Carotid Artery Disease and What's Pertinent

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Goal of treatment of carotid disease

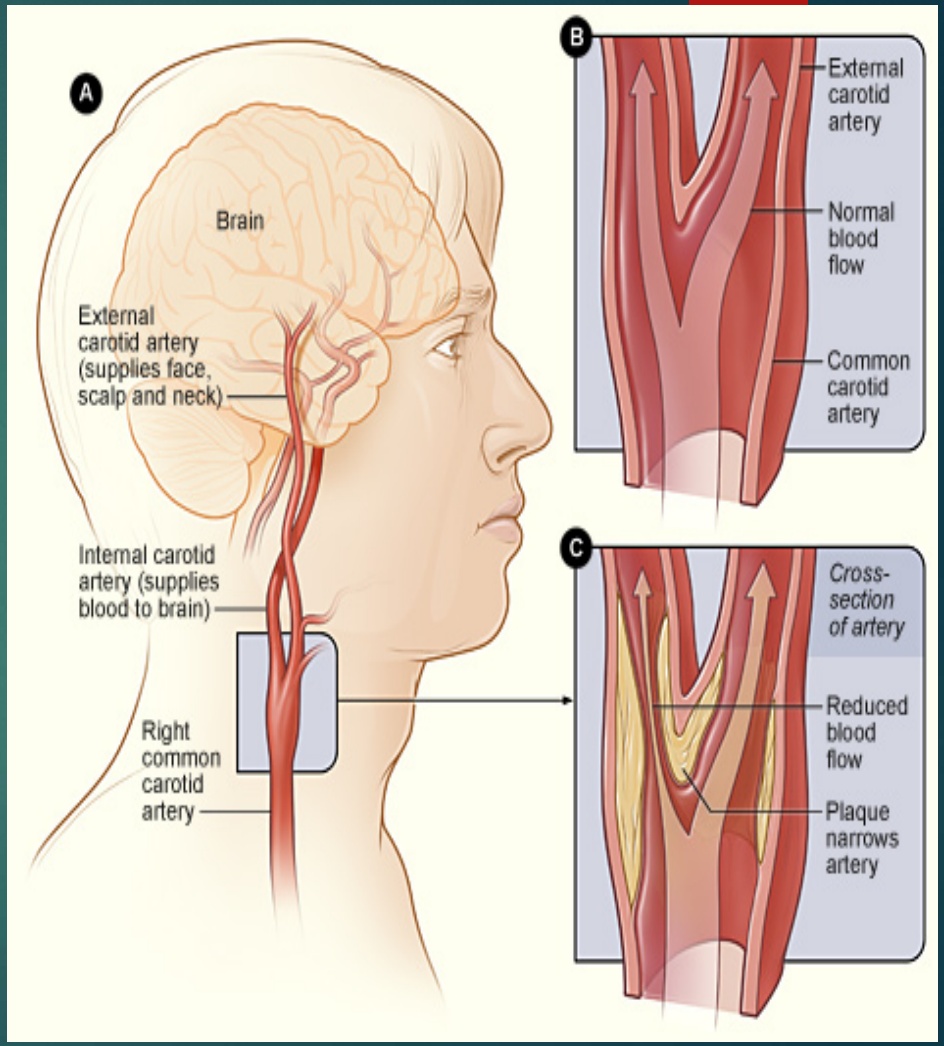
- Identify those at risk of developing symptoms
- Prevent patients at risk from developing symptoms
- Prevent people who have already been symptomatic from developing further and worsening symptoms

Carotid Disease

- Most common disease process: atherosclerosis
  - Other rare disease entities: Fibromuscular dysplasia, carotid artery aneurysms, dissections and carotid body tumors
  - Increased risk:
    - Cigarette smoking, high cholesterol, diabetes, age, obesity, CKD
- Symptoms:
  - TIA (transient ischemic attacks) – precedes 15-20% of CVAs
    - Amaurosis fugax
    - <24 hrs
  - CVA (cerebrovascular accidents)
    - More than 24 hours
  - Syncope?

