Part VII

Surgical treatments

The Use of Arm Vein in Lower Extremity Revascularization

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In patients with lower extremity arterial disease requiring revascularization, the ipsilateral greater saphenous vein remains the conduit of choice, with unequaled long-term patency and limb salvage rates. (1) Limitations arise, however, in those patients in whom the greater saphenous vein has previously been harvested, such as for coronary or previous infrainguinal revascularization, and in the emerging population of patients who have previously undergone vein stripping procedures. Even among patients with an intact ipsilateral greater saphenous vein, a portion of the vein may be of poor quality or nonusable, thereby compromising a previously planned distal revascularization.

When ipsilateral saphenous vein is not available for arterial reconstruction, several alternatives exist. Although prosthetic grafts may achieve comparable secondary patency rates to autologous vein when placed to the above knee popliteal artery, those in the infrageniculate position remain markedly inferior despite multiple technical modifications with vein cuffs and other additions. Certainly, in our opinion, prosthetic grafts should not be used in the paramalleolar or inframalleolar level, since almost all will fail within the first one month. (2) High failure rate, cost, availability, and long-term durability have similarly limited the use of cryopreserved human saphenous vein allografts and human glutaraldehyde stabilized umbilical vein grafts.

Alternative autologous vein can be obtained from several sources, including, the contralateral saphenous vein, lesser saphenous vein, superficial femoral vein, or arm vein. The choice of autologous vein is somewhat dependent upon the specific circumstances of the proposed operation. Many of these are secondary or repeat arterial reconstructions where the expectation of success is not as high as with primary procedures.

Another consideration is the probability that arterial reconstruction may be necessary in the opposite leg and, if that is a primary procedure, the expectation of success may be high. In these patients with a high incidence of coronary artery disease, there is the competing need for future coronary bypass. These competing issues may complicate the decision process, and may interfere with a rational approach toward limb salvage.

Our approach has been to use arm vein grafts as the first alternative when ipsilateral greater saphenous vein is not available. (3) Initially, this decision was based on a good experience with arm vein grafts in terms of patency but without significant data on the other factors involved. These considerations have been subsequently reviewed in two separate reports from our institution, with the most recent being an eight year experience with 520 revascularization procedures using arm vein as conduit. (4) Almost all procedures (98%) were for limb salvage (gangrene, ischemic ulceration, or rest pain) and the majority (274, or 53%) were secondary ("redo") procedures. In most of the procedures (86%), the target was an infrapopliteal artery, including 100 grafts to the dorsalis pedis or plantar/tarsal vessels. Ipsilateral saphenous vein was unavailable in most cases due to either its use in a previous ipsilateral reconstruction (61%) or coronary revascularization (23%). A single arm vein segment was used in 70% of the cases, with composite venovenostomy required in the remaining number.

Technical Considerations

These data illustrate that arm vein grafts are often available and of suitable length for the reconstruction. Its use should be planned preoperatively, to allow for preoperative vein mapping and subsequent protection of the selected vein from venipunctures or cannulation. Recently we have been performing ultrasound vein mapping to assist in identifying patent arm veins and recommend it as a routine. Once the appropriate arm has been selected, the operating room team (including anesthesia) should be notified of the decision to use arm vein, to allow for the use of general anesthesia and appropriate surgical prep and draping. The surgical field should include the clavicle when there is any possibility of using the upper arm cephalic vein. Similarly, the proximal hand should be included, if there are plans to use the forearm cephalic vein.

Fundamental considerations of peripheral arterial reconstruction include the availability of conduit, inflow and outflow options, and the magnitude of perfusion necessary for success. For example, the first choice in a reconstruction might be common femoral to tibial; the second choice might be common femoral to an isolated popliteal segment, accepting less complete revascularization. The surgeon may be faced with the need for full revascularization, as in the infected ischemic diabetic

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foot, where it is almost imperative to restore foot pulses to salvage the limb. On the other hand, a patient will usually be relieved of rest pain with a less complete revascularization, such as using an isolated popliteal segment for outflow. Ultimately it is the availability of high quality autogenous conduit that drives this complex decision-making. For these reasons, it is a good policy to first determine the length of autogenous conduit that is available before making a final choice on inflow and outflow sites.

