Indications for Carotid Endarterectomy

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Case Presentation

- 70 yo M
- PMHx: HTN, seizure disorder, CVA (2010)- no deficits.
- PSHx: partial gastrectomy for ?tumor (non malignant)
- Meds: amlodipine, carbemazepine
- Social Hx: ½ PPD (many years), social ETOH
- Presented to vascular clinic for work up of left foot pain
- Also noted to have a carotid duplex (done by PMD), showing 70-99% Left ICA stenosis
Case Presentation

Relevant exam findings

- No neurological deficits - sensory/motor
- No carotid bruit
- Abdomen soft NT no pulsatile masses
- Ext: b/l cool with decreased cap refill, no ulceration/ gangrene
- Pulse exam : b/l palp femoral pulses, absent pop, DP, PT
Case Presentation

Pre-operative work-up

- Labs: unremarkable
- Imaging:
  - Carotid Duplex: Right- normal velocities, no plaque; Left- 70-99% stenosis ICA, homogenous plaque bulb to proximal ICA
  - CTA neck: Left- Moderate to severe stenosis of ICA from origin to 2cm, calcified plaque. Right- Moderate stenosis of ICA from origin to 1.5cm
Case Presentation

Contrast: CONTRAST
Gantry: 0°
FoV: 311 mm
Slice: 0.8 mm
Pos.: 613.3 mm
Pat.pos.: HFS

Exam: CT ANGIO NECK WITH IV CONTRAST
Series: CTA CAROTID/Neck
Filter: B
140kV-77mA-821ms
Image 509 of 803
2/4/2013 - 7:06:47 PM
Case Presentation

Operative Details
- General anesthesia
- SSEP monitoring
- Incision - anterior sternomastoid border
- Left carotid endarterectomy
- Patch angioplasty with bovine pericardial patch

Post-operative Course
- Uneventful
- No neuro deficits
- Discharged home on POD 3
Questions??
Outline

- Relevant definitions: TIA, stroke, carotid stenosis-symptomatic and asymptomatic

- Topics of discussion:
  - Diagnosis of carotid stenosis- best method
  - Degree of stenosis and relation to stroke
  - CEA in symptomatic patients- trials, indications
  - CEA in asymptomatic patients- trials and indications
  - Role of carotid stenting

- Guidelines and recommendations
Definitions

- **Transient Ischemic Attack (TIA)**

  Old definition: Sudden onset of a focal neurologic symptom sign lasting less than 24 hours, from transient decrease in blood supply rendering the brain ischemic in the area producing the symptom.

  New definition: (AHA/ASA 2009 endorsed): transient episode of neurologic dysfunction caused by focal brain, spinal cord, or retinal ischemia, **without** acute infarction.
Ischemic stroke: infarction of central nervous system tissue
• embolism of the thrombotic material
• low flow due to the stenosis with inadequate collateral compensation

795,000 strokes in the US each year

80% ischemic
• 15% of patients have warning TIA
• 15% have >50% carotid stenosis

Amaurosis fugax: transient monocular blindness caused by a small embolus to the ophthalmic artery
Symptomatic carotid stenosis:

- Focal neurologic symptoms of sudden onset
- Ipsilateral to significant carotid atherosclerotic pathology
- TIA's
- Nondisabling ischemic stroke
- Within the previous 6 months

Atypical symptoms:

- Unilateral limb shaking
- Transient loss of monocular vision upon exposure to bright light
Asymptomatic carotid artery stenosis:

- Significant carotid stenosis (>60%) without symptoms.

NOT symptoms of carotid stenosis:

- Vertigo
- Syncope
Diagnosis of Carotid Stenosis

Diagnostic modalities

- Cerebral angiography
- Carotid duplex ultrasound
- Magnetic resonance angiography
- Computed tomographic angiography

Stenosis Measurement

Methods of measuring carotid stenosis in NASCET and ECST

<table>
<thead>
<tr>
<th>NASCET</th>
<th>ECST</th>
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<tbody>
<tr>
<td>30</td>
<td>65</td>
</tr>
<tr>
<td>40</td>
<td>70</td>
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<tr>
<td>50</td>
<td>75</td>
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<td>60</td>
<td>80</td>
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<td>70</td>
<td>85</td>
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<td>80</td>
<td>91</td>
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<tr>
<td>90</td>
<td>97</td>
</tr>
</tbody>
</table>

Approximate equivalent degrees of internal carotid artery stenosis used in NASCET and ECST according to recent direct comparison.

