

# Carotid Artery Dissections

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# Blunt Carotid Artery Injuries Causes

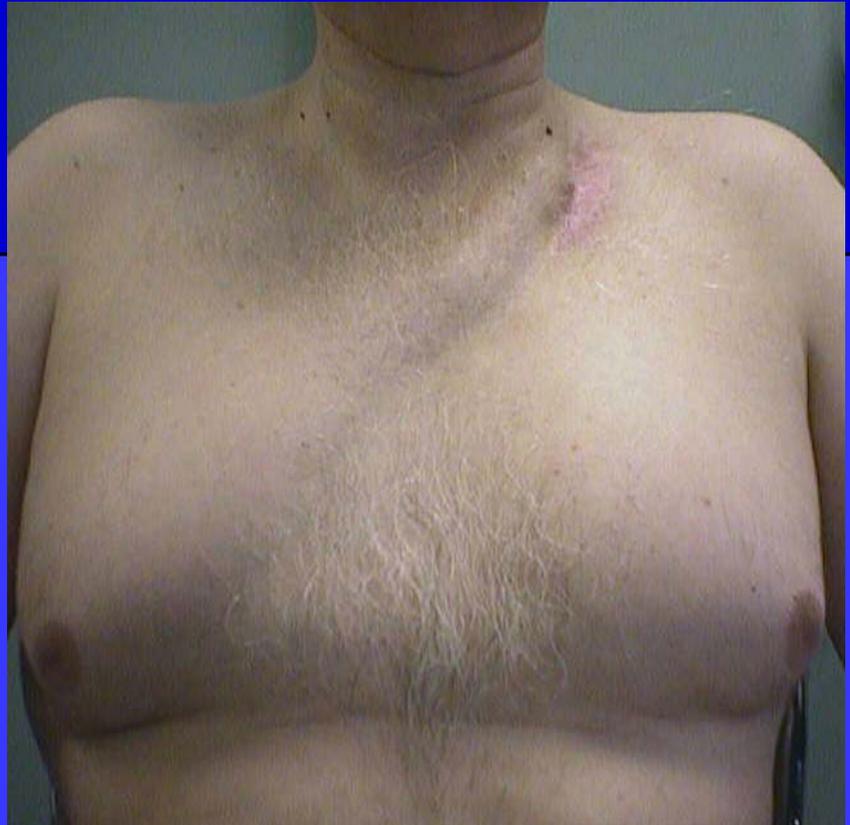
- MVC
- Airplane crashes
- Sports events (parachute jump, ski crash)
- Strangulation
- Chiropractic manipulation
- Assaults
- Nose blowing
- Neck turning while leading a parade



# Blunt Carotid Artery Injuries

## Mechanism

- Mechanism
  - ➔ direct blow
  - ➔ hyperflexion
  - ➔ hyperextension
- Source
  - ➔ seatbelt
  - ➔ other object
  - ➔ airbag



# Blunt Carotid Artery Injuries Epidemiology

- Incidence

- ➔ highly variable

- ➔ different populations

- ◆ symptomatic

- ◆ asymptomatic

- ◆ high-risk

- ➔ influence of aggressive screening protocols



# Blunt Carotid Artery Injuries

## Associated injuries

- Head injuries 65%
- Facial fxs 60%
- Thoracic injuries 51%
- Basilar skull fxs 32%
- Cervical fxs 5%
- 9% with **NO** associated injuries



# Blunt Carotid Artery Injuries

- Delayed symptoms
  - ➔ mean 12 hours after admission
  - ➔ >25% develop after 12 hours
  - ➔ outcome worse when diagnosis delayed



# Blunt Carotid Artery Injuries

## Outcome

- Mortality

- ➔ 11-57%

- ➔ Shock,  $GCS \leq 8$  increase mortality

- ➔ Lowest with asymptomatic patients

- Morbidity

- ➔ 10-37%

- ➔  $GCS \leq 8$ , thrombosis increase risk of deterioration



# Blunt Carotid Artery Injuries

## Outcome

- Stroke rate related to injury Grade
- Outcome not related to injury Grade I-IV
- $\geq 50\%$  Grade I heal
- Majority Grade III, IV unchanged
- Risk of follow-up angiography



# Blunt Carotid Artery Injuries Summary

- Epidemiology

- ➔ 0.1 to 1.1% all blunt trauma admissions
- ➔ increases 4-10 x with screening
- ➔ 40 - 80% MVC
- ➔ 20 - 40% bilateral



# Blunt Carotid Artery Injuries Summary

- Delayed onset of sx
- Injury from intimal tear, subsequent emboli
- Majority asymptomatic
- Low incidence, high morbidity/mortality
- Treatment unclear



# Blunt Carotid Artery Injuries

## Summary

- Clinical questions

- ➔ Who to study?

- ➔ How to study?

- ◆ angiography

- ◆ MRA

- ◆ ultrasound

- ➔ How to treat?

- ◆ antiplatelet

- ◆ anticoagulation

- ◆ stent

- ◆ operative



# Search of NASS Data

## AIS Codes Beginning “3202”

- Nineteen internal carotid artery injuries 1993-2000
- Unknown injury source
- Ejected occupants
- Injuries coded “NFS”
- Laceration (perforation, puncture)
- Three potentially “good” dissection cases

Note: AIS injury coding incorporated into NASS data beginning 1993

# Review of NASS Data

## “Good Cases”

- One rollover; Source = roof
- One frontal pole impact - Source = belt webbing
- One full-frontal impact - Source = steering wheel

