Carotid Artery Surgery for the Prevention and Treatment of Ischemic Stroke – Update 2015

John L. Crawford, MD, FACS
Neuroscience Summit 2015
UNT Health Sciences Center
September 12, 2015
Deaths and Mortality

- Number of deaths: 2,596,993
- Death rate: 821.5 deaths per 100,000 population
- Life expectancy: 78.8 years
- Infant Mortality rate: 5.96 deaths per 1,000 live births

Number of deaths for leading causes of death:
- Heart disease: 611,105
- Cancer: 584,881
- Chronic lower respiratory diseases: 149,205
- Accidents (unintentional injuries): 130,557
- Stroke (cerebrovascular diseases): 128,978
- Alzheimer's disease: 84,767
- Diabetes: 75,578
- Influenza and Pneumonia: 56,979
- Nephritis, nephrotic syndrome, and nephrosis: 47,112
- Intentional self-harm (suicide): 41,149

Source: Deaths: Final Data for 2013, tables 1, 7, 10, 20 [PDF - 1.5 MB]

www.cdc.gov/datastatistics2013
Cause of Death – 2013
Other Neurologic Diseases

CNS Tumors 15,345
Alzheimers Disease 84,767
Parkinsons Disease 25,196
Meningitis 584
Polio 0
Total 125,892

www.cdc.gov/datastatistics2013
Stroke

Stroke is the fifth leading cause of death in the US – Number 1 cause of disability 2013

- 700,000 new stroke victims in the US each year
  - 130,000 of these strokes are fatal
- 2,000,000 stroke victims alive and disabled at any given time
- Current annual incidence 195/100,000 population
- Direct and indirect costs of stroke $20 billion in the US annually
- Cost per male stroke victim - $188,000/ patient

www.cdc.gov/datastatistics2013
Natural History of Stroke

• 80% of strokes are ischemic
• Initial mortality of ischemic stroke 30 - 40 %
• Stroke survivors at high risk of subsequent stroke (4.8 to 20 % each year, or half in 5 years)
• Subsequent stroke more deadly - study of 535 stroke victims - leading cause of death - another stroke
• 1/3 – ½ of all strokes in the US related to carotid artery bifurcation disease
• Most of these cerebral infarctions associated with atherosclerotic plaques within 3 cm of the common carotid artery bifurcation

www.cdc.gov/datastatistics2013
Take Away # 1

30 – 40% of first strokes are fatal.
Stroke increases the incidence of further strokes.
Additional strokes are more likely to be more devastating and/or fatal.
1927 - First reported the use of carotid and intracerebral arteriography
1949 – Nobel prize in Physiology or Medicine
Dr. Sven Ivar Seldinger
1921 - 1998

1953 – First described catheter guided arteriogram technique

Acta Radiologica 39 (5): 368-76. 1953
OCCULSION OF THE INTERNAL CAROTID ARTERY

MILLER FISHER, M.D., F.R.C.P.(Canad.)
MONTRÉAL, CANADA

SINCE the introduction of carotid arteriography, many unsuspected cases of occlusion of the internal carotid artery have been discovered. In the last 13 years approximately 45 cases have been reported, the diagnosis resting to a great extent on neuro-ophthalmic evidence. Review clinical and pathological studies have led me to the conclusion that thrombosis of the internal carotid artery is much more frequent than these figures indicate. Indeed, it may well prove to be one of the major causes of apoplexy. This impression is confirmed by Hotaling, who, in his extremely thorough study of the pathological aspect of this subject, found thromboembolism of the carotid system in about 1 per cent of routine autopsies. Clinicians and pathologists have heretofore failed to appreciate this condition, because the cervical portion of the carotid artery lies in a "no-man's land" between general pathology and neuropathology, its examination at autopsy being therefore neglected. Chevallier and later Hunt emphasized investigation of the carotid vessels in the neck in all cases of apoplexy, but their advice has been disregarded.

