Disorders of the vascular system are the leading causes of death and disability in the western world. One of the most debilitating forms of vascular disease is peripheral arterial occlusive disease when it is manifested as critical limb ischaemia. Patients with limbs threatened by distal tibioperoneal occlusive disease present an ongoing challenge to the vascular surgeon.

Since the first experimental venous by-pass graft by the Nobelist Alexis Carrel in 1906 [18] and the first femoropopliteal by-pass in a patient by Jean Kunlin in 1948 [48], infra-inguinal by-pass has become increasingly applied with markedly improved efficacy and safety. Despite the pioneering reports by Auer and Hershey [7] in the 1970s, distal by-passes were infrequently performed until two decades ago, when accumulated experience, the upgrading to fine surgical instrumentation and advances in arterial imaging made infrapopliteal by-passes widely acceptable. In recent years more aggressive attitudes in limb-salvage procedures have been adopted, related mostly to interventions on arteries distal to the popliteal artery.

In any consideration of distal by-passes, one cannot escape the fact that these operations are required in patients with severe generalized atherosclerosis and, specifically, in patients whose disease involves not only the tibial and peroneal arteries but often the aorta as well as the iliac arteries and femoropopliteal system.

Considerable attention has been given to improving the long-term results of peripheral grafting, mainly emphasizing proper patient selection and refinement of surgical technique. Several factors, such as patient characteristics, smoking, graft placement, surgical experience and adjunctive medications, have been investigated as to whether they affect the results of femorodistal by-passes [17, 24, 43, 52, 67, 74, 75]. Although certain diseases, such as renal failure and diabetes, have implications for peri-operative morbidity and long-term survival, none has any predictive value for graft patency [39, 45, 61, 94]. The only reliable predictors of graft patency are derived from the anatomical and haemodynamic aspects of the reconstruction itself, such as the quality and origin of the conduit and its outflow bed.

There are, however, some critical issues that are decisive for the successful outcome of femorodistal reconstructions. The first is the arteriographic technique, with which all patent, named arteries in the leg and foot should be visualized. Only with accurate imaging of the extent of occlusive and stenotic disease can revascularization of distal arteries be planned appropriately. Of even greater importance is the fact that the limb-salvage surgeon should have appropriate training, experience and a meticulous and fine technique. Surgical manipulations (occlusion, arteriotomy and suturing) must be performed with diligence, since many patients have extensive atheromatous involvement or heavy calcification in the patent segment of the artery available for anastomosis. Moreover, the skilled surgeon should be familiar with all surgical options that are available. Finally, it has to be made clear that disadvantaged outflow arteries such as those connecting incomplete plantar arches, those consisting of isolated or blind segments, and those with considerable disease or heavy calcification can sometimes serve as effective sites for by-pass implantation. This high operability is further increased by the use of appropriate measures preoperatively, intraoperatively and postoperatively to accomplish with reasonable safety the sometimes long operation designed to save a limb. From this point of view, careful preoperative cardiac evaluation with a resting ECG and
7.2 Femorodistal By-pass Surgery

7.2.3 Operative Indications

As by-passes to either the tibial arteries or the peroneal artery are generally complex, difficult operations with a significant incidence of early and late failure and considerable of operative morbidity and mortality, these operations should never be performed for intermittent claudication. All by-passes to arteries distal to the popliteal artery should be performed to save a critically ischaemic limb. Occasionally, however, patients with advanced ischaemia and limited ischaemic rest pain, small patches of gangrene, or ischaemic ulceration may improve through conservative management [9, 85]. In cases in which the lesions are limited and the outcome is uncertain, a trial period of hospitalization with conservative treatment may be warranted before undertaking a difficult distal by-pass. These cases are rare. Generally, these manifestations, if severe or extensive, will cause limb loss if the circulation is not restored by arterial reconstruction.

Extensive gangrene in the foot, particularly gangrene of the heel, has long been regarded as a contraindication to performing a limb-salvage arterial by-pass. Increasingly, over the years, it has been shown that functional remnants of foot can be obtained even when extensive necrosis and gangrene involve the bones and soft tissues of the forefoot or heel. A healed foot remnant, which can sometimes only be obtained with a split-thickness skin graft, will allow some of these aged, debilitated patients to ambulate far better than a below-knee amputation. On the other hand limb-threatening ischaemia typically occurs in elderly patients with multiple, severe, coexisting medical conditions. There is appropriate concern regarding the advisability of revascularization surgery, especially because patients undergoing these major procedures often require multiple transfusions, prolonged hospitalization, intensive care and, frequently, subsequent procedures to achieve foot healing. Unfortunately, a decision not to perform revascularization in the setting of limb-threatening ischaemia makes amputation virtually inevitable. Amputation is in itself a surgical procedure whose risks and length of hospitalization are at least equivalent to those of revascularization and with a far less desirable outcome from the patient’s point of view. Although there has never been a randomized study comparing revascularization with amputation for limb-threatening ischaemia, it has been demonstrated that operative mortality, hospital stay and long-term survival were all superior in the revascularization group [27, 62, 72]. Based on these studies, most vascular surgeons recognize few contraindications to revascularization for limb-threatening ischaemia.

Only chronically institutionalized, neurologically impaired, permanently nonambulatory patients with severe organic mental syndrome or gangrene and infection of the midportion of the foot are absolute contraindications to attempts at limb salvage. In these cases there is no advantage to revascularization over amputation.

7.2.4 Technical Considerations

7.2.4.1 Proximal Anastomotic Site

Traditionally, the common femoral artery has been the in-flow site of choice for infrapopliteal by-pass. The location of in-flow site has no impact on femorodistal by-pass patency provided that the chosen segment is relatively healthy and there is no proximal haemodynamically significant stenosis [84, 92]. Yet, patients requiring distal by-passes frequently present stenotic or occlusive lesions involving the distal aorta or the iliac arteries or both. In this setting percutaneous transluminal angioplasty offers an attractive solution since it should be performed in combination with the distal revascularization procedure [33]. It should be noted that frequently proximal repair will be enough to obviate the need for a more difficult distal procedure, which must be required if the iliac gradient were not large and would probably be required if the patient had ischaemic tissue loss in the foot.

Since the early 1980s, the superficial femoral, deep femoral, popliteal and tibial arteries have all been used as in-flow sources when these vessels were relatively disease-free or when the amount of autologous vein available was limited [6, 57, 76, 95]. The strategy of utilizing more distal in-flow sources is particularly applicable to inframalleolar by-passes, in which very long vein segments would be required to reach the dorsalis pedis or other pedal arteries from the usual more proximal in-flow sites.