Symptoms

- **Motor or sensory deficit contralateral to affected carotid artery**
- **Amaurosis ipsilateral to affected carotid artery**


A
Brain
External carotid artery (supplies face, scalp and neck)
Internal carotid artery (supplies blood to brain)
Right common carotid artery
B
External carotid artery
Normal blood flow
Common carotid artery
C
Cross-section of artery
Reduced blood flow
Plaque narrows artery

Pathophysiology of carotid plaquing

- At bifurcation of carotid
  - Where artery splits into two, high shear stress and tendency for stagnation of blood
  - Over time, an ulcer can form thought the fibrous cap of the plaque.
  - Platelets then deposit within the ulcer
    - These platelets lead to more platelets
  - As blood flows into the ulcer, the platelets and other debris can embolize up the internal carotid and into the brain
    - Can cause a TIA, CVA or nothing
      - Transcranial doppler example
  - Further study into morphology of plaque to identify high risk patients.

Stroke

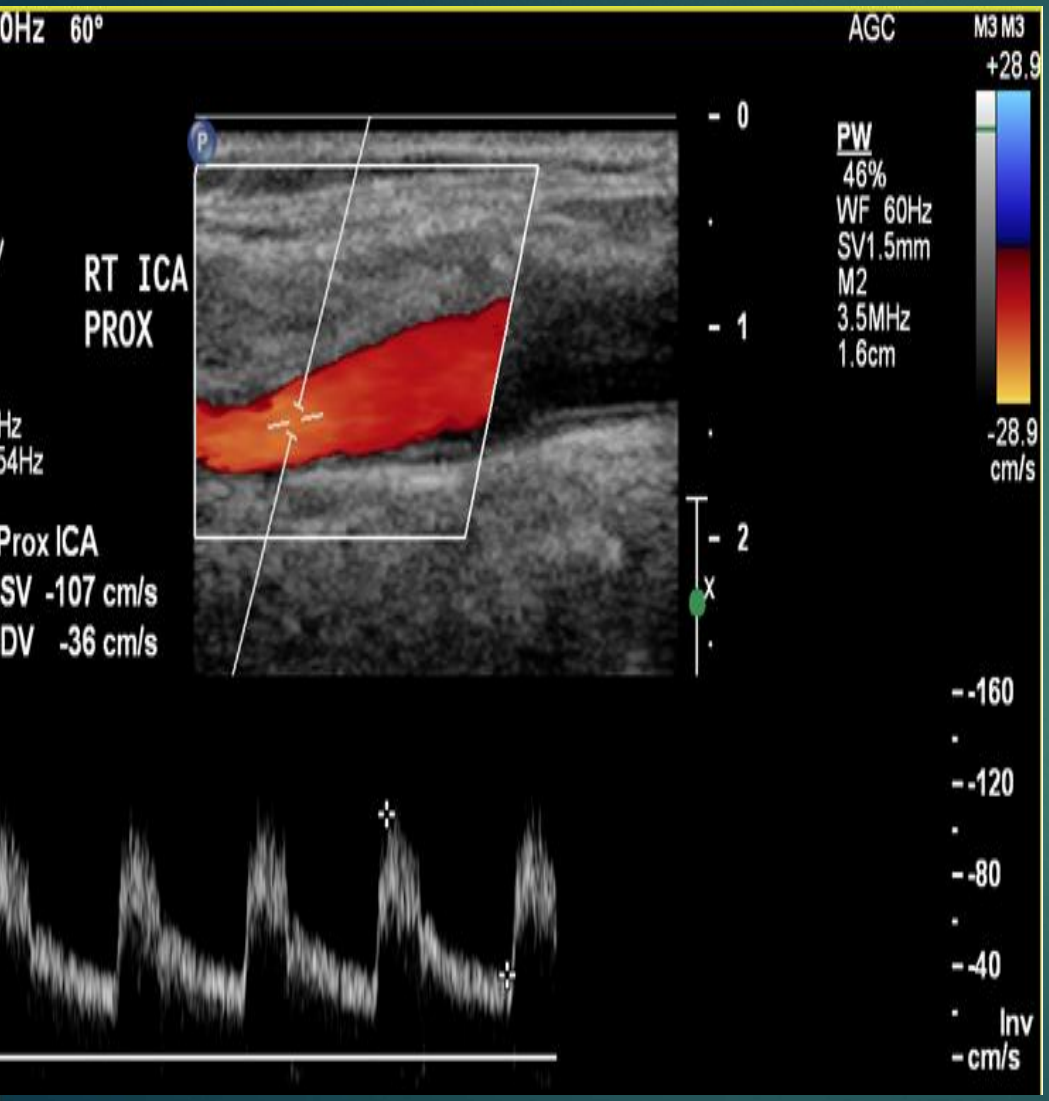
- **600,000 strokes per year in U.S.**
- **150,000 deaths from stroke per year**
- **3rd leading cause of death**

