

Updates in Management of Carotid Stenosis

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► None

Introduction

- ▶ Stroke is the leading cause of serious long-term disability in the United States
- ▶ About 10% of all strokes are related extracranial carotid stenosis
- ▶ About 10% of all people in their 80s have at least moderate extracranial cervical stenosis

Case Example – Common Pitfalls

- ▶ 65-year-old male who presents to the ED with a 30 min episode of left hemi-body weakness.
- ▶ By the time of arrival to ED his symptoms completely resolved
- ▶ The patient underwent subsequent imaging which demonstrated 70% stenosis of the right carotid artery
- ▶ The patient was discharged home on ASA, with instructions to follow up with a PCP

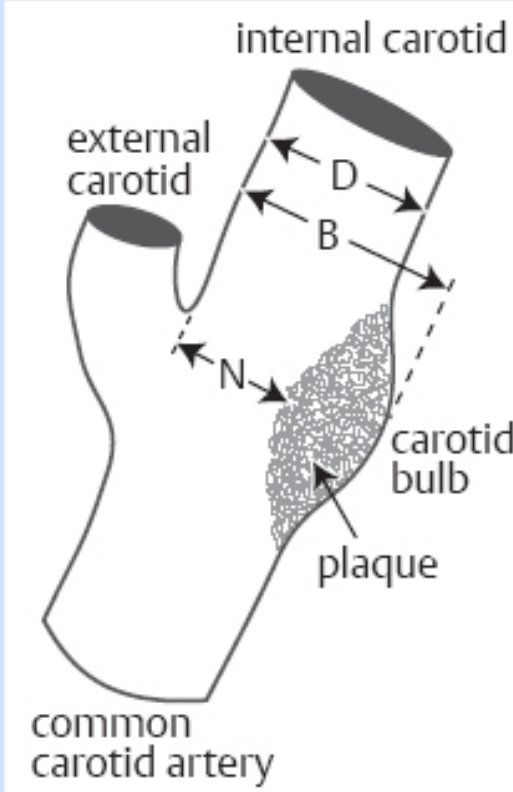
Key Definitions

Definition of stenosis is primarily by NASCET Criteria

- Mild Stenosis <50%
- Moderate stenosis: 50-70%
- Severe Stenosis >70%
- Occlusion 100%

Symptomatic Carotid Stenosis

- Any related stroke, Transient Ischemic Attack, or Amaurosis Fugax attributable to the carotid lesion within **6 months**

	NASCET	ECST
	$1 - \frac{N}{D}$	$1 - \frac{N}{B}$
Approximate equivalent degrees of ICA stenosis based on direct comparison (%)		
	30 ^b	65 ^b
	40 ^b	70
	50	75
	60	80
	70	85
	80	91
	90	97

Carotid Stenosis Treatment Algorithm

CAROTID STENOSIS DIAGNOSIS
IMAGING (DUS, CTA, MRA, etc.) & RISK ASSESSMENT.

BEST MEDICAL THERAPY (BMT) - ALL PATIENTS

- Antiplatelet Therapy
- Blood Pressure Control
- Diabetes Management
- Statins (Target LDL)
- Smoking Cessation
- Lifestyle Modification

IS PATIENT SYMPTOMATIC?
(TIA, Carotid Stroke <6 mos)

YES

NO

**STENOSIS
SEVERITY (%)**

**STENOSIS
SEVERITY (%)**

Best Medical Therapy – All Patients with carotid stenosis

Pharmacological Targets

- ▶ SBP $\leq$ 130 mm Hg
- ▶ LDL <70 mg/dl
- ▶ HbA1C <7.0%
- ▶ Single Antiplatelet Therapy

Lifestyle Modifications

- ▶ Smoking Cessation
- ▶ Dietary Modification
- ▶ Physical Activity
- ▶ Weight Management

Available Surgical Treatment Options

- ▶ Carotid Endarterectomy (CEA)
- ▶ Carotid Artery Angioplasty and Stenting (CAS)
- ▶ Trans Carotid Artery Revascularization (TCAR)

The need for additional surgical intervention is highly dependent on if they are symptomatic + the degree of stenosis

Early Studies in Carotid Stenosis

Symptomatic Patients – Carotid Endarterectomy

- ▶ **NASCET – 659 patients with recent TIA or non-disabling stroke ($MRS \leq 2$) with 70-99 percent carotid occlusion - within 120 days**
 - ▶ **CEA > Medical Management (predominantly ASA), @ 2 years**
 - ▶ Any stroke or Death: 15.8 vs 32.3%
 - ▶ Ipsilateral stroke 9 vs 26%
- ▶ **ECST – 2518 patients (recent TIA/non-disabling stroke in last 6 months, followed over 10 year period, mean follow up 3 years)**
 - ▶ 3 years – patients treated with severe stenosis
 - ▶ 2.8 versus 16.8 percent for ipsilateral stroke
 - ▶ 14.9% vs 26.5% (control group ASA only) - total risk of surgical death, surgical stroke, ipsilateral ischemic stroke, or any other stroke
 - ▶ 80% diameter

