

From Neck to Brain The Vascular Surgeons' Role in Stroke Prevention

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Conflicts

Consultant for Anthem BCBS
Doximity and ATEC stocks

I do lunches

I am open to having more!

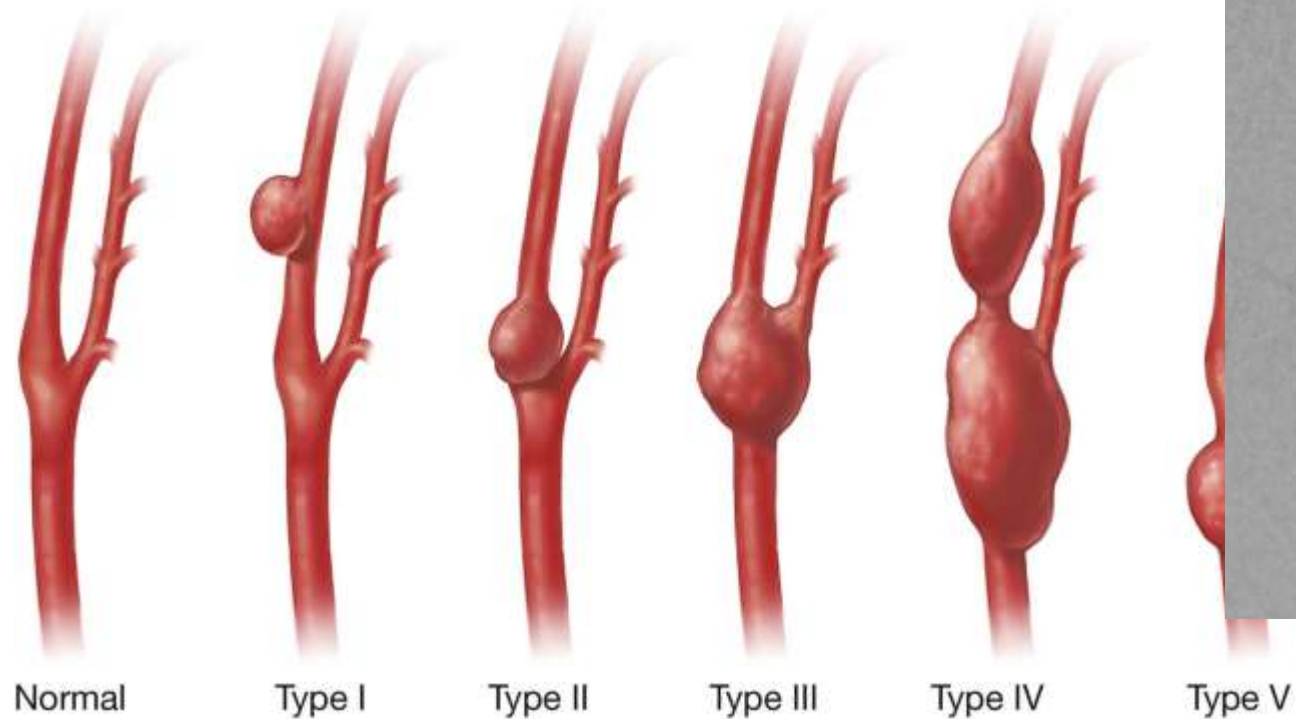


A Comprehensive Approach to Extracranial Cerebrovascular Disease

Objectives

1. Review modern stroke prevention strategies for extracranial cerebrovascular disease.
2. Understand the vascular surgeon's role throughout the continuum of care.

Rarities That Will Be Absent



Why Does This Even Matter



Stroke remains a leading cause of death and disability



Carotid stenosis is one of the few surgically modifiable stroke risks



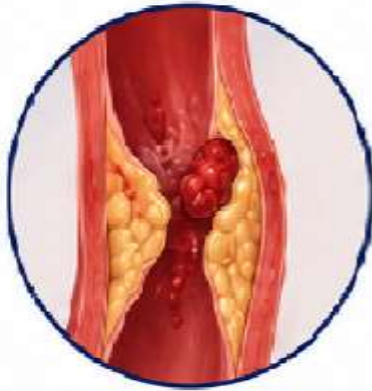
Modern medical therapy has dramatically lowered stroke risk

Atherosclerosis in the Carotid Artery



Plaque builds up
over time.

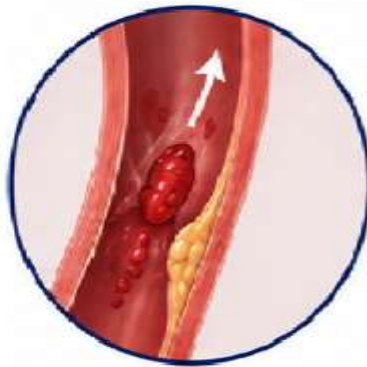
Plaque Instability



Plaque can rupture
or become inflamed.



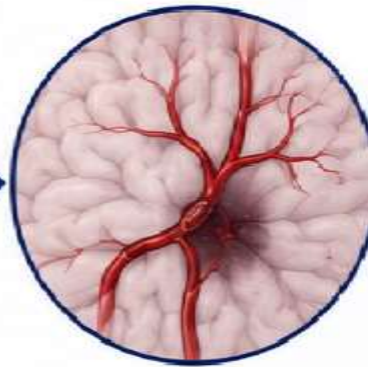
Embolization



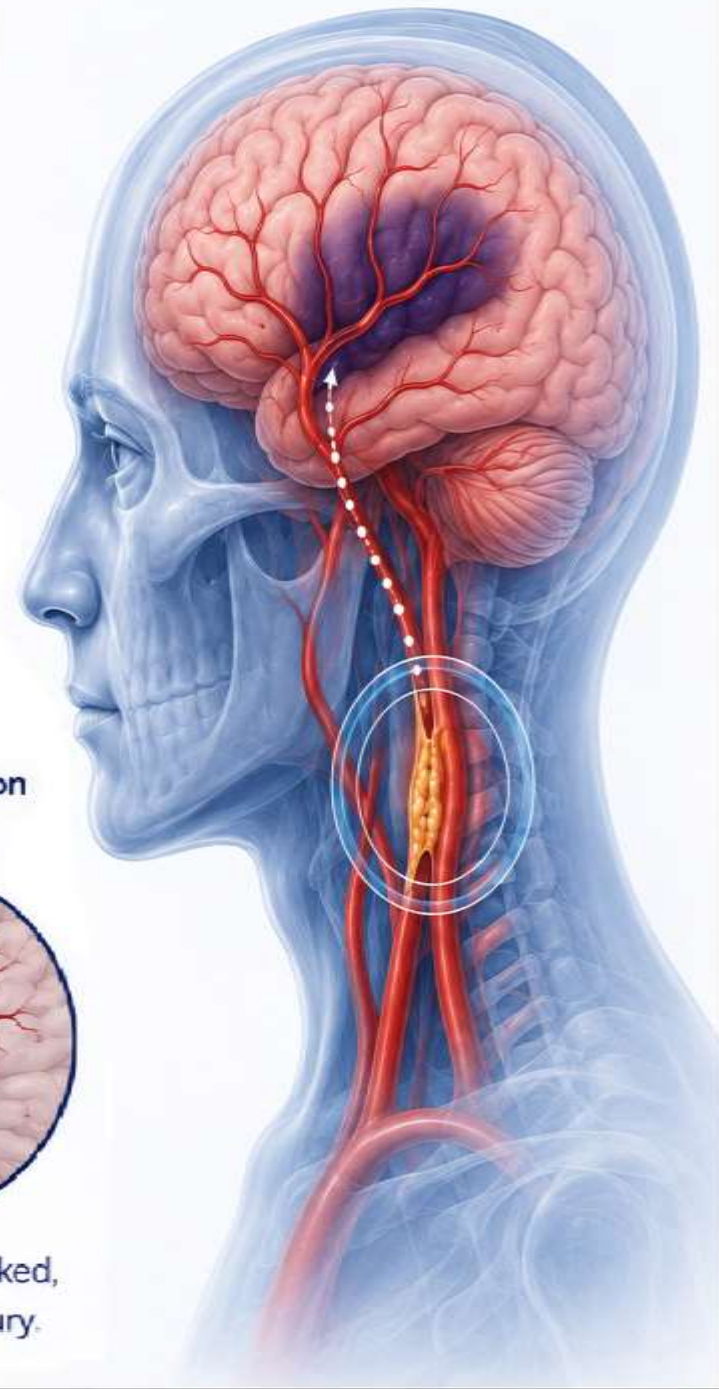
Fragments or clots
travel to the brain.



