Long-term results of covered stent repair of internal carotid artery dissections

A. Assadian, MD, C. Senekowitsch, MD, R. Rotter, MD, C. Zölß, MD, J. Strassegger, MD, and G. W. Hagmüller, MD, Vienna, Austria

Background: Traumatic and spontaneous dissections of internal carotid arteries (ICA) are rare conditions. So far, these pathologies are primarily treated conservatively, surgical revascularization being an option only after recurrent thromboembolic neurologic episodes or continuous aneurysm growth. Successful endovascular treatment strategies with covered stents have been reported in patients with ICA dissections. However, no long-term results are published so far. Herein, we report our experience of a combined conventional and endovascular repair of ICA dissections under reversed flow and their respective long-term results.

Methods: In a prospective evaluation of clinical and morphologic outcome of 6 patients with carotid artery dissections, 2 patients were treated for continuous aneurysm growth and 4 patients for high-grade ICA stenoses with recurrent thromboembolic episodes during a 6-month follow-up period. A 6-mm polytetrafluoroethylene Hemobahn endoprosthesis was inserted under reversed flow of the internal carotid artery.

Results: No perioperative strokes were observed; one TIA occurred, lasting less than 3 hours; no peripheral cranial nerve injuries or deaths were observed. No occlusions, hemodynamically significant stenosis, or recurrent neurologic symptoms were seen during follow-up, which ranged from 6 to 54 months (mean, 38.3 months).

Conclusion: Open endovascular repair of the ICA of symptomatic patients with dissections with a 6-mm covered endoprosthesis is a safe alternative to conventional surgery, with excellent long-term patency. (J Vasc Surg 2004;40:484-7.)

Traumatic and spontaneous dissections of internal carotid arteries (ICA) are rare conditions compared with atherosclerotic ICA lesions. The incidence of detected dissections is estimated to be 2.5 to 3 per 100 000.1 The reported annual recurrence rate of thromboembolic episodes varies from 0.6% to 10.4%.2,3 The distribution of cerebral infarcts in these patients does suggest that most recurrent events after dissections are thromboembolic, arising from intimal tears.4,5 Widely used primary treatment modalities are antiplatelet therapy or oral anticoagulation.6,7 Additionally, high blood pressure needs to be treated aggressively if present, as hypertensive patients do have a significantly increased risk for recurrent stroke.8 However, prospective randomized controlled trials to compare antiplatelet and oral anticoagulation are pending. So far, there is no level I evidence suggesting one therapeutic modality to be superior for dissections with recurrent symptoms affecting only the minority of patients.3,8 Equally, a combination of these drugs is also not proven to be more effective than either therapy alone. The majority of patients have no recurrence of thromboembolic neurologic episodes on either antiplatelet or oral anticoagulation therapy. Therefore, only patients under oral anticoagulation or antiplatelet therapy for recurrent neurologic episodes and persistent high-grade stenosis or growing aneurysms are considered candidates for surgery after at least 6 months of follow-up.7,9

More recently, successful endovascular treatment strategies with covered stents have been reported in patients with traumatic and spontaneous ICA lesions.10,11 Yet, no long-term results have yet been published. The long-term fate of these patients and their stented arteries is of crucial importance, especially since ICA dissections do affect predominantly younger populations.

Herein, we report our experience of a combined conventional and endovascular covered stent repair of ICA dissections under reversed flow and their respective long-term results.

PATIENTS AND METHODS

Patient selection. Patients with and without symptoms who were referred to our department with carotid artery dissections were initially screened with duplex sonography of the carotid and vertebral arteries accompanied by a magnetic resonance angiography (MRA). If the findings were inconclusive, a digital subtraction angiography (DSA) was performed. In cases of aneurysm formation, a computed tomography (CT) scan was initiated to evaluate maximum diameter and length as well as the thrombus layer of the aneurysm. After assessing all patients neurologically as well as assessing the morphology of the lesions, antiplatelet therapy was commenced or continued.

