

# **Atlanto-Occipital Dislocation in Side Impact**

**Department of Neurosurgery  
Medical College of Wisconsin  
and VA Medical Center**

# Case Occupant

- Driver
- 51-year-old female
- 165 cm (5'5"), 101 kg ( 222 lb)
- 3-point belt worn
- Driver airbag not deployed



# Case Occupant History

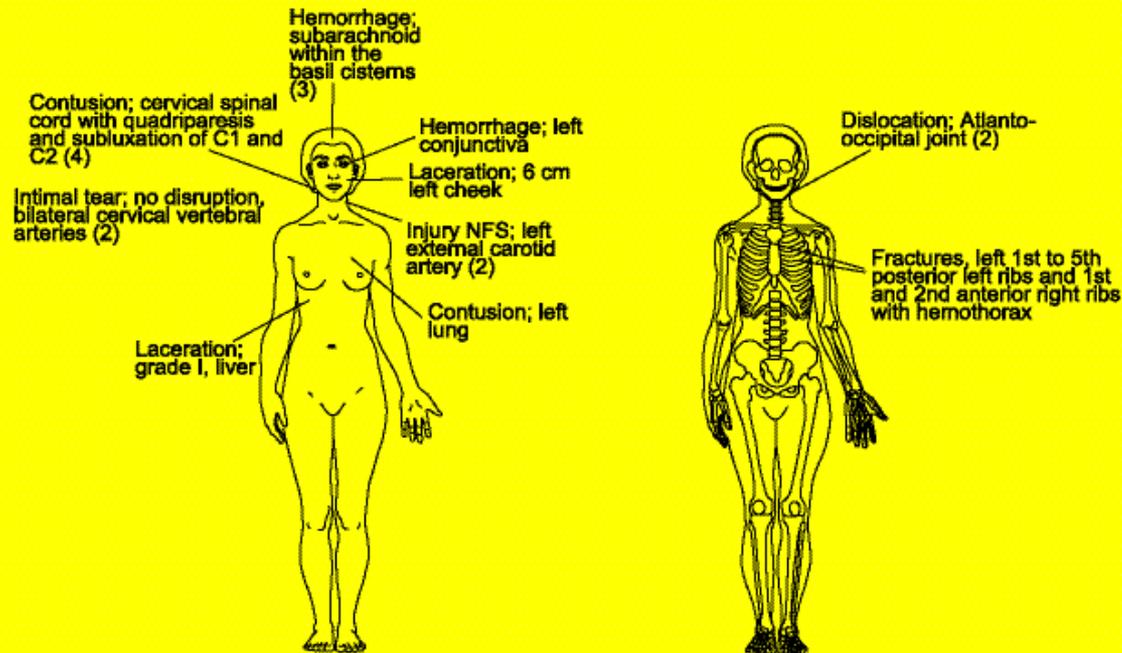
- GCS 15 at scene
- GCS 15 when admitted on 4th floor
- Moved to SICU due to change in respiratory status (Day 2)
- Move to NICU post-operatively (Day 3)