# Diagnosis of Carotid Stenosis

<table>
<thead>
<tr>
<th>Modality</th>
<th>Conventional Angiography</th>
<th>CDUS</th>
<th>MRA</th>
<th>CTA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advantage</td>
<td></td>
<td>• Entire carotid system</td>
<td>• Non invasive</td>
<td>• Best for anatomy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Plaque morphology</td>
<td>• Safe</td>
<td>• Sensitive for anatomy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Collateral circulation</td>
<td>• Cheap</td>
<td>• Sensitive, specific (97%,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Sensitivity 81-98%</td>
<td>99%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Specificity 82-89%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disadvantage</td>
<td></td>
<td>• Invasive</td>
<td>• Reproducible</td>
<td>• DM, CHF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Expensive</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Neuro event risk 1.2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Hairline residual lumen</td>
<td>• Moderate lesions</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Body habitus</td>
<td>• Pacemakers, defibrillators</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Tortuous arteries</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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# Diagnosis of Carotid Stenosis

<table>
<thead>
<tr>
<th>Degree of Stenosis (%)</th>
<th>ICA PSV (cm/s)</th>
<th>ICA/CCA PSV Ratio</th>
<th>ICA EDV (cm/s)</th>
<th>Plaque Estimate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&lt;125</td>
<td>&lt;2.0</td>
<td>&lt;40</td>
<td>None</td>
</tr>
<tr>
<td>&lt;50</td>
<td>&lt;125</td>
<td>&lt;2.0</td>
<td>&lt;40</td>
<td>&lt;50</td>
</tr>
<tr>
<td>50–69</td>
<td>125–230</td>
<td>2.0–4.0</td>
<td>40–100</td>
<td>≥50</td>
</tr>
<tr>
<td>≥70 to less than near occlusion</td>
<td>&gt;230</td>
<td>&gt;4.0</td>
<td>&gt;100</td>
<td>≥50</td>
</tr>
<tr>
<td>Near occlusion</td>
<td>High, low, or not detected</td>
<td>Variable</td>
<td>Variable</td>
<td>Visible</td>
</tr>
<tr>
<td>Total occlusion</td>
<td>Not detected</td>
<td>Not applicable</td>
<td>Not detected</td>
<td>Visible, no lumen</td>
</tr>
</tbody>
</table>
## Diagnosis of Carotid Stenosis

### Choice of imaging test:

Non-invasive imaging compared with intra-arterial angiography in the diagnosis of symptomatic carotid stenosis: a meta-analysis.


<table>
<thead>
<tr>
<th>Stenosis group</th>
<th>Imaging</th>
<th>Sensitivity (95% CI)</th>
<th>Specificity (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>70–99%</td>
<td>US</td>
<td>0.89 (0.85 to 0.92)</td>
<td>0.84 (0.77 to 0.89)</td>
</tr>
<tr>
<td></td>
<td>CTA</td>
<td>0.77 (0.68 to 0.84)</td>
<td>0.95 (0.91 to 0.97)</td>
</tr>
<tr>
<td></td>
<td>MRA</td>
<td>0.88 (0.82 to 0.92)</td>
<td>0.84 (0.76 to 0.90)</td>
</tr>
<tr>
<td></td>
<td>CEMRA</td>
<td>0.94 (0.88 to 0.97)</td>
<td>0.93 (0.89 to 0.96)</td>
</tr>
<tr>
<td>50–69%</td>
<td>US</td>
<td>0.36 (0.25 to 0.49)</td>
<td>0.91 (0.87 to 0.94)</td>
</tr>
<tr>
<td></td>
<td>CTA</td>
<td>0.67 (0.30 to 0.90)</td>
<td>0.79 (0.63 to 0.89)</td>
</tr>
<tr>
<td></td>
<td>MRA</td>
<td>0.37 (0.26 to 0.49)</td>
<td>0.91 (0.78 to 0.97)</td>
</tr>
<tr>
<td></td>
<td>CEMRA</td>
<td>0.77 (0.59 to 0.89)</td>
<td>0.97 (0.93 to 0.99)</td>
</tr>
<tr>
<td>0–49,100%</td>
<td>US</td>
<td>0.83 (0.73 to 0.90)</td>
<td>0.84 (0.62 to 0.95)</td>
</tr>
<tr>
<td></td>
<td>CTA</td>
<td>0.81 (0.59 to 0.93)</td>
<td>0.91 (0.74 to 0.98)</td>
</tr>
<tr>
<td></td>
<td>MRA</td>
<td>0.81 (0.70 to 0.88)</td>
<td>0.88 (0.76 to 0.95)</td>
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Diagnosis of Carotid Stenosis