My interest in this subject was aroused while working in the McAlpine Institute of Pathology, under the direction of Dr. Raymond D. Adams. There, in case after case, neuropathological examination failed to confirm the clinical impression of disease of the middle cerebral artery. During a period of nine months, in which the brains in 200 cases of cerebrovascular disease were examined, not a single case of thrombosis of the middle cerebral artery was found, although the diagnosis had often been made clinically. It was logical to look more proximally, namely, in the internal carotid artery, for unrecognized disease. Moreover, during our study of brain embolism, in many cases no source for the embolus could be found in the conventional locations—the pulmonary veins, the left atrium, the left ventricle or the ascending aorta. The neglected area, again, seemed to lie in the carotid system, which we did not investigate by direct visual inspection at autopsy, only testing its

* Lecturer in Neurology, McGill University.
From Queen Mary Veterans’ Hospital, the Montreal General Hospital and McGill University Faculty of Medicine.

“It is even conceivable that some day vascular surgery will find a way to bypass the occluded portion of the artery during the period of ominous, fleeting symptoms.”

C. Miller Fisher 1951
Take Away #2

1/3 to ½ of all strokes in USA are due to atherosclerotic disease within 3 cm of the surgically accessible carotid artery bifurcation.
Risk Factors for Ischemic Stroke
Non - Modifiable

Age
Male Gender
African American Race
Diabetes Mellitus
Family History of Stroke
Increased Fibrinogen Level
Migraine Headache

(Wolf, PA. Prevention of Stroke. Cardiology Rounds 2001; 5: 1-5.)
Risk Factors for Ischemic Stroke Modifiable

- Elevated Blood Pressure
- Cigarette Smoking
- Low Levels of Physical Activity
- Elevated Homocysteine Levels
- Congestive Heart Failure
- Atrial Fibrillation
- Coronary Heart Disease
- Significant Extracranial Carotid Stenosis

(Wolf, PA. Prevention of Stroke. Cardiology Rounds 2001; 5: 1-5.)
Prevention of Ischemic Stroke

- Blood pressure control
- Stop smoking
- Increased Physical Activity
- Weight Loss
- Antiplatelet Agents
- Coumadin in Afib and CHF
- HMG-CoA reductase Inhibitors
- Diet higher in fish, whole grains, fruits, and vegetables
- Folic acid, Vits B6 and B12
- Carotid Endarterectomy

( Wolf, PA. Prevention of Stroke. Cardiology Rounds 2001; 5: 1 -5. )
Natural History of Asymptomatic Carotid Stenosis

• Carotid bruit itself does not predict stroke
• Degree of carotid stenosis by duplex scan predicts risk of stroke
  
  Roederer - 167 pts. Lesions with >80% stenosis carried 35% risk of ischemic symptoms or ICA occlusion in 6 months, 46% risk at 12 months. Only 1.5% of lesions < 80% developed symptoms

• Soft plaques at higher risk of stroke than dense or calcified plaques
• Complex, ulcerated plaques at carotid bifurcation at higher risk - 7.5% per year
Natural History of Asymptomatic Carotid Stenosis

- Pittsburgh VA - 10 year period 1701 carotid arteries in 1004 patients followed with serial duplex scans
  mean followup 28 months
- risk of progression of ICA stenosis substantial and increases steadily with time - annualized risk 9.3%
- ICA stenosis > 50%, ECA stenosis > 50%, contralat ICA stenosis > 50%, BP > 160 mmHg ass. with progression
- Annual progression 3.2% (no risk factors) up to 31.5% (all 4 risk factors)
- progression of ICA stenosis correlated with ischemic neurologic event (14%)
Natural History of TIA

- Patients who experience TIA’s at higher risk of stroke
- Mayo Clinic Population Study
  118 patients with TIA followed as controls without Rx
  stroke rate $23\%$ at 1 yr, $37\%$ at 3 yrs, $45\%$ at 5 yrs
- represents 16-fold increase in stroke compared to age and sex-adjusted population
- Average risk of stroke reported in the literature 30-35% at 5 years or 10% the first year, 6% each year thereafter
Diagnosis of Carotid Occlusive Disease

- History – risk factors, amaurosis, TIA, crescendo TIA, stroke
- Carotid Bruit
- Carotid Duplex Scan
- Arteriogram
- MR Angiogram
- Spiral CT angiogram
- CT scan / MRI of the Brain
Phillips IU22 Duplex Scanner
### Extrinsic Carotid Duplex Evaluation

