Occipital artery to extradural vertebral artery bypass procedure

Case report

MARK N. HADLEY, M.D., ROBERT F. SPETZLER, M.D., ROBERTO MASFERRER, M.D., CAPT. MC, USAF, NEIL A. MARTIN, M.D., AND L. PHILIP CARTER, M.D.

Division of Neurological Surgery, Barrow Neurological Institute, Phoenix, Arizona

A 17-year-old boy suffered blunt trauma to the posterior cervical spine and later developed vertebrobasilar transient ischemic attacks refractory to medical management. At angiography, a pseudoaneurysm of the distal left vertebral artery was found. By means of a posterior midline approach, an extradural occipital artery to vertebral artery anastomosis was performed and the affected vertebral artery was clipped distal to the pseudoaneurysm. The indications for this procedure, the operative approach, and the clinical outcome are described.

KEY WORDS: • vertebral artery • traumatic pseudoaneurysm • bypass procedure • ischemia • occipital artery

REvascularization of the posterior fossa for vertebrobasilar insufficiency has become an important therapeutic option in the treatment of thrombo-occlusive cerebrovascular disease. Extracranial to intracranial (EC-IC) bypass procedures are currently being performed with increasing frequency and variation with respect to donor and recipient blood vessels.

We present a case of recurrent vertebrobasilar ischemia due to emboli from a pseudoaneurysm of the cervical vertebral artery. One of the authors (R.F.S.) exposed the vertebral artery posteriorly and performed an extradural occipital artery to vertebral artery bypass procedure distal to the pseudoaneurysm and clipped the vertebral artery just proximal to the anastomosis. With this procedure we were able to preserve blood flow through the affected vertebral artery and to eliminate the embolic source of the recurrent transient ischemic attacks (TIA's). To the best of our knowledge, this is the first report of a successful extradural occipital artery to distal vertebral artery bypass procedure undertaken through a posterior approach.

Case Report

This healthy 17-year-old boy suffered blunt trauma to the neck while playing basketball 7 weeks prior to transfer to our institution. While rebounding a basketball he was struck with an elbow in the posterior aspect of the neck at the craniocervical junction. He was momentarily dazed but did not lose consciousness. Two weeks after this incident, the patient was playing basketball when he suddenly developed nausea, vomiting, diplopia, and vertigo. These symptoms cleared after a few minutes but recurred with associated dysarthria, gait ataxia, and a right homonymous hemianopsia. Again, all his symptoms resolved except for a residual right inferior quadrantanopsia. He was evaluated at a regional hospital. An angiogram revealed a pseudoaneurysm of the left vertebral artery just above the transverse foramen of the axis. An irregular roughened intima with mural thrombus was visualized (Fig. 1).

The patient was maintained on intravenous heparin. Each time the heparin was tapered the patient suffered recurrent TIA's, despite concomitant anticoagulation therapy with Coumadin (sodium warfarin). After 28 days of heparinization, he received an intramuscular injection for pain relief and developed massive hemorrhage into his right buttock and thigh. He developed weakness and numbness of the right lower extremity due to femoral nerve compression and severe pain at the hematoma site.

Admission. The patient was transferred to the Bar-
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row Neurological Institute by air ambulance. Repeat angiography demonstrated the previously noted vascular pathology. Computerized tomography revealed an infarction in the left occipital lobe.

Operation. The patient was taken to surgery while still heparinized, and the left vertebral artery was exposed through a midline posterior approach (Fig. 2 left). Bone was removed from the transverse foramen of the atlas, and the pseudoaneurysm was examined. Primary repair of the vertebral artery was not feasible, so the vertebral artery was clipped just distal to the intimal laceration. In order to prevent a source of emboli from a vessel stump and to maintain flow through the major vertebral artery, an occipital artery to vertebral artery anastomosis procedure was performed. This was accomplished just distal to the clip but proximal to the vertebral artery entering the dura (Fig. 2 right). Heparinization was then discontinued.

In our experience, continuous intraoperative electroencephalography, brain-stem evoked potential monitoring, and barbiturate anesthesia have been positive adjuncts when performing neurovascular operations.6 These techniques were utilized in this case.

Postoperative Course. The patient had no new deficit, but the incomplete right inferior quadrantanopsia persisted. The right buttock and thigh hematoma improved with conservative care. There was resolution of numbness and weakness in the right leg. Postoperative angiography revealed a widely patent bypass. The vertebral artery filled to the clip, continuing to supply flow to the muscular branches. The pseudoaneurysm and source of emboli had been effectively eliminated from the intracranial circulation (Fig. 3).

FIG. 1. Preoperative angiogram, oblique subtraction view, of the left vertebral artery showing the pseudoaneurysm.
Discussion

George and Laurian\textsuperscript{8} described a posterolateral approach to the distal vertebral artery which they had effectively employed in eight cases of extracranial vertebral artery pathology. Others have advocated an anterior or anterolateral approach to extracranial distal vertebral artery disease, allowing dissection of the external carotid artery or one of its proximal branches for use in anastomosis to the diseased vertebral artery.\textsuperscript{3,13} None of these approaches would have been practical in our case.

We employed a posterior midline approach with the patient in the prone position. With this technique we avoided the need to turn the patient’s head and were able to perform surgery with minimal traction on the diseased vertebral artery, therefore reducing the risk of intraoperative embolization. Access to the vertebral artery was relatively simple through a wide lateral exposure. Once it was decided that primary repair of the vertebral pseudoaneurysm was not possible, the artery was clipped and an occipital to vertebral artery bypass was performed.

