Superficial temporal and occipital artery bypass pedicles to superior, anterior inferior, and posterior inferior cerebellar arteries for vertebrobasilar insufficiency

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Eighty-three patients underwent 85 intracranial to extracranial pedicle bypass anastomosis procedures to the posterior circulation. There were 15 patients with occipital artery (OA) to posterior inferior cerebellar artery (PICA) anastomosis, 20 patients with OA to anterior inferior cerebellar artery (AICA) anastomosis, and 50 patients with superficial temporal artery (STA) to superior cerebellar artery (SCA) anastomosis. All patients had transient ischemic attacks (TIA's) suggestive of vertebobasilar ischemia. Twenty-seven patients had crescendo TIA's or stroke in evolution and were considered to be clinically unstable. All patients had severe bilateral distal vertebral artery or basilar artery disease. Twenty-two patients had bilateral vertebral artery occlusion and three had basilar artery occlusion. In this series, 69% had complete resolution of symptoms; the mortality rate was 8.4% and the morbidity rate 13.3%. Clinically stable patients did better than unstable patients. The STA-SCA anastomosis was well tolerated and technically less demanding than the OA-PICA or OA-AICA anastomosis procedures. Patients with symptomatic severe bilateral vertebral or basilar artery disease have a grave prognosis and the option of a surgical arterial pedicle revascularization procedure should be offered to them.

KEY WORDS - verteobasilar insufficiency - anterior inferior cerebellar artery - revascularization - superior cerebellar artery - posterior inferior cerebellar artery

Vertebobasilar insufficiency (VBI) occurs approximately one-half as frequently as anterior circulation ischemia. As in the carotid system, atherosclerosis is the most common disease process affecting the vertebobasilar circulation. Transient ischemic attacks (TIA's) in either circulation are associated with a 35% risk of subsequent infarction over 4 to 5 years. Ausman, et al., performed the first intracranial posterior circulation revascularization procedure for VBI: an occipital artery (OA) to posterior inferior cerebellar artery (PICA) anastomosis. Subsequently, the OA to anterior inferior cerebellar artery (AICA) anastomosis and the superficial temporal artery (STA) to superior cerebellar artery (SCA) anastomosis procedures were developed for the treatment of VBI. In this paper, we review our experience with 83 patients who underwent 85 intracranial (IC) to extracranial (EC) arterial pedicle bypass anastomoses to the posterior circulation.

Clinical Material and Methods

From November, 1984, to March, 1988, 83 patients underwent posterior circulation bypass surgery for VBI. There were 15 patients with OA-PICA anastomosis, 19 patients with OA-AICA anastomosis, one patient with a tandem bypass of the same OA to both the PICA and AICA ipsilaterally, and 50 patients with STA-SCA anastomosis. Two of the patients who had STA-SCA anastomosis had previously undergone OA-PICA anastomosis. The patient with the tandem bypass to both PICA and AICA was placed in the OA-AICA group when the results were analyzed. There were 70 men and 13 women, with an age range of 40 to 79 years (mean 58 years).

All patients presented with symptoms suggestive of VBI. We considered patients with crescendo TIA's or stroke in evolution as being clinically unstable (26 patients). Of the 57 stable patients, 25 (44%) received
IC-EC pedicle anastomosis for vertebrobasilar insufficiency

**TABLE 1**

<table>
<thead>
<tr>
<th>Severity of Disease</th>
<th>OA-PICA</th>
<th>OA-AICA</th>
<th>STA-SCA</th>
<th>Total Cases</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>stable TIA's</td>
<td>5</td>
<td>10</td>
<td>18</td>
<td>33</td>
<td>39</td>
</tr>
<tr>
<td>stable TIA's while anti-coagulated</td>
<td>7</td>
<td>4</td>
<td>15</td>
<td>26</td>
<td>31</td>
</tr>
<tr>
<td>unstable crescendo TIA's</td>
<td>2</td>
<td>4</td>
<td>11</td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>unstable stroke in evolution</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>total cases</td>
<td>15</td>
<td>20</td>
<td>50</td>
<td>85</td>
<td>100</td>
</tr>
</tbody>
</table>

* OA = occipital artery; PICA = posterior inferior cerebellar artery; AICA = anterior inferior cerebellar artery; STA = superficial temporal artery; SCA = superior cerebellar artery; TIA = transient ischemic attack.