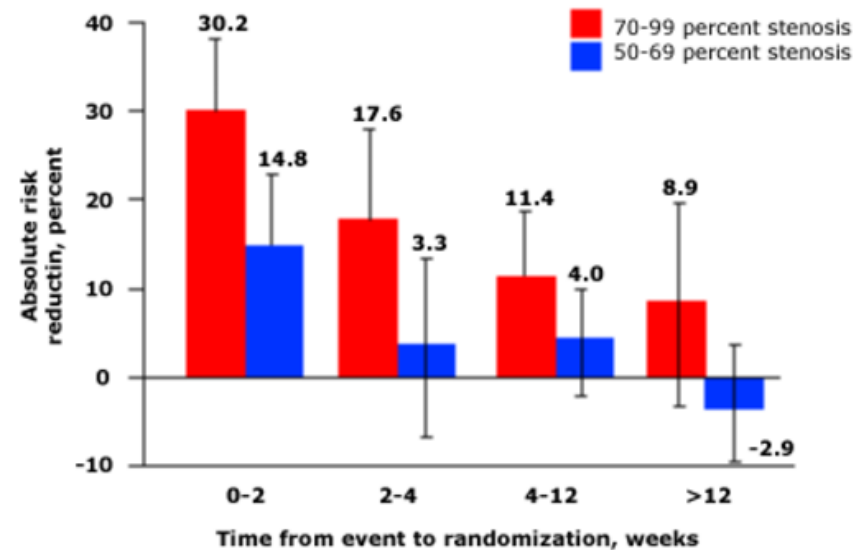
Early Studies in Carotid Stenosis Symptomatic Patients – Carotid Endarterectomy

- ▶ **Pooled Data of VA Studies (VACS) / ECST/ NASCET**
- ▶ **CEA was beneficial for patients with greater than 70 percent symptomatic stenosis**
 - ▶ **NNT of 5, ARR of 16%**
- ▶ **CEA was beneficial for patients with 50 to 69 percent symptomatic stenosis.**
 - ▶ **The NNT to prevent one stroke over five years in this group was 22, with an Absolute risk reduction of 4.6 percent.**
- ▶ **In CEA for symptomatic patients, combined morbidity and mortality that should not be greater than 6%**

Timing of intervention – Recent Mild Symptomatic Event

Pooled NASCET and ECST trials showed
benefit within 2 weeks of intervention

Early carotid endarterectomy is associated with improved outcomes



Rothwell PM, et al. Endarterectomy for symptomatic carotid stenosis in relation to clinical subgroups and timing of surgery. Lancet. 2004;363(9413):915.

Early Studies in Carotid Stenosis

Asymptomatic patients

- ▶ **Veterans Affairs Cooperative Study Group (1993)**
 - ▶ **444 Men ASA alone vs ASA + CEA 50-99% stenosis**
 - ▶ End point combine incidence of TIA, amaurosis Fugax, stroke
 - ▶ Average follow up 2 years
 - ▶ **ASA + CEA vs CEA – primary end point (8 vs 20.6%)**
 - ▶ **Nonsignificant lower incidence of ipsilateral stroke (4.7 versus 9.4 percent).**

Early Studies in Carotid Stenosis

Asymptomatic patients

- ▶ **Asymptomatic Carotid Atherosclerosis Study (ACAS)**
 - ▶ 1662 Patients (40-79yrs) with 60-99% Carotid stenosis
 - ▶ CEA + ASA vs ASA alone
 - ▶ End point – cerebral infarction in distribution of study artery, or any stroke/death in perioperative period
 - ▶ CEA reduced 5-year stroke risk 66% in males, 17% in females (not statistically significant), and 53% overall (males & females lumped together).
 - ▶ Half of the morbidity was related to angiography (1.2%)

