

# THORACIC TRAUMA

# **SEVERE THORACIC TRAUMA**

- **Full size automobile**
- **Adult male patient (State trooper)**
- **Frontal crash**
- **Restrained with airbag**

# CIREN INVESTIGATION

- **Special investigation meeting including...**
- **EMS present at scene (U.S. secret service)**
- **MD present at scene and in helicopter**
- **Ciren crash reconstruction team**
- **Maryland State Police reconstruction team**

# CIREN INVESTIGATION

- **Special investigation meeting including...**
- **Resuscitating and operating surgeon**
- **Ciren site principle investigator, having also been present in OR and resuscitation**
- **State medical examiner**
- **NHTSA Ciren and special investigators**

# ROADWAY



- **2 lane asphalt paved 35 foot travel lanes of ...**
- **A 4 lane, divided, limited access trafficway**
- **Roadway is straight and level**
- **Posted speed limit is 55 mph**

# V1 DRIVER (CASE OCCUPANT)

- 27 y/o male
- Height: 72 inches
- Weight: 199 pounds
- Restrained by 3-point manual lap/shoulder
- Wearing protective vest *without trauma shield*

# VEHICLE 1

**1996 Ford Crown Victoria  
Marked state police car**



**Dual airbags**

# VEHICLE 2

- 1994 Dodge Ram 250 van
- 500 pounds of cargo
- Driver: 30 y/o male
- No ht or wt given
- Restraint availability/usage unknown



# CRASH



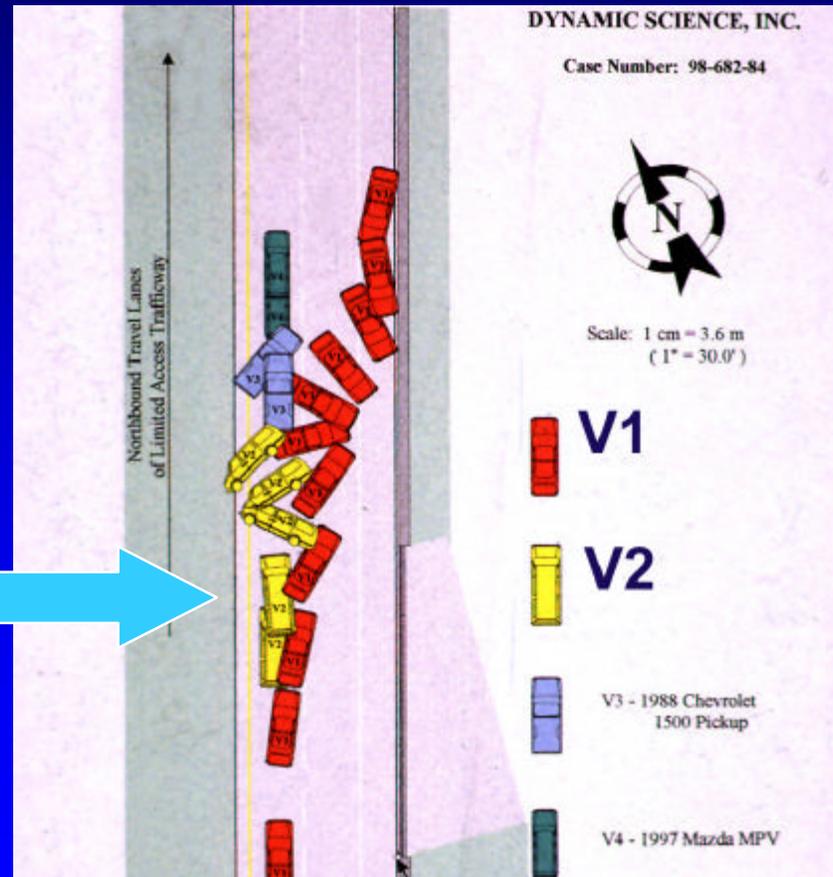
- **V1 was being driven north, estimated speed 70-75 mph. Vehicles 2, 3, 4 were stopped, facing north in N/B travel lane, due to road construction**

# CRASH

- **Upon seeing V2 stopped in his travel path, the driver of V1 applied the brakes and steered sharply right (30 ft skid) in an unsuccessful effort to avoid V2**

