Surgical Approach to Long-Segment SFA Occlusion: Femoral-Distal Bypass

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Abstract

Lower extremity open bypass surgery remains a mainstay of management for patients with chronic limb-threatening ischemia. Open bypass is often compared with endovascular options for revascularization, but in 2023, the ability to offer patients open, endovascular, or hybrid procedures is key to ensuring that the optimal revascularization plan is promoted. The aim of this paper is to describe the patient selection criteria, procedural overview, and postoperative surveillance strategies for open lower extremity distal bypass surgery in patients with long-segment superficial femoral artery disease.

J CRIT LIMB ISCHEM 2023;3(3):E114-E116. Epub 2023 September 25. doi: 10.25270/jcli/CLIG23-00015

Key words: open lower extremity distal bypass, revascularization, long-segment superficial femoral artery disease

Lower extremity open bypass surgery remains a mainstay of management for patients with chronic limb-threatening ischemia (CLTI). Open bypass is often compared with endovascular options for revascularization, but in 2023, the ability to offer patients open, endovascular, or hybrid procedures is key to ensuring that the optimal revascularization plan is promoted.

This paper details the important aspects when considering an open surgical intervention in patients with long-segment superficial femoral artery occlusion and distal tibial disease. Long-segment superficial femoral artery (SFA) occlusions can be challenging to revascularize from an endovascular approach, and open surgical bypass can often provide a durable result with high, long-term patency rates. The aim of this paper is to describe the patient selection criteria, procedural overview, and postoperative surveillance strategies for open lower extremity distal bypass surgery in patients with long-segment SFA disease.

Selection Criteria

Patient selection includes an initial decision regarding whether the patient would be better served by surgical intervention vs optimal medical management and exercise therapy. The extent of disease process as well as patient symptomatology can help in this decision process. Patients with claudication that is not significantly lifestyle-limiting can generally be managed by optimizing their antiplatelet and statin therapy as well as prescribing a structured exercise regimen to promote angiogenesis; these patients should be followed closely as outpatients to ensure they are not progressing to CLTI. Patients who have progressed to severe lifestyle-limiting claudication warrant consideration of surgical intervention, and conversations with the patient about the potential risks and benefits of surgery are beneficial in coming to a decision. Patients whose disease process has progressed to the point of tissue loss or rest pain typically warrant surgical intervention for revascularization. The WIfI (Wound, Ischemia, and foot Infection) classification system can be used as an adjunct to help determine the appropriateness of surgical intervention on an individual patient basis.

Among patients who are surgical candidates, the decision must be made between open surgery vs endovascular therapy. Factors contributing to this decision include the degree and location of stenosis or occlusion, the degree of calcification of the lesion, and the patient's overall comorbid status and ability to undergo major open surgery. In our scenario for this paper, a long-segment SFA occlusion can be quite difficult to treat from an endovascular approach, particularly if heavily calcified, and open surgical revascularization is often preferable. Preoperative workup should include assessment of the patient's comorbidities and a risk stratification of undergoing major open surgery. A landmark clinical trial comparing open vs endovascular intervention in patients with CLTI is BEST-CLI (Best Endovascular vs Best Surgical Therapy in Patients with Critical Limb Ischemia).

Data from this clinical trial were recently published in a landmark paper comparing these 2 groups.[1] Among the 1420 patients who had adequate great saphenous vein (GSV) conduit for bypass construction, there was a statistically significantly higher rate of major adverse limb events or death in the endovascular cohort (57.4%) compared with the open surgical cohort (42.6%). However, among the 393 patients who did not have adequate GSV for bypass, the rate of major adverse limb events or death was not statistically significantly different between patients who underwent open vs endovascular repair. These data have been important in helping to guide operative planning in patients with CLTI requiring intervention.

Prior to surgery, risk stratification is important to limit morbidity and mortality. A complete workup should include a thorough history and physical exam, laboratory workup, and at a minimum, an electrocardiogram. As so many patients have concomitant coronary artery disease, a more invasive cardiac workup may be necessary, including involvement of cardiology for preoperative risk stratification. Exercise tolerance may not be able to be fully assessed in many patients with severe peripheral arterial disease (PAD), as their disease process significantly limits their ability to participate in exercise; however, surrogate measures such as stress tests may be used if indicated. By the time the patient is referred for bypass, many vascular planning studies have likely been completed. We recommend computed tomography (CT) angiography with lower extremity runoff for anatomical planning, Further, it is well recognized that assessing distal targets for bypass can be limited with noninvasive studies. For this, an arteriogram provides essential details when there is concern about distal vessel patency.

Procedure

Lower extremity bypass surgery remains a mainstay therapy for treatment of atherosclerotic occlusive disease. For many years, the volume of peripheral bypass surgery has been steadily declining; however, new clinical trial data such as the BEST-CLI study described above suggests that open bypass surgery is likely underutilized. In essence, the procedure creates a new pathway of flow by circumventing the occlusion with a conduit.

Various types of bypass can be performed based on the patient's clinical scenario, but clinical success hinges on 3 major principles: a healthy inflow vessel (typically the common femoral, profunda femoral, or SFA), a favorable conduit (native vein over graft), and a good quality outflow vessel (anterior tibial [AT], dorsalis pedis, posterior tibial [PT], or peroneal) are critical to ensure a durable result.

