

Extracranial atherosclerotic disease in vertebral and carotid arteries: Who warrants Intervention vs medical management

Christopher S. Ogilvy, MD

Director, Endovascular and Operative Neurovascular Surgery

BIDMC Brain Aneurysm Institute

Professor of Neurosurgery

Harvard Medical School

Justin Im, MD

Resident in Neurosurgery, BIDMC

Disclosures

- None relevant to this presentation

The carotid artery bifurcation is probably one of the most studied and written about 4 cm of vessels in the body-
many specialties interested

- Neurosurgery
- Neurology
- Medicine/Vascular Medicine
- Cardiology
- Vascular Surgery
- Interventional Neuroradiology

Introduction

- Carotid Artery disease cases 10-20% of strokes
- Strokes affect approximately 800,000 patients in the US
- This results in mortality, morbidity and costs of 41 Billion

Practice Guidelines

2011 ASA/ACCF/AHA/AANN/AANS/ACR/ASNR/CNS/SAIP/SCAI/SIR/SNIS/SVM/SVS Guideline on the Management of Patients With Extracranial Carotid and Vertebral Artery Disease: Executive summary

A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines, and the American Stroke Association, American Association of Neuroscience Nurses, American Association of Neurological Surgeons, American College of Radiology, American Society of Neuroradiology, Congress of Neurological Surgeons, Society of Atherosclerosis Imaging and Prevention, Society for Cardiovascular Angiography and Interventions, Society of Interventional Radiology, Society of NeuroInterventional Surgery, Society for Vascular Medicine, and Society for Vascular Surgery

Developed in Collaboration With the American Academy of Neurology and Society of Cardiovascular Computed Tomography

Writing Committee Members

A. Creager, MD[#]; Susan B. Fowler, PhD^{**}; Gary Friday, MD^{††}; Vicki S. Hertzberg, PhD; E. Bruce ~~Meigs, MD^{††}; Wesley S. Moore, MD; Peter D. Pave~~
Thomas G. Brott, MD, Co-Chair*; Jonathan L. Hal-

SIZE OF TREATMENT EFFECT										
ESTIMATE OF CERTAINTY (PRECISION) OF TREATMENT EFFECT	CLASS I <i>Benefit >>> Risk</i> Procedure/Treatment SHOULD be performed/administered	CLASS IIa <i>Benefit >> Risk</i> Additional studies with focused objectives needed IT IS REASONABLE to perform procedure/administer treatment	CLASS IIb <i>Benefit ≥ Risk</i> Additional studies with broad objectives needed; additional registry data would be helpful Procedure/Treatment MAY BE CONSIDERED	CLASS III No Benefit or CLASS III Harm <table><tr><th>Procedure/ Test</th><th>Treatment</th></tr><tr><td>COR III: No Benefit</td><td>No Proven Benefit</td></tr><tr><td>COR III: Harm</td><td>Excess Cost w/o Benefit or Harmful to Patients</td></tr></table>	Procedure/ Test	Treatment	COR III: No Benefit	No Proven Benefit	COR III: Harm	Excess Cost w/o Benefit or Harmful to Patients
	Procedure/ Test	Treatment								
	COR III: No Benefit	No Proven Benefit								
	COR III: Harm	Excess Cost w/o Benefit or Harmful to Patients								
	LEVEL A Multiple populations evaluated* Data derived from multiple randomized clinical trials or meta-analyses	■ Recommendation that procedure or treatment is useful/effective ■ Sufficient evidence from multiple randomized trials or meta-analyses	■ Recommendation in favor of treatment or procedure being useful/effective ■ Some conflicting evidence from multiple randomized trials or meta-analyses	■ Recommendation's usefulness/efficacy less well established ■ Greater conflicting evidence from multiple randomized trials or meta-analyses	■ Recommendation that procedure or treatment is not useful/effective and may be harmful ■ Sufficient evidence from multiple randomized trials or meta-analyses					
LEVEL B Limited populations evaluated* Data derived from a single randomized trial or nonrandomized studies	■ Recommendation that procedure or treatment is useful/effective ■ Evidence from single randomized trial or nonrandomized studies	■ Recommendation in favor of treatment or procedure being useful/effective ■ Some conflicting evidence from single randomized trial or nonrandomized studies	■ Recommendation's usefulness/efficacy less well established ■ Greater conflicting evidence from single randomized trial or nonrandomized studies	■ Recommendation that procedure or treatment is not useful/effective and may be harmful ■ Evidence from single randomized trial or nonrandomized studies						
LEVEL C Very limited populations evaluated* Only consensus opinion of experts, case studies, or standard of care	■ Recommendation that procedure or treatment is useful/effective ■ Only expert opinion, case studies, or standard of care	■ Recommendation in favor of treatment or procedure being useful/effective ■ Only diverging expert opinion, case studies, or standard of care	■ Recommendation's usefulness/efficacy less well established ■ Only diverging expert opinion, case studies, or standard of care	■ Recommendation that procedure or treatment is not useful/effective and may be harmful ■ Only expert opinion, case studies, or standard of care						

Pathophysiology

- Atherosclerosis is the most common disease affecting carotid.
 - Often develop at flow branch points (turbulence, shift in shear stress)
 - Distal emboli, thrombotic occlusion
 - Hemodynamically significant stenosis leads to hypoperfusion (water shed zones, repetitive transient TIAs)
- Dissection
- Fibromuscular Dysplasia

THE NEW ENGLAND JOURNAL of MEDICINE

CLINICAL PRACTICE

Caren G. Solomon, M.D., M.P.H., *Editor*

Carotid Stenosis

James C. Grotta, M.D.

Carotid stenosis

- A 2mm residual luminal diameter or a 60-70% reduction in diameter is associated with marked increase in stroke.
- Factors include rate of stenosis, type of plaque, presence of collateral
- Risk factors for atherosclerotic carotid disease include
 - Hypertension
 - Hyperlipidemia
 - Smoking