#### Diagnostic Criteria

<table>
<thead>
<tr>
<th>Diameter Stenosis</th>
<th>Peak Systolic Velocity (cm/sec)</th>
<th>Peak Diastolic Velocity (cm/sec)</th>
<th>Systolic Velocity Ratio (cm/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 50%</td>
<td>&lt; 125</td>
<td>&lt; 40</td>
<td>&lt; 1.8</td>
</tr>
<tr>
<td>50 – 80%</td>
<td>125 - 250</td>
<td>40 - 100</td>
<td>&gt; 1.8</td>
</tr>
<tr>
<td>80 – 99%</td>
<td>&gt; 250</td>
<td>&gt; 100</td>
<td>&gt; 3.7</td>
</tr>
<tr>
<td>100%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
REferred by: John Crawford, MD  
1325 Pennsylvania Ave, Ste 720  
Fort Worth, TX 76104

Exam: US Carotid Arteries Duplex - BILATERAL

Carotid Doppler sonogram

History: Prior endarterectomy. Peripheral vascular disease.

Findings: Color and Doppler sonographic evaluation of the right carotid arteries shows a moderate, partially calcified, irregular atherosclerotic plaque formations involving the right carotid bulb and internal carotid artery. There is 50-69 percent stenosis. The peak systolic velocity of the right common carotid artery measures 100 centimeters per second. The peak systolic velocity of the right internal carotid artery measures 139 centimeters per second. The right internal to common carotid artery ratio measures 1.4.

Color and Doppler sonographic evaluation of the left carotid arteries shows a mild, partially calcified, irregular atherosclerotic plaque formations involving the left carotid bulb and internal carotid artery. There is less than 50% stenosis. The peak systolic velocity of the left common carotid artery measures 101 centimeters per second. The peak systolic velocity of the left internal carotid artery measures 114 centimeters per second. The left internal to common carotid artery ratio measures 1.1.

There is normal antegrade flow within the bilateral vertebral arteries.

Impressions:
1. 50-69 percent right internal carotid artery stenosis
2. Less than 50 percent left internal carotid artery stenosis

Finalized by: MCAULEY, MICHAEL MD 01/12/2015 15:05:55

Exam: Carotid Doppler Ultrasound

History: 433.10 Carotid Stenosis

Technique: Ultrasound evaluation at the carotid bifurcation was performed bilaterally. Grayscale imaging, compression and augmentation, color Doppler, pulsed Doppler, and spectral analysis were used in evaluation.

Comparison: 5/16/14

Findings: On the right, a moderate amount of smooth, calcified and noncalcified atherosclerotic plaque were seen at the carotid bulb and proximal ICA. There is tortuosity of the distal ICA. The velocities measured were within normal range. ICA/CCA ratio measured 1.1. Vertebral artery flow was antegrade.

On the left, a moderate amount of smooth, calcified and noncalcified atherosclerotic plaque were seen at distal CCA and carotid bulb. The velocities measured were mildly elevated in the proximal ICA measuring 140 cm/s. ICA/CCA ratio measured 1.2. Vertebral artery flow was antegrade.

Impression: Moderate plaque in the distal CCA and carotid bulb bilaterally.

Elevated velocity in the left proximal ICA, increased from prior study, without elevated ICA to CCA ratio. The degree of stenosis is probably close to 50 percent.

Velocities in the right ICA are within normal range with less than 50 percent stenosis.

D. Kim Kuo, MD
Procedure: CAR US Doppler Arterial Carotid Bilatera
Exam Date/Time: 03/23/2015 1554
Accession #: HU272600-15

CAROTID DOPPLER ULTRASOUND

HISTORY: Followup carotid stenosis identified on previous ultrasound and CTA

The extracranial carotid arteries were evaluated with duplex and color Doppler sonography.

Comparison: Previous ultrasound from 12/15/08 and CTA neck from 3/23/15.

Left carotid bifurcation:
There is a moderate amount of heterogeneous and calcific plaque in the left carotid bulb and internal carotid artery. Left ICA peak systolic velocity is 146 cm/s with an end-diastolic velocity of 50 cm/s systolic velocity ratio of 2.1. These findings are consistent with 50-69% left ICA stenosis, probably closer to 50%.