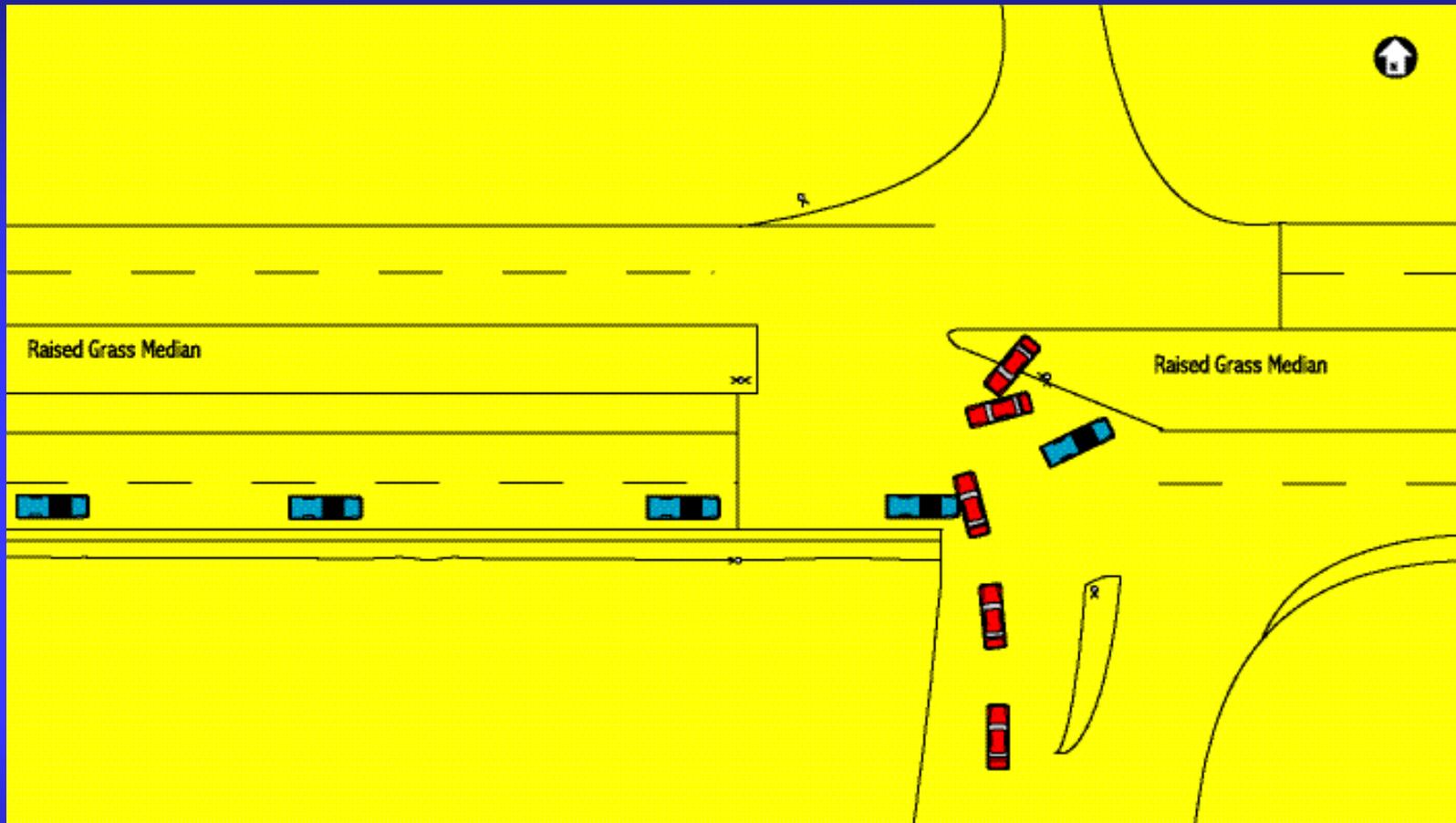
# Case Occupant Injuries

**CASE NO.:** 13-02  
**CASE VEHICLE:** 1997  
**TYPE:** Oldsmobile Acheiva

**OCCUPANT:** Driver:  
**STATURE:** 165 cm                      **MASS:** 101 kg  
**RESTRAINTS:** 3-point belt worn  
**SEVERITY:**    **MAIS - 4**        :    **ISS - 36**



# Crash Overview



The case vehicle was stopped at the controlled intersection in the left-turn lane of a off-ramp from a divided highway and four-lane divided roadway.

# Scene Photo



Vehicle two was traveling east in the outside lane approaching the intersection. As the driver of the case vehicle began a left turn, vehicle two entered the intersection and struck the case vehicle on the left-side doors.



# Scene Photo



The impact caused the case vehicle to rotate counterclockwise. The case vehicle came to rest with its rear wheels on the gore of the median, facing south west.