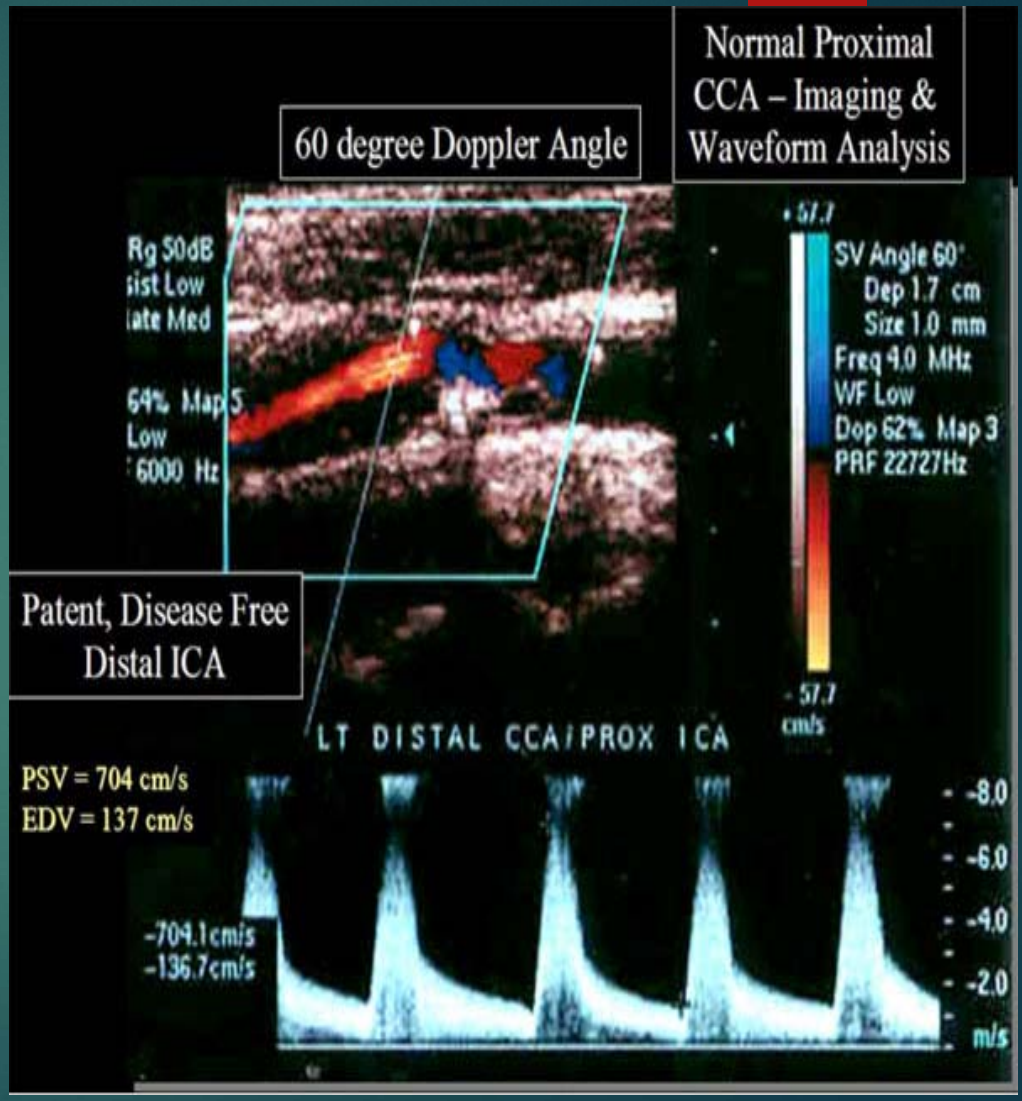
Causes of stroke

- Hemorrhagic (15%)
- Non-hemorrhagic (85%)
  - Cardioembolic
    - Afib, valvular disease
  - Large vessel disease 10-20%
    - Carotid artery atherosclerotic disease
  - Small vessel disease
    - Usually hypertension induced
  - Hematologic disorders
    - Polycythemia, hypercoagulable state

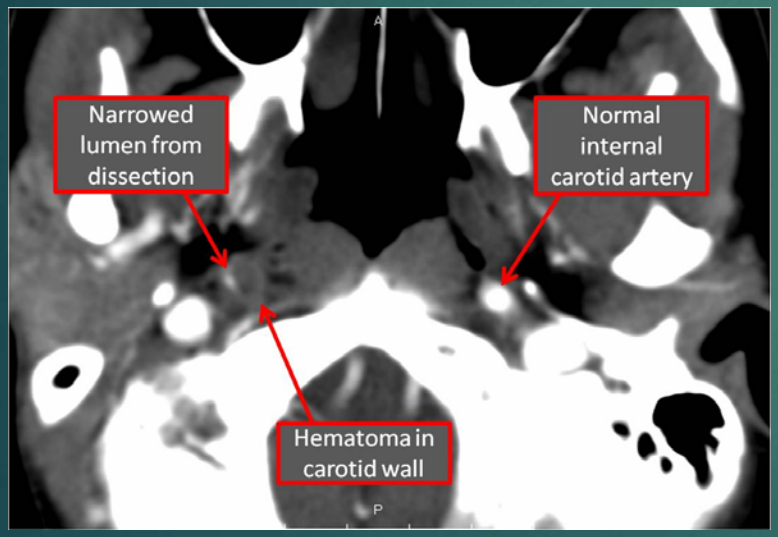
Imaging of the Carotid arteries

