-Size SUVT vs Sedan/Full-Size SUVT



Lateral Sedan/Sedan vs Sedan/Full-Size SUVT



+ = p<0.05

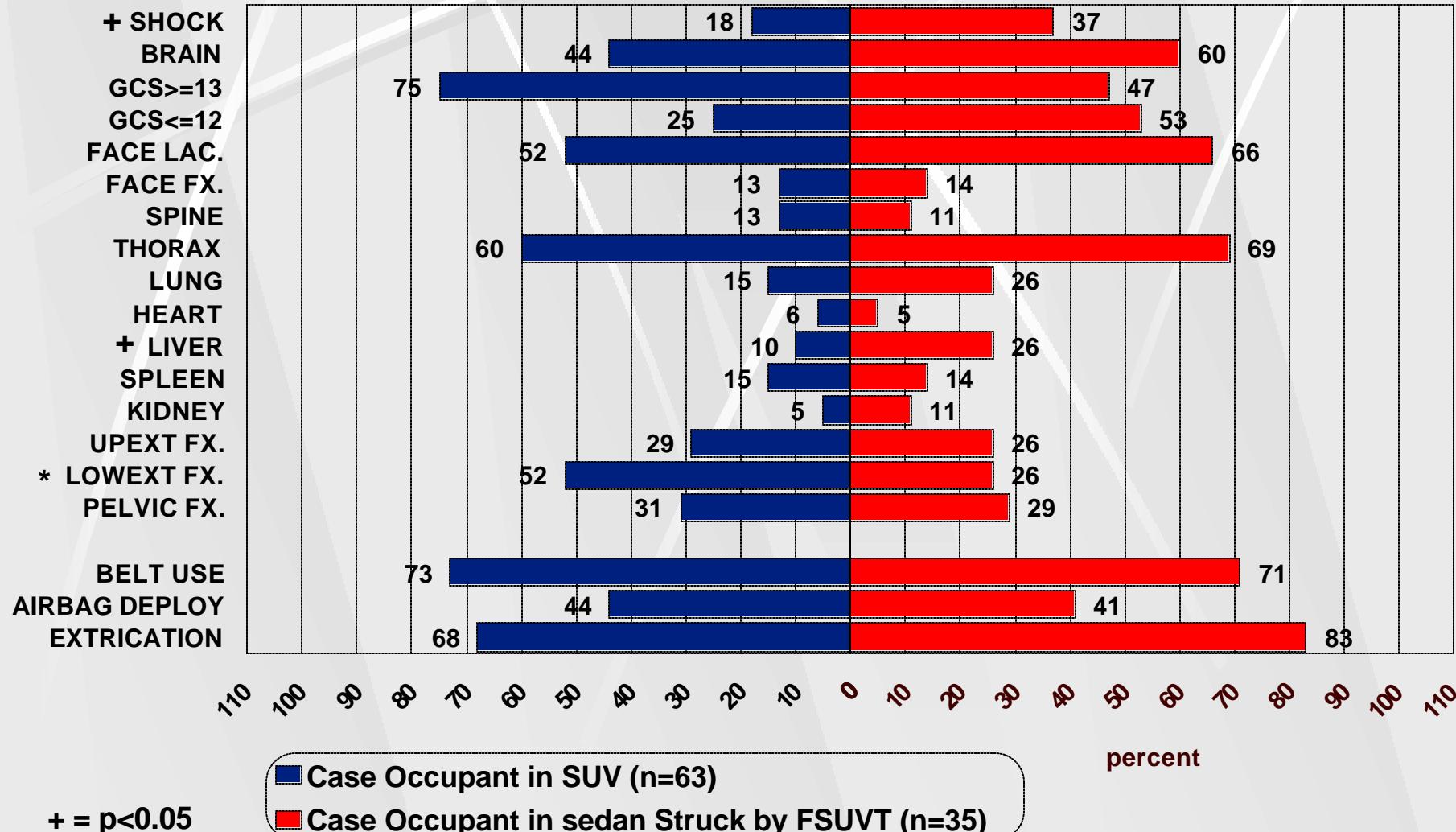
* = p<0.01

++ = p<0.005

SUV Injury Comparison:

Patient in SUV vs. Patient struck by FSUVT (frontal or lateral)

Organ System



+ = p<0.05

* = p<0.01

FSUVT = >= 1850 kg.