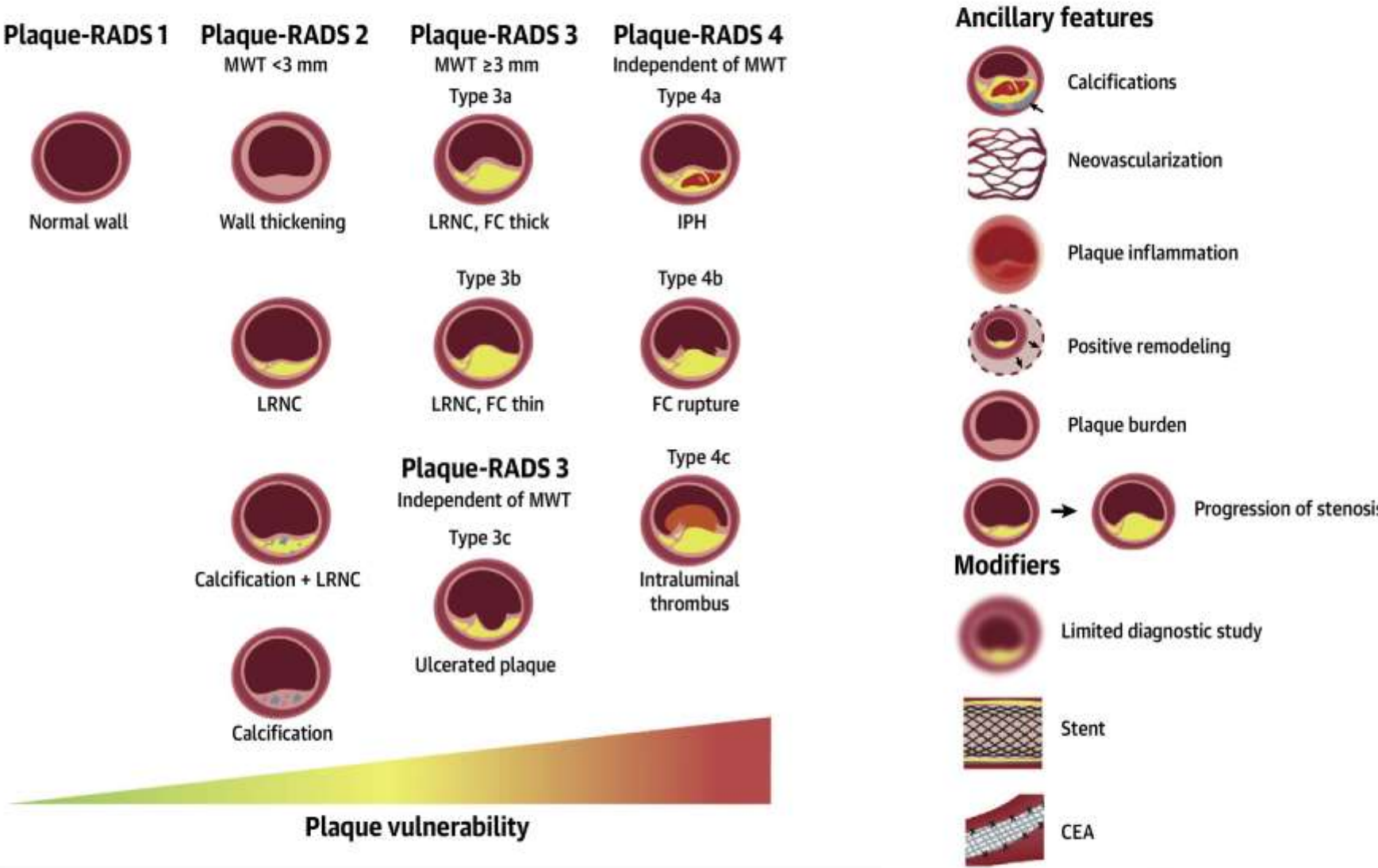
Cerebral Infarction (Stroke)

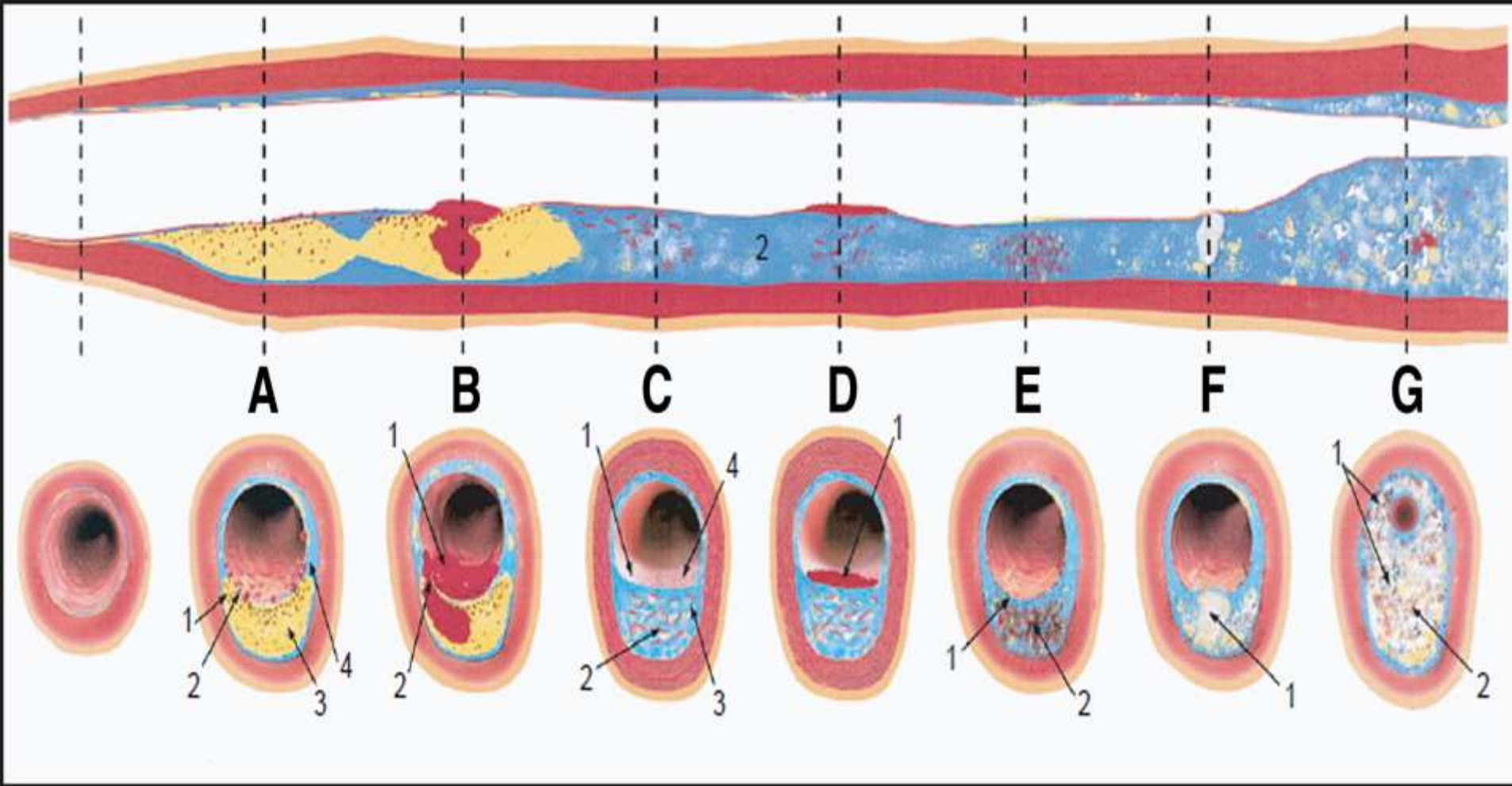


Blood flow is blocked,
causing brain injury.



