Novel technique to improve vessel mismatch when using saphenous vein bypass grafts for intracranial revascularization procedures

Technical note

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Cerebral bypass procedures in the posterior circulation are difficult to perform and are considered to be high-risk surgery. Venous grafts, like that formed using the saphenous vein (SV), are simple to obtain without posing a high risk of morbidity. The main disadvantage of these high-flow grafts is the mismatch in vessel diameter between donor and recipient vessels in the posterior circulation.

The authors performed a retrospective case study based of data from intraoperative video, patient charts, axial images, and cerebral angiograms.

They treated a 66-year-old man who presented with a giant aneurysm of the verteobasilar junction and another large aneurysm of the basilar tip. They chose to create a vertebral artery (VA)–superior cerebellar artery anastomosis with a tapered-down SV graft. It was necessary to reengineer the SV graft to include a gentle taper that would allow for this anastomosis. The vein was incised for a distance of 2.5 cm. A triangular section of the vein, 2 mm at the base and 20 mm high, was then excised from the opened end of the SV. The 2.5-cm-long venotomy was then closed with interrupted 9-0 Prolene sutures creating a gentle taper to the vein down to ~ 2.5 mm in diameter. Thereafter, the authors created a standard end-to-side anastomosis of the VA to the SV with 8-0 Prolene. Postoperatively both VAs were obliterated with coils just proximal to the verteobasilar aneurysm. The bypass was patent; after a prolonged stay in the intensive care unit, the patient recovered gradually.

This technique of linear venotomy along the distal 2.5 cm of the vein and subsequent tapering down of the diameter diminishes the circumference of the distal end of the graft, facilitating bypass to smaller vessels. This is a novel and feasible technique to eliminate vessel mismatch in cerebral bypass procedures in the difficult accessible vessels of the posterior circulation. (DOI: 10.3171/2009.9.JNS09367)

Key Words • cerebral bypass • revascularization • posterior circulation • saphenous vein • high-flow bypass • giant aneurysm

Abbreviations used in this paper: PCA = posterior cerebellar artery; SCA = superior cerebellar artery; SV = saphenous vein; SVG = SV graft; VA = vertebral artery.
We have developed an easy and feasible technique to decrease vessel mismatch between the recipient arteries and the donor veins for cerebral bypass procedures, thus allowing for the use of SVG bypass in cases in which vessel mismatch may have previously precluded their use.

Methods

We performed a retrospective case study based on data obtained from intraoperative video, patient charts, axial images, and cerebral angiograms. The surgical strategy was documented during surgery, and the results of this novel technique were excellent.

A 66-year-old man presented with difficulty ambulating (he was wheelchair dependent), and he had dizziness, dysarthria, hearing loss, and mild expressive aphasia. Radiological studies revealed a giant aneurysm of the vertebrobasilar junction/trunk as well as a large aneurysm of the basilar tip (Fig. 1). Balloon test occlusion demonstrated only toleration of single vertebral vessel occlusion, but either remaining VA readily filled the aneurysm.

The surgical plan was to anastomose the VA with the posterior circulation and subsequent endovascular occlusion. Because the PCA was difficult to access with sufficient exposure to create an anastomosis, we instead created a VA-SCA bypass. The SCA was too small to allow for a direct end-to-side anastomosis with the SVG. Consequently, it was necessary to reengineer the SVG to include a gentle taper that would allow for an anastomosis between the large SV and the SCA (Fig. 2).

Specifically, the SV was measured so that it would be able to reach from the vertebral loop at C1–2 to the SCA at the tentorial incisura exposed via a subtemporal approach. Next, the vein was incised for a distance of 2.5 cm. A triangular section of the vein, 2 mm at the base and 20 mm high, was excised from the opened end of the SV. The 2.5-cm-long venotomy was then closed with interrupted 9-0 Prolene sutures, creating a gentle taper to the vein, down to ~ 2.5 mm in diameter. For this maneuver, the vein was placed on a sterile towel, working with high magnification. No device was used to manipulate the vessel other than a pair of fine forceps and the needle (Fig. 2 lower).

