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# Superficial Femoral Artery Endovascular Therapy with Atherectomy

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## Background

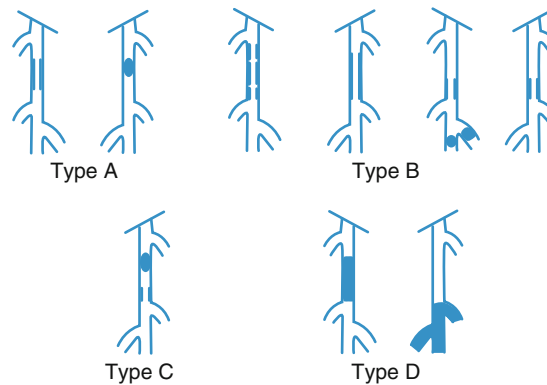
Over the past decade, considerable progress has been made in endovascular therapy treatment of patients with peripheral vascular disease (PVD). Surgical bypass, while effective and safe, is losing ground to less invasive endovascular techniques [1]. PVD is on the rise in the United States. It is estimated that 20 % of patients >75 years will be living with the disease by the year 2030 [2]. The prevalence of PVD is particularly more common in high-risk groups such as patients with diabetes mellitus (DM), hypertension (HTN), hyperlipidemia, and smoking [3]. A significant proportion of earlier trials comparing surgery to endovascular therapy have been limited in size and have primarily compared balloon angioplasty results [4]. The recent trial of bypass versus angioplasty in severe ischemia of the leg (BASIL trial) provided evidence that endovascular therapy can be as effective as surgery in patients with critical limb ischemia [5]. The trial, while recent by time standards, lags significantly due to rapidly evolving technology. In an effort to categorize the anatomical properties of the femoral popliteal lesions, the Transatlantic Inter-Society Consensus (TASC) divided these lesions in four categories. This classification has been recently updated to TASC II (Fig. 52.1) [6].

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**Fig. 52.1** Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II) classification of femoral popliteal lesions



Lesion type	Description
A	Single stenosis $\leq 10$ cm in length Single occlusion $\leq 5$ cm in length
B	Multiple lesions (stenoses or occlusions), each $\leq 5$ cm Single stenosis or occlusion $\leq 15$ cm not involving the infrageniculate popliteal artery Single or multiple lesions in the absence of continuous tibial vessels to improve inflow for a distal bypass Heavily calcified occlusion $\leq 5$ cm in length Single popliteal stenosis
C	Multiple stenoses or occlusions totaling $> 15$ cm with or without heavy calcification Recurrent stenoses or occlusions that need treatment after two endovascular interventions
D	Chronic total occlusion of CFA or SFA ( $> 20$ cm, involving the popliteal artery) Chronic total occlusion of popliteal artery and proximal trifurcation vessels

### Case Presentation

Here, we describe a patient referred to our institution from his primary care physician's office. The patient is a 56-year-old Caucasian male with a past medical history significant for hypertension and hyperlipidemia and a remote history of smoking. The patient presented mainly with pain on exertion involving his left leg. Initially, the patient thought it might be related to arthritis in his left knee. Despite a trial of nonsteroidal anti-inflammatory drugs, his pain continued to worsen. His symptoms appear mainly with ambulation. Peripheral vascular disease was suspected as possibly the culprit. In our office, the exam revealed a well-nourished male. His vascular exam revealed equal blood pressure in both arms. Radial and femoral pulses were both equal. There was evidence of a soft left femoral bruit. The popliteal, posterior tibial, and dorsalis pedis pulses were all absent on the left side. The popliteal, posterior tibial, and dorsalis pedis on the right were graded at +1. Handheld Doppler showed evidence of biphasic flow in the left posterior tibial and dorsalis pedis artery. An ankle-brachial index measured at 0.8 on the right and 0.6 on the left. The patient

complained of left lower extremity pain with walking less than 200 ft, clearly indicative of significant claudication. The patient was placed at Rutherford class III. The Rutherford classification is a clinical tool that grades the degree of PVD based on the patient's symptoms (Table 52.1) [7]. There was no evidence of any wounds or ulcers involving the left lower extremity. Our physical exam and the clinical scenario identified the arterial level of disease at the superficial femoral artery (SFA) or the popliteal vessels. The patient was scheduled for