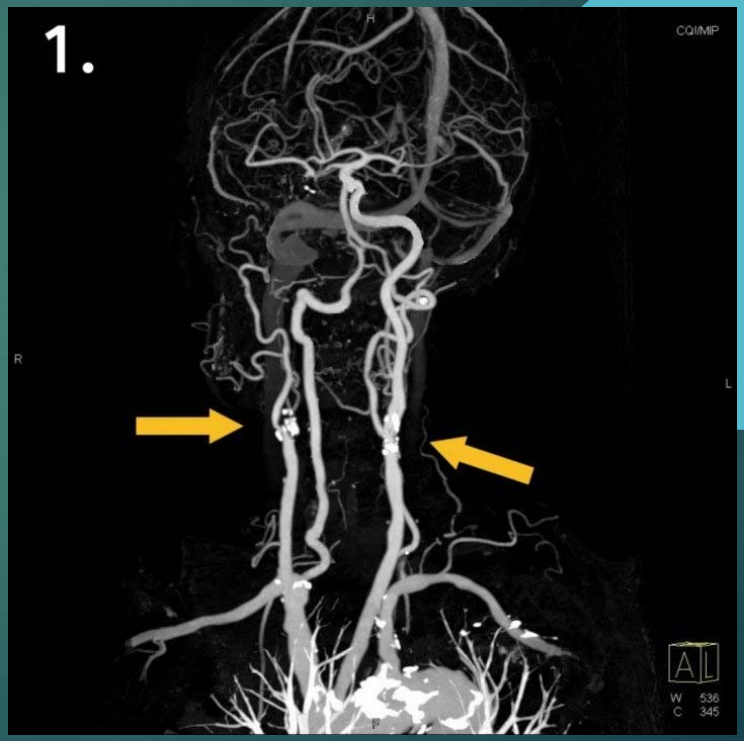
- Ultrasound
  - Least invasive, low risk
  - Measure Peak systolic velocity and end diastolic velocity
    - Allows an estimate of percent stenosis
  - Good screening tool
- CTA
  - Tends to underestimate
  - Helps delineate anatomical variations
    - High or low bifurcation
    - Aneurysmal/fmd and other rare entities
  - Risk of contrast: allergy and renal impairment