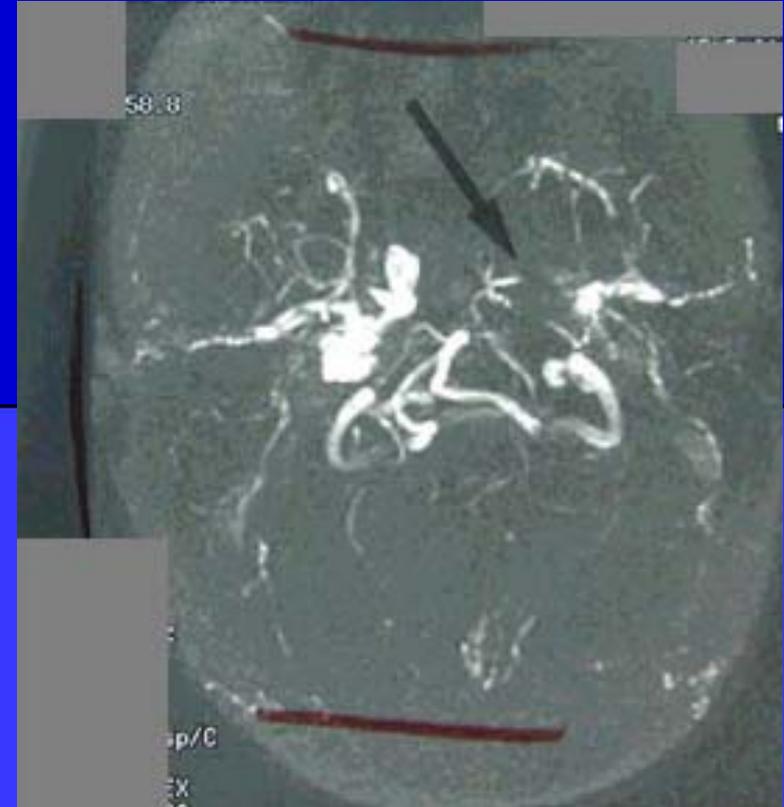
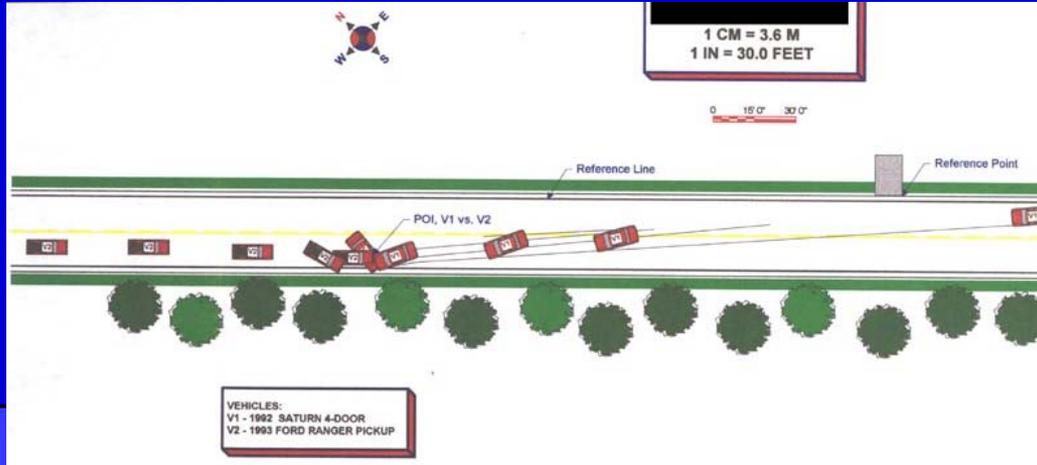


# Search of CIREN Cases

- 1992 Saturn - 14-year-old female right-front passenger
- 2000 Ford Focus - 43-year-old female driver
- 1994 Toyota Corolla - 34-year-old female right-front passenger



# 1992 Saturn Offset-frontal Impact



**Left carotid artery dissection  
with lucid interval of 20 days  
Source = belt webbing**

**1 o'clock impact**

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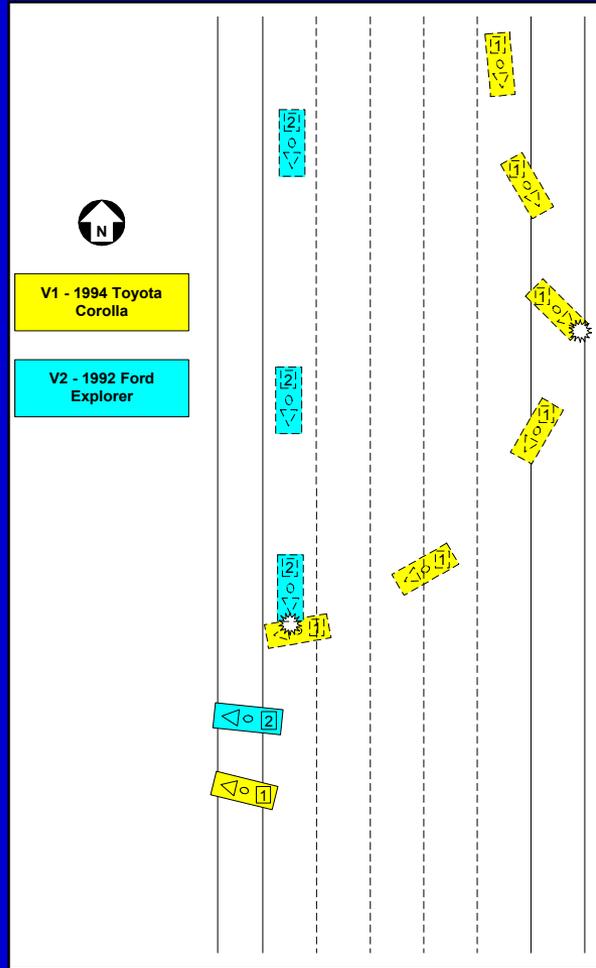
**Milwaukee, Wisconsin**



