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Open Surgical Therapy for Peripheral Artery Disease

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Abstract

Purpose of Review The surgical management of symptomatic peripheral artery disease (PAD) has changed in the last few decades. Improvement in endovascular technology has resulted in more complex lesion once reserved for open surgery being addressed in an endovascular fashion. Even with these advances, there are lesions and patients that are better managed with an open surgical procedure. The aim of this review is to describe the most commonly performed open surgical procedures for PAD.

Recent Findings The recently published Best Endovascular versus Best Surgical Therapy (BEST-CLI) trial was an international, prospective, randomized controlled trial that aimed to investigate which revascularization (endovascular vs. surgical bypass) approach was superior for limb salvage. The evidence supports an open surgical bypass as an initial approach.

Summary The advancements made in the surgical management of PAD have provided options for patients who were once deemed poor surgical candidates. The goal continues to be utilization of the best available tools to address patient disease. In this current era, it is important to be familiar with the open surgical therapies.

Keywords Lower extremity bypass · Peripheral artery disease · Open surgical bypass · Aortoiliac disease · Direct aortic reconstruction · Extra-anatomic bypass

Introduction: Epidemiology and Background

Peripheral artery disease (PAD) is most commonly caused by atherosclerosis and like other atherosclerotic disease processes; PAD continues to have an enormous impact on the healthcare system [1, 2]. As a result of a global epidemic of diabetes and metabolic syndrome, there has been an increase in the incidence of PAD with approximately 10 million people affected in the USA [3] and more than 230 million people globally [4]. This increase in the disease incidence parallels the aging of the world population. According to epidemiologic data, 25% of the people affected by PAD are octogenarians [5]. In addition to age and diabetes, hypertension, hyperlipidemia, and smoking are common risk factors for PAD.

While approximately 50% of those with PAD are asymptomatic, symptomatic presentation of PAD includes intermittent claudication (IC), chronic limb threatening ischemia (CLTI), and acute limb ischemia (ALI). Non-interventional management of PAD comprises aggressive treatment of cardiovascular comorbidities which prevents worsening atherosclerosis and reduces major adverse cardiovascular events [6]. In addition to optimal medical management, risk factor modification includes smoking cessation and exercise therapy for IC. Revascularization is performed to improve ambulation, relieve pain, heal wounds, preserve a functional limb, and prevent a major limb amputation. Currently, endovascular revascularization, surgical revascularization, and hybrid procedures are practiced and standard of care treatment strategies in select clinical scenarios [6].

Indications

Asymptomatic Peripheral Artery Disease

While those with asymptomatic PAD require guideline-directed optimal medical therapy to manage their

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cardiovascular risk, there is no reason to undertake revascularization in such patients [7]. Presence of stenoses or occlusions on imaging studies does not constitute a reason to intervene. The one exception to this rule involves patients who have had a prior lower extremity bypass or stent that demonstrates evidence of a severe stenosis. In such patients, revascularization can prolong primary assisted patency [6, 7].

Intermittent Claudication

Intermittent claudication manifests with reproducible, exertional pain or fatigue in leg muscles that results from unmet metabolic demand imposed on a particular muscle group due to decreased perfusion. Although most commonly described in the muscles in the calf, it can also involve thigh or buttock muscles. More proximal occlusive disease tends to result in more proximal muscle symptomatology; Leriche syndrome is a triad of buttock claudication, diminished femoral pulse, and impotence in the setting of aortoiliac disease. Most patients with IC, with the exception of those with diabetes or current smoking, rarely progress to CLTI or ALI and therefore are at low risk for limb loss. Consequently, such patients should initially and primarily be managed with guideline-directed medical therapy including smoking cessation, cilostazol, and supervised exercise [7]. Only those who fail medical therapy or have short distance IC that interferes with activities of daily living are candidates for revascularization. Treating a single level of disease, rather than all lesions, is sufficient to treat IC.

Chronic Limb Threatening Ischemia

Chronic limb threatening ischemia, the most advanced form of PAD, presents with ischemic rest pain and/or tissue loss. If no intervention is undertaken, those with CLTI have a 22% risk of major amputation and a 22% risk of death at 1 year [8]. Arterial revascularization to mitigate the high risk of limb loss is indicated in patients with CLTI. Endovascular, surgical, and hybrid revascularization strategies are used to achieve reperfusion of the affected lower extremity. Guideline-directed medical therapy is used to mitigate the high risk of associated cardiovascular death. At present, a diverse group of practitioners, among them interventional cardiologists, interventional radiologists, and vascular surgeons, provide revascularization treatment to those with CLTI. The decision to recommend surgical or endovascular revascularization varies significantly among physicians and is based on a range of patient factors, such as disease pattern, availability of autogenous conduit, and comorbidities. There are other external factors such as physician training, surgical and endovascular skillsets, and disparate treatment biases that also play a role.

