



# Carotid Artery Disease Management: Reconciling Competing Paradigms in the Era of Medical Optimization

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## DESCRIPTION

The optimal management of carotid artery stenosis remains one of the most debated topics in vascular medicine, with evolving evidence challenging long-established practices and creating uncertainty in clinical decision-making. This controversy reflects the complex interplay between advances in medical therapy, refinements in revascularization techniques, and changing patient demographics. As we navigate these competing paradigms, a thoughtful reassessment of our approach to carotid disease is warranted.

Carotid Endarterectomy (CEA) established itself as the gold standard for stroke prevention in symptomatic carotid stenosis following the landmark NASCET and ECST trials in the early 1990s, which demonstrated absolute risk reductions of 17% and 11.6% respectively for ipsilateral stroke over two years compared to best medical therapy. For asymptomatic stenosis, the ACAS and ACST trials showed more modest but still significant benefits of surgical intervention. These findings shaped practice patterns for nearly two decades, establishing CEA as a cornerstone of stroke prevention strategies.

However, the landscape has changed considerably since these pivotal trials. Perhaps most significantly, "best medical therapy" has undergone substantial evolution. Contemporary pharmacologic management now includes high-intensity statin therapy, more effective antithrombotic agents, better blood pressure control, and more aggressive risk factor modification. The SAMMPRIS trial, though focused on intracranial stenosis, demonstrated remarkably low stroke rates with intensive medical management alone, suggesting potentially similar benefits in extracranial carotid disease. This medical progress raises legitimate questions about whether the absolute benefit of revascularization observed in earlier trials still applies in the current era.

Carotid Artery Stenting (CAS) emerged as an alternative to CEA, offering a less invasive approach with reduced perioperative stress. Initial enthusiasm was tempered by the

CAVATAS and EVA-3S trials, which showed higher periprocedural stroke rates with stenting. However, subsequent studies including CREST demonstrated comparable composite outcomes between the two modalities, with differences in complication profiles: CEA associated with higher risks of myocardial infarction and cranial nerve injury, and CAS with higher risks of periprocedural stroke, particularly in older patients. Technological improvements including embolic protection devices, mesh-covered stents, and transcatheter approaches with flow reversal have subsequently improved CAS outcomes, narrowing the safety gap with CEA.

The controversy surrounding asymptomatic carotid stenosis has intensified with emerging data suggesting lower-than-expected stroke rates under contemporary medical management. The annual stroke risk in medically managed asymptomatic patients has declined from approximately 2-3% in earlier trials to as low as 0.5-1% in more recent observational studies. This dramatic reduction calls into question the risk-benefit ratio of prophylactic intervention, particularly when considering the non-negligible perioperative risks and significant healthcare resources involved.

Risk stratification has consequently emerged as a critical focus in asymptomatic disease management. Various markers including plaque echolucency, intraplaque hemorrhage on MRI, microemboli detected by transcranial Doppler, progressive stenosis, and contralateral occlusion have shown promise in identifying higher-risk subgroups who might derive greater benefit from intervention. However, the integration of these markers into clinical decision-making remains inconsistent, and robust validation in prospective studies is needed.

The ongoing CREST-2 trial represents the most significant effort to address these uncertainties, randomizing asymptomatic patients to optimal medical therapy alone versus optimal medical therapy plus either CEA or CAS. Until these results become available, clinicians must navigate considerable ambiguity, balancing individual patient factors, institutional expertise, and evolving evidence.

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For symptomatic disease, timing of intervention has gained increased attention, with converging evidence supporting expedited treatment. The risk of recurrent stroke is highest in the first two weeks following a neurological event, with particularly elevated risk in the first 48-72 hours. This "hyperacute period" presents both an opportunity for effective stroke prevention and a challenge in balancing urgency with procedural safety. Several studies suggest that intervention within 14 days of symptoms confers maximum benefit, though the optimal timing within this window remains controversial, particularly for patients with large territory infarcts or hemorrhagic transformation.

Sex-specific considerations have also emerged as important factors in carotid disease management. Women appear to derive less benefit from CEA for asymptomatic stenosis and face higher perioperative risks than men. Conversely, the benefit of intervention for symptomatic disease may be greater in women with severe stenosis. These differences highlight the importance of sex-specific risk-benefit calculations rather than applying uniform criteria across populations.

Beyond binary stenosis measurements, advanced plaque imaging has transformed our understanding of carotid atherosclerosis. Multimodal approaches including ultrasound, CT, and MRI can characterize vulnerable plaque features such as thin fibrous cap,

large lipid core, and intraplaque hemorrhage. These characteristics may ultimately prove more predictive of stroke risk than luminal narrowing alone, though their implementation in routine clinical practice remains limited by standardization challenges and reimbursement constraints.

The emerging concept of "precision medicine" in carotid disease aims to synthesize these various factors-degree of stenosis, symptom status, plaque characteristics, patient demographics, comorbidities, and life expectancy-into individualized treatment recommendations. Moving beyond the traditional dichotomies of "symptomatic versus asymptomatic" and "surgical versus medical" therapy requires sophisticated risk modeling and shared decision-making tools that are still under development.

Looking ahead, several shifts in management paradigms seem likely. First, revascularization for asymptomatic stenosis will likely become more selective, reserved for patients with higher-risk features and reasonable life expectancy. Second, symptomatic intervention will continue to trend toward earlier treatment, facilitated by streamlined care pathways and systems-based approaches. Third, plaque characterization will increasingly supplement degree of stenosis in risk stratification. Finally, medical therapy will remain the foundation of management for all patients, regardless of whether they undergo intervention.