Carotid Artery Injuries

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Presentation Objectives

- Introduction
- Incidence
- Mortality Rates
- Anatomy
- Mechanism of Injury
- Signs and Symptoms
- Screening Tools
- Diagnosis
- Treatment Options
  - Surgical vs. Non-Surgical
- Case Study
Carotid Artery Injury (CAI)

- Second leading cause of early death following trauma to neck
- Injury may be missed or delayed in presentation
- Early detection and treatment are key to patient survival
- Must recognize MOI

Incidence Rates

- Historically considered an uncommon injury
- May be considered uncommon but are not rare
- \(\sim 3\) cases /100,000 population for all age groups
- Accounts for 20% of strokes in patients <30 years old

Mortality Rates

- 15-40% overall mortality rate\textsuperscript{1, 2, 3}
- 49 patients over 6 years with carotid injury
  - 16 of these resulted in death\textsuperscript{1}
- 40-80% of survivors will have severe neurological deficit\textsuperscript{3, 4}
  - Most often between 25\% and 40\%\textsuperscript{1}
“Pipelines to the Brain”

- Common carotid artery on each side of neck
- Each divides above the larynx
- Resulting in internal and external carotid arteries
- Provide blood supply to head and neck
Anatomy

- Internal Carotid artery
- Carotid bifurcation
- External Carotid artery
- Common Carotid artery

Available at: http://www.vascularsociety.org.uk/patient/carotid.html
Anatomy

- Intimal tear usually occurs 2 cm distal to carotid bifurcation
- Anatomic level of C2 and C3
- True aneurysms contain all 3 layers of the arterial wall (intima, media, and adventitia)

Schematic view of an arterial wall in cross-section

Intima:
endothelial cell layer
and
basement membrane
(collagens IV and XVIII,
laminin, nidogen)

Media:
smooth muscle cells,
elastic connective matrix
(collagens I and III,
vitronectin, laminin,
elastin fibrils)

Adventitia:
fibroblasts, nerve cells,
collagens and elastin fibrils

Expert Reviews in Molecular Medicine ©2002 Cambridge University Press

http://www.expertreviews.org/
Mechanism of Injury

- Direct trauma to neck \(^1,2\)
  - Blunt trauma or penetrating wound\(^3\)
  - 50% of Cases\(^2\)

- Neck hyperextension with rotation\(^1,2,3\)
  - Common in MVA's\(^3\)

- Blunt intra-oral trauma\(^1,2,3\)
  - Characteristic in children

- Basilar skull fracture involving carotid canal\(^1,3\)

- Blunt direct compression by seat belt\(^1,2,3\)

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Development of Symptoms

*Symptoms can be acute, subacute, or chronic

- Asymptomatic
  - Can develop symptoms within 24 hours or up to 6 months
  - Neuro deficits can develop up to 15 years later
- 10% display immediate symptoms
- 55% symptoms within 24 hours
- 35% no symptoms until >24 hours

**Major source of delay in detection and treatment**

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**Signs / Symptoms**

- Neck hematoma
- Loss of temporal artery pulse
- Hemicrania (unilateral headache)
- Horner's Syndrome (eyelid ptosis, miosis, flushing, and unilateral anhidrosis)
- TIA
- Paralysis
- Unilateral face weakness
- Hemianesthesia
- Aphasia
- Unilateral blindness
- Seizure


Classification

Grade I
- Luminal irregularity
- Dissection with <25% stenosis

Grade II
- Dissection with >25% stenosis or a raised intimal flap

Grade III
- Pseudoaneurysm

Grade IV
- Complete occlusion

Grade V
- Transection of carotid artery

Differential Diagnosis

- Concussion
- Subarachnoid hemorrhage
- Cluster headaches
- Migraines
- Horner's Syndrome
- Stroke
- Syncope
- Cervicocephalic arterial dissection


Screening Tools

- CT Scan
- MRI
- MRA
- Doppler Ultrasonography
- Carotid Angiograph
- Carotid Duplex Scanning
Carotid Angiographic Studies

- Considered the standard in detecting CAI
- Shows arterial occlusion
- Invasive, expensive
- Usually a transfemoral approach
  - Catheter passed through femoral artery
  - Contrast dye injected into catheter

Risks:

- Problems with catheter insertions, formation of pseudoaneurysm, stroke

Research shows significant morbidity and mortality rates associated with angiography for diagnosis of CAI.
Color-Flow Duplex Ultrasonography

- Non-invasive, usually combined with MRI/MRA
- Risk free
- High sensitivity for common carotid and proximal internal carotid artery
- More sensitive for thrombus than MRI
Color-Flow Duplex Ultrasonography

- Shows flow volume, velocity, and direction
  - Increased or high resistance flow
- Limited to common and proximal internal carotid artery.
  - Limited US window


Health A to Z: www.healthatoz.com
Accessed November 14, 2007
Color-Flow Duplex Ultrasonography

- Does not detect Grade I or II.
- Bony structures interfere with imaging of complete vessel.
  - Unable to detect dissection high in the neck near the base of the skull.