# CRASH

Traffic stops  
suddenly



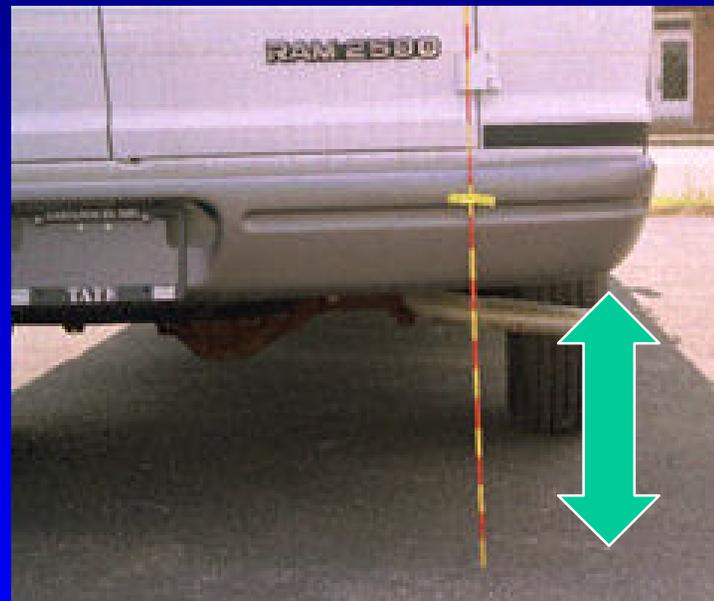
# CRASH

- The L/F corner of V1 impacted the R/R corner of V2. The front bumper of V1 *severely underrode* the rear bumper of V2 at impact

# MISMATCH



**Deceleration**



**Commercial**

# CRASH: FRONTAL AND VERTICAL OFFSET



# DELTA V's

Estimated using missing vehicle algorithm

- V1:

Delta V  
CDC  
PDOF  
Max.Crush

=19 mph  
=12 FLEE6  
=355 deg  
=77 inches

- V2:

Delta V  
CDC  
PDOF

=17 mph  
=06 BREE3  
= 175 deg

# VEHICLE 1

- The effects to the passenger compartment are catastrophic



# V1 AT IMPACT

- **The forces involved in the initial impact exceeded the SRS threshold, both driver's and passenger's airbags deployed.**
- **The right rear of V2 rested on the L front of V1 while both remained together for about thirty feet, at which time V2 "fell off" V1 and rolled onto its right side plane.**

# SCENE DATA



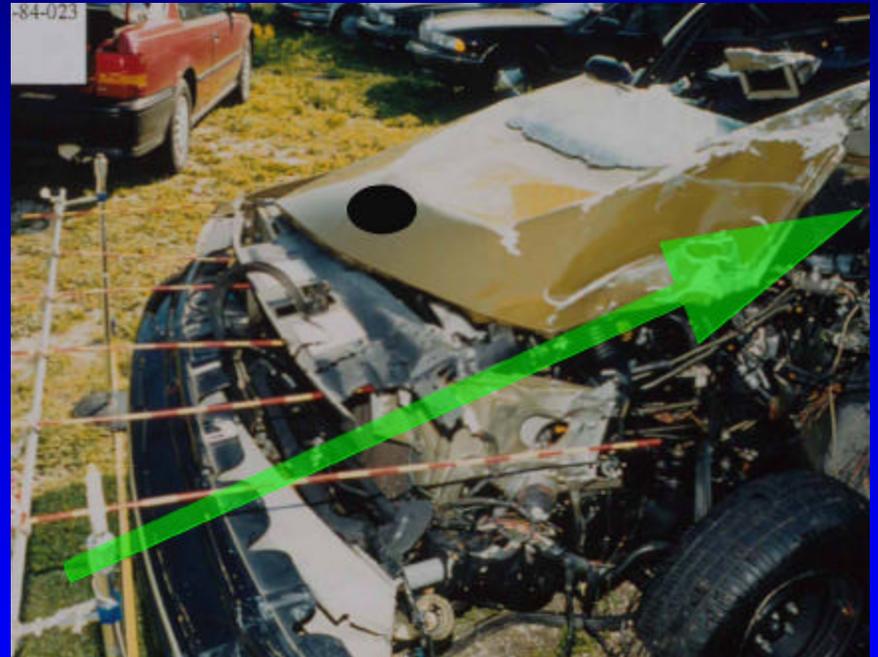
# VEHICLE 1

- No participation by the lower “frame” components in managing the energy of the crash
- No participation of the right side of the vehicle in managing the energy of the crash