CENTRAL ILLUSTRATION: Schematic Representation of the Different Plaque-RADS Categories 1 to 4





Normal

Rupture-prone

1. Macrophage
2. Thin cap
3. Large lipid core
4. Collagen

Ruptured/
healing

1. Non-occlusive clot
2. Ruptured cap

Erosion-Prone

1. Dysfunctional endothelium
2. Smooth muscle cells
3. Proteoglycans
4. Platelets

Eroded

1. Non-occlusive mural thrombus/
Fibrin

Intra-Plaque
Hemorrhage

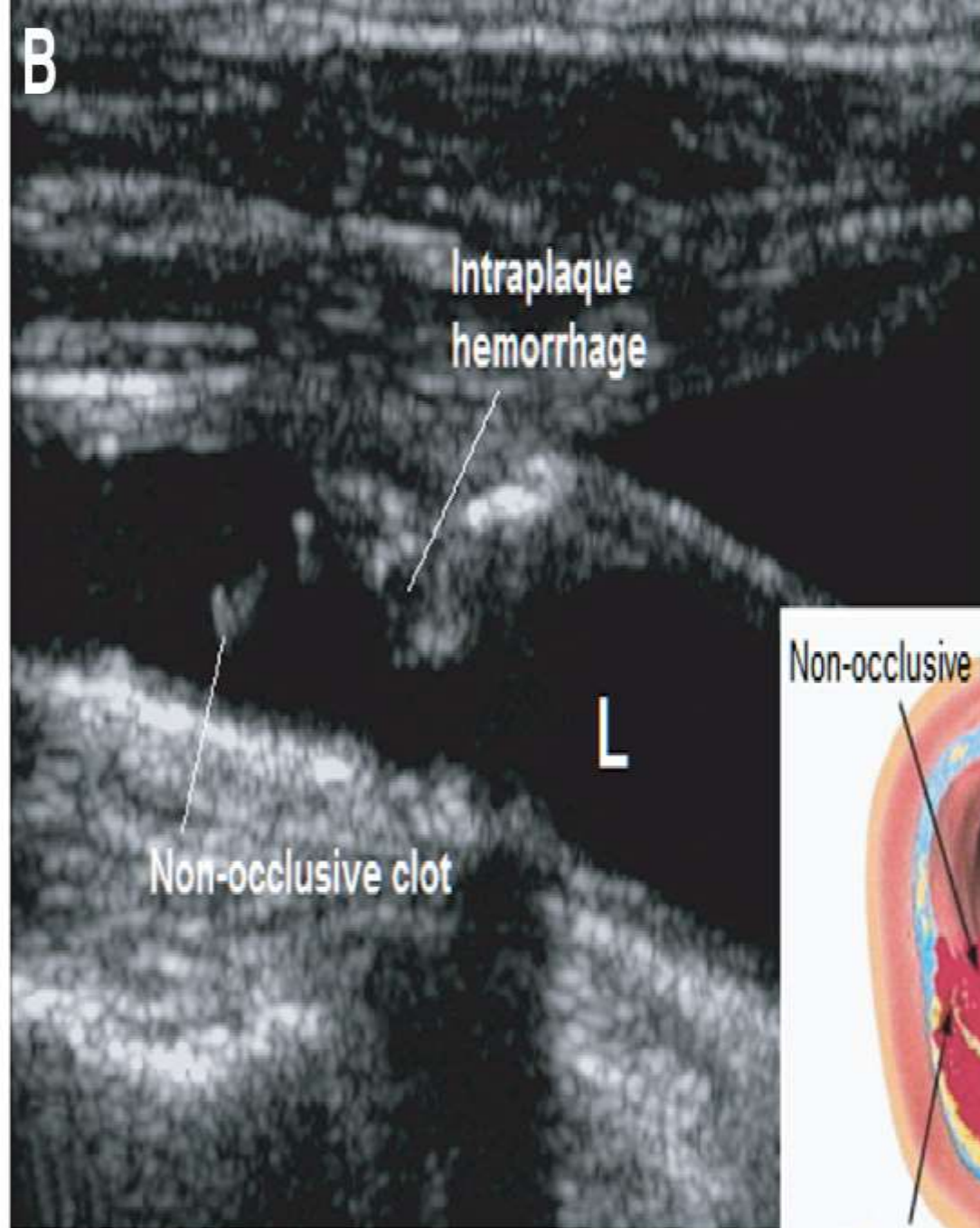
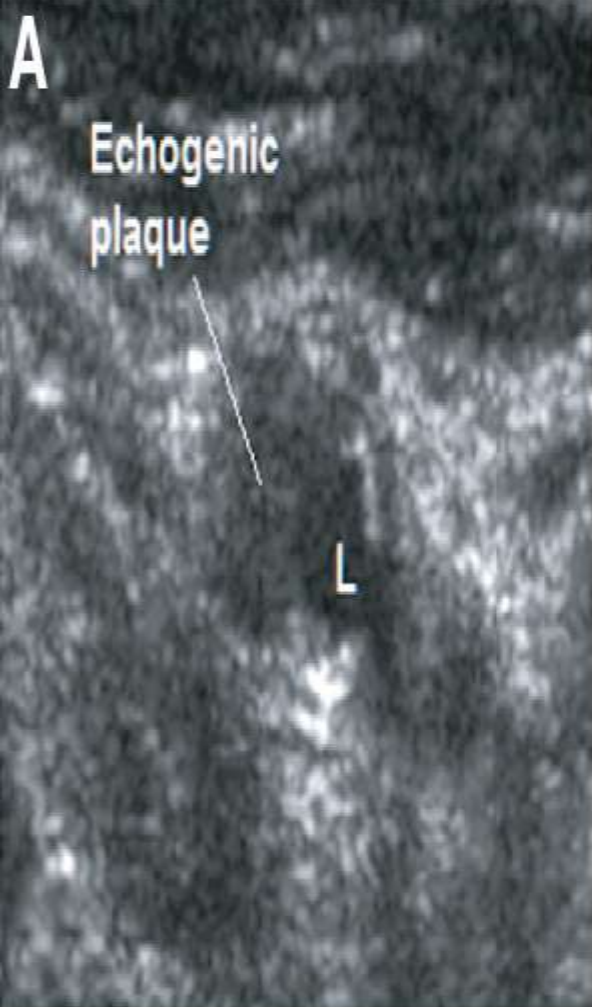
1. Intact cap
2. Leaking vasa vasorum/
Angiogenesis

Calcified
nodule

1. Calcified nodule

Critically
stenotic

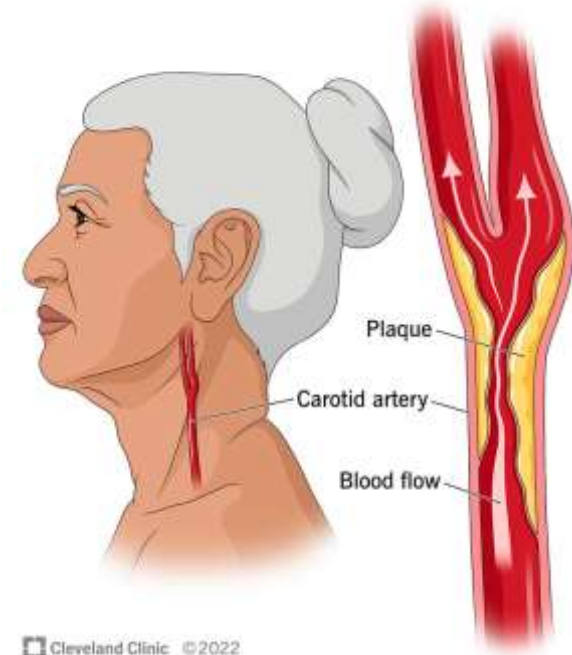
1. Extensive calcification
2. Old thrombus