0Hz 60°
AGC
M3 M3
+28.9
RT ICA
PROX
PW
46%
WF 60Hz
SV1.5mm
M2
3.5MHz
1.6cm
-28.9
cm/s
Prox ICA
SV -107 cm/s
DV -36 cm/s
Inv
cm/s


Normal Proximal CCA – Imaging & Waveform Analysis
60 degree Doppler Angle
SV Angle 60°
Dep 1.7 cm
Size 1.0 mm
Freq 4.0 MHz
WF Low
Dop 62% Map 3
PRF 22727Hz
Patent, Disease Free Distal ICA
LT DISTAL CCA/PROX ICA
PSV = 704 cm/s
EDV = 137 cm/s
-704.1cm/s
-136.7cm/s
m/s

CTA


Narrowed lumen from dissection
Normal internal carotid artery
Hematoma in carotid wall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CQIMIP
R
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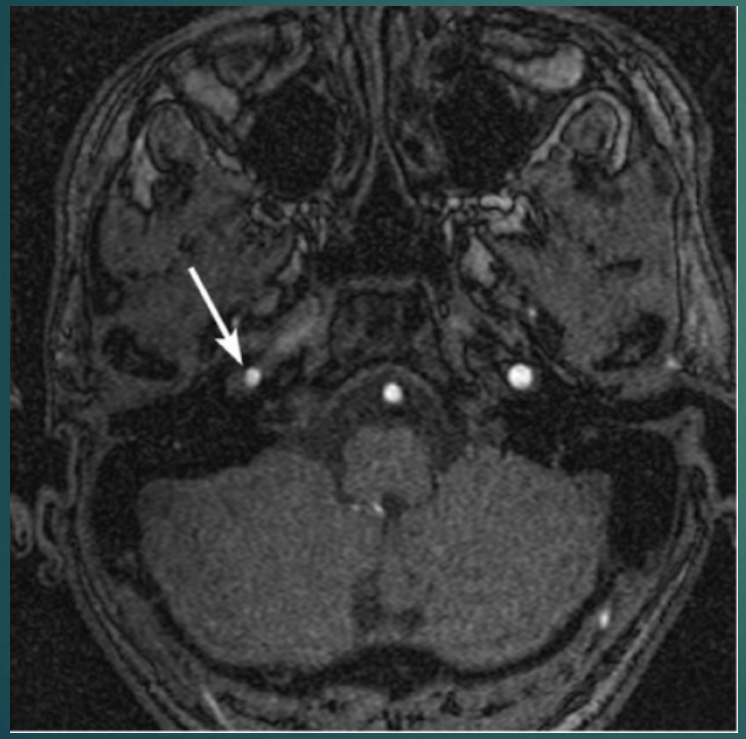
Imaging of the Carotid arteries

- MRA
  - Tends to overestimate
  - Technology may be institutionally dependent
    - Risk of magnet: patient metal
  - Gandolinium toxicity
  - Nephrogenic systemic fibrosis
- Digital Subtraction Angiography
  - Most invasive
  - Less iv contrast
  - Gold standard
  - Risk of access site and stroke (0.1 percent)
  - Tie breaker
- Rare tests PET/CT and Transcranial doppler (TCD)

MRA and DSA



How do we identify people at risk of developing a stroke from carotid stenosis

- History and physical
  - Carotid Bruit
    - Low sensitivity and specificity
  - Eye Exam
    - Hollenhorst plaque
- Screening Ultrasounds
  - High rate of detection of disease in asymptomatic patients
  - Low yield if other risk factors not present
  - US Preventive Services Task force currently recommends in patients at high risk
- People with potential symptoms