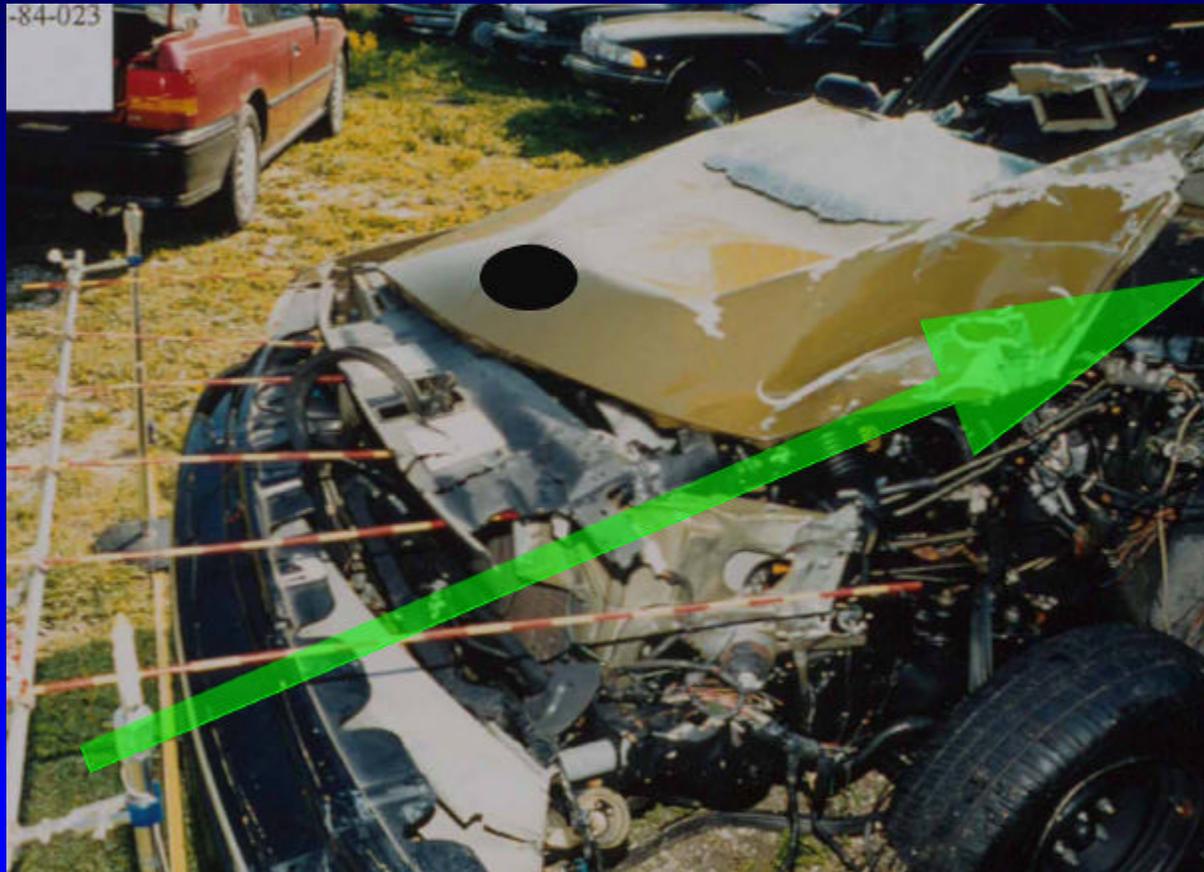


# RESULTING CONCENTRATION OF FORCE

- The Crown Victoria is a “front steerer”
- The steering box is forward of the engine in this front-engine, rear drive car
- This may permit early, concentrated engagement of steering column



# RESULTING CONCENTRATION OF FORCE



**Toward chest**

# INJURIES AND KINEMATICS

- At impact, the driver of V1 was projected forward and slightly left, loading the shoulder restraint ...



# INJURIES AND KINEMATICS

- At impact, the driver of V1 was projected forward and slightly left, loading the shoulder restraint ...
- Resulting in a...

**4 inch laceration of the neck**

# INJURIES AND KINEMATICS

- His face impacts the deploying airbag  
(multiple contusions/abrasions)
- Intruding A pillar/spotlight handle contact  
causes open mandibular fracture

# IMPACT KINEMATICS

- L front door intrudes longitudinally and laterally, L interior door panel/window frame/B pillar impact driver's L arm
- Injuries: Fx L distal humerus, multiple contusions