Table II: Comparison of Vehicle Structural Parameters in Frontal Crashes:
Striking V2 vs Occupant V1

Parameters	Sedan (V2) vs Sedan (V1)	MSUVT (V2) vs Sedan (V1)	FSUVT (V2) vs Sedan (V1)
N	84	43	19
Delta V1 (kph)	47.69	46.59	41.71
Mass excess V2-V1 (kg)	93.93 *	281.81 ***	1117.00 ***
Mass ratio V2/V1	1.11	1.27	2.02
Width Excess (in)	0.52	0.75	6.56 *
Wheelbase excess (in)	1.19	8.75 *	17.00 *
Bumper height excess (in)	0.02	2.46 ***	3.22 *
Hood height excess (in)	0.10	8.82 ***	13.33 ***

paired t-test: P-value: * < 0.05; ** < 0.01; *** < 0.001

Table III: Comparison of Vehicle Structural Parameters in Lateral Crashes:
Striking V2 vs Occupant V1

Parameters	Sedan (V2) vs Sedan (V1)	FSUVT (V2) vs Sedan (V1)
N	33	16
Delta V1 (kph)	31.40	39.77
Mass excess V2-V1 (kg)	253.15 ***	887.44 ***
Mass ratio V2/V1	1.24	1.77
Width Excess (in)	1.53	7.22 ***
Wheelbase excess (in)	3.74 *	23.22 **
Bumper height excess (in)	-0.32	6.44 ***
Hood height excess (in)	1.11	12.22 ***

paired t-test: P-value: * < 0.05; ** < 0.01; *** < 0.001

Table IV: Comparison Between Categories of Vehicle Crashes by Striking V2 vs Occupant V1 Categories

Parameters	FRONTAL			LATERAL
	SvS vs MSUVTvS	SvS vs FSUVTvS	MSUVTvS vs FSUVTvS	SvS vs FSUVTvS
N	127	103	62	49
Mass excess V2-V1 (kg)	**	***	***	***
Mass ratio V2/V1	**	***	***	***
Delta V1 (kph)	n/s	n/s	n/s	*
Width Excess (in)	n/s	*	n/s	***
Wheelbase excess (in)	*	*	n/s	**
Bumper height excess (in)	***	*	n/s	***
Hood height excess (in)	***	***	*	***

paired t-test: P-value: * < 0.05; ** < 0.01; *** < 0.001

Table V: Effect of Crash Type on Incidence of Injury Producing Occupant Compartment Contacts

Frontal and Lateral Two-Vehicle Crashes Only	All Frontal	Sedan (V2) vs Sedan (V1)	SUVT (V2) Vs Sedan (V1)	All Lateral	Sedan (V2) vs Sedan (V1)	SUVT (V2) Vs Sedan (V1)
No. of patients	41	27	14	41	20	21
No. of hits	98	58	40	53	27	26
Windshield (%)	7	5	10	2	4	0
Steering Wheel (%)	21	21	22	4	0	8
Instr. Panel (%)	36	41	28	11	15	8
Floor/toepan (%)	20	17	25	6	7	4
A-pillar (%)	5	5	5	15	11	19
Door panel (%)	9	9	10	51	48	54
B-pillar (%)	1	2	0	11	15	8

Conclusions

- In two-vehicle MVCs, SUVT occupants are better protected against serious brain and face injuries than occupants of the sedans that they hit.
- Full size SUVTs striking sedans shift the pattern of injuries in a cephalad direction, increasing the incidence of brain, thorax, lung and liver injuries and decreasing the incidence of pelvic fractures and lower extremity injuries, compared to sedan vs sedan crash injuries.

