Experimental Microvascular Autografting

Technical Note

R. M. CROWELL, M.D., AND M. G. YASARGIL, M.D.
Neurochirurgische Universitätsklinik, Kantonsspital Zurich, Switzerland

Since Jacobson and Suarez adapted the operating microscope to the surgery of small vessels in 1960-1962, it has become clear that microvascular surgery is rich in research possibilities and clinical applications. We are reporting the successful application of microsurgical techniques to problems of small vessel autograft transplantation.

Received for publication September 3, 1968. Revision received February 17, 1969.

Methods and Materials

Microvascular procedures were carried out under a Zeiss binocular operating microscope. Instruments included "spring handle" needle holders and scissors, fine jeweler's forceps, and a Buncke counter-pressor. The Malis bipolar coagulator was used for hemostasis, and flexible silastic tubes (outer diameter 1 mm) served as intraluminal splints. Monofilament 8-0 nylon swaged on a 5 mm stainless steel needle (Davis and Geck) was

---

Fig. 1. Schematic representation of operative techniques of arterial autografting. A & B. Stripping adventitia. Adventitia is opened longitudinally and removed as a single sheet. C. Placement of initial sutures. Silastic tube splint and Buncke counter-pressor are used. Sutures are spaced at 120° intervals, as indicated in cross-sectional view. D. Suture technique, front wall. Fine hemostat holds stay suture b to muscle. Forceps fixes stay suture a. Simple interrupted sutures are placed at 0.4 mm intervals from a to b. E. Suture technique, side walls. Stay sutures are used to rotate and fix vessel. F & G. Removal of splint. H. Result. Small sheet of rubber dam is used to aid external hemostasis at anastomosis sites.
Fig. 2. Left: Arteriography of femoral artery autograft 3 months after operation. Graft site (arrow) shows patency with slight narrowing. Right: Arteriography of venous autograft in rabbit carotid artery 7 weeks after operation. Graft (arrow) is patent and shows no narrowing or dilatation.

Fig. 3. Histologic section of venous autograft in carotid artery 3 months after operation. New intima (IN) now covers sutures originally placed within the lumen; artery (A) is to the left, view (V) to the right. New intima is about 250 μ thick and consists of hyaline connective tissue and collagenous connective tissue. New endothelium (E) is probably also present. Note granulomatous reaction to suture material (G). Van Gieson, ×83.
Experimental Microvascular Autografting

employed for vascular suture. The anesthetic was Numal-Roche, administered intravenously (0.5 cc/kg).

In 11 rabbits, a segment of femoral artery (outer diameter 1.5 to 2.0 mm) from the right leg was interposed between the cut ends of the left femoral artery. In 12 rabbits, a segment of external jugular vein was interposed between the cut ends of the left carotid artery (outer diameter 2 to 3 mm). Figure 1 illustrates technical details in these procedures.

One week to 3 months after operation, the grafts were inspected, and angiography was carried out. The animals were sacrificed, and graft sites were removed for histologic examination.

Results

Excessive anesthesia or excessive blood loss caused operative deaths. In surviving animals, inspection and angiography demonstrated patency of all grafts 1 week to 3 months after operation (Fig. 2). Histologic examination showed a proliferation of fibrous tissue around the grafts, a moderate granulomatous reaction to the suture material, and a layer of new intima covering the sutures interiorly (Fig. 3).

Discussion

Certain details of technique have proved helpful in microvascular autograft surgery. For positioning the microscope lens system, the forehead and orbital rims can be used; such maneuvers free the hands for surgery. A magnification of 16 to 25 seems best for fine dissection and suturing. The Buncke counter-pressor is useful for the placement of the initial stitches in an anastomosis. A fine silastic tube serves as a splint but was not effective as an internal shunt in our hands. A strip of rubber dam slipped behind the vessel protects neighboring tissues and prevents loss of suture and needle. At the end of the procedure, the rubber dam can be fixed loosely around the vessel to promote external hemostasis at the anastomosis site (Fig. 1). Vessels must be moistened frequently to keep them from becoming weak and friable. Stripping the adventitia from an area of proposed suturing is critical to the accurate placement of sutures (Fig. 1 A and B). Dilute papaverine renders adventitia white and aids this maneuver. Gentle fixation of the vessel for suturing is achieved by the use of stay sutures placed at 120° intervals (Fig. 1 D and E). Simple interrupted sutures spaced about 0.4 mm apart and end-to-end anastomoses seem satisfactory.13-15,22 Flushing of the vessel at the end of the procedure assures distal back-flow and proximal patency. Irrigation with dilute heparin solution also appears helpful.

We learned in this study that practice with microvascular techniques can be rewarding. Our first results in small vessel transplantation were not favorable; in 18 animals, less than 50% had patent vessels on follow-up. Nonetheless, practice promoted technical proficiency, and the definitive series of procedures was performed by the same operator with 100% late patency.

This study demonstrates the technical feasibility of microvascular autografting. In the clinical setting, it may be possible to use such procedures for the replacement of diseased arterial segments or for the creation of appropriate by-pass shunts.

Summary

Twenty-three microvascular autografting procedures were carried out in rabbits. In 11 animals, segments of femoral artery from the right leg were interposed in the left femoral artery. In 12 animals, segments of external jugular vein were interposed in the carotid artery.

Inspection and angiography 1 week to 3 months postoperatively demonstrated patency in all grafts in the 20 animals that survived surgery. Pathologic examination showed connective tissue around the graft, a granulomatous reaction to suture material, and new intima lining the graft. Some of the technical points helpful in this use of microvascular surgery have been discussed.

Acknowledgments

It is a pleasure to express our gratitude to Profs. Krayenbühl and Sweet for supporting this experimental effort, to Dr. Ulrich for help with the histology, and to Mr. Vetterli for technical assistance.

References