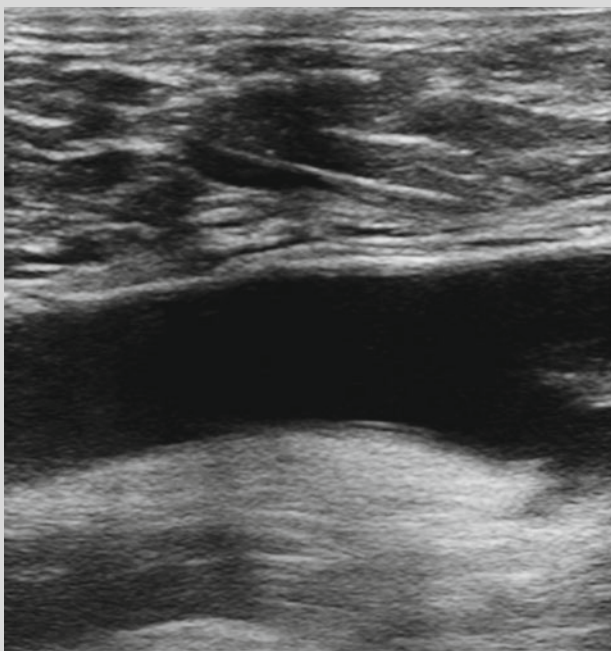
**Table 52.1** The Rutherford classification describing symptoms of PVD

Rutherford stage	Description
0	Asymptomatic
I	Mild claudication
II	Moderate claudication
III	Severe claudication
IV	Rest pain
V	Ischemic ulceration, not exceeding ulcer of the digits of the foot
VI	Severe ischemic ulcers or frank gangrene

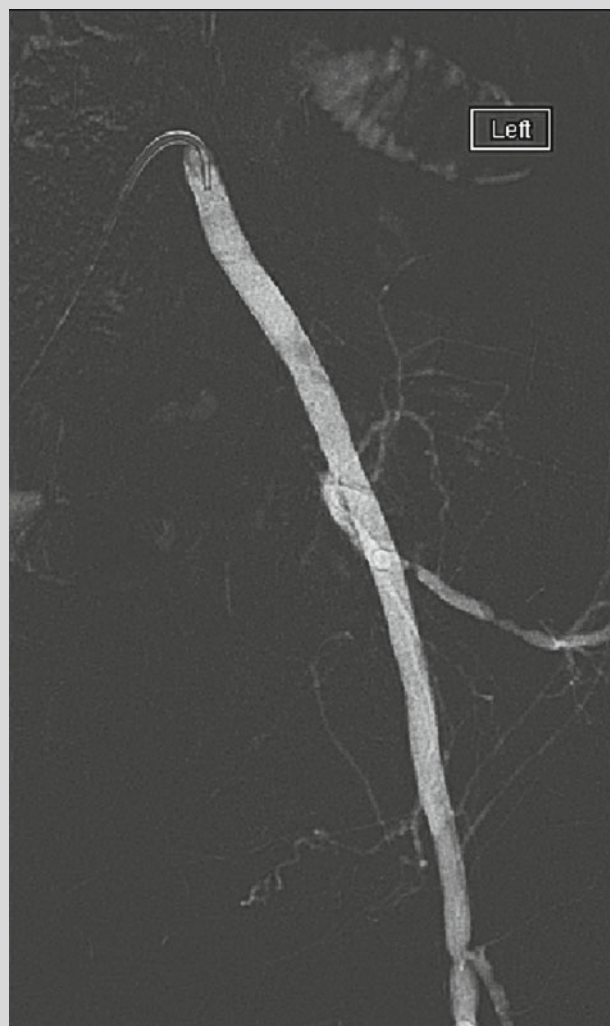
an elective angiogram of the left lower extremity with a plan to revascularize the SFA.

The practical steps involving the revascularization process are numbered below:

1. The right common femoral artery was chosen for access in this patient. The operator chose a retrograde approach.
2. The operator used a combination of fluoroscopy- and ultrasound-guided techniques to evaluate the access site. Vascular access is an important aspect of any endovascular procedure.
3. With fluoroscopy, the operator identified the femoral head as the area of interest. A handheld ultrasound was used to identify the common femoral artery. The operator identified the bifurcation of the profunda and the SFA (Fig. 52.2).
4. Under direct visualization, the common femoral artery was accessed.
5. A 5 French 11 cm sheath was introduced into the right common femoral artery.
6. A rim catheter was introduced into the lower abdominal aorta. Under fluoroscopic guidance, the contralateral left iliac system was engaged.
7. A road map was created. A 0.035" glide wire was advanced into the left common femoral artery (Fig. 52.3).
8. The Rim catheter was advanced over the glide wire to the left common femoral artery.
9. The glide wire was withdrawn and angiographic images of the SFA and popliteal arteries were obtained.
10. Images identified multiple tandem lesions in the distal SFA (Fig. 52.4).
11. It is the opinion of these authors that atherectomy should be employed in treating atherosclerotic lesions. Plaque modification is an important step in treating the vessel.
12. We proceeded with the placement of a 0.035" "Magic Torque wire" (Boston Scientific, Miami, FL) into a relatively healthy segment of the proximal SFA.
13. A 7 French Destination Pinnacle sheath (Terumo Interventional Systems, Somerset, NJ) was advanced under fluoroscopic guidance into the proximal SFA.
14. Antithrombotic therapy with heparin was initiated on a weight-adjusted bases. Typically, we bolus the