Factors Inducing Injuries in SUVT vs Sedan Crashes

- Increase in mass ratio SUVT vs sedan
- Increase in bumper height SUVT vs sedan
- Increase in hood height SUVT vs sedan
- Increase in strike width of SUVT

Suggestions for Vehicle Modifications to Reduce Injury Incidence and Severity

- Uniform bumper height of sedans and SUVTs to match sedan frame support
- Increase side impact standards to reduce intrusion of side door components into vehicle
- Greater crush force dissipation in frontal structure of SUVTs
- Side airbags at head and thorax/pelvis level in sedans



New Jersey State Regional Medical Examiner's Office

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- o J. Shaikh, MD
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 - Fred Rivara, MD
 - Charles Mock, MD

Additional Discussion

- ME case with brush guards
- Tabular results – airbag effects

ME Case Presentation

Sedan vs SUV

Right Lateral Crash

Right lateral motor vehicle crash

V1 = 1996 Plymouth Neon 4 door sedan (1096 kg), attempting to make left turn on green. This vehicle DID meet the 1997 side protection standards.

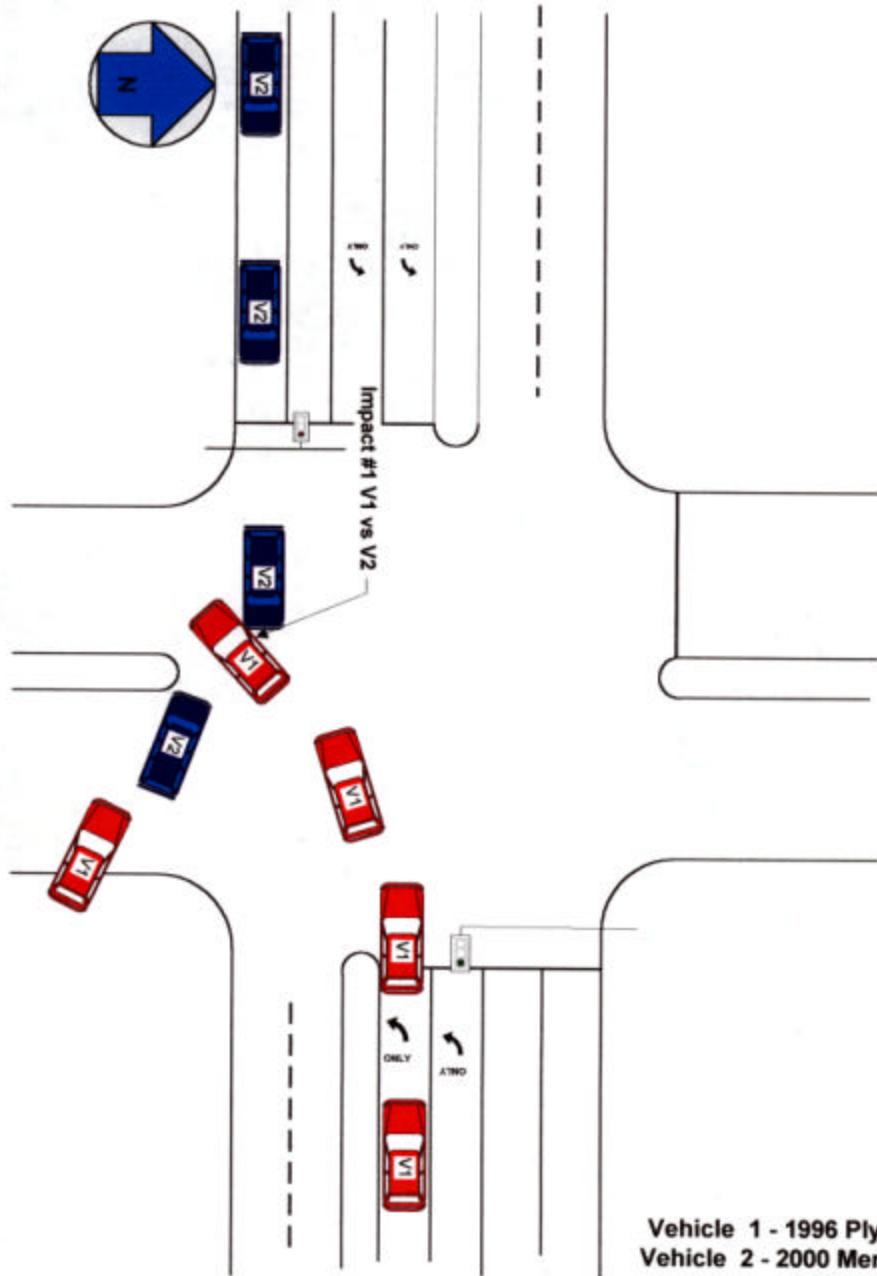
V2 = 2000 Mercedes-Benz ML430 SUV (2714 kg), passed through intersection on red traffic signal