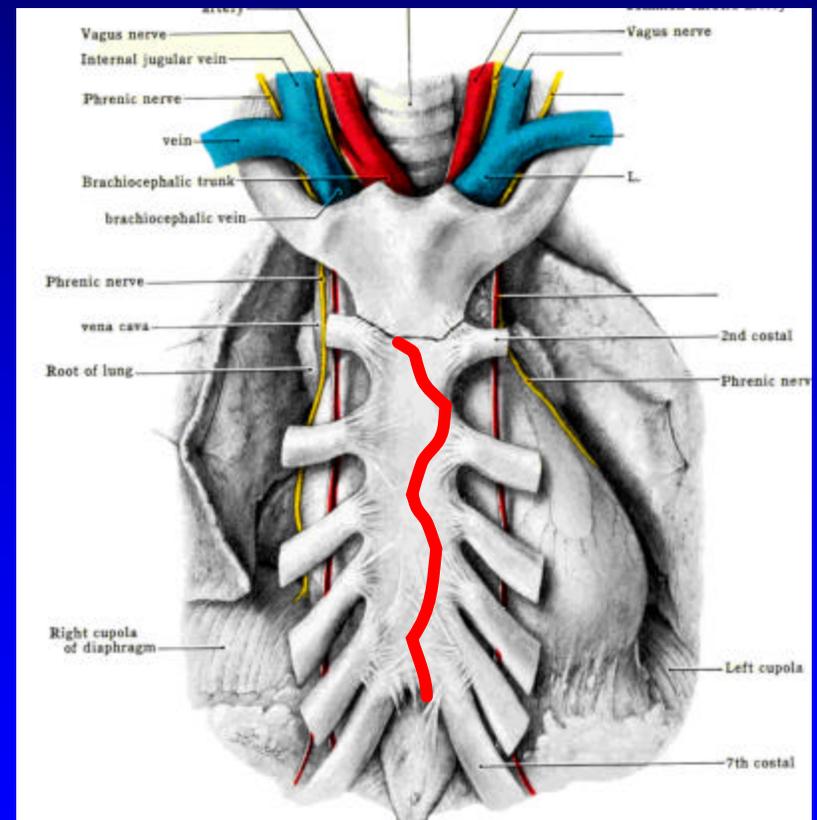
# IMPACT KINEMATICS

- After activation (and deflation ?) of the airbag, the steering wheel rim/hub/spoke impacted the driver's torso through the vest.

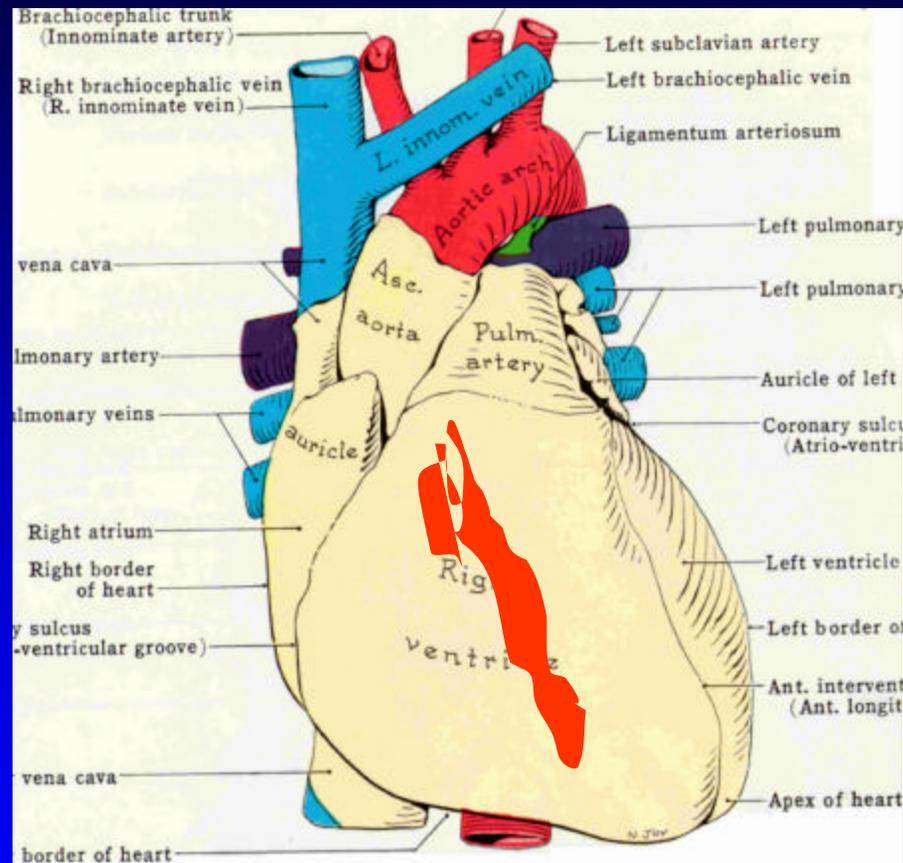


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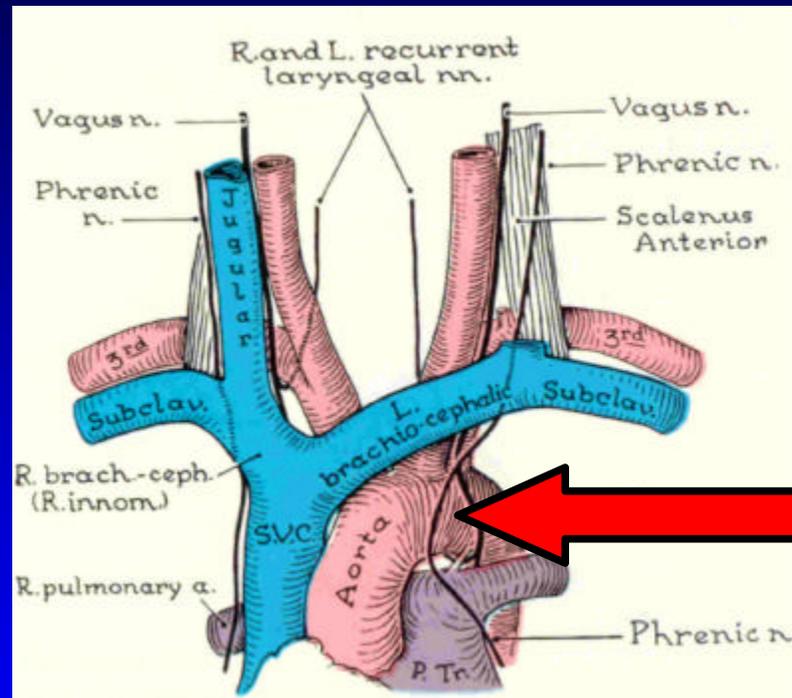


