Cerebrovascular Disease
Carotid Artery
Vertebral Artery
Arch Vessels

Jerry Goldstone, MD

Disclosure

• I have no relationships to disclose.
• I may discuss unlabeled or unapproved uses of drugs or devices in my presentation in that some stents, although within the generally accepted standard of practice, do not have specific FDA approval for use in the arteries to be discussed.

CAROTID ARTERY DISEASE

JERRY GOLDSTONE, MD, FACS, FRCSE
SVS REVIEW COURSE
SEPTEMBER 9-10, 2011

CAROTID RECONSTRUCTION FOR OCCLUSIVE DISEASE

• MAY 19, 1954
• ST MARY’S HOSPITAL
  – LONDON
• CAROTID RESECTION WITH END-TO-END ICA-CCA ANASTOMOSIS

EXTRACRANIAL CAROTID DISEASE

• PROBLEM: STROKE

• OBJECTIVE: PREVENTION
  PRIMARY
  SECONDARY

STROKE

FACTS

• DECLINING INCIDENCE
• DECLINING MORTALITY
• 700,000 STROKES / YEAR, 200,000 NEW
• 160,000 DEATHS ANNUALLY
• 3RD LEADING CAUSE OF DEATH
• TOTAL COSTS: $68.9 BILLION (2009)
STROKE

FACTS

- Incidence increases with age
- 15-33% mortality with first stroke
- Men and women affected equally
- 87% ischemic
  - 15-20% due to carotid athero

EXTRACRANIAL CAROTID DISEASE

ETIOLOGY

- Atherosclerosis
  - Primary
  - Recurrent
- Fibromuscular dysplasia
- Cystic medial necrosis
- Dissection
- Arteritis
  - Radiation
  - Takayasu’s

CAROTID ATHEROSCLEROSIS

FACTS

- 15-20% of all ischemic strokes
- Cervical bruit
  - Non-specific / sensitive for stenosis
  - Annual stroke rate: >5%
  - 2.6 x increased stroke (Framingham)
- Arch vessel disease: 5-15%

CEREBRAL ISCHEMIC EVENTS

CLASSIFICATION

- Anatomic
  - Anterior / carotid territory
  - Posterior / vertebrobasilar territory
  - Global
- Symptom status
  - Symptomatic
  - Asymptomatic

CEREBRAL ISCHEMIC EVENTS

- Transient ischemic attack
  - Lasts < 24 hours
  - No permanent brain damage (24% with lesions)
- Reversible ischemic neurol deficit (RIND)
  - 24-48 hours (7 days)
  - PRIND (up to 7 days)
- Stroke
  - >48 hours
  - Brain infarction
- Lacunar
  - Thrombosis vs embolic

CAROTID TERRITORY EVENTS

CLINICAL MANIFESTATIONS

- Focal: common
  - Monoparesis / hemiparesis
  - Hemisensory deficit
  - Aphasia / dysphasia
  - Monocular blindness
  - Partial field cut
- Global: uncommon
  - Light-headedness
  - Bright light amaurosis
  - Cognitive decline
CEREBRAL ISCHEMIC EVENTS

MECHANISM

• EMBOLIC
  • FOCAL SYMPTOMS
• HYPOPERFUSION
  • NON-FOCAL SYMPTOMS
  • SEVERE MULTIVESSEL OCCLUSIVE DISEASE

CEREBRAL ISCHEMIC ATTACKS

CAROTID ATHEROSCLEROSIS

ICA OCCLUSION

CAROTID ATHEROSCLEROSIS

EVALUATION

• HISTORY AND PHYSICAL EXAM
  • CARDIOVASCULAR
  • RISK FACTORS
  • OTHER VASCULAR BEDS
    • CARDIAC
    • NEUROLOGIC
  • DETAILED IF SYMPTOMATIC
CAROTID ATHEROSCLEROSIS

