Short Term Neurological Outcomes of Carotid Artery Stenting; a Multidisciplinary Team Experience

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ABSTRACT

Background: Carotid artery stenting is an alternative method to surgical endarterectomy for treatment of carotid artery stenosis. Nonetheless, in Egypt the procedure is perceived as a nidus for conflicts between multiple specialties.

Objectives: To report the results of a multidisciplinary approach to percutaneous treatment of carotid occlusive disease.

Methods: Sixty patients underwent a total of sixty six carotid interventions under the care of the multidisciplinary team. Independent neurological assessment was performed both before and after carotid stenting. Procedures were performed at Ain Shams University Hospitals. All procedures were attempted using distal protection devices to guard against distal embolization. Stents were routinely used in all sixty six interventions.

Results: Rate of neurological events was assessed independently in the early (<30 days) post interventional period. Twenty patients (33.3%) had asymptomatic carotid occlusive disease; in this group there were no strokes reported in the early post interventional period. Forty patients had symptomatic carotid occlusive disease, in the form either transient ischemic attack (TIA), ipsilateral stroke, or amaurosis fugax; in this group, TIA was reported in three patients (7.5%) and an ipsilateral stroke was reported in two patients (5%) in the early post interventional period (p=0.005). Cardiovascular mortality was not observed in any patient in the current registry.

Conclusion: Carotid artery stenting with distal protection devices yields acceptable short term results with respect to neurological events. Asymptomatic patients have significantly less periprocedural strokes than symptomatic patients. Independent neurological assessment is crucial to the accurate reporting of adverse events following the procedure. (Egypt J. Neurol. Psychiat. Neurosurg., 2009, 46(2): 329-336)

Key words: Carotid artery stenting, neurological outcome.

INTRODUCTION

Carotid artery stenosis is a major cause of stroke in Caucasians among other populations.¹ Medical treatment has been proven to be inferior to surgical treatment through carotid endarterectomy, both in symptomatic²,³ and asymptomatic patients.²,³ Percutaneous carotid intervention with balloon angioplasty and stent implantation gained popularity as an alternative to endarterectomy. Several neuroprotective devices, such as distal or proximal occlusion systems and filter systems, have been developed to prevent distal embolization during the standardized interventional procedure.⁴

In the past five years, data of the global carotid artery stent registry and several device specific registries [CABERNET, BEACH, SECURITY] or trials [ARCHER⁵] have pointed out that the use of a protection device and increasing operator experience both decrease the incidence of embolic events during carotid stenting in both symptomatic and asymptomatic patients.³ Four randomized studies – CAVATAS¹, Saphire⁶, SPACE¹¹, EVA-3S¹² – comparing carotid stenting to carotid endarterectomy have been published. CAVATAS and SAPPHIRE showed no difference between surgical and endovascular treatment strategies with respect to neurological side effects.¹⁰ In the SPACE trial in symptomatic carotid stenosis, outcome was comparable in carotid endarterectomy and stenting arms. Statistically, however, non-inferiority of stenting could not be proven.¹¹ EVA-3S investigators demonstrated that symptomatic patients showed a higher neurological event rate in the stent arm. EVA-3S had significant methodological flaws, allowing also inexperienced interventionalists to participate.¹²

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PATIENTS AND METHODS

The current study enrolled sixty consecutive patients, who underwent sixty six consecutive carotid interventions between October 2005 and May 2008 at Ain Shams University Hospitals, cardiology and neuroradiology units. The multidisciplinary team is comprised of an interventional cardiologist, neuroradiologist, and neurologist.

Patients were enrolled into the study when the degree of carotid stenosis met the criteria of guidelines for carotid surgery, i.e. carotid stenosis of ≥ 50% in symptomatic patients; carotid stenosis ≥ 70% in asymptomatic patients. Stenosis was assessed pre-procedure by duplex ultrasound assessment. Other imaging modalities were used had the duplex been inconclusive.

Patients enrolled in the current registry did not necessarily need to have a contraindication to carotid endarterectomy. A careful history was elicited in search for cardiovascular risk factors, other co-morbidities, and potential contraindications to the stenting procedure. An oral (occasionally written) informed consent was obtained in all patients. Exclusion criteria to carotid stenting were refusal to undergo angioplasty, pregnancy, contraindications to the use of dual antiplatelet therapy with aspirin and a thienopyridine ADP antagonist for at least 4 weeks, and contraindication against the use of contrast agents.

