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Secondary Bypass after Infrainguinal Bypass Graft Failure

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Patients who suffer failure of a previous infrainguinal bypass graft often present with recurrent ischemia requiring secondary revascularization for limb salvage. These patients pose major challenges for the vascular surgeon. Management strategies vary with the time interval from bypass, the functional status of the patient, the degree of ischemia and the availability of autogenous vein. This article reviews the treatment options for these difficult patients and the results which can be achieved.

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THROMBOSIS OF A previous infrainguinal arterial bypass graft remains a distressing and challenging problem for every vascular surgeon. In most cases, bypass graft failure manifests as a recrudescence of ischemic symptoms ranging from claudication to frank limb-threatening ischemia. Early graft failure (within 1 month of surgery) has been reported in approximately 5% to 10% of cases.^{1,2} Conversely, intermediate-to-late graft failure (beyond 1 month) occurs in 20% to 50% of cases within 5 years of surgery.³⁻⁵ In our experience, approximately 10% of patients undergo a major amputation as their next intervention at the time of failure of their infrainguinal bypass graft.⁵ In the majority of patients, however, restoration of graft patency or a repeat bypass procedure is appropriate in order to relieve symptoms and prolong limb salvage.

The etiology of vein graft thrombosis varies with the interval from the time of operation to the time of graft failure.⁵ Early graft occlusions within the month of surgery are generally attributable to errors in operative technique, such as clamp injuries, retained valves, vein graft injuries, and anastomotic errors. Judgmental errors, such as employing inadequate inflow or outflow vessels and use of inadequate venous conduit, can also play a role. In unusual cases, early graft thrombosis may be attributable to graft surface thrombogenicity or unsuspected hypercoagulable states.⁶ Intermediate vein graft failure (from 30 days to 18 months after reconstruction) most commonly occurs from formation of intimal hyperplasia within the vein graft itself or at the site of anastomosis. Finally, late graft failure (beyond 18 months) is usu-

ally due to the progression of atherosclerotic disease in the inflow or outflow vessels, ultimately leading to vein graft thrombosis.

Reoperation for Early Vein Graft Failure

Patients who suffer early graft failure within 30 days of surgery are generally treated by an immediate return to the operating room for an attempt at restoration of vein graft patency. The etiology of graft failure can often be determined from a review of intraoperative findings as well as the completion arteriogram. For example, use of a marginal venous conduit or history of vein wall trauma during the surgery may indicate the etiology of graft occlusion. Assuming the patient is stable and an acceptable risk for intervention, an expeditious return to the operating room is generally indicated. The patient is anticoagulated with heparin and the proximal and distal graft hoods are opened and the thrombus is gently extracted using a combination of heparinized saline solution irrigation through the graft and a balloon catheter thrombectomy. All potential defects are aggressively corrected with patch angioplasty and interposition grafts if necessary. Larger amounts of the graft may be replaced with newly harvested vein, if necessary. Intraoperative duplex ultrasonography is often extremely helpful in identifying the presence of any residual defects. Short-term anticoagulation (1-4 weeks) is used in all patients, while long-term anticoagulation with warfarin is employed selectively. This is particularly important for the small number of patients in whom no particular technical defect is identified. If, indeed, the original conduit employed in surgery was a marginal conduit in terms of quality or size, consideration for abandoning the vein graft and proceeding with a new bypass (if indicated) should be made.

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Reoperation for Intermediate and Late Vein Graft Failure

Unlike patients who suffer early graft failure, a number of considerations must be undertaken before considering reoperation in patients who suffer intermediate to late vein graft failure. First and foremost among these are the patient's general condition and ambulatory status at the time of graft occlusion. Progressive comorbidities may preclude major reoperative surgery and dictate more temporizing nonoperative measures or even progression to amputation. The degree of ischemia that recurs at the time of graft failure is also a major determinant. Patients who are initially operated on for claudication may often be managed conservatively while those who have limb-threatening ischemia will often require reoperation for limb salvage.

The availability of autogenous vein for a reoperative intervention is also an important consideration. Sources of vein not only include the contralateral greater saphenous vein (GSV), but various ectopic veins harvested from the arms as well as the lesser saphenous veins. In patients in whom there is insufficient autogenous vein, an attempt at salvage of the thrombosed graft may be appropriate.

