Chapter 19
Peripheral Vascular Intervention

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Clinical Background

Approximately 16 % of the total population of the USA and Western Europe aged over 55 years have peripheral arterial disease (PAD), with 10–35 % presenting with classic claudication and 20–40 % having atypical leg pain (Fig. 19.1). Nearly 50 % are asymptomatic, detectable by their ankle-brachial index (ABI), the ratio of the highest systolic blood pressure (SBP) in the dorsalis pedis or posterior tibial arteries in each leg to the highest SBP in the brachial artery.

Risk factors include:

- Age
- African-American or Hispanic ethnicity
- Current or past tobacco use
- Diabetes
- Dyslipidemia
- Hypertension
- Chronic kidney disease

Of the aforementioned, smoking and diabetes represent the greatest risk for the development and progression of PAD.

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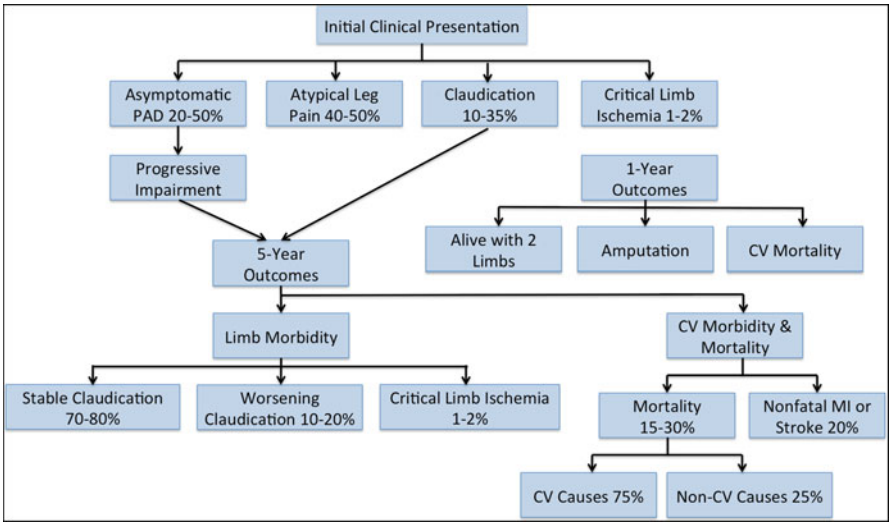

Fig. 19.1 Presentation, evolution, and outcomes in PAD

Differential Diagnosis

Differentiating between different leg pain syndromes can be quite challenging at times. The major causes include arterial claudication, nerve root compression, spinal stenosis, hip arthritis, and venous claudication (Fig. 19.2).

Classic Claudication

Claudication is often located in the calf, thigh, hip, or buttock muscles (depending on the arterial segment involved), with symptoms including cramping, aching, tightness, weakness, burning, or pain, precipitated by a predictable degree of exercise and relieved by standing within a few minutes.

Nerve Root Compression

Pain caused by nerve root compression often radiates down the leg, usually posteriorly, and may follow distribution of classic claudication pain. Onset occurs relatively close to the onset of exercise and is not quickly relieved. The pain may be present at rest. Adjusting back position, sitting, or lying down affects the precipitation and dissipation of pain. Patients often have an accompanying history of back pain.