Screening



Carotid artery stenosis



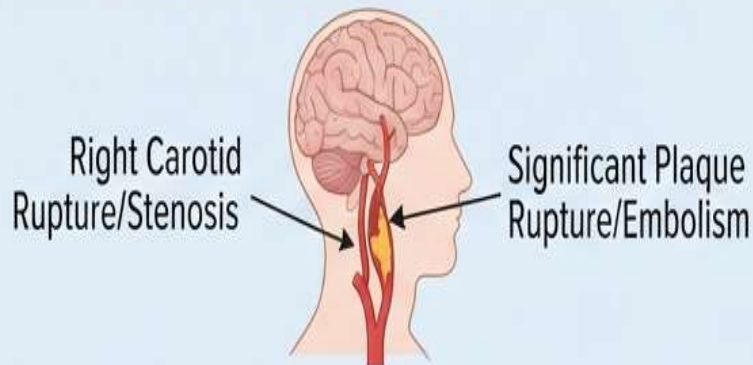
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Population	Recommendation	Grade
Asymptomatic adults	The USPSTF recommends against screening for asymptomatic carotid artery stenosis in the general adult population. See the Practice Considerations section for a description of adults at increased risk.	D

SYMPTOMATIC

CAROTID STENOSIS

ASYMPTOMATIC

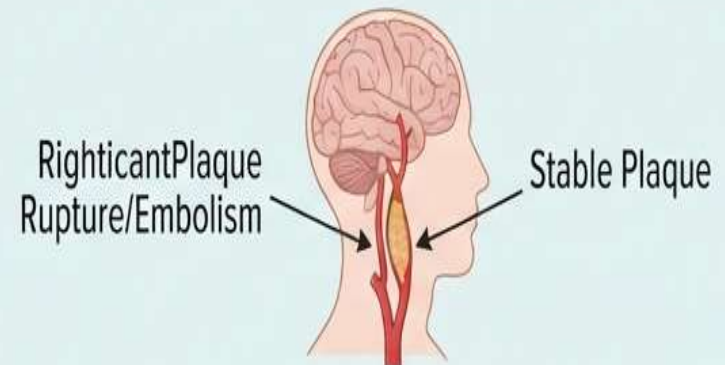


CLINICAL PRESENTATION

- 1  **STROKE**
(Sudden weakness/paralysis, face/arm/leg)
- 2  **TIA**
(Transient Ischemic Attack - temporary symptoms)
- 3  **AMAUROSIS FUGAX**
(Sudden monocular vision loss)

30-DAY STROKE RISK

(e.g., >20%)



CLINICAL PRESENTATION

- 1 **NO FOCAL NEUROLOGICAL SYMPTOMS**  
- 2 **Often incidentally discovered**
e.g., during routine screening, ultrasound, or carotid bruit)
- 3 **RISK FACTORS**
(Hypertension, Hyperlipidemia, Smoking)

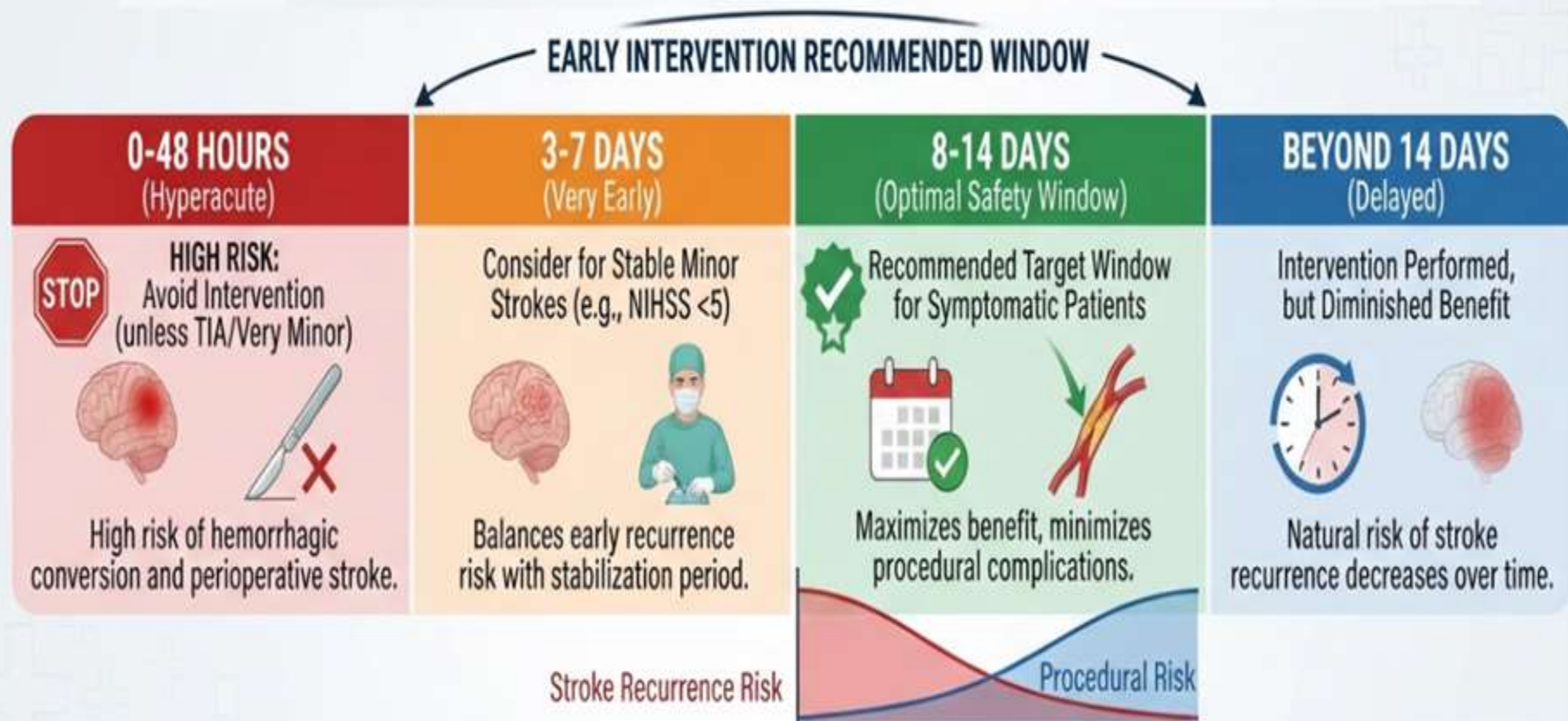
ANNUAL STROKE RISK

(e.g., <1-2%)



TIMING OF CAROTID INTERVENTION AFTER STROKE OR TIA

Balancing Recurrent Stroke Risk vs. Procedural Risk



Landmark Trials

ACST) carotid stenosis					
Trial	CEA/Medical (No. of Patients)	Stenosis (%)	Stroke Rate (%) ^a		P Value
			CEA	Medical	
NASCET	328/331	≥70	9.0	26.0	<.001
ECST	586/389	≥80	14.9	26.5	<.001
ACAS	825/834	≥60	5.1	11.0	.004
ACST	1560/1560	≥60	6.4	11.8	.001

Abbreviations: ACAS, Asymptomatic Carotid Atherosclerosis Study; ACST, Asymptomatic Carotid Surgery Trial; ECST, European Carotid Surgery Trial; NASCET, North American Symptomatic Carotid Endarterectomy Trial.