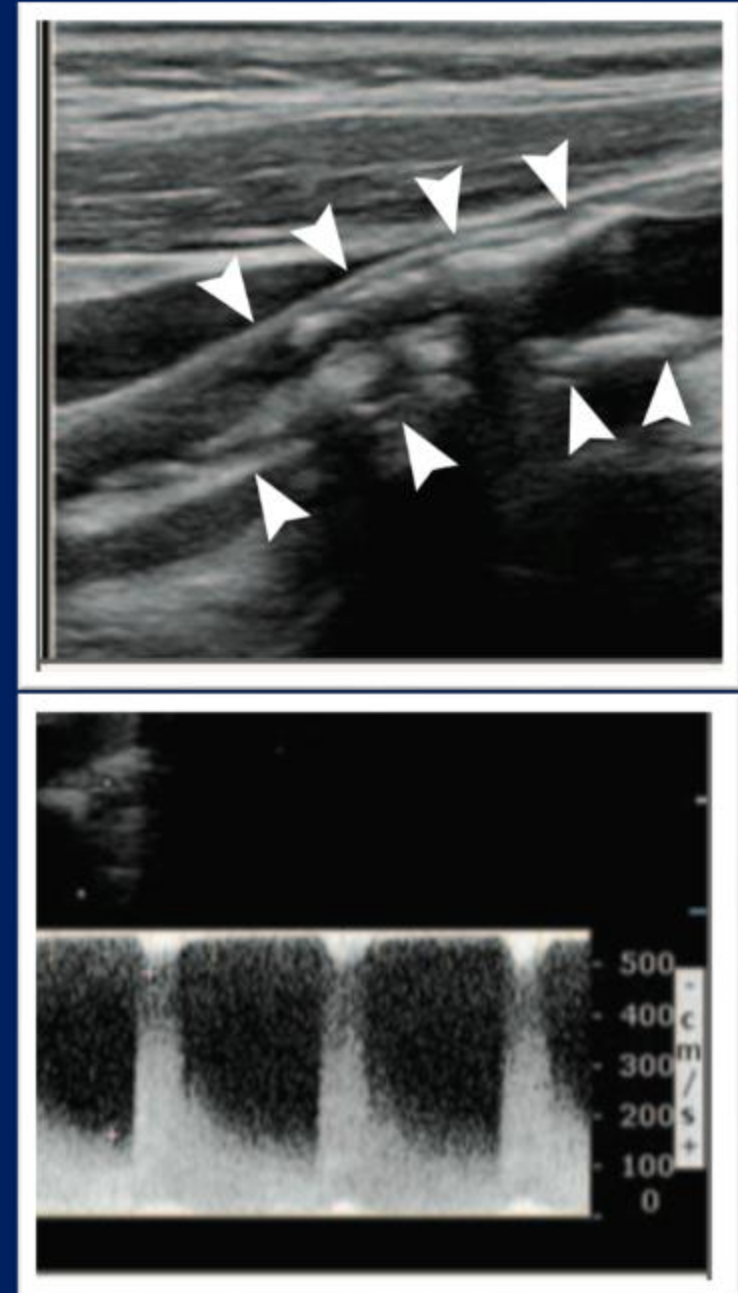
Carotid Stenosis

James C. Grotta, M.D.



Investigations

- Duplex Ultrasonography
 - Widely available, rapid, non invasive
- Magnetic Resonance Angiography
 - Less availability, immobilization of patient
- Computed tomographic angiography
 - Widely available, rapidly performed, excellent resolution
- Catheter angiography
 - Exquisite resolution, invasive, expensive



Imaging Guidelines

- Symptomatic (Class I evidence)
 - Duplex Ultrasound for focal neurological symptoms referable to ICA
 - CTA/MRA reasonable alternative
 - Catheter angiography (Class II evidence)
- Asymptomatic
 - Duplex Ultrasound if known stenosis of bruit.
 - Monitor yearly if greater than 50% stenosis
 - Reasonable to screen with following risk factors: HTN, HLD, tobacco smoking, FH atherosclerosis manifested before age 60yo (first-degree relative), FH ischemic stroke.
- Do not screen in asymptomatic patients without risk factors of atherosclerosis

Treatment

*Medical Management or
Revascularization?*

Medical Management

- Management of stroke risk factors
 - Hypertension
 - Anti hypertensive treatment: Below 140/90 mmHg (Class I, Evidence level A)
 - Cholesterol
 - Statin Reduce LDL cholesterol below 100mg/dL, if stroke aim below 70mg/dL, Diet changes
 - Class I, Evidence level B
 - Diabetes
 - Improved glucose control
 - Smoking
 - Cessation
 - Obesity
 - Exercise program, diets
 - Sedentary life styles
 - Exercise programs

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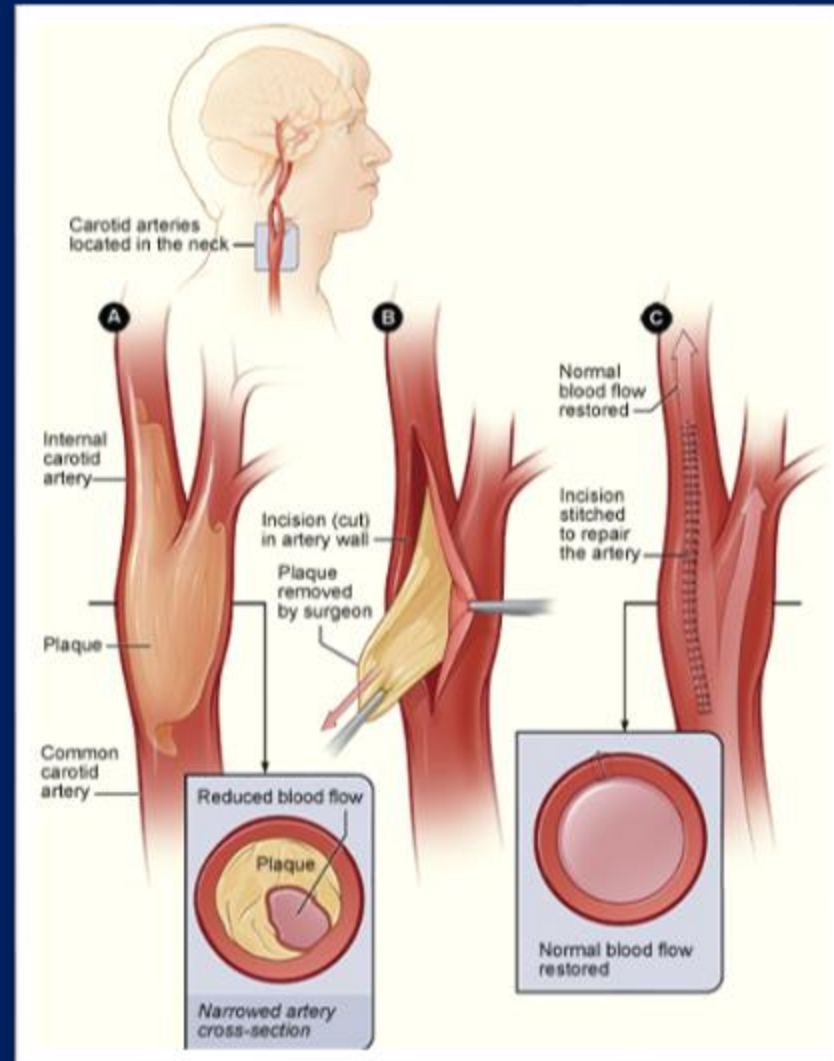