One of the most critical aspects of a successful bypass is the choice of conduit. Assessing the vein quality is best performed with an ultrasound evaluation via vein mapping, although today, CT scans can supplant this study.[2,3] Today, the best results are obtained when native venous tissue is used, particularly the greater saphenous vein. This is particularly applicable when discussing below-the-knee bypasses. Ideally, we select a vein that is at least 3 mm in diameter, though this can vary based on the target artery diameter. When the vein sample is suboptimal, spliced vein grafts can be constructed by sewing 2 separate vein segments together. If the saphenous vein is too small or has been previously harvested, upper extremity cephalic and basilic veins are considered. If a vein conduit remains elusive, cryopreserved vein or synthetic grafts can be used. In general, these alternative conduits do not carry long-term favorable outcomes.

There are several differing techniques for harvesting, preparing, and tunneling the bypass conduit. The saphenous vein can be harvested either endoscopically or open through incisions. Most surgeons will use skip incisions when harvesting the vein to limit wound burden.[2] Some favor the endoscopic option as it can be less traumatic. Additionally, often the vein can be harvesting simultaneous to the arterial vessel exposure, decreasing operative time. Once freed, the vein can be tunneled in a reversed fashion. When tunneled unreversed, a valvulotome is required to disrupt the venous valves. This technique is often utilized when there is a large size mismatch between the vein and the arterial target. To avoid vein harvest, in situ bypasses are an efficient strategy, although they do require valvulotomies.[2,4,5] Lastly, tunneling can be performed anatomically or subcutaneously, the former of which is favored when conduit length is of concern. It should be stated that many research studies have revealed no difference in long-term graft patency based on harvesting or tunneling techniques.[4,5]

A surgical approach includes vein harvesting (when applicable), exposure of the proximal and distal arterial targets, tunneling, and creating a proximal and distal anastomosis, followed by assessment of the patency of the bypass prior to closure of incisions. A full description of the various bypass options is well beyond the scope of this article, but we feel compelled to discuss the exposure of the tibial vasculature. The PT artery is readily accessible through a medial leg incision. The incision is made 2 cm behind the posterior margin of the tibia. Tibial attachments of the soleus are then divided. The vessel bundle can be identified in the deep plane. The AT artery can be exposed nicely at the distal third of the leg. A longitudinal incision is made and deepened. A place is developed between the tibialis anterior and extensor hallucis longus muscle tendon, and the vessel is isolated on the anterolateral surface of the tibia. The peroneal artery is an often forgotten but very suitable target for bypass. Like the PT exposure, an incision is made 2 cm behind the lower border of the tibia. The tibial attachments of the soleus are divided. Posterior retraction of the soleus exposes the flexor digitorum longus. The vessel bundle can be found anterior to the flexor hallucis longus.

Tunneling for a femoral-distal bypass can be performed subcutaneously or anatomically. Anatomical tunneling for a femoral-AT bypass requires creation of an incision in the interosseus membrane through which the graft will travel. The popliteal fossa is accessed via a medial approach to assist in guiding the tunneling process from the anterior compartment through the interosseous membrane and proximally to the groin. The anatomic approach allows for a shorter distance to be traversed compared to a subcutaneous tunnel, and therefore a shorter conduit can be used. The superficial approach allows for easier postoperative monitoring due to the superficial nature of the conduit; however, this can also lead to a higher risk of overlying ulceration of the skin. Superficially tunneled bypasses are typically easier to access than anatomically tunneled bypasses if future surgical intervention is needed.

Careful dissection of the arteries below the knee is stressed. Various clamping techniques can be employed, all of which should remain atraumatic. To decrease the risk of incisional hematomas, careful hemostasis and the generous employment of drains are recommended. Immediate postoperative results can be assessed prior to leaving the OR by use of Doppler at a minimum, with assessment of flow through the bypass as well as the distal runoff. Angiography can also be performed at the completion of the case to better visualize the flow through the bypass graft as well as the inflow and outflow. Open surgical bypass is a valuable technique that all vascular surgeons should master.

Surveillance

Surveillance in the postoperative setting includes monitoring a pulse or Doppler exam immediately postoperatively and throughout the patient's hospitalization. A duplex ultrasound of the graft can be performed during the hospitalization or at the patient's outpatient postoperative visit. The patient should be seen as an outpatient approximately 2 to 4 weeks postoperatively for assessment of the groin and leg wounds. Serial duplex ultrasounds should be obtained in the outpatient setting at approximately 1, 3, 6, and 12 months postoperatively; this interval can be increased if the bypass remains patent without significant stenosis. Ideally, serial duplex ultrasound will help increase the chance of detecting impending graft failure prior to actual failure of the graft, allowing for a higher chance at successful revascularization. The graft should be assessed in its entirety, including at the proximal and distal anastomoses. A peak systolic velocity (PSV) of >300 cm/sec corresponds to significant stenosis that should warrant consideration of intervention; a very low PSV of <40 cm/sec can also indicate possible impending graft failure.[6] Pulse-volume recordings can also be useful in assessing global perfusion at various levels of the lower extremity. Graft failure shortly after graft creation is most likely due to technical errors, whereas graft failure at a later date can be more commonly linked to neointimal hyperplasia. Intervention for failing grafts can include endovascular methods via balloon angioplasty or stenting but can also include open surgical revision of the bypass. To decrease the risk of graft failure, adherence to a continued plan of optimized medical therapy is critical, including statin and antiplatelet medications for most patients, and anticoagulation as well if clinically indicated. Smoking cessation and management of comorbidities is also important in improving long-term outcomes.

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Disclosure: The authors have completed and returned the ICMJE Form for Disclosure of Potential Conflicts of Interest. The authors report no conflicts of interest regarding the content herein.

Manuscript accepted September 13, 2023.

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