

# Treating Infrapopliteal PAD in CLI Patients

Exploring the role of excisional atherectomy in below-the-knee revascularization.

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**A**rterial revascularization therapy for below-the-knee peripheral arterial disease (PAD) remains a challenge from both surgical and endovascular perspectives.<sup>1</sup> Critical limb ischemia (CLI) is usually caused by multilevel disease but invariably also involves infragenicular arteries. With increasing incidence of diabetes and end-stage renal disease, the population of patients with complex infrapopliteal PAD continues to grow. In the absence of timely revascularization, CLI carries a 25% risk of mortality and another 25% risk of amputation over the next 1 year—a prognosis worse than some malignancies.<sup>2</sup> Historically, the primary goal of therapy in CLI is to establish pulsatile straight-line flow to the foot in order to relieve ischemic pain, heal ischemic ulcers, and prevent limb loss.

Endovascular therapy for treatment of CLI has excellent acute technical success rates over 90%, low frequency of complications, and high limb-salvage rates, even in patients with long-segment and diffuse PAD involving the tibial arteries.<sup>2</sup> Balloon angioplasty remains the gold standard therapy in this territory. However, bare-metal and drug-eluting stents have also been used primarily or as bailout for failed percutaneous transluminal angioplasty (PTA). An important limitation of balloon angioplasty is its high rate of recurrent restenosis, which has been estimated to be 30% for short stenoses and up to 80% after recanalization of an occlusion at 1-year follow-up.<sup>3</sup> This poses an enormous challenge from public health and repeat-intervention standpoints, as well as an economic perspective.

Recently, single- and multicenter registries have reported outcomes from newer devices such as laser, excisional, and rotational atherectomy systems, as well as drug-eluting stents or drug-coated balloons; however, there have been

no published data from randomized controlled trials to date.<sup>3</sup> We review the role of excisional atherectomy in revascularization of infrapopliteal PAD in patients with CLI.

## ATHERECTOMY FOR BELOW-THE-KNEE VESSELS

Atherectomy is a potentially attractive option for treatment of below-the-knee arterial disease because infrapopliteal vessels are usually small in size (between 2–3 mm), highly calcified, and often totally occluded, thus decreasing the long-term patency rates with the use of balloon angioplasty alone. The theoretic advantages of directional atherectomy over PTA include removal or debulking of the plaque rather than just being compressed against the vessel wall; lack of barotrauma, reducing the risk of intimal/medial hyperplasia; lesser risk of dissection; and the advantage of using adjunctive balloon angioplasty at lower pressures.<sup>4</sup> Finally, atherectomy neither precludes the use of surgical bypass at a future stage nor, in most cases, changes the target bypass sites, in contrast to stenting.

Atherectomy techniques can broadly be classified into two categories: (1) atheroablative (ablation or fragmenting plaque into smaller particles), which include laser atherectomy, rotational atherectomy, and orbital atherectomy; and (2) excisional atherectomy.

## EXCISIONAL ATHERECTOMY

### The SilverHawk Plaque Excision System

The only device that is currently approved by the US Food and Drug Administration (FDA) for excisional atherectomy is the SilverHawk plaque excision system (ev3 Inc., Plymouth, MN). It is a forward-cutting directional atherectomy

tomy device that can be used with or without the adjunctive use of balloons or stents. The catheter consists of a 135-cm flexible shaft designed to track over a 0.014-inch guidewire. It has a crossing profile of 1.9 to 2.7 mm and can be introduced through a 6- to 8-F sheath in an antegrade ipsilateral or retrograde crossover technique. When the catheter is activated and manually advanced through a lesion, a high-speed cutting blade (rotating at 8,000 rpm) excises a “ribbon” of plaque that is collected into the catheter nose cone. Multiple catheter passes are made through the lesion, during which the blade is redirected sequentially toward all quadrants of the vessel lumen.

