

## Directional Atherectomy and Drug-Coated Balloons for Femoropopliteal Disease: A Case-Based Discussion

By Brian G. DeRubertis, MD, FACS

Although surgical bypass remains the gold standard by which we assess the efficacy of new endovascular technology for the femoropopliteal circulation, the “endovascular-first” strategy has become the primary approach in recent years for treating most patients with superficial femoral artery (SFA) or popliteal artery stenoses and occlusions, especially in the claudicant population. Compared with endovascular therapy, surgical bypass has the advantage of circumventing heavy plaque burden in diseased arteries, adhering to the surgical principle of sewing the graft from a healthy inflow artery to a healthy outflow artery. Most percutaneous approaches to revascularization require crossing the diseased artery, either in a true luminal or subintimal plane, both of which subject the newly recanalized flow lumen to the continued effects of mechanical plaque burden and biologically active medial and adventitial cells that can result in the production of intimal hyperplastic tissue.

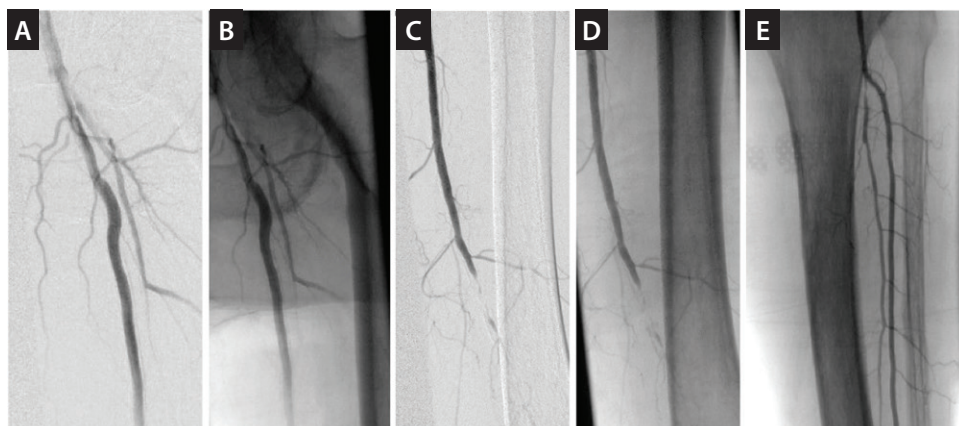
The two major challenges to successful revascularization and sustained patency when performing endovascular interventions for femoropopliteal disease are (1) residual plaque burden and the mechanical forces that plaque burden exerts on the flow lumen and (2) the biologic phenomenon of restenosis due to intimal hyperplasia. Both of these challenges must be effectively overcome for successful revascularization and lasting freedom from claudication in our patients.

### MANAGING THE MECHANICAL AND BIOLOGIC FORCES THAT THREATEN SFA PATENCY

In the early period of percutaneous revascularization, balloon angioplasty alone was the primary treatment modality for SFA and popliteal revascularization. Angioplasty alone was eventually supplanted by self-

expanding nitinol stents after randomized trial data showed the superiority of stents over angioplasty alone.<sup>1</sup> However, the limitations of stents are well known, especially when used extensively in a “full-metal jacket” in the entire SFA and above-the-knee (ATK) popliteal arteries. Nitinol stents can also fracture, which is almost universally associated with loss of patency, and in-stent occlusion carries important ramifications for reintervention on these patients. Occluded stents are significantly more difficult to treat than native arteries. They carry an increased risk of embolization, and the patency rates after treatment of in-stent restenosis have been quite dismal historically. For these reasons, there has been a move away from standard nitinol stent use in recent years toward a “leave nothing behind” approach. However, for this strategy to be effective, devices that have the potential to adequately debulk plaque burden must be used. Ideally, such devices should be paired with delivery of antirestenotic drugs to mount a two-pronged attack on the mechanical and biologic forces that threaten patency of percutaneous femoropopliteal interventions.

