Endoscopic harvesting of the radial artery for neurovascular bypass

Technical note

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Object. The radial artery is a common conduit used for high-flow bypasses. Until now the radial artery has been harvested using a long incision in the forearm that follows the course of the artery. The authors present an endoscopic technique that has been used during coronary bypass surgery but is not yet widespread in the neurosurgical arena.

Methods. From October 2006 to October 2007, the authors used the radial artery as a graft in 6 patients during the treatment of complex cerebral aneurysms. The artery was harvested via an endoscopic technique.

The radial artery was exposed distally at the wrist. Using the VasoView vessel harvesting system, the endoscope was inserted into the arm. The radial artery was dissected from its surrounding tissues endoscopically. With direct current energy via the HemoPro device, the side branches were coagulated and cut. The artery was transected at the wrist, then retrieved through a counterincision at the proximal forearm.

Results. There were no neurological or bleeding complications in the hand or forearm.

Conclusions. Endoscopic harvesting of the radial artery is feasible, faster, and produces a more aesthetically pleasing result than standard open harvesting. The learning curve associated with the endoscope can be overcome by practice on cadavers and by collaboration with a cardiac surgical team. (DOI: 10.3171/FOC/2008/24/2/E10)

KEY WORDS • bypass • endoscopy • graft • radial artery

Clinical Materials and Methods

Between October 2006 and October 2007, 6 patients (3 male, 3 female; age range 17–58 years; mean age 38 years) required a high-flow bypass during the management of complex aneurysms. The artery was harvested as described in the following sections.

Preoperative Testing

Collateral blood flow in the hand via the palmar arch must be assessed when the radial artery will be sacrificed. We used a modified Allen test, which is performed by placing a pulse oximeter on the thumb and simultaneously compressing the radial and ulnar arteries until the oximeter waveform is flat. The compression on the ulnar artery is then released, leaving only the radial artery under compression. If the palmar arch is complete, the curve on the oximeter should return to its normal waveform within a few seconds. When the results regarding the collateral circulation are ambiguous, formal arterial Doppler studies with arterial compression should be performed. As a safety

EXTRACRANIAL–INTRACRANIAL bypass has a role in the management of complicated cerebral aneurysms, in patients with cerebral hypoperfusion related to atherosclerotic disease, in skull base surgery when a major vessel must be sacrificed, and in the radical treatment of tumors. Significant evidence from the cardiothoracic literature⁴ indicates that endoscopic harvesting of the radial artery for a coronary bypass is advantageous because harvesting time is decreased, aesthetic outcomes improve, and the incidence of numbness and paresthesia decreases.⁴ This technique has been used to harvest the saphenous vein for EC–IC bypasses with excellent results.¹ About 7 years ago we began using the radial artery rather than the saphenous vein when we anticipated the need for a high-flow bypass conduit. This past year, in collaboration with the chief physician assistant of our hospital's cardiac surgery service (D.L.P.), we have harvested 6 radial artery grafts endoscopically.

Abbreviations used in this paper: EC–IC = extracranial–intracranial; STA = superficial temporal artery.

backup in the event of moderate bleeding, a nonsterile tourniquet is placed on the upper arm but not inflated.

Surgical Technique

The craniotomy and neck exposure were initiated concurrently with harvest of the radial artery. The radial artery pulse was identified 3 cm proximal to the wrist crease. A 2-cm incision was made through the skin, subcutaneous tissue, and fascia. The artery was identified and dissected from the surrounding tissue along with its 2 complementary veins. Branches that were seen directly were clipped and cut.

We used the VasoView system (Boston Scientific) to harvest the radial artery. First, the endoscope was used to carefully free the artery from the surrounding subcutaneous tissues. The artery was dissected upward to 3 cm below the antecubital fossa at the elbow. Under endoscopic visualization, a semicircular cradle was used to protect the radial artery while direct current energy (HemoPro, Boston Scientific) was used to coagulate and cut the side branches. The cradle was then directed along the entire course of the artery ensuring separation from its surrounding tissue and branches. When directing the cradle, one must be careful not to evulse any branches.