DIAGNOSTIC TESTS

- DUPLEX ULTRASOUND
- TRANS-CRANIAL DOPPLER
- MRI / MRA
- CT / CTA
- CATHETER ANGIOGRAPHY

DUPLEX ULTRASOUND

- PREFERRED FIRST-LINE MODALITY
  - CERTIFIED VASCULAR LAB
  - CERTIFIED VASCULAR TECH
  - ESTABLISHED PROTOCOLS
  - VERIFIED ACCURACY
  - CAN ASSESS PLAQUE MORPHOLOGY
- MAY COMBINE WITH OTHER MODALITY
  - INADEQUATE DUPLEX SCAN
  - CONFIRM EQUIVOCAL FINDINGS
  - PLANNING ENDOVASCULAR THERAPY

CAROTID DUPLEX SCAN

CALCIFIED PLAQUE
HOMOGENEOUS PLAQUE

CAROTID STENOSIS

DUPLEX DIAGNOSTIC CRITERIA*

<table>
<thead>
<tr>
<th></th>
<th>50-69%</th>
<th>70-99%</th>
</tr>
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<tbody>
<tr>
<td>PSV</td>
<td>125-230</td>
<td>&gt;230</td>
</tr>
<tr>
<td>EDV</td>
<td>40-100</td>
<td>&gt;100</td>
</tr>
<tr>
<td>ICA/CCA</td>
<td>2-4</td>
<td>&gt;4</td>
</tr>
</tbody>
</table>

WITH DEMONSTRATION OF SIGNIFICANT PLAQUE BY GRAY-SCALE ULTRASOUND

*RESULTS VARY BY LAB AND BY INDIVIDUAL MACHINE

MRI / MRA

- PROVIDES INTRA- AND EXTRACRANIAL DATA
- OVER-ESTIMATES SEVERE STENOSIS
- CE-ENHANCED TOF IS BETTER
- MANY PATIENTS UNSUITABLE
  - CLAUSTROPHOBIC
  - METALLIC IMPLANTS
  - MORBID OBESITY
  - CAN'T LAY STILL
- NOT RECOMMENDED FOR SCREENING
CT / CTA

• MULTI-DETECTOR (64-128+) CT
  • FAST SCAN TIMES
  • EXCELLENT SPATIAL RESOLUTION (0.3MM)
  • HI QUALITY 3-D REFORMATTING
    • 2.2mm LUMEN = 50% STENOSIS (NASCET)
    • 1.3mm LUMEN = 70% STENOSIS (NASCET)
• NOT RECOMMENDED FOR SCREENING
• NOT NECESSARY FOR CEA
• BEST NON-INVASIVE METHOD TO DETERMINE
  APPROPRIATENESS FOR CAS

CAROTID BIFURCATION

ANGIOGRAPHY

CAROTID STENOSIS

NATURAL HISTORY

• >75% STENOSIS: 22% TIA / STROKE AT 1 YEAR
• SILENT CT INFARCTION
  • 35-50% STENOSIS: 10%
  • 50-75% STENOSIS: 17%
  • >75% STENOSIS: 30%

CHAMBERS BR, NORRIS JW. NEJM 315:860; 1986

ASYMPTOMATIC CAROTID STENOSIS

NATURAL HISTORY

• 2295 PATIENTS FOLLOWED FOR 4.5 YEARS
• OVERALL STROKE RISK AT 3 YRS: 2.1%
• STROKE RISK <2% IN EACH DECILE UP TO 80%
  STENOSIS
• STROKE RISK 9.8% IN 80-89% STENOSIS
• STROKE RISK 14.4% IN 90-99% STENOSIS

ECST, Lancet, 1995

SYMPTOMATIC CAROTID DISEASE

NATURAL HISTORY

• RECURRENT TIA: 25-35%
• STROKE AFTER TIA: 25-35% AT 5 YEARS
  • HIGHEST IN FIRST WEEK
  • 13% FIRST 90 DAYS
  • 10% AFTER 1ST YEAR
• RECURRENT STROKE: 6-12% / YR
CAROTID STENOSIS