Regardless of choice of revascularization strategy, clinical wisdom dictates that in the setting of tissue loss, in-line establishment of direct flow to the ankle or foot is crucial, while for ischemic rest, pain treatment of one level of occlusive disease is sufficient. In the setting of tissue loss, attention must be paid to the foot and source control of infection, if present; incision and drainage of foot abscess or open toe/forefoot amputation may be needed before definitive revascularization is offered [9]. In some patients, particularly those with non-salvageable tissue loss, primary leg amputation is appropriate.

Diagnostic Evaluation

In addition to a thorough history and physical examination, lower extremity noninvasive vascular studies should be obtained. These vascular studies can confirm the diagnosis and guide further workup and treatment. They include the ankle-brachial index (ABI), segmental pressures, toe pressures, pulse volume recordings (PVRs), and tibial doppler waveforms. Studies with exercise are required to diagnose IC. Non-invasive vascular studies can assist in quantifying the degree of arterial insufficiency and localize the level of stenoses or occlusions [10]. Tests like arterial duplex, computed tomography angiography (CTA), magnetic resonance angiography (MRA), and digital subtraction angiography (DSA) are used to further define the arterial anatomy in patients considered for possible intervention.

Surgical Therapy

Before discussing the surgical options for PAD, it is important to understand how anatomy, disease location, and overall clinical status of a patient can influence the surgical approach. The Trans-Atlantic Intersociety Consensus (TASC) is a comprehensive document that was published by multidisciplinary group from various professional societies. In this document, aortoiliac lesions were classified A through D, with TASC A and B used to describe simple, short segment lesions while TASC C and D lesion denoting more complex disease [11]. Based on this classification, recommendations were made as to which approach would be ideal for endovascular versus open revascularization. In 2007, The Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II) was published. This revision included femoropopliteal disease in the classification scheme in addition to incorporating the patient's comorbidities in the treatment algorithm [6]. More recently, The Global limb Anatomic Staging System (GLASS) was proposed by the Global Vascular Guidelines (GVG). In this guideline, two novel concepts (target artery path (TAP) and limb-based patency (LBP)) are combined to create a staging system that correlates with evidence-based revascularization [12].

Endarterectomy

Endarterectomy is defined as the removal of occlusive plaque from a diseased artery. Prior to routine use of prosthetic grafts to address aortoiliac occlusive disease (AIOD), endarterectomy of the aortoiliac segment was routinely used to treat focal disease [13, 14]. In the modern era, it is routinely performed in the common femoral (CFA) or deep femoral arteries (DFA) as a standalone procedure to address focal stenosis/occlusion [15] or as an adjunct to an aorto-bifemoral bypass, infrainguinal bypass, or any extra-anatomic bypass that involves the CFA or DFA. This surgical procedure can be performed under general or local anesthesia. A longitudinal arteriotomy is performed on the CFA and continued onto the DFA if significant plaque extends into that artery. After control of inflow and outflow arteries, the plaque is removed using a specialized instrument through the layer between the media and adventitia of the vessel [16] (Fig. 1). In order to avoid narrowing the vessel the arteriotomy is closed with a patch that is sewn on using polypropylene sutures. While expanded polytetrafluoroethylene (ePTFE) or autologous vein can be utilized, the authors prefer using a bovine pericardial patch. Some have reported successfully using an occluded, endarterectomized superficial femoral artery (SFA) as a patch [17]. It is important to extend the patch angioplasty onto the DFA even when there is little disease in that artery. Doing so will ensure that a source of collateral blood flow should be the bypass or the SFA become occluded. For patients with concomitant disease proximally or distally, additional revascularization, surgical or endovascular, may be warranted [18].

Common femoral artery endarterectomy performed in isolation has been shown to be sufficient to address symptoms of IC and CLTI [19]. Cambria et al. reported 1- and 5-year patency rate of 93 and 91% of this procedure, respectively, in their series. There was no difference in primary patency rates between patients treated for IC compared to those treated for CLTI [15]. Although femoral endarterectomy has a 30-day mortality of 1.5% [20], the associated surgical site infection in the groin continues to be a concern.