The indication for operation was given in patients with recurrently symptomatic high-grade stenosis measured by flow velocities and DSA as well as aneurysm formation or enlargement during a 6-month follow-up period.
Patients. From January 1999 to March 2002, 6 patients and ICAs were revascularized by using a hybrid open/endovascular technique. These patients with dissection of the ICA were treated with an intravascular Hemobahn device. The age ranged from 34 to 78 years (mean, 52.8 years). Four patients were male, 2 female. Three patients had hemispheric neurologic symptoms, 1 patient had experienced recurrent episodes of amaurosis fugax, 1 patient had hemiparesis, Horner syndrome, and 1 presented with a peripheral Horner’s syndrome due to aneurysmal compression.

The dissections of all patients with recurrent neurologic symptoms occurred 6 to 8 weeks (mean, 6.5 weeks) prior to referral to our department. One patient had no trauma history; 4 patients had a trauma causing ICA dissection. The patient with unspecified headache with aneurysm growth was not entirely certain about the onset of the symptoms. He reported a bicycle accident, after which the symptoms commenced. This incident was 4 months prior to presentation to our department. The aneurysms measured 2.1 × 2.8 cm and 2.7 × 3.6 cm. The length of the stenosed segments ranged from 1.9 cm to 3.7 cm (mean, 2.9 cm). Of the dissections with stenotic lesions, 2 patients had a persisting false lumen, and 2 patients had a recanalized true lumen with fresh thrombi adherent.

The time from onset of symptoms until surgery ranged from 8 months to 11 months (mean, 9.25 months). Patients, perioperative course, and follow-up are listed in Table I.

Operative procedure. Preoperatively, all patients had a DSA of the extracranial and intracranial ICA. The maximum length and width of the lesions and the estimated landing zones of the graft within the ICA were measured. The covered stent that was used was suitable for all patients and lesions.

After a transverse skin incision of the neck, the CCA, external carotid artery (ECA), and ICA were dissected free with minimal manipulation. Before clamping and manipulating the CCA and ECA, 5000 IU’s of heparin were given intravenously. Subsequently, the blood flow was interrupted by clamping of the CCA and ECA to prevent intraprocedural cerebral embolism during insertion of the device. After transverse arteriotomy, a 7F introducer sheath was inserted into an unaffected portion of the CCA. Under fluoroscopy, a guidewire (Viva Primo 3.75, Boston Scien-

Table I. Patient characteristics

<table>
<thead>
<tr>
<th>Patient</th>
<th>Pathology</th>
<th>Age</th>
<th>Gender</th>
<th>Presenting symptoms</th>
<th>Perioperative morbidity</th>
<th>Clamping time (min)</th>
<th>Follow-up (mo)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Stenosis &gt;80%</td>
<td>49</td>
<td>Male</td>
<td>Recurrent hemiparesis (TIA)</td>
<td>TIA</td>
<td>29</td>
<td>42</td>
</tr>
<tr>
<td>2</td>
<td>Stenosis &gt;80%</td>
<td>43</td>
<td>Female</td>
<td>Recurrent amaurosis fugax</td>
<td>None</td>
<td>12</td>
<td>45</td>
</tr>
<tr>
<td>3</td>
<td>ICA aneurysm</td>
<td>49</td>
<td>Female</td>
<td>Hemiparesis, Horner syndrome</td>
<td>None</td>
<td>14</td>
<td>54</td>
</tr>
<tr>
<td>4</td>
<td>Stenosis &gt;80%</td>
<td>34</td>
<td>Male</td>
<td>Hemiparesis</td>
<td>None</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>ICA aneurysm</td>
<td>78</td>
<td>Male</td>
<td>Unspecific unilateral headache</td>
<td>None</td>
<td>9</td>
<td>35</td>
</tr>
<tr>
<td>6</td>
<td>Stenosis &gt;80%I</td>
<td>64</td>
<td>Male</td>
<td>Recurrent aphasia</td>
<td>None</td>
<td>11</td>
<td>48</td>
</tr>
</tbody>
</table>

ICA, Internal carotid artery; TIA, transient ischemic attack.