NATURAL HISTORY

- Neurologic symptoms
- Natural history of disease
- Degree of carotid stenosis
- Medical co-morbidities
- Vascular and anatomic factors
- Carotid plaque morphology
- Surgeon stroke risk

CAROTID ATHEROSCLEROSIS

TREATMENT

- Medical
  - Hypertension
  - Lipids
  - Anti-thrombotic
- Surgical
  - Endarterectomy
  - Stenting

CAROTID ENDARTERECTOMY

- Over 50 years of clinical use
- More than 150,000 / year in USA
- Efficacy and safety supported by at least 9 RCT
- TIA, stroke and death have been usual end-points

RANDOMIZED TRIALS IN SURGERY

Because most new treatments are only marginally better than existing ones, we need statistical comparisons between approaches to discern relevant differences.

CAROTID ENDARTERECTOMY RANDOMIZED CLINICAL TRIALS

SYMPOMATIC

- EAO
- NASCET
- ECST
- VA SYMPTOMATIC
- Mayo

ASYMPTOMATIC

- ACAS
- VA ASYMMPTOMATIC
- CASANOVA
- ACST I & II
## RULES OF EVIDENCE

<table>
<thead>
<tr>
<th>GRADE</th>
<th>LEVEL OF EVIDENCE</th>
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<tbody>
<tr>
<td>A</td>
<td>RCT’s, META-ANALYSES, METHODS STRONG, NO HETEROGENEITY</td>
</tr>
<tr>
<td>B</td>
<td>RCT’s, META-ANALYSES, METHODS INTERMEDIATE, HETEROGENEITY</td>
</tr>
<tr>
<td>C</td>
<td>OBSERVATIONAL STUDIES, EXPERT OPINION, METHODS WEAK</td>
</tr>
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</table>

1. BENEFIT / RISK CLEAR
2. BENEFIT / RISK UNCLEAR

## SVS GUIDELINES-2011

**GRADES SYSTEM**

- **GRADES OF RECOMMENDATION, ASSESSMENT, DEVELOPMENT AND EVALUATION**
  - GRADES: 1-3 BASED ON BENEFIT / RISK AND OTHER FACTORS
  - QUALITY OF EVIDENCE: A, B, C
NASCET

- TIA OR NON-DISABLING STROKE
- > 30 % STENOSIS BY ANGIO
- 2 SUB-GROUPS
  - 30-69% STENOSIS (MODERATE)
  - 70-99% STENOSIS (SEVERE)
- CEA + ASA vs ASA ALONE
- 5-YEAR STUDY

<table>
<thead>
<tr>
<th>STENOSIS</th>
<th>MEAN FOLLOW UP YEARS</th>
<th>STROKE/ DEATH SURGERY</th>
<th>STROKE/ DEATH MEDICINE</th>
<th>ARR %</th>
<th>RRR %</th>
<th>P %</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-49</td>
<td>5</td>
<td>14.9</td>
<td>18.7</td>
<td>3.8</td>
<td>20.3</td>
<td>0.16</td>
</tr>
<tr>
<td>50-69</td>
<td>5</td>
<td>15.7</td>
<td>22.2</td>
<td>6.5</td>
<td>29.8</td>
<td>0.045</td>
</tr>
<tr>
<td>70-99</td>
<td>2</td>
<td>9.0</td>
<td>26.0</td>
<td>17</td>
<td>65.4</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

NEJM 1991;325:445

ECST

SEVERE STENOSIS

<table>
<thead>
<tr>
<th>STENOSIS %</th>
<th>FOLLOW UP YEARS</th>
<th>MEDICAL IPSILAT STROKE</th>
<th>SURGICAL IPSILAT STROKE</th>
<th>ARR %</th>
<th>RRR %</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-99</td>
<td>3</td>
<td>20.6</td>
<td>6.8</td>
<td>13.8</td>
<td>67</td>
</tr>
</tbody>
</table>