The distal (wrist) end of the artery was then ligated with a suture ligature stitch. The artery was cut at the wrist and a clip was applied to it to prevent bleeding. Under endoscopic visualization a 3-mm counterincision was made through the skin, just below the elbow crease. The soft adventitia of the artery was grasped with mosquito forceps and retrieved through the small proximal (elbow) counterincision. A suture ligature was placed, and the artery was cut and removed completely from the arm. The remaining stump retracted back into the arm. The proximal and distal ends of the vessel should be marked with a surgical pen. Both incisions were irrigated and closed in 2 planes with absorbable sutures. Harvest times averaged 1 hour, skin to skin.

On a side table, the artery was irrigated carefully with a papaverine solution to remove intraluminal blood and prevent vasospasm. Any remaining side vessels were tied with 4-0 silk. The artery was mounted on a blunt needle attached to a 20-cm³ syringe and very gently distended sequentially in segments to check for patency and any leakage from side branches. (It has been reported in the cardiac literature that aggressive distention promotes vasospasm.³) The artery is then stored in a normothermic papaverine solution until needed. As this vessel is prone to spasm, it must be handled carefully during sewing of the anastomoses. Postoperatively, patients are administered calcium channel blockers orally to help prevent spasm.

Results

All arteries appeared to be acceptable. Based on our experience, there were no obvious differences from vessels harvested in an open fashion. No case had to be converted to an open procedure for arterial harvesting. No complications related to the harvesting occurred, but in one patient acute aphasia developed on the 2nd postoperative day. Angiography performed on an emergency basis demonstrated vasospasm at the distal end of the anastomosis. The patient

was treated with an intraarterial infusion of nicardipine, which reversed his symptoms. The cosmetic outcome of all 6 cases was excellent.

Discussion

Initiated by Yaşargil in the late 1960s, EC-IC bypass surgery involves anastomosing the STA to the middle cerebral artery in a patient with a carotid occlusion. As a donor vessel, the STA is easily accessed and only one end must be sutured. The STA must mature; that is, its size must be allowed to increase over time to match the volume of blood delivered to it. Because maturation takes time, the capacity of the STA to carry large volumes of blood quickly is questionable.

An alternative is to use a larger conduit, high-flow bypass based on the volume of blood that will flow through the bypass. Such high-flow bypasses, which are also called replacement bypasses, deliver blood at a rate ≥ 50 cm³/minute. Saphenous veins and radial artery grafts are classified as high-flow bypasses. Lougheed et al.⁶ described the use of a saphenous vein graft in a bypass from the common carotid artery to the internal carotid artery in a patient with occlusion of the carotid artery. Sundt and colleagues^{8,9} described the early use of high-flow (saphenous vein) bypasses for the treatment of aneurysms and cerebrovascular occlusive disease.

Ausman et al.² first described the use of a radial artery graft for revascularization of the posterior fossa from the cervical vertebral artery to the posterior inferior cerebellar artery. Based on the experience of cardiovascular surgeons^{4,5} who have used the saphenous vein when a radial artery graft is unavailable,⁷ the radial artery is the graft of choice because its patency rates are better than those associated with the saphenous vein. Open harvesting of the radial artery entails cosmetic disadvantages. It is also possible to injure the superficial branch of the radial nerve in the proximal third of the forearm and the lateral antebrachial cutaneous nerve in the mid- and distal forearm. Such damage causes hypesthesia and numbness of the dorsal thenar region, the incidence of which has been reported to be as high as 10%.⁴ The endoscopic approach is associated with the potential for the same type of damage, but the risk is diminished because the smaller incisions do not cross the forearm.

The steep learning curve associated with use of the endoscope can be overcome by practice on cadavers because the tactile feedback in that setting is comparable to that experienced during surgery in live patients. Such practice can be arranged through the local representative of companies marketing endoscopic harvesting systems. We highly encourage initially performing these procedures with the assistance of a cardiovascular team to take advantage of their expertise in retrieving saphenous veins and arteries in a routine fashion.

Conclusions

We obtained good outcomes with endoscopic harvest of a radial artery graft in 6 patients requiring a high-flow bypass. Because of their considerable experience harvesting vessels, collaboration with members of the cardiac surgery service was helpful and is recommended.

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