CDUS as initial test

CEMRA/CTA for additional information
Degree of Stenosis and Relation to Stroke


- <2% for stenosis <70%
- 9.8% for stenosis 70-79%
- 14.4% for stenosis 80-99%
Cause of stroke in patients with carotid stenosis

- Cardioembolic
- Lacunar
- Large-artery

Risk of stroke at 5 years, percent

- <60 percent stenosis:
  - Cardioembolic: 1.2
  - Lacunar: 1.9
  - Large-artery: 5.4

- 60-99 percent stenosis:
  - Cardioembolic: 2.1
  - Lacunar: 6.0
  - Large-artery: 9.9

Carotid Endarterectomy in Symptomatic Patients

North American Symptomatic Carotid Endarterectomy Trial (NASCET)


- Medical management + CEA vs. medical management alone for symptomatic carotid stenosis.
- Prospective randomized trial.
- Multicenter (50 US and Canadian centers with peri-op stroke and death rate <6%)
- 1212 pts from January 1988 to February 1991
- 2 strata
  - 30-69% stenosis
  - 70-99% stenosis (659pts)
Carotid Endarterectomy in Symptomatic Patients

Premature termination in 70-99% group

- A lower risk of any stroke or death (15.8 versus 32.3 percent)
- 17% Absolute risk reduction
- 65% Relative risk reduction
Carotid endarterectomy should be offered to patients with symptomatic 70-99% carotid stenosis.
Carotid Endarterectomy in Symptomatic Patients

European Carotid Surgery Trial (ECST)

- Multicenter randomized prospective trial
- Range of stenosis within which carotid endarterectomy confers statistically proven benefit.
- Final report of 3024 pts. followed for 6 yrs
  - CEA was beneficial for symptomatic carotid stenosis of 80 - 99%
  - Increased risk of ipsilateral stroke with > 80% stenosis
Cochrane Database Systematic Rev. 2011: Carotid endarterectomy for symptomatic carotid stenosis.

Rerkasem.K. et.al. Published Online: 13 APR 2011. Cochrane Stroke Group

- Pooled analysis- 6092 pts- ECST, NASCET, VA
- <30% - Increased 5yr risk of ipsilateral stroke (N = 1746, ARR -2.2%, P = 0.05)
- 30-49% - No significant effect (N = 1429, ARR 3.2%, P = 0.6)
- 50-69% - Marginal benefit (N = 1549, ARR 4.6%, P = 0.04)
- 70-99% - Highly beneficial (N = 1095, ARR 16.0%, P < 0.001)
- Near occlusion – No benefit (N = 262, ARR -1.7%, P = 0.9)
Carotid Endarterectomy for Asymptomatic Patients

Asymptomatic Carotid Artery Stenosis Study (ACAS). JAMA. 1995;273(18):1421

- Objective: CEA + aspirin vs aspirin alone in reduction of incidence of cerebral infarction in patients with asymptomatic carotid artery stenosis.
- Randomized, prospective, multi-center trial
- 1662 adults, 40 – 79 yrs, 60 – 99% stenosis
- Primary end point - cerebral infarction in the distribution of the study artery or any stroke or death in the perioperative period
Carotid Endarterectomy for Asymptomatic Patients

Median follow up of 2.7 yrs

- 5 yr stroke / death risk
  - 11.0% medical group
  - 5.1% surgery group

- Sub group analysis
  - ARR in men 8%
  - ARR in women 1.4%
Carotid Endarterectomy for Asymptomatic Patients

Cochrane Database Systematic Rev. 2008: Carotid endarterectomy for asymptomatic carotid stenosis. Chambers BR et al. Cochrane Stroke Group

3 studies, 5223 patients (3579 M and 1644 F)
- ACAS (< 80 yrs)
- ACST
- VA (men only)

Follow up 2.7-4 yrs
Carotid Endarterectomy for Asymptomatic Patients

Results

- **Peri-op stroke/death/any subsequent stroke:**
  - 31% RRR from CEA
  - ARR of 1% over 4 yrs - VA study
  - ARR of 3% over 2.7 yrs - ACAS
  - ARR of 3.1% over 3.4 yrs - ACST