AHA/ASA GUIDELINE

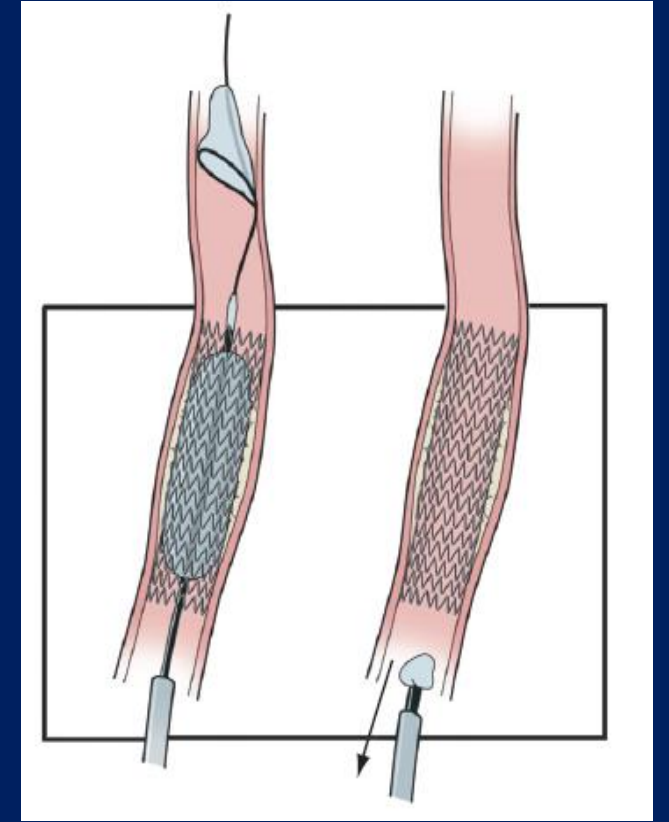
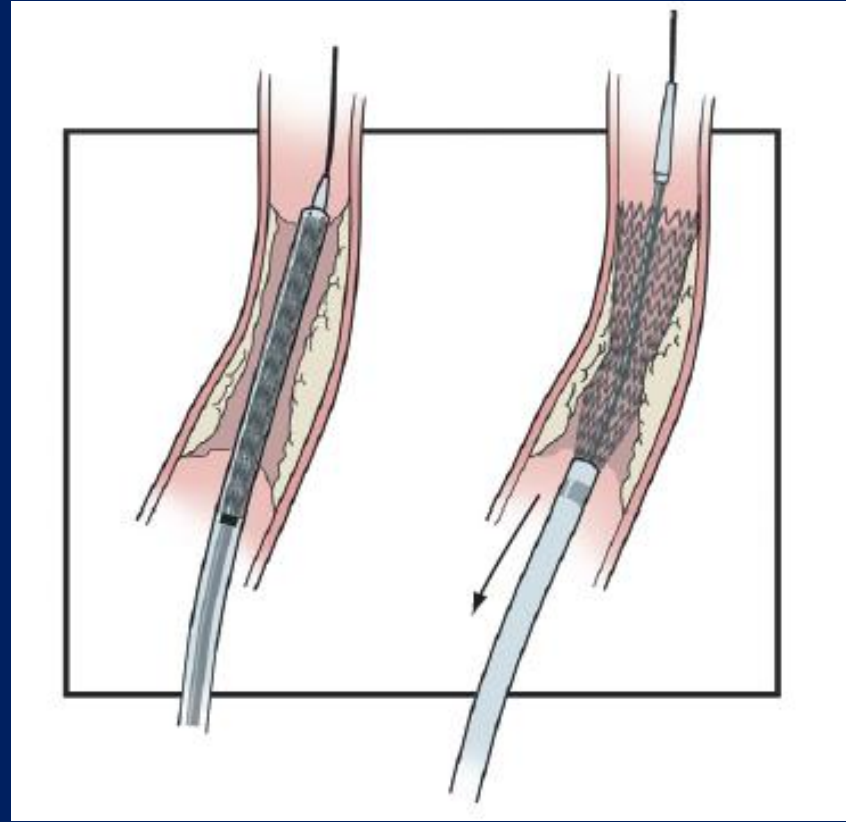
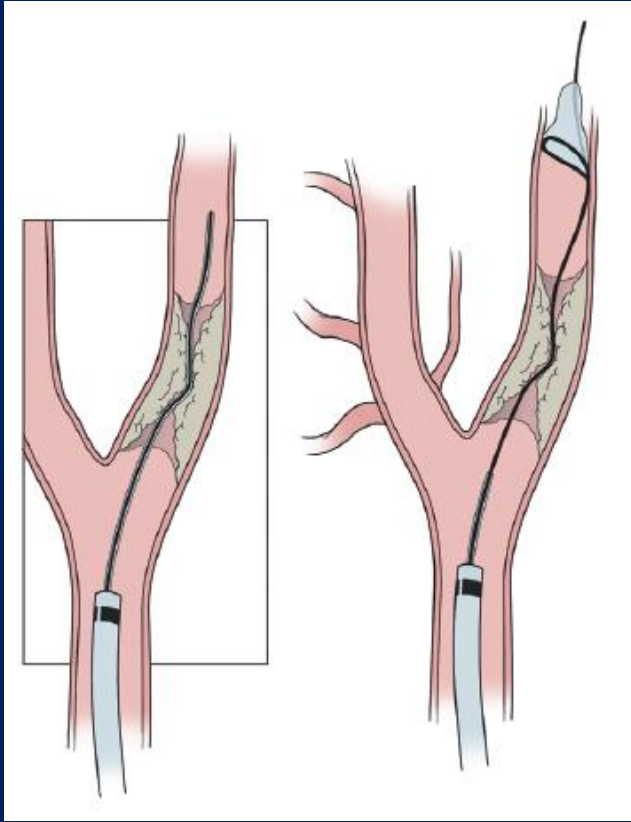
2021 Guideline for the Prevention of Stroke in Patients With Stroke and Transient Ischemic Attack: A Guideline From the American Heart Association/American Stroke Association

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Carotid Endarterectomy (CEA)