**Fig. 52.2** Longitudinal ultrasound view of the common femoral artery and the bifurcation. Note the wire through the needle in the common femoral artery



**Fig. 52.3** Glidewire advanced into the left common femoral artery



**Fig. 52.4** Multiple tandem lesions in the distal SFA



**Fig. 52.5** Unresolved type C dissection

patient with 60 units/kg. Our ACT target is in the 250 range.

15. A soft-angled glide wire was manipulated across the lesion into the infrapopliteal segment.
16. Utilizing a 0.035" exchange catheter, we exchanged the glide wire for a 0.009 Viper Wire (Cardiovascular Systems, Inc.).
17. We decided to perform orbital atherectomy using a 1.5 mm Diamondback Classic Crown (Cardiovascular Systems, Inc.). The CSI system utilizes a differential sanding system that modifies the atherosclerotic plaque, changing the compliance of the vessel wall and allowing for a more sustained and controlled angioplasty result.
18. We then proceeded with performing balloon angioplasty of the distal portion of the SFA and

the proximal popliteal. The operator utilized a 5.0 × 120 mm Mustang balloon (Boston Scientific, Natick, MA) that was inflated at 4 atmospheric pressure for 2 min. Repeated angiogram showed type C dissection in a focal area with contrast stagnation.

19. Repeat balloon angioplasty did not resolve or tack up the type C dissection (Fig. 52.5). Decision was made to proceed with stent placement. 5 × 160 mm Supera stent (IDEV, Houston, TX) was deployed with excellent TIMI III flow and resolution of the type C dissection (Fig. 52.6).

The patient was discharged home the following day. At 3-month follow-up, he was asymptomatic, Rutherford 0 category.





**Fig. 52.6** Resolved type C dissection

## Discussion

With the increasing prevalence of PVD in an aging population and the limitation of vascular surgery in patients with significant comorbidities, operators are gravitating more toward less invasive endovascular therapy. Both approaches have been proven equivalent in patients with critical limb ischemia (CLI) [5]. The use of balloon angioplasty (POBA) has been shown to be effective. However, the benefit is limited to short, noncomplex lesions [8]. In contrast, trials have shown superior long-term patency with moderate length lesions when stents were used as compared to POBA only [9–11]. Earlier trials have failed to document or compare the difference between subintimal and intraluminal interventions. Nonetheless, most operators prefer to remain intraluminal whenever the conditions allow. Whatever the modality of crossing the lesion, stenting appears to yield better results compared to angioplasty alone. In essence, selective stenting depending on the lesion length and characteristics will offer the most sustainable results. We believe that POBA should

be the first option of therapy in patients with the less complex, short TASC II A and B lesions. Stenting appears to provide a more favorable outcome in patients with complex, long TASC II C and D lesions. In a study by Nguyen et al., stenting had a better primary patency rate at long-term follow-up (up to 98 months) [12]. In the above-mentioned trial, the primary patency rate in patients treated with POBA was 27 % compared to 36 % in the stenting arm. More than 70 % of patients were categorized at TASC II A and B. However, the limb salvage rates were at 80–90 %. These rates are certainly comparable to autogenous vein grafts and certainly better than prosthetic conduits [13, 14]. As endovascular techniques continue to evolve, the durability and sustainability of treatment options will improve. Data regarding TASC II C and D are scarce. The results of balloon angioplasty in long and complex lesions have been disappointing. In patients with chronic total occlusion (CTO) and TASC II C and D lesions, the use of subintimal angioplasty has been adopted by many operators. The technique relies on deliberately dissecting the vessel proximal to the lesion. This method has a good technical success rate; however, the 12-month patency rates ranged anywhere from 22 to 79 % [15–19]. In a recent paper by Boisiers et al., the 12-month primary patency rate related to the use of long stents (>200 mm) in 100 patients with TASC II C and D lesions was 64.5 %. Each patient received on average 1.5 stents [20]. The authors of this chapter tend to use, as many other operators, selective stenting in patients with long and complex lesions. We tend to reserve POBA to short and less complex lesions.