# 1994 Toyota Corolla Side Impact

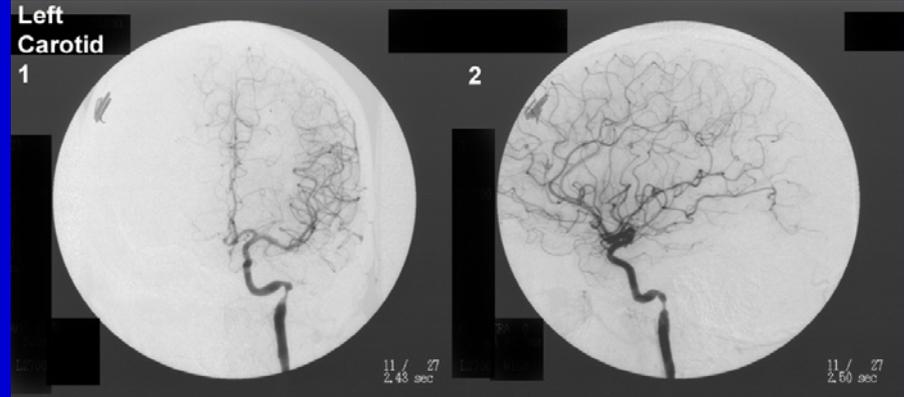
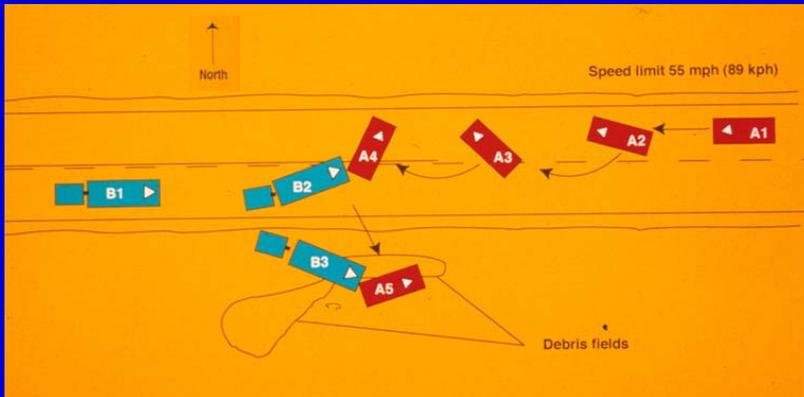


3 o'clock impact



Left carotid artery  
dissection detected  
8 hours after  
admission  
Source = unknown

# 2000 Ford Focus Oblique Rear Impact



**7 o'clock impact**

**Source = hyperextension over seat back;  
diagnosed 12-24 hrs after crash**



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# 1993 Nissan Altima 4-door sedan vs 1991 Chevrolet Blazer 2-door 4X4 SUV

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and VA Medical Center



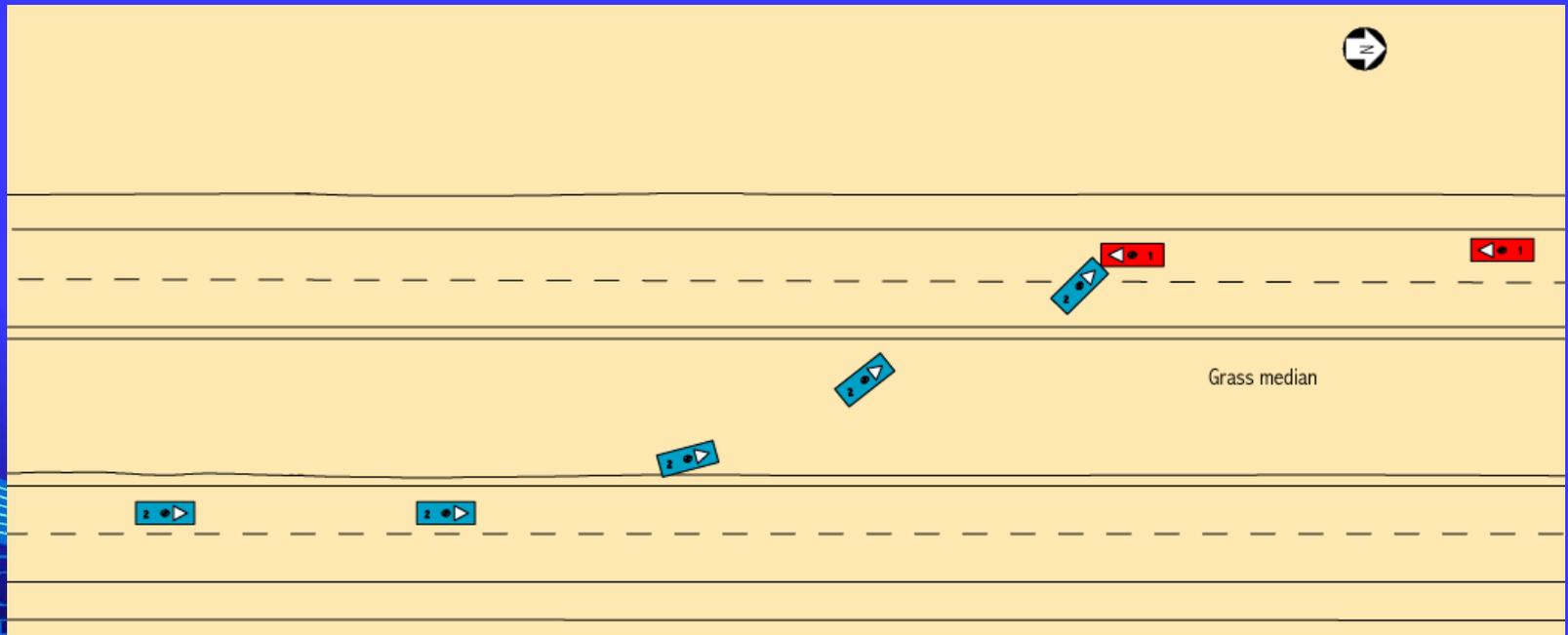
# Case Occupant

- Driver
- 38-year-old male
- 180 cm (5' 11"), 80 kg (176 lb)
- 2-point shoulder belt worn
- Manual lap-belt not worn
- Driver airbag deployed



# Crash Overview

The case vehicle (red) was traveling southbound on a four-lane highway with a speed limit of 65 mph (105 kph). Vehicle two (blue) was traveling northbound on the same roadway. It was snowing and the roadway was covered lightly with snow. Vehicle two went out of control and entered a counterclockwise rotation and crossed the median and entered the path of the case vehicle.