Early Studies in Carotid Stenosis

Asymptomatic patients

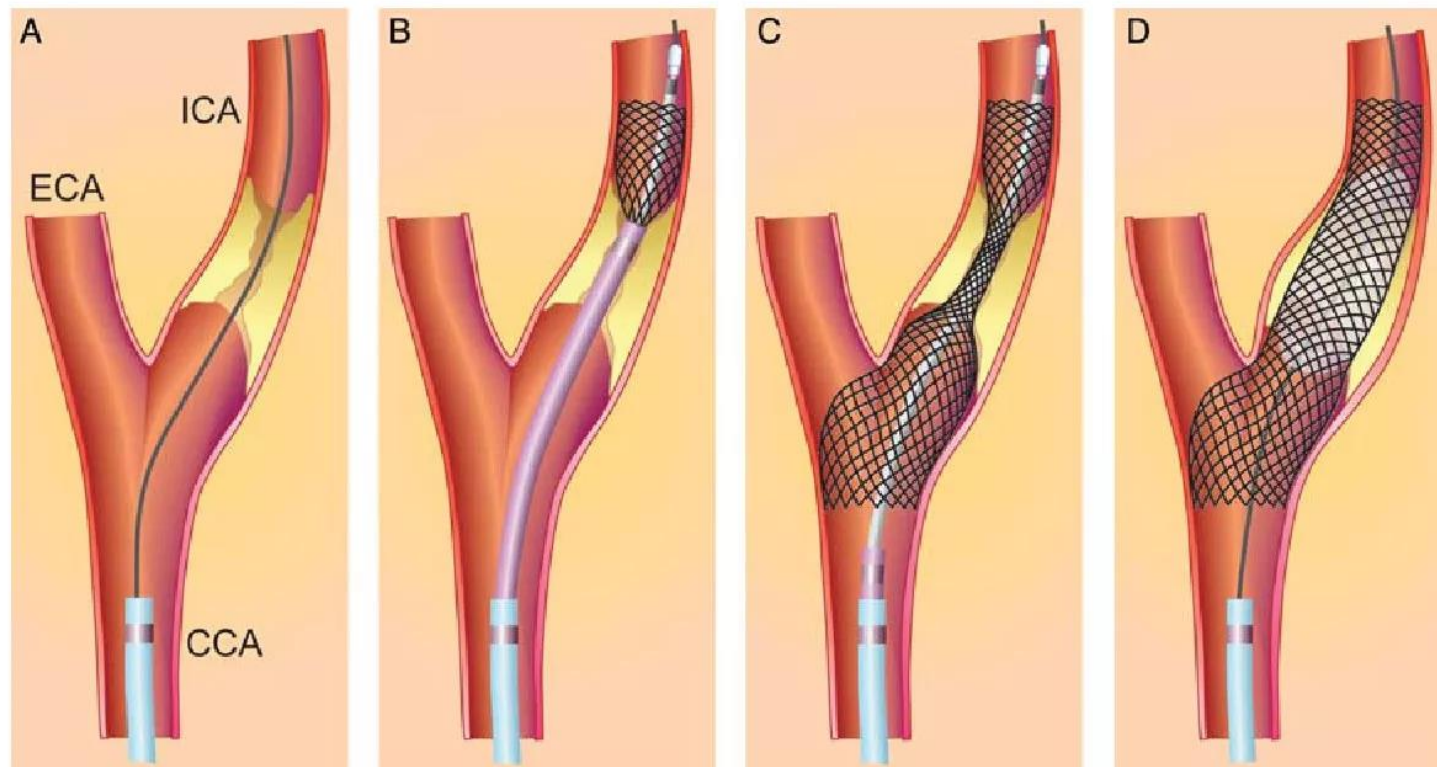
- ▶ **Asymptomatic Carotid Surgery Trial (ACST) from 1993 – 2003**
 - ▶ 3120 patients ($\geq 60\%$ -99%) Asymptomatic carotid stenosis
 - ▶ Immediate CEA vs deferral of CEA until a definite indication occurred
 - ▶ 5-year risk reduction of ipsilateral stroke if CEA was performed (6.4 versus 11.8 percent, 95% CI 2.96-7.75)
 - ▶ The net benefit of CEA was delayed for about two years after surgery

Early Studies in Carotid Stenosis Asymptomatic patients

Generalization of three older studies of Asymptomatic carotid stenosis

- ▶ **Absolute risk reduction was about 3% in 3 years**
- ▶ **NNT to prevent one stroke was 33**
- ▶ **Medical Therapy during that time was suboptimal**

Carotid Artery Angioplasty and Stenting



CREST 1 – 2010

- ▶ **CREST trial (2010) was a multicenter randomized controlled study that compared carotid endarterectomy to carotid artery stenting in both symptomatic and asymptomatic patients**

Carotid artery Angioplasty & Stenting

CREST - 1

- ▶ **2502 patients with CAS or Stenting**
 - ▶ 47% Asymptomatic vs 53% Symptomatic
- ▶ **Primary End point – Stroke, MI, or death within 30 days following treatment and ipsilateral stroke 10 years**
 - ▶ Results were Similar: 11.8% vs 9.9% (CI 0.83-1.44)
 - ▶ No statistically different ipsilateral stroke
 - ▶ CEA vs CAS 10.8% vs 7.9% (CI 0.98-1.80)

Carotid artery Angioplasty & Stenting

CREST - 1

Retrospective Sub-group analysis of CREST

- For CAS the risk for primary end point increase with age by 1.77x per 10 year increment, with no change to CEA
- Equal risk of stroke shown to be at 64 years
- Stroke or Death within 30 days for symptomatic carotid disease
 - CAS vs CEA (4.4 vs 2.3%)
- Frequency of Myocardial Infarction within 30 days was lower in stenting group (1.1 vs 2.3%)

