TECHNICAL NOTES

The two-stage brachial artery–brachial vein autogenous fistula for hemodialysis: An alternative autogenous option for hemodialysis access

Niren Angle, MD, and **Ankur Chandra, MD,** *San Diego, Calif*

The optimal dialysis access for the patient with chronic renal failure is considered to be an autogenous fistula; this is reflected in the recommendations of the National Kidney Foundation–Disease Outcomes Quality Initiatives (NKF-DOQI). If adequate superficial veins at the wrist or the forearm are not available, the next option is usually a prosthetic arteriovenous graft. In this case series, we describe our experience with an autogenous fistula constructed using the brachial vein. There were 20 patients over a 14-month period who were operated on for dialysis access. In these patients, no adequate superficial veins were found at operation. Instead of using a prosthetic graft, we performed a brachial artery–brachial vein fistula in two stages. The first stage involved a forearm anastomosis and then subsequently, weeks later, this fistula was "superficialized." Twenty patients underwent a brachial artery–brachial vein fistula. Of these patients, all had successful maturation of their fistula and after a minimum waiting period of 12 weeks for maturation; all but one were able to be successfully dialyzed through their fistula. One patient developed arm swelling due to previously placed subclavian vein pacemaker wires. None of the other patients developed arm swelling or vascular steal. The brachial artery–brachial vein fistula is a feasible option for hemodialysis access and we suggest that this option be considered before a prosthetic arteriovenous graft is inserted. Arm swelling and steal have not been a problem, and all patients have been able to have full dialysis through the fistula after appropriate maturation times. (J Vasc Surg 2005;42:806-10.)

Dialysis access complications account for a very high percentage of hospitalizations in chronic renal failure patients.[1,2] Of these complications, dialysis access failures comprise a significant number of these hospital admissions. In 1997, the National Kidney Foundation (NKF) through its Disease Outcomes Quality Initiative (DOQI) guidelines attempted to provide some evidence-based guidance to clinicians and to reduce practice variations.[2] Fundamental in these guidelines was the recommendation that of new renal failure patients, at least 50% should have a primary fistula constructed, given the superior patency of fistulae over prosthetic grafts.

The ability to construct a usable fistula depends on many things, not least among which is the availability of adequate superficial veins. In our practice, routine ultrasound vein mapping is performed, and the fistula is constructed at the site of the most suitable vein. Options for fistulae are the traditional radiocephalic fistula, brachiocephalic fistula, brachiobasilic fistula, and the occasional transposed radiobasilic fistula. If none of these options is possible, traditionally, the next step has been the insertion of a prosthetic graft in the forearm or upper arm.

Due to the dismal patency rates for grafts, we began performing brachiobrachial fistulae, in which one of the paired brachial veins, ie, the venae comitantes flanking the brachial artery, is sutured to the brachial artery in the antecubital fossa, and then subsequently in a separate operation, the maturing brachial vein is superficialized. This article describes 20 such patients in whom we have performed this operation with success.

PATIENT AND METHODS

From November 2002 until December 2004, 20 patients had a brachiobrachial fistula performed for dialysis access. Of the 18 patients, all but one had already initiated dialysis through a catheter as they had presented for the first time in renal failure. The one patient that was an exception was a 46-year-old man with declining renal function and anticipating dialysis in the near future. All 19 patients who had a tunneled dialysis catheter had it dwelling in the internal jugular vein as is the routine practice. These patients comprise the entire group of patients in our clinical practice who have undergone this operation. There were two other patients in whom the deep veins were explored and were thought to be too small for this procedure and those patients, both of them women, underwent an ipsilateral upper arm prosthetic arteriovenous graft.

From the UCSD Section of Vascular and Endovascular Surgery, UCSD School of Medicine.

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Reprint requests: Niren Angle, MD, UCSD Section of Vascular and Endovascular Surgery, 200 West Arbor Drive, San Diego, CA 92103-8403 (e-mail: nangle@ucsd.edu).

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All these patients were undergoing dialysis access surgery for the first time, and in preparation, all had undergone ultrasound vein mapping. The routine vein mapping that is done for the dialysis access planning examines the superficial veins in both upper extremities and evaluates patency and diameter. No attempt is made to examine the deep veins, ie, the brachial veins. It is our preference to approach the best vein, as assessed by ultrasound mapping, the first time and not to necessarily start on the most distal site on the nondominant arm in contrast to traditional dogma.

