Carotid Artery Stenosis

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December 16, 2004
Some Facts

• Internal Carotid Artery Stenosis is responsible for 30% of ischemic strokes
• 4-8% of 50-79 year old patients have ICA stenosis >50%
• ICA stenosis causes mostly (90%) embolic strokes, rarely failure of perfusion
Carotid Artery Stenosis

- Asymptomatic
- Symptomatic
Natural History

• Short term (2-3 years) 1-3% incidence of unheralded ipsilateral CVA
• Approximate event rate of <1%/year for <50% stenosis
• Approximate event rate of 1%/year for >50% stenosis
Ipsilateral Event Rate

3 year, ECST

5 year, NASCET

ICA stenosis

0-29  30-69  70-99

<50  50-59  60-74  75-94

ICA stenosis

Dodick
CASANOVA
(Carotid artery stenosis with asymptomatic Narrowing: Operation vs. Aspirin)

- 410 patients, 3 years
- Asymptomatic ICA 50-90%
- Overall, CEA not beneficial for ICA stenosis <90%
VA Study

- 444 patients, 4 year followup
- Asymptomatic ICA 50-99%
- ASA 1300mg/day vs CEA + ASA 1300
- TIA reduction in CEA + ASA
- No stroke reduction in CEA group
ACAS
Asymptomatic Carotid Atherosclerosis Study

- 1662 patients, mean 2.7 years; projected 5 years
- Asymptomatic ICA 60-99% (noninvasive or angiographic)
- ASA 325 vs. CEA + ASA 325
- 53% relative risk reduction in CVA/death, Absolute reduction of 5.9% over 5 years
Limitations of ACAS

• Absolute stroke risk reduction of 1.2%/year
  – Eg pt with 3%/year stroke risk now with 1.8%/year stroke risk
  – Risk of cardioembolic, lacunar CVA NOT reduced
• Perioperative complication rate 2.3%; death 0.1%
  – Good risks; 25 pts screened for every 1 enrolled
  – Other studies show 4.6-5.1% incidence of perioperative stroke/death in asymptomatic ICA with CEA
  – If 5% event rate applied, results of ACAS are nullified
• CEA not beneficial for women with ICA 60-99%!
• No incremental benefit for increasing stenoses
  – 60-69% stenosis had HIGHER benefit than 80-89%!
ACST
Asymptomatic Carotid Surgery Trial

- Largest prospective study to date, most recent (May 2004)
- 3120 patients, 5 year followup; 10 year period
- ICA >60% stenosis (ultrasound)
- Immediate CEA vs. Deferred CEA (+ ‘usual therapy)
- 5 year stroke risk – 6.4% CEA; 11.8% medical
  - Men and women, all age groups, all stenosis subsets
  - 3% perioperative event rate
Meta-analysis

- 2206 patients, 2-4 years
- Ipsilateral/perioperative stroke or death
  - 4.9% CEA
  - 6.8% Medical
- Any stroke or death
  - 8.1% CEA
  - 10.4% Medical
- NNT: 53 patients undergo CEA to prevent 1 CVA over 3 years
Screening Asymptomatic Patients

- Risk factors for ICAS
  - Age
  - HTN
  - Smoking
  - PVD
Screening Asymptomatic Patients

- Risk factors for CVA with ICAS
  - Age
  - Male
  - HTN
  - Smoking
  - HLP
  - DM
  - Degree of stenosis
  - Ulceration of plaque
  - Ischemic heart disease
  - PVD
  - Obesity
Screening Patients
A strategy

• Carotid US for population at risk (40-50% pre-test probability) in surgical candidates who would undergo surgery

• Follow up patients with >50% stenosis, especially with smoking + CAD or PVD
Cost Effectiveness

• Primary Prevention: To prevent 1 nondisabling stroke in 2 years
  – $1.5 million
Screening Methods

• Carotid duplex US
  – 85% sensitivity/specificity for 70-99% vs <70%

• Digital Subtraction Angiography
  – Clinical periprocedure CVA rate of 1%
  – Gold standard

• MRA (Elliptic Centric Contrast Enhanced MRA)
  – 95% sensitivity/ 90% specificity for 70-99% vs <70%

• Spiral CTA
  – 74-100% sensitivity/ 83-100% specificity for 70-99% vs <70%
Summing up the Evidence

- 4-8% of patients age 50-79 with ICA stenosis
- Stroke risk increases with stenosis, esp. >80%
- Unheralded stroke risk is low (1-3%/year)
- Screening?
- CEA supported with >60% stenosis in medically stable patient expected to live >5 years with a low surgical (<3% event) risk
Secondary prevention

- TIA
- CVA
NASCET

- 2267 patients with TIA or nondisabling stroke within past 3 months
- 30-99% ICA stenosis
- Best medical tx vs CEA + best medical tx
- Stratified Moderate (30-69%) vs. Severe 70-99%
  - Severe: 9% ipsilateral stroke with CEA; 26% medical
  - 50-69%: 15.7% ipsilateral stroke with CEA; 22% medical
    - Higher risk (more surgical benefit) = male, CVA (not TIA), hemispheric sx, failure of ASA 650/day
    - 30-49%: 14.9% CEA; 18.7% medical at 5 years
- Surgical risk – 6-7% at 30 days (stroke, death) vs. 2.5-3% for medical tx.
Stroke Events in NASCET

• Most Patients with ICAS have multiple risk factors

• In NASCET
  – In patients with symptomatic stenosis, 20% of ischemic CVA’s were not related to ICA stenosis!
  – In asymptomatic patients, 45% of ischemic CVA’s were unrelated to ICA
  – Other causes: Carioembolic, lacunar
ECST

- 2518 patient with nondisabling stroke or TIA in past 3 months
- Angiographic method different than NASCET
  - 70-99%: 10.3% ipsilateral stroke or death CEA: 16.8% with medical at 3 years
  - Perioperative stroke/death rate of 7.5%
  - CEA harmful for <30% stenosis
  - 30-69% no benefit of CEA
- Recommend CEA for >=80% stenosis (60% by NASCET)
Both NASCET and ECST define D (the narrowest point) the same way but differ in how they define N (the normal diameter). This can lead to different stenosis measurements for the same lesion.