Salvage of Thrombosed Vein Graft

When surgeons are confronted with a patient with late thrombosis vein graft, there is a natural tendency on the part of the vascular surgeon to want to restore patency to the thrombosed graft. This may be achieved by thrombectomy followed by angiography and duplex ultrasonography with subsequent repair of the defects responsible for graft failure. Unfortunately, thrombectomy of vein grafts has seldom proved to be a rewarding long-term strategy with patency rates. In two studies from our previous experience, thrombectomy of thrombosed vein grafts, followed by repair of the conduits, resulted in only 19% to 28% patency rates at 5 years after intervention.^{7,8} Recognition of the limitations of thrombectomy led to considerable enthusiasm for the use of thrombolytic therapy. Thrombolytic therapy offers several potential advantages, including more complete thrombus dissolution from the outflow vessels and preoperative recognition of the lesions responsible for vein graft occlusion. This affords the surgeon with a road map to allow graft revision. This technique also may allow avoidance of balloon catheter-induced trauma to the vein graft wall. Unfortunately, despite these potential advantages, thrombolytic therapy has not proven to be a particularly useful strategy for restoring patency to vein grafts. In our previous study, only 23% of vein grafts remained patent 3 years after successful thrombolysis and revision.⁹ Other studies have confirmed similar disappointing results.^{10,11} In subgroup analysis, vein grafts that have been patent for more than a year tend to have more durable patency rates after thrombolysis and revision than those that have failed within a year of the original operation.¹¹

Given the limitations of thrombolytic therapy for restoring

durable vein graft patency, we have become increasingly more selective in its use. Currently, we prefer this approach only for patients with limited quantities of autogenous vein, significant thrombus in the outflow vessels, or those with advanced comorbidities that preclude a major reoperation. In general, our preferred approach for intermediate to late vein graft failure is to proceed with an entirely new surgical reconstruction in those in whom revascularization is indicated.

Reoperative Bypass Surgery

The challenges of secondary infrainguinal bypass surgery after a previous failed reconstruction are well-known to vascular surgeons. Severe scarring in the operative field and the lack of ipsilateral GSV necessitating use of alternative vein conduits presents technical challenges to the surgeon. Furthermore, by virtue of the fact that these patients have suffered failure of a previous reconstruction they include among them "vascular bad actors." These patients suffer from more severe atherosclerosis, a marked intimal hyperplastic response, poor-quality venous conduits and hypercoagulable states. It is therefore not surprising that the published results of secondary bypass surgery in a large series of patients are generally inferior to those achieved with primary bypass procedures.^{12,13} Successful completion of a secondary bypass procedure in this setting requires resourcefulness in maximizing the use of available vein and adapting the operative strategy to the patient's particular anatomy. Adherence to certain general principles and avoidance of common pitfalls are important in achieving success.

Arterial Exposure

Reexposure of previously dissected arteries within scarred surgical fields is challenging and time-consuming. Such dissection is best performed sharply, while carefully avoiding entry into the outer layers of the entire arterial wall ("exarterectomy"). Dissection should be minimized, whenever possible opting for intraluminal control with occlusive balloons or use of a proximal thigh tourniquet to control distal vessels in difficult reoperative cases.¹⁴ Use of such tourniquets for distal control allows only the anastomotic surface of the distal vessels to be exposed.

In order to avoid the difficulties of previously operated fields, alternative inflow and outflow sites should be employed whenever possible. Alternative inflow sites might include the superficial artery below the femoral bifurcation or the popliteal artery. Preoperative balloon angioplasty with or without stenting may optimize the superficial femoral artery and popliteal arteries for use as inflow vessels for reoperative surgery.¹⁵ The profunda femoris artery may also be a useful inflow vessel and can be exposed distally via previously unoperated planes. In some situations, the distal external iliac artery may be suitable for inflow. Although this has a disadvantage of lengthening the necessary venous conduit, it is easily exposed and may be particularly useful when the distal anastomosis can be constructed at the popliteal level. Avoid-

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