Carotid artery angioplasty and stent placement for recurrent stenosis

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Object. The use of endovascular management for recurrent carotid artery (CA) stenosis is rapidly expanding due to the increased surgical risk associated with repeated carotid endarterectomy (CEA). Carotid artery angioplasty and stent placement for recurrent CA stenosis offers a less invasive strategy with fewer procedural complications and may provide a more durable treatment. The authors report on their experience with this procedure in the management of recurrent CA stenosis.

Methods. A retrospective review was performed to evaluate clinical and ultrasound imaging outcomes after CA angioplasty and stent placement. Twenty-three vessels in 22 patients with severe recurrent stenosis (> 80%) post-CEA were treated with balloon angioplasty and stent placement without distal protection. There were no perioperative neurological or cardiac complications in this series. Over a mean follow-up period of 36 months, one patient (5%) suffered recurrent stenosis requiring retreatment with angioplasty alone.

Conclusions. The use of CA angioplasty and stent placement provides a safe and effective treatment for recurrent CA stenosis. The use of drug-eluting and/or bioactive stents in the future will likely further improve the efficacy of this procedure for recurrent CA stenosis.

KEY WORDS • carotid artery stenosis • angioplasty • carotid stent placement

CLINICAL MATERIAL AND METHODS

A retrospective review was performed to evaluate clinical and Doppler imaging follow up in patients who underwent CA angioplasty and stent placement for recurrent stenosis after CEA. All procedures were performed in the interventional neuroradiology suite by using biplane digital fluoroscopy. The procedures were performed after induction of general anesthesia and with somatosensory evoked potential monitoring. All patients were pretreated with aspirin and clopidogrel for at least 3 days before the procedure. Because of the risk of bradycardia or asystole, the Zoll transcutaneous pacer was used in all patients. This device paced the HR in approximately 30% of these patients, similar to the frequency among first-time CA angioplasty and stent placement procedures, with an increased incidence of firing when the lesion was close to the carotid bulb/sinus.

Initially, a No. 5 French femoral sheath (Cordis Endovascular, Johnson and Johnson Corp., Miami, FL) was placed, and arteriography was performed through a No. 5 French Berenstein diagnostic catheter (Cordis Endovascular, Johnson and Johnson Corp.). Measurements were made of the degree and length of stenosis as well as the diameter of the internal carotid artery above and the CCA below the stenosis (Fig. 1a). These measurements were...
important to determine the appropriate stent diameter and length. The femoral sheath was then converted to a No. 8 French sheath to accommodate the angioplasty balloon and stent. A No. 8 French 90-cm guiding catheter (Vista Brite Tip; Cordis Endovascular, Johnson and Johnson Corp.) was positioned in the CCA. Based on their weight, patients then received boluses of heparin and were maintained on a continuous drip to keep the activated clotting time at two times the baseline value.

With the aid of roadmap guidance, a 0.35 to 0.38-in Te-rumo guidewire (Boston Scientific, Fremont, CA) was passed through the stenosis. The Savvy angioplasty balloon catheter system (Cordis Endovascular, Johnson and Johnson Corp.) was then passed over the wire, across the stenosis, and the balloon was inflated up to 8 to 10 atm (Fig. 1b). The pressure of balloon inflation was dependent on tactile and radiographic assessment. The number of balloon inflations was determined based on pre- and post-dilation angiograms. A follow-up angiogram was obtained after each inflation. If results of the angiogram were not satisfactory, repeated angioplasty was performed (Fig. 1c). Once angioplasty was deemed adequate on the pre-liminary angiogram, a nitinol transhepatic biliary system stent and catheter system was passed across the diseased area under roadmap guidance.

The types of stents used in our series included 22 SMART (Cordis Endovascular) and one ACCULINK (Guidant Corp., Santa Clara, CA) device. The size of stents used in our series varied in length from 20 to 40 mm and in diameter from 5 to 8 mm. After the device was positioned, a follow-up angiogram was obtained to ensure that the postdelivery dilation of the stent was adequate (Fig. 1d). If not, balloon dilation was performed after delivery of the stent. Once treatment was completed, a low-magnification angiogram was obtained to view the carotid bifurcation and intracranial vessels to evaluate for thromboembolic events. Postoperatively, patients were maintained on a continuous heparin infusion for 24 to 48 hours to a goal activated clotting time of 2 to 2.5 times baseline. Patients were discharged on a maintenance dose of aspirin and clopidogrel.