For these reasons, the first step in arm vein grafting is exposure and preparation of the conduit to determine the potential limits of the arterial reconstruction.(5) In most patients, it is best to begin the dissection in the antecubital fossa to determine the status of the median cubital vein. At the confluence of the median cubital and cephalic veins, there is a deep branch that connects to the brachial vein. This branch is ligated at the brachial vein and the central end is cannulated with a Marx needle. From this point, the median cubital, upper cephalic, and upper basilic veins can be irrigated and distended. We use 5000 units of Heparin and 60 mg Papaverine in one liter of balanced salt solution to distend the vein and prevent venospasm.

Alternatively, the cephalic vein may be exposed at the wrist and subsequent dissection carried out to the deltopectoral groove, if the cephalic vein is to be used as one long segment. The surgeon may have a choice between several vein complexes to create the graft, and there are no fixed rules or guidelines on this. Probably the most important point is to recognize that creation of a high-quality conduit is the single most important part of this operation. Therefore it is not something to be delegated to residents who may only be familiar with harvesting saphenous vein or may not be aware of the many options involved.

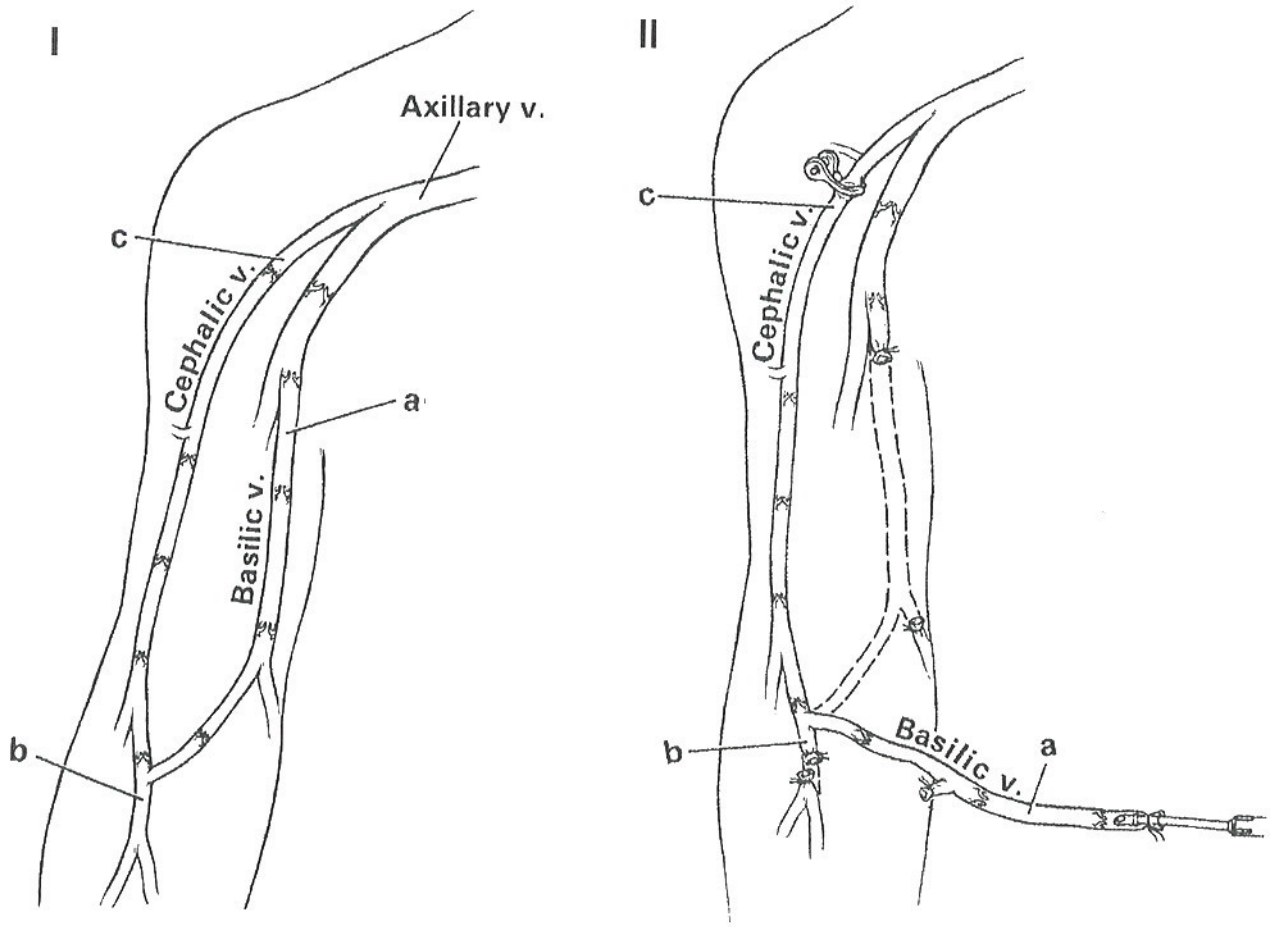

FIGURE 1

Once the cephalic and basilic veins are exposed, a "loop" graft may be formed, in which the mobilized basilic vein will become the inflow segment once the valves are lysed. The stump of the divided cephalic vein (b) should be left long so as to introduce the valvulotome for valve lysis.