While some have attempted endovascular interventions for CFA disease with some success [21], the overall outcome has not been promising. The 1-year patency is inferior to the patency reported for surgical endarterectomy. Additionally, the routine use of stents in the common femoral artery is not recommended because of the risk of stent fracture with flexion of the hip [7] and loss of access to the ipsilateral femoral artery if future open surgical access is needed. Use of stents in the CFA have been associated with increased rate of reintervention and amputation [22].

Aortobifemoral Bypass

Aortoiliac occlusive disease usually affects the distal aorta, the common iliac arteries (CIA), and can also involve external iliac arteries (EIA), CFAs, and DEAs. It is commonly observed in patients who use tobacco. In its mildest form,

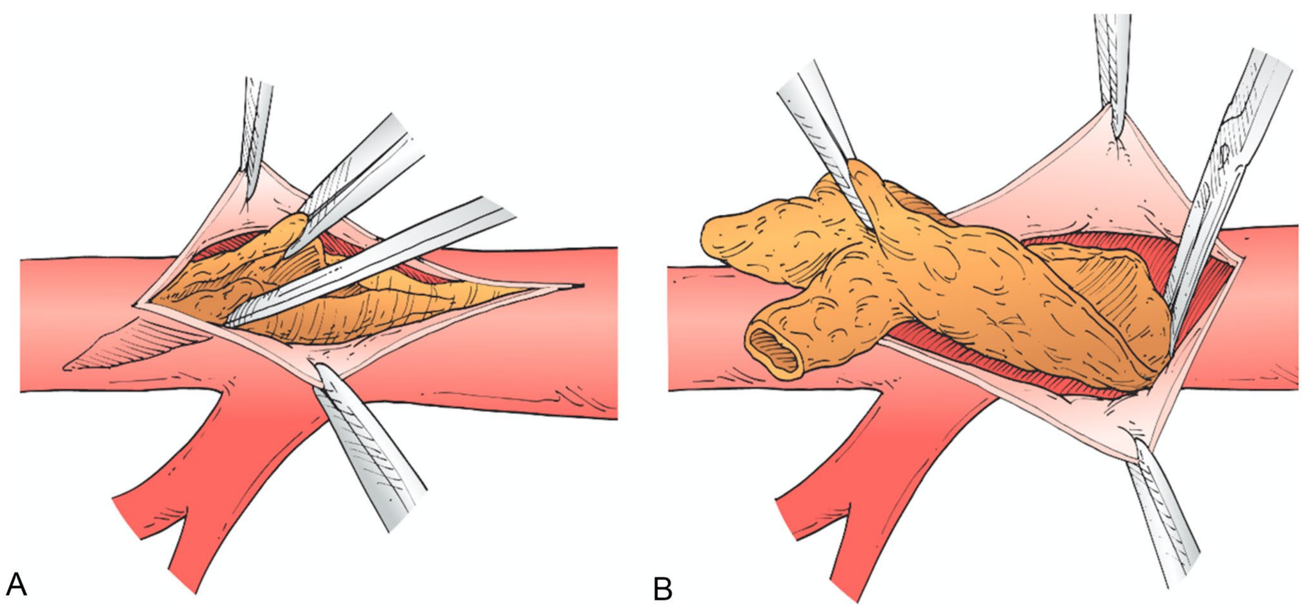

Fig. 1 **A** Removal of plaque from a diseased vessel. **B** The plaque is transected to achieve a tapered endpoint (reprinted from: Menard MT, et al. © 2023, with permission from Elsevier) [55]

patients can be asymptomatic due to presence of a rich collateral network. However, when such collaterals are not enough to maintain distal perfusion, patients will begin to experience symptoms. In the setting of severe AIOD that requires treatment (Fig. 2), aortobifemoral bypass (ABFB), a direct, in-line bypass between the aorta and the femoral arteries, is a suitable intervention. It is usually performed through a transperitoneal incision. Although feasible, the retroperitoneal approach, given patient left lateral decubitus positioning, presents a technical challenge for accessing the right CFA. When performed through a transperitoneal incision, the patient, after undergoing general anesthesia, is placed supine on the operating table. The operation is begun by dissecting out CFAs through both groin incisions. Next, a laparotomy incision is made in the abdomen to facilitate adequate exposure of the infrarenal aorta. After the infrarenal aorta is exposed, a tunnel is created between the abdomen and the groins underneath the inguinal ligament. Once heparin is given, a bifurcated Dacron or ePTFE graft is chosen. After placement of aortic clamps, the proximal anastomosis can be configured in an end-to end or end-to-side fashion, depending on whether there is a concomitant aortic aneurysm present, or there is concern for pelvic ischemia. Next, the limbs of the bifurcated graft are tunneled to lie next to CFAs bilaterally. The distal anastomoses are performed end to side and after flushing of the graft flow is re-established to both legs. Of note, the thoracic aorta can be an alternate source of inflow. In this scenario, a left thoracotomy incision is used to gain access to the thoracic aorta, the graft is tunneled lateral to the left diaphragm and across the retroperitoneum for a thoraco-bi-femoral bypass.