^a Stroke rate according to treatment modality.

Adapted from Siddiqui AH, Natarajan SK, Hopkins LN, et al. Carotid artery stenting for primary and secondary stroke prevention. *World Neurosurg* 2011;76:S40–59.

2010

CEA vs CAS

Similar composite endpoint

CAS → more periprocedural stroke

CEA → more periprocedural MI

Age interaction: >70 favored CEA



Stenting versus Endarterectomy for Treatment of Carotid-Artery Stenosis

Thomas G. Brott, M.D., Robert W. Hobson, II, M.D.,* George Howard, Dr.P.H., Gary S. Roubin, M.D., Ph.D., Wayne M. Clark, M.D., William Brooks, M.D., Ariane Mackey, M.D., Michael D. Hill, M.D., Pierre P. Leimgruber, M.D., Alice J. Sheffet, Ph.D., Virginia J. Howard, Ph.D., Wesley S. Moore, M.D., Jennifer H. Voeks, Ph.D., L. Nelson Hopkins, M.D., Donald E. Cutlip, M.D., David J. Cohen, M.D., Jeffrey J. Popma, M.D., Robert D. Ferguson, M.D., Stanley N. Cohen, M.D., Joseph L. Blackshear, M.D., Frank L. Silver, M.D., J.P. Mohr, M.D., Brajesh K. Lal, M.D., and James F. Meschia, M.D., for the CREST Investigators†

Table 1. Some detailed data from CREST.

Adverse events (within 30 days)	Patients		p-value
	Number of CAS treated (n = 1262)	Number of CEA treated (n = 1240)	
Deaths	9	4	0.18
Total strokes	52	29	0.01
Major strokes (ipsilateral to procedure)	11	4	0.09
Minor strokes (ipsilateral to procedure)	37	17	0.01
Minor MIs	14	28	0.03

CAS: Carotid artery stenting; CEA: Carotid endarterectomy; MI: Myocardial infarction.
Data taken from [1].

Table 2. Primary End Point, Components of the Primary End Point, and Other Events, According to Treatment Group.^a

End Point	Periprocedural Period						4-Yr Study Period (Including Periprocedural Period)				
	CAS (N=1262)	CEA (N=1240)	Absolute Treatment Effect of CAS vs. CEA (95% CI)	Hazard Ratio for CAS vs. CEA (95% CI)	P Value		CAS (N=1262)	CEA (N=1240)	Absolute Treatment Effect of CAS vs. CEA (95% CI)	Hazard Ratio for CAS vs. CEA (95% CI)	P Value
	no. of patients (% ± SE)		percentage points				no. of patients (% ± SE)		percentage points		
Death	9 (0.7±0.2)	4 (0.3±0.2)	0.4 (−0.2 to 1.0)	2.25 (0.69 to 7.30) [†]	0.18 [†]		94 (11.3±1.2)	83 (12.6±1.5)	−1.3 (−5.1 to 2.5)	1.12 (0.83 to 1.51)	0.45
Stroke											
Any	52 (4.1±0.6)	29 (2.3±0.4)	1.8 (0.4 to 3.2)	1.79 (1.14 to 2.82)	0.01		105 (10.2±1.1)	75 (7.9±1.0)	2.3 (−0.6 to 5.2)	1.40 (1.04 to 1.89)	0.03
Major ipsilateral	11 (0.9±0.3)	4 (0.3±0.2)	0.5 (−0.1 to 1.2)	2.67 (0.85 to 8.40)	0.09		16 (1.4±0.3)	6 (0.5±0.2)	0.8 (0.1 to 1.6)	2.56 (1.00 to 6.54)	0.05
Major nonipsilateral [‡]	0	4 (0.3±0.2)	NA	NA	NA		6 (0.9±0.4)	8 (0.8±0.3)	0.1 (−0.9 to 1.1)	0.73 (0.25 to 2.11)	0.56 [†]
Minor ipsilateral	37 (2.9±0.5)	17 (1.4±0.3)	1.6 (0.4 to 2.7)	2.16 (1.22 to 3.83)	0.009		52 (4.5±0.6)	36 (3.5±0.6)	1.0 (−0.7 to 2.7)	1.43 (0.94 to 2.19)	0.10
Minor nonipsilateral	4 (0.3±0.2)	4 (0.3±0.2)	0.0 (−0.4 to 0.4)	1.02 (0.25 to 4.07)	0.98 [†]		33 (4.0±0.8)	29 (3.8±0.9)	0.2 (−2.1 to 2.4)	1.11 (0.67 to 1.82)	0.69
Myocardial infarction	14 (1.1±0.3)	28 (2.3±0.4)	−1.1 (−2.2 to −0.1)	0.50 (0.26 to 0.94)	0.03						
Any periprocedural stroke or postprocedural ipsilateral stroke	52 (4.1±0.6)	29 (2.3±0.4)	1.8 (0.4 to 3.2)	1.79 (1.14 to 2.82)	0.01		72 (6.2±0.7)	50 (4.7±0.7)	1.5 (−0.4 to 3.4)	1.44 (1.00 to 2.06)	0.049
Major stroke	11 (0.9±0.3)	8 (0.6±0.2)	0.2 (−0.5 to 0.9)	1.35 (0.54 to 3.36)	0.52		16 (1.4±0.3)	10 (0.8±0.3)	0.6 (−0.2 to 1.4)	1.55 (0.70 to 3.42)	0.28
Minor stroke	41 (3.2±0.5)	21 (1.7±0.4)	1.6 (0.3 to 2.8)	1.95 (1.15 to 3.30)	0.01		56 (4.8±0.6)	40 (3.8±0.6)	1.0 (−0.8 to 2.7)	1.39 (0.93 to 2.09)	0.11
Any periprocedural stroke or death or postprocedural ipsilateral stroke	55 (4.4±0.6)	29 (2.3±0.4)	2.0 (0.6 to 3.4)	1.90 (1.21 to 2.98)	0.005		75 (6.4±0.7)	50 (4.7±0.7)	1.7 (−0.2 to 3.7)	1.50 (1.05 to 2.15)	0.03
Primary end point (any periprocedural stroke, myocardial infarction, or death or postprocedural ipsilateral stroke)	66 (5.2±0.6)	56 (4.5±0.6)	0.7 (−1.0 to 2.4)	1.18 (0.82 to 1.68)	0.38		85 (7.2±0.8)	76 (6.8±0.8)	0.4 (−1.7 to 2.6)	1.11 (0.81 to 1.51)	0.51

^a The periprocedural period was defined, according to the study protocol, as the 30-day period after the procedure (for all patients who underwent the assigned procedure within 30 days after randomization) or the 36-day period after randomization (for all patients who did not undergo the assigned procedure within 30 days after randomization). Because the periprocedural period was relatively short, which minimized the need for censoring, event proportions and the absolute differences in event proportions were calculated as the percentage of patients with events. For the 4-year study period, proportions reflecting the absolute efficacy of carotid-artery stenting (CAS) over that of carotid endarterectomy (CEA) were based on Kaplan–Meier survival estimates at the end of the 4 years. Hazard ratios for the periprocedural period were based on data for all patients, censored at the end of the periprocedural period. All hazard ratios were adjusted for age, symptomatic status, and sex. P values were calculated on the basis of the significance of the hazard ratio (per study protocol). For death, stroke, and myocardial infarction end points, patients may have had more than one event (e.g., fatal stroke was counted as both a death and a stroke, and patients may have had an ipsilateral stroke followed by a nonipsilateral stroke).

[†] Because of the small number of events, a univariate proportional-hazards model was used to estimate the hazard ratio for death during the periprocedural period, the P value for minor nonipsilateral stroke during the periprocedural period, and the P value for major nonipsilateral stroke during the 4-year study period.