Preprocedural neurological assessment:

Independent neurological assessment was done before carotid stenting. During the intervention, neurological monitoring was performed clinically. The severity of strokes was graded according to a modified Rankin scale: minor stroke is Rankin grades 0-2, grade 2 denoting slight impairment with inability to perform all activities previously possible, while the patient is able to live his life without external help. Major stroke is defined by grades 3 (needs some help, but can walk alone) to 5 (severe disabling stroke). Transient ischemic attacks were defined as temporary deficit completely reversible within 24 h.

Procedural details:

Pre-treatment with acetyl salicylic acid (100 mg/d) and clopidogrel (75 mg/d) for ≥3 days prior to intervention and at least 4 weeks thereafter was mandatory in all patients. Procedures were performed by the first two authors. Both authors had performed at least twenty carotid stenting procedures (each) prior to the enrollment of patients in this registry, both inside and outside Egypt. The use of distal protection device was attempted in all cases and was not deferred unless there was failure to deliver and properly seat the distal protection device to a distance of at least 30 mm beyond the target lesion. The use of stents was attempted in all cases.

Post procedural neurological assessment:

Independent neurological assessment was done 30 days after carotid stenting. All sixty patients were available for follow up neurological assessment, which was performed by the third author.

Statistical analysis:

All demographic, clinical, and technical data were collected using the “Data Collection Form” and entered into a computerized database. Data obtained from all patients were statistically analyzed. Continuous variables were compared using analysis of variance (ANOVA) for repeated measures. The Fischer-exact chi square test was used for comparison of categorical variables. P-value < 0.05 was considered statistically significant. All data were expressed as mean ± standard deviation (mean±SD) or number (%) as appropriate.

RESULTS

Sixty patients with sixty six carotid stenotic lesions were enrolled. Forty (75%) were males, twenty (25%) were females. The mean age±SD of the study cohort was 66 ± 8 years (range 45-82 years). Carotid stenosis by duplex ultrasound was 75±10 %. Twenty patients had asymptomatic carotid stenosis that was discovered accidentally, either during the course of a preoperative assessment prior to CABG (n=8), or during a routine medical check-up procedure (n=12). Forty patients had one or more neurological symptom(s) before the procedure in the form of: ipsilateral non-disabling stroke (n=12), ipsilateral major stroke (n=8), TIA (n=18), amaurosis fugax (n=5). Co-morbidities were frequently encountered, with arterial hypertension and coronary artery disease (either by history or
documented by coronary angiography) being the two most common co-morbidities. Table (1) summarizes the co-morbidities encountered in the current study.

Six patients had bilateral carotid stenosis, and lesions were tackled on two separate interventional settings. All sixty six procedures were performed via the right transfemoral approach. Accessing the carotid artery was achieved using a long 95 centimeter sheath in sixty procedures (90.9%). In the other six procedures (9.1%), accessing the carotid artery was achieved using a coronary 8-French guiding catheter. Distal protection devices used were Cordis’ Angioguard™ (48/66, 72.7%), Boston Scientific’s EZ® filter (14/66, 21.2%), or EV3’s Spider™ (2/66, 3%).

In two procedures, there was failure of adequate seating of the guidewire of the distal protection device owing to tortuosity of the internal carotid artery. In these two cases, distal protection was abandoned, and the stenting procedure was performed using a standard 0.014 inch guide wire. Post stent deployment balloon dilatation, known to be associated with the highest likelihood of distal embolization was also discarded. One patient developed a TIA following this unprotected stenting approach; the other patient had an uneventful postprocedural course.

Predilatation was done in six procedures (9.1%). In all other procedures, direct stenting was performed. Stent delivery was successful in all sixty six procedures. The mean stent length was 48±9 mm; the mean stent diameter was 8 ± 0.6 mm. The following stents were used: Cordis Smart, (n=20), Cordis Precise (n=28), Boston Scientific’s Sentinol (n=14), and EV3’s Protégé (n=4).

Post dilatation was done in 90.9% (n=60) of procedures. As mentioned earlier, post dilatation was discarded in two procedures in which there was inability to properly “park” a distal protection device at least 30 millimeters distal to the lesion. In the other four occasions, post dilatation was discarded because of minimal indentation within the stent. The mean balloon diameter was 5.1±0.8 mm. Procedural success (defined as adequate seating of a distal protection device distal to the stenosis, stent deployment in the target lesion, ± post stent deployment balloon dilatation, and finally retrieval of the distal protection device) was achieved in 97% of attempted procedures (n=64). Procedural details are summarized in table (2).

**Neurological outcomes in the 30-day post-procedural interval:**

Independent neurological assessment was carried out in all patients. In the asymptomatic group (prior to carotid intervention), no neurological events were reported in the 30 days post-procedural interval. In patients who were symptomatic prior to carotid intervention, TIA occurred in three patients (3/40; 7.5%), and an ipsilateral major stroke occurred in two of the three patients (2/40; 5%) following the occurrence of the TIA, despite hospitalization and initiation of anticoagulation.