# Crash Overview

The impact caused the case vehicle to rotate clockwise and depart the road off of the west shoulder. Vehicle two continued to rotate counterclockwise and came to rest on the west shoulder.



Case vehicle



Vehicle two

# Scene Photo



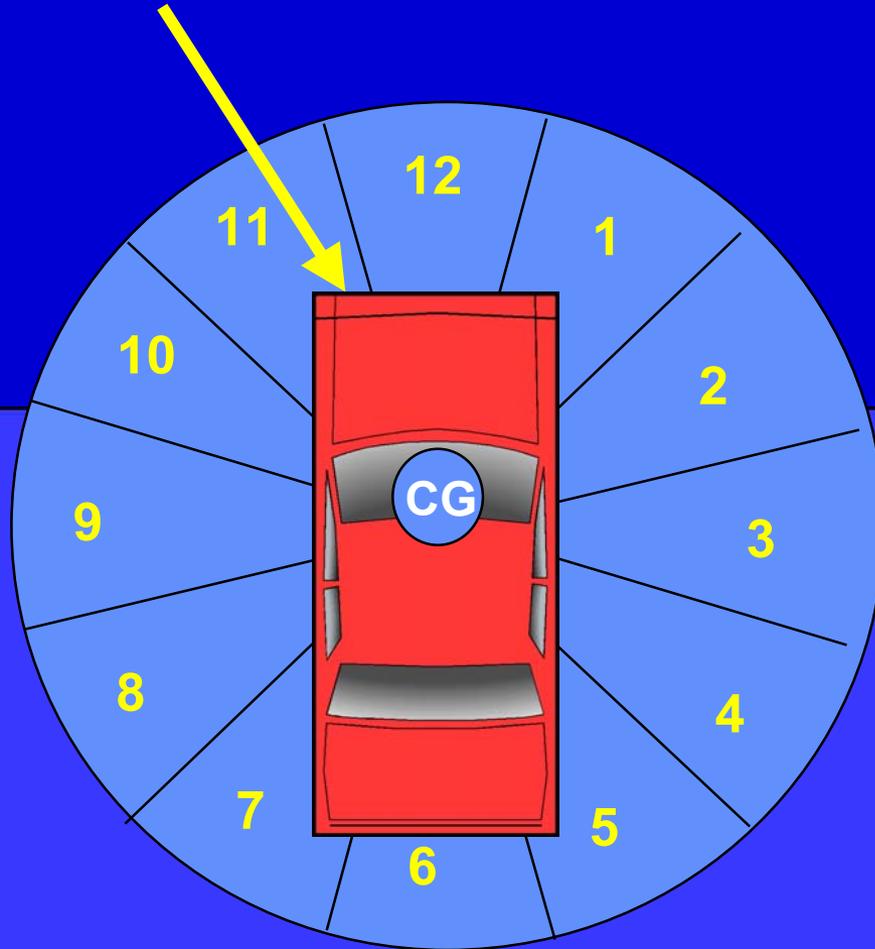
# Path of Case Vehicle



# Path of Vehicle Two



# 11 o'clock PDOF CDC 11-FLEW-4



# 1993 Nissan Altima



24 mph  $\Delta V$  (ROLD MISS) - 29 mph EBS

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# 1993 Nissan Altima



42 cm of direct damage



80 cm of maximum crush  
at left-front bumper corner



# 1993 Nissan Altima



Approximate height of bumper/frame-rail of V2

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# 1993 Nissan Altima



Left wheelbase reduced 28 cm



# 1993 Nissan Altima



# 1993 Nissan Altima



Effect of the geometric mismatch between the two vehicles



# 1993 Nissan Altima



32 cm longitudinal intrusion at left IP; 23 cm of measured steering wheel intrusion. An estimated 8 cm repositioned toward front of vehicle during extrication

# 1993 Nissan Altima



# 1993 Nissan Altima



2 cm rim deformation



Wheel out of round



# 1993 Nissan Altima

Shear capsules  
compressed.  
Probably extrication  
related.



Scuff mark  
extrication  
related per  
commander of  
rescue unit

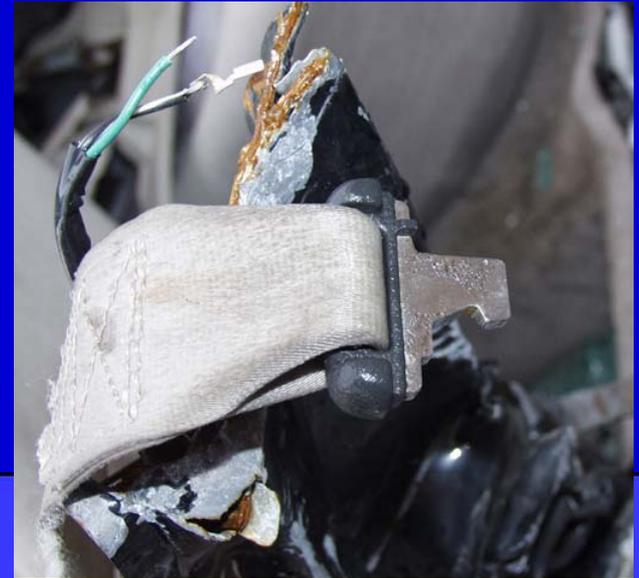


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# 1993 Nissan Altima



2-point motorized automatic belt mouse jammed in retracted position prior to impact - used as a manual belt