[‡] Absolute treatment effect, hazard ratio, and P value for major nonipsilateral stroke were not available (NA) because of the small number of events, resulting in unreliable estimates.

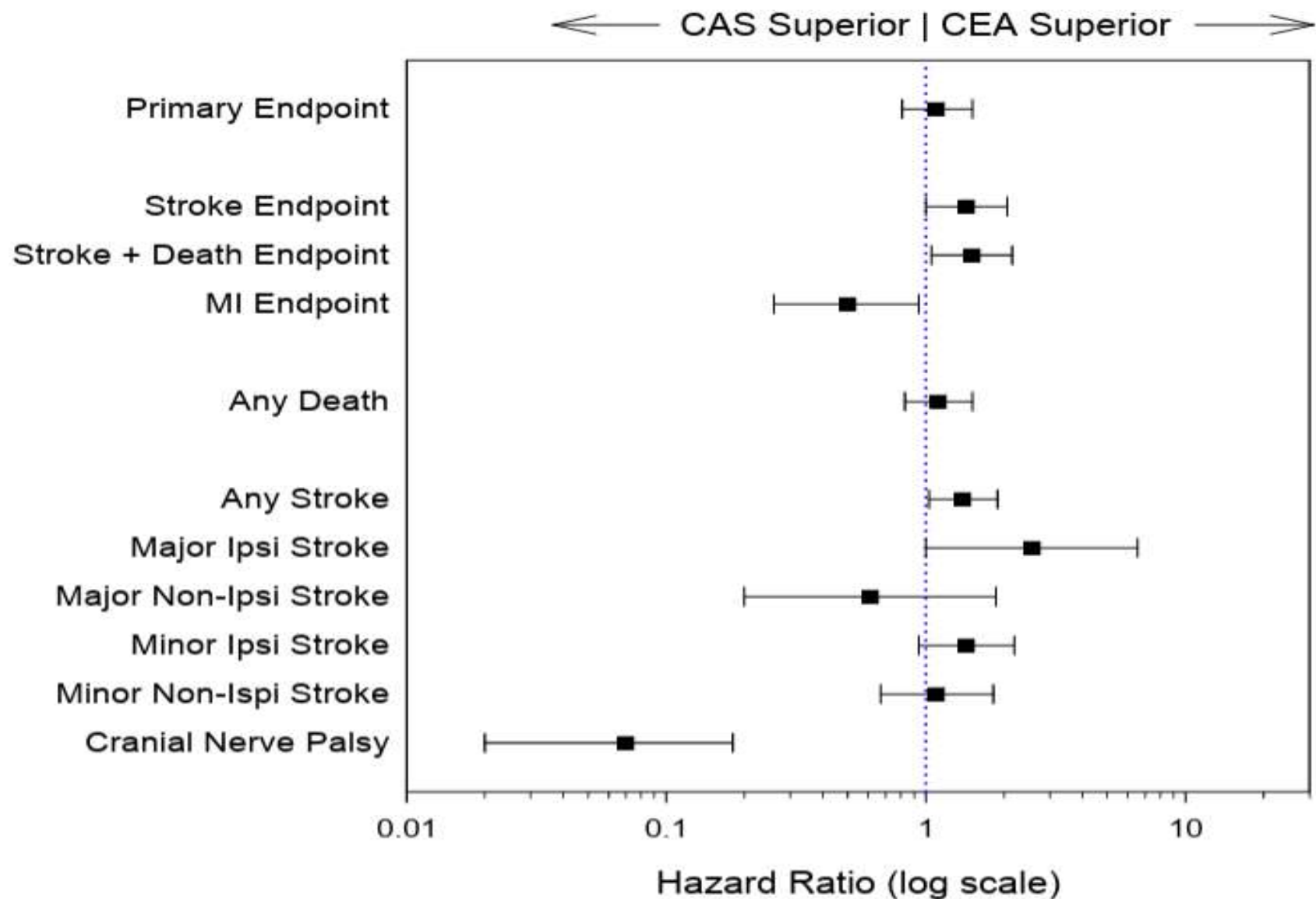


Figure 1. Hazard ratios (and associated 95% confidence intervals) for the primary endpoint and selected efficacy and safety endpoints comparing CAS vs. CEA.

Statins

Plavix

Nonoperative management

The bar for procedural justification is now
higher

Equipoise?

CREST-2: Management of Asymptomatic Carotid Stenosis - Stenting vs. Endarterectomy vs. Intensive Medical Management

BACKGROUND & QUESTION

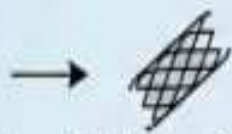


Optimal management for high-grade ($\geq 70\%$) asymptomatic carotid stenosis is unclear.

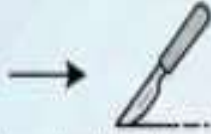
Does adding revascularization to intensive medical management provide greater benefit?



Intensive Medical Management
(Pills, Lifestyle)



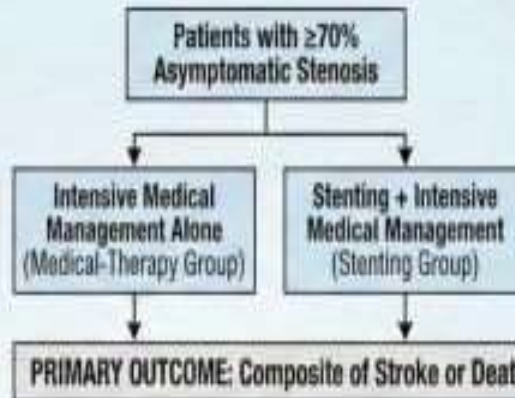
Carotid-Artery Stenting
+ Medical Management



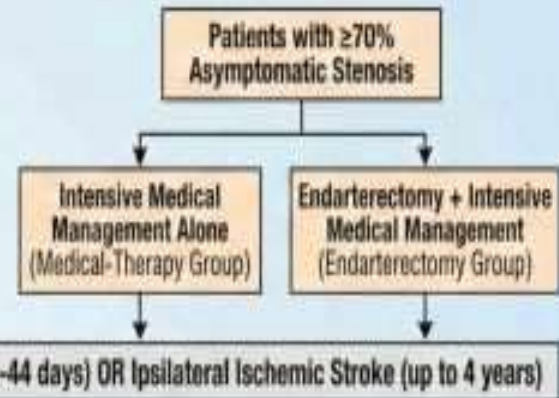
Carotid Endarterectomy
+ Medical Management

METHODS: TWO PARALLEL CLINICAL TRIALS

STENTING TRIAL (N=1245)



ENDARTERECTOMY TRIAL (N=1240)



RESULTS: 4-YEAR PRIMARY OUTCOME INCIDENCE & PERIOPERATIVE EVENTS (0-44 DAYS)

STENTING TRIAL RESULTS



ENDARTERECTOMY TRIAL RESULTS



CONCLUSIONS



Stenting + Medical Management: Lower risk of composite primary outcome compared to Medical Management alone (P=0.02).



Endarterectomy + Medical Management: No significant benefit compared to Medical Management alone (P=0.24).

Best Medical Therapy

Aspirin 325 mg daily

SBP < 130 mmHg

LDL < 70 mg/dL

Glucose management

Lifestyle optimization

- cigarette smoking
- excess body weight
- physical inactivity

What does the trial show?



Stroke remains a leading cause of death and disability



Carotid stenosis is one of the few surgically modifiable stroke risks



Modern medical therapy has dramatically lowered stroke risk



Intervention now requires stronger justification than ever

Crest did NOT show

That intervention is obsolete

That asymptomatic stenosis is benign

That high-risk plaques do not exist

That procedural stroke risk is irrelevant

That one procedure is better than another

Study Eccentricities

NOT procedural comparison

If CEA compared against the BMT group from the stent trial it would have been significant

NOT real-world data

Interventionalists had to submit 100 stent cases with at least 25 in last year

Only 50% accepted

Patients and lesions for stent highly selected (calcification, aortic arch angulation etc.)

