Patient, Anatomic, and Procedural Characteristics That Increase the Risk of Carotid Interventions

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KEYWORDS

• Carotid artery stent • Angioplasty • High risk

KEY POINTS

- Carotid artery stenting (CAS) was developed as a less invasive alternative to carotid endarterectomy (CEA) in patients at increased risk of complications with conventional surgery.
- Several randomized trials have demonstrated equipoise between CAS and CEA in both high-risk and average-risk surgery patients.
- Current evidence suggests that there are identifiable patient, anatomic, and procedural characteristics that increase the incidence of carotid stenting complications.
- Such evidence reaffirms the importance of careful case selection when performing CAS.

INTRODUCTION

Carotid artery stenting (CAS) was developed as a less invasive alternative to carotid endarterectomy (CEA) in patients at increased risk of complications with conventional surgery (**Table 1**). Multiple randomized controlled trials and registry studies conducted in high surgical risk patients, average surgical risk patients, symptomatic patients, and asymptomatic patients have clearly shown equipoise for CAS versus CEA, and in some cases CAS is preferred over CEA.[1–14] CAS is a very young procedure, and as would be expected, there has been significant improvement in outcomes over the past 10 years (**Fig. 1**). These data led to Food and Drug Administration device approval for the carotid stent system (RX ACCULINK; Abbott Vascular, Abbott Park, Il) and to multisocietal guidelines that recommended CAS as an alternative to CEA in average and low surgical risk symptomatic (Level I) and asymptomatic (Level II) patients who require carotid revascularization for stroke prevention.[15,16]

As high-risk patients were identified for surgery, it has also become apparent that there are patients who are at increased risk for complications with stenting. The purpose of this article was to review the evidence supporting risk stratification of patients being considered for CAS.

CAROTID STENT RISK ASSESSMENT

Presumptive high-risk features for complications of CAS include thrombus-containing lesions, heavily calcified lesions, very tortuous vessels, and near occlusions. In addition, patients have been considered to be at increased risk for complications if they have (1) contraindications to dual antiplatelet therapy (aspirin and thienopyridines), (2) a history of bleeding complications,

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Table 1
Features associated with high surgical risk for carotid disease

Medical Comorbidity	Anatomic Criteria
Elderly (>75/80 y) Congestive heart failure (NYHA III/IV) Unstable angina	Surgically inaccessible lesions • At or above C2 • Below the clavicle
CAD with ≥2 vessels ≥70% stenosis	Prior neck irradiation or surgery (prior CEA)
Recent heart attack (≤30 d)	Spinal immobility of the neck
Planned open heart surgery (≤30 d)	Contralateral carotid artery occlusion
Ejection fraction ≤30%	Laryngeal palsy
COPD with FEV ≤30%	Tracheostoma

Abbreviations: C2, cervical spine vertebral body #2; CAD, coronary artery disease; CEA, carotid endarterectomy; COPD, chronic obstructive pulmonary disease; FEV, forced expiratory volume; NYHA, New York Heart Association.

and/or (3) severe peripheral arterial disease (PAD) making femoral artery vascular access difficult.

Variables that increase the risk of CAS complications can be placed into 3 categories: (1) patient characteristics, (2) anatomic or lesion features, and (3) procedural factors (Table 2). Some of these high-risk features have been identified empirically by expert consensus (eg, thrombus-containing lesions), whereas other criteria of CAS risk are supported by clinical trial evidence (eg, operator experience).[17]

In terms of expert consensus, a multidisciplinary Delphi Carotid Stenting Consensus Panel made recommendations regarding CAS risk factors.[18] High-risk CAS features were those that (1) prolonged catheter or guide wire manipulation in the aortic arch, (2) made crossing a carotid stenosis more difficult, (3) decreased the likelihood of successful deployment or retrieval of an embolic protection device (EPD), or (4) made stent delivery or placement more difficult. The highest-risk feature for CAS was determined to be a Type III aortic arch (Fig. 2) followed by friable aortic arch atheroma. The least important feature for predicting CAS complications, by expert consensus, was the severity of the carotid stenosis.

CAS patient selection criteria were proposed in 2006 by Roubin and colleagues.[19] They identified clinical features, such as older age (≥80 years) and decreased cerebral reserve (dementia, multiple prior strokes, or intracranial microangiopathy), as being associated with increased CAS risk. They also identified anatomic features, such as excessive tortuosity (more than two 90° bends within

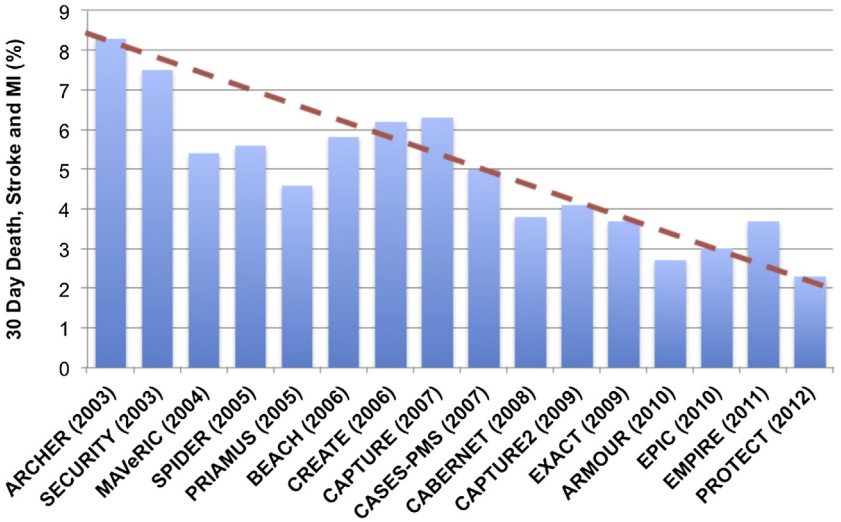

Fig. 1. Declining risk of stroke and death with carotid stenting. (*From* White CJ, Ramee SR, Collins TJ, et al. Carotid artery stenting: patient, lesion, and procedural characteristics that increase procedural complications. Catheter Cardiovasc Interv 2013. http://dx.doi.org/10.1002/ccd.24984; with permission.)