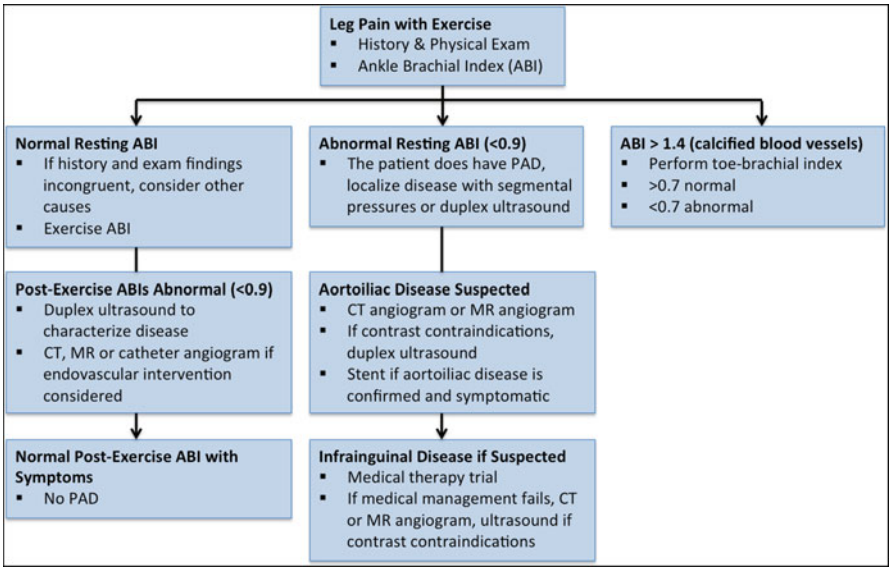

Fig. 19.2 Diagnostic workup of PAD

Spinal Stenosis

Spinal stenosis affects the hip, thigh, buttocks, or calf, and motor weakness can be seen. The distance to reproduce pain is variable, unlike classic claudication. Pain is relieved only with position change and limiting movement. Spine flexion accelerates recovery, which may take up to 30 min. The pain can be provoked by increased intra-abdominal pressure.

Hip Arthritis

Pain caused by hip arthritis manifests as an ache, usually in the hip and gluteal region, which occurs after variable degrees of exercise and may occur with standing alone. Pain is not quickly relieved and may be improved with avoidance of weight-bearing.

Venous Claudication

Venous claudication affects the entire leg, but is usually worse in the thigh and groin. The pain is described as tight and bursting, occurring during walking. Pain is relieved within 30 min and hastened by leg elevation.

Anatomy

General Principles

1. Patients with claudication affecting function should undergo revascularization only after a trial of exercise and pharmacotherapy. Isolated iliac artery stenosis is the exception to this rule, as revascularization success rates are excellent and restenosis is low.
2. Inflow (aortoiliac) and outflow (infrapopliteal) should be assessed before attempted revascularization. Inflow lesions should be revascularized first, followed by outflow lesions if symptoms persist.
3. Revascularization of CLI with tissue loss should try to provide straight-line blood flow to the foot.
4. Patients undergoing revascularization should be aggressively managed for cardiovascular risk factor modification, as myocardial infarction (MI), stroke, and cardiovascular deaths are very high among these individuals.
5. A foot inspection should be performed at every visit, as it is essential to avoid foot amputation.

Indications

Two clear indications exist for revascularization in PAD: critical limb ischemia and claudication that causes functional impairment [1, 2].

Contraindications

No absolute contraindications to using stents in peripheral vessels exist. Renal insufficiency may limit the ability to use iodinated contrast for the procedure. Carbon dioxide angiography could be performed in case with renal impairment or allergy to contrast medium. Pregnancy contraindicates the use of radiation [1, 2].

Specific Revascularization

Iliac Artery Disease [1]

The stenting initial success rate is >90 %, complication rate <2 %, and 5-year patency about 80 % (Fig. 19.3). Retrospective studies show acceptable rates of primary patency in lesions TASC A-D (Fig. 19.1) (see later for TASC classifications). If claudicating symptoms are thought to be due to iliac disease, CT angiography, MR

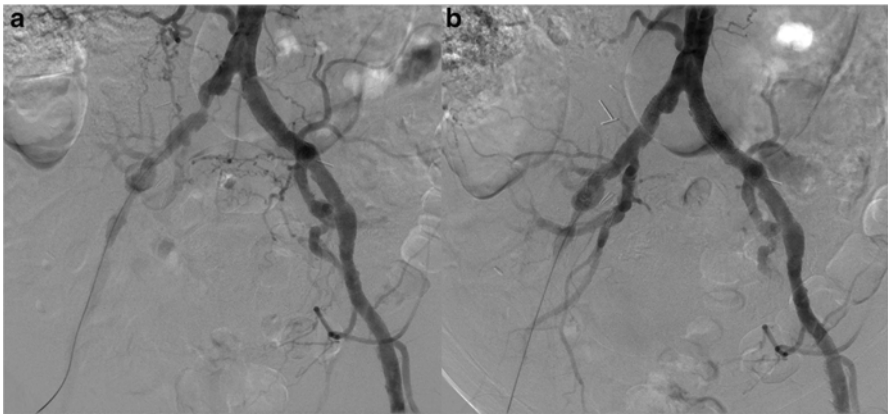

Fig. 19.3 (**a**) Left Common Iliac stent and Right Common Iliac Artery stenosis. (**b**) Right Common Iliac Artery stenosis treated by self-expanding stent

angiography, or catheter angiography should be performed with the intent of subsequent percutaneous revascularization.