Right carotid artery bifurcation:
There is a large amount of heterogeneous and calcific plaque in the bulb and ICA. The right ICA peak systolic velocity is 312 cm/s with an end-diastolic velocity of 79 cm/s and systolic velocity ratio of 4.0. Two of the 3 criteria suggests 70 percent or greater right ICA stenosis but the end-diastolic velocity suggest 50-69% stenosis. Based on overall Doppler and imaging findings the stenosis is likely close to 70%.

Antegrade flow is seen in the right vertebral artery. The left vertebral...
EXAMINATION: CAROTID DOPPLER ULTRASOUND

CLINICAL HISTORY: Amaurosis fugax.

FINDINGS:

Bilateral carotid Doppler ultrasound demonstrates significant plaque formation of the carotid bifurcations bilaterally with flow velocity elevation in the proximal right ICA of 285 cm/second with an ICA/CCA ratio of 8.7 suggesting a significant stenosis of about 80 or 90% diameter narrowing. Antegrade right vertebral flow.

On the left, there is significant plaque formation as well at the carotid bifurcation with flow velocity elevation of about 221 cm/second within the proximal ICA, yielding a significantly elevated ICA/CCA ratio of 6.0.

Antegrade left vertebral artery flow.

There was also the suggestion of some retrograde flow within the left ICA.

IMPRESSION:

Significant left internal carotid artery stenoses bilaterally. CT angiography is suggested for further workup.
Take Away # 3

Critical atherosclerotic disease at the carotid bifurcation is best diagnosed by high index of suspicion in patients with risk factors and carotid duplex scan.

A cervical bruit does NOT necessarily indicate critical carotid stenosis.

Lack of a cervical bruit does NOT rule out critical carotid stenosis
History of Carotid Artery Surgery

1951 – Landmark Description of Disease at the Carotid bifurcation and stroke – Dr. C. Miller Fisher


Drs. Eastcott, Pickering, and Robb.

Houston, August, 1954 – DeBakey/ Crawford Report of first Carotid Endarterectomy

Houston – Dr Denton Cooley – First Report of Shunt During Carotid Endarterectomy
Cerebrovascular insufficiency constitutes a problem of considerable magnitude in terms of both death and disability. At least two million people now alive in the United States are victims of this condition and that it ranks third as a cause of death in this country. Studies of the natural course of the disease in patients in whom the diagnosis was made clinically without arteriography reveal that death occurs within 5 years after onset in 80 per cent of the patients, with 21 per cent dying during the initial attack.97 Survival studies of patients with extracranial carotid artery occlusion proved by arteriography suggest a similarly grave prognosis. Reports of collaborative studies of patients randomized into a control group receiving no treatment and a group receiving treatment with anticoagulants indicate that the latter form of therapy does not significantly alter the course of the disease, particularly as it affects survival.98

During the past decade—and as a consequence of surgical experience, more frequent use of arteriography and more intensive investigations—a much better understanding of this problem has been obtained. It is now known, for example, that the disease tends to assume certain characteristic and recognizable pathologic, anatomic and clinical patterns of involvement. Most frequent are those resulting from well localized occlusive lesions in the extracranial arterial bed which are amenable to surgical treatment. About three fourths of patients with extracranial occlusions have forewarning symptoms. Early recognition of these manifestations—along with precise diagnosis by means of arteriography dem­onstrating the presence of an occlusive lesion in the extracranial arterial bed, followed by application of surgical treatment—may not only relieve the symptoms of cerebral ischemia but also prevent the development of a subsequent stroke. It is thus apparent that surgical therapy constitutes an effective approach to this problem in a significantly high proportion of these patients.

Clinical Material

Our own experience with this surgical approach, beginning with the performance of our first operation for correction of an extracranial arterial occlusion causing cerebrovascular insufficiency on August 7, 1953, now extends for more than 11 years. During this period we have employed some form of arterial reconstructive operation in the treatment of 1,150 patients with cerebrovascular insufficiency produced by extra-
Indications for Carotid Endarterectomy

- Asymptomatic internal carotid stenosis > 70%
- Amaurosis fugax
- TIA
- Crescendo TIA
- Completed stroke when neurologic recovery plateaus
- Severe carotid stenosis associated with coronary artery disease requiring CABG, AAA, or symptomatic AI occlusive disease
- Global cerebral ischemia
Do not operate!