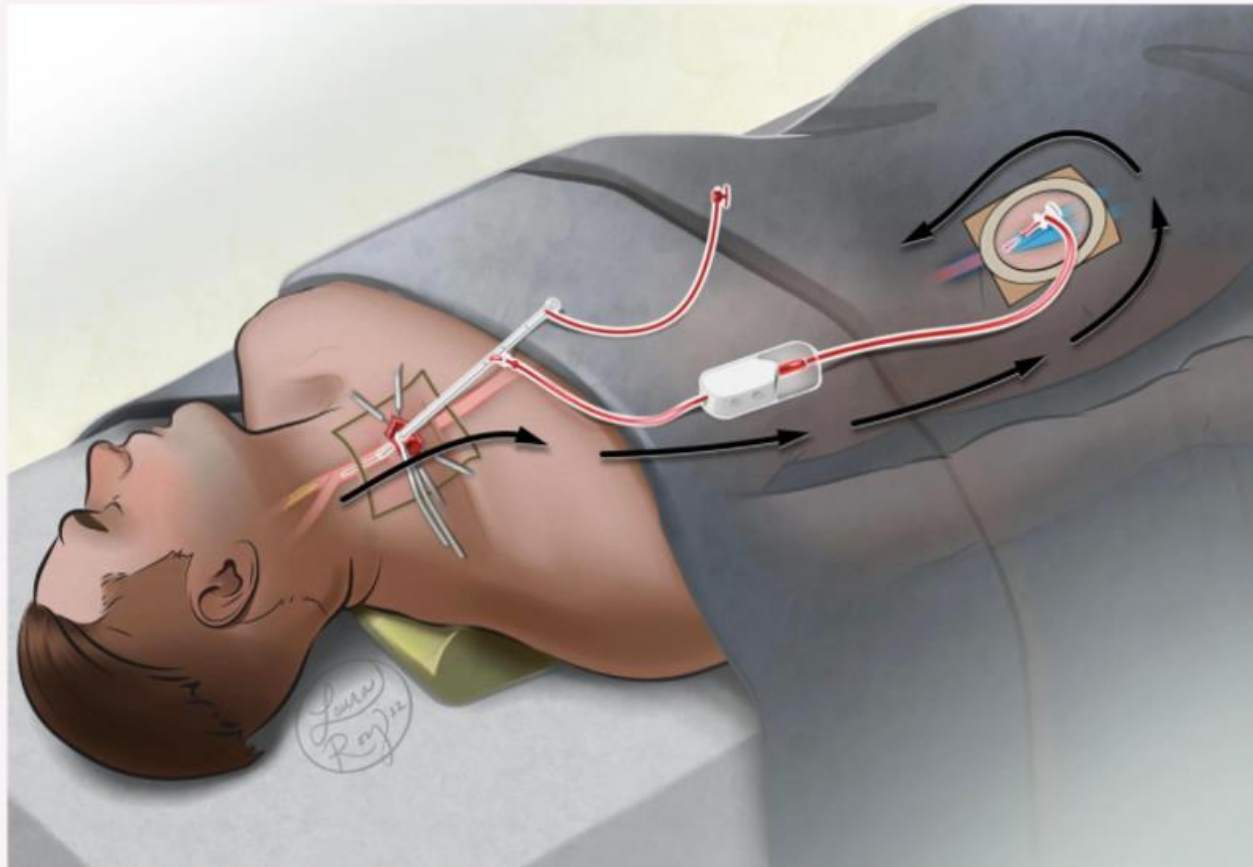
Table 1.

Which Anatomy Complicates Carotid Artery Stent and Carotid Endarterectomy?

Which Anatomy Complicates CEA?	Which Anatomy Complicates CAS?
Low lesions	Bifurcation
High lesions (above C2)	Long lesions
Prior CEA	Extensive calcification
Other major neck operation (radical neck, laryngectomy, tracheostomy, etc)	ICA or CCA tortuosity
Cervical fusion or immobility	Occlusion or stenosis of the external carotid artery
Prior neck radiation	Fresh thrombus at ICA lesion
	Access related
	Aorto-iliac occlusive disease
	Type III aortic arch
	Stenosis or calcification of innominate or left CCA origin
	Bovine arch

Abbreviations: CAS, carotid artery stent; CCA, common carotid artery; CEA, carotid endarterectomy; ICA,

Transcarotid Artery Revascularization



Sujjantararat MD, Matouk C. Unpublished.

Advantages

- 1 Minimally invasive.
- 2 Similar stroke rate to CEA.
- 3 Few nuisance complications.
- 4 Hostile neck not as important a consideration.

Disadvantages

- 1 It's still a stent.
- 2 Need for dAPT.