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**Table 1. Common Co-morbidities.**

<table>
<thead>
<tr>
<th>Co-morbidity</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>Coronary Artery Disease</td>
<td>75%</td>
</tr>
<tr>
<td>Diabetes Mellitus</td>
<td>45%</td>
</tr>
<tr>
<td>Arterial Hypertension</td>
<td>80%</td>
</tr>
<tr>
<td>Critical Limb Ischemia</td>
<td>8.3%</td>
</tr>
<tr>
<td>Peripheral Vascular Disease</td>
<td>25%</td>
</tr>
<tr>
<td>Congestive Heart Failure</td>
<td>30%</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>70%</td>
</tr>
<tr>
<td>Tobacco</td>
<td>20%</td>
</tr>
<tr>
<td>Age &gt; 80 years</td>
<td>3.3%</td>
</tr>
</tbody>
</table>
Table 2. Summary of Procedural Details.

<table>
<thead>
<tr>
<th>Procedural Detail</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distal Protection Attempted</td>
<td>100%</td>
</tr>
<tr>
<td>Distal Protection Device Parked</td>
<td>97%</td>
</tr>
<tr>
<td>Failure to Park DP Device</td>
<td>3%</td>
</tr>
<tr>
<td>Predilatation</td>
<td>9.1%</td>
</tr>
<tr>
<td>Post Dilatation</td>
<td>90.9%</td>
</tr>
<tr>
<td>Attempt to Deliver a Stent</td>
<td>100%</td>
</tr>
<tr>
<td>Successful Stent Delivery</td>
<td>100%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DP Devices Used:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cordis:</td>
<td>72.7%</td>
</tr>
<tr>
<td>Boston Scientific:</td>
<td>21.2%</td>
</tr>
<tr>
<td>ev3:</td>
<td>3%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stents:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cordis Smart:</td>
<td>30.3%</td>
</tr>
<tr>
<td>Cordis Precise:</td>
<td>42.4%</td>
</tr>
<tr>
<td>Boston Sentinel:</td>
<td>21.2%</td>
</tr>
<tr>
<td>ev3 Protégé:</td>
<td>6.1%</td>
</tr>
</tbody>
</table>

| Mean Stent Length               | 48±9 mm    |
| Mean Stent Diameter             | 8±0.6 mm   |
| Post Dilatation Attempted       | 90.9%      |
| Post Dilatation Performed       | 90.9%      |
| Post Stent Deployment Balloon Diameter | 5.1±0.8 mm |

Case (1): Tight stenosis of the left internal carotid artery.  
Case (1): EZ Filter secured in the distal internal carotid artery.  
Case (1): Final angiographic result.
Case (2): Tight stenosis of the left internal carotid artery (RAO).

Case (2): Tight stenosis of the left internal carotid artery (LAO).

Case (2): After stent deployment.

Case (2): Final angiographic result (LAO).

Case (3): Tight stenosis of the right internal carotid artery (LAO).

Case (3): AngioGuard Filter secured in the distal internal carotid artery.

Case (3): Final angiographic result (LAO).
DISCUSSION

The current study confirms the safety of carotid artery stenting as an alternative to carotid endarterectomy. Since the clinical introduction of carotid stenting, registry data, observational studies, but only few randomized trials assessing the clinical outcome have been published.1,10–17

In the randomized CAVATAS trial1, the combined endpoint of any death and stroke at 30 days occurred in 10.0% of patients treated percutaneously, vs. 9.9% treated surgically. In this study, 96% of patients were symptomatic prior to intervention; the percutaneous intervention was performed without embolic protection, stents were used in 26% of patients.1 The randomized SAPPHIRE trial, generally using stents and emboli-protection-devices, included both symptomatic (29.9%) and asymptomatic surgical high-risk patients.10

The 30-day endpoint of stroke, myocardial infarction or death was 4.8% in the PCI arm and 9.8% of patients undergoing surgery. There was, however, no difference in the neurological event rate in both treatment groups.10 In the SPACE trial14, including only symptomatic patients, angioplasty was performed without protection in 73% of the cases.