Case Occupant (V1)

- 51 year old white female restrained front seat passenger
 - Weight = 67 kg (148 lbs)
 - Height = 168 cm (5' 6")

Crash Scene

- 4-lane urban intersection controlled by a lighted traffic signal
- 2 left lanes marked for left turn in both directions
- Speed limit = 80 km/h (50 mph)
- Roadway – dry, free of defects
- Coefficient of friction – 0.75
- Curbs were covered by snow



Vehicle 1 - 1996 Plymouth Neon
Vehicle 2 - 2000 Mercedes ML430





Reconstruction Data (V1)

- Right lateral collision
- CDC = 02RYEW4
- PDOF = 060 degrees
- Delta V = 58.8 kph (36.6 mph)
- Max Crush = 61 cm (24.4 in.) at C2
- Estimated speed V1 = 19 kph (12 mph)
- Estimated speed V2 = 80 kph (50 mph)

















Right lateral motor vehicle crash vs SUV – Case Occupant Injury List

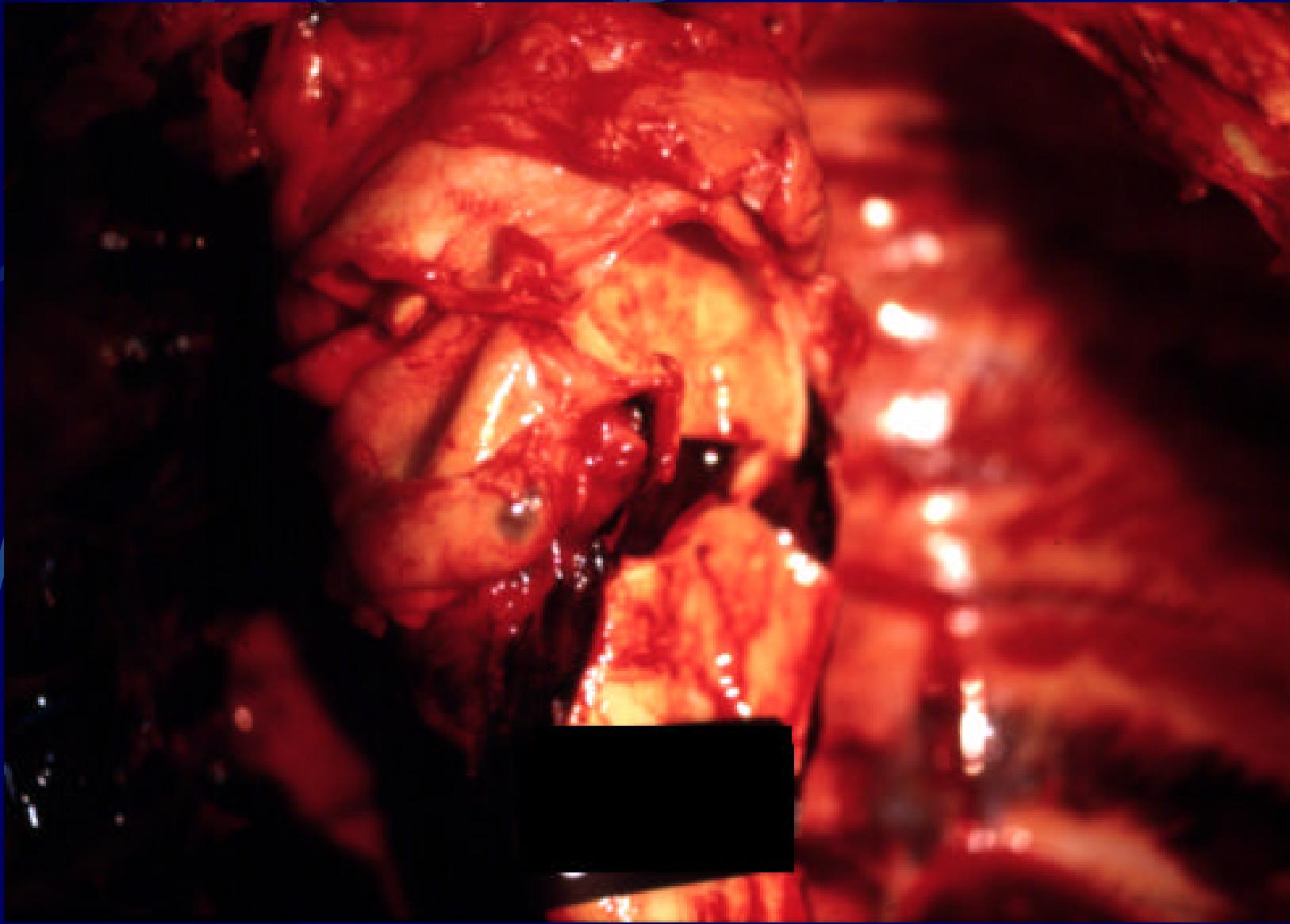
INJURY	SOURCE	INTRUSION
Unconsciousness at scene	B-pillar	34 cm (13.6 in)
Right parietal scalp abrasion	B-pillar	34 cm (13.6 in)
Right subgaleal hemorrhage	B-pillar	34 cm (13.6 in)
Right forehead, eyelid abrasions	B-pillar	34 cm (13.6 in)
Bilateral posterior rib fractures (Right II-IX; Left V, VI)	Right door panel	39 cm (15.4 in)
Posterior thoracic aorta laceration (4cm distal to the ostium of LSA)	Right door panel	39 cm (15.4 in)
Bilateral hemothoraces (3500cc)	Right door panel	39 cm (15.4 in)