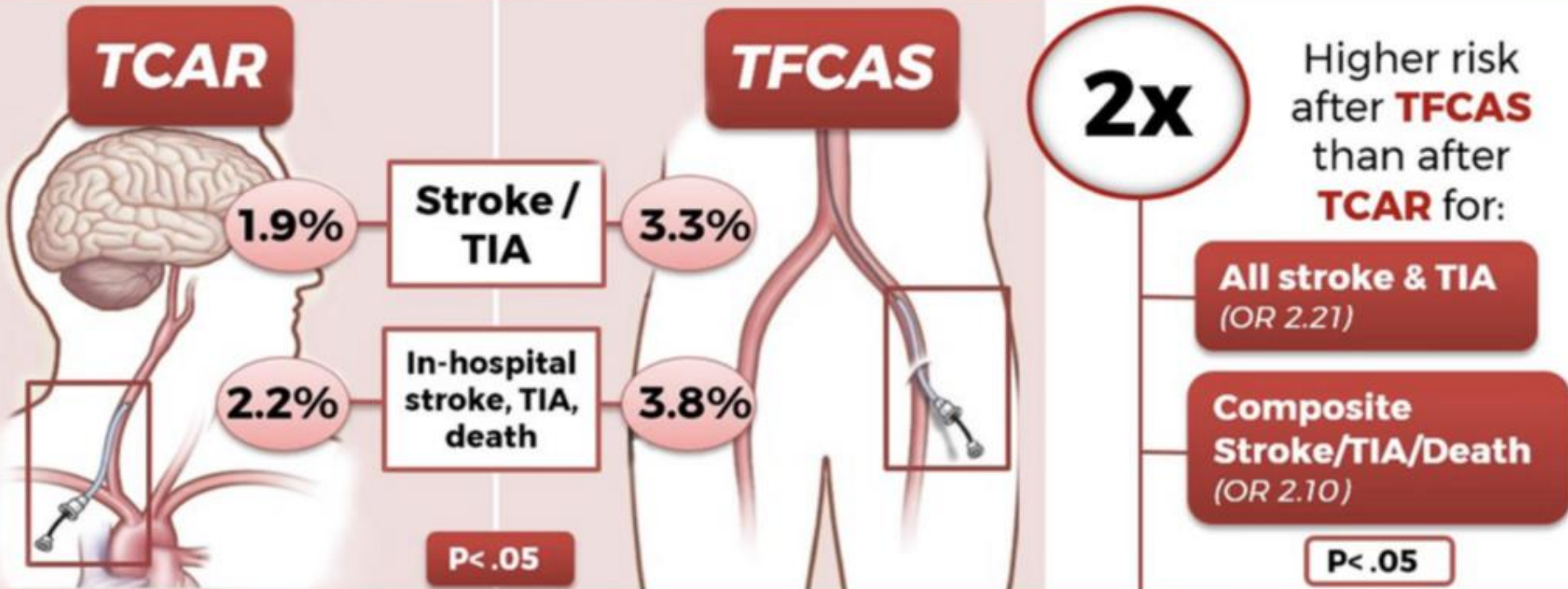
Transcarotid Artery Revascularization

- ▶ Multi-institutional studies 663 patients underwent CEA and TCAR in four sites
- ▶ Procedure time was shorter
- ▶ Stroke rates were similar at 30 days
 - ▶ TCAR 1.0% vs 0.3% in the CEA at 30 days ($P=0.62$),
 - ▶ Stroke rates were similar 2.8% vs 2.2% @ 1 year
- ▶ Cranial nerve injury 3.1 vs 0.3% was statistically significant lower