**RESULTS**

Twenty-three vessels in 22 patients were treated using CA angioplasty and stent placement for recurrent stenosis after CEA. The mean patient age was 71 years. The mean period between CEA and CA angioplasty and stent placement was 28 months. All patients had high-grade stenosis (> 80%) on angiography. Twenty-two patients presented with transient ischemic attacks or amaurosis fugax, whereas one was asymptomatic. There were no neurological or cardiac complications in this series in the perioperative period. In one patient a groin/retroperitoneal hematoma developed, which required blood transfusion and delayed hospital discharge. During a mean clinical follow-up period of 36 months no further ischemic events occurred in this series of patients. Follow-up duplex ultrasonography studies performed every 6 months after CA angioplasty and stent placement were available on 20 vessels in 19 patients and demonstrated one case of recurrent stenosis (4%) 14 months after CA angioplasty and stent placement, which was treated with angioplasty alone.

**DISCUSSION**

The incidence of recurrent stenosis after CEA ranges from 2 to 50%, depending on the routine use of follow-up imaging studies, follow-up duration, and methods/criteria for defining restenosis. Two distinct pathophysiological processes are responsible for recurrent CA stenosis. Stone and String found that early restenosis (< 24 months postoperatively) was due to fibrous myointimal hyperplasia, whereas late restenosis (> 24 months) was due to progressive atherosclerotic disease of the vessel. Surgical management of recurrent CA stenosis is technically more challenging, leading to increased complication rates compared with the initial endarterectomy. Meyer, et al. described an 11% major morbidity/mortality rate with repeated CEA due to the difficulty of dissecting scarred planes between the recurrent atheroma and underlying media and due to the friable nature of a recurrent plaque, increasing the risk of emboli. The durability of reoperation for recurrent disease is also an issue; delayed failure, including ischemic events, is as high as 20%. The need
rates between the two treatment groups.1,4,10

better in terms of neurological outcome and restenosis
with repeated CEA for recurrent CA disease, and angio-
angioplasty and stent placement procedure was compared
6-month postprocedure angiography.14 The addition of
stents to angioplasty for the endovascular management of
recurrent CA stenosis reduces the risk of emboli from a
friable vessel wall and provides a more durable endolumi-
nal frame. Lanzino, et al.,5 evaluated outcomes of an-
gioplasty alone and CA angioplasty and stent placement,
demonstrating a higher recurrence rate in the group treat-
ed with angioplasty alone, with no neurological complica-
tions in 16 patients over a mean follow-up duration of 27
months. In a number of single-institution studies, the CA
angioplasty and stent placement procedure was compared
with repeated CEA for recurrent CA disease, and angi-
plasty and stent placement was found to be equivalent or
better in terms of neurological outcome and restenosis
rates between the two treatment groups.1,4,10

We successfully treated 23 vessels in 22 patients with
no neurological complications and one case of restenosis
over a mean follow-up duration of 36 months. There was
one groin complication (4.5%) in this series, which is
slightly higher than our overall experience with CA angi-
plasty and stent placement, for which the incidence is 2%.
This compares favorably with the 4 to 10% risk of wound
hematoma or infection and cranial nerve injury associated
with repeated endarterectomy.1,6 Although no thromboem-
bolic complications occurred in our series, endovascular
management of CA stenosis after CEA allows for recog-
nition and treatment with intraarterial mechanical devices
and/or thrombolytic agents during the procedure. The role
of distal protection devices for CA angioplasty and stent
placement for recurrent CA disease has not been well ex-
a mined, and in our series there were no neurological com-
lications when distal protection was not used.

It is important to note that there were no cardiac events,
severe coronary artery disease in most patients in
our series. For patients at high risk of cardiac or other
medical complications during repeated CEA, CA angi-
plasty and stent placement requires less anesthesia time
and can be performed with patients in a state of conscious
sedation, thus reducing complications attributed to general
anesthesia. The main issue in comparing repeated surgery
with CA angioplasty and stent placement for recurrent CA
stenosis is durability. The introduction of drug-eluting
stents has revolutionized the management of coronary ar-
tery disease by significantly reducing the incidence of
restenosis.8 The application of these devices to CA angi-
plasty and stent placement will likely improve long-term
outcomes, providing an even greater advantage for endo-
vascular treatment of recurrent CA stenosis. There is an

ongoing need to compare CA angioplasty and stent place-
ment to CEA in a prospective randomized fashion. Many
ongoing trials should provide a larger patient experience
and more definitive outcomes on which management de-
cisions for CA disease will be based.

CONCLUSIONS

Our experience with CA angioplasty and stent place-
ment in a limited number of patients confirms the safety
and durability of endovascular management of recurrent
CA stenosis. The application of bioactive and drug-eluting
stents in the future should further improve the durabil-
ity of endovascular management of recurrent stenosis af-
after CEA.

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