Directional (or excisional) atherectomy has been available for many years, although the TurboHawk™ peripheral plaque excision system (Medtronic) and the HawkOne™ directional atherectomy system (Medtronic) have evolved several times such that current iterations are extremely effective at removing large volumes of soft and calcific plaque from diseased arteries. Directional atherectomy has been evaluated in the DEFINITIVE LE trial, a core-lab adjudicated, single-arm registry that enrolled 800 patients with lesions in the femoropopliteal and/or tibial circulation.<sup>2</sup> The 12-month primary patency was 78% in claudicants, and the freedom from major unplanned amputation of the target limb was 95% at 12 months.<sup>2</sup>



**Figure 1. Diagnostic angiograms showing the widely patent common femoral artery and proximal SFA (A, B), the occluded distal SFA and proximal ATK popliteal artery with reconstitution of the behind-knee popliteal artery (C, D), and the patent peroneal artery (beyond a high-grade TPT stenosis) and anterior tibial artery (E).**

Users of directional atherectomy are familiar with the versatility of the device and its ability to achieve significant luminal gain while minimizing dissections and need for stent implantation. However, until the advent of drug delivery for the SFA, many patients who were treated with atherectomy ultimately had restenosis due to intimal hyperplasia. Throughout the last 5 years, several devices designed for antirestenotic drug delivery have become approved for use in the United States and around the world, and these devices serve as a natural complement to the debulking effects of directional atherectomy. In the IN.PACT SFA trial, the IN.PACT™ Admiral™ drug-coated balloon (DCB; Medtronic) was shown to be superior to angioplasty alone. Primary patency rates with IN.PACT Admiral exceeded those previously seen with most standard nitinol stents, with 12- and 36-month primary patency rates of 82.2% and 69.5%, respectively.<sup>3,4</sup> Considering the mechanical debulking effects of directional atherectomy and the biologic antirestenotic effect of the IN.PACT Admiral DCB, the combination of the two is an intuitively attractive treatment strategy and has been widely applied clinically and in several recent clinical trials.

## CASE REPORT

A woman in her late 60s with a history of hyperlipidemia and hypertension presented with an extensive left lateral lower leg pressure ulcer and a 2.5-cm heel ulcer that developed after hospitalization for pneumonia. She had no palpable pulse in her left foot, and vascular lab evaluation demonstrated reduced ankle-brachial indices of 0.80 and 0.35, respectively, on the right and left legs. A duplex ultrasound exam suggested a distal SFA and proximal popliteal occlusion with monophasic ankle signals. Diagnostic angiography dem-

onstrated a widely patent common femoral artery and proximal SFA but noted an occlusion of the distal SFA and proximal ATK popliteal artery, with reconstitution of the behind-knee popliteal artery (Figure 1A-1D). Tibial runoff consisted of a patent peroneal artery beyond a high-grade tibial-peroneal trunk (TPT) stenosis and a patent anterior tibial artery (Figure 1E).

The occlusion in the SFA and ATK popliteal artery was crossed with a stiff, angled Glidewire™\* (Terumo Interventional Systems) and a 0.035-inch Trailblazer™ support

catheter (Medtronic). Next, a 6-mm SpiderFX™ embolic protection device (Medtronic) was delivered into the distal popliteal artery (Figure 2).

The distal SFA and proximal popliteal artery were then treated with a TurboHawk SX-C device. The device was first passed through the lesion in the "off" position to ensure a smooth passage, followed by one pass in each of four different orientations: lateral, anterior, medial, and posterior (Figure 3). The device was removed once for cleaning and was then reinserted for one more pass in each orientation, for a total of 8 passes of the atherectomy catheter.

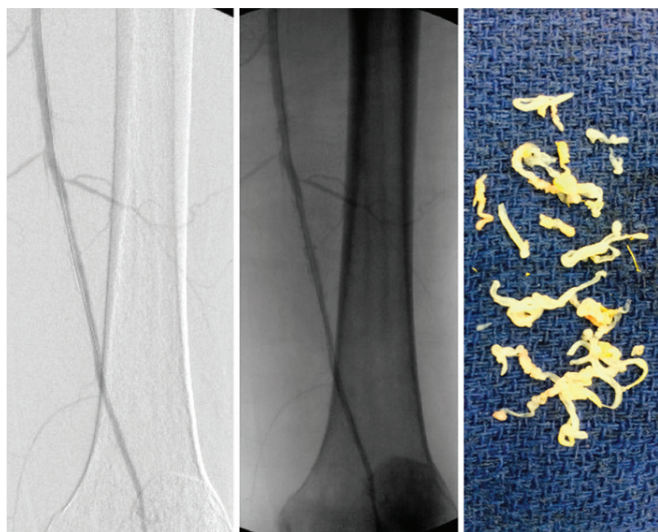
Repeat angiography showed significant lumen gain, with only minimal size mismatch to the more proximal, nondiseased SFA (Figure 4). After atherectomy, the treated portions of the SFA and popliteal artery were postdilated with a 5- X 150-mm IN.PACT Admiral DCB, which was inflated to 8 atm (Figure 5A). Completion angiography demonstrated a widely patent SFA and popliteal artery, without residual stenosis or dissection (Figure 5B). After treatment of the femoropopliteal circulation, the SpiderFX device



**Figure 2. The SFA and ATK popliteal artery occlusion was crossed with a stiff, angled Glidewire and a 0.035-inch Trailblazer. A 6-mm SpiderFX embolic protection device was delivered into the distal popliteal artery.**



**Figure 3.** Angiograms showing directional atherectomy with a TurboHawk SX-C device in the distal SFA and proximal popliteal artery.