Trans-Carotid (TCAR) vs. Trans-Femoral (TFCAS) Carotid Artery Stenting

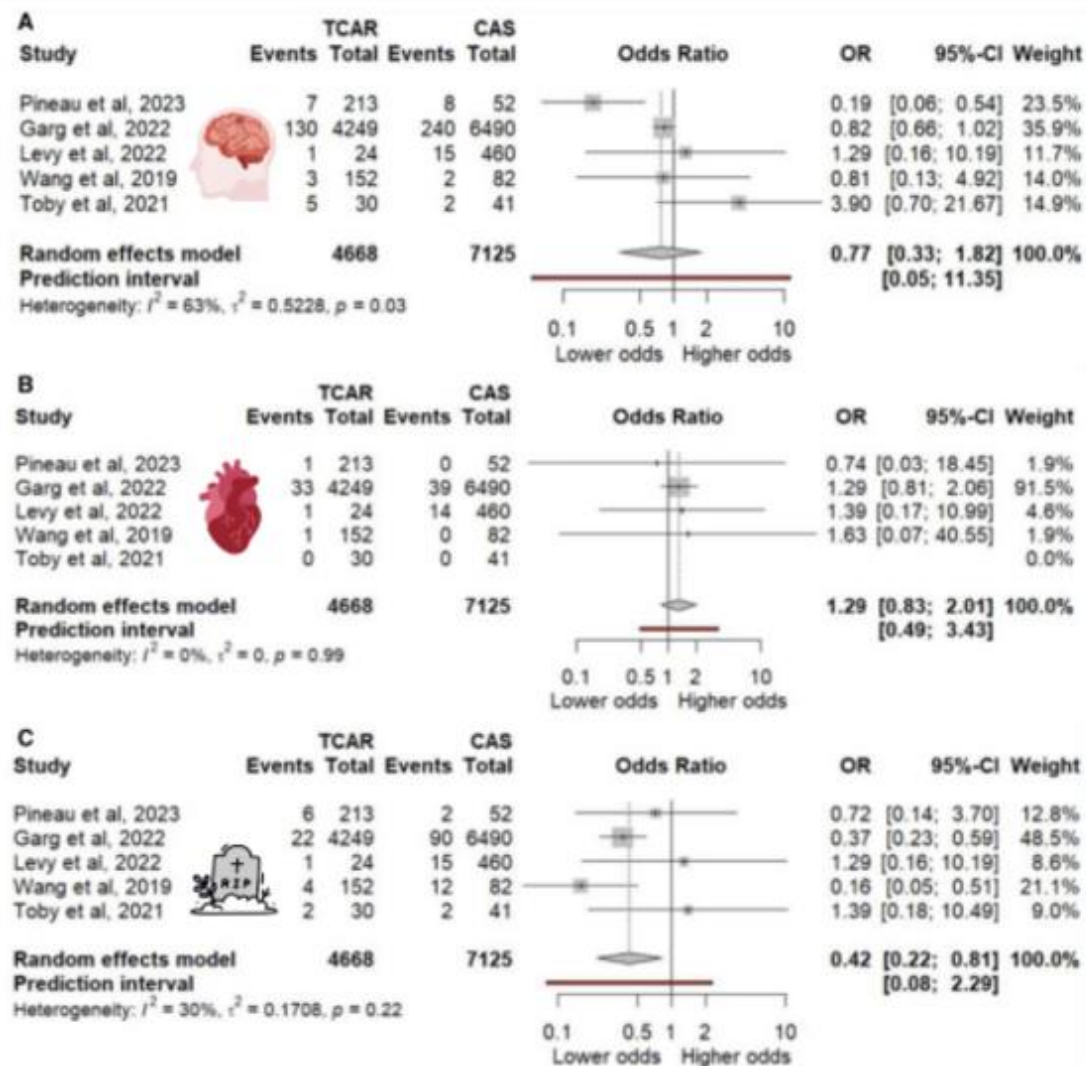
 SVS VQI TCAR Surveillance Project

 638 TCARs vs. 10,136 TFCASs

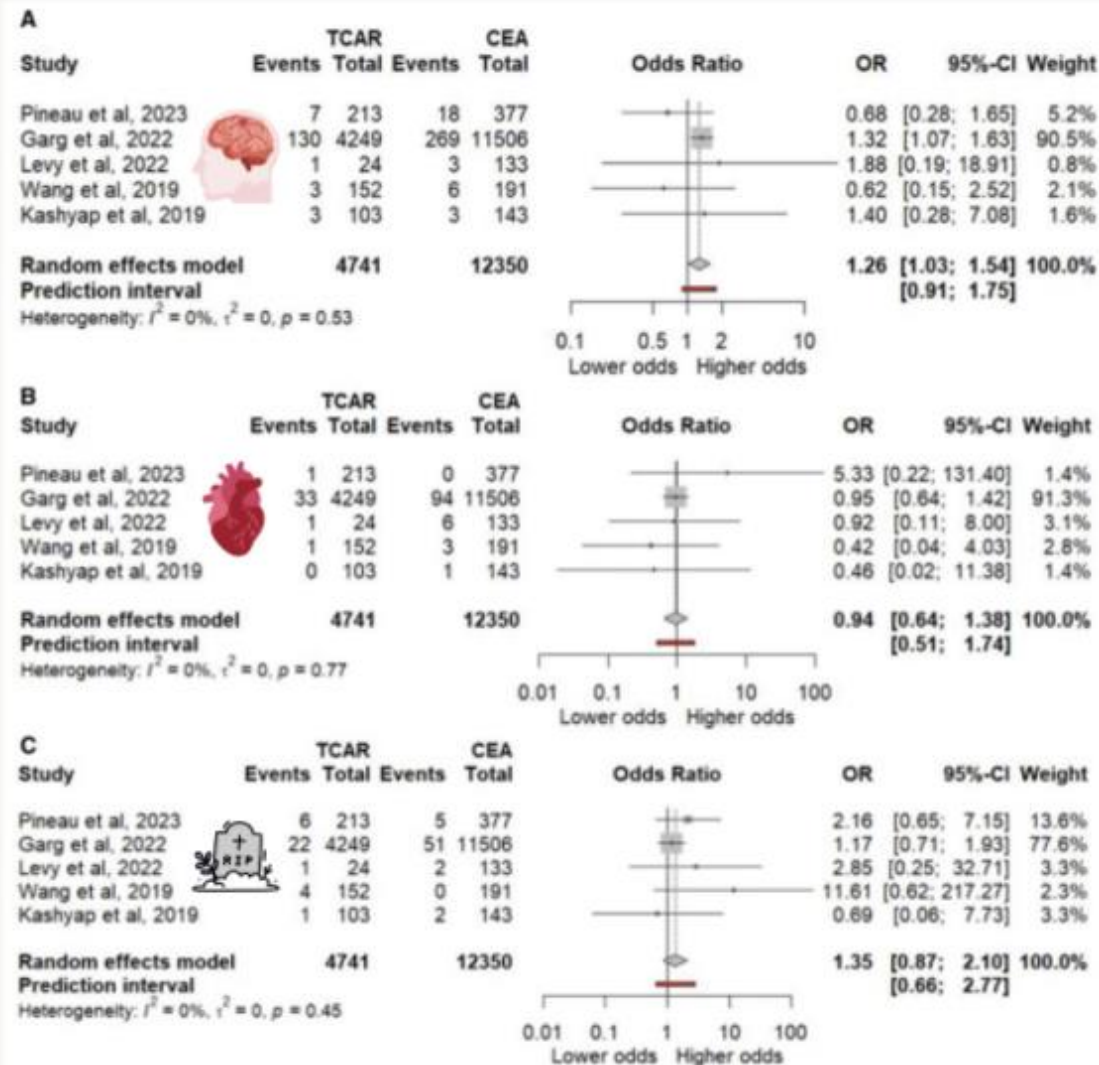


Transcarotid Arterial Revascularization of Symptomatic Internal Carotid Artery Disease: A Systematic Review and Study-Level Meta-Analysis

TCAR vs TF-CAS



TCAR vs CEA



TCAR

Largest Caveat

- ▶ There is NO Randomized Multi-Center, with third party adjudication comparing ECA + CAS + TCAR

ACST-2 (2021)

(**ACST-2**) is the largest randomized controlled trial to date comparing Carotid Artery Stenting (CAS) and Carotid Endarterectomy (CEA) in patients with severe asymptomatic carotid stenosis.