# 1993 Nissan Altima



Lap belt not used



# 1993 Nissan Altima



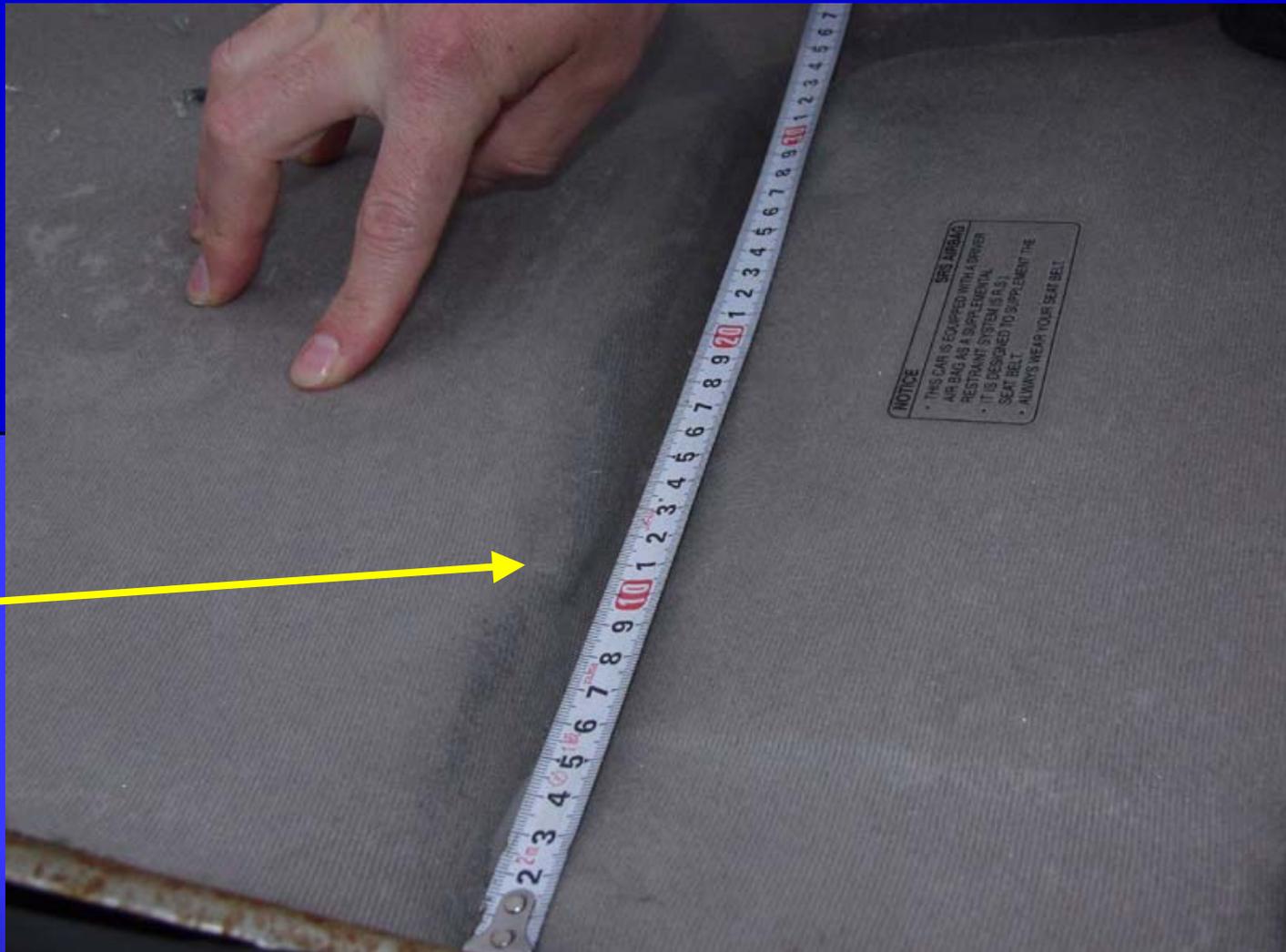
Post-crash blood deposits

# 1993 Nissan Altima



Head Contact

# 1993 Nissan Altima



7 cm long  
dent



# 1993 Nissan Altima



Knee Bolster Cover

# Significant Crash Elements

- **Angle of impact**
- **Geometric mismatch**
- **Extent of intrusion**
- **Lack of three-point restraint**



# Kinematically Significant Injuries

CASE NO.: 01-01

CASE VEHICLE: 1993 Nissan

TYPE: Altima 4-door sedan

OCCUPANT: Driver: 38-year-old male

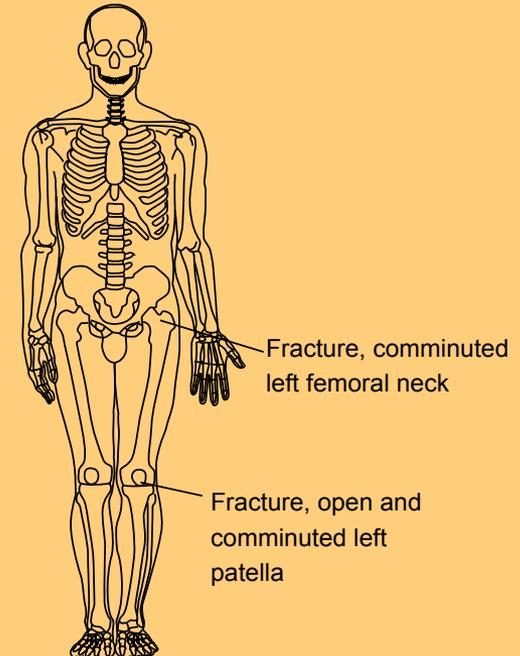
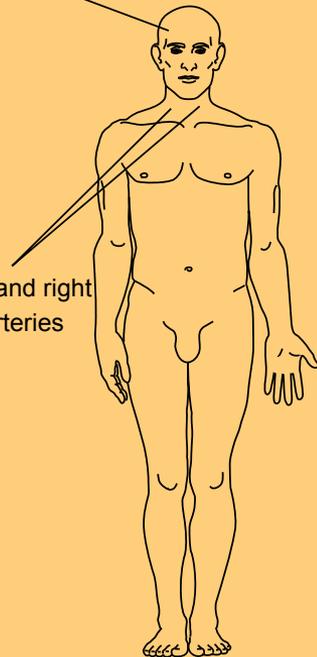
STATURE: 180 cm (5 ft 11 in)