Carotid Artery Stenting

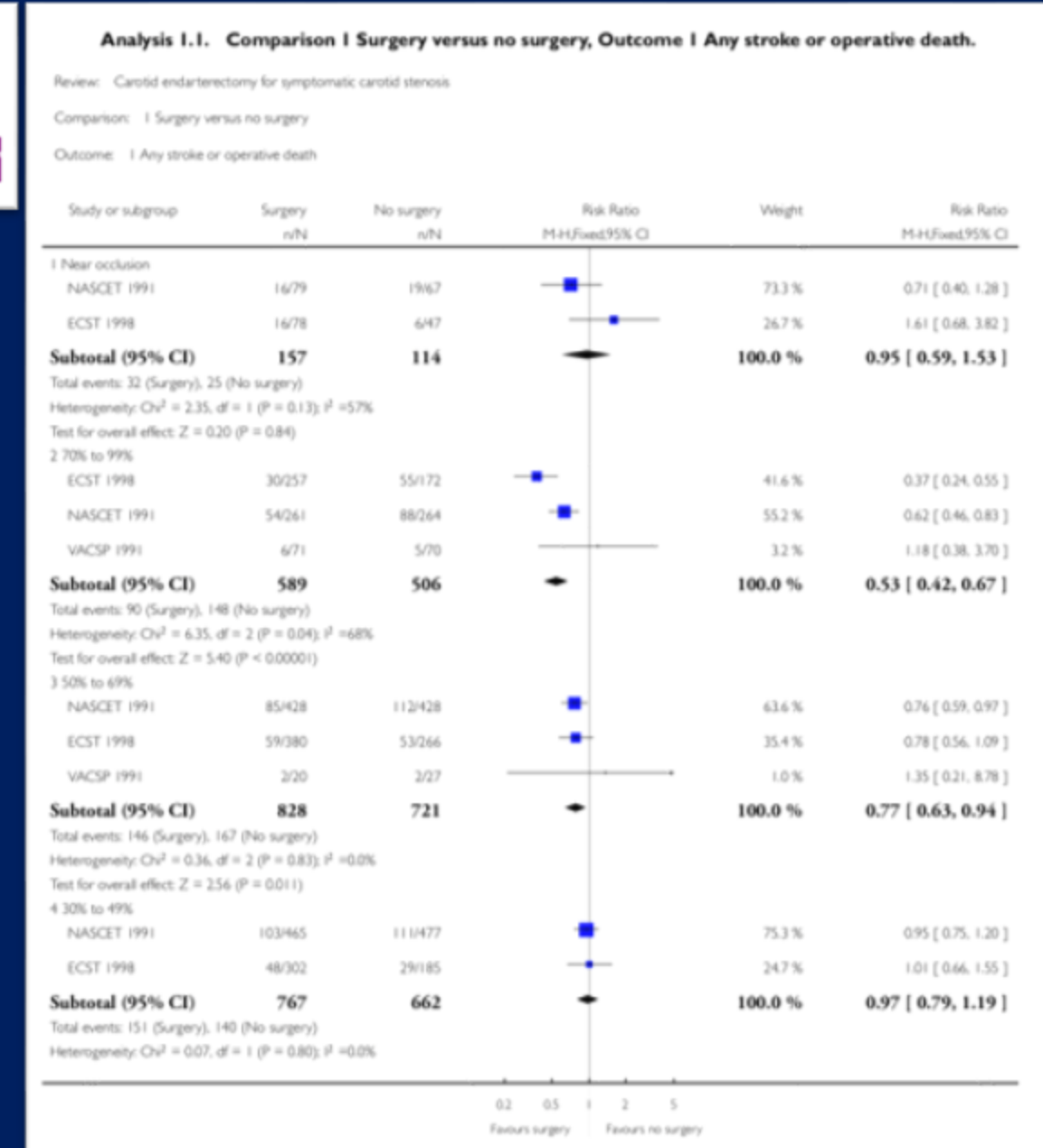
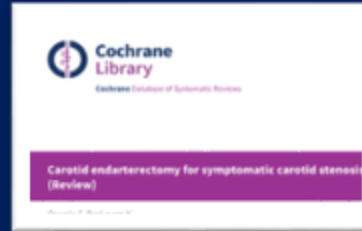


Key Early Trials

- Intervention (CEA) versus Medical Management
- NASCET (1999)
 - 2,885 patient TIA/Minor strokes within 120 days
 - < 80 years old
 - Angiogram:
 - 70-99%: 17% ARR (65% RRR) at 2 years
 - 50-69%: 6.5% ARR (29% RRR) at 2 years
 - <50%: No Benefit
- ECST (1998)
 - 3,024 patients with TIA, retinal infarction or non- disabling
 - Stroke within 6 months
 - Angiogram
 - 70-99%: 21.2% ARR 5 years
 - 50-69%: 5.7% 5 years
 - <50 % No Benefit

Key Point

- Cochrane review on symptomatic carotid stenosis CEA versus medical treatment identified on pooled data
- 50-69% stenosis: CEA high risk for first two years, but subsequently reverse and thus the NNTB at 5 years for any stroke or operative death to prevent 1 was 13.
- 70-99% stenosis there was benefit to CEA within 1 year and NNTB at 5 years was 6
- Benefits were sent particularly in in Male, greater than 75 years of age and in those treated within 2 weeks of last event.
- Intervention: CEA was superior to best medical management at the time of the trial, when stenosis was greater than 50%



Guidelines for Revascularization: Symptomatic (2011)

- Patients at average/low surgical risk who
 - Experience nondisabling ischemic stroke/TIA (include ischemic, hemispheric events or amaurosis fugax) within 6mo
 - Anticipated rate of perioperative stroke or mortality is less than 6%.
- Should undergo CEA if the diameter of the ICA lumen is reduced more than 70% on non-invasive imaging or more than 50% on catheter angiography (Level of Evidence: B)

Practice Guidelines

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Disease: Executive summary

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Guidelines CAS vs CEA (2011)

- CAS is indicated as an alternative to CEA for
 - Symptomatic patients at average /low risk of complications
 - When ICA diameter is reduced by >70% on non-invasive imaging or more than 50% on catheter angiography
- Anticipated rate of periprocedural stroke or mortality is less than 6% (Level of Evidence: B).