# IMPACT KINEMATICS



- Fracturing the sternum and lacerating the right ventricle of the heart.

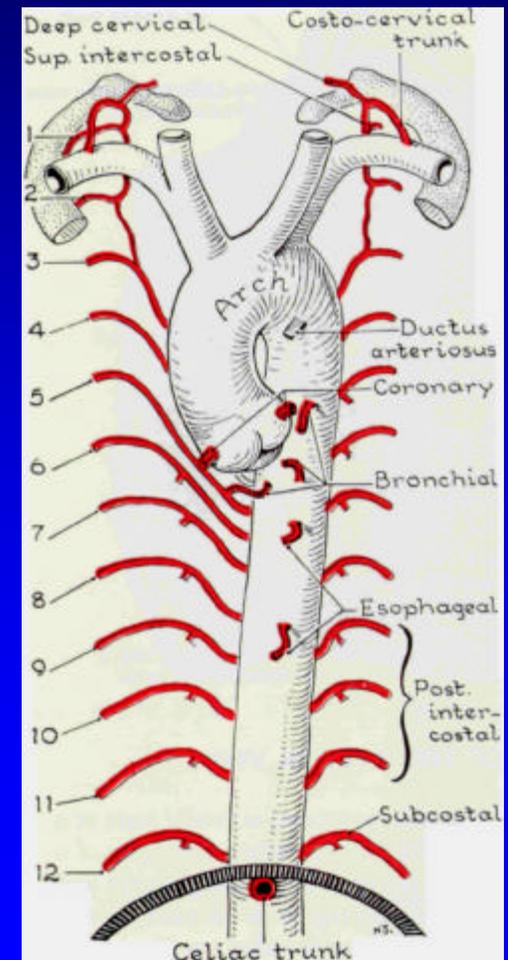
# IMPACT & TORSO INJURIES



- The aorta was lacerated at junction of arch and descending aorta, there were multiple intimal tears in the descending thoracic aorta.

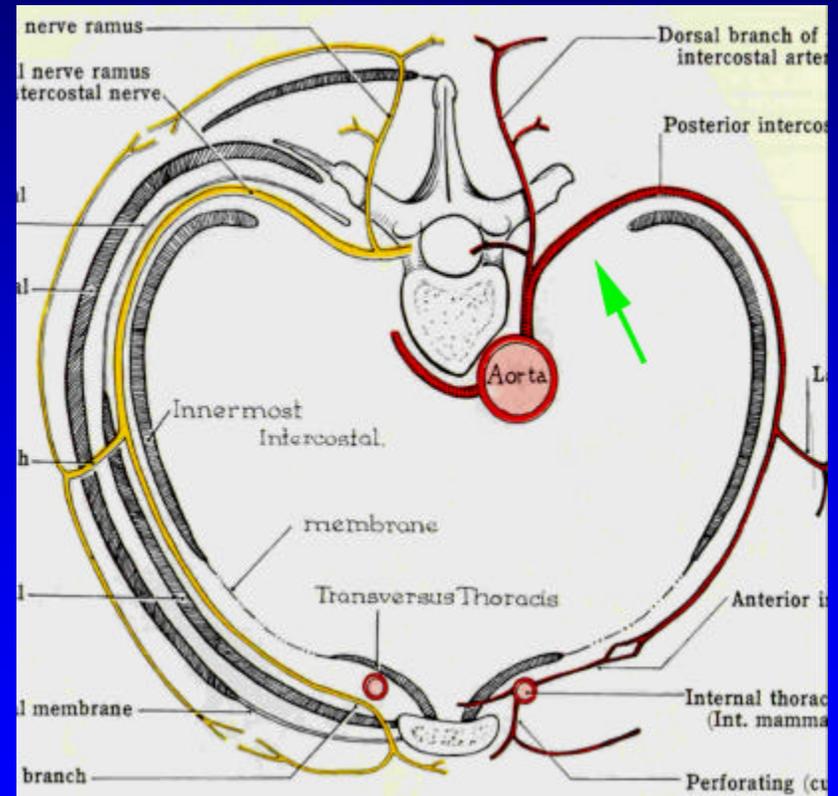
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# ANATOMY OF INJURY