### Tips and Tricks

The SilverHawk catheter comes in various sizes to allow treatment of femoral, popliteal, tibial, and even pedal vessels. Two of the catheters, LX-M (large-vessel Xtended tip) and LS-M (large-vessel standard tip) have extra-large nose cones for greater plaque capacity and are mainly used in the large vessels (4.5–7 mm) above the knee, whereas the SilverHawk-MS catheter has a slightly lower-profile blade (0.2 mm vs 0.3 mm) that was designed for greater efficacy in calcified lesions and less aggressive stance against calcium or vessel walls. The SilverHawk SS+ (small-vessel standard tip) and ES+ (extra-small vessel standard tip) are mainly used for smaller infrapopliteal vessels (2–3.5 mm).<sup>3</sup> A lower-profile version of the device, the SilverHawk-DS, or “MiniHawk,” was approved by the FDA in 2007 and allows treatment in tibial and pedal vessels down to 1.5 mm in diameter. This device can be used with or without the distal wire in position to allow greater flexibility and ability to deliver the device in the distal vasculature.

Excisional atherectomy with the SilverHawk offers the advantage of directional control for debulking lesions, which is especially helpful in the case of eccentric lesions. This aspect of excisional atherectomy provides a key difference compared to other currently available atherectomy devices.

Recent studies have suggested that excisional atherectomy can be associated with distal embolization, and the use of distal embolic protection devices can be considered in certain patient populations.<sup>5,6</sup> However, experienced operators have reported a low incidence of clinically significant embolization using good technique—slow passes, frequent packing, and avoidance of overpacking. Distal embolic protection should be used for lesions in which embolic debris is more likely, such as “coral reef” calcification or single-vessel runoff with CLI.<sup>7</sup>

The risk of dissection, pseudoaneurysm, or vessel perforation has been reported to be less than 1% in experienced hands. However, care should be taken to avoid continued passes in the same planes, which can result in these compli-

cations.<sup>7</sup> The SilverHawk device should be used carefully in bifurcations, such as the origin of the anterior tibial artery, due to risk of dissection or perforation. This is primarily when the operator directs the device toward the flow divider or carina, causing a deep cut to occur that creates a perforation.

Excisional atherectomy is not FDA approved for treatment of in-stent restenosis. However, many operators reported it to be useful for debulking a large amount of plaque within a stent to then allow further adjunctive therapy as needed. However, care should be exercised because aggressive debulking can be associated with entrapment of a stent strut in the cutting device, which can result in stent dislodgement and frank loss of integrity.

Overall, many operators suggest a deliberate approach with directional atherectomy for most lesions either above or below the knee. Further care should be taken when using atherectomy in any bifurcation, and “wire bias” should be used to the physician’s advantage for the intervention. Lastly, when appropriate, consider distal embolic protection before having a significant complication.

### Evidence-Based Data for Excisional Atherectomy in CLI

In patients with CLI, there have been no published data from a randomized controlled trial for excisional atherectomy with the SilverHawk; however, there have been several single- and multicenter registries (Table 1). The largest of the registries is the TALON (Treating Peripherals with SilverHawk: Outcomes Collection), which involved 19 centers in the United States and included patients with both claudication and CLI who had either above- or below-the-knee lesions.<sup>8</sup> Midterm (6- and 12-month) outcomes for 728 patients with 1,517 symptomatic lesions (mean lengths: 62.5 mm, above the knee; 33.4 mm, below the knee) treated with the SilverHawk device have been reported with an excellent procedural success rate (97.6%). Adjunctive therapy was required in 21.7% of the patients, and stents were required in only 6.3%. Total lesion revascularization rates at 6 and 12 months were 90% and 80%, respectively. The 12-month outcomes compare favorably to angioplasty and stenting, which have reported patency rates of 61% to 67%. However, an important limitation of this observational registry was the lack of independent ascertainment of clinical and objective outcomes.