Practice Guidelines

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Guidelines: Asymptomatic (2011)

Practice Guidelines

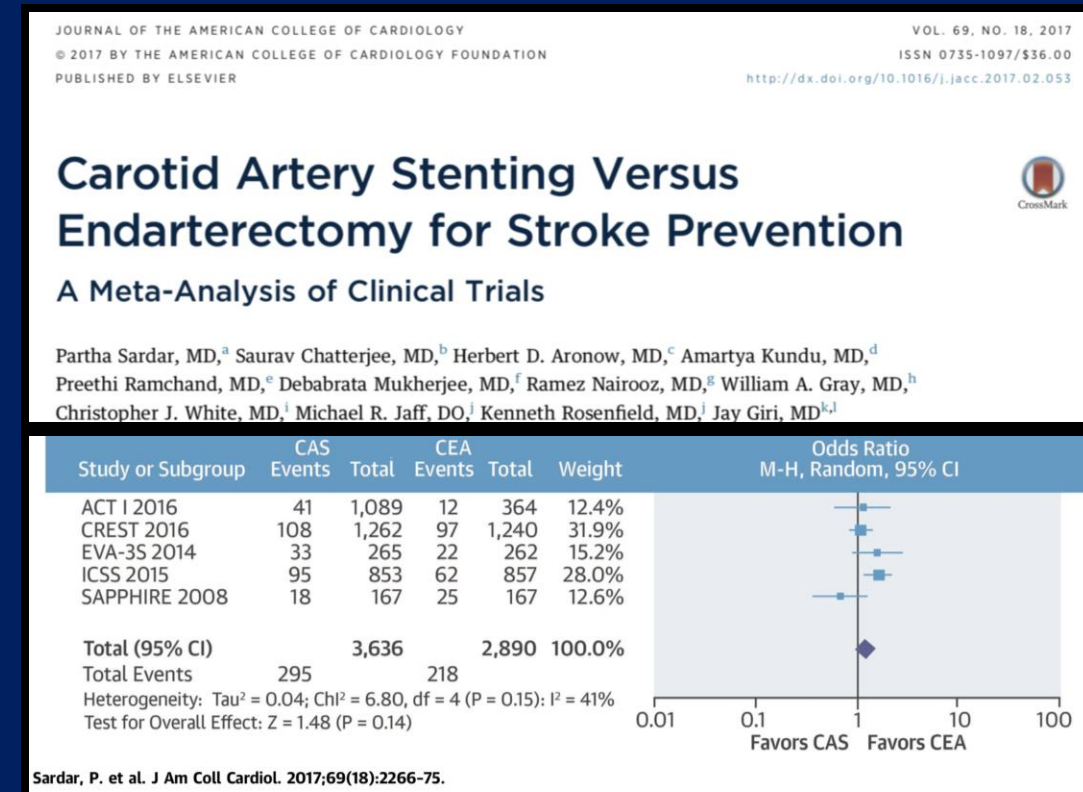
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- **Consider CEA in asymptomatic** patients who have more than 70% stenosis of the ICA if the risk of perioperative stroke, MI, and death is low (less than 3%)
- Consider CEA over CAS for re-vascularization in older patients
- CAS over CEA when re-vascularization is indicated in patients with neck anatomy unfavorable for arterial surgery

Updated Treatment: CEA vs CAS

- Sardar et al: Trials > 50 patient, Use of EPD
- Metanalysis of 5 trials: 6526 patients, 3636 CAS and 2890 CEA group
- Outcome
- Aggregate efficacy/Safety (composite Death, stroke, MI, non periprocedural ipsilateral stroke)
- Similar CAS vs CEA 8.1% vs 7.5%
- Risk of periprocedural stroke and non periprocedural stroke higher in CAS: 7.6 vs 5.6%.
- Long term results: No difference in long term major/disabling strokes 2.9% vs 3.0%.
- Risk of MI/Cranial nerve palsy: Higher in CEA (9.1 vs 6.2%)



Long term results

- Jung et al: RCT, 10m studies, 4473 and 3771 CAS vs CEA
- Long term stroke rates: Similar RR 1.04.
- CAS higher risk of restenosis (RR: 1.46 1.03-2.07)
- Procedural stroke/death/MI ipsilateral stroke rates
 - CAS versus CEA similar overall and in asymptomatic patients; RR 1.22 (CI 0.97-1.52) and RR 1.14 CI 0.77-1.7
 - In symptomatic patients CAS significantly higher risk: RR 1.35 CI 1.04-1.77

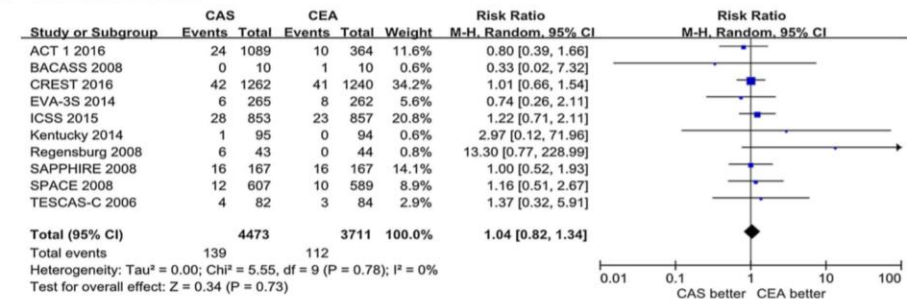
Ischemic stroke

ORIGINAL RESEARCH

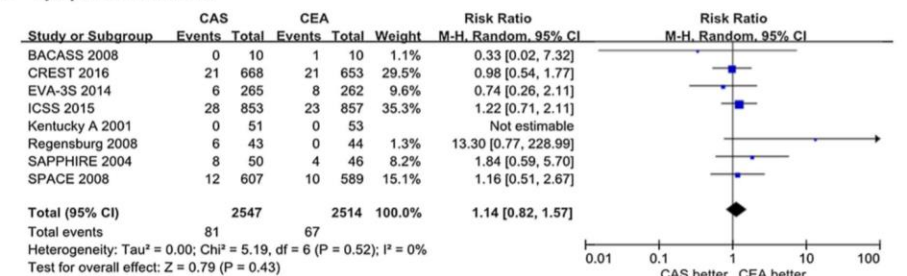
Long term durability and outcomes of carotid stenting and carotid endarterectomy

Jin-Man Jung,¹ Jeong-Yoon Choi,² Hyun Jung Kim,^{2,3} Sang-il Suh,⁴ Woo-Keun Seo^{4,5}

A All-inclusive stenosis



B Symptomatic stenosis



C Asymptomatic stenosis

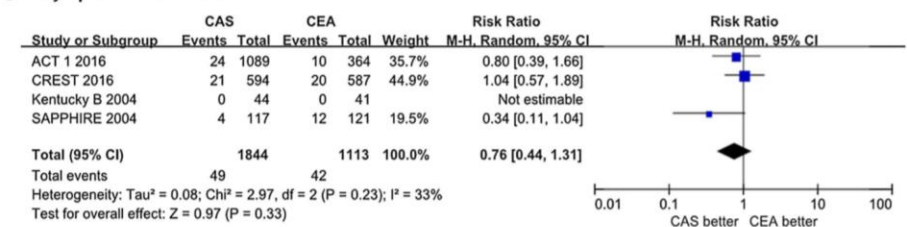


Figure 2 Pooled risk ratio of postprocedural ipsilateral stroke. (A) All inclusive stenosis. (B) Symptomatic stenosis. (C) Asymptomatic stenosis. CAS, carotid angioplasty and stenting; CEA, carotid endarterectomy. See text for details of the studies.