- The multiple aortic intimal tears were secondary to multiple intercostal arterial avulsions
- Associated with multiple costo-vertebral rib fractures

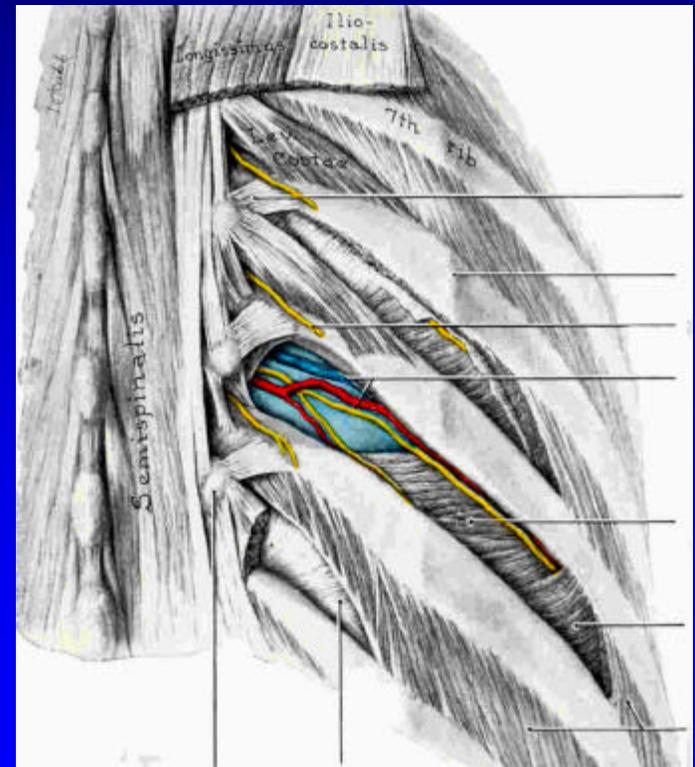


# TROOPER'S VEST AND IT'S EFFECT ON THORACIC INJURY

- NHTSA special investigators suggest that the vest alters the pattern of injury
- With frontal blunt trauma, the ribs usually break laterally, at the greatest curvature...

# TROOPER'S VEST AND IT'S EFFECT ON THORACIC INJURY

- The vest distributes force in a way which tears the ribs from their attachment to the spine, and hence the intercostal artery avulsions with aortic intimal tears



**SPECIAL INVESTIGATION**

**SECOND GENERATION AIRBAGS**

**THORACIC TRAUMA**

University of Maryland

# ISSUES OF INTEREST

- **Belt usage as reported**
- **Validation by scene data**
- **Conflicting physical findings**
- **Accuracy of on-board data recorders**