Right lateral motor vehicle crash vs SUV – Case Occupant Injury List, p. 2

INJURY	SOURCE	INTRUSION
Bilateral diaphragmatic laceration at the crura and T-spine junction	Right door panel	39 cm (15.4 in)
Three linear liver lacerations (Grade II)	Right door panel	39 cm (15.4 in)
Spleen laceration (Grade I)	Center console	None
Bladder mucosal laceration	Right door panel	39 cm (15.4 in)
Right knee abrasion	Lower door panel	32 cm (12.6 in)
Left pubic rami fracture	Center console	None
Right sacroiliac joint fracture dislocation	Right door panel	39 cm (15.4 in)



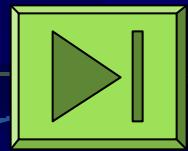






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END



**Table II - Effect of Increased Mass Ratios
Frontal Airbag & Frontal No-Airbag Crashes**

Mechanics	Sedan noAB / Sedan	Sedan AB / Sedan	Sedan noAB / SUVT	Sedan AB / SUVT	SUVT noAB / Sedan	SUVT AB / Sedan
N	35	52	28	34	9	16
Mass V-occ / Mass V-str (kg)	1177/1290	1317/1389	1190/1781	1301/1795	1461/1346	1767/1255
Mass ratio (striking/occupant)	1.1	1.05	1.5	1.38	0.92	0.71
Delta V-occ (kph)	48.3	47.2	49.8	41	48	47.2
% Occupant Belted	74	73	61	68	100	81
ISS-occ	35.4	20.7	24.3	21.4	18	12.4
% Survival - occ	71	80	64	76	100	100
Hospital Days	15	10.1	11.6	10.1	28.8	5

Table III - Effect of Increased Mass Ratios

Lateral Crashes

Mechanics	Sedan / Sedan	Sedan / SUV/T
N	33	37
Mass V-occ / Mass V-str (kg)	1176/1429	1243/1810
Mass ratio (striking/occupant)	1.22	1.46
Delta V-occ (kph)	31.6	40.7
% Occupant Belted	55	72
ISS-occ	23.8	32.3
% Survival - occ	81	68
Hospital Days	18.2	16.2



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END