Lancet 1991;337:1235

NASCET / ECST

- UNEQUIVOCAL BENEFIT FROM CEA
- GREATEST BENEFIT
  - MEN > WOMEN
  - HEMISPHERIC > RETINAL EVENTS
  - AGE > 75
- NNT
  - NASCET SEVERE: 6
  - NASCET MODEST: 15

RECOMMENDATION FOR CEA

SYMPTOMATIC

- > 70% STENOSIS [A]
  - AVERAGE OR GOOD RISK PATIENTS
- >50% STENOSIS (PROBABLY) [A]
  - SURGEON PERI-OP STROKE RATE <6%
- SHOULD BE PERFORMED WITHIN 2 WEEKS OF LAST EVENT [A]

ASYMPTOMATIC CAROTID ATHEROSCLEROSIS STUDY (ACAS)

- NORTH AMERICAN RCT
- >60 % CAROTID STENOSIS
- 1662 PATIENTS RANDOMIZED

JAMA 1995; 273:1421-28
ACAS RESULTS

- Peri-op risk of stroke or death
  - 2.3% surgical (30 days)
  - 0.4% medical (42 days)
- Estimated 5-year risk of stroke or death
  - 5.1% surgical
  - 11% medical
- Risk reduction favoring surgery
  - 5.9% absolute
  - 53% relative

JAMA 1995;273:1421

ACAS CRITIQUE

- Only all ipsilateral strokes statistically significant.
- Other endpoints (major ipsilateral stroke, etc.) not significant.
- 1% per year risk reduction extrapolated after only 2.7 years F/U.
- 70% of patients had stenosis <80%.
- No difference in stroke risk by decile of stenosis.
- NNT: 67

ACST

8/19 events in surgical group occurred pre-op.
- Peri-op risk of stroke/death 1.5% if pre-op events excluded.
- Angio stroke rate 1.2% in surgical patients only.
ACST

ASYMPTOMATIC CAROTID STENOSIS

RECOMMENDATION FOR CEA

ASYMPTOMATIC

- MEN
  - <75 YEARS WITH 70-99% STENOSIS [A]
  - SURGEON PERIOPERATIVE RISK RATE <3%
- WOMEN
  - ONLY YOUNGER, FIT [A]
  - 70-99% STENOSIS

RCTs OF CAROTID ENDARTERECTOMY

PERI-OPERATIVE MORTALITY

<table>
<thead>
<tr>
<th>Study</th>
<th>Patients</th>
<th>Deaths</th>
<th>Mortality %</th>
</tr>
</thead>
<tbody>
<tr>
<td>NASCET</td>
<td>1415</td>
<td>16</td>
<td>1.1</td>
</tr>
<tr>
<td>ECST</td>
<td>1745</td>
<td>4</td>
<td>1.3</td>
</tr>
<tr>
<td>VA SYMPT</td>
<td>90</td>
<td>3</td>
<td>3.33</td>
</tr>
<tr>
<td>VA ASYMPT</td>
<td>203</td>
<td>4</td>
<td>1.97</td>
</tr>
<tr>
<td>CASANOVA</td>
<td>171</td>
<td>3</td>
<td>1.75</td>
</tr>
<tr>
<td>MAYO</td>
<td>36</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>ACAS</td>
<td>825</td>
<td>3</td>
<td>0.36</td>
</tr>
<tr>
<td>ACST</td>
<td>1348</td>
<td>15</td>
<td>0.01</td>
</tr>
<tr>
<td>TOTAL</td>
<td>4543</td>
<td>48</td>
<td>1.03</td>
</tr>
</tbody>
</table>

