INTRODUCTION

The profunda femoris artery is the major source of blood flow to the thigh muscles, and the superficial femoral artery is the primary source of circulation to the calf muscles and distal extremity. When the superficial femoral artery is diseased or occluded, the profunda femoris becomes the major blood supply to the lower extremity. Although superficial femoral artery disease can cause symptoms of severe and limiting claudication, limb loss is rare unless there is significant concomitant profunda disease. Maintenance of normal blood flow into the profunda and its collaterals is a critical factor in avoiding amputation in patients with peripheral vascular disease. The purpose of this chapter is to review the anatomy of the profunda femoris artery, as well as the techniques and strategies of maintaining blood flow in the profunda.

ANATOMY

The profunda is one of the two main branches of the common femoral artery. It exits the common femoral artery posterolaterally approximately 3 to 5 cm below the inguinal ligament and is crossed anteriorly by the circumflex femoral vein (Fig. 1). It then tracks deep to the sartorius and vastus medialis muscles. An extensive network of collaterals via the medial and lateral circumflex femoral arteries anastomoses with branches of the internal iliac artery and posteriorly with the sciatic artery. The profunda provides retrograde flow to the pelvis in circumstances of internal iliac or external iliac artery occlusion. Additionally, the profunda supplies the lower extremity in cases of superficial femoral and popliteal artery occlusion. Branches of the profunda communicate with the popliteal artery through the genicular arteries around the knee.

DIAGNOSIS AND IMAGING

The profunda should be imaged on all evaluations for peripheral vascular disease. Imaging modalities include duplex ultrasound, computed tomography (CT) angiography, magnetic resonance (MR) angiography, and angiography. Duplex ultrasound can provide not only an anatomic description of the artery but can also help to determine the location of the stenotic areas but can also help to determine the severity of the stenosis. Duplex examination can be unreliable in cases of severe calcification. CT angiography can provide detailed information but requires an intravenous contrast and close image sequencing. Angiography is considered the standard for imaging. Typically, angiography is performed with a lateral oblique projection of 30 to 45 degrees to best visualize the profunda. Figure 2 demonstrates the increased separation of superficial femoral and profunda femoral arteries with oblique imaging.

Figure 1 The profunda femoris artery originates from the common femoral artery in the groin and courses posterolaterally to supply the muscles of the thigh. Image courtesy Dr. Diem Tran-Pham, MD.

Figure 2 Angiogram of the femoral artery demonstrating increased separation of the superficial and profunda femoral arteries with a lateral oblique projection of the image intensifier.
INDICATIONS AND SELECTION OF PATIENTS

Patients with profundaplasty or occlusion and lower-extremity symptoms may benefit from profundaplasty. However, treatment of ischemic symptoms is rarely accomplished by profundaplasty alone but usually requires aortoiliac inflow or femoropopliteal outflow reconstruction. In certain circumstances of severe superficial femoral or popliteal disease, isolated profundaplasty may provide significant improvement of lower-extremity perfusion. Symptoms of rest pain are usually relieved, and claudication improved. However, isolated profundaplasty is unlikely to heal ulcerations in the foot and gangrenous lesions on the toes. Patients with severe profundaplasty stenosis and superficial femoral occlusion may benefit from profundaplasty reconstruction by revascularization of the extensive network of collaterals. The lower extremity is often supplied through collaterals from the deep femoral branches to the superficial femoral artery. Figures 3 and 4 demonstrate the extensive collateral that may provide significant lowering of ischemic symptoms.

PROFUNDAPLASTY

Profundaplasty is most commonly performed in combination with an inflow or outflow revascularization procedure. The profunda femoral artery is versatile and can be used as an inflow or outflow vessel.

Profundaplasty can be used as the inflow source for a femoral or femorotibial artery bypass. Endarterectomy of the common femoral artery and profunda orifice may be necessary before profundaplasty of the proximal profunda. If the bypass fails, the profundaplasty may provide adequate perfusion of the lower extremity. Although the patient may experience claudication, the ischemic foot lesions may have healed and reoperation may be avoided. In the case of severe common femoral artery disease with proximal stenosis of the profunda and common femoral artery occlusion, femoral endarterectomy and profundaplasty alone may relieve symptoms of rest pain. More mild stenoses can often be treated with balloon angioplasty and stenting, thus avoiding aortofemoral bypass surgery.

The profunda femoral artery is an essential outflow vessel for aortofemoral reconstruction procedures such as aortofemoral, axillofemoral, and femorofemoral bypass. The profundaplasty provides long-term patency of such bypass grafts by providing outflow for the superficial femoral artery disease and ensuring patency in the event of progression of disease in the femoral artery. If there is stenosis of the orifice of the profunda, the stenosis should always be corrected at the time of profundaplasty. If there is stenosis of the orifice of the profunda, the stenosis should always be corrected at the time of profundaplasty. If there is stenosis of the orifice of the profunda, the stenosis should always be corrected at the time of profundaplasty. Profundaplasty will also provide outflow for endovascular procedures such as iliac angioplasty and stenting.