The distal diameter of the SVG was thus reduced from ~ 5 mm to ~ 2 mm, which allowed anastomosis with the SCA, also 2 mm in size. The vessel was then tested for integrity by placing an aneurysm clip at the very end of the tapered vessel and using a syringe to vigorously inflate the structure.

After introducing 5000 U heparin intravenously, we created a standard end-to-side anastomosis of the VA to
the SV with 8-0 Prolene. The distal anastomosis was then created using 9-0 Prolene, also utilizing an end-to-side technique. Intraoperative angiography demonstrated the patency of the bypass (Fig. 3). Postoperatively, both VAs were obliterated with coils placed just proximal to the vertebrobasilar artery aneurysm.

In the intensive care unit the patient was unresponsive due to status epilepticus, which was resolved using antiepileptic drugs and benzodiazepine therapy. Following this, the patient continued to require intensive care and exhibited gradual progress. He was monitored closely with both CT perfusion scanning and angiography. Studies demonstrated the patency of the bypass, no ischemic injuries, and a well-perfused brainstem. Two weeks after the procedure the patient’s neurological status improved and he became awake and interactive.

One month postoperatively, angiography demonstrated patency of the bypass (Fig. 4). At the time of discharge to a rehabilitation hospital, the patient was neurologically stable, communicative, interactive, and had recovered to his preoperative level of performance. He returned home 6 months after surgery, his neurological function having advanced beyond his original baseline status; he was now capable of simple activities involving the care for himself, but he still required care from family members. Additional angiography was planned 1 year after surgery, but the patient died of end-stage cardiac disease and urosepsis.

Discussion

Following a decrease in the number of cerebral bypass procedures performed after the publication of negative results of the EC/IC Study Group in 1985, cerebral revascularization underwent a period of rebirth during the last decade. The increased use of revascularization has been in part due to its utility in the management of complex aneurysms and vascular anomalies. Numerous reports on methods of revascularization involving a superficial temporal artery bypass, radial artery graft, or SVG have been described. In the posterior fossa, SVGs, though readily available and harvested with minimal morbidity, require large recipient arteries, either the PCA, VA, or the basilar artery. In the case presented here, elevation of the PCA by the mass of the aneurysm made exposure and anastomosis to the PCA technically difficult. Access...
of 3.91 ± 0.54 mm). Moreover, as in our case, the diameter of the SCA was even smaller than the diameter of the PCA. Suturing a donor vessel that is almost twice the size of the recipient vessel poses a high risk of creating blood flow turbulence and subsequent thrombosis or embolism. If the ratio of the diameter of graft to parent vessel is 2:1 or more, the possibility of graft occlusion is a very high. Even the distal SV is too large for the small posterior circulation vessels. Another difficulty in long-term patency of the SVG graft is the transition from a high-flow vessel (SVG) to a low-flow vessel (PCA).

An alternative is a radial artery graft, which has a similar graft to recipient vessel diameter and a higher rigidity for suturing, but the excision of the radial artery is an invasive procedure associated with a substantial incidence of local morbidity. Moreover, harvesting of the vessel, as well as the possibility of perioperative vasospasm, increases the risk of major complications. Another way of compensating for vessel mismatch may be the linear arteriotomy. Nevertheless, this procedure prolongs the manipulation period and the extent of the manipulation of the recipient artery, with the possible chance of creating vasospasm.

In contrast, the morbidity of harvesting the SV is minimal, particularly when utilizing minimally invasive endoscopic techniques.1

**Conclusions**

Our technique for performing a linear venotomy along the distal 2.5 cm of the vein and subsequent tapering down of the diameter diminishes the circumference of the distal end of the graft, facilitating bypass to smaller vessels (Fig. 2). We have described a novel technique for eliminating structural mismatch between donor and recipient vessel in the posterior circulation. The advantages of minimal morbidity associated with obtaining venous grafts rather than arteries are evident. This method broadens the neurosurgical operative spectrum for venous bypass procedures in the posterior fossa.

**Disclaimer**

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

**References**


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*Fig. 4.* Anteroposterior (*upper*) and sagittal (*lower*) angiograms obtained 1 month postoperatively showing that the bypass is patent.
Technique to improve vessel mismatch


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