- 3625 asymptomatic patients with severe carotid stenosis, 130 centers, 5 years.

	Allocated CAS (n=1811)	Allocated CEA (n=1814)	p value	Had CAS first	Had CEA first
Had no carotid procedure	106	78	..	..	..
Had a carotid procedure†	1705	1736	..	1653	1788
Worst procedural stroke, mRS score					
6 (fatal)	7	5	0.77	6	6
3-5 (disabling)	6	7	1.00	8	5
2	9	9	1.00	9	9
1	23	15	0.25	21	17
0	16	5	0.03	15	6
0-2 (non-disabling)	48 (2.7%)	29 (1.6%)	0.03	45 (2.7%)	32 (1.8%)
Subtotal: any stroke	61 (3.6%)	41 (2.4%)	0.06	59 (3.6%)	43 (2.4%)
MI					
Fatal	0	4	0.13	0	4
Non-fatal	5	8	0.58	4	9
Subtotal: any MI	5 (0.3%)	12 (0.7%)	0.15	4 (0.2%)	13 (0.7%)
Other death‡	2	2	1.00	3	1
Death, MI, or any stroke	67 (3.9%)	55 (3.2%)	0.26	65 (3.9%)	57 (3.2%)
Death or any stroke	63 (3.7%)	47 (2.7%)	0.12	62 (3.8%)	48 (2.7%)
Death or disabling stroke	15 (0.9%)	18 (1.0%)	0.77	17 (1.0%)	16 (0.9%)

Data are n or n (%), unless otherwise specified. CAS=carotid artery surgery. CEA=carotid endarterectomy. MI=myocardial infarction. mRS=modified Rankin Scale. *First carotid procedure undergone after randomisation. †Denominator for percentages. ‡One groin haemorrhage after CAS, one unrelated trauma death after CAS, one cervical haemorrhage after CEA, and one generalised sepsis (allocated CEA but got CAS).

Table 2: Death, stroke, or MI within 30 days of first carotid procedure*

ACST-2 (2021)

Non-Disabling Stroke: There was a slight, statistically significant excess of minor, non-disabling strokes in the stenting group (2.7%) compared to the surgical group (1.6%)

Otherwise, no significant statistical difference in periprocedural and long term 5 year follow up risks

Overall Conclusion: carotid stenting and carotid endarterectomy offer comparable, highly similar long-term protection against disabling and fatal strokes