- Internal carotid artery occlusion
- Dense stroke with poor neurologic recovery
- Strokes with altered level of consciousness
- Cerebral infarction associated with intracranial hemorrhage
- Stroke in evolution
- Asymptomatic patients with smooth plaques and < 60% stenosis
- Low surgical volume + poor results
The NASCET Study

• 51 US and Canadian Medical centers
• 2,226 pts randomized < 80 yrs old, TIA or non-disabling stroke within 120 days, angio 70-99% ICA lesions

  1,114 - optimal medical Rx
  1,112 - carotid endarterectomy (stroke 5.8%, death 1%)

  2 year followup:
  • CEA reduced the risk of ipsilateral stroke from 26% to 9%, and major ipsilateral stroke from 13% to 3%
  • 17% risk reduction at 2 years
  • less benefit with less degrees of stenosis

The ACAS Study

• Begun in 1987, Preliminary results published September, 1994, Detailed results May, 1995
• 39 Centers across United States and Canada
• Randomized 1,662 patients with 60 - 99% ICA stenosis
• Aggregate risk of death and stroke at 5 years significantly lower in the surgical group (5%) than in medical group (11%)
• Relative risk of stroke reduced 55% in good risk patients
• Benefit of prophylactic CEA demonstrated in men but not in women

(JAMA 1995; 273: 18.)
Technique of Carotid Endarterectomy
How I do it - 2015

General Anesthesia - cerebral protection
Routine preop ASA, prophylactic antibiotics ? Statins
Foley catheter, arterial line
Routine shunting - heparin
Routine tacking of distal ICA intima  7-0 prolene
Complete ECA Endarterectomy
Routine PTFE patch angioplasty
Intraoperative doppler to evaluate flow – Casmed Monitor
Meticulous hemostasis
Extubate - neurological evaluation in the OR
Strict BP control in OR and in CV ICU
CasMed Neuroperfusion Monitor
Carotid Endarterectomy

Anatomy

- External Carotid Artery
- Hypoglossal n.
- Internal Carotid Artery
- Vagus n.
- Superior Thyroid Artery
- Common Carotid Artery

Superior Thyroid Artery

Common Carotid Artery

Vagus n.
Argyle Carotid Shunts
Carotid Endarterectomy
Postoperative Care

ICU post op for blood pressure control
Aspirin / Persantine started evening of surgery
clear liquids only 1st 24 hrs
IV antibiotics for 24 hrs
Home POD 1 - 2
Control risk factors with PCP during office follow up
Duplex scan at 6 months - watch contralateral side
Complications following Carotid Endarterectomy

Hypertension
Stroke
TIA
Bleeding
Myocardial Infarction
Cranial nerve injuries
Patch infection
Recurrent Carotid Stenosis
Headache, Photophobia, Seizures
# Acceptable Results of Carotid Endarterectomy

## 30 Day MI / CVA / Death

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asymptomatic Stenosis</td>
<td>3 %</td>
</tr>
<tr>
<td>TIA</td>
<td>5 %</td>
</tr>
<tr>
<td>Prior Ischemic Stroke CT -</td>
<td>7 - 10 %</td>
</tr>
<tr>
<td>Prior Ischemic Stroke CT +</td>
<td>7 - 16 %</td>
</tr>
<tr>
<td>Recurrent Carotid Stenosis</td>
<td>7 %</td>
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Carotid Endarterectomy Results 1985-2015

<table>
<thead>
<tr>
<th>Condition</th>
<th>Count (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hematoma</td>
<td>3 (0.6%)</td>
</tr>
<tr>
<td>Stroke</td>
<td>2 (0.6%)</td>
</tr>
<tr>
<td>RLN Palsy (Transient)</td>
<td>1 (0.2%)</td>
</tr>
<tr>
<td>Death</td>
<td>2 (0.4%)</td>
</tr>
<tr>
<td>Recurrent Stenosis</td>
<td>5 (0.93%)</td>
</tr>
</tbody>
</table>

30 Day CVA/MI/Death (0.7%)
Take Away # 4

Carotid endarterectomy is still the gold standard for the surgical treatment of symptomatic carotid artery occlusive disease, or asymptomatic plaques > 70% for the prevention of stroke.