**TABLE 2**

<table>
<thead>
<tr>
<th>Type of lesion and anastomosis performed*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesion</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>bilat distal VA occlusion</td>
</tr>
<tr>
<td>distal VA stenosis with contralateral VA occlusion hypoplasia or stenosis</td>
</tr>
<tr>
<td>proximal BA stenosis/occlusion</td>
</tr>
<tr>
<td>mid-BA stenosis/occlusion</td>
</tr>
</tbody>
</table>

* OA = occipital artery; PICA = posterior inferior cerebellar artery; AICA = anterior inferior cerebellar artery; STA = superficial temporal artery; SCA = superior cerebellar artery; VA = vertebral artery; BA = basilar artery.

Results

Table 3 summarizes the postoperative outcome in the 83 patients in this series. The average follow-up period was 25 months (range 2 months to 9 years).

**OA-PICA Anastomosis**

Postoperative angiography showed patency in eight (73%) of 11 OA-PICA anastomoses (Fig. 1). Eight (53%) of the 15 patients undergoing this procedure had complete resolution of their symptoms. There was one death secondary to cardiac failure. Three patients developed neurological deficits after surgery (left hemiplegia in one, quadriplegia in one, and brain-stem deficits in one), and three had recurrent VBI symptoms. Angiography revealed an occluded anastomosis in two of the patients with recurrent VBI; these two subsequently underwent STA-SCA anastomosis, after which their symptoms resolved. The third patient developed unilateral dysmetria 3 months after surgery despite a functioning anastomosis; the dysmetria improved over several weeks.

**TABLE 3**

Operative outcome of the 85 procedures in 83 patients*

<table>
<thead>
<tr>
<th>Procedure &amp; Severity of VBI</th>
<th>No. of Cases</th>
<th>Resolution of Symptoms</th>
<th>Mortality</th>
<th>Morbidity</th>
<th>VBI Recurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>OA-PICA bypass</td>
<td>15</td>
<td>8 (53%)</td>
<td>1 (7%)</td>
<td>3 (20%)</td>
<td>3 (20%)</td>
</tr>
<tr>
<td>OA-AICA bypass</td>
<td>20</td>
<td>14 (70%)</td>
<td>1 (5%)</td>
<td>2 (10%)</td>
<td>3 (15%)</td>
</tr>
<tr>
<td>STA-SCA bypass</td>
<td>50</td>
<td>35 (70%)</td>
<td>5 (10%)</td>
<td>6 (12%)</td>
<td>4 (8%)</td>
</tr>
<tr>
<td>stable cases</td>
<td>58</td>
<td>45 (78%)</td>
<td>3 (5%)</td>
<td>4 (7%)</td>
<td>6 (10%)</td>
</tr>
<tr>
<td>unstable cases</td>
<td>27</td>
<td>12 (44%)</td>
<td>4 (15%)</td>
<td>7 (26%)</td>
<td>4 (15%)</td>
</tr>
</tbody>
</table>

* VBI = vertebrobasilar insufficiency; OA = occipital artery; PICA = posterior inferior cerebellar artery; AICA = anterior inferior cerebellar artery; STA = superficial temporal artery; SCA = superior cerebellar artery.
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**OA-AICA Anastomosis**

Postoperative angiography showed patency in 15 (94%) of 16 OA-AICA anastomoses (Fig. 2). Fourteen (70%) of the 20 patients undergoing this procedure had complete resolution of symptoms. There was one death secondary to brain-stem infarction. Two patients developed major morbidity secondary to sepsis and meningitis. Three patients developed recurrent VBI symptoms between 9 months and 2 years after their surgery despite demonstration of a functioning anastomosis on angiography.

**STA-SCA Anastomosis**

Postoperative angiography showed patency in 48 (98%) of 49 STA-SCA anastomoses (Fig. 3). Thirty-five (70%) of the 50 patients undergoing this procedure had complete resolution of symptoms. There were five deaths, three in the clinically unstable group which were due to perioperative brain-stem infarction. In the clinically stable group, one patient died from a leaking anastomosis. The second death was due to an unexpected basilar artery thrombosis 2 weeks after surgery in a patient who was discharged home in good condition. Four patients in this group had recurrent VBI symptoms. In the two patients who underwent angiography, the anastomosis was still patent. In all four cases with disease recurrence, the VBI symptoms eventually resolved.