In all 20 patients, ultrasound mapping suggested an adequate or marginal (ie, >2.0 mm) cephalic or basilic vein. With an anticipation that an adequate superficial vein would be found, the superficial veins were explored on the relevant side through a transverse incision one fingerbreadth below the antecubital crease.

In these 20 patients, on exploration no suitable cephalic or basilic vein was found in the antecubital fossa. The vein was either smaller than the ultrasound suggested or chronically inflamed with a thickened wall. On exploration of the brachial artery and its flanking brachial veins, there was found a usable brachial vein(s). In the absence of preoperative ultrasound measurement, we can only estimate that the size of the brachial vein was at least 2.5 mm as gauged by the ability to accommodate a 2.5-mm coronary dilator.

Technique. All operations were done under local anesthesia with monitored anesthesia care. A transverse incision is made approximately one fingerbreadth below the antecubital fossa. In these cases, the search for the anticipated superficial veins being fruitless, the bicipital aponeurosis was opened and the brachial artery exposed. The flanking veins were carefully exposed and dissected for an adequate length. The larger of the veins was chosen for the fistula; if they were of equal caliber and quality, the medial brachial vein was used preferentially. The vein was divided and sutured to the brachial artery in an end vein to side artery configuration with a 7-0 Prolene suture. This concluded the first stage of the operation.

Approximately 6 weeks later, the patient underwent a second operation for "superficialization" of the fistula. This operation was also done under local anesthesia and intravenous sedation. At that time, through a medial incision on the arm, the brachial vein was mobilized by dividing all tributaries between silk sutures. During this operation, it is critical that one does not divide a tributary that may represent the main inflow from the arteriovenous anastomosis. A useful method of ensuring this is to occlude the tributary with a DeBakey forceps and ensure that a strong thrill remains in the fistula. After all the tributaries have been divided, the maturing vein is able to assume a more superficial position. We make no attempt to tunnel it laterally as it tends to cause a loss of length in amount of fistula available for cannulation. We merely create a small flap in the subcutaneous tissue on the anterior aspect of the incision and "tuck" the vein in by putting interrupted 3-0 absorbable sutures in the subcutaneous tissue to house the vein, always making double sure that there is no acute angulation or kink of the vein. The incision is then closed with a 3-0 absorbable suture and staples. No drains are used. The skin is allowed to heal, and the fistula is not used for 12 weeks from the time of the first operation.

RESULTS

Twenty patients underwent this operation, and all of them were done under local anesthesia with sedation. Additionally, all the patients had the operation done in two stages as described above. There were eight women and 12 men. The mean age of the patients was 51 ± 16 years (range, 25-77). The risk factors for the development of chronic renal failure were as follows: hypertension (17/20), diabetes mellitus (12/20), and polycystic kidney disease (2/20). None of these patients had had any previous attempt at surgical access, save the tunneled catheter placement. Of the 19 patients who were already on dialysis and were being dialyzed through a tunneled catheter, 18 patients had an indwelling right internal jugular vein catheter. Thirteen patients had the fistula placed in the right arm and the remaining six patients had it placed in the left arm. The mean follow-up was 14 ± 4 months (range, 8-23).

In all these cases, the decision to perform the brachiobrachial fistula was made intraoperatively based on our finding of "inadequate superficial veins." In the 20 patients described here, the preoperative vein mapping indicated only one superficial vein as patent and possibly of adequate caliber. Specifically, in 15 patients, the vein was either not of an adequate caliber or had a significant length of stenosis or stricture upstream of the antecubital fossa, when evaluated at the time of operation. In the other five patients, the vein was patent and appeared to be of usable caliber but had an inflamed appearance, ie, the wall of the vein was white and thickened. For this reason, a fistula using the superficial veins in these patients was thought to be unlikely to mature.

The second stage operation was done approximately 6 weeks later in all these patients. No imaging of the fistula was performed between the first and second operations. The NKF-DOQI recommendations suggested an ideal waiting time for fistula cannulation of approximately 3 to 4 months and in concert with this, we like to ideally wait 3 months before cannulating fistulae. By this time, all the incisions have healed.

No patient developed a steal syndrome. Except for one patient, none of the patients developed signs of significant or prolonged arm swelling. The one patient developed severe venous hypertension in the presence of a patent fistula. A venogram was performed that revealed a severe stenosis of the ipsilateral subclavian vein. This patient had indwelling pacemaker wires traversing that subclavian vein; his preoperative venous duplex had shown no signs of venous obstruction. A balloon angioplasty of the vein was successful for only 1 week, after which the swelling began to recur. Due to the pacemaker wires, there was a great reluctance to place a metallic stent in apposition within the vein. The fistula was ligated and parenthetically was noted

during this operation to have matured nicely. The arm swelling abated within days of the fistula ligation.