Asymptomatic patients

- Moresoli et al. 5 trials 3019 asymptomatic patients, q88q CAS, 1138 CEA
- Periprocedural outcomes:
 - CAS Increase risk of stroke: RR 1.84 (CI 0.99-3.4), but primarily non disabling/mild strokes
 - CAS Significant decrease risk of cranial nerve palsy (RR 0.07 CI 0.02-0.25) and non significant reduction in MI (RR 0.55; 95% CI, 0.26–1.16)
- Long term outcomes
 - No significant difference overall in stroke rate, MI and death.

Carotid Stenting Versus Endarterectomy for Asymptomatic Carotid Artery Stenosis A Systematic Review and Meta-Analysis

Paola Moresoli; Bettina Habib, MSc, MScPH; Pauline Reynier, MSc; Matthew H. Secrest, MSc; Mark J. Eisenberg, MD, MPH; Kristian B. Filion, PhD

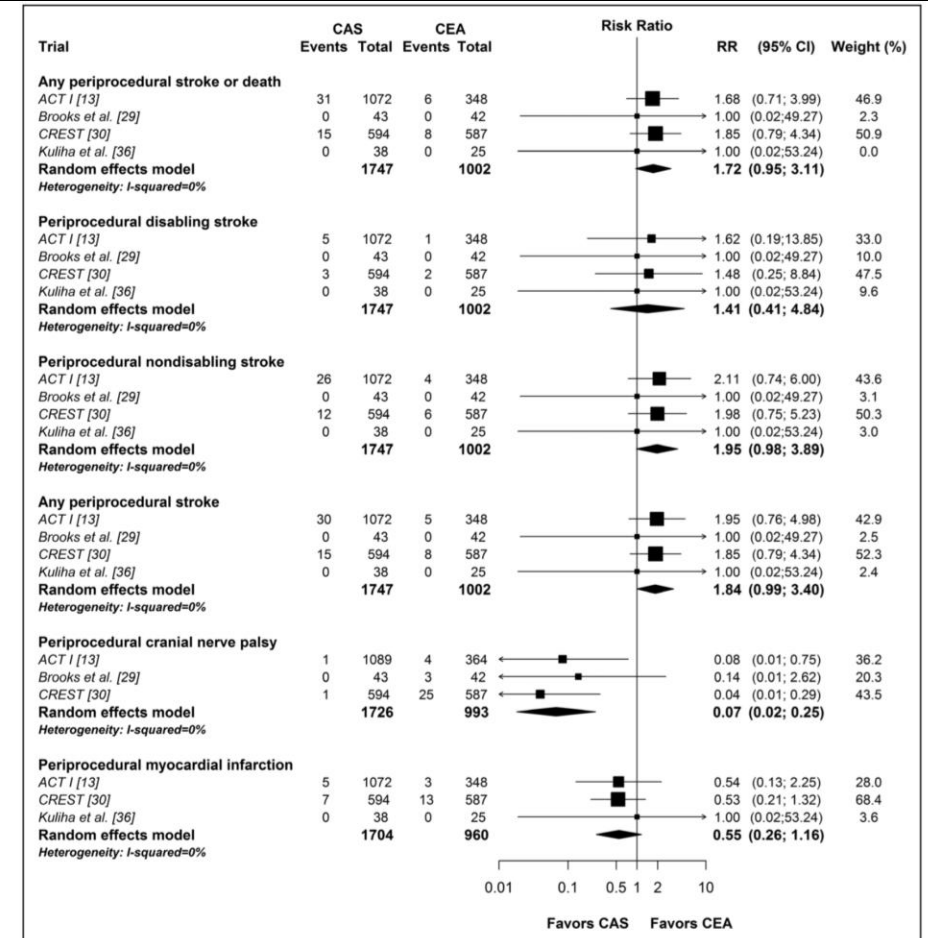


Figure 2. Forest plots of periprocedural (30-day) outcomes in randomized controlled trials (RCTs) comparing carotid artery stenting (CAS) vs carotid artery endarterectomy (CEA) in patients with asymptomatic carotid stenosis. ACT I indicates Asymptomatic Carotid Trial I; CI, confidence interval; CREST, Carotid Revascularization Endarterectomy Versus Stenting Trial; RR, risk ratio; and SAPHIRE, Stenting and Angioplasty with Protection in Patients at High Risk for Endarterectomy.

Key Points

- Recent long term trials (ACT1 and CREST) found similar risk of CAS and CEA
 - ACT1 5 year ipsilateral stroke (excluding perioperative period) for both CAS and CEA was 0.4%/years vs 0.5% year
 - CREST 10 years: 0.7% versus 0.6%
- Aggregate Safety risk: Similar CAS versus CEA
 - CEA: Lower risk of non-disabling strokes and lower rates of restenosis
 - CAS: Lower risk of cranial nerve palsy and MI
- Individualized patient treatment essential to determine optimal safety profile.