The outcomes for ABFB have been excellent. Review of the available data shows that over the course of the pat decades, its mortality and morbidity continue to trend down while the patency rates have remained constant [23]. The reported 30-day morbidity and mortality rate in the most recent studies is 8.3% and 3.3%, respectively. This is in contrast to six decades ago when the morbidity and mortality rates were 13.1% and 4.6%, respectively [23]. The 5-year primary patency rates for ABFB are between 85 and 95% [23, 24]. Durability of this bypass procedure is similar regardless of the indication for intervention (IC vs. CLTI) [23]. Although most common perioperative complications are cardiac in origin, graft limb thrombosis and complications from surgical site infections are not infrequent [16]. Most unplanned readmissions that occur within 30 days are due to wound complications [25]. In one series, there was a 12% wound complication rate with 5% requiring operative intervention [25]. Nevertheless, ABFB remains a safe and well tolerated operation in patients who are surgical candidates with a 30-day mortality that is less than 1% [26]. In a recent retrospective analysis by Abdelkarim et al., the preoperative use of statin was associatd with a 32% reduction in 30 day mortalitiy after ABFB for AIOD [27]. This finding highlights the importance of medical optimization in the perioperative period and beyond.

Although the gold standard intervention for aortoiliac disease is ABFB, endovascular revascularization for AIOD has become increasingly popular. Particularly, the use of covered stents in the iliac arteries have acceptable results with less morbidity and mortality that open surgery [28]. In comparing ABFB with "kissing stents," Dorigo et al. reported similar patency rates at 6 years [29]. The comparable durability and improved safety make endovascular therapy an attractive option for patients who are deemed high risk for an open surgical intervention. In our practice, ABFB is reserved for younger patients with acceptable surgical risk who have severe AIOD (TASC D) or have failed endovascular therapy.

Axillo-bifemoral Bypass

For patients who are unable to tolerate aortic clamping due to frailty, comorbid conditions, or in the setting of a severely calcified aorta that precludes safe clamping, an axillo-bifemoral bypass (AxBFB) is an acceptable alternative. This extra-anatomical bypass is also performed in the

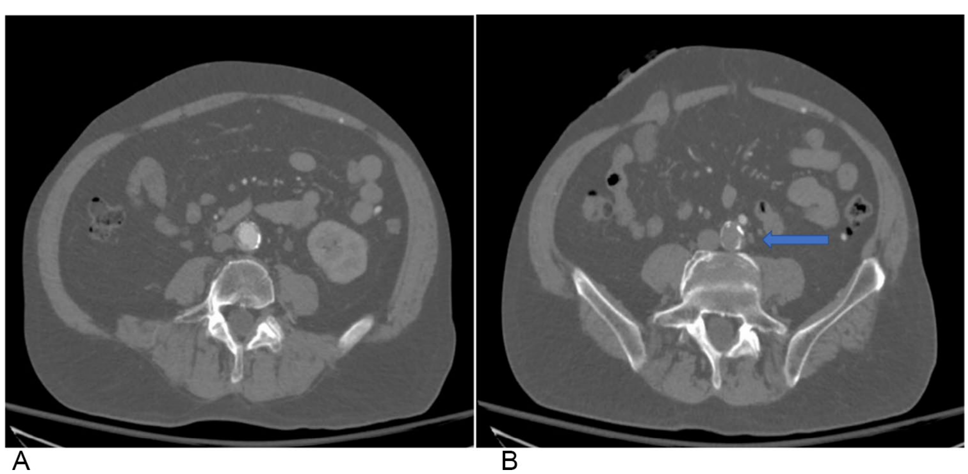

Fig. 2 **A** CTA showing contrast in the lumen of the distal aorta. Further down the same image (**B**), there is absence of contrast in the distal aorta signifying an aortic occlusion (*blue arrow*) in a patient with rest pain

setting of infected native aorta or graft or in patients with prior multiple abdominal surgeries and a "hostile abdomen." Prior to performing this procedure, bilateral upper extremity blood pressure should be checked to ensure that there is no significant difference between the two extremities that suggest presence of a subclavian artery stenosis [30]. In the absence of significant axillo-subclavian arterial disease, either axillary artery can be the donor artery.