In the remaining patients, the mean time to cannulation of the fistula was 13 ± 1 weeks. The primary functional access patency in this group, to date, as defined by the Society for Vascular Surgery and American Association for Vascular Surgery in their reporting standards for recommended standards for reports dealing with arteriovenous hemodialysis accesses is 95%.[3] Successful hemodialysis was performed and continues to be performed in all these patients. There were no secondary interventions performed in any of these patients, other than the superficialization procedure.

DISCUSSION

Chronic renal failure and the need for dialysis remain one of the most vexing problems facing clinicians, both nephrologists and surgeons. Even with renal replacement therapy, end-stage renal disease patients have a significantly shorter life expectancy across quartiles of age. Successful construction and maturation of a dialysis fistula are necessary prerequisites for these patients to survive their diminished life span, short of transplantation.

It is clear that autogenous fistulae, should they mature successfully, have a significantly superior patency rate and also require much less in the way of secondary interventions. Dialysis access surgery has evolved considerably, particularly due to the impetus of the NKF-DOQI guidelines. There is a much stronger emphasis and a more insistent search for adequate veins so that a fistula may be created. Certainly, in patients who have had no dialysis access surgery before, it is much more predictable that an autogenous fistula will be successfully constructed. This preference for an autogenous fistula has led many to perform some innovative access operations such as the use of the translocated femoropopliteal vein, which was reported by Huber et al.[3] However, this operation had some significant morbidity including a 43% incidence of hand ischemia. Bazan and Schanzer[8] recently reported on two patients in whom a brachial artery–brachial vein fistula was performed with good results, patients in whom no superficial veins were available. We have been using this operation in patients over the past 2 years, and although our technique differs somewhat from that of Bazan and Schanzer, we have been satisfied with the success of the brachial artery–brachial vein fistula.

The preoperative vein mapping is very important in this regard as it allows one to choose the best vein the first time rather than the traditional approach that places a high value on starting the quest in the nondominant arm, in the most distal available vein, reserving other sites for subsequent remedial operations.[5,6] We approach access surgery with preoperative ultrasound vein mapping as the principal guide as to which arm and which vein to use, with the intent being to perform the best operation the first time using the best vein. Although in these patients, the vein mapping was not sufficiently predictive, this is a small portion of a large denominator of patients with dialysis access, and in the overwhelming majority of patients, ultrasound vein mapping is very useful and allows the best access procedure to be done the first time. We have since modified the techniques of ultrasound vein mapping such that a complete visualization of the veins is performed from wrist to axilla as opposed to segmental interrogation of the vein at specific sites as was done in these patients.

Accordingly, we obtain routine comprehensive vein mapping in almost all patients. Imaging of the brachial veins is not routinely done as part of the vein mapping procedure, and in the setting of marginal superficial veins or absent/thrombosed superficial veins, we will now institute this selectively as part of the study. In the majority of these patients, the putative superficial vein was either smaller than suggested by ultrasound mapping or of the diameter suggested by ultrasound mapping but chronically inflamed and thickened and thus unsuitable. In these 20 patients, we were unable to find a suitable superficial vein, and in attempting to avoid the placement of a prosthetic graft in the first two patients with small veins and small arteries, we proceeded with the brachial artery–brachial vein fistulae. We were pleasantly surprised at the success of the fistula, the lack of any visible arm swelling above and beyond that of any other arm fistula, and the ease of the operation. Since then, it is our preference to perform this operation before resorting to an upper arm graft. The body habitus of the patient as well as the size of the vein and artery may affect one's decision on whether to perform this operation. Obviously, the caliber of the vein is an important determinant of whether to use it for a fistula. An overweight or obese patient with a fat arm is the one patient in whom to avoid this operation. The reason is that because of the amount of subcutaneous fat, elevation/superficialization of the vein results in a significant loss of length of the vein as it begins to travel from deep to the fascia to the subcutaneous level.