Computed Tomography

- Non-invasive
- Readily available
- Usually does not show abnormalities in first few hours
- CTA- computed tomography angiography
  - Usually included with CT scan
  - Can detect dissecting aneurysms of the carotid artery
- Not considered reliable at this time

Magnetic Resonance Imaging

- MRI/MRA
- High sensitivity and specificity for detection of dissection
- Ability to image remainder of head and neck
- Limited availability
- Greatest promise for supplanting angiogram

Treatment Options

- Conservative versus Surgical
  - Debate exists
  - Depends on the area of the carotid artery that is affected
    - Common carotid should be repaired surgically
    - Distal internal dissection should be treated with anticoagulant therapy
  - Surgery is done in those with progressing aneurysms


Treatment Options

- Conservative versus Surgical
  - Goal is to prevent the development of neurological events
  - Conservative treatment is done if an operative approach is hazardous
  - Some evidence shows that conservative treatment results are equivalent to surgical intervention

References:
Conservative Treatment

- Observation
- Anticoagulation or anti-platelet medication
  - Heparin, Warfarin, aspirin
  - Prevents thrombus formation and artery to artery embolism
  - Can be on these for months
  - Requires Doppler monitoring

Surgical Treatment

- Neurological symptoms
- Asymptomatic
- Can prevent thrombotic occlusion or embolus from forming
- Common carotid is easily accessible

Surgical Treatment

- Aneurysmal resection with arterial reconstruction
- Thrombectomy with intimal repair
- Carotid ligations
  - Those with severe neurological deficits
  - Dangerous
- Balloon dilation

Surgical Treatment

- Local excision and grafting
  - Common carotid
- Extracranial-to-intracranial carotid artery bypass
  - Distal internal carotid artery

Society for Vascular Surgery: www.vascularweb.org
Accessed  November 14, 2007
Surgical Treatment

- Endovascular stenting
  - Less invasive
  - Faster than open repair
  - Selective cases
  - Success dependent upon:
    - Site of rupture
    - Operator’s expertise
    - Durability of graft

Cothren, CC, et al. Blunt cerebrovascular injuries. 60(6), 2005
Surgical Treatment

- Endovascular Stenting
  - Stent acts as a filter to trap any thrombus within the pseudoaneurysm which prevents additional embolization and stroke
  - Helps decrease flow into pseudoaneurysm

Society for Vascular Surgery: www.vascularweb.org
www.vascularweb.org
Outcomes

- Strokes cause worse prognosis
- Risk of stroke after onset of dissection high in the first month and the risk of recurrent of dissection is about 1% per year after first year.
- Study: 30 patients with 1st stroke and dissection
  - Mortality was 23% within first week
  - 48% had long-term disability


Outcomes

- Two-thirds re-open over time
- 4% of patients with 1st carotid artery dissection may experience a 2nd event over time
  - Not known why
  - Anticoagulant and antiplatelet therapy not shown to prevent recurrence
Case Study

- 19 Year Old Male
- Division III Collegiate Lacrosse Player
- Struck in the side of neck with thrown lacrosse ball
- “Body went numb”
- Walked off on his own
- Dizziness was first symptom
Initial Evaluation

- Pain with swallowing
- Headache
- Dizziness
- Nausea
- "Taste of blood in mouth"
- Head flew to opposite side like "whiplash"
- Hx of Concussion and post-concussion syndrome
Redness / Mild ecchymosis over area where hit

Neck tenderness on left side

No cervical, thoracic, or lumbar pain

No observable bleeding in mouth, throat, tongue, or teeth

Unable to recall information (birthday, SS#, parent's address, location, friends)
Range of Motion

Normal ROM for:
- Open/close mouth
- Mandibular protrusion/retraction/lateral deviation
- Thoracic and lumbar motion

Increased dizziness/numbness/tingling in right arm with all cervical motion.
Neurological Testing

- Dermatomes
- Myotomes
- Cranial Nerves

**All normal at initial evaluation. Decreased sensation appeared and disappeared at various times in right arm and hand.**
Special Tests

- Rhomberg and Finger to Nose tests positive
- Unable to perform Heel/Toe Tandem Walking Test and Heel to Knee Test secondary to increased dizziness
- Brachial Tension Test, Tinel’s Sign for Brachial Plexus, and Brachial Plexus Stretch Test all positive eliciting numbness in right arm and hand
Progression of Symptoms

- Nausea/dizziness
- Unable to recognize teammates and coach
- Disoriented to time and place
- Unable to recall information
- Intermittent numbness and tingling in arm and hand

***Patient sent via ambulance to local ER
Emergency Room Visit

- Head CT
  - “NORMAL” exam
- Diagnosis – Headache / Confused
- Discharged that evening
- Patient did not want to go to dinner or home with parents
- Returned to dorm room
Patient carried to athletic trainers by a friend after collapsing in cafeteria
- Non-responsive
- Stupor
- Unable to speak
- Possible Bell’s Palsy on right side of face
- Spineboarded and sent via ambulance back to ER
Evaluation and Treatment

- Re-evaluated and films reviewed
- Carotid artery dissection
- Clot formed resulting in stroke
- Repeat CT scan
- Flown to Hershey Medical Center
Final Outcome

- 6 days after initial injury
- Increased brain swelling
- Brain stem herniation
- Removed from life support
- Resulting in death
Relevance to Athletic Training

- Prevention, major goal
- Proper headgear and neck protection
- Familiar with exact MOI
- Relevance of symptoms
- Accurate report of symptoms to EMS and/or other medical professionals
- Proper diagnosis and immediate treatment
Thank You!

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