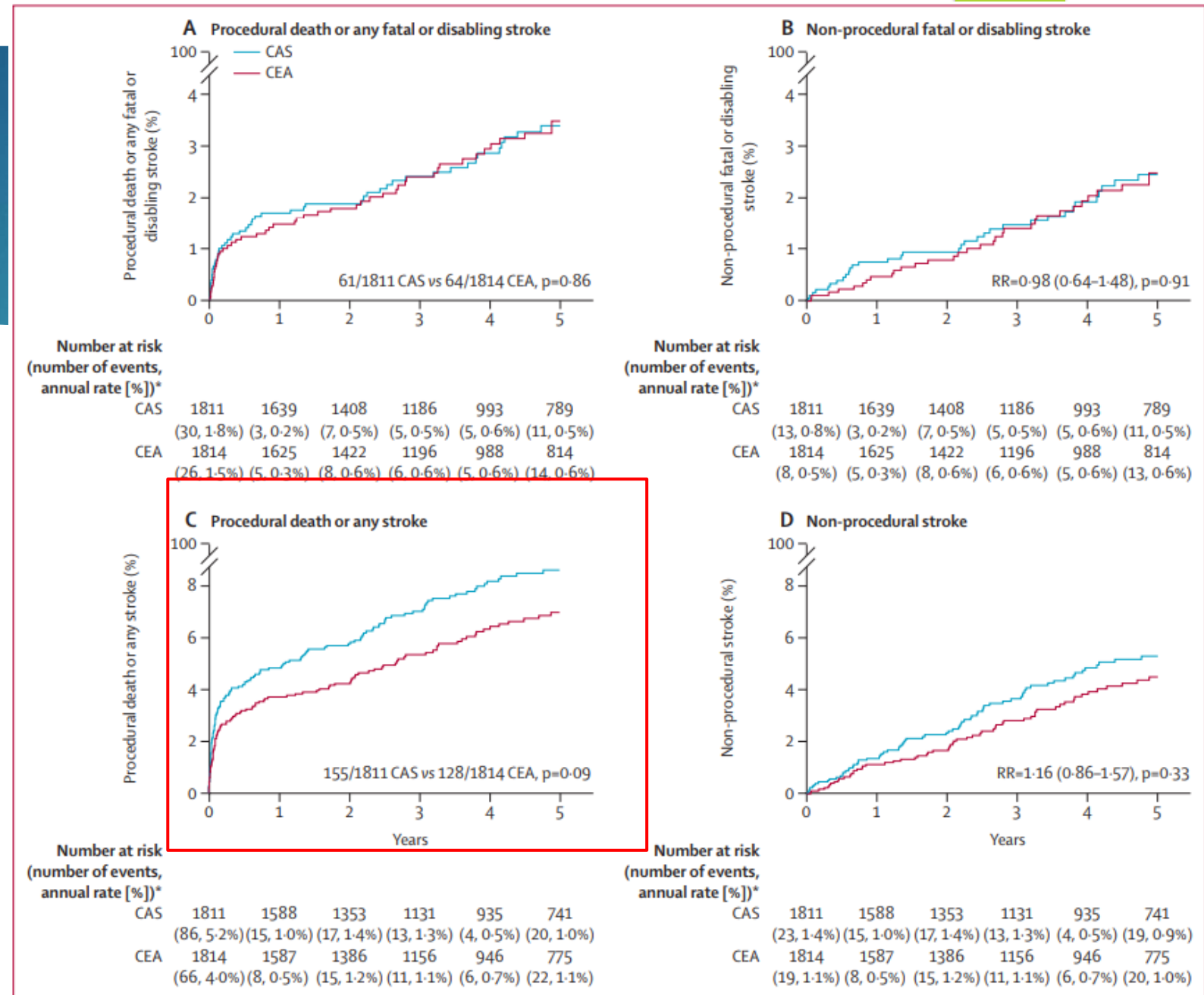


Figure 2: Kaplan-Meier estimates of 5-year outcomes among asymptomatic patients randomly allocated to CAS versus CEA. CAS=carotid artery stenting. CEA=carotid endarterectomy. *Last rate is after year 5 (and all three procedural strokes due to a second carotid procedure were after year 5).

CMS Guidelines

- ▶ **As of 10/2023**
- ▶ **CMS Expands Coverage for Carotid Artery Stenting**
 - *A. Patients with symptomatic carotid artery stenosis $\geq 50\%$; and*
 - *B. Patients with asymptomatic carotid artery stenosis $\geq 70\%$*

CREST-2 (2025)

Carotid Revascularization and Medical Management for Asymptomatic Carotid Stenosis Trial (CREST-2), published in 11/2025

A total of 1245 patients underwent randomization in the stenting trial and 1240 in the endarterectomy trial. 155 centers in 5 countries.

Modern intensive medical therapy against procedural revascularization for preventing stroke.

- ▶ **Intensive Medical Management vs CEA**
- ▶ **Intensive Medical Management vs CAS**

Primary outcome, stroke or death to 44 days, or ipsilateral ischemic stroke for up to 4 years

Best Medical Therapy – All Patients with carotid stenosis

Pharmacological Targets

- ▶ SBP $\leq$ 130 mm Hg
- ▶ LDL <70 mg/dl
- ▶ HbA1C <7.0%
- ▶ Single Antiplatelet Therapy

Lifestyle Modifications

- ▶ Smoking Cessation
- ▶ Dietary Modification
- ▶ Physical Activity
- ▶ Weight Management

CREST-2 Trial: Primary Outcomes

4-Year rates of stroke or periprocedural death

Severe Asymptomatic Stenosis ($\geq 70\%$)

CAS + IMM vs IMM Alone

n = 1,245

6.0% → 2.8%

IMM ALONE

CAS + IMM

P = .016

Absolute Risk Reduction 3.2 pp

Number Needed to Treat 31

Post-Op Annual Stroke 1.7% → 0.4%

CEA + IMM vs IMM Alone

n = 1,240

5.3% → 3.7%

IMM ALONE

CEA + IMM

P = .24

Absolute Risk Reduction 1.6 pp

Relative Risk 1.43

Post-Op Annual Stroke 1.3% → 0.5%

Benchmarks

Carotid interventions should be performed by well trained practitioners.

- ▶ Comprehensive Stroke Center Certification tracks all carotid outcomes
 - ▶ <6% stroke/death rate symptomatic
 - ▶ <3% stroke death rate for asymptomatic patients

AHA Get With the Guidelines – Stroke, tracks carotid intervention for a non-disabling symptomatic carotid artery within 14 days of presentation.

My Personal Conclusions

- ▶ Intensive Medical Therapy is the low-risk foundation for nearly every patient with carotid stenosis
- ▶ Symptomatic carotid stenosis, CEA is preferred for patients with standard surgical risk
- ▶ CAS is preferred in treatment of patients with severe asymptomatic carotid stenosis
- ▶ CAS VS TCAR:
 - ▶ TCAR remains promising, but lack of prospective randomized comparison with 3rd party adjudication between the three techniques makes it advantageous in only select cases.