Another modality of peripheral vascular revascularization resorts to plaque modification with excision and atherectomy. Endovascular plaque excision is a catheter-based approach where plaque removal improves blood flow in the area supplied. Plaque excision has several theoretical advantages compared to balloon angioplasty or stent placement. There is lack of barotrauma or dottering effect when the vessel is treated with atherectomy. One of the commonly used atherectomy devices is the SilverHawk device (Fig. 52.7) (Covidien/EV3, Mansfield, MA). It consists of a metal chamber containing a cylindrical knife. The excised plaque is caught in a metal housing distal to the cutting mechanism. When the metal housing is full, it needs to be emptied to reuse the device. The device has been evaluated in multiple small trials, [21–25]. One of the largest series was the data reported from treating peripherals with SilverHawk: Outcomes Collection (TALON Registry). In a midterm analysis, 1,258 patients with Rutherford scale >4 underwent atherectomy with the SilverHawk device. Freedom from target lesion revascularization was reported at 80 % in 1 year [26]. Nearly 73 % of lesions did not require any additional therapy. Only 6 % of patients required additional stent placement. Perforation was reported in 0.8 % of patients. The Diamondback 360 orbital atherectomy (Cardiovascular Systems Inc, St. Paul, MN)



**Fig. 52.7** SilverHawk atherectomy device



**Fig. 52.8** Diamondback 360 atherectomy device



**Fig. 52.9** Jetstream atherectomy system

is a device that was initially advocated for the treatment of tibial vessels (Fig. 52.8). The device employs a diamond-coated crown that rotates at high speeds to sand away plaque as it slowly advances through atherosclerotic lesions [27]. Atherectomy results of this device have been favorable in the tibial vessels [28]. The device has been traditionally used for SFA disease because of ease of use and low profile. Another new device is the Jetstream atherectomy system (Pathway Medical Technologies, Kirkland, WA) that employs a cutting tip (Fig. 52.9). The tip remains at a certain diameter (2.1 mm) as it rotates clockwise. The cutting tip expands to 3 mm when