ACST

- IN SPITE OF 3% PERI-OPERATIVE RISK THERE WAS NEARLY 50% REDUCTION IN STROKE OVER LONG TERM AND 50% OF THE STROKES PREVENTED WERE FATAL OR DISABLING
- ANNUAL RATE OF STROKE IN MEDICALLY TREATED GROUP: 2%
- ANNUAL RATE OF STROKE IN SURGICAL GROUP: 1%

ASYMPTOMATIC CAROTID STENOSIS

- CEA PROVEN TO MODERATELY REDUCE STROKE RISK IN MULTIPLE RCT
- REQUIRES PROCEDURAL MORBIDITY <3%
- TRIALS CONDUCTED 1980’S-2005
  - NO STATINS, ACE INHIBITORS, ARB
  - ASA AS ONLY ANTI-PLATELET
- STROKE RATE WITH BMT HAS DECREASED FROM 2-2.5% TO <1%
- BMT AS EFFECTIVE AS CEA FOR MOST (95%) ASYMPTOMATIC PATIENTS
  MAGDY S, MOLINA CA. STROKE 42:1156, 2011
CAROTID ENDARTERECTOMY

FACTORS AFFECTING OUTCOME

• SYMPTOM STATUS
• SEVERITY OF STENOSIS
• PLAQUE MORPHOLOGY
• PATIENT FACTORS
• TECHNICAL FACTORS

NASCET SURGICAL RESULTS

OPERATIVE DETAILS

• GENERAL ANESTHESIA 93%
• ANESTH TIME (MINUTES) 178 (40-415)
• SHUNT 41%
• UNSHUNTED CLAMP TIME 31 (9-95)
• PATCH
  - VEIN 10%
  - PROSTHETIC 10%
• CEREBRAL MONITORING 51%
  - EEG 35% (18% CHANGE)
  - BACK PRESSURE 14%

NASCET SURGICAL RESULTS

WOUND AND CRANIAL NERVES

HEMATOMA 7.2%
  • MILD 3.6%
  • SEVERE 0.3%
INFECTION 2.0%
CRANIAL NERVE DYSFUNCTION*
  • HYPOGLOSSAL 3.7%
  • VAGUS 2.6%
  • FACIAL 2.2%

*ALL MINOR

CAROTID ENDARTERECTOMY

FACTORS AFFECTING OUTCOMES

• NEUROLOGIC STATUS
• ANATOMIC FEATURES
• AGE
• GENDER
• CO-MORBIDITIES
• TECHNICAL FACTORS

CAROTID ENDARTERECTOMY

TECHNICAL FACTORS

• ANESTHESIA [A]
  - GENERAL
  - LOCAL / REGIONAL
• SHUNT
  - SELECTIVE [A]
  - ROUTINE
• PATCH
  - ROUTINE [A]
  - PATCH MATERIAL

CAROTID TEA: PATCHES

DACRON
BOVINE PERICARDIUM
VEIN
CAROTID ENDARTERECTOMY

TECHNICAL ISSUES
• BRAIN FUNCTION MONITORING
  – EEG
• COMPLETION IMAGING [B]
  – ULTRASOUND
  – ANGIO

PERIOP MEDICAL MANAGEMENT
– ASA 75-325 MG/DAY [A]
– STATINS [A]
– ASA + CLOPIDOGREL
• ENDARTERECTOMY TYPE [A]
  – LONGITUDINAL
  – EVERSION

CAROTID TEA

COMPLETION STUDIES

DOPPLER
ANGIOGRAPHY

CAROTID ENDARTERECTOMY

IS NOT PERFECT

DEATH & DEATH
TRIAL MAJOR STROKE ANY STROKE

ECST 3.7 7.5
NASCET 2.1 5.8

PERCENT
30 DAY RESULTS AS

PERCUTANEOUS TREATMENT OF CAROTID LESIONS

ADVANTAGES
• QUICKER
• AVOIDS ANESTHESIA
• SHORTER CAROTID OCCLUSION TIME
• NO CERVICAL HEMATOMA
• NO CRANIAL NERVE INJURY
• APPLICABLE TO WHOLE RANGE OF LESIONS
• LESS EXPENSIVE