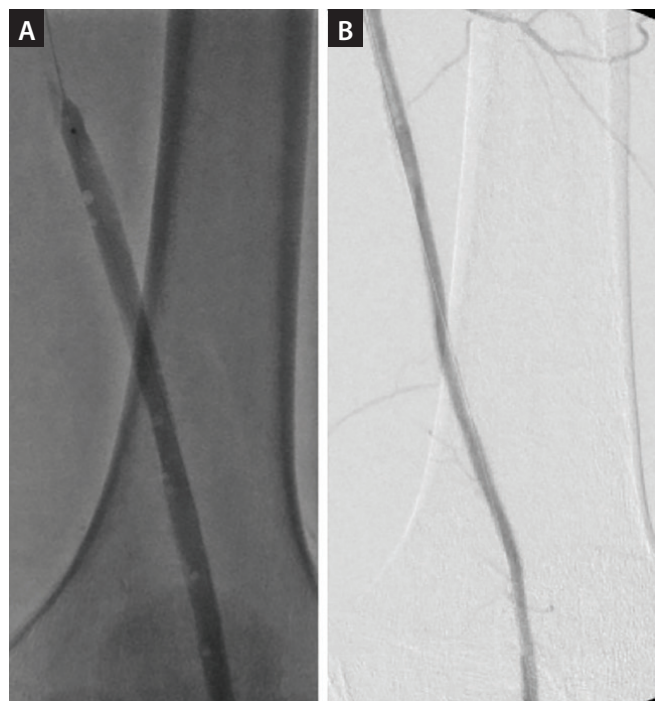


**Figure 4.** Repeat angiograms after directional atherectomy showing significant lumen gain and atheroma extraction.

was retrieved in exchange for a 0.014-inch wire. The TPT stenosis was then treated over the wire with the same TurboHawk SX-C catheter, followed by a 3- X 40-mm angioplasty balloon to achieve uncompromised two-vessel runoff to the foot. The patient's wounds healed within 2 months after operative debridement, which was performed after revascularization.

## DISCUSSION

The combination of directional atherectomy and DCB angioplasty is an attractive strategy for femoropopliteal revascularization because it addresses both of the major challenges to sustained patency in femoropopliteal interventions: (1) mechanical forces caused by residual plaque



**Figure 5.** Angiogram showing postdilation of the SFA and popliteal artery with a 5- X 150-mm IN.PACT Admiral DCB after atherectomy (A). Completion angiogram showing a widely patent SFA and popliteal artery without residual stenosis or dissection (B).

burden or dissections and (2) biologic restenosis due to development of intimal hyperplasia. The combination of these two modalities has been studied in the DEFINITIVE AR randomized controlled trial, a pilot study evaluating the TurboHawk atherectomy system in conjunction with DCB angioplasty.<sup>5</sup> Although this study showed no statistically significant difference in primary patency between combination therapy with atherectomy plus DCB versus DCB alone at 12 months, it is important to note that patients with severely calcified lesions were excluded from randomization. Instead, these patients were followed in a small registry arm of the trial in which combination therapy of atherectomy and DCB was used. This is notable because the main trend noted in this trial indicated that the patients with the most complex lesions (ie, those with long and severely calcified lesions) derived the most benefit from the combination therapy of atherectomy and DCB. Additionally, patients that were fully debulked with atherectomy to  $\leq 30\%$  before DCB use had the most benefit from combination therapy, with an angiographically determined 12-month primary patency rate of 88.2% compared to 68.8% for those with  $> 30\%$  residual stenosis before DCB use.<sup>5</sup> This pilot study also demonstrated the safety of the combination therapy of atherectomy and DCB, as shown



by the absence of an increase in the major adverse events rate in the atherectomy plus DCB group compared with DCB alone at 12 months.<sup>5</sup>