Sent to CEA arm

Other Learning Opportunities

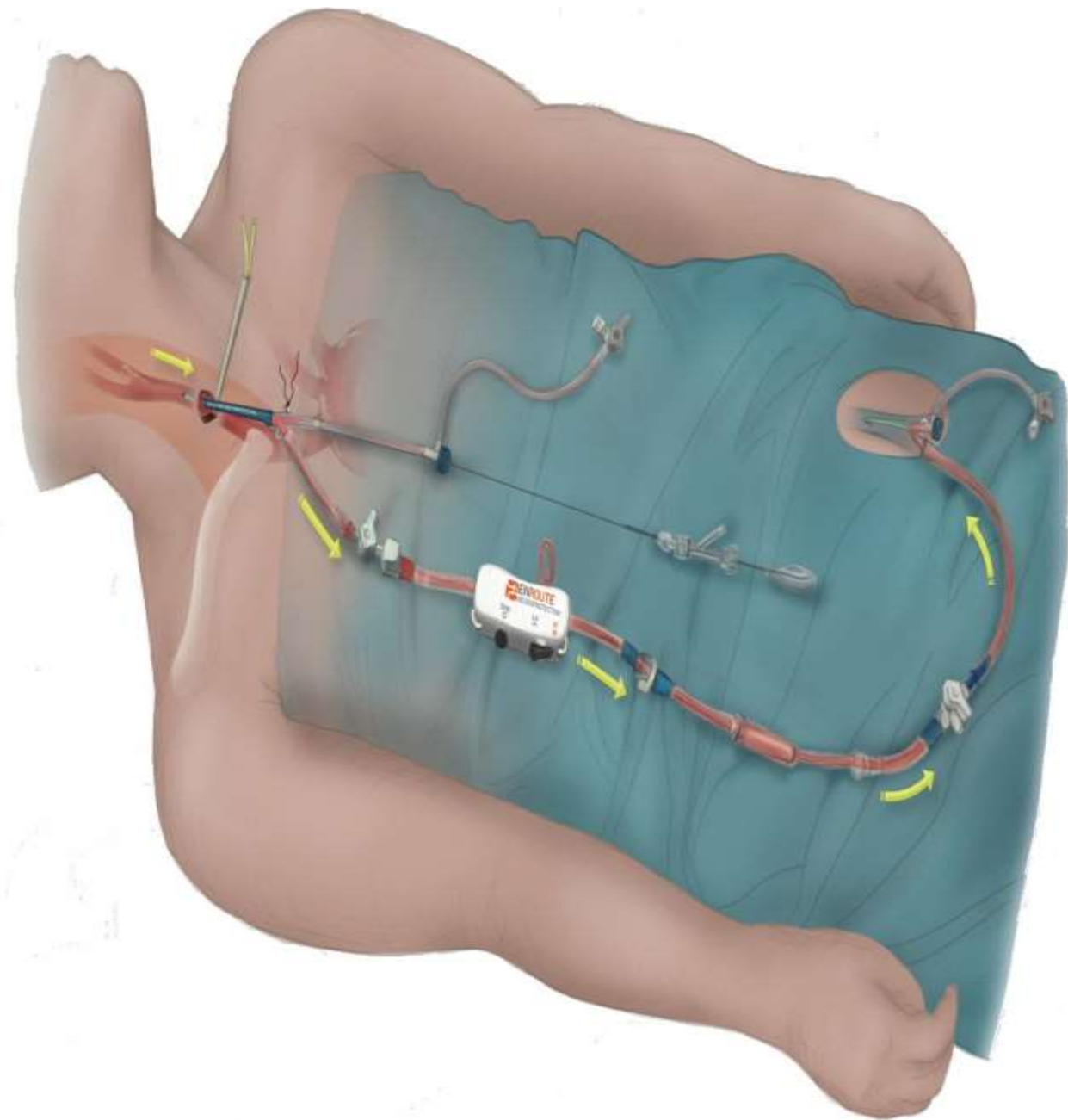
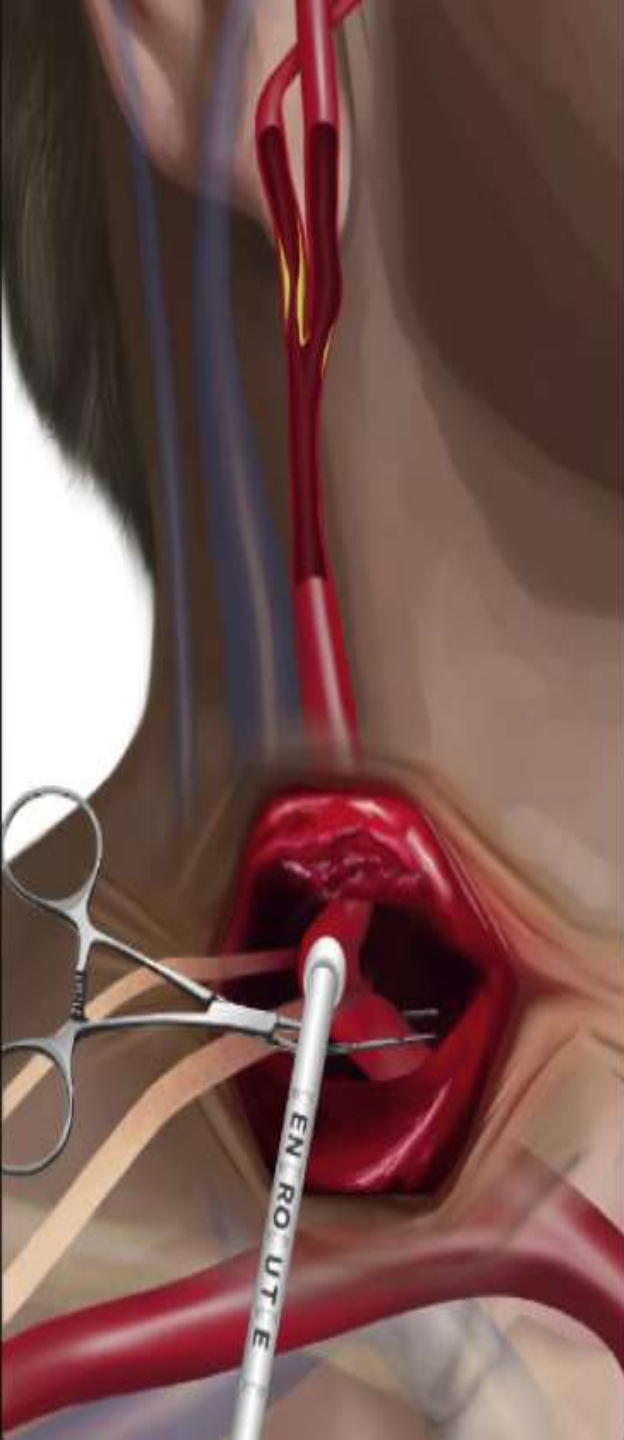
Antiplatelet protocols were more aggressive in CAS arm than CEA arm