We have previously used the posterior midline approach to perform an occipital to vertebral artery bypass in three cases, once for a traumatic pseudoaneurysm and twice for thrombo-occlusive vertebrobasilar disease. The advantage of an extradural anastomosis between the occipital artery and the vertebral artery, aside from the comparative technical ease of the procedure, is in the avoidance of meningismus, cerebrospinal fluid leakage, and possible brain-stem injury which can occur with an intradural approach. The operative exposure with the extradural technique allows intradural examination of the vertebral artery should this be necessary.

The decision to perform an occipital to vertebral artery bypass in this patient with a normal yet small contralateral vertebral artery instead of simply occluding the affected vertebral artery is controversial. There are limited data in the literature regarding the outcome in patients who have had surgical ligation of the vertebral artery. Shintani and Zervas\textsuperscript{16} reviewed 100 cases of vertebral artery ligation and noted a mortality rate of 12\%, yet only five patients had a documented ischemic cause of death. Three others had postoperative ischemic complications resulting in mild to moderate disability.

Drake\textsuperscript{6} and others have reported a favorable experience with unilateral vertebral artery occlusion in the treatment of large unclippable vertebrobasilar aneurysms, indicating that ischemia due to hypoperfusion is of little consequence in patients with bilateral vertebral artery contributions to the basilar system. Of considerable concern, however, is the risk of distal embolization following surgical ligation of the vertebral artery and/or the potential for propagation of a thrombus.

Recently Steinberger, et al.,\textsuperscript{18} and Yamada, et al.,\textsuperscript{20} reported embolic complications following therapeutic occlusion of the parent vertebral artery for giant aneurysms of the vertebrobasilar system. The emboli were presumably from the incompletely thrombosed aneurysm or due to propagation of thrombus from the site of vertebral artery occlusion.

Fisher, et al.,\textsuperscript{7} in their description of lateral medullary infarction, found vertebral artery occlusion in 14 patients. While they did not address surgical occlusion of the vertebral artery, they did document vertebrobasilar TIA’s due to emboli originating from the site of vertebral artery occlusion in patients with atherosclerotic thrombotic vascular disease. Castaigne, et al.,\textsuperscript{4} reviewed 44 patients with vertebrobasilar arterial occlusions and found that the predominant pathological lesions were thrombo-occlusive in nature. It is significant that, among 13 patients with “pure” vertebral artery occlusion (that is, unilateral vertebral artery occlusion with no other major arterial occlusions), six had a medullary and/or cerebellar infarction from either embolization or propagation of thrombus. Two other patients with unilateral vertebral artery thrombosis had evidence of emboli and subsequent infarctions in the posterior cerebral artery distribution.

The risk of embolization from a surgically occluded vessel in the anterior circulation is well documented. Odom and Tindall\textsuperscript{12} reviewed 220 patients with intracranial aneurysms who were treated with common carotid artery ligation. Sixteen percent developed postoperative complications due to hypoperfusion and/or embolization. Roski, et al.,\textsuperscript{15} have also reported a high incidence of immediate TIA’s and stroke following ligation of the common or internal carotid arteries. They also described a delayed risk of TIA and stroke in this group. It may be that vertebral artery occlusion

![Fig. 3. Postoperative angiogram with external carotid artery injection demonstrating the occipital artery (small arrows), the site of anastomosis (open arrow), and blood flow into the distal vertebral and basilar arteries (large arrows). Note the proximity of the clip to the anastomosis, leaving no distal stump.](image-url)
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is analogous to internal carotid artery ligation in that the site of occlusion may serve as a nidus for thrombus formation, creating a column of vascular dead space from which emboli may be generated. Although an EC-IC bypass in combination with internal carotid artery occlusion decreases the ischemic risk, there remains a real risk of embolization despite revascularization.5,10,17

The advantage of the present procedure over internal carotid artery occlusion and superficial temporal-middle cerebral artery revascularization is that the anastomosis to the vertebral artery is directly above the surgical occlusion, effectively eliminating the vascular column of dead space from which an embolus could originate.

The evidence suggests that elective vertebral artery occlusion may not be an entirely benign entity. While the precise incidence is unavailable, it is apparent that distal embolization from an occluded vertebral artery is a real phenomenon. Because of the relative technical ease of performing the extradural occipital artery to vertebral artery anastomosis via this approach, we elected not only to occlude the affected vertebral artery, but also to create the bypass above the pseudoaneurysm at the C-1 level. Although we cannot definitely establish that the bypass will be protective in this circumstance, we believe that the end-to-side anastomosis just above the surgical clip effectively eliminates the anatomical substrate on which a thrombus could form, thus reducing the likelihood of recurrent embolization and/or propagation of thrombus to distal vascular channels while at the same time maintaining patency of the major vertebral artery.

Conclusions

We present a case of blunt injury to the neck with pseudoaneurysm formation of the vertebral artery as it exits from the transverse foramen of the axis. This patient had recurrent vertebrobasilar TIA's and a small stroke despite long-term anticoagulation therapy. In an attempt to eliminate the pseudoaneurysm and the embolic source, as well as to maintain blood flow through the affected vertebral artery, we performed an extradural occipital artery to vertebral artery bypass procedure through a posterior midline approach. We believe this technique (which we have performed a total of three times previously with zero morbidity and mortality and 100% patency) may be useful in other forms of vertebrobasilar insufficiency where extradural revascularization of the distal vertebral artery may be indicated.

References


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Address reprint requests to: Robert F. Spetzler, M.D., c/o The Editorial Office, Barrow Neurological Institute, 350 West Thomas Road, Phoenix, Arizona 85013.