With the patient in a supine position, after induction of general anesthesia, a roll is placed between the shoulder blades so as to distract the infraclavicular fossae. Exposure of the axillary artery is achieved through a transverse incision placed inferior to the clavicle. Once the first segment of the axillary artery is fully exposed and controlled, attention is turned to the groins for bilateral CFA exposure. Next, the graft is tunneled along the flank, underneath the pectoralis major muscle, and in the subcutaneous plane. Subsequently, the patient is systemically heparinized, and the proximal anastomosis is performed followed by the bilateral distal anastomoses.

Complications associated with AxBFB include injury to brachial plexus during axillary artery dissection, as well as bowel or bladder injury during tunnel creation. A rare but serious complication of AxBFB is disruption of the graft at the axillary anastomosis [31], and this is avoided if the proximal axillary anastomosis is based on the first–second segment of the axillary artery. Historically, the reported outcomes of AxBFB have been poor in comparison to those for ABFB. This is partly because the patient population that undergoes this operation are generally more frail and have multiple comorbidities [32]. The documented overall patency rates range from 49 to 85% at 3 years [33, 34, 35]. An increase in overall patency was observed after introduction of ePFTE as a conduit [36, 33] while the 30-day operative mortality rate has remained the same at 3% [32]. A more recent publication reports 1- and 5-year primary patency rates of 98% and 82%, respectively [37].

In contrast to the favorable results of ABFB performed for patients with intermittent claudication (IC), AxBFB has worse outcomes when performed for IC [38]. There is an observed increase in perioperative amputations in addition to a greater risk of reintervention at 1 year [38]. Due to these limitations, this operation should not be offered to patients with IC who are able to tolerate ABFB [38]. In our practice, AxBFB continues to be an appropriate procedure for those who require an open inflow procedure and are unable to tolerate ABFB.

Femorofemoral Bypass

Another example of an extra-anatomical bypass is the femoro-femoral bypass (FFB) constructed between bilateral CFAs (Fig. 3). Because it does not require entering a body cavity and can be done under local anesthesia, FFB

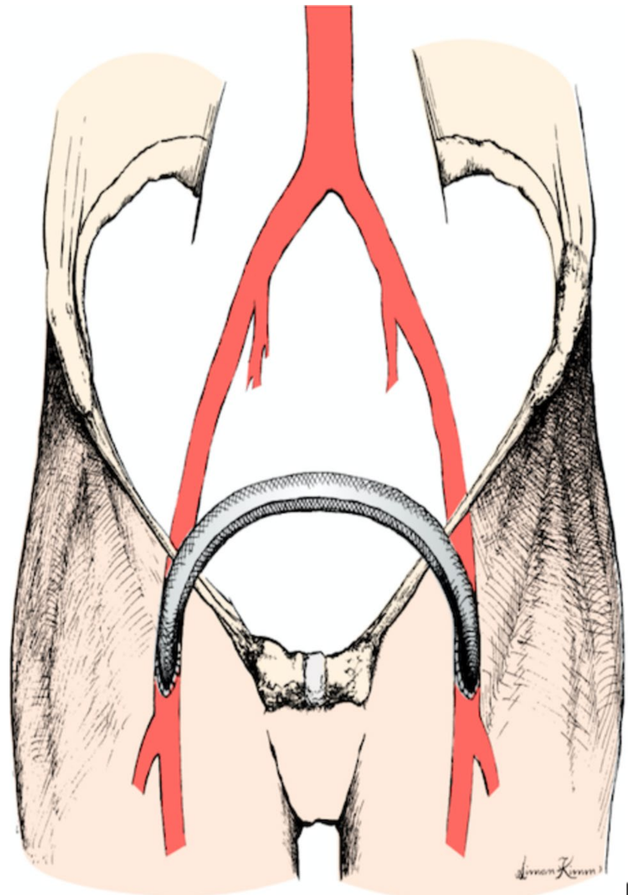

Fig. 3 Configuration of a femorofemoral bypass (reprinted from: Schneider © 2023, with permission from Elsevier) [56]