# Scene Photo



Vehicle two rotated slightly counterclockwise and came to rest facing east in the inside lane.



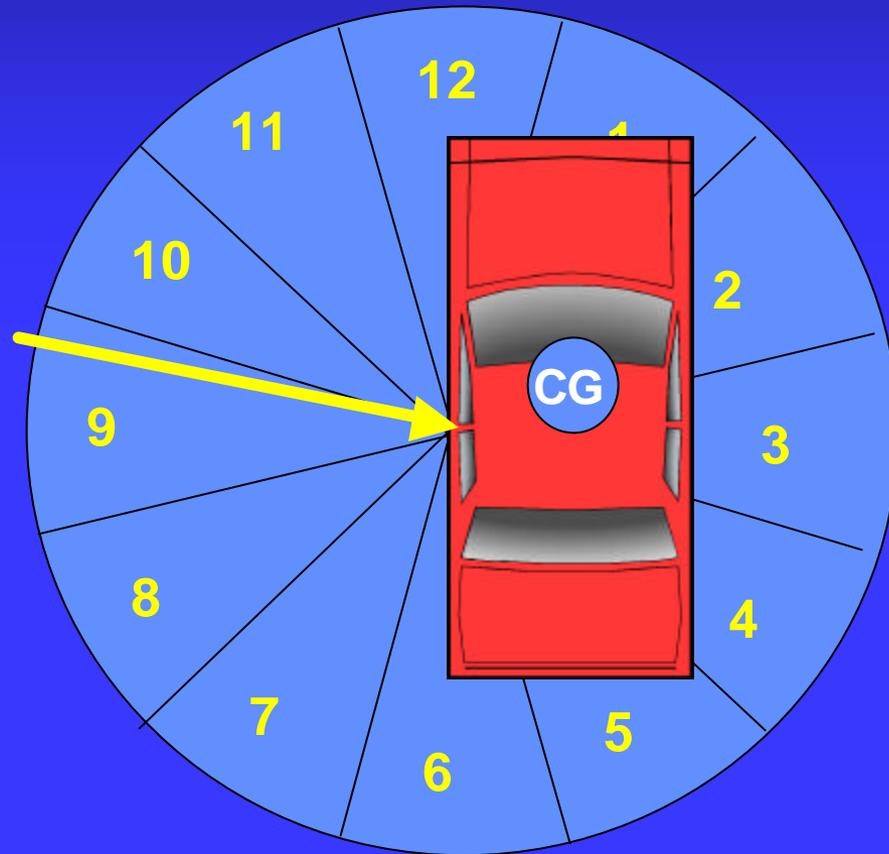
# Path of Case Vehicle



# Path of Vehicle Two



# 09 o'clock PDOF CDC 09-LZAW-4



# 1997 Oldsmobile Achieva 4 door



21 mph ?V  
Missing Vehicle  
Algorithm



# 1997 Oldsmobile Achieva 4 door



# 1997 Oldsmobile Achieva 4 door



Crashed  
Vehicle



Exemplar  
Vehicle



# 1997 Oldsmobile Achieva 4 door



# Crashed & Exemplar Oldsmobile Achieva



# 1997 Oldsmobile Achieva 4 door



# Exemplar Oldsmobile Achieva



# 1997 Oldsmobile Achieva 4 door – Interior



**MEDICAL  
COLLEGE  
OF WISCONSIN**

**DEPT OF NEUROSURGERY**

**Milwaukee, Wisconsin**

# 1997 Oldsmobile Achieva 4 door – Interior



# 1997 Oldsmobile Achieva 4 door – Interior



48 cm estimated B-pillar intrusion  
46 cm estimated door intrusion



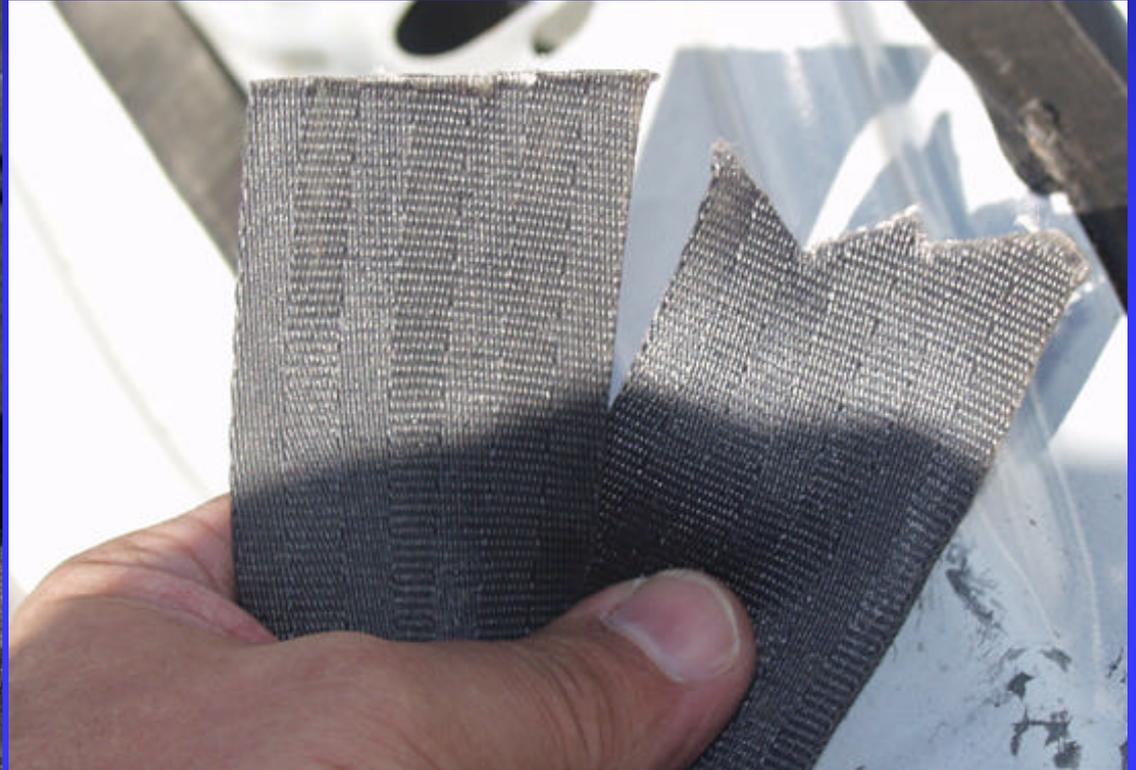
# 1997 Oldsmobile Achieva 4 door – Interior



# 1997 Oldsmobile Achieva 4 door



# 1997 Oldsmobile Achieva 4 door



System Status At Near Deployment	
SIR Warning Lamp Status	DEF
Driver's Belt Switch Circuit Status	BUCKLED
Passenger Front Air Bag Suppression Switch Circuit Status	Air Bag Not Suppressed
Ignition Cycles At Near Deployment	8053
Ignition Cycles At Investigation	8054
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	68.75
Maximum SDM Recorded Velocity Change (MPH)	-4.8268

Shoulder belt cut with scissors and seat belt cutter

# Vehicle Two 1998 Dodge Dakota Club Cab 4x4



Probable source of C-spine injury and facial laceration

# Exemplar 1997 Oldsmobile Achieva with Mock-up of a Dodge Dakota



A subarachnoid brain hemorrhage within the basil cisterns, a dislocation of the atlanto-occipital joint, a contusion of the cervical spinal cord with a subluxation of C1 and C2, with resulting motor deficit, an intimal tear without disruption of the bilateral cervical vertebral arteries and an injury to the left external carotid artery were probably caused by the left shoulder being loaded in and down by the intruding door as it was loaded by V2 and the trapping of the driver's head by the hood/grille of V2, which resulted in a distraction of the head-neck complex.