Exposure of the profunda femoral artery is obtained by dissection of the common femoral artery and its bifurcation into the superficial femoral and profunda branches. In cases in which there have been multiple previous groin operations, scarring may make dissection of the femoral artery difficult. In these circumstances, if the proximal profunda is patent without stenosis, the distal profunda may be procedures. Profundaplasty will also provide outflow for endovascular procedures such as iliac angioplasty and stenting.

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Femoral distal bypass Profunda interposition graft

Figure 5 An interposition graft to the left profunda femoris artery provides outflow for a femorofemoral bypass and serves as the inflow source for a left femorotibial bypass graft. (See color insert Figure 36.)

exposed through new, more lateral dissection planes and used as the inflow source for more distal bypass procedures. This avoids reoperating in the area of the groin crease, avoids the scarred areas, and may reduce the risk of infection. The profunda femoral artery can be used as an inflow vessel, thus shortening the length of vein necessary for lower bypass procedures. An additional 10 to 15 cm can be gained by placing the proximal anastomosis of a distal bypass graft on the profunda femoris artery instead of the common femoral artery. This may facilitate the use of autogenous vein for the distal bypass rather than a prosthetic graft, which has a significantly lower patency rate.

In some cases, the profunda can perform both inflow and outflow functions. In the case shown in Figure 5, a new interposition prosthetic graft to the profunda provides outflow from a femorofemoral bypass while also serving as the inflow source for a femorotibial bypass graft.

Techniques

The profunda femoris artery is exposed by dissection distal of the bifurcation of the common femoral artery. The transition in the diameter of the common femoral artery to the superficial femoral artery is a reliable marker of the location of the origin of the profunda femoral artery. This transition point is typically several centimeters inferior to the inguinal ligament. The profunda femoris artery usually emerges posterolateral to the common femoral artery. However, one should be aware that the lateral and medial circumflex branches of the deep femoral artery may originate from the common femoral artery or close to it. Incomplete dissection and control of the profunda femoris artery and its branches will interfere with vascular reconstruction because of retrograde bleeding from uncontrolled circumflex branches. Haphazard dissection can result in injured profunda branches with significant bleeding and the need to obliterate important profunda outflow branches. The lateral circumflex femoral vein crosses over the anterior surface of the proximal profunda and should be ligated and divided to ensure good exposure. Exposure of the distal profunda is facilitated by dissection of the superficial femoral artery with gentle retraction medially to reveal the underlying profunda. Operative exposure of the distal profunda through a lateral approach is shown in Figure 6.

Figure 6 Operative exposure of the distal profunda femoral artery. m, Muscle. From Valentine RJ, Wind GG. Anatomic exposures in surgery, ed 2, Baltimore. 2003. Lippincott Williams & Wilkins, p. 425.

Profunda femoris reconstruction may be performed using autogenous or prosthetic graft material. The most favorable autogenous material is saphenous vein, but this is rarely used for profunda reconstruction because autogenous saphenous vein is usually employed for use in lower-extremity bypass or coronary bypass procedures. In cases in which the superficial femoral artery is occluded, a segment of endarterectomized superficial femoral artery may be used as a profunda patch material. However, the endarterectomized superficial femoral artery is prone to restenosis, and there is no advantage over prosthetic patch materials. Long segment endarterectomized profunda can be successfully patched with Dacron or polytetrafluoroethylene (PTFE) patch material. This requires careful and extensive dissection of the profunda with preservation of all the profunda branches to provide good outflow. Endarterectomy and interposition grafts in the profunda with ligation of vessels is suboptimal because important collateral branches are sacrificed. Polypropylene sutures, usually 6-0 for anastomoses and 7-0 for tacking upfitted intima, are most commonly used.

Reconstruction of the profunda as an outflow vessel for aortoiliac or iliofemoral bypass can be accomplished by extending the hood of the bypass graft onto the profunda, past the level of the profunda plaque. Such an anastomosis is preferable to extension of the graft onto the orifice of the superficial femoral artery because this is often progression of disease in the superficial femoral. Extension of the bypass onto the profunda is facilitated by extending the aortoarteriostomy laterally onto the profunda and avoiding the endarterectomy of the femoral artery. Because most profunda femoris plaques occur at the most proximal portion of the artery, it is not necessary to dissect the profunda femoral artery far but it must be far enough well past the plaque (Fig. 7). Care must be taken to avoid a dissection plane in the artery with potential intimal flaps. In rare cases, an aortofemoral bypass can be anastomosed end-to-end.
The possibility of endovascular treatment is an attractive alternative for such high-risk patients with critical limb ischemia. Silva reported on 31 consecutive patients with critical limb ischemia treated with endovascular profundaplasty: the procedure was successful in 91% of patients, with a mean increase in ABI from 0.5 to 0.7 ± 0.2 (p < .01). During a mean follow-up of 34 months, no additional amputations were necessary, three patients required repeat revascularization, and five patients died. The profunda lesion treated was located in the proximal profunda before the lateral circumflex branch in 88% of patients; 62% of patients had concomitant occlusion of the SFA. These results of endovascular treatment are promising, but direct comparison with other published series of profundaplasty is not possible because of differences in patient-selection criteria. Nonetheless, these results suggest that endovascular strategies to treat the profunda femoris deserve consideration.