- **Peri-op stroke/death/subsequent ipsilateral stroke:**
  - 29% RRR for CEA

- **Peri-op stroke or death:** 3.1%
  - Overall operation related complication rate: 2.9%
Carotid Endarterectomy for Asymptomatic Patients

Implications for practice

- Stroke and death rate reduction by 30% over 3 yrs despite peri-op risk rate of 3%
- ARR builds with time
- Men benefit more than women
- Insufficient data for older pts., younger pts., different degrees of stenosis
Carotid Artery Stenting (CAS) Vs. Carotid Endarterectomy (CEA)


- 16 trials involving 7572 patients

- CAS a/w higher risk within 30 days
  - Death or stroke (p = 0.0003)
  - Odds Ratio for primary safety outcome
    - <70yrs 1.16
    - >70yrs 2.20
    - p = 0.02

- CAS a/w lower risk of
  - MI
  - Cranial nerve palsy
  - Access/ surgical site hematoma

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CAS vs. CEA

- CAS - higher risk of peri-procedural stroke and death
  - In older patients

- CAS long term efficacy and rates of restenosis - undetermined
Symptomatic Carotid Artery Stenosis (SVS)

- CEA is preferred to CAS for reduction of all-cause and peri-procedural death [grade I; level of evidence, B].

- CAS over CEA if >50% stenosis and
  - tracheal stoma
  - prior ipsilateral surgery or external beam radiotherapy,
  - lesions that extend proximal to the clavicle or distal to the C2 vertebral body
  - Severe CAD, CHF, COPD [grade II; level of evidence: B].
Asymptomatic Carotid Artery Stenosis (SVS)

- >60% stenosis - CEA for reduction of long-term stroke risk
  - 3- to 5-year life expectancy
  - Perioperative stroke/death rates 3%

CAS as primary therapy - insufficient data
CEA for symptomatic patients: 50-99% stenosis
CEA for asymptomatic patients: 60-99% stenosis
CAS: symptomatic patients with surgical / medical prohibitive risks

No benefit of CEA
- severe medical co-morbidities
- Complete occlusion of ICA
- Prior ipsilateral disabling stroke

Controversial topics
- CAS
- Long term benefits of CAS vs. CEA
- Best Medical Therapy alone for asymptomatic stenosis

References

- Cochrane Database Systematic Rev. 2008: Carotid endarterectomy for asymptomatic carotid stenosis. *Chambers BR et. al.* Cochrane Stroke Group
- Management of asymptomatic carotid atherosclerotic disease: Authors: Emile R Mohler, III, MD. Section Editor — Vascular Medicine Uptodate- Nov 8 2012
- Schwartz's Principles of Surgery, 9e
Thank you
Questions
Question 1

Carotid endarterectomy would be preferred to carotid artery stenting for a(n):

A. Patient with severe three-vessel coronary artery disease
B. Recurrent stenosis 5 years after carotid endarterectomy
C. Patient with ankylosing spondylitis and severe chronic obstructive pulmonary disease
D. 82-year-old patient with a recent history of transient ischemic attack
E. 60-year-old patient with a history of neck irradiation
Question 1

Carotid endarterectomy would be preferred to carotid artery stenting for a(n):

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Question 2

Compared with carotid endarterectomy, carotid stenting at 30-day follow-up is associated with:

A. A lower incidence of ipsilateral stroke
B. A lower incidence of non-fatal myocardial infarction
C. A lower incidence of complications in patients with atherosclerotic disease
D. Better outcomes in asymptomatic patients
E. A higher incidence of stroke and death
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Compared with carotid endarterectomy, carotid stenting at 30-day follow-up is associated with:

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With regard to the Asymptomatic Carotid Atherosclerosis Study (ACAS), which of the following patients could be recommended for carotid endarterectomy?

A. A 65-year-old woman with 30% stenosis and complaints of lower extremity claudication
B. A 70-year-old man with a carotid bruit and 60% stenosis revealed on angiogram
C. An 80-year-old woman with atrial fibrillation, complete left hemiplegia, and a 30% stenosis on duplex ultrasound imaging
D. A 70-year-old man with hyperlipidemia, a recent myocardial infarction, and a 50% carotid stenosis
E. An 80-year-old man with obstructive pulmonary disease and 90% stenosis of the left internal carotid artery
Question 3

With regard to the Asymptomatic Carotid Atherosclerosis Study (ACAS), which of the following patients could be recommended for carotid endarterectomy?

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E. An 80-year-old man with obstructive pulmonary disease and 90% stenosis of the left internal carotid artery