MASS: 80 kg (176 lb)

RESTRAINTS: 2-pt. belt worn w/o lap belt; Airbag deployed

Abrasion, right forehead

Thrombosis, left and right  
internal carotid arteries



# Case Occupant Presenting History

- 38-year-old male
- GCS at scene: 12
- GCS at 17:00: 14
- GCS at 18:38: 13
- GCS at 19:55: 7
- Intubated and chemically paralyzed on admission

# Case Occupant Highest AIS Injuries

- **Thrombosis, right CCA with neurological deficit = AIS 4**
- **Comminuted, displaced fracture, left femoral neck = AIS 3**
- **Grade I liver laceration = AIS 2**
- **ISS = 29**



# 1993 Nissan Altima Carotid Artery Injuries

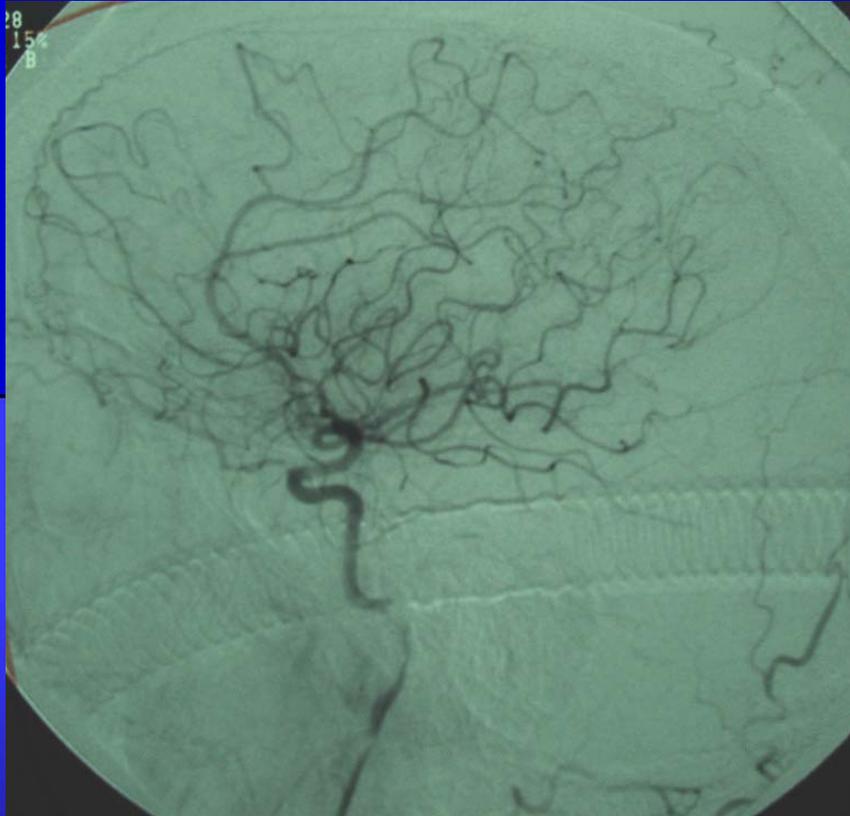


Left



Right

# 1993 Nissan Altima Carotid Artery Injury



Left



Right



# 1993 Nissan Altima

Left Femoral neck FX



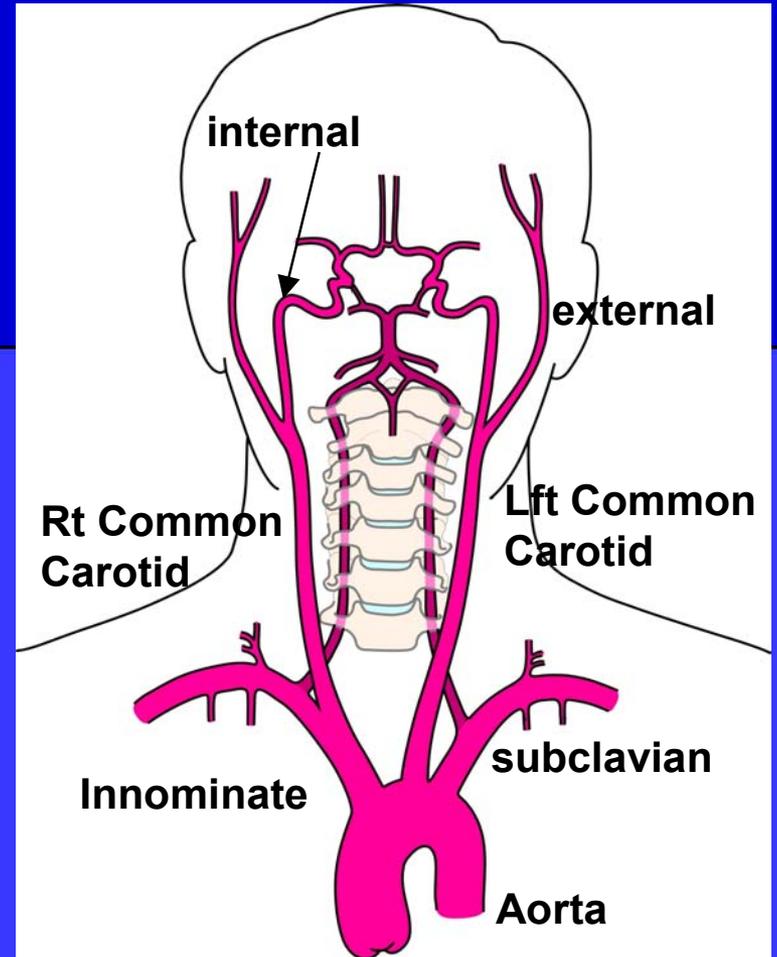
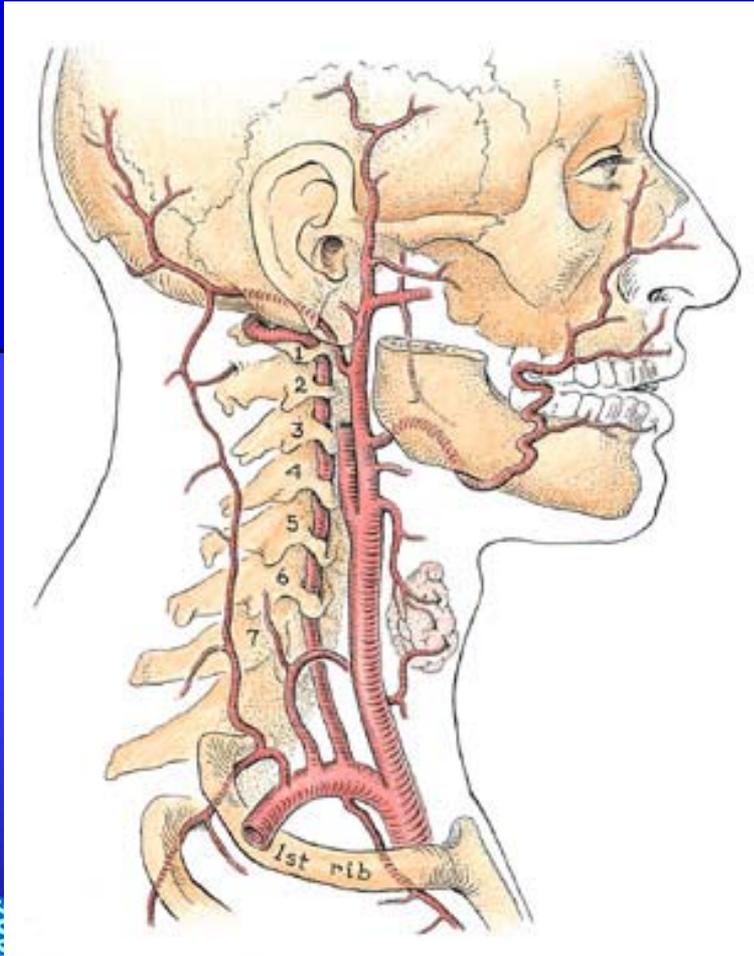
# 1993 Nissan Altima