(FROM LOGERFO FW, PANISZYN CW, MENZOIAN J. A new arm vein graft for distal bypass. J Vasc Surg 1987; 5: 889-891)

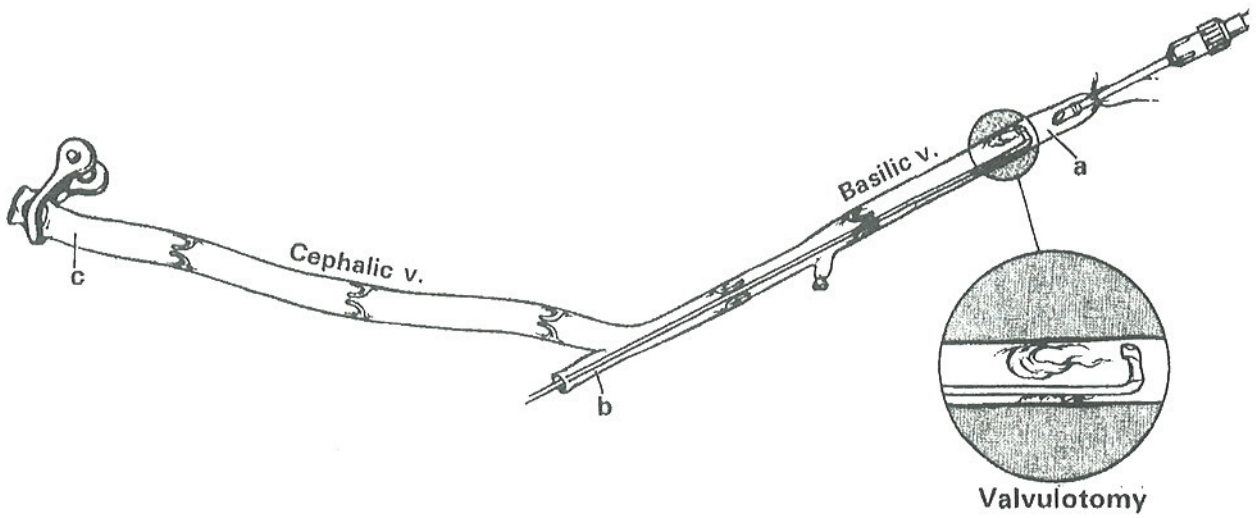

FIGURE 2

The valvulotome is introduced through the stump of the divided cephalic vein (b) and valve lysis of the basilic (and, if desired, the cephalic) vein(s) may be performed.
(From LOGERFO FW, PANISZYN CW, MENZOIAN J. A new arm vein graft for distal bypass.
J Vasc Surg *1987; 5: 889-891)*

In addition, we use angioscopy as a routine for identifying webs, bands, and other sequelae of pre-existing injury to arm veins as a result of venipunctures or cannulation. It is difficult to provide fixed rules about criteria for excision or patching of an injured area of vein. In general if the web or band is 'equivalent' to a valve and can be cut or removed with the valvulotome, it may be treated without excision of the segment. Nest-like clusters of bands and webs require removal of the segment and venovenostomy. Our data indicate that angioscopy is particularly valuable in preparation of the arm vein conduit. (6) Of note is that it can be very easily performed in these grafts which are all explanted, eliminating problems of keeping blood out of the field of view as with in-situ vein grafts. As in all lower extremity vein grafting, the quality of the conduit is an important element of success.

Once the vein has been harvested, valve lysis can be performed. The straight Mills valvulotome works very well. The graft is cannulated from the central end and distended while the valvulotome is inserted from the peripheral end and the valves are incised. With longer grafts, it is necessary to imbricate the vein over the valvulotome in order to reach the full length. This can be done under direct angioscopic control.