Treatment of Carotid Stenosis

- Asymptomatic vs Symptomatic
  - same three options just when utilize is different
  - Best medical therapy
    - Aspirin, Plavix and statins
    - Control risk factors
  - Surgery (revascularization)
    - Carotid endarterectomy
  - Stenting (revascularization)
    - Unless hospital/surgeon is in a trial, only approved in symptomatic patients

Indications for Revascularization

- Largely independent of method of revascularization
- Symptomatic disease
- Asymptomatic disease
- 3% rule (ACAS 2.3% stroke/death)
- We will ignore posterior fossa and external carotid disease today

Contraindications to Revascularization

- **Disabling stroke, especially with altered LOC**
- **Total occlusion**
- **Medical comorbidities**
- **Life expectancy too short to derive benefit**

Symptomatic Disease

- **70 – 99%**
- **NASCET 2 year follow up**
  - **26% stroke risk in medical arm**
  - **9% stroke risk in surgical arm**

Symptomatic Disease

- **50 – 69%**
- **NASCET 5 year follow up**
  - **22.7% stroke risk in medical arm**
  - **15.7% stroke risk in surgical arm**

Symptomatic Disease

- **Symptoms within 120 days**
- **Increased risk reduction with greater degrees of stenosis**
- **Especially benefits males > 75**
- **There is benefit for women, but not as dramatic**