is well suited for patients who have prohibitive risk factors for an open operation. In the setting of asymmetric iliac artery occlusive disease, blood flow can be diverted from the patent iliofemoral artery to the contralateral iliofemoral arterial system (Fig. 4). After exposing the bilateral groins, a prosthetic graft is tunneled in the subcutaneous plane, anterior to the abdominal wall fascia. For the operation, both Dacron and ePTFE have been shown to have similar results and can be used as the conduit [39]. The graft is then anastomosed to the CFA or sometimes more distally to incorporate the origin of the DFA. If there is evidence of significant disease in the CFA, an endarterectomy is performed. Femoro-femoral bypass should only be performed if the donor limb can tolerate reduced blood flow that will most certainly occur with flow diversion. Often, noninvasive studies can be helpful in determining the wisdom of proceeding with FFB [40]. If there is evidence of significant flow limiting disease in the donor artery, balloon angioplasty and possible stent placement can be performed in the same setting to improve inflow [41].

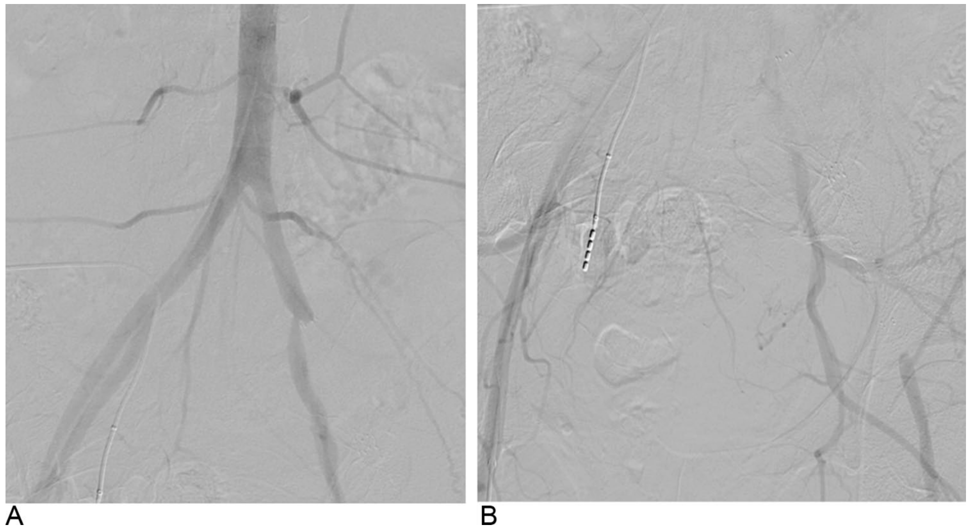

Fig. 4 **A** Angiogram showing occlusion of left external iliac artery, with reconstitution (**B**) at the level of the common femoral artery

Like other procedures that involve groin dissection, wound complications can occur. Additionally, violation of the peritoneum or injury to the bladder can occur during creation of the tunnel. It has an associated mortality and morbidity rate of 2% and 10% respectively [42, 7] and a reported long-term patency of 60 to 83% at 3 years [43, 44].

In addition to its use in addressing AIOD, FFB is also used as adjuct procedure during EVAR with an aortoiliac stent graft. Prior to the availability of bifurcated endografts, aortouniliac stent graft placement, exclusion of the contralateral common iliac artery and FFB was common practice [45]. In current practice, this approach is utilized when the anatomy is not favorable for bifurcated stent graft. The data pertaining to FFB as an adjuction procedure to aortoiliac EVAR is more promising in comparison to its outcomes for AIOD. Some have reported a primary patency rate of 91% at 3 years and 83% at 5 years [45]. Although not the standard surgical therapy for aortoiliac disease, FFB provides adequate results in high-risk patients. We use it in patients at intermediate surgical risk who require aortoiliac revascularization when one iliac system is normal and can act as a donor artery and when endovascular therapy of the ipsilateral CIA or EIA is contraindicated or has failed.

Infrainguinal Bypass

Infrainguinal bypass (IB) is a common procedure used to treat PAD, particularly CLTI. The following considerations are required before its use. First, an appropriate inflow artery needs to be chosen to provide adequate flow into the graft; adequate proximal flow to that artery is ensured, and a decision is made whether to perform an endarterectomy on that vessel. Second, the choice of conduit for bypass is decided. The ideal conduit for IB is single-segment great saphenous vein (SSGSV) which has been shown to have superior patency in comparison to prosthetic conduits [46]. If GSV is inadequate or unavailable, then short saphenous, composite arm vein, or prosthetic can be used.