This operation is highly effective and can be performed on properly selected patients with 30 day MI/CVA/Death rate of <1% in a community hospital setting.
Carotid Artery Surgery
What’s New in 2015

Local Anesthesia
Outpatient Surgery
Plaque morphology studies
Preop statin medications
CasMed cerebral blood flow monitor
Carotid artery Angioplasty and Stent
Carotid Angioplasty and Stent
vs
Carotid Endarterectomy

1998 – 2010 14 Clinical Trials 7,874 patients
2005 – 2011 15 Meta-Analyses 60,107 patients
2005 – 2011 12 Registry Studies 5,904 patients

2007 SVS Vascular Registry
CEA (3,259) vs CAS (2,763)
Symptomatic CEA 3.75% CAS 7.13%
Asymptomatic CEA 1.97% CAS 4.6%
Decision Memo for Carotid Artery Stenting (CAG-00085R)

Decision Summary

The Centers for Medicare and Medicaid Services (CMS) has determined that the evidence is adequate to conclude that carotid artery stenting (CAS) with embolic protection is reasonable and necessary for the following:

1. Patients who are at high risk for carotid endarterectomy (CEA) and who also have symptomatic carotid artery stenosis ≥ 70%. Coverage is limited to procedures performed using FDA approved carotid artery stenting systems and embolic protection devices;
2. Patients who are at high risk for CEA and have symptomatic carotid artery stenosis between 50% and 70%, in accordance with the Category B IDE clinical trials regulation (42 CFR 405.201), as a routine cost under the clinical trials policy (Medicare NCD Manual 310.1), or in accordance with the National Coverage Determination on CAS post approval studies (Medicare NCD Manual 20.7);
3. Patients who are at high risk for CEA and have asymptomatic carotid artery stenosis ≥ 80%, in accordance with the Category B IDE clinical trials regulation (42 CFR 405.201), as a routine cost under the clinical trials policy (Medicare NCD Manual 310.1), or in accordance with the National Coverage Determination on CAS post approval studies (Medicare NCD Manual 20.7).

Patients at high risk for CEA are defined as having significant comorbidities and/or anatomic risk factors (i.e., recurrent stenosis and/or previous radical neck dissection), and would be poor candidates for CEA in the opinion of a surgeon. Significant comorbid conditions include but are not limited to:

- congestive heart failure (CHF) class III/IV;
- left ventricular ejection fraction (LVEF) < 30%;
- unstable angina;
- contralateral carotid occlusion;
- recent myocardial infarction (MI);
- previous CEA with recurrent stenosis;
- prior radiation treatment to the neck; and
- other conditions that were used to determine patients at high risk for CEA in the prior carotid artery stenting trials and studies, such as ARCHER, CABERNET, SAPPHIRE, BEACH, and MAVERIC II.
Carotid Angioplasty and Stent
Current Recommendations - 2015

- Symptomatic patients
- Prior neck irradiation
- Prior radical neck surgery
- Symptomatic intimal flap after CEA
- Recurrent carotid stenosis after CEA
- Poor anesthesia risk
- Extensive lesions extending to base of the skull
- Heavily calcified tortuous arteries
- Age < 80 years
- Randomized Controlled Clinical Trials
Take Away #5

Carotid artery angioplasty and stent procedure has evolved as an alternative to CEA in high risk patients.

Multiple clinical trials in academic centers have reported 30 day MI/CVA/Death rates of 3.6%.

CMS continues to restrict reimbursement for CAS.
Summary

• Atherosclerotic disease within 3 cm of the carotid bifurcation accounts for 1/3 of all strokes in the US
• Symptoms include amarosis fugax, TIA, global ischemia, and completed stroke
• Index of suspicion should be high in hypertensive, diabetic, smokers with CAD, AAA, fem-pop disease
• Dx made with Duplex scan, CTA, carotid arteriogram. MRI angio in pts with contrast allergy
• Medical therapy appropriate in asymptomatic patients with carotid stenosis < 70%
Summary

- Indications for carotid endarterectomy include amaurosis fugax, TIA, global ischemia, non-disabling stroke. Operation should be considered in asymptomatic patients with large ulcerations or stenotic plaques >70% and good anesthesia risk.
- Meticulous surgical technique mandatory.
- Strict blood pressure control in post op period.
- Surgical results directly related to presenting neurological status.
- Carotid endarterectomy (CEA) is still the gold standard - carotid angioplasty with stent should be reserved for special circumstances in patients at high risk for CEA.