# TECHNICAL SUMMARY

- Two vehicle crash
- Late night hours; fall weekday



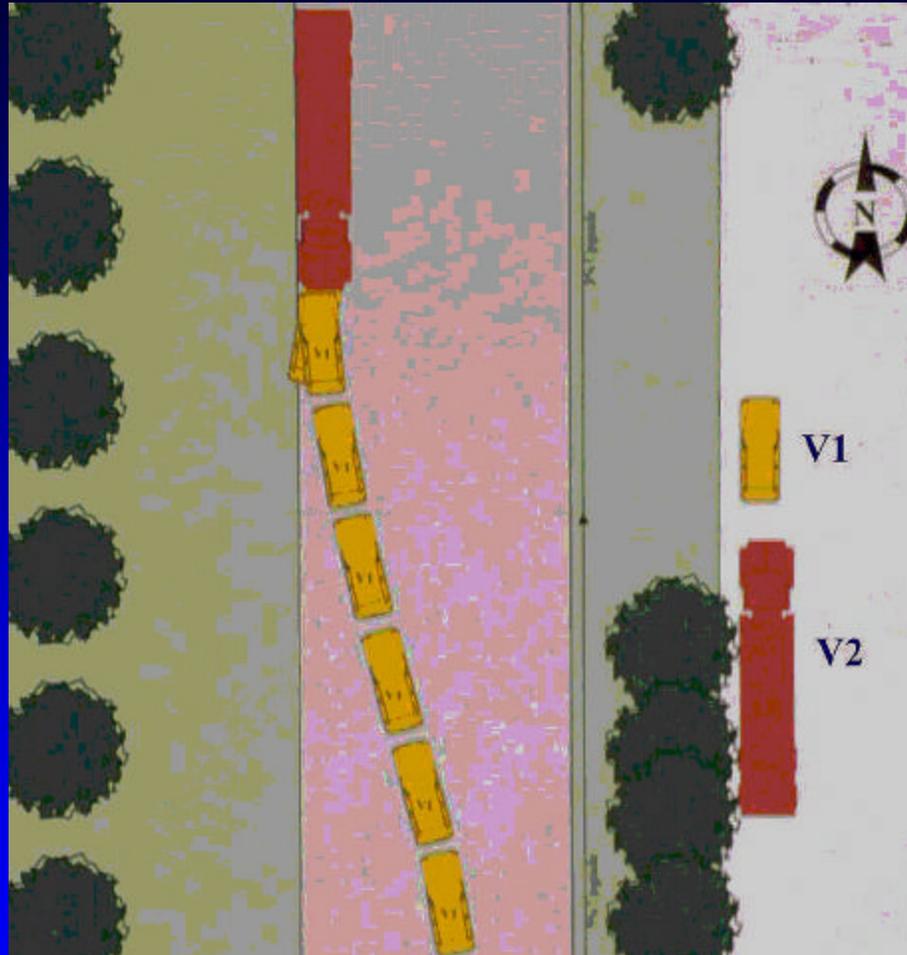
# VEHICLE 1

- 1998 Chevrolet Malibu *rental car*
- Speed estimated 30-35 mph
- 26 yo male driver
- Reported restrained

# VEHICLE 2

- **A parked 1990 International**
- **Tractor trailer combination**

# CRASH CIRCUMSTANCES



- V1 driver apparently fell asleep
- V1 drifted L, crossing southbound lane

# TECHNICAL SUMMARY

- The size of V2 places crash outside scope of computer's reconstruction program
- Therefore, a Delta V was not computed
- Maximum crush of 26 in

# CRASH RECONSTRUCTION



# TECHNICAL SUMMARY

- **Using these figures, a Speed Estimate was computed as 23 mph**
- **This estimate appears somewhat low**

# TECHNICAL SUMMARY

- Both driver's side and passenger's side depowered airbags deployed

# SECOND GENERATION AIRBAGS



# AIRBAG

- **Not damaged P119078-01F---**
- **No evidence of occupant contact**
- **Measures 58cm (23in) in diameter**
- **Two vent ports**

# AIRBAG



# TECHNICAL SUMMARY

- During the crash sequence, the fuel injector of V1 was sheared by the front bumper of V2 and **a small engine fire ensued in V1**

# **TECHNICAL SUMMARY**

- **The fire was not a threat to the driver, and was quickly extinguished**
- **The driver of V1 sustained major injuries**
- **Not entrapped, but extrication required secondary to jammed doors**

# DRIVER: CASE OCCUPANT

## INJURY

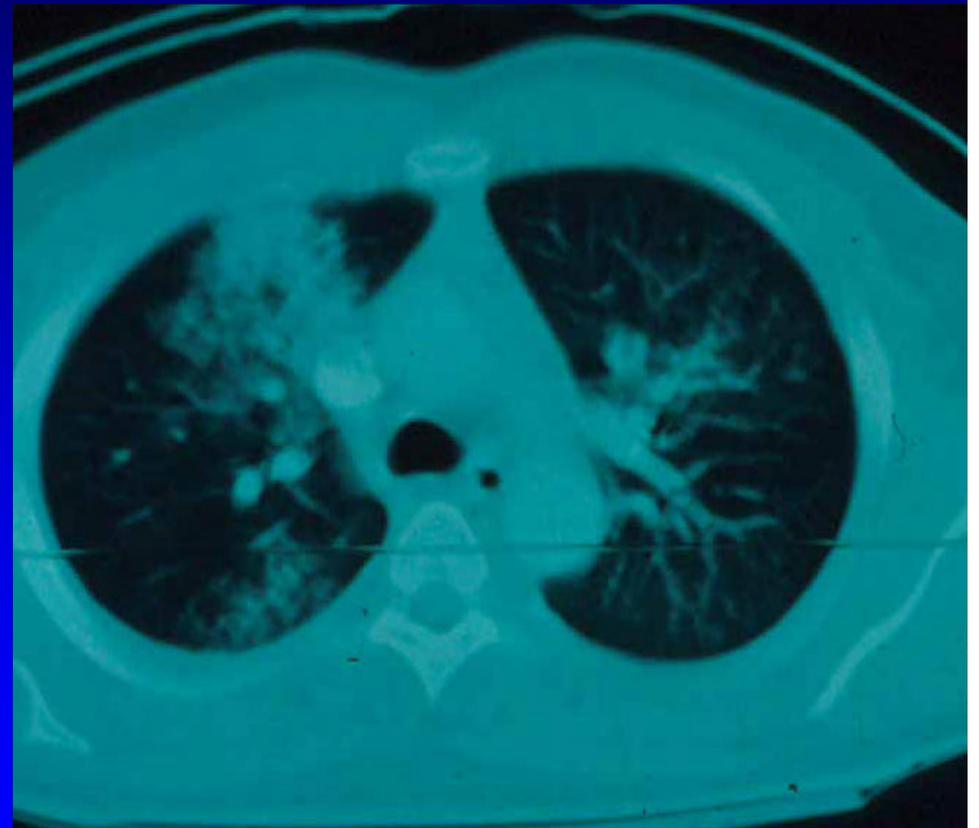
- Bilat pulm contusions
- R acetabular fx
- Laceration, scalp
- Abrasions, mid chest