PERCUTANEOUS CEREBROVASCULAR INTERVENTIONS

• FIRST REPORTED CASE : FMD

HASSO ET AL. AJR, 1981
CAROTID STENTING TRIALS

- ARCHER REGISTRY
- SHELTER
- BEACH
- MAVERICK
- CABERNET
- EV-3S
- TACIT
- SECURITY
- CARESS
- CAVATAS
- ICSS
- SAPPHIRE
- CREST

TRIALS AND REGISTRIES

SAPPHIRE TRIAL

- RANDOMIZED MULTI-CENTER TRIAL
- STENTING WITH PROTECTION VS CEA
- HIGH-RISK SURGICAL PATIENTS
- STENT AND SURGERY REGISTRIES FOR NON-RANDOMIZED PATIENTS
- SURGEONS AND INTERVENTIONALISTS VETTED
- 29 INVESTIGATIVE SITES

SAPPHIRE ENTRY CRITERIA

- SYMPTOMATIC: >50% STENOSIS
- ASYMPTOMATIC: >80% STENOSIS
- 1 OR MORE HIGH-RISK CONDITIONS
  - MEDICAL
  - ANATOMIC

SAPPHIRE RANDOMIZATION SCHEME

Physician Team: Neurologist, Surgeon, Interventionist

CONSENSUS

INTERVENTIONAL REFUSAL

STENT REGISTRY 409

RANDOMIZED 307

Stenting=156
CEA=151
Stratified for Sx, ASx

SAPPHIRE ENTRY CRITERIA

CONSENSUS

INTERVENTIONAL REFUSAL

STENT REGISTRY 409

RANDOMIZED 307

Stenting=156
CEA=151
Stratified for Sx, ASx

RANDOMIZED PATIENTS 30-DAY EVENTS

<table>
<thead>
<tr>
<th>Events</th>
<th>Stent (156 pts)</th>
<th>CEA (151 pts)</th>
<th>p Value</th>
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</thead>
<tbody>
<tr>
<td>Death</td>
<td>0.6% (0.1%,1.2%)</td>
<td>2.0% (0.4%,4.2%)</td>
<td>0.36</td>
</tr>
<tr>
<td>Stroke</td>
<td>3.8% (0.8%,3.9%)</td>
<td>5.3% (1.7%,8.9%)</td>
<td>0.59</td>
</tr>
<tr>
<td>Major Ipsilateral</td>
<td>0.0%</td>
<td>1.3%</td>
<td>0.24</td>
</tr>
<tr>
<td>Major Non-Ipsilateral</td>
<td>0.0%</td>
<td>0.7%</td>
<td>&gt;0.99</td>
</tr>
<tr>
<td>Minor Ipsilateral</td>
<td>0.8%</td>
<td>3.3%</td>
<td>&gt;0.99</td>
</tr>
<tr>
<td>Minor Non-Ipsilateral</td>
<td>0.8%</td>
<td>0.0%</td>
<td>&gt;0.99</td>
</tr>
<tr>
<td>Ml (Q or NQ)</td>
<td>2.6% (0.1%,4.3%)</td>
<td>7.3% (3.1%,11.4%)</td>
<td>0.07</td>
</tr>
<tr>
<td>Q-Wave MI</td>
<td>0.1%</td>
<td>1.2%</td>
<td>0.20</td>
</tr>
<tr>
<td>Non-Q Wave MI</td>
<td>2.6%</td>
<td>0.6%</td>
<td>0.16</td>
</tr>
<tr>
<td>Death/Stroke/MI</td>
<td>4.9% (2.1%,7.7%)</td>
<td>6.6% (2.7%,10.4%)</td>
<td>0.46</td>
</tr>
<tr>
<td>Death/Stroke/MI</td>
<td>5.8% (2.1%,9.4%)</td>
<td>12.6% (7.3%,17.9%)</td>
<td>0.047</td>
</tr>
</tbody>
</table>
CAROTID STENTING