Meta-analysis of six-trials (2,116 patients) comparing PTA versus primary stenting showed that no statistically significant differences in procedural complications or 30-day mortality were noted [1]. The stent group showed higher procedural success rates and superior primary patency at 4-year follow-up [1].

Infrainguinal Disease

The benefit of revascularization is less pronounced relative to aortoiliac disease. Excellent results can be achieved with short focal lesions. Longer lesions are associated with lower patency rates over time. Common femoral artery (CFA), superficial femoral artery (SFA), and popliteal artery are all relatively superficial vessels. Sitting, standing, and exertion can affect the patency of these superficial vessels (Fig. 19.4). CFA endarterectomy remains the treatment of choice for CFA lesions due to the theoretical risk of stent fracture with hip flexion and the potential loss of a vascular access site. Patency is >80 % at 1 year [2, 3].

Balloon Angioplasty Versus Stenting of SFA

Balloon angioplasty offers excellent technical success rates, but higher restenosis rates compared to other vascular beds [4–7]. Since balloon-expandable stents are deformed by compression, their use in SFA has been replaced by self-expandable nitinol stents. In short lesions (<5 cm), balloon angioplasty and provisional stenting should be used, and in large lesions (>5 cm), primary stenting is a reasonable choice.

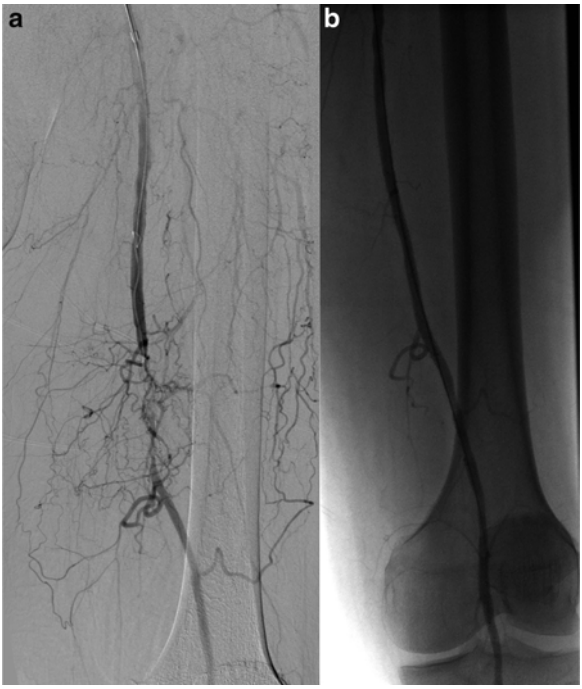

Fig. 19.4 (**a**) Superficial Femoral Artery occlusion. (**b**) Post-angioplasty and stenting of occluded Superficial Femoral Artery

Stent fracture has been linked with early restenosis and occlusion [4]. The highest rate of stent fracture occurs with the use of multiple overlapping long stents, while single short stents have the lowest likelihood of stent fracture [5–7].

Tibial and Peroneal Disease

Unlikely to be the sole cause of functional claudication, tibial and peroneal disease rarely occurs in isolation. Technical success and patency are reduced, and complications are more common compared to more proximal interventions. Symptoms usually improve with inflow revascularization, eliminating the need for below-knee intervention. An exception is intervention for ischemic ulcers, where the goal is straight-line blood flow to the foot. Stenting has been shown to have improved patency compared to balloon angioplasty, but reductions in clinical outcomes such as mortality, limb salvage, and other morbidities have not been demonstrated [4–7].