Restenosis

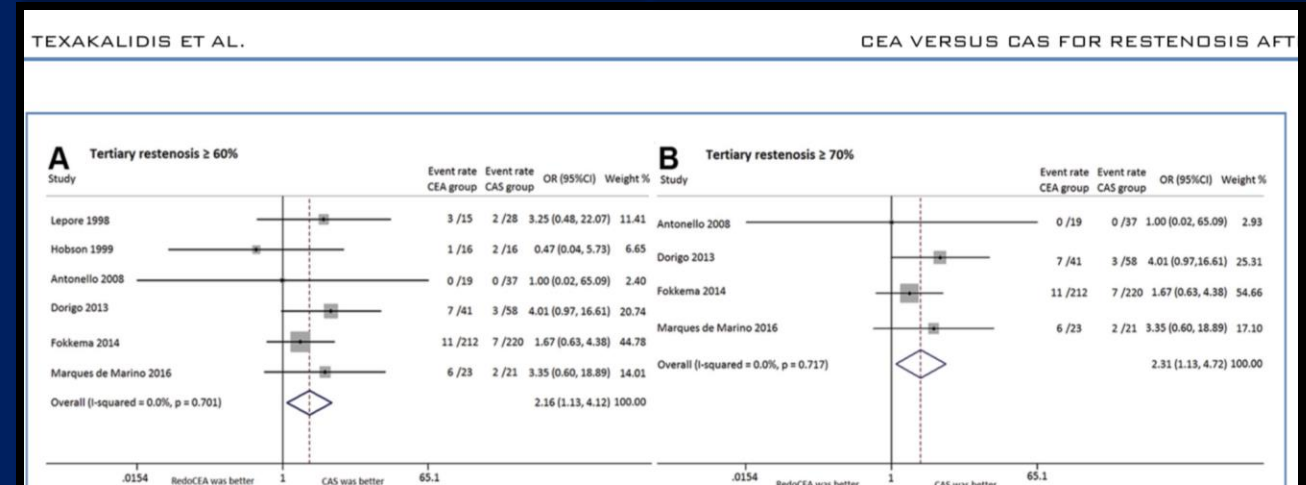
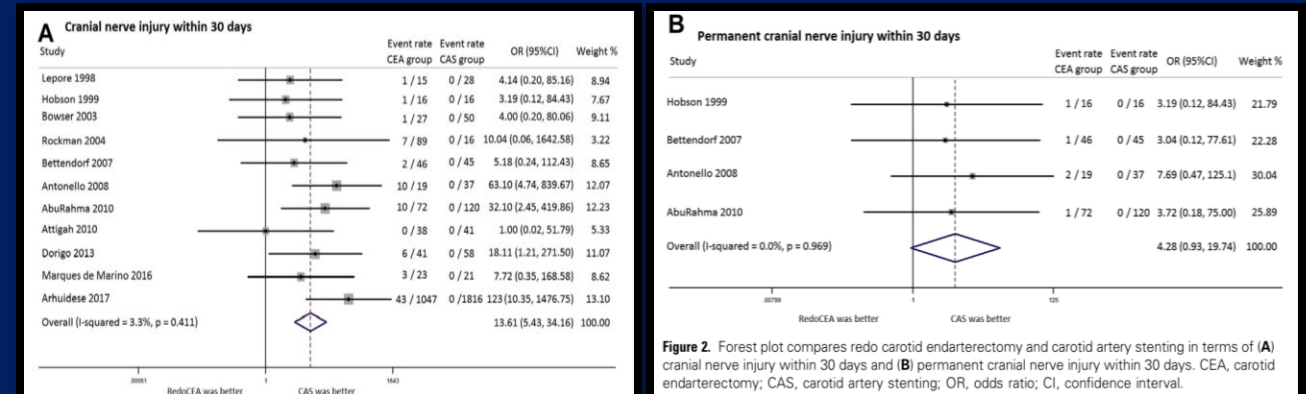
- Guidelines
 - If symptomatic cerebral ischemia and recurrent carotid stenosis due to intimal hyperplasia or atherosclerosis, it is reasonable to repeat CEA or perform CAS using the same criteria as recommended for initial revascularization (Class IIa)
- Texakalidis et al Restenosis after CEA
 - 13 studies, 4163 patients
 - Repeat CEA higher risk for CN injury: OR: 13.61 (6% vs 1.3).
 - Stroke rate similar (2.3 v 1.7%)
 - MI rate similar (1.2% vs 0.9%).
 - Tertiary restenosis: 8.1% CEA and 3.5% CAS group (OR: 2.16)

LITERATURE REVIEW

Check for updates

Carotid Artery Endarterectomy versus Carotid Artery Stenting for Restenosis After Carotid Artery Endarterectomy: A Systematic Review and Meta-Analysis

Pavlos Texakalidis¹, Stefanos Giannopoulos², Anil K. Jonnalagadda³, Damianos G. Kokkinidis⁴, Theofilos Machinis⁵, John Reavey-Cantwell⁶, Ehrin J. Armstrong⁶, Pascal Jabbour⁷



2026 – What has changed in carotid stenosis ?

- CREST 2 – landmark study that changes how we think of asymptomatic carotid stenosis
 - **CAS (+ medical management) statistical benefit over medical management alone**
 - Stenting: stroke or death at 4y: 2.8% (stenting + intensive medical therapy) vs 6.0% (medical therapy alone) → ARR 3.2% (P=0.02)
 - CEA: stroke or death at 4y: 3.7% (CEA + medical therapy) vs 5.3% (medical therapy alone) → ARR 1.6% (P=0.24)
- Contemporary medical management has improved
 - CREST 2: 5.3-6.0% of events in medical management alone

EXTRACRANIAL VERTEBRAL ARTERY STENOSIS



Extracranial vertebral artery disease (EVAD): The forgotten cousin

- Symptomatic vertebral artery obstruction is less encountered in practice and more paucity of evidence compared to carotid
 - Vertebral artery atherosclerosis can be attributed to 10-20% of posterior circulation strokes
- Clinical presentation
 - Dizziness, vertigo, diplopia, perioral numbness, blurry vision, tinnitus, ataxia, sensory deficits, syncope

Extracranial Vertebral Artery Disease (EVAD)

- Medical management is favored for both symptomatic and asymptomatic and symptomatic
 - Recently symptomatic EVAD, antiplatelet therapy, lipid lowering, BP control (Class I)
 - Patients with ischemic stroke/TIA with EVAD whose symptoms persist despite medical management, open or endovascular therapy questionable (Class lib)
 - VAST, VIST, SAMMPRIS
 - Only VAST + VIST had extracranial vertebral data
 - Negative trials
- Aspirin 75-325mg QD for all vertebral atherosclerosis

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Vertebral Artery Stenosis: Imaging

- For symptomatic patients:
 - CTA/MRA (Class I)
 - If candidate for revascularization, angiography may be useful to define pathology/anatomy (Class IIa)
- For asymptomatic patients
 - If there is b/l carotid occlusions or unilateral carotid artery occlusion and incomplete circle of Willis → noninvasive imaging for vertebral arteries (Class I)
- Ultrasound is less suitable

Vertebral Artery Stenosis: Treatment

- Medical management is favored for both symptomatic and asymptomatic patients
 - In recently symptomatic EVAD, utilize intensive medical therapy - antiplatelet therapy, lipid lowering, BP control (Class I)
 - In patients with ischemic stroke/TIA whose symptoms persist despite medical management, endovascular/open intervention is equivocal (Class IIb)
 - VAST, VIST, SAMMPRIS
 - Only VAST + VIST had extracranial vertebral data
 - Negative trials
- All vertebral atherosclerosis: aspirin 75-325mg QD (Class I)
- Ischemic stroke/TIA: Aspirin 81-325mg QD, aspirin + ER dipyridamole, clopidogrel 75mg QD are acceptable (Class I)

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Vertebral Artery Stenosis: When to consider stenting?