# 1997 Oldsmobile Achieva 4 door



Probable source of left rib fractures and left lung contusion



# Case Occupant



Possible source of liver laceration



# **Atlanto-Occipital Injuries: Clinical Case Perspective and Review**



# Scene Photo



# Mechanism of Injury

- Tension-Extension
  - Most Common
  - Injury to Tectorial Membrane
  - Airbag injury most common
  - Supported by high incidence of facial lacerations and mandibular fractures



# Exemplar 1997 Oldsmobile Achieva with Mock-up of a Dodge Dakota



# Exemplar 1997 Oldsmobile Achieva with Mock-up of a Dodge Dakota



# Intraoperative Findings

- Complete ligamentous disruption at Oc-C1
- Small Epidural Hematoma
- No evidence of fracture



# Mechanism of Injury

- Hyperflexion
  - More unusual
  - Associated with posterior element fractures



# Mechanism of Injury

- Rotation/Lateral Flexion
  - Very rare
  - Alar Ligaments very strong in adults
  - Usually results in occipital condyle fractures



# Clinical Presentation

- Few specific symptoms
- Diagnosis based on constellation of
  - Associated Injuries
    - ◆ Facial abrasions/lacerations
    - ◆ Mandibular fractures
  - Radiological features
  - High index of suspicion in the proper situations



# Clinical Presentation

- Major Head Injury
  - Traumatic contusions
  - Posterior Fossa SAH
  - Intraventricular hemorrhage



# Clinical Presentation

- Cardiorespiratory Abnormalities
- Cranial Nerve Palsies
  - Sixth most common
  - Lower Cranial Nerve Palsies



# Clinical Presentation

- Asymmetric Motor Deficits
  - Hemiparesis and Decerebration
  - Spinal cord Injury from Subluxation
    - ◆ Direct SCI
    - ◆ Hematoma
  - Vascular Injury leading to Brainstem Infarction



# Radiology

- Frank skeletal dislocation or severe malalignment rare
- Swelling of the retropharyngeal space
- Associated cervical fractures
- Diagnosis is often delayed for days



# Referenced Research Papers

- Kaufman et al: Occipital Condyle-Superior facet of atlas (Longitudinal AOD)
- Dublin et al: Atlas arch-Post mandibular cortex
- Wholey et al: Tip of Odontoid-Basion  
→ >5mm abnormal



# Radiology

- Powers Ratio

- BC/OA

- ◆ (Basion- Post arch/Ophisthion-Ant arch)
    - ◆ Normal  $0.77 \pm 0.09$
    - ◆  $<0.9$ -normal;  $>1.0$  OAD
    - ◆  $0.9-1.0$ ; Gray Area (7% of normal, none in AOD)
    - ◆ Useful if abnormal, indicates need for neck stabilization



# Radiology

- None of these measurements are completely reliable
- CT scan is conclusive
- CT indicated if
  - High clinical suspicion
  - Retropharyngeal Swelling



# Radiology

- MRI

- Details ligamentous injury
- Highlights associated spinal cord injury
- Useful to diagnose associated hematoma



# Treatment

- Immediate: Cervical Immobilization: Collar/Halo
- Traction Dangerous: Can worsen Deficits
- Definitive Treatment
  - ➔ Halo Immobilization
  - ➔ Internal Fixation (Occiput to Upper Cervical Spine)



# Case Occupant Outcome

- Currently lives independently, on disability
- Residual right hemiparesis, mild
- Left 6<sup>th</sup> nerve palsy



# Summary

- OAD is a rare but often lethal injury
- Diagnosis requires a high degree of suspicion
- Hitherto most commonly described from hyperextension injuries from airbag deployment
- Based on this case, clinical suspicion should be widened to side impact injury



**Thank You for your attention**