**Discussion**

The syndrome of VBI has recently been reviewed. The natural history of the various pathological "patterns" of atherosclerotic disease causing VBI has not been well defined. Cartlidge, et al.,11 using strict diagnostic criteria for VBI but without angiography, documented a 35% risk of infarction over 4 to 5 years. There is evidence that atherosclerosis in various parts of the posterior circulation can present with similar VBI symptoms and yet have a different prognosis. The origin of the vertebral arteries is the most common site of pathology in the vertebrobasilar system and is a common cause of VBI; however, disease at this site is less likely to result in infarction because of extensive collateral circulation in contrast to more distally located disease where the collateral circulation is less well developed. Symptomatic, angiographically defined basilar artery occlusion and bilateral distal vertebral artery occlusion are associated with a mortality rate as high as 70% and significant morbidity in survivors. Caplan9 reported a series of nine patients with bilateral distal vertebral artery occlusion, all of whom died subsequent to brain-stem infarction within 2 weeks from the onset of symptoms.

The patients selected for surgery in our series belonged to the category of patients with VBI who have a grave prognosis. Twenty-two patients had bilateral distal vertebral artery occlusion and three had basilar artery occlusion. The rest had severe bilateral vertebral or basilar artery disease. In our series 69% of patients had complete resolution of symptoms after surgery, 8.4% died, and 13.3% suffered morbidity; this represented better results than appear to be seen in the natural history of the disease.

The clinical severity of the VBI affects the outcome of the patients. Table 3 clearly shows a better outcome in clinically stable patients as compared to unstable patients. This difference in outcome highlights the im-

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**Fig. 2.** Postoperative selective external carotid angiogram demonstrating patency of an occipital artery to anterior inferior cerebellar artery anastomosis.

**Fig. 3.** Postoperative selective carotid angiogram demonstrating patency of a superficial temporal artery to superior cerebellar artery anastomosis.
IC-EC pedicle anastomosis for vertebrobasilar insufficiency

importance of treating VBI early. If stable patients are medically managed until they become unstable before surgery is considered, the risk of surgery is going to escalate.

The arterial pedicle in posterior circulation revascularization must be anastomosed to a vessel distal to the occlusive lesion. For this reason, OA-PICA and OA-AICA anastomoses are unsuitable for mid-basilar artery lesions. In our effort to find a treatment for VBI, we first developed the OA-PICA anastomosis operation, then the OA-AICA followed by the STA-SCA anastomosis procedures. We find that the STA-SCA anastomosis is better tolerated by patients than the other operations and is technically less demanding because the vessels involved are usually larger in diameter. Anatomical studies from our laboratory revealed that the perimesencephalic SCA is well suited to microvascular anastomosis in that it is sizable, can be mobilized, and is relatively devoid of brain-stem perforators. We have used the STA-SCA anastomosis almost exclusively in the past 3 years for posterior circulation revascularization. The higher mortality and morbidity rates in the STA-SCA operation group when compared to the OA-AICA anastomosis group (Table 3) is a result of the larger number of unstable patients who underwent STA-SCA anastomosis (Table 1).

Hopkins, et al.,12 reported good results in 36 OA-PICA and STA-SCA anastomosis procedures. There was one death, and one patient whose bypass became occluded remained symptomatic; the rest of the patients had complete resolution of their symptoms. Sundt and Piepgras25 described good results with OA-PICA anastomosis and interposition venous graft bypass from the external carotid to the posterior cerebral artery. Olteanu-Nerbe, et al.,17 Roski, et al.,18 and Khodadad16 all reported good results with OA-PICA anastomosis. Review of these reports on posterior circulation bypass procedures shows that this technique can be performed with high patency and reasonable mortality and morbidity rates.

The role of medical management of VBI is unclear. Heparin and/or Coumadin have been used on an empirical basis. In our series, the clinically unstable patients and 44% of the stable patients were symptomatic despite receiving anticoagulation therapy with heparin or Coumadin.

This paper describes the outcome in symptomatic patients with significant distal vertebral artery and basilar artery disease after an arterial pedicle anastomosis procedure. The outcome appears to be better than the natural history of the disease. The challenge facing those managing patients with VBI is to better define the natural history of the various patterns of posterior circulation atherosclerosis. This can only be done if patients with VBI undergo angiography or autopsy. Current knowledge suggests that the prognosis is grave in symptomatic patients with significant distal vertebral artery and basilar artery disease, and that surgery improves the outcome. Until information is available to disprove the grave prognosis in this group of patients with VBI, the option of surgical revascularization should be offered to them.

References


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