The inflow and outflow depend on the level of the disease. Long segment SFA and popliteal artery occlusions are best managed with femoropopliteal bypass (FPB) while disease in the distal popliteal artery or tibial vessels will require a more distal target for outflow. For FPB, the femoral artery is exposed as previously described. CFA endarterectomy is performed as an adjunct if there is evidence of significant disease in this area (Fig. 5). The distal target will depend on the level of disease and the quality of the vessel beyond this point. The outflow vessel can be the above knee or the below knee popliteal artery. Alternatively, anterior tibial, posterior tibial, and peroneal target arteries can be used; in the setting of poor tibial targets, a bypass can be constructed to the dorsalis pedis, tarsal, or plantar arteries of the foot.

When facing more distal disease with normal CFA and SFA, the popliteal artery can be a source of inflow, and the distal anastomosis could be constructed to a patent tibial or pedal artery. Since the quality of the vessel has a greater impact on patency than the distal location of the artery, the outflow vessel that has the best quality with continuous flow to the ankle or foot should be chosen [6]. Pomposelli et al. found success with pedal bypasses performed with autologous vein in diabetic patients with tissue loss. The authors reported a primary patency rate of 82% and a limb salvage rate of 87% at 18 months [47].

To perform an FPB, the patient is placed supine on the table. If the patient has adequate GSV of the ipsilateral limb as determined from pre-operative vein mapping, then it is

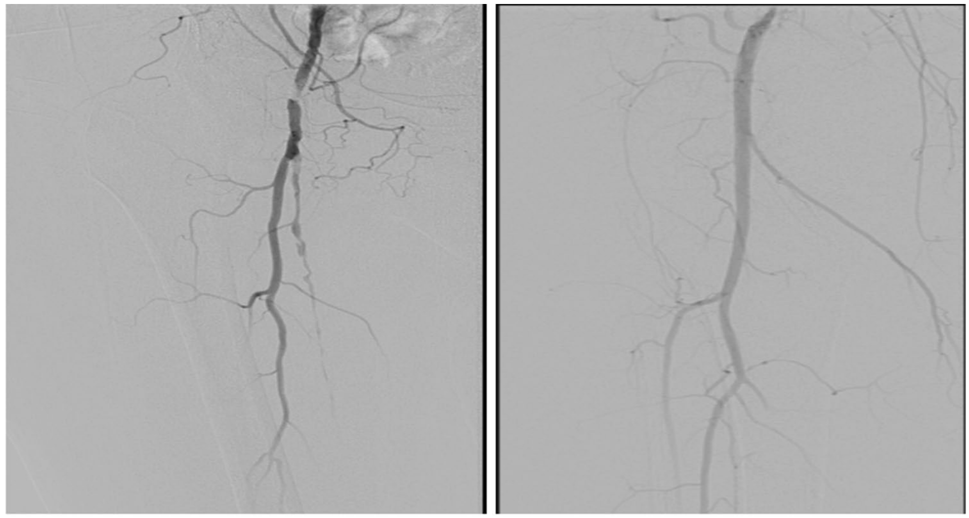

Fig. 5 Angiogram showing CFA stenosis and SFA occlusion (**A**). More distally (**B**), there is reconstitution of popliteal artery

dissected out, and the branches are ligated. Subsequently, the vein is inspected, and if any defects are identified, these can be repaired with a 7.0 polypropylene suture. Proximally, the CFA, SFA, and DFA are exposed through a longitudinal incision made along the medial thigh, halfway between the pubic tubercle and the anterior superior iliac spine. Next, the outflow vessel is dissected out and using a long tunnelling device, a tunnel is created between the two sites. If the above knee (AK) popliteal artery is chosen as the site of distal anastomosis, it is exposed via a medial incision in the distal thigh. After the artery is clearly dissected out, a tunnel is created that goes underneath the sartorius muscle and directed toward the anatomic path of the SFA to reach the AK popliteal artery. Alternatively, the bypass can be tunneled superficially above the sartorius muscle. The patient is systemically heparinized, the proximal anastomosis is performed, and then, the vein is allowed to fill. The pressurized vein graft is marked to maintain proper orientation and then tunneled to the site of distal anastomosis while avoiding twisting or kinking. Its tip is then sutured to the skin of the distal incision to avoid twisting, and the distal clips are removed to empty the vein. A sterile tourniquet is placed on the thigh, the leg is exsanguinated with an Esmarch bandage, and tourniquet is inflated to 350 mmHg prior to performing the distal anastomosis. For an anastomosis at the below knee (BK) popliteal artery, the artery is exposed through a 10-cm longitudinal incision made 2 cm posterior to the tibia. To reach this site, the vein graft should continue distally through the adductor canal and tunneled behind the knee between the femoral condyles and the heads of the gastrocnemius muscle at the level of the knee joint before entering the popliteal fossa. The distal anastomosis is then performed, and the bypass is checked for any compression in the tunnel. As stated, a more distal anastomosis can be performed at the tibial vessels when indicated.