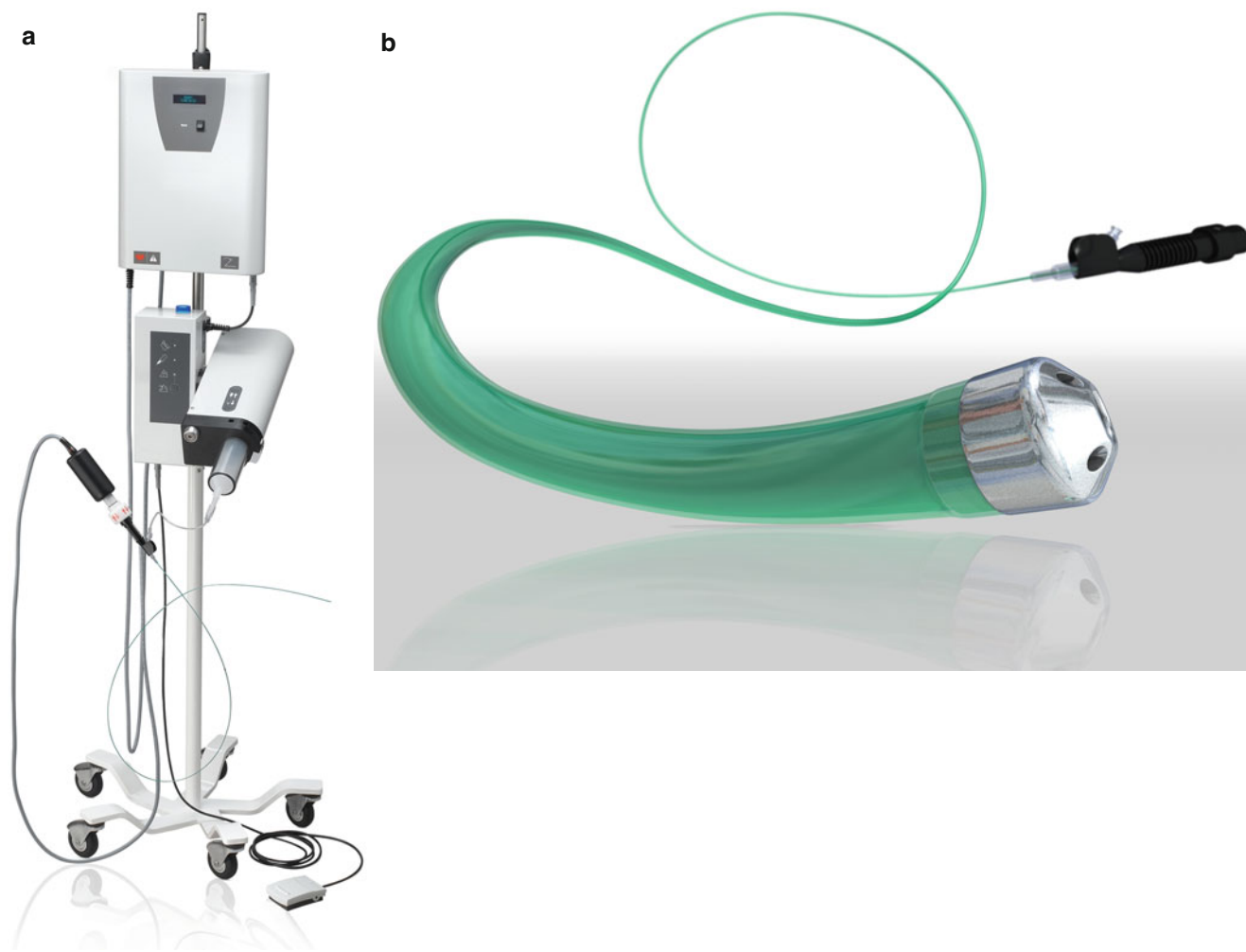


**Fig. 52.10** Excimer laser

it is rotating counterclockwise. The excised material is aspirated through ports within the tip into an aspiration bag. This device has the theoretical advantage of modifying the vessel compliance with decreased risk of aspiration. Another atherectomy device is the excimer laser (Spectranetics, Colorado Springs, CO) (Fig. 52.10). The laser acts by creating a vapor bubble that ablates the plaque up to 50  $\mu\text{m}$  in depth. It is essential to ablate at a steady rate of 1 mm/s to achieve the best results. The benefits of laser therapy have been highlighted in limb salvage following laser-assisted angioplasty for critical limb ischemia (LACI trial) [29]. The LACI was a multicenter trial (15 sites in the United States and 1 German site) that enrolled 145 CLI patients with 155 ischemic limbs classified as Rutherford Class IV–VI. The patients were considered poor or nonsurgical candidates. This was a limb salvage trial with 41 % of the lesions treated in the SFA. At 6-month follow-up, the rate of limb salvage was reported at 92 %.

Recently, the Crosser recanalization system (Bard Peripheral Vascular, Tempe, AZ) has been approved as an atherectomy device (Fig. 52.11a, b). The Crosser system employs ultrasonic vibration that is created by conversion of electrical energy through piezoelectric crystals within the system. Ultimately, the vibration will help guide the catheter through the vessel. The technique is very helpful in patients with chronic total occlusions.

The treatment of SFA disease is changing rapidly. All the techniques described above have both multiple benefits and drawbacks. The operator needs to choose the appropriate technique depending on the patient presentation and lesion



**Fig. 52.11** (a, b) Crosser recanalization system

characteristics. Table 52.2 describes the authors’ own experience in applying these modalities. Until we have more clear evidence that supports one modality over the other, clinical judgment and experience will guide the treatment plan. The near future may hold the answers with the introduction of

drug-eluting balloons and bio-absorbable stents. The success of these techniques will depend initially on operator skill and experience. It is the responsibility of the operator to document the outcomes of these procedures to adequately capture the impact of these new technologies on patient care.

**Table 52.2** Effectiveness of different types of atherectomy devices for treating different plaque composition within the superficial femoral artery

	Thrombus	Soft plaque	In-stent restenosis <sup>a</sup>	Mild calcification	Moderate calcification	Severe calcification
Crosser recanalization	++	++	++	++	++	++
SilverHawk	--	++	++	++	++	+
Diamondback 360	--	+	-	++	++	++
Excimer laser	++	++	++	++	++	++
Jetstream	++	++	+	++	+	+

Plaque composition within the superficial femoral artery  
 This table represents original work by Dr. Mustapha et al. The information documented here represents the authors’ opinion  
 + benefit, ++ very beneficial, - limited benefit, -- no benefit

<sup>a</sup>Some of these devices might be contraindicated in the treatment of in-stent restenosis

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