DISCUSSION

Traumatic or spontaneous dissections are, even 5 decades after the first carotid artery revascularization for ath-
erosclerotic lesions of the ICA, a challenge in carotid artery surgery. Carotid artery dissections affect predominantly younger adults and are the cause of ischemic stroke in up to 22% of patients under 30 years of age. So far, primary treatment of acute carotid dissection is nonsurgical, with antiplatelet or anticoagulant agents. Spontaneous recanalization of the ICA is described in 47% to 85% of the cases. Intervention is considered indicated if the follow-up angiography (MRA and duplex sonography or DSA) displays a complication caused by the dissection. Surgical management is indicated with stenosis >80% or aneurysm formation. Operative treatment options are either resection of the affected artery and saphenous vein graft replacement or thrombendarterectomy. In cases of lesions exceeding the extracranial ICA, ligation of the artery is reported as safe if the stump pressure is above 70 mm Hg. However, operative morbidity is high. Perioperative stroke rates of 10%, peripheral cranial nerve injury rates of 58%, and mortality rates of 2% in surgically managed patients are reported.

Due to the unfavorable results of surgery, endovascular strategies for treating non-atherosclerotic ICA lesions in patients with recurrent symptoms are increasingly applied. In our series, we chose a hybrid technique to implant a covered stent into the diseased portion of the
ICA. For ICA dissections, a PTFE-covered stent appears to be an ideal therapeutic option. Dissections usually occur in the transition zone of the ICA, where the elastic type of the artery changes into the muscular type.\textsuperscript{21,22} This is usually a few centimeters distal to the carotid bulb. Therefore, a cylindrically shaped graft can be used in a portion of the ICA that usually has little or no caliber changes. All our patients could be treated safely with good anatomical and clinical long-term results.

A carotid approach was chosen for 3 reasons. First, the device had to be implanted with a retrograde flow of the ICA in order to avoid periprocedural embolization. This strategy is especially important since most aneurysms and also stenotic lesions in patient’s dissections do have a thrombus layer despite antiplatelet therapy (Fig 2).\textsuperscript{7} At the time of treating our first patients, we did not have access to a Parodi balloon-occluding sheath or similar devices. Second, microcatheterization of the true lumen in dissections from the femoral approach is technically demanding. By accessing a healthy portion of the CCA, technical success is easily achievable. Finally, the working length of the He-mobahn stent graft was not long enough to reach the distal extracranial ICA safely. We do believe this strategy to be the safest approach until technical shortcomings have completely been solved.

One patient suffered from an intraoperative neurologic deficit affecting the upper extremity corresponding to the operated carotid artery. The symptoms only lasted few hours, and the patient did not have any CT changes. This patient had the longest clamping time of 29 minutes and repeated intraoperative angiographies and guide-wire manipulations. Both circumstances may cause neurologic deficits by different mechanisms.Repeated guide-wire manipulation and angiography may cause embolization; prolonged CCA clamping and flow reversal may cause cerebral hypoperfusion and hence neurologic deficits. It has been reported that up to 10% of patients do not tolerate flow reversal.\textsuperscript{23}

The mean follow-up of our patients was 38.3 months, with a maximum observation period of 54 months. All patients but 1 received postoperatively only acetylsalicylic acid. One patient received a vitamin K antagonist and acetylsalicylic acid due to multiple pulmonary embolisms in the past. During follow-up, no occlusions or hemodynamically significant stenoses were observed. This favorable result is possibly due to the nonatherosclerotic etiology of the ICA pathology and its location at the transition zone, distal to the carotid bulb.

CONCLUSION

Our series of 6 patients and 6 operated ICAs with an open endovascular procedure with a covered stent does demonstrate an alternative to open surgery and percutaneous endovascular intervention for ICA dissections. It is especially an alternative in those patients whose vascular pathologies are exceeding the extracranial course of the ICA or have a difficult femoral access. No occlusions or stenoses were seen during follow-up. After a 30-day follow-up, no patient had any signs of central neurologic deficit induced by the procedure.

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