McKinsey et al recently described the results of excisional atherectomy in 275 patients (579 lesions) from 2004 to 2007 in which 63% of the patients had CLI. The 30-day perioperative mortality was 1.8%; 18-month primary and secondary patency rates for claudicants were 58% and 82.5%, respectively, and 49% and 70%, respectively, for CLI patients. Limb salvage was 100% in claudicants, and overall

TABLE 1. EXCISIONAL ATHERECTOMY FOR CLI DUE TO INFRAPOPLITEAL DISEASE

	Patients/ Lesions	Patients With CLI (%)	Mean Lesion Length (Occlusion %)	Location	De Novo Lesions	Limb Salvage	Primary Patency	Secondary Patency
Talon <sup>8</sup>	728/1,517	NA	8.4 cm (28.60%)	SFA/BTK	87.50%	NA	79% at 1 y	NA
McKinsey <sup>9</sup>	275/579	63%	9 cm (SFA); < 5 cm (BTK)	SFA/BTK	NA	92% at 18 mo	52% at 18 mo	75% at 18 mo
Yancey <sup>12</sup>	16/18	100%	NA	SFA/BTK	100%	70% at 1 y	22% at 2 y	NA
Kandzari <sup>11</sup>	69/76	100%	6.5 cm (34%)	SFA/BTK	100%	82% at 6 mo	NA	NA
Keeling <sup>13</sup>	60/66	35%	8.8 cm (27%)	SFA/BTK	100%	87% at 1 y	62% at 1 y	76% at 1 y
Zeller <sup>14</sup>	36/49	53%	4.8 cm (22%)	BTK	72%	NA	60% at 2 y	80% at 2 y

Abbreviations: BTK, below the knee; SFA, superficial femoral artery.

limb salvage was 92.4% per patient at 18 months; only 4.4% required bypass.<sup>9</sup>

Zeller et al also reported 1- and 2-year outcomes with the use of the SilverHawk device in 36 patients (49 below-the-knee lesions), 53% of whom had CLI.<sup>10</sup> Primary atherectomy was the treatment of choice in 67% of the lesions, whereas 33% received balloon predilatation. Thirty-nine percent of lesions underwent subsequent balloon angioplasty, whereas 4% required bailout stenting due to dissection. Primary and secondary patency rates after 1 year (freedom from restenosis, assessed by Doppler ultrasound or angiography, less than 70%) were 67% and 91%, respectively, and 60% and 80% after 24 months, respectively, suggesting favorable outcomes for the treatment of small-vessel disease with excisional atherectomy.

Kandzari and colleagues evaluated SilverHawk atherectomy for patients presenting with CLI (Rutherford category 5–6). A total of 76 limbs were treated in 69 patients at seven centers in the United States. Approximately 40% of the lesions treated were in the infrapopliteal vessels. Procedural success was achieved in 99% of cases. Complications were infrequent, and target lesion revascularization occurred in only 4% of cases. Amputation was less extensive than initially planned or avoided altogether in 92% of patients at 30 days and 82% at 6 months.<sup>11</sup>

Yancey et al also reported on complicated TASC (TransAtlantic Inter-Society Consensus) type C femoropopliteal lesions with SilverHawk atherectomy.<sup>12</sup> The patient cohort consisted of 16 patients with CLI who had tissue loss or rest pain. All patients had a second level of disease, either inflow or tibial/pedal. Results showed resolution of the initial symptoms in 12 limbs and partial healing in two others. Early amputation was required in three patients for progressive foot ischemia and inframalle-

olar disease. The 1-year patency rates were low at 22%; however, target lesion revascularization was only required in 18%, and limb salvage was achieved in 70%. Despite the high-risk cohort with advanced CLI, excisional atherectomy resulted in significant limb salvage.