Moore found in his 18-year experience with 281 aortofemoral bypass grafts that the primary cause of late graft failure was profunda disease. Obstructive disease of the profunda femoral artery was believed to be the primary cause of graft failure among 54 patients who experienced aortofemoral graft limb occlusion. Repair of graft limb occlusion consisted of profundaplasty and proximal thrombectomy. No deaths were reported, and patency after the reconstruction was 100% at 30 days. In Moore’s experience, long-term patency following thrombectomy and profunda reconstruction was best in nondiabetic patients who underwent patch profundaplasty using autogenous vein as the patch material. Others have experienced similar good long-term results using prosthetic profundaplasty patches. Kalman reported favorable long-term results when profundaplasty is combined with aortofemoral bypass, with a 5-year patency of the aortofemoral bypass of 97 ± 1.3%.

CONCLUSIONS

The profunda femoris artery is a major source of blood supply to the lower extremity and is critical to maintaining limb viability in patients with peripheral occlusive disease. Severe profunda stenosis should be corrected with profundaplasty in all patients with symptomatic peripheral occlusive disease who are undergoing either inflow or outflow procedures in the groin. Isolated profundaplasty has limited usefulness as a primary procedure for the treatment of occlusion or critical limb ischemia. The role of endovascular treatment of profunda stenosis is unsettled.

SUGGESTED READINGS

A (Illofemoral Bypass

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INTRODUCTION

Although atherosclerosis is a diffuse process, distinct disease patterns of arterial occlusive disease can be identified. One such pattern is disease within the aortoiliac segment. Classic symptoms are those of thigh or buttock claudication and impotence in male patients, known as Leriche syndrome. This pattern can be found in isolation or in combination with infrapopliteal occlusive disease, in which the presentation is frequently more severe. The diagnosis of aortoiliac occlusive disease is made on the basis of history and physical examination, with findings of diminished or absent pulses throughout the lower extremities. These findings can be confirmed with a number of diagnostic tests. Pulse-volume recordings, a plethysmographic evaluation of lower extremity arterial circulation, show decreased waveforms in all segments, including thigh tracings, distinguishing aortoiliac occlusive disease from infrapopliteal disease, in which thigh tracings are largely preserved. Arterial duplex mapping can be used to assess noninvasively the degree of stenosis or occlusion (or both) within the aortoiliac segment and can also be used to plan intervention. Traditional angiography, especially in the setting of concomitant infrapopliteal disease, provides detailed anatomic information and permits assessment of the abdominal, pelvic, and lower-extremity arterial tree. If warranted, intervention may be performed at the same time as the diagnostic procedure. In the setting of aortoiliac occlusive disease, femoral artery access may be difficult or impossible, and the use of alternative access sites, such as the brachial artery, may be required. Computed tomography (CT) angiography is also a useful modality for defining aortoiliac anatomy and has the added advantage of providing evaluation of the degree and extent of calcification within the aortoiliac segment. This modality may be especially useful in patients who have undergone previous arterial surgery in that nonfunctioning grafts are well visualized by this method, and knowledge of their locations is helpful in planning subsequent interventions. A potential limitation of CT angiography is its difficulty in evaluating tributary vessels when infrapopliteal disease is present. Magnetic resonance angiography can also be used to evaluate aortoiliac and lower-extremity arterial anatomy but may also have limitations in the evaluation of the distal circulation.

Axillofemoral bypass was first introduced in the early 1960s as an alternative to direct aortoiliac reconstruction in patients with aortoiliac occlusive disease (Fig. 1). This extra-anatomic bypass, so called because the reconstruction does not course along the normal anatomic path of the vessels, permits placement of the graft in a superficial and largely subcutaneous position, reducing physiologic stress on the patient during the perioperative period, compared with direct reconstruction, which requires abdominal dissection and clamping of the aorta. Because of the long length of conduit required, these procedures are usually performed with prosthetic grafts.

INDICATIONS

Patients requiring axillofemoral bypass generally have chronic insufficiency, manifest as disabling claudication, ischemic ulceration, or gangrene. Axillofemoral bypass is also required in the setting of acute occlusion. The choice of intervention depends on the indication for operation as well as the overall health status of the patient. The primary indications are severe aortoiliac disease; an inability to undergo aortoiliac bypass for any reasons. These include anatomic considerations such as severe calcification; hostile abdomen or the need for peritoneal dialysis; medical comorbidities such as severe cardiopulmonary disease; or hepatic, or the presence of intra-abdominal visceral organ ischemia; and the result of infected grafts, mycotic aneurysms, or aortoiliac occlusive disease (Table 1). Another indication is the placement of an axillofemoral bypass graft after an iliac anastomosis has failed.