## SOURCE

- Shoulder restraint
- L instrument panel
- L/F door, window frame
- Shoulder restraint

# INJURIES

- **Bilateral pulmonary contusions**



# INJURIES



**Acetabular fracture-dislocation**

# POINTS OF DISCUSSION

- An “average” case were it not for our interest in second generation airbags
- Our investigation indicated Delta V of 23 mph
- Seatbelt assessment indicated usage at time of crash
- Bilateral pulmonary contusions were caused by the shoulder restraint by 1st assessment

# 1998 AIRBAGS

- But, bilateral pulmonary contusions in a 71 in tall adult male who was...
- Allegedly belted, and was supplementally restrained by...
- Second generation, 1998 airbags...
- Was troublesome to NHTSA special investigators

# FURTHER INVESTIGATION

- An “interview” of the Sensing and Diagnostic Module (SDM) was indicated...
- A printout of the data stored in the Malibu’s SDM indicated that...

# DATA FROM SDM OF V1

- SIR light off at crash (no malfunctions)
- Air bags deployed 27.5 milliseconds after collision first detected by SDM
- Delta V recorded by SDM= 50 mph
- Crash occurred on ignition cycle 724
- The driver's seatbelt was unlatched at the time the deployment occurred

# SENSING & DIAGNOSTIC MODULE DATA

- In addition to the deployment crash event, the SDM also stored a Near-Deployment Event that occurred sometime during ignition cycle number 628. The maximum Delta V for this event was 8.9 mph
- The driver seat belt was latched during that previous event

# CHEST ABRASION



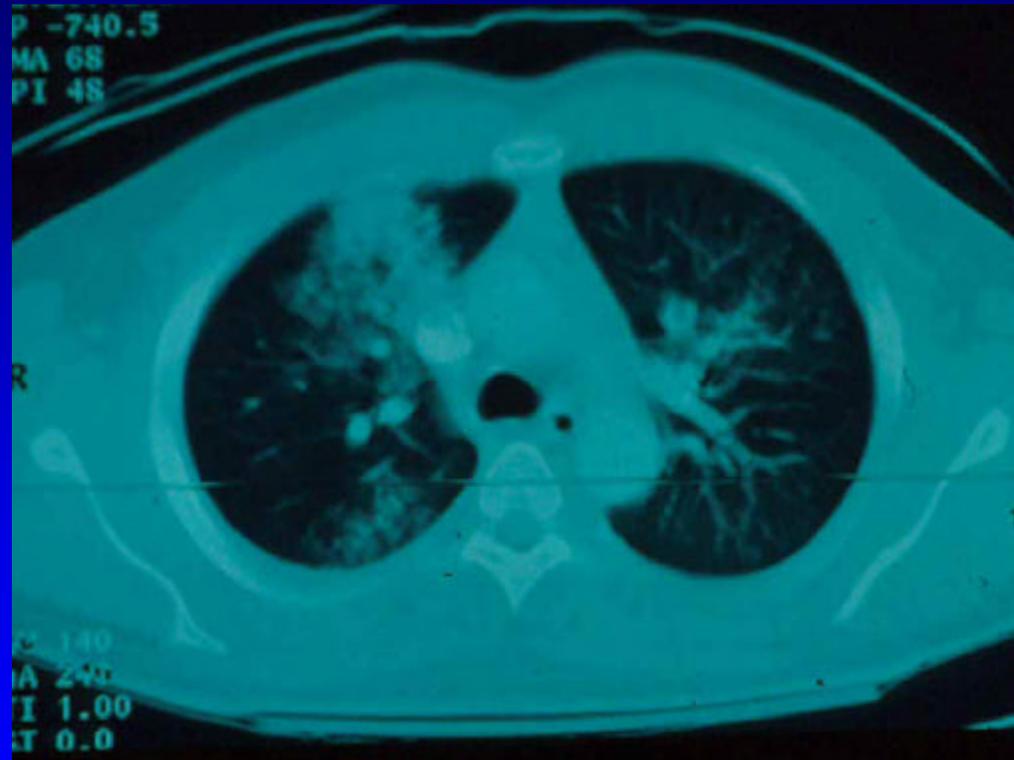
Atypical for shoulder restraint

# CHEST ABRASION



Typical for “barn door” airbag covers

# BILATERAL PULMONARY CONTUSIONS



# BILATERAL PULMONARY CONTUSIONS



In restrained, tall driver with “soft” airbags

# THE VALUE OF THIS CASE

- **It validates the new level of clinical and engineering research that will be possible when on-board data recorders are compared to patterns of injury**
- **When the numbers become meaningful, the value of such research will increase exponentially**