A few technical points are worth mentioning. It is our clinical impression that mobilization of the vein after it has had a chance to mature results in less trauma to the vein and perhaps better long-term patency; hence, our preference for the 6-week interval between the arteriovenous anastomosis and the superficialization of the vein. In an article attempting to determine whether a traditional one-stage brachiobasilic fistula had any difference in patency compared to a staged superficialization of the brachiobasilic fistula, El-Mallah[4] noted a significant difference in patency of 60% vs 90%, respectively.[4] It is not unreasonable to apply the same principle to that of superficialization/elevation of the brachial vein. It is also extremely important that, as one is mobilizing the brachial vein that is principally matured, not to ligate any tributaries that may represent the inflow from the brachial artery (Fig 1).

The incision during the second stage of the operation is made in a vertical fashion between the biceps and the triceps and extends from just above the antecubital crease all the way up to just below the axillary crease. All the tributaries are ligated and divided. Once the vein is mobilized along its length, a subcutaneous flap is created laterally and the vein is placed in this flap. Interrupted sutures

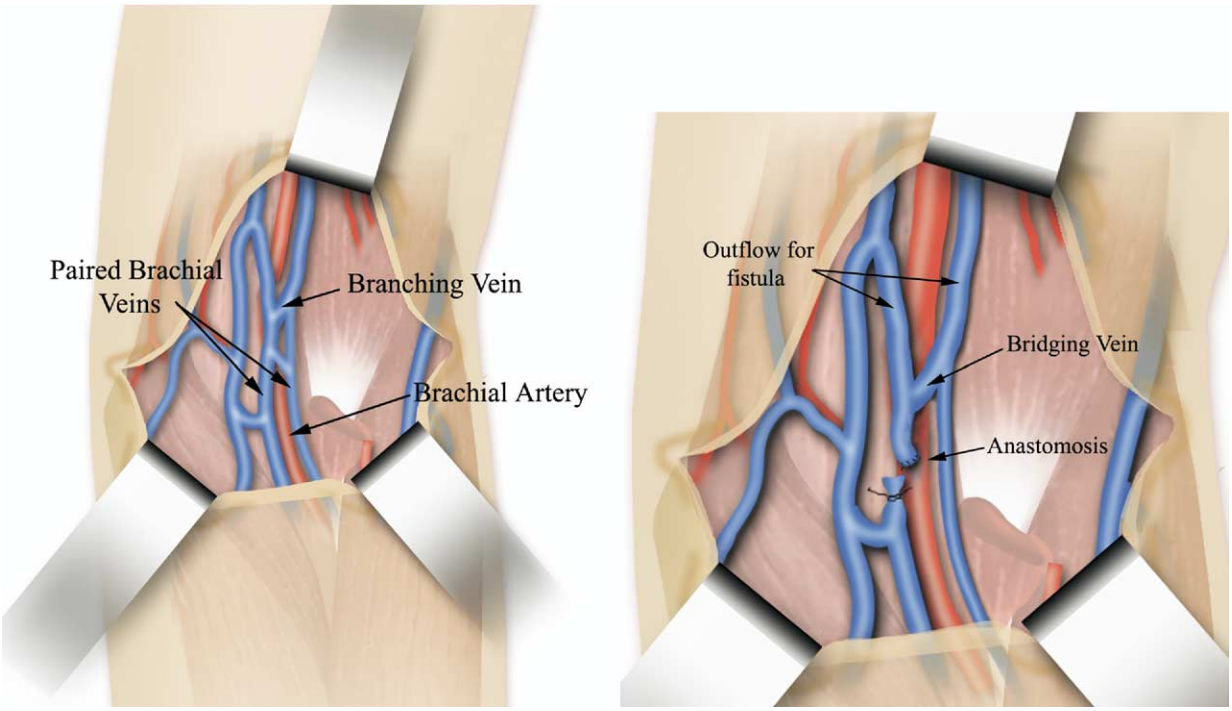

Fig 1. a, The exposure of the left antecubital fossa below the bicipital aponeurosis revealing the brachial artery and paired brachial venae comitantes. Care must be taken to not divide the branching vein during exposure as this will subsequently contribute to the fistula outflow. **b**, The exposure after the completed brachial artery–brachial vein fistula. It is important to note the outflow through the branching vein to the paired brachial veins.