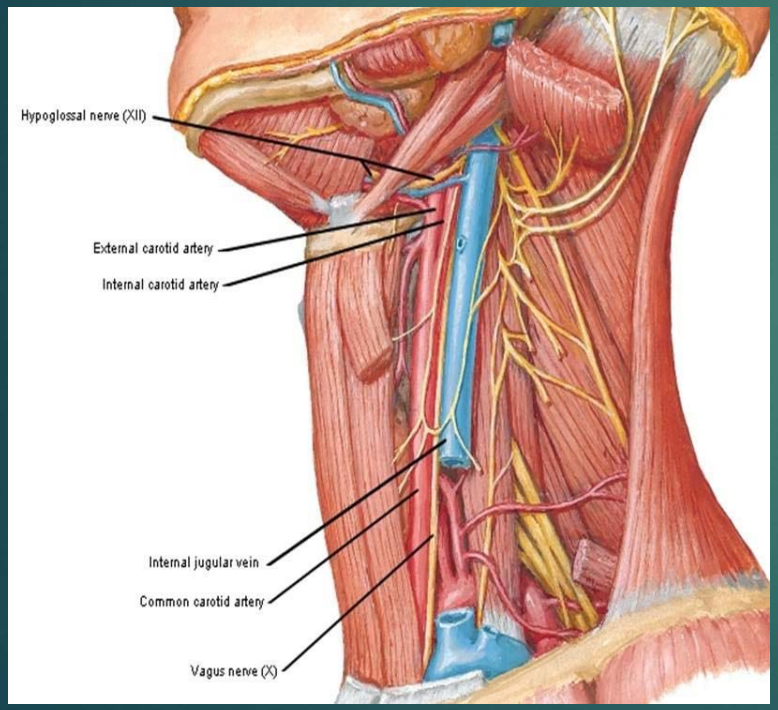
Asymptomatic Disease

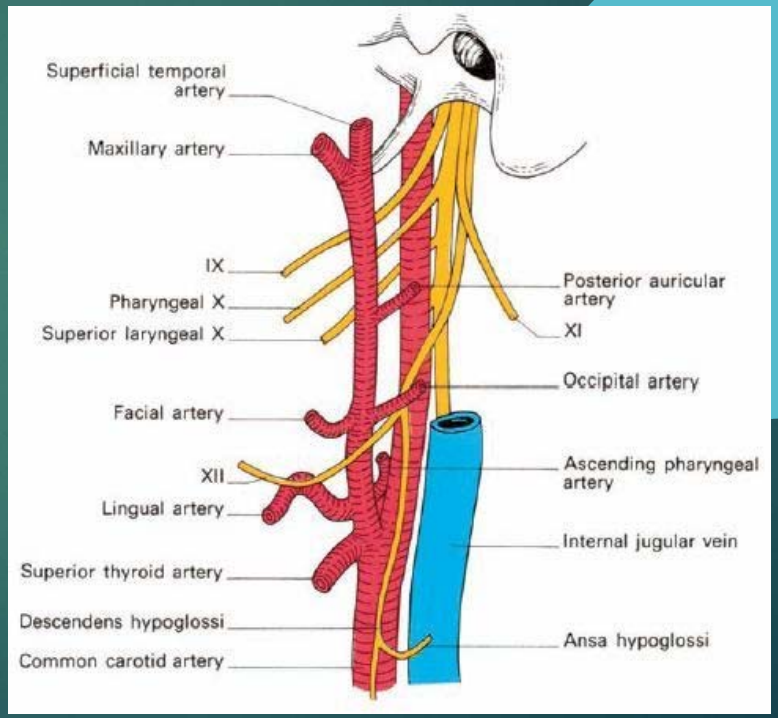
- **> 60%**
- **ACAS 5 year follow up**
  - **11% stroke risk in medical arm**
  - **5.1% stroke risk in surgical arm**

Asymptomatic Disease

- No increased risk reduction with greater degrees of stenosis
- Greatest benefits in patients < 65
- Lesser benefit in women
- Consider limiting to
  - > 80%
  - contralateral occlusion or high grade stenosis
  - ulcerated lesions

Anatomy


Hypoglossal nerve (XII)
External carotid artery
Internal carotid artery
Internal jugular vein
Common carotid artery
Vagus nerve (X)


Superficial temporal artery
Maxillary artery
IX
Pharyngeal X
Superior laryngeal X
Facial artery
XII
Lingual artery
Superior thyroid artery
Descendens hypoglossi
Common carotid artery
Posterior auricular artery
XI
Occipital artery
Ascending pharyngeal artery
Internal jugular vein
Ansa hypoglossi

Endarterectomy vs. Stenting

- **High-risk for endarterectomy – CMS criteria**
- **CEA vs. CAS trials**

Anatomic High Risk for Endarterectomy

- **Anatomically inaccessible lesion**
- **Cervical immobility**
- **Prior neck dissection**
- **Tracheostomy**
- **Contralateral cranial nerve injury**
- **Radiation**
- **Contralateral occlusion**
- **Recurrent stenosis**

Medical High Risk for Endarterectomy

- **COPD**
- **NYHA III or IV CHF**
- **EF < 30%**
- **Unstable angina**
- **Recent MI**

Endarterectomy Outcomes

- **Symptomatic**
  - **0.6 – 1% death**
  - **5 – 7% stroke/death**
- **Asymptomatic**
  - **2.3% stroke/death**

Endarterectomy Outcomes

- **Cranial nerve injury: 4 – 7%**
- **Hemorrhage: 3%**
- **MI: 1 – 2.6%**
- **Hyperperfusion syndrome/intracranial hemorrhage: 1%**
- **Restenosis: 3 - 6%**
- **Infection: 0.3 – 0.8%**

Stenting Outcomes

- **Randomized trials plagued by**
  - **bias**
  - **operator inexperience**
  - **aberrant CEA outcomes**
  - **nonstandardized EPD**
  - **angioplasty without stent**

Stenting Outcomes

Trial	CEA stroke/death	CAS stroke/death	CEA restenosis	CAS restenosis
CAVATAS 2001	9.9%	10%	10.5%	30.7%
SAPPHIRE 2004	20.1%	12.2%		
EVA-3S 2006	3.9%	9.6%		
SPACE 2006	6.3%	6.8%	4.6%	10.7%

Technical Aspects of Endarterectomy

- **GA or regional**
- **Routine or selective shunting**
- **Monitoring**
- **Eversion or longitudinal endarterectomy**
- *****Patch or no patch*****