Alternatively, the valves may be blindly incised first, followed by angioscopic evaluation from the central end of the vein to inspect the lysed leaflets and the entire vein. Abnormalities in the graft should be corrected at this time, usually by resection or vein patching.

Of particular note are the results with the basilic-cephalic loop graft, described previously (7), in which the upper arm basilic, median cubital, and upper arm cephalic vein are harvested in continuity. (8) (Figure 1) The valves in the basilic segment are incised, and this forms the inflow end of the graft in continuity, with the reversed cephalic segment as the outflow end. (Figure 2) The graft is usually long enough to reach from the common femoral to the midtibial or peroneal level as a single segment, and is certainly of adequate length for most grafts originating from the popliteal artery.

Techniques such as this illustrate the importance of being facile with all methods of arm vein graft harvesting and preparation to maximize limb salvage under difficult circumstances.

With the available length of conduit defined, final decisions can be made about the options for arterial reconstruction, and the dissection of the inflow and outflow arteries may be completed.

Results

The results of arterial reconstruction with arm vein grafts are generally inferior to comparable revascularization procedures in which ipsilateral saphenous vein is used. (9) The reasons for this difference are multiple and probably not related to any flaw in the intrinsic biology of arm veins. Patients undergoing arm vein grafting are elderly, and have often been treated for significant illnesses, including previous CABG or other arterial reconstructive procedures. As a consequence, the arm veins have received many venipunctures or cannulations with resultant injury and scarring.

Angioscopy and careful preparation of the conduit can diminish, but not eliminate, the sequelae of these

injuries, which probably contribute to both acute and delayed graft failure. Although it is true that most arm vein grafts are thin walled and require extra attention during harvest, valve lysis, and in the creation of an anastomosis, concerns about being too thin walled to function durably as a conduit are unjustified and not supported in any literature on this subject.

Other factors leading to a reduced success rate for arm vein grafts relate to the circumstances of the arterial reconstruction. These are often reoperative procedures where the success rate is compromised regardless of the conduit employed. For example, within our initial series of 250 arm vein grafts, the 3-year primary patency of grafts used for first-time reconstructions was 52% compared with 42% for grafts inserted for repeat operation (p=0.035). Similar advantages for primary over repeat grafts were seen in limb salvage rates. In our subsequent report, a similar (though statistically non-significant) difference was seen.

Therefore, a valid comparison between arm vein and saphenous vein in terms of intrinsic biology of the conduit is difficult, but there is no reason to assume a difference.

In our large series of 520 procedures using arm vein for lower extremity revascularization, one- and three-year primary patency rates were 80% and 69% with limb salvage rates of 89% and 82%. The higher limb salvage rate reflects the high incidence of reconstructions done in conjunction with toe or forefoot amputations that remain healed following delayed graft failure. Morbidity related to the arm incision is very low. In our series, this was limited to four patients with numbness over the volar aspect of the forearm and two patients with self-limiting edema.

About 50% of veins require some corrective intervention following angioscopy, and these grafts do as well as those that do not have lesions requiring correction. However, arm vein grafts of inferior quality perform worse than either upgraded or normal vein grafts, again emphasizing the importance of operative angioscopy for the detection of potentially correctable endoluminal disease. (10) Any questionable or clearly inferior areas of the harvested vein should be discarded, and, if needed, a meticulous venovenostomy may be performed. Composite arm vein grafts constructed from normal segments perform as well as single arm vein segments, and no difference was seen in our series with respect to patency or limb salvage between spliced and single segment vein grafts.

When ipsilateral autologous vein is not available, the contralateral saphenous vein is an obvious alternative. However, several considerations limit its potential use. First, we have found that contralateral saphenous vein is available in less than 50% of patients who require arm vein grafts. Second, and more important, is the probability of a future need for subsequent bypass in the contralateral limb. Among 520 patients with arm vein conduit, we followed the fate of the contralateral greater saphenous vein in 107 patients for an average follow-up period of 15 months. At two years, the probability of using the contralateral saphenous vein was over 25%, and, based on an earlier report, approaches 60% at three years. This probably reflects the fact that nearly all of our operations are done for limb salvage in patients with diabetes. Others have confirmed diabetes to be a strong risk factor for contralateral bypass. (11) Therefore our policy of using arm vein as the first alternative to ipsilateral saphenous vein may apply most specifically to patients with diabetes mellitus.

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