Keeling et al published on the outcomes of SilverHawk atherectomy as a primary treatment for infrainguinal lesions in claudicants and CLI.<sup>13</sup> A prospective database was created and assigned Society for Vascular Surgery ischemia scores and femoropopliteal TASC lesion criteria in patients undergoing atherectomy with 1-, 3-, 6-, and 12-month duplex ultrasound follow-up. Follow-up was reported for a 17-month period on 66 limbs in 60 patients who underwent 70 plaque excisions. The technical success rate was high (87.1%). One-year primary, primary-assisted, and secondary patency rates were 61.7%, 64.1%, and 76.4%, respectively. Restenosis developed in 16.7% of patients and was detected at a mean of  $2.8 \pm 0.7$  months. Restenosis was significantly higher in TASC C or D lesions than in TASC A or B lesions. The investigators concluded that SilverHawk atherectomy was a viable option for infrainguinal revascularization and that ischemia and lesion severity significantly contributed to 12-month patency outcomes.

Another study, DEFINITIVE LE (Determination of Effectiveness of SilverHawk Peripheral Plaque Excision [SilverHawk Device] for the Treatment of Infrainguinal Vessels/Lower Extremities) is a global registry currently enrolling patients with both claudication and CLI across 50 sites in the United States and Europe. This registry is the largest ever conducted, with enrollment of 800 patients worldwide, evaluating a real-world patient population with lesions up to 20 cm in length and multilevel lesions with the same lesion lengths.

Even though the initial results of excisional atherectomy from observational registry data and single-center cohorts in the treatment of CLI have shown promising results for limb salvage, further evidence is required from randomized controlled trials to ensure data quality regarding long-term outcomes and safety. With continued research and device improvements, excisional atherectomy may prove to be a reliable and consistent endovascular therapy for this high-risk population.

In summary, the SilverHawk device offers a fundamental advantage in treating lower-extremity atherosclerotic lesions that have been notoriously difficult to treat with plaque displacement technology. Future developments will be directed at designing a catheter with greater capability to excise calcified plaque and one that incorporates imaging (optical coherence tomography or intravascular ultrasound) to better direct plaque excision.

## Excisional Atherectomy for Calcified Lesions

The TurboHawk peripheral plaque excision system (ev3 Inc.) (TurboHawk catheter and SilverHawk cutter driver) is designed for the treatment of de novo and restenotic atherosclerotic calcified lesions located in native peripheral arteries. The TurboHawk catheter consists of a flexible shaft designed to track over a 0.014-inch guidewire. It is very similar in design to the SilverHawk, except that it has four angled cutters that are designed to engage and cut atheroma and that have been designed to engage and cut calcium, thus making it useful for moderately calcified vessels. With the cutter engaged, the TurboHawk catheter is slowly advanced across the lesion, shaving the calcified plaque from the artery. The excised tissue is captured and stored in the tip of the device, as is normal. Distal embolic protection has been reported by some operators to be useful with this device given the higher embolic likelihood with calcified lesions, although to date, no distal embolic protection device is FDA approved for the lower extremity. The TurboHawk device can often be used as a stand-alone therapy, with adjunctive PTA and stenting reserved for suboptimal results.

The other alternative to the TurboHawk for calcified lesions is the use of rotational atherectomy with the Jetstream G3 (Pathway Medical Technologies Inc., Kirkland, WA) or the Diamondback 360° (Cardiovascular Systems Inc, St. Paul, MN).<sup>14</sup> No current study has reported outcomes with the use of TurboHawk for treatment of CLI.

## CONCLUSION

The challenge of successful treatment of infrapopliteal arterial obstructive disease remains a difficult goal for both surgical and endovascular specialists. Clearly, the lack of good scientific data further clouds the selection of the best

device or approach. Endovascular approaches that include directional atherectomy have been shown (with modest registry data) to be safe and effective in the treatment of infragenicular disease. The benefit for long-term patency in this territory remains a true Achilles' heel for any approach. However, directional atherectomy should be considered a reasonable alternative in the treatment of patients with distal peripheral arterial obstructive disease. Ultimately, the results of the ongoing DEFINITIVE LE study and its anti-restenosis arm will help in defining the best locations for therapy with directional atherectomy, where it should be avoided, and ultimately where the treatment for lower extremity claudication and CLI is best served. ■

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