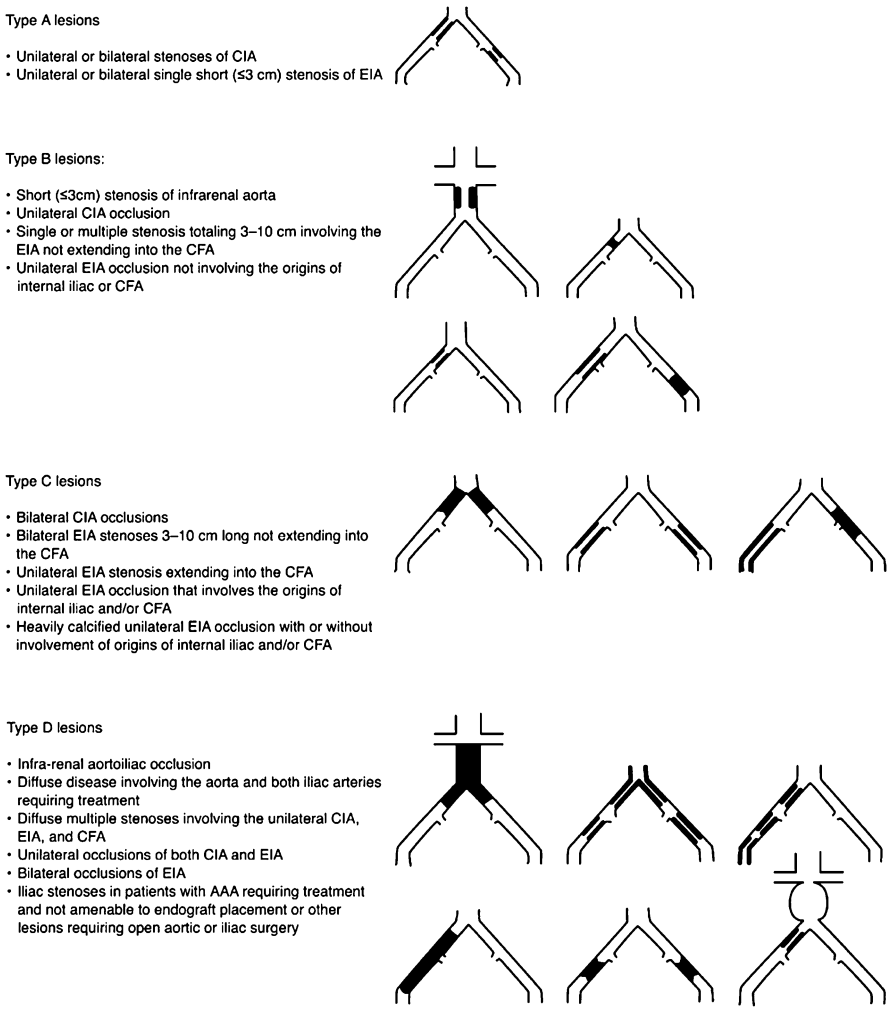

Fig. 19.5 TASC II classification of aortoiliac peripheral arterial disease

Classification

The classification of vascular disease is based on the Trans-Atlantic Inter Society Consensus (TASC) document on the management of peripheral arterial disease (Figs. 19.5 and 19.6 [8]).