The 30-day results showed no difference in ipsilateral stroke or death in patients treated surgically (6.34%) or percutaneously (6.84%). In contrast, the EVA-3S study12 in symptomatic patients showed a significantly lower 30-day stroke and death rate in surgically treated patients (3.9% vs. 9.6% in the stent arm). In this study, the surgical results are exceptionally good. However, the minimum requirements for interventionalists to participate in this study (previous performance of 12 carotid interventions or five carotid interventions plus 30 other supraaortic stenting procedures) are very much different from joint interdisciplinary recommendations, e.g., from Italy, requiring at least 75 carotid stenting procedures (50 thereof as primary operator) and 150 supraaortic vessel engagements to achieve basic competence and technical skill for carotid stenting.16

Thus, investigator experience may have influenced the overall results of the stent arm by incorporating the individual learning curve in EVA-3S given the well-known relation between operator volume and outcome.1

A non-randomized retrospective single center analysis18 in asymptomatic patients showed similar outcomes after carotid stenting for high-risk patients (stroke 1.1%, additional death 1.1% at 30 days) and endarterectomy for standard-risk patients (stroke 2.1%, additional stroke plus death 0.7%).

An overview of published registry data and observational studies showed that the combined endpoint of any death and stroke in hospital or at 30 days, respectively, was within a range of 2.8–6.9%; there was, however, a considerable incompleteness of neurological assessment in some of these studies. When comparing asymptomatic to symptomatic patients, a higher event rate was found in symptomatic patients (3.8–5.8% vs. 3.2–3.8%).9

The use of distal protection devices in this study was the “standard” procedure, given the increasing popularity of such procedure, and the fact that many would consider not using this tool despite being available as a shortcoming on the behalf of the operator. It is of note however that despite the data from several large trials, series, and registries of carotid artery stenting—reflecting the experience with distal protection in thousands of patients—routine use of cerebral protection has not been confirmed by level I evidence.19

A recent small scale randomized study20 demonstrated that the use of filters during carotid artery stenting provided no demonstrable reduction of microemboli, in contrary to expect. Authors pointed out that “Routine use of cerebral protection filters should undergo a more critical assessment before mandatory universal adoption”.20

This registry is distinct in the completeness of the neurological outcome data both pre and postprocedural. The risk of any stroke at 30 days was zero % in asymptomatic and 5.0% in symptomatic patients in this small registry. These results are comparable to the reported neurologic event rates both of randomized studies and registry data for carotid stenting1,10–17 and also meet the established criteria for surgical interventions.13 Some may contemplate that the current registry patients could have undertaken a carotid endarterectomy; given it is the “benchmark” for tackling carotid occlusive disease.
In Egypt however, there has been no randomized data comparing carotid stenting, without or with distal protection to endarterectomy, and there are not any national guidelines that rule which patient may undergo carotid stenting. In this “unregulated” environment, the decision is usually left to patient’s choice, and operator discretion. The center for Medicare and Medicaid services (CMS) in the US has restricted reimbursement for CAS to patients who are high risk for carotid endarterectomy. FDA currently recommends that CAS should be in the context of randomized trials. Results of the Carotid Revascularization Endarterectomy vs. Stenting (CREST) are being anxiously waited for in the interventional community.

The current study underscores the importance of a multidisciplinary approach to treating patients with carotid disease. The decision to proceed to some form of carotid revascularization was the neurologist’s, and the performance of the procedures was conducted in such a way that patients did benefit from the cumulative, rather than the individual experience of the first two authors.

This may in part explain the low complication rates reported in the asymptomatic group. Operator experience lowers complication rates in carotid stenting as in other procedures. The net effect is a better service delivered to the patient.

REFERENCES


الملخص العربي

النتائج قصيرة المدى بعد تدعيم الشريان السباتي على الجهاز العصبي. خبرة فريق متعدد التخصصات

الخليفة البحثية: يعتبر دعامة الشريان السباتي منافس لجراحة هذا الشريان في حالات جلطة الدم الناتجة عن خلل الشريان السباتي أو وجود جلطة على جدار.

الهدف من البحث: مدى التنسيق بين التخصصات المختلفة لعلاج أنسداد الشريان السباتي بدرجات مختلفة.

الطريقة البحثية المتبعة: عدد المرضى في هذا البحث وصل إلى 60 مريض وقد تم عمل 66 تدخل علاجي في الشريان السباتي بعد التقييم اللامن لمشاكل الجهاز العصبي.

النتائج: تم تقييم النتائج العصبية في خلال الشهر الأول بعد العلاج البداعي، ووجد أن عشرين مريضاً كانوا يعانون من أنسداد بدون أعراض للشريان السباتي، و40 مريضاً كانوا يعانون من أعراض في الجهاز العصبي ناجت عن أنسداد عرضي أو مستمر، ولوحظ عدم وجود وفيات بين كل مرضى العلاج البداعي.

التوصيات الطبية: يلزم العلاج البداعي للشريان السباتي في حالة الأنسداد المعمول سواء ذات أعراض مرضية أو لا وذلك لمنع حدوث جلطة مخية.

الملخص العربي