# Options for Revascularization: Artery Versus Vein: Technical Considerations

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**KEYWORDS**

• Upper extremity bypass • Upper extremity revascularization • Arterial conduits • Arterial grafts

**KEY POINTS**

- Vascular grafts, as either interpositional conduits or bypass grafts, can be used for revascularization procedures in the upper extremity.
- Vein grafts are more readily available and can be easier to harvest.
- Arterial grafts may provide superior patency rates compared with vein grafts.
- Arterial grafts can be located and harvested with consistent and reliable anatomy throughout the body.

## INTRODUCTION

Vascular reconstructions, in the form of interposition conduits or bypass grafts, are often needed for definitive management of upper-extremity ischemia. Indications for reconstruction include both isolated lesions resulting from repetitive trauma or use (eg, hypothenar hammer syndrome) and a multitude of systemic disease with upper-extremity vascular manifestations. Such systemic diseases include collagen vascular disease (scleroderma, CREST [calcinosis, Raynaud's phenomenon, esophageal dysmotility, sclerodactyly and telangiectasia], lupus erythematosis), Buerger disease, advanced renal disease, diabetes, and peripheral vascular disease.[1] Following adequate excision of the diseased segments, primary end-to-end closure is often not possible, necessitating interpositional grafts. Alternatively, the diseased segment may be left in situ with end-to-side bypass grafting, providing an alternate avenue for perfusion to the end tissues.

## ARTERIAL VERSUS VENOUS GRAFTS

### *Flow Dynamics and Intimal Hyperplasia*

Historically, vein grafts have been the mainstay of treatment given their widespread availability and ease of harvest. Vein grafts are most commonly accomplished with reversed vein grafts harvested from the ipsilateral arm (superficial venous system) or the leg (greater or lesser saphenous veins). More recently, arterial grafts have gained popularity given the concern for high rates of vein graft occlusion postoperatively. Alterations in flow dynamics following vein grafting may result in intermediate and long-term graft occlusion. Several studies have demonstrated adaptive intimal hyperplasia that results when vein grafts are subjected to arterial flow and subsequent intimal sheer stress. The end result is luminal narrowing in up to 30% to 50% of patients.[2,3] In accordance with the reconstructive principle of "replacing like with like," arterial grafts provide native vessels more aptly suited to the high-pressure system

The authors have nothing to disclose.

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Hand Clin 31 (2015) 85–92

http://dx.doi.org/10.1016/j.hcl.2014.09.008

0749-0712/15/$ – see front matter 

with reduced compensatory intimal hyperplasia.[4] The use of arterial grafts for peripheral bypass has been studied extensively in the vascular surgery literature since the 1960s.[5] Much of the recent focus on arterial bypass grafts is based on cardiac surgery literature in which patency and success rates have been shown to be superior in the setting of coronary artery bypass grafting.[4]

### *In Situ Graft Vasodilatory Response and Growth*

There is some evidence that arterial grafts continue to respond to local vasodilatory (strong response) and vasocontrictive (weak response) mediators; this has been demonstrated with the deep inferior epigastric artery (DIEA) in vitro.[6] Furthermore, work by Faruqui and Stoney[5] indicates that arterial grafts in children continue to grow proportionately following inset. The authors find this property to be unique to arterial grafts.[5] Although these studies may be considered investigational, such data do support the hypothesis that arteries are truly the more physiologic graft compared with their venous counterparts. Finally, a recent systematic review of the literature noted arterial grafts have higher patency rates postoperatively than do venous grafts when used for upper-extremity vascular reconstruction.[7]

### *Anatomical Variations in Arterial Versus Venous Grafts*

From an anatomic standpoint, arterial grafts are better suited to upper-extremity bypass when compared with veins. Within the hand, narrow outflow vessels with numerous branch points require multiple distal outflow junctures; this has become increasingly relevant as revascularization techniques have evolved and a more extensive surgical exploration of the hand has become standard. Although earlier reconstructions relied on single-vessel exposures and isolated segment excision (radial or ulnar arteries), now more aggressive identification of the superficial arch as well as both common and proper digital vessels have become commonplace.[8,9] This approach allows for a more thorough assessment of disease and identification of healthy outflow arterial targets. As such, there is often a need for a conduit or graft that allows revascularization of multiple, small-caliber outflow vessels. Venous grafts must be reversed in situ (unless a valvulotome is used) to prevent the native valve from impeding flow. A significant size mismatch is often encountered when vein grafts are reversed; this is of particular concern with anastomoses distal to the wrist.

In addition, reversed vein grafts rarely provide usable branches for revascularizing multiple small distal outflow arteries. In contrast, arterial grafts maintain the proximal to distal orientation, allowing for excellent size matching distally. Several commonly used arterial grafts also end in multiple small distal branches, ideally suited for anastomosis to the digital arteries (**Fig. 1**). These side branches can also be used in small vessel revascularization, such as digital replant or revascularization requiring interpositional grafts.

Last, the handling and microsurgical anastomosis of an artery to artery can be less challenging and less prone to technical errors than veins because of their thicker wall with less tendency to collapse.

### *Indications for Venous Grafts*

Despite the potential superiority of arterial grafts in upper-extremity vascular reconstruction, there are certain scenarios in which the surgeon must consider using a vein. The most common of such indications is the need for significant length. The most commonly used arterial grafts offer only 10 to 15 cm in length at most. However, when the reconstructive surgeon is confronted with gaps or diseased segments in excess of 20 cm, often a long venous graft must be used.

In addition, venous grafts are often superficial, lending to an easier exposure and harvest compared with their arterial counterparts, which often require deeper and more tedious dissections. It is also possible to harvest a vein graft from the ipsilateral arm, reducing the surgical burden to the patient. Any of the arterial graft options require surgical exploration of an additional extremity or the trunk, resulting in an additional donor site and morbidity.

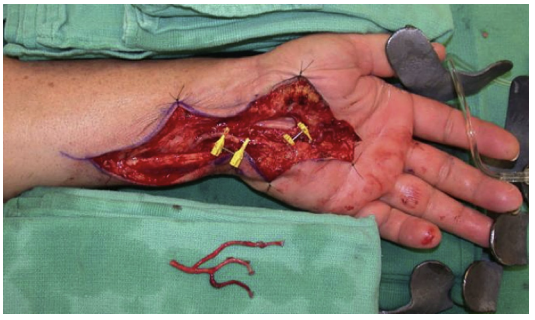

**Fig. 1.** Thoracodorsal arterial graft with multiple distal branches prepared for inset. (*From* Masden DL, McClinton MA. Arterial conduits for distal upper extremity bypass. J Hand Surg Am 2013;38(3):572–7; with permission.)