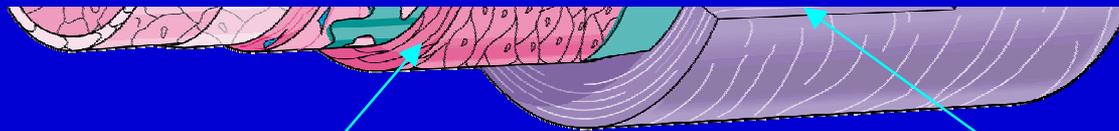
Left patella FX



# Carotid Artery Anatomy



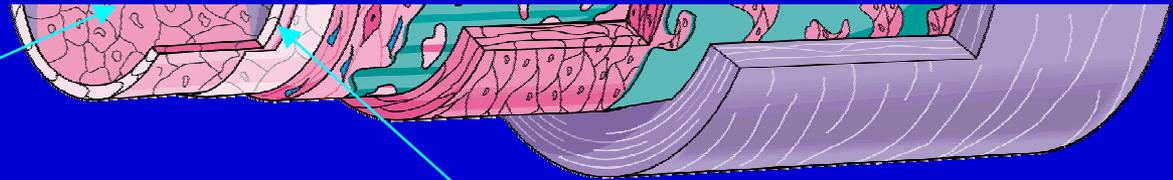
# Microanatomy of an Artery



**Media:** middle layer; primarily muscular tissue; aligned transversely around vessel

**Adventitia:** outer layer; primarily connective tissue; can stretch up to 100% of original length

# Microanatomy of an Artery



**Glycocalyx:** “lubricant” layer on inner surface; may contribute to non-thrombogenic properties of intact endothelium

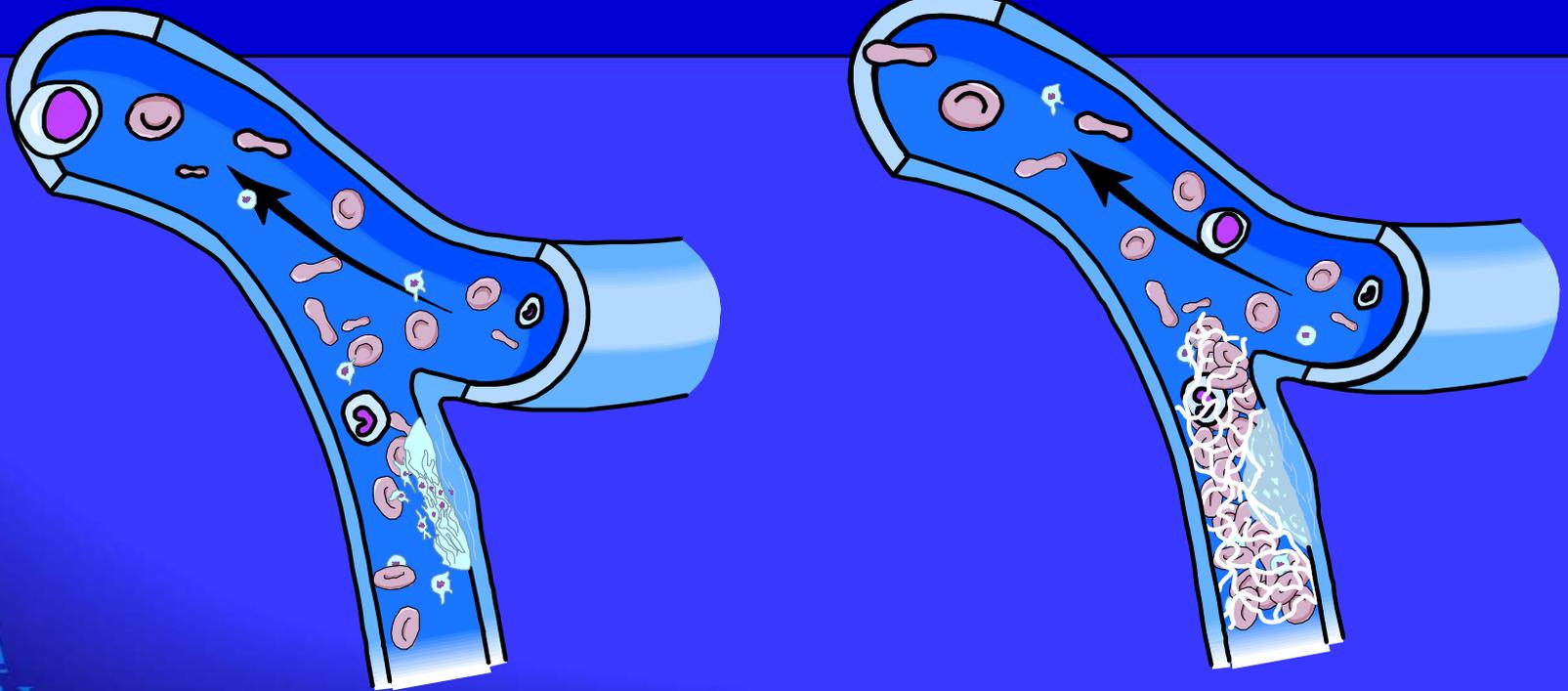
**Intima:** inner layer; primarily endothelial cells; aligned in tile-like layout, elongated in direction of blood flow

# Micro-Biomechanics of Artery

- Adventitia (outer layer) high tolerance to local stretch; will rarely rupture
- Media (middle layer) less tolerant to stretch since muscle alignment not longitudinal
- Intima (inner layer) least tolerant to stretch with tightly packed cells

# Carotid Artery Dissection with Occlusion

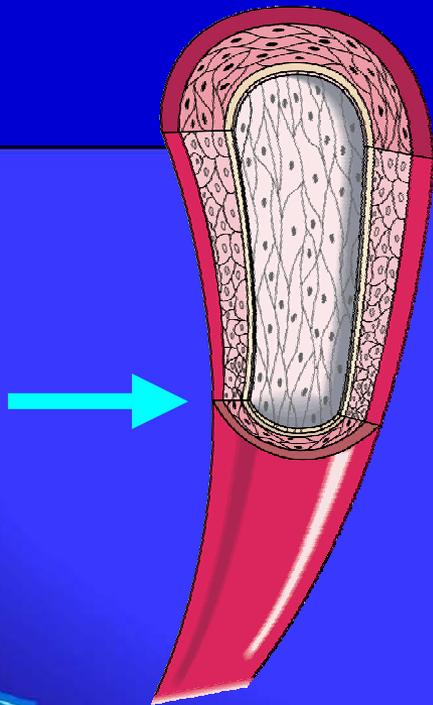
Disruption of Intima and maybe media layers cause Thrombosis



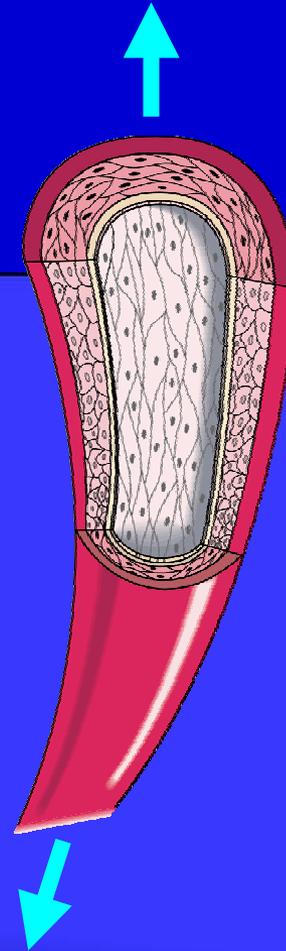