Design of intent-to-treat

About 20% from BMT crossed into treatment

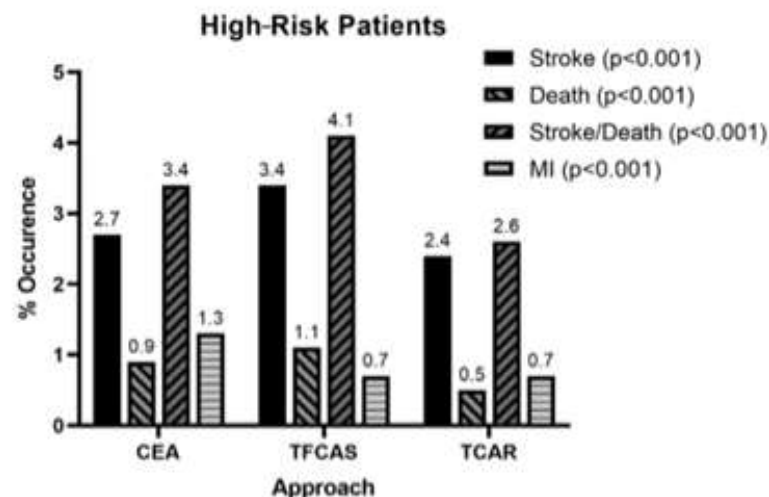
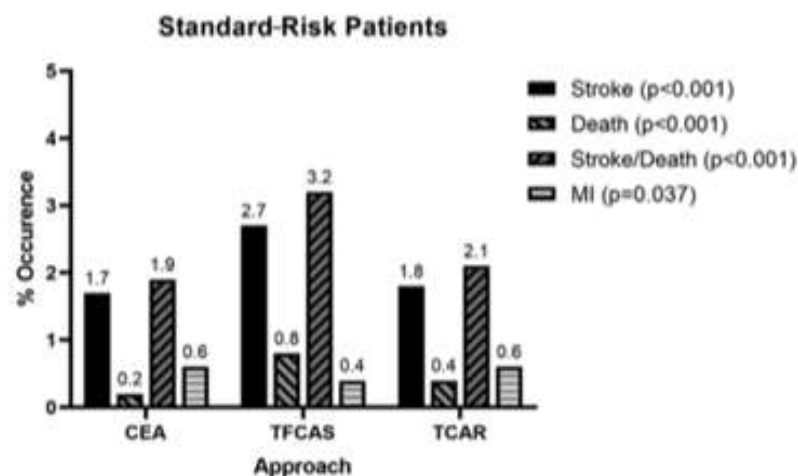
Difference in BMT arm outcomes

6 late strokes in the CEA arm unrelated to procedure



Transcarotid artery revascularization is associated with similar outcomes to carotid endarterectomy regardless of patient risk status

George Q. Zhang, MD, MPH,^a Sanuja Bose, MD,^b David P. Stonko, MD, MS,^c Christopher J. Abularrage, MD,^{c,d} Devin S. Zarkowsky, MD,^e and Caitlin W. Hicks, MD, MS,^{c,d} Boston, MA; Baltimore, MD; and Denver, CO



Seven years of the transcatheter artery revascularization surveillance project, comparison to transfemoral stenting and endarterectomy



Retrospective VQI cohort study, September 2016 - August 2023



50,068 TCAR, 25,361 tfCAS, and 122,737 CEA patients

Objectives

Compare effectiveness and safety of TCAR, tfCAS, and CEA using data from the Vascular Quality Initiative (VQI) over seven years

Outcomes

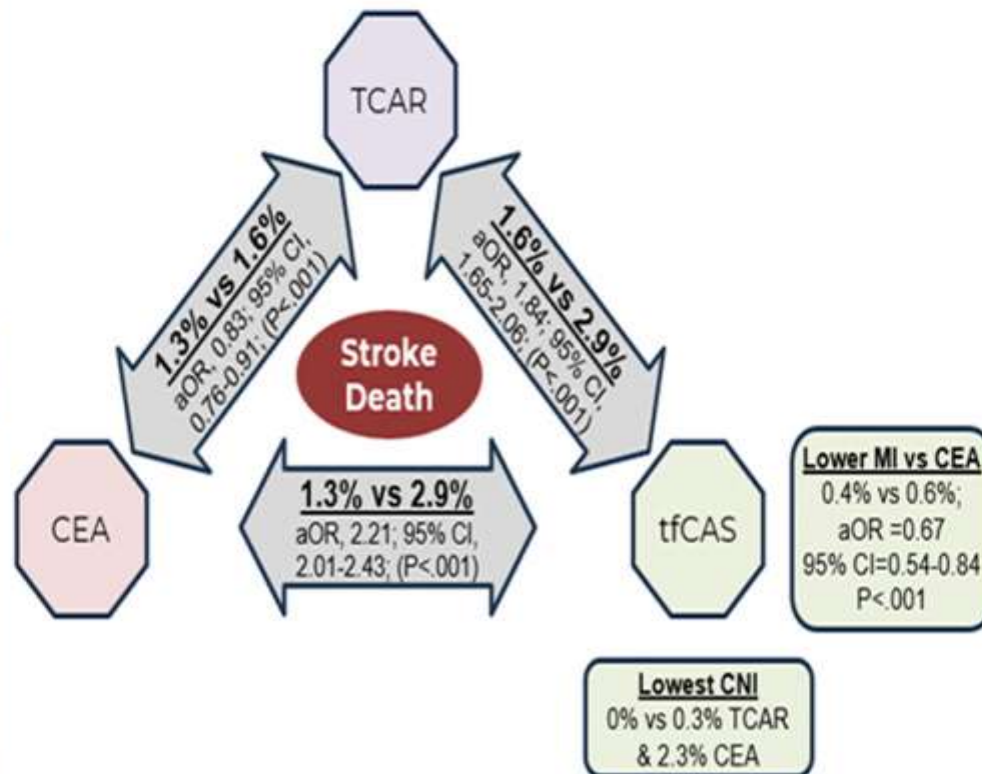
Primary Outcome

In-hospital stroke/death

Secondary Outcomes

Myocardial infarction (MI), cranial nerve injury (CNI), prolonged length of stay, and bleeding

Results



Conclusions

TCAR and CEA preferred over tfCAS due to lower stroke/death rates

TCAR vs CEA should consider MI and CNI rates

tfCAS is an option for prohibitive neck anatomy or other contraindications for TCAR and CEA



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Vascular Surgery

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CEA Remains the Gold Standard

Lowest perioperative stroke risk

Excellent durability

Lowest restenosis

No prosthetic implant

No arch manipulation

Which procedure?

Situation	Favored Procedure
Heavy calcification Angulation Tortuosity of ICA	CEA
Diseased, tortuous or angulated aortic arch	CEA or TCAR
Low carotid bifurcation Disease of common carotid	CEA or tfCAS
Severe cardiac or pulmonary disease Neck radiation Prior neck surgery High lesions C-spine immobility Contralateral vocal cord paralysis	TCAR or tfCAS

Stroke Prevention Does Not End in the Operating Room

Restenosis After Intervention

- Approximately 5–10% (slightly higher after CAS)
- Most restenosis develops within 24 months

Contralateral progression

- Occurs in approximately 15–30%

Patient-centered approach to lifelong care

Custom tailor therapy based on the patient, their lifestyle, etc.

Longitudinal follow-up

Long term relationship for long-term diseases



What Does a Vascular Surgeon Actually Do?

Diagnosis	Medical optimization	Surveillance	Patient selection
CEA	CAS	TCAR	Complex anatomy
Redo surgery	Radiation disease	Hostile neck	Subclavian disease
	Arch disease	Long-term follow-up	

When to Refer to Vascular Surgery?

Symptomatic carotid stenosis $\geq 50\%$

Asymptomatic carotid stenosis $\geq 70\%$ with favorable life expectancy and high-risk plaque features

Rapidly progressive carotid disease on surveillance

Restenosis after prior carotid intervention

Radiation-associated carotid stenosis

Tandem carotid and great vessel disease

Complex aortic arch or supra-aortic trunk pathology

WHENEVER YOU WANT! 😊

If Nothing Else...

Stroke prevention begins long before stroke treatment.

Symptomatic carotid disease demands timely evaluation and intervention.

Modern management of asymptomatic disease requires careful patient selection and optimal medical therapy.

Carotid endarterectomy remains the benchmark against which newer technologies are measured.

Surveillance and aggressive risk-factor modification are essential to durable stroke prevention.

Vascular surgeons provide comprehensive, lifelong management of extracranial cerebrovascular disease—from diagnosis through intervention and long-term follow-up.

Help us recruit and enroll!



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