The creation of a functional hemodialysis fistula in patients who develop end-stage renal disease (ESRD) has critical importance. The majority of surgeons would agree that a primary radiocephalic arteriovenous fistula is the procedure of choice in new dialysis patients. But in patients who lack adequate forearm vasculature secondary procedures are indicated. Currently, in the United States, more than 50% of hemodialysis that is performed occurs through polytetrafluoroethylene (PTFE) grafts. Numerous reports have described the various complications of PTFE grafts, including high primary failure rates and multiple thrombotic events during the life of the graft. Because of the frequency of graft thrombosis in these patients yearly surgical intervention may be required. Recent reports on long-term upper arm dialysis access procedures, specifically, the transposed brachiobasilic arteriovenous fistula, have shown significant long-term primary patency rates reaching 70% at 8 years. To date there have been no descriptions of a minimally invasive approach to address the long morbid upper arm dissection needed to create this fistula (Fig. 1). We describe an effective, technically simple, minimally invasive surgical approach to create an upper arm transposed brachiobasilic fistula.

TECHNIQUE

The upper extremity has multiple variations in venous anatomic patterns, necessitating preoperative mapping of both upper arms with duplex ultrasonography to determine position and caliber of the veins. The portion of the basilic vein used to create the vascular access arises approximately 10 cm below the antecubital fossa, and courses over the medial epicondyle of the humerus, to lie within the medial bicipital furrow. This vein perforates the deep fascia at approximately one-third the distal extent of the humerus. Using local anesthesia with occasional intravenous sedation, a 2.5- to 3.0-cm slightly curved transverse incision is made just medial and 1 cm superior to the antecubital fossa. Dissection continues to expose the brachial artery and the basilic vein, using standard surgical instruments and technique. After assessing the quality of these structures within this wound, the basilic vein is liberated along its length by ligation and dividing the visualized venous tributaries. Through this working incision, using conventional techniques, the beginning of a subcutaneous tunnel is created over the basilic vein. This tunnel is extended using the Ethicon endovein harvesting small spoon dissector (Ethicon Endo-Surgery, Inc, Cincinnati, OH) with a 5-mm, 30-degree endoscope (Fig. 2). This device creates an operative working space, allowing mobilization to proceed along the length of the basilic vein. Dissection is technically achieved with endoscopic instrumentation using an endoscopic curved scissors, endoscopic forceps, and a pigtail or ring linear dissector. An endoscopic endoclipping device is used to obtain vascular exclusion and allow division of the subcutaneous venous tributaries.

Dissection proceeds along the length of the basilic vein under endoscopic vision to carefully avoid injury to the medial cutaneous nerve, which is found surrounding the vein superiorly and inferiorly along its length. Next, the basilic vein is followed as it dives and penetrates the aponeurotic fascial plane. It is critical to meticulously perform this maneuver to avoid injury to the median and ulnar nerves adjacent to the vein in this region.

When the appropriate length of the vein has been liberated above and below the antecubital fossa, a 1-cm transverse counter incision is placed directly over the basilic vein 2 cm inferior to where the pectoralis major muscle inserts into the humerus. The vein is retrieved through the uppermost incision and, under gentle dilation with dilute heparin saline, all tributaries that have
been clipped are suture-ligated with nonabsorbable vascular sutures (Fig. 3).

The basilic vein, brought superficially, is transposed and drawn through a lateral subcutaneous tunnel in a gentle curving fashion to the region of the brachial artery in the anticubital fossa. The length of the basilic vein harvested will dictate the outer curving trajectory of the tunnel and affect the landing and angle of the anastomosis (Fig. 4). Ensuring an adequate length of vein is prudent, and can be obtained by dividing the basilic vein 2 to 3 cm below the anticubital fossa incision. A 5-mm arteriovenous anastomosis is created in an end-to-side fashion with the spatulated end of the vein to the side of the brachial artery. At the completion of the procedure the functional dynamics of the newly created fistula are evaluated. This is done by assessing the arterial outflow to the hand using Doppler ultrasonography. The two wounds are closed in standard fashion.

RESULTS
During a 10-month period from January 1999 to October 1999, nine consecutive patients were identified who required placement of a brachiobasilic arteriovenous fistula. These patients were not candidates for primary radiocephalic or brachiocephalic fistulas because of poor venous anatomy demonstrated on ultrasound. The majority of these patients had end-stage renal disease from diabetes and required dialysis, and others had nephropathy from hypertension, hepatitis C, and HIV. One patient had a diagnosis of polycythemia vera and required frequent phlebotomy.

The procedure as described was technically completed in all patients, and the fistulas were assessed at 19 months. Eight fistulas were in current use and one patient thrombosed the brachiobasilic fistula 24 hours postoperatively. This fistula was not revascularized because of findings of prior thrombophlebitis in the basilic vein at the original operation. The thrombophlebitis was not seen on preoperative ultrasound or retrospectively. In the remaining eight patients the average time to fistula maturation was 2.6 months, as determined by surgical permission to use fistula or by the first use of the access. There were no technical factors delaying the first use of the fistula, and the average time was 4.4 months.
The average total time of fistula use in these eight patients was 12.6 months, for a total of 101 patient-months of fistula patency. The overall primary patency rate at the averaged 1 year was 88% (8 of 9). There were no other thromboses in these patients, but other complications included transient parasthesias in the operative arm (1), iatrogenic hematoma formation at cannulation site (1), venous stenosis (2), and venous aneurysm (1). During routine fistula surveillance venous stenoses were noted and addressed by angioplasty and surgical revision, respectively. The venous aneurysm found on surveillance was corrected surgically. The immediate advantages of this approach were fast healing times, no infections, minimal scarring, and minimal postoperative edema.

**DISCUSSION**

Surgeons today are facing increasing demands to provide dialysis access in the growing population of patients with ESRD maintained on chronic hemodialysis. The traditional approach to vascular access has been creation of a radiocephalic arteriovenous fistula. Current trends in the United States show that prosthetic fistulas are used in more than 80% of primary dialysis access procedures. Cumulative 1-year and 2-year primary patency rates for PTFE fistulas range from 44% to 70% and 35% to 49%, respectively. Fistulas created with a transposed basilic vein sutured end to side to the brachial artery have been shown to be the most reliable and dependable secondary vascular access procedure reported for chronic hemodialysis. Primary patency rates for the first and second year range from 80% to 90% and 74% to 86%, respectively, with a longterm patency of 70% at 8 years reported in a large series. Despite the advantages of this vascular access procedure—which include excellent primary patency, a single anastomosis, lack of a graft-venous anastomosis (the most common site of graft failure), low incidence of infection, relocation of the scar from the cannulation zone, and high flow rates generated with a basilic-axillary run-off—the procedure has not increased in favor presumably because of the extensive upper arm dissection required to create this dialysis access.

Minimally invasive vascular surgical techniques were incorporated into this procedure to address this issue of...
the extensive upper arm incision, allowing us to capitalize on the advantages offered by autologous fistulas. Creation of adequate space achieved with the Ethicon subcutaneous dissector allows the operation to proceed smoothly. Under videoscopic guidance, dissection of the structures of the upper arm can be accomplished under direct vision, adding to the technical simplicity and ease of performing the procedure. The advantages of autologous fistulas are numerous and the morbidity experienced by patients, the yearly health care cost, and the demand on surgeons to maintain vascular access may be reduced with the wider use of these procedures. This minimally invasive vascular surgical approach eliminates the extensive dissection required with conventional surgery, and achieves all the advantages offered by autologous vascular access.

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REFERENCES