- Markus et al (2019, Lancet Neurology) preplanned pooled individual patient data analysis of VAST, VIST, SAMMPRIS trials to compare vertebral stenting (intracranial and extracranial) vs medical management
 - No overall benefit of stenting vs medical management
 - Some evidence of benefit for stenting for extracranial stenosis (not statistically significant)
 - Much lower periprocedural stroke risk compared to intracranial vertebral stenosis (1% in extracranial stenting vs 16% in intracranial stenting)
 - Extracranial stenting vs medical treatment group: HR for any stroke 0.63 (95% CI 0.27-1.46)
- Limitations
 - Small sample size, stenting for first occurrence of stroke/TIA

**Stenting for symptomatic vertebral artery stenosis:
a preplanned pooled individual patient data analysis**

Hugh S Markus, Eric L Harshfield, Annette Compter, Wilhelm Kuker, L Jaap Kappelle, Andrew Clifton, H Bart van der Worp, Peter Rothwell, Ale Algra, on behalf of the Vertebral Stenosis Trialists' Collaboration*

Vertebral Artery Stenosis: When to consider stenting?

Extracranial vertebral artery stenosis patients that may benefit from stent placement: post-hoc analysis from randomized controlled trials

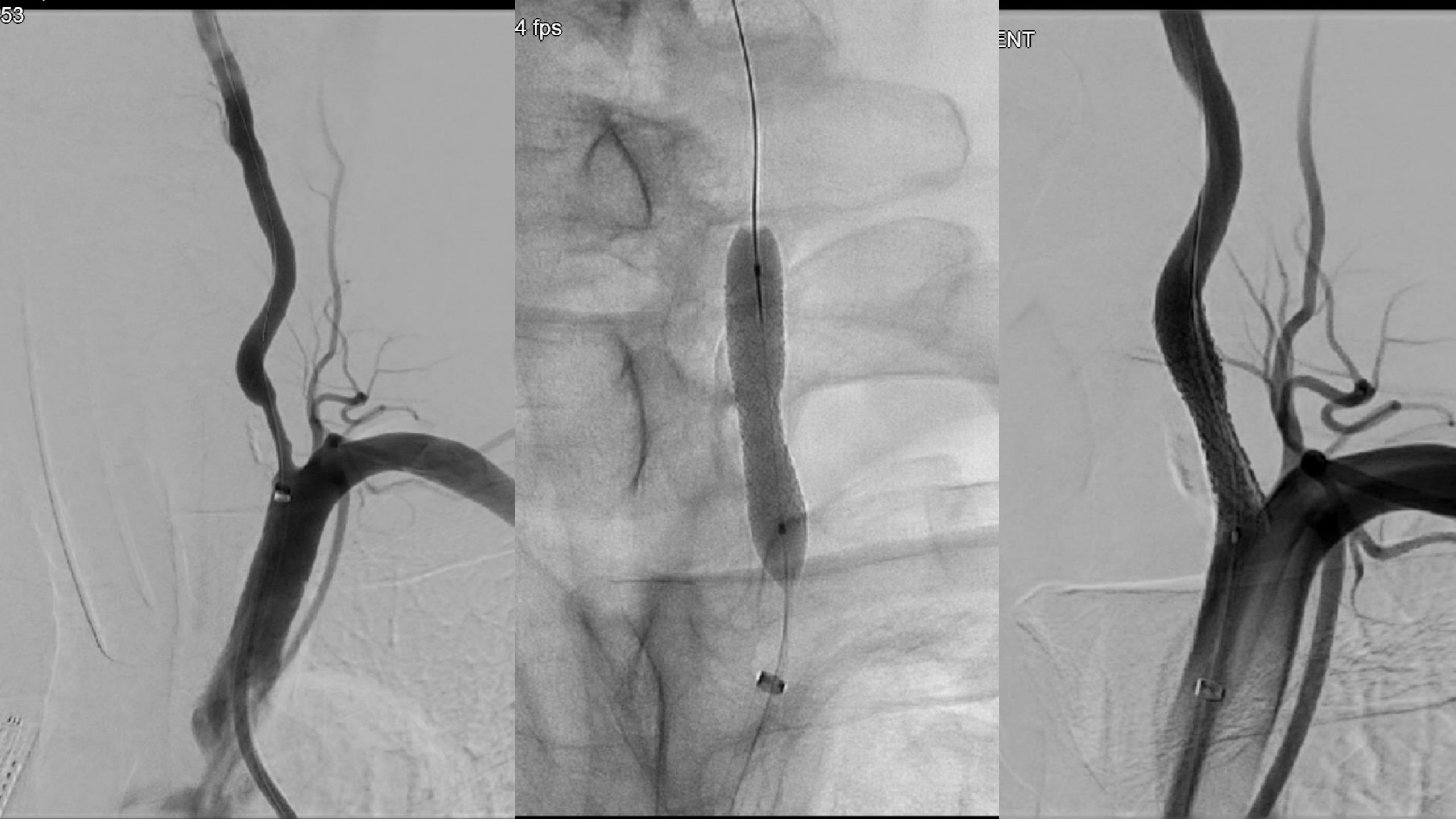
Adnan I. Qureshi^{1,2*}, Nived J. Ranjini^{1,2}, Yilun Huang², Hatem Tolba², Mojgan Golzy², Pashmeen Lakhani¹, Akash Roy³, Christy N. Cassarly³, Renee' H. Martin³ and William J. Powers⁴

¹Zeenat Qureshi Stroke Institute, Columbia, MO, United States, ²University of Missouri, Columbia, MO, United States, ³Department of Public Health Sciences, Medical University of South Carolina, Charleston, SC, United States, ⁴Department of Neurology, Duke University School of Medicine, Durham, NC, United States

- Qureshi et al (2026, Frontiers Neurology) post-hoc analysis of VAST and VIST trials to explore benefits of stenting
- EVAD $\geq 50\%$ stenosis who undergo stenting within 30d stroke
 - Lower rates of recurrent vertebrobasilar stroke and death in the stenting group
 - HR for any stroke 0.2 ($p=0.02$)
 - HR any stroke and/or death 0.3 ($p = 0.03$)
- Limitations
 - Post-hoc, small sample size, stenting for first occurrence of stroke/TIA

Vertebral Artery Stenosis: Case Example

59M PMH previous strokes (R>L superior cerebellar stroke 9/2025 s/p TNK, basilar LVO s/p MT and L VA angioplasty 10/16/25) who presented for angioplasty L VA stenting



Vertebral Artery Stenosis: When to consider stenting?

- Consider stenting in patients with symptomatic EVAD with recurrent ischemic events, hemodynamic compromise despite best medical management

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