Based on the trends observed in the DEFINITIVE AR trial, VIVA Physicians has sponsored the REALITY trial, which is a single-arm, core-lab adjudicated study evaluating the combination of TurboHawk/HawkOne atherectomy and IN.PACT Admiral DCB angioplasty for long, severely calcified lesions of the femoropopliteal circulation. Although the final results of this trial are forthcoming, enrollment has been completed. Interim results for the 102 patients in the trial demonstrate a mean lesion length of 17.9 cm and a PACSS (Peripheral Arterial Calcium Scoring Scale) score of 3 to 4 in 76.4% of patients.<sup>6</sup> Interim analysis suggests a bailout stent rate of 4.9%, which is extremely low considering such complex lesions.<sup>6</sup>

## SUMMARY

Complex lesions—including long, severely calcified lesions—have significant challenges to sustained long-term patency after successful percutaneous revascularization. The combination of directional atherectomy and DCB offers solutions to both the mechanical effects of plaque burden and dissections as well as the biologic phenomenon of restenosis. The upcoming results of the REALITY trial will further delineate the effectiveness of this intuitive treatment modality.

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**Disclosures: Compensated speaker, consultant, proctor, and/or advisory board member for Abbott Vascular, Boston Scientific Corporation, Cook Medical, and Medtronic.**

## Medtronic

### Indications, Safety, and Warnings

If you are located in the United States, please refer to the brief statement(s) below to review applicable indications, safety and warning information. See the device manual for detailed information regarding the implant procedure, indications, contraindications, warnings, precautions, and potential complications/adverse events. For further information, please call Medtronic at 1.763.514.4000 and/or consult the Medtronic website at [www.medtronic.com](http://www.medtronic.com).

If you are located outside the United States, see the device manual for detailed information regarding instructions for use, the implant procedure, indications, contraindications, warnings, precautions, and potential adverse events. For further information, contact your local Medtronic representative and/or consult the Medtronic website at [www.medtronic.eu](http://www.medtronic.eu). For applicable products, consult instructions for use on [manuals.medtronic.com](http://manuals.medtronic.com). Manuals can be viewed using a current version of any major internet browser. For best results, use Adobe Acrobat® Reader with the browser.

**Important Reminder:** This information is intended only for users in markets where Medtronic products and therapies are approved or available for use as indicated within the respective product manuals. Content on specific Medtronic products and therapies is not intended for users in markets that do not have authorization for use.

### IN.PACT™ Admiral™ Paclitaxel-coated PTA balloon catheter Brief Statement

#### Indications for Use:

The IN.PACT™ Admiral™ Paclitaxel-coated PTA Balloon Catheter is indicated for percutaneous transluminal angioplasty, after appropriate vessel preparation, of de novo, restenotic, or in-stent restenotic lesions with lengths up to 360 mm in superficial femoral or popliteal arteries with reference vessel diameters of 4-7 mm.

#### Contraindications

- The IN.PACT Admiral DCB is contraindicated for use in:
  - Coronary arteries, renal arteries, and supra-aortic/cerebrovascular arteries
  - Patients who cannot receive recommended antiplatelet and/or anticoagulant therapy
  - Patients judged to have a lesion that prevents complete inflation of an angioplasty balloon or proper placement of the delivery system
  - Patients with known allergies or sensitivities to paclitaxel
  - Women who are breastfeeding, pregnant or are intending to become pregnant or men intending to father children. It is unknown whether paclitaxel will be excreted in human milk and whether there is a potential for adverse reaction in nursing infants from paclitaxel exposure.

### Warnings

- A signal for increased risk of late mortality has been identified following the use of paclitaxel-coated balloons and paclitaxel-eluting stents for femoropopliteal arterial disease beginning approximately 2-3 years post-treatment compared with the use of non-drug coated devices. There is uncertainty regarding the magnitude and mechanism for the increased late mortality risk, including the impact of repeat paclitaxel-coated device exposure. Physicians should discuss this late mortality signal and the benefits and risks of available treatment options with their patients.**
- Use the product prior to the Use-by Date specified on the package.
- Contents are supplied sterile. Do not use the product if the inner packaging is damaged or opened.
- Do not use air or any gaseous medium to inflate the balloon. Use only the recommended inflation medium (equal parts contrast medium and saline solution).
- Do not move the guidewire during inflation of the IN.PACT Admiral DCB.
- Do not exceed the rated burst pressure (RBP). The RBP is 14 atm (1419 kPa) for all balloons except the 200 and 250 mm balloons. For the 200 and 250 mm balloons the RBP is 11 atm (1115 kPa). The RBP is based on the results of in vitro testing. Use of pressures higher than RBP may result in a ruptured balloon with possible intimal damage and dissection.
- The safety and effectiveness of using multiple IN.PACT Admiral DCBs with a total drug dosage exceeding 34,854 µg of paclitaxel in a patient has not been clinically evaluated.