The NASCET method defines normal as the diameter just distal to the carotid bulb (not the bulb itself nor a region of poststenotic dilatation). In this example, the stenosis is 46% by the NASCET method.

The ECST method defines normal as the estimated diameter of the carotid bulb as it was before the disease narrowed the lumen. In this example, the stenosis is 75% by the ECST method.
Guidelines
A Moving Target

• 1997 NASCET (assume <=6% surgery risk)
  – CEA for symptomatic stenosis >=70%
  – ? CEA for asymptomatic stenosis >=60%

• 1998 AHA/Stroke
  – With <3% risk, CEA for asymptomatic ICA >=60%
  – With 3-5% risk, CEA for asymptomatic ICA >=75% with contralateral 75-100% stenosis
  – CEA for symptomatic stenosis >=70%
2004 Hurst

• Symptomatic ICA stenosis
  – CEA for >80% stenosis
  – CEA probably indicated for 50-79% stenosis (closer to 79%), assess risk factors
  – CEA may be indicated with 50-79% stenosis (closer to 50%), assess risk factors

• Asymptomatic ICA stenosis
  – CEA for >80% stenosis
  – CEA may be indicated for 50-79% stenosis (closer to 79%), assess risk factors
  – CEA not indicated for 50-79% stenosis (closer to 50%)
Putting it all together

• Clear Indications for CEA
  – Symptomatic men and women, aged 80 years or younger, with 70% or greater carotid stenosis if surgical risk for stroke and death is 6% to 7% or less.
  – Asymptomatic men and women, aged 80 years or younger, with 80% or greater carotid stenosis if surgical risk for stroke and death is 3% or less.

• Possible indications for CEA
  – Symptomatic stenosis >50% with risk factors
  – Asymptomatic stenosis >60%

• CEA Clearly NOT indicated
  – Any stenosis <=50%
  – Asymptomatic stenosis <60%
CEA vs Carotid Stenting

- Trials thus far demonstrate comparable short term (30 day) outcomes
- Stenting favored for high risk patients (heart failure, angina, COPD) or patients with difficult surgical anatomy (scar tissue, radiation, etc)
- Surgery favored in tortuous vessels
Concomitant Coronary and Carotid disease

• Overall CABG CVA risk 1-3%
  – 9% risk with >50% ICA stenosis
  – 14% risk with >75% ICA stenosis

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Stroke Rate</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staged (CEA then CABG)</td>
<td>3-4%</td>
<td>3-4%</td>
</tr>
<tr>
<td>Reverse Staged (CABG then CEA)</td>
<td>14%</td>
<td>5%</td>
</tr>
<tr>
<td>Combined (CEA and CABG)</td>
<td>3%</td>
<td>4%</td>
</tr>
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Carotid Ultrasound

• Right then left side
• Transverse imaging
  – Visualize plaque, calcium
• Longitudinal imaging
  – Visualization of plaque
  – Duplex sonography
  – Left of screen = cephalid, right = caudal
• (Subclavian), CCA, ECA, ICA, (vertebral)
A. Normal ECA (High resistance)
B. Normal ICA (Low resistance)
C. Normal CCA
D. Normal Color Doppler at Bifurcation; Normal Flow reversal

Polak, 117
Internal carotid artery (at the stenosis)

Internal carotid artery (proximal to the stenosis)

Common carotid artery

Peak-systolic velocity in the internal carotid artery, at the stenosis (A)
Peak-systolic velocity in the common carotid artery (B)
Peak-systolic velocity ratio = A/B = 2
Stenosis >90%, velocity falls
## Ultrasound Criteria for Stenosis

<table>
<thead>
<tr>
<th></th>
<th>Primary</th>
<th>Secondary</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>ICA PSV</td>
<td>Plaque (%)</td>
</tr>
<tr>
<td><strong>Normal</strong></td>
<td>&lt;125</td>
<td>None</td>
</tr>
<tr>
<td><strong>&lt;50</strong></td>
<td>&lt;125</td>
<td>&lt;50</td>
</tr>
<tr>
<td><strong>50-69</strong></td>
<td>125-230</td>
<td>&gt;=50</td>
</tr>
<tr>
<td><strong>&gt;=70</strong></td>
<td>&gt;230</td>
<td>&gt;=50</td>
</tr>
<tr>
<td><strong>Near Occlusion</strong></td>
<td>Variable</td>
<td>Visible</td>
</tr>
<tr>
<td><strong>Total Occlusion</strong></td>
<td>Undetectable</td>
<td>Visible, no lumen</td>
</tr>
</tbody>
</table>
Carotid Doppler Report

• Plaque estimate (> or <50%)
  – Homogenous vs Heterogenous
  – +/- calcium

• ICA stenosis estimate

• Vertebral Artery
  – Antegrade v retrograde flow
References

- Topol, EJ. Textbook of Cardiovascular Medicine, 2nd ed. Lippincott Williams & Wilkins, 2002.