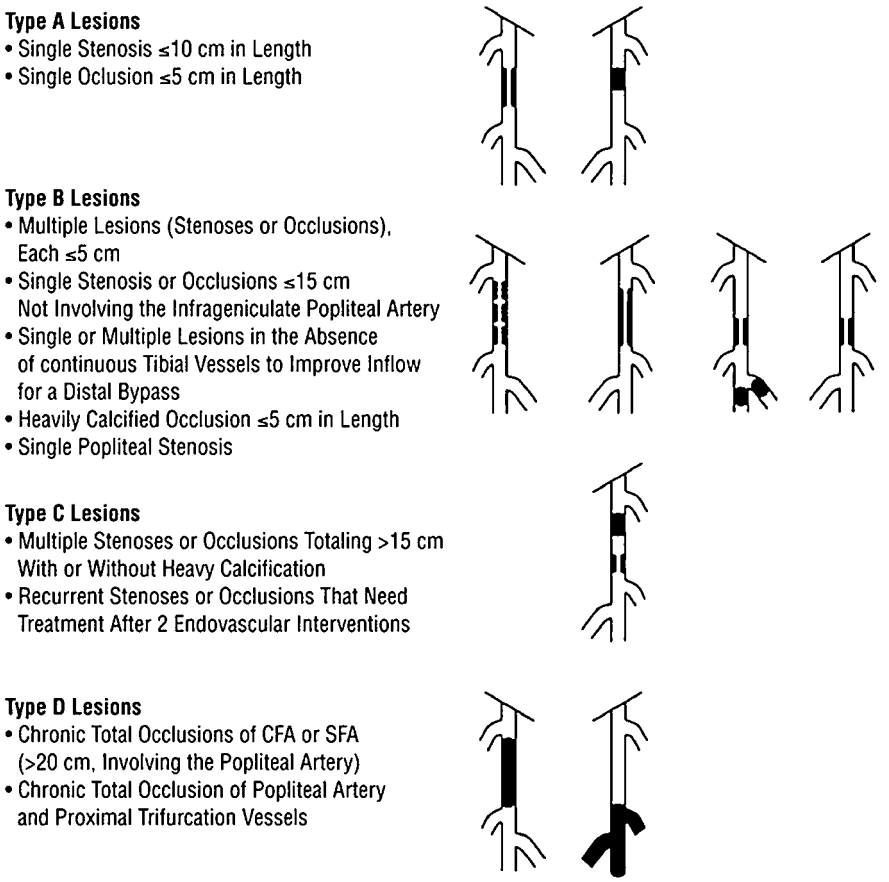

Fig. 19.6 TASC II classification of femoropopliteal peripheral arterial disease

Procedure

Please refer to the chapter on arterial access (Chap. 8) for an overview of the Seldinger technique.

Vascular access is achieved using an 18-gauge needle or Micropuncture Kit. An aortogram is performed to assess for adequate flow, as well as areas of specific stenosis (Fig. 19.7). A guide wire is used to cross the lesion of concern. The wire must be long enough to accommodate the shaft length of the stent device. Choose the right size sheath to allow the insertion of the balloon catheter or stent deployment system as recommended by the manufacturer.

If angioplasty is initially performed, a balloon is placed across the lesion and inflated for 1–2 min, without exceeding the vessel diameter. Residual stenosis >30–40 % or flow-limiting intimal dissection prompts the placement of a stent. Balloon-

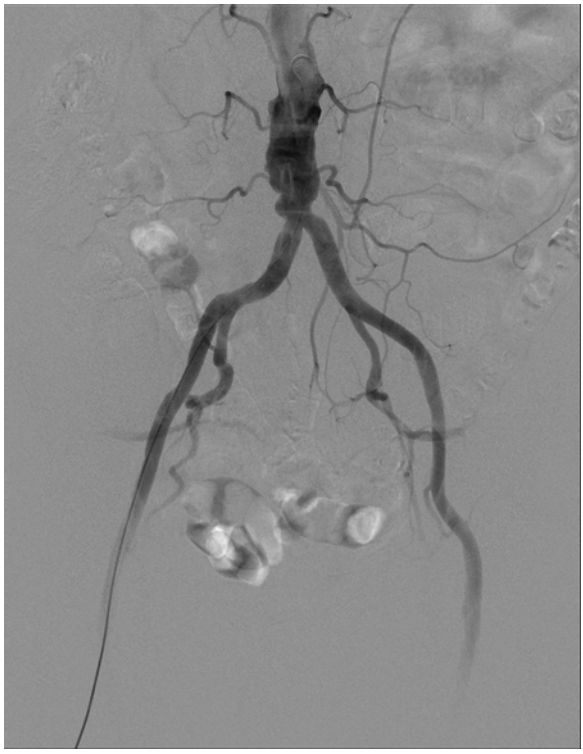

Fig. 19.7 Aortogram with catheter in distal abdominal aorta

expandable stents must match the vessel diameter, but self-expandable stents may be upsized to maintain radial force on the vessel wall. Predilation with a smaller balloon can help pass the stent device, as balloon-expandable stents are more rigid and less trackable than self-expanding stents.

The length of the stent should cover the length of the lesion. If multiple stents are required, 1–2 cm of overlap should be used and stents placed distally first then extending proximally.

Angiography is performed to assess the result of the intervention, and distal imaging is useful to rule out embolization following the intervention.

Complications

Complications include:

- Bleeding (hematoma or pseudoaneurysm) at the puncture site
- Infection
- Dissection of vessel
- Contrast nephropathy
- Distal embolization

- Stent fracture
- In-stent thrombosis or restenosis
- Arterial rupture
- Arterial spasm

Outcomes

Femoropopliteal Stenting Versus PTA

Variables associated with favorable femoropopliteal PTA include claudication, non-diabetic patients, proximal short lesions, good distal runoff, lack of residual stenosis on post-PTA angiogram, and ABI improvement by >0.1 [9–11].

Primary patency rates for femoropopliteal PTA are 47–86 % at 1 year, 42–60 % at 3 years, and 41–58 % at 5 years [9–16]. For femoropopliteal stenting, patency rates are 22–86 % at 1 year and 18–72 % at 3 years [17–19].