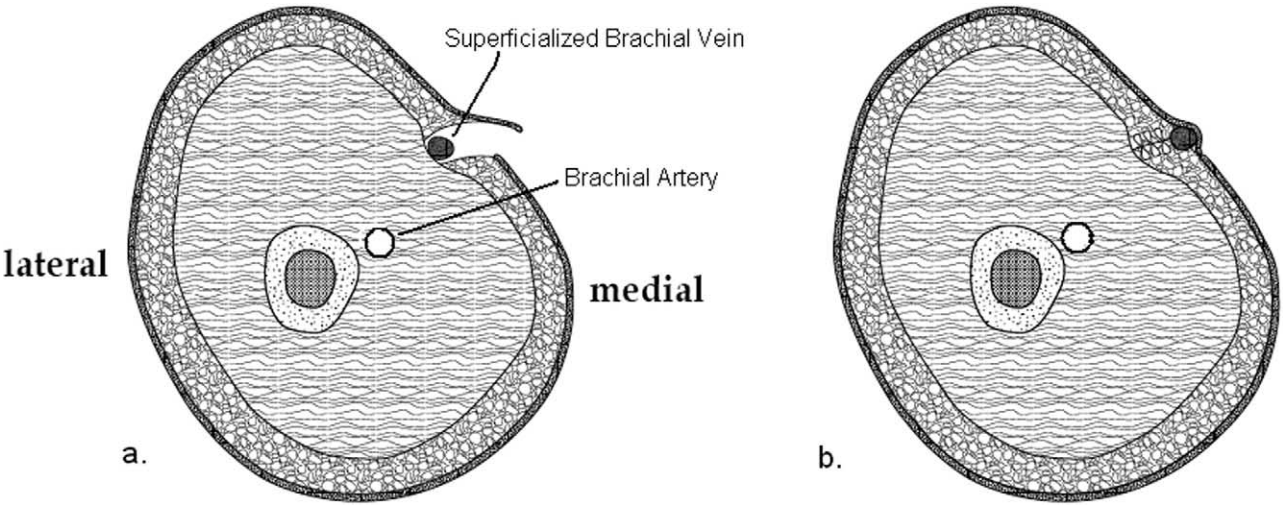

Fig 2. a, This cross section of the right arm displays the superficialized mature brachial vein in its subcutaneous location under a tissue flap. **b,** The completed location of the superficialized brachial vein fistula after closure of both the subcutaneous layer and the skin layer.

are placed such that it stays in the pocket created. Occasionally, there may not be enough length for this flap, and in those cases, we merely close the tissues under the vein and place the fistula directly under the incision, which is then closed in two layers (Fig 2). Alternatively, the vein does not have to placed in this pocket; it can merely be "elevated" in that the soft tissue underneath the fistula is closed with a running 3-0 absorbable suture and the skin is closed over the vein. This places the fistula directly under the scar and can be accessed successfully. This "fistula

elevation" procedure has been described for a brachiobasilic transposition and, in fact, is ideal for an overweight patient.[7] The dialysis technicians have not had any difficulty accessing these fistulae. All these operations are easily done under local anesthesia with sedation as an outpatient.

In the standard algorithm, if the antecubital fossa is explored and no adequate superficial veins are found, the usual next option is a prosthetic arteriovenous graft. The attempt to create this fistula does not eliminate that possibility. In 6 weeks during the superficialization procedure, if the vein is judged to not have matured to the point of satisfaction or is thought to be inadequate in terms of length, it is very easy to place an upper arm arteriovenous prosthetic graft. We suggest that the possibility of placing an autogenous fistula take priority over the adherence to the traditional dogma of site preservation for future access, which has failure of access as one of its guiding precepts. Although most access does not last forever, even fistulae, it is clear that an autogenous fistula will last longer and do so with a lesser chance of requiring secondary interventions than prosthetic grafts.

This operation can be done under local anesthesia with intravenous sedation and as an outpatient, and all the patients have tolerated this well. The brachial artery–brachial vein fistula can be performed either as described by Bazan and Schanzer[8] or as described in this report, but no matter which technique is chosen, we suggest that the brachial artery–brachial vein fistula holds promise as yet another option for autogenous dialysis access in the patient with chronic renal failure.

Admittedly, the follow-up to date is limited but quite encouraging in terms of both success of fistula maturation and the absence of significant complications. To our knowledge, this report represents the largest series of patients with end-stage renal disease with brachiobrachial fistulae in the English literature. In the patient in whom superficial veins are inadequate or absent, more likely than not, in these patients, the deep veins are likely to be of good size and caliber and this approach, if adopted, promises to place the prosthetic graft as an even more remote option for dialysis access. We suggest that this operation represents yet another good option for autogenous fistulae and highly recommend its incorporation into the algorithm for dialysis access surgery.

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