Like many vascular surgical interventions, the outcome of the IB is associated with patient specific factors, technical success of operation, and the conduit utilized. The most common complications after IB consist of graft failure, infections, and myocardial infarction [48]. In general, the outcomes for IB have been favorable. The PREVENT III trial was a prospective, randomized, double blinded trial across 83 centers that evaluated the efficacy of edifoliglide in preventing vein graft failure in patients with CLTI who underwent an infrainguinal bypass [48]. In this trial, most of the distal anastomosis were to the tibial arteries. The investigators reported a primary patency rate at 1 year of 61%, while the primary assisted and secondary patency rates at 1 year were 77% and 80%, respectively [48].

Infrainguinal bypass, specifically FPB performed for IC has durable results. The reported cumulative survival rate at 30 days, 1 year, and 5 years are 100%, 98%, and 86%, respectively [49]. Conversely, patients who undergo FPB for CLTI have worse overall outcomes. These patients often have associated cardiac disease which impacts their outcome. The 10-year survival rate for patients with CLTI undergoing FPB is 15% compared with 51% for those with IC [50].

The increase in endovascular interventions led to a paradigm shift in the management of symptomatic PAD. With this also came an increase in the number of secondary interventions [51]. The Bypass versus Angioplasty in Severe Ischaemia of the Leg (BASIL) trial was designed to compare outcomes of surgical bypass and balloon angioplasty in patients with CLTI. Overall, the outcomes were similar, and more importantly, the authors found no major difference in amputation free survival [52], although there was a statistical trend for improved outcome with IIB in patients who survived more than 2 years. More recently, the same investigators published their findings of BASIL II trial where patients undergoing infrapopliteal interventions with or without more proximal revascularization were randomized to

IIB or endovascular therapy. The primary outcome of amputation-free survival favored the endovascular arm although the difference between strategies were due to increased mortality among those offered IIB [53•]. Conversely, the Best Endovascular versus Best Surgical Therapy in patients with CLTI (BEST-CLI) trial, a multicenter, multispecialty, international randomized controlled trial, also evaluated outcomes between IIB and endovascular therapy as initial treatment of CLTI in patients who were candidates for both strategies. Its primary findings revealed that IIB in patients had adequate SSGSV, and who were appropriate surgical candidates resulted in a significantly lower incidence of a major adverse limb event or all cause death when compared with patients who underwent endovascular intervention [54••]. In our practice, IIB is used in approximately a third to a quarter of patients with symptomatic PAD. In the setting of IC, FPB is offered to those patients who failed medical/exercise therapy, who have short distance IC and who have TASC II D disease with a popliteal target. In our hands, revascularization of a complete SFA with or without AK POP occlusion while technically possible does not carry durable outcomes in those with IC whose treatment demands consideration for durability. In patients with CLTI, IIB is offered to those with adequate surgical risk, adequately sized and normal SSGSV on duplex, and complex arterial disease (femoral popliteal TASC II C, D with or without severe tibial disease).

Conclusion

As new endovascular technology continues to emerge, the treatment algorithm for patients with symptomatic PAD has evolved. While there is an increase in the number of endovascular therapies available to treat for complex PAD, their durability remains an issue [51]. To that end, surgical therapy remains a viable and complementary option in patients with symptomatic PAD. The vascular specialist treating PAD should not ignore the evidence base that supports medical therapy and surgical therapy in certain patient groups. To that end, team-based practice of PAD should include those physicians who have skills in medical, endovascular, and surgical treament paradigms. Such strategic posture toward patient management, as demonstrated in a number of fields such as oncology, should be the bedrock of value based, patient centric care.

Author Contributions E.N. wrote and reviewed the manuscript and prepared all the figures. A.F. wrote and reviewed the manuscript and prepared all the figures. All authors contributed to the final manuscript.

Data Availability No datasets were generated or analyzed during the current study.

Compliance with Ethical Standards

Conflict of Interest The authors declare no conflict of interests.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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- • Of importance
- •• Of major importance

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