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ORIGINAL ARTICLE

Efficacy and safety of carotid artery stenting for stroke prevention

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KEYWORDS

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Abstract *Background:* Extracranial carotid artery stenosis is a leading cause of ischemic stroke. Carotid endarterectomy (CEA) is the gold-standard management for secondary stroke prevention yet carotid artery stenting (CAS) has emerged in the last decade as an alternative for high surgical risk patients.

Purpose: To assess the effectiveness, safety and outcomes of CAS in extra-cranial carotid artery stenosis patients in terms of stroke prevention.

Methodology: Twenty patients with symptomatic and asymptomatic carotid artery stenosis were enrolled between 2012 and 2014. Symptomatic patients were eligible for CAS if the internal carotid artery stenosis was $\geqslant$50%, while 80% was the threshold in asymptomatic patients.

Results: Symptomatic patients enrolled were fifteen (75%) and asymptomatic patients were five (25%). Two patients (10%) were excluded owing to target vessel occlusion. One patient (5%) underwent bilateral CAS. The procedure was successful in eighteen patients (90%) one of them complicated by distal embolization (5%). One patient died secondary to associated chronic liver disease (5%), otherwise no stroke or death was recorded along the follow-up period.

Conclusion: Careful patient selection and technique optimization are crucial to improve clinical outcome which make it a safe alternative for surgical revascularization in stroke prevention.

1. Introduction

Stroke is the third most common cause of death in industrialized nations, after myocardial infarction and cancer. It is the single most common reason for permanent disability. Approximately 1 in 4 people die within 1 year after having an initial stroke (1). Moreover, 30–50% of stroke survivors do not regain functional independence and 15–30% of all stroke survivors are permanently disabled (i.e., not able to walk, talk clearly, or feed themselves with a favored hand). Thus stroke demands a massive financial and personal burden on our society (2). Approximately 25% of ischemic strokes are secondary to extracranial carotid artery occlusive disease. Carotid artery

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Table 1 Study group clinical presentation and associated comorbidities.

Age (range, mean ± SD)	45–75 years & mean age 60.8 ± 7.8
Men	17 (85%)
Smoking – current or past	12 (60%)
Symptomatic ICA/CCA stenosis	15 (75%)
Previous stroke	10 (50%)
TIA	4 (20%)
Amaurosis fugax	1 (5%)
Diabetes mellitus	8 (40%)
Arterial hypertension	12 (60%)
Peripheral arterial disease	4 (20%)
History of myocardial infarction	5 (25%)
Significant bilateral ICA disease	3 (15%)
High risk lesion	14 (70%) (Near total 'string-sign' stenoses; 9 (45%) & ulcerated plaque; 5 (25%))
Others	1 (5%) with hepatocellular carcinoma

stenosis is quite common, with 2–8% of the population having asymptomatic stenosis of >50% (3), with a higher prevalence among patients with heart disease (18.2%) or concomitant hypertension and heart disease (22.1%). The prevalence is even higher among patients with acute strokes, with up to 60% having carotid stenosis on duplex ultrasonography (4). The carotid stenosis related stroke risk is dependent on the stenosis severity, patient symptom, and specific lesion characteristics. Symptomatic patients who have had stroke or transient ischemic attack within the previous 6 months, have a much higher stroke risk than do asymptomatic individuals (5).

Antiplatelet therapy of carotid disease reduces the incidence of stroke (6), yet several studies have demonstrated that carotid endarterectomy (CEA) is more effective than medical therapy alone for both symptomatic and asymptomatic carotid atherosclerotic disease (including the North American Symptomatic Carotid Endarterectomy Trial (NASCET) (7), Asymptomatic Carotid Atherosclerosis Study (ACAS) (8), and Asymptomatic Carotid Surgery Trial (ACST) (9)). Endarterectomy has several limitations as the operation carries a significant risk of complications, particularly in patients with multiple comorbidities, and is highly operator dependent (10).

Kerber et al. published the first report of carotid artery balloon angioplasty in 1980 (11). In 1987, Theron et al. published a larger series including 48 patients with 94% technical success rate and 4.1% major stroke morbidity (12). By 1995, a worldwide experience review among 523 patients claimed favorable results with 96.2% technical success, 2.1% morbidity, 6.3% transient minor complications, and no deaths (13). Over the past decade, the intraprocedural use of cerebral protection devices to guard against micro- or macroembolism has further improved these outcomes (14) making carotid artery stenting (CAS) an accepted alternative to CEA for patients at high surgical risk (15).

This study was constructed to assess the effectiveness and safety as well as the short- and long-term clinical outcomes of CAS in management of extra-cranial carotid artery stenosis including patients with no high surgical risk in terms of stroke prevention.

2. Patient and methods

2.1. Study group

Twenty patients were enrolled in this study between 2012 and 2014 for carotid artery stenting (Fourteen men and two women with age range from 45 to 75 years and mean age 60.8 ± SD 7.8) each of them gave informed written consent to participate. Symptomatic patients were eligible for CAS if the ICA stenosis was 50%, while 80% was the stenosis threshold in asymptomatic patients. Lesions were classified as "high risk" by morphology (Near total "string-sign" stenoses were nine patients (45%) and five patients (25%) have ulcerated plaques). The clinical presentation and associated comorbidities are demonstrated in Table 1.

2.2. Imaging

All patients underwent Duplex ultrasound performed with a linear 7- to 10-MHz probe to evaluate lesion severity (area and diameter stenosis) and morphology (echogenicity, the presence and degree of calcification, or ulceration). Extra- and intracranial CTA (biplanar, 3-dimensional reconstructions with smart vascular analysis) or contrast enhanced MRA was performed in selected patients to characterize the target lesion, aortic arch type, and supra-aortic vessel anatomy and to exclude significant intracranial pathology as well as evaluation of the collateral circulation. Morphological (semiquantitative) lesion assessment included fatty, fibrous, and calcium content was depicted.

2.3. CAS procedure

Patients received a dual antiplatelet regimen consisting of aspirin (100 mg daily) and clopidogrel (75 mg daily) at least 3 days before the stenting. A loading dose of clopidogrel (300–600 mg) administered early on the day of the procedure was an alternative for patients who are already taking aspirin. The patient receives an intravenous loading dose of heparin (50–70 U/kg) with activated clotting time of 250–300 s is maintained throughout the procedure. During the procedure patient was under ECG monitoring due to potential bradycardia and blood pressure monitoring for possible hypotension related to carotid sinus stimulation by balloon inflation.

Procedures were done under the image guiding of (Artis zee Flat Detector Biplane-Angiosuite, Siemens, Forchheim, Germany). The vascular access via the femoral artery was the approach that was employed. Femoral artery was punctured using a Seldinger needle and then 6–8 F sheath was placed under local anesthesia.

Angiography of the aortic arch was often performed prior to selective carotid angiography in order to identify possible