The literature surrounding drug-eluting stents in the femoropopliteal artery is still developing. The 18-month results from the SIROCCO trial showed no restenosis in the slow-release sirolimus-eluting stent group, compared to the rates of 33 and 30 % in the rapid drug-eluting stent group and uncoated stent group, respectively [20].

Iliac Artery PTA Versus Stenting

For iliac artery PTA, the technical and initial clinical success is >90 %, and 5-year patency rates range between 54 and 92 % [12, 21–26]. Stenting of iliac arteries provides a 3-year patency rate of 41–92 % for stenoses and 64–85 % for occlusions [27–45]. Stents do appear to improve the results of iliac PTA without an increased complication rate. Factors associated with decreased patency rates include poor quality of runoff vessels, severity of ischemia, and extended length of diseased segments [12, 21–44].

Infrapopliteal Stenting Versus PTA

PTA is mainly used in the setting of critical limb ischemia. Clinical success is more important than angiographic improvement as collateral flow may be enough to preserve tissue perfusion if there is no subsequent injury (Fig. 19.8 [46]). The primary patency rate for PTA in infrapopliteal vessels ranges from 40 to 81 % at 1 year and 78 % at 2 years [47–50]. Limb salvage rate is higher at 77–89 % at 1 year [47–50]. The presence of diabetes and renal failure are risk factors for limb loss in this setting [47, 51].

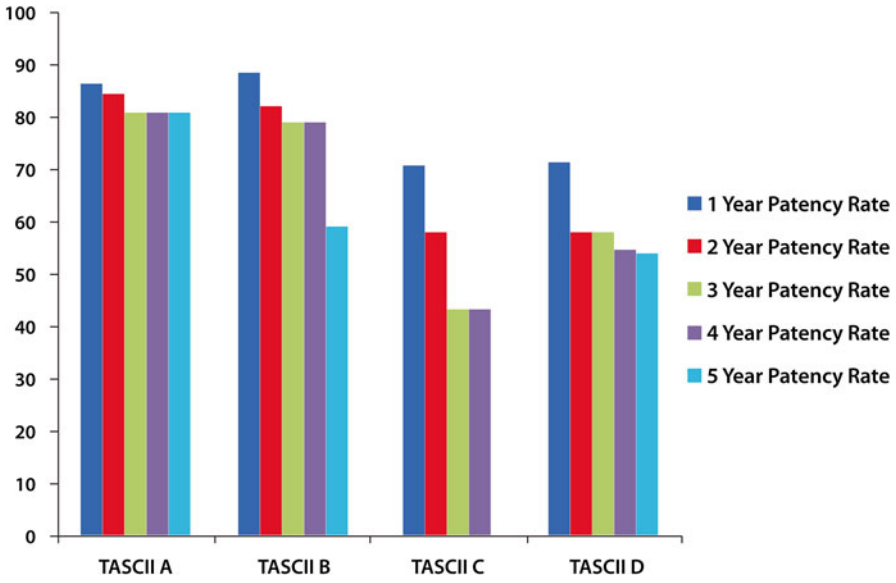

Fig. 19.8 Femoropopliteal intervention. Primary potency among TASC II classifications. Retrospective study involving 639 limbs in 511 patients using self-expanding nitinol stents [46]

Intimal Hyperplasia

Vascular injury after intraluminal manipulation results in the thickening of the tunica intima of a blood vessel—intimal hyperplasia (IH). This contributes to a high rate of restenosis in diffuse segmental stenoses or when multiple stents are placed [17, 52]. Animal studies reveal that slow flow promotes thrombus deposition as well as more pronounced IH [53, 54]. The rate of IH is related to the caliber of arteries as well. Surface thrombus reduces the effective circulation in smaller arteries more markedly, leading to increased restenosis rates in smaller caliber arteries. When this hypothesis was studied, stent restenosis rates were found to increase with decreased vessel caliber: 4 % in the proximal SFA, 10 % in the mid-segment of the SFA, and >18 % in the distal SFA [52]. Metal stents used were made smaller to minimize restenosis through improvements in mesh design [55].

Several interventions or modifications are currently being explored to improve rates of IH. Modifications of the polymer cover of stent grafts may improve patency. Graft pore size modifications and Dacron or PTFE-covered stent grafts are also being explored [56–58]. Stents with drug carrier systems to inhibit IH are also being investigated. The SIROCCO study examines a self-expanding nitinol stent coated with a polymer containing sirolimus (a lactone with immunosuppressive activity) [59].

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