SYMPTOMATIC

- META ANALYSIS
- 8 RCTs COMPARING CEA WITH CAS
- CEA ASSOCIATED WITH LOWER STROKE AND DEATH RATES AND HIGHER CRANIAL NEUROPATHY RATE

COCHRANE DATABASE SYST REV 2007
CREST RESULTS

• COMPOSITE PRIMARY END POINTS
  - PERI-PROCEDURE (30-36 DAYS): CEA=CAS
  - POST-PROCEDURE (4 YEARS): CEA=CAS
  - AGE > 70: CAS > CEA

• INDIVIDUAL END POINTS
  - STROKE: CAS>CEA
  - MI: CEA>CAS
  - GENDER: CEA = CAS
  - SYMPTOM STATUS: CEA = CAS

CREST

SUMMARY
• EXCELLENT RESULTS WITH BOTH CAS AND CEA
  - STROKE: 4.1 / 2.3%
  - DEATH: 0.7 / 0.3%
• CAS ASSOCIATED WITH MORE STROKES
• CEA ASSOCIATED WITH MORE MI
• CEA WAS BETTER IN PATIENTS > 70 YEARS
• CAS WAS BETTER IN PATIENTS < 70 YEARS
• STROKE HAD GREATER ADVERSE EFFECT ON BROAD RANGE OF HEALTH-STATUS DOMAINS

CAROTID TIA / STROKE

CEA vs CAS
7.1. Recommendations for Selection of Patients for Carotid Revascularization

- CEA indicated as an alternative to CAS for symptomatic carotid stenosis

CAROTID STENTING

ASYMPTOMATIC PATIENTS
• ADVISABLE ONLY IN HIGH-VOLUME CENTERS WITH DOCUMENTED LOW PERI-PROCEDURAL STROKE AND DEATH RATES OR WITHIN CLINICAL TRIALS [C]

ESVS GUIDELINES, 2009
# CAROTID STENTING

**LOCAL ANATOMIC FACTORS**

- Indicated with contralateral laryngeal nerve palsy, radical neck dissection, cervical irradiation, prior CEA, high bifurcation [C]
  - Peri-procedural morbidity <3%

ESVS Guidelines, 2009

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# CAROTID ENDARTERECTOMY

**SUMMARY**

- Over 50 years of clinical experience
- Proven effective, efficacious and durable in 9 RCTs
- Level of evidence: A-1
- Still the gold standard

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# CAROTID ENDARTERECTOMY

**CONCLUSION**

- The treatment of choice for most patients with severe carotid stenosis and appropriate indications for invasive therapy

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# RULES OF EVIDENCE 1998

<table>
<thead>
<tr>
<th>GRADE</th>
<th>LEVEL OF EVIDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>RCTs, meta-analyses, methods strong, no heterogeneity</td>
</tr>
<tr>
<td>B</td>
<td>RCTs, meta-analyses, methods intermediate, heterogeneity</td>
</tr>
<tr>
<td>C</td>
<td>Observational studies, methods weak</td>
</tr>
<tr>
<td></td>
<td>1. Benefit/risk clear</td>
</tr>
<tr>
<td></td>
<td>2. Benefit/risk unclear</td>
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</tbody>
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# CAROTID ENDARTERECTOMY & STENTING

**RECOMMENDATIONS BASED ON RULES OF EVIDENCE**

<table>
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<tr>
<th>SCENARIO</th>
<th>RECOMMENDATION</th>
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<tr>
<td>CEA, 80% STENOSIS, SYMPTOMATIC</td>
<td>A-1</td>
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<tr>
<td>CEA, 60% STENOSIS, ASYMPTOMATIC</td>
<td>A-2</td>
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<tr>
<td>CAS, 80% STENOSIS, SYMPTOMATIC</td>
<td>A-1</td>
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