# Mechanisms of Injury

## Carotid Artery Dissection

Direct Blow, "Pinching"



Distractive load,  
Tension, Stretching



# Mechanisms of Injury

## Pinching Mechanism

- Foreign object impinges
  - ➔ Kids: toothbrush, other objects in mouth
  - ➔ Strangulation
- High riding seatbelt on neck?



# Mechanisms of Injury

## Stretching Mechanism

- Bilateral CAD: uniform hyperextension of head-neck
  - ➔ Rear impact: extension over headrest
  - ➔ Frontal impact: Forehead impeded, chest moves forward
    - ◆ Forehead into windshield
    - ◆ Forehead into top of steering wheel
    - ◆ Forehead into top of header
  - ➔ Frontal impact: Airbag unfolding (timing must be right)

# Mechanism of Injury Bilateral CAD



# Mechanisms of Injury

## Stretching Mechanism

- Unilateral CAD: non-uniform extension of head-neck
  - ➔ Offset crash: front-lateral forehead
  - ➔ Head turned before crash
  - ➔ Lateral impact: hyper lateral extension



# SUMMARY

## Carotid Artery Dissections

- NASS missing cases?
  - ➔ Lucid interval a problem
- CIREN plays major role in identifying
- Mechanism of Injury: look for hyper-extension of head-neck complex
- Treatment: pre-screening asymptomatic patients ?