### Precautions

- This product should only be used by physicians trained in percutaneous transluminal angioplasty (PTA).
- This product is designed for single patient use only. Do not reuse, reprocess, or sterilize this product. Reuse, reprocessing, or sterilization may compromise the structural integrity of the device and/or create a risk of contamination of the device, which could result in patient injury, illness, or death.
- Assess risks and benefits before treating patients with a history of severe reaction to contrast agents.
- The safety and effectiveness of the IN.PACT Admiral DCB used in conjunction with other drug-eluting stents or drug-coated balloons in the same procedure or following treatment failure has not been evaluated.
- The extent of the patient's exposure to the drug coating is directly related to the number of balloons used. Refer to the Instructions for Use (IFU) for details regarding the use of multiple balloons and paclitaxel content.
- The use of this product carries the risks associated with percutaneous transluminal angioplasty, including thrombosis, vascular complications, and/or bleeding events
- Vessel preparation using only pre-dilatation was studied in the clinical study. Other methods of vessel preparation, such as atherectomy, have not been studied clinically with IN.PACT Admiral DCB.

- This product is not intended for the expansion or delivery of a stent.

## Potential Adverse Effects

- The potential adverse effects (e.g. complications) associated with the use of the device are: abrupt vessel closure; access site pain; allergic reaction to contrast medium, antiplatelet therapy, or catheter system components (materials, drugs, and excipients); amputation/loss of limb; arrhythmias; arterial aneurysm; arterial thrombosis; arteriovenous (AV) fistula; death; dissection; embolization; fever; hematoma; hemorrhage; hypotension/hypertension; inflammation; ischemia or infarction of tissue/organ; local infection at access site; local or distal embolic events; perforation or rupture of the artery; pseudoaneurysm; renal insufficiency or failure; restenosis of the dilated artery; sepsis or systemic infection; shock; stroke; systemic embolization; vessel spasms or recoil; vessel trauma which requires surgical repair.
- Potential complications of peripheral balloon catheterization include, but are not limited to the following: balloon rupture; detachment of a component of the balloon and/or catheter system; failure of the balloon to perform as intended; failure to cross the lesion.
- Although systemic effects are not anticipated, potential adverse events that may be unique to the paclitaxel drug coating include, but are not limited to: allergic/immunologic reaction; alopecia; anemia; gastrointestinal symptoms; hematologic dyscrasia (including leucopenia, neutropenia, thrombocytopenia); hepatic enzyme changes; histologic changes in vessel wall, including inflammation, cellular damage, or necrosis; myalgia/arthralgia; myelosuppression; peripheral neuropathy.
- Refer to the Physician's Desk Reference for more information on the potential adverse effects observed with paclitaxel. There may be other potential adverse effects that are unforeseen at this time.
- Please reference appropriate product Instructions for Use for a detailed list of indications, warnings, precautions and potential adverse effects. This content is available electronically at [www.manuals.medtronic.com](http://www.manuals.medtronic.com).

**CAUTION:** Federal (USA) law restricts this device to sale by or on the order of a physician.

## HawkOne™ directional atherectomy system Reference Statement

**Important Information:** Indications, contraindications, warnings and instructions for use can be found in the product labeling supplied with each device.

**Indications for Use:** The HawkOne directional atherectomy system is intended for use in atherectomy of the peripheral vasculature. The HawkOne catheter is indicated for use in conjunction with the SpiderFX™ embolic protection device in the treatment of severely calcified lesions. The HawkOne catheter is NOT intended for use in the coronary, carotid, iliac or renal vasculature.

**CAUTION:** Federal (USA) law restricts this product for sale by or on the order of a physician.

## TurboHawk™ peripheral plaque excision system Reference Statement

**Important Information:** Indications, contraindications, warnings and instructions for use can be found in the product labelling supplied with each device.

**Indications for Use:** The TurboHawk peripheral plaque excision system is intended for use in the

atherectomy of the peripheral vasculature. The TurboHawk catheter is NOT intended for use in the coronary, carotid, iliac, or renal vasculature.

The TurboHawk catheter is indicated for use in conjunction with the SpiderFX™ embolic protection device in the treatment of severely calcified lesions (LX-C only).

**CAUTION:** Federal (USA) law restricts this product for sale by or on the order of a physician.

## SpiderFX™ embolic protection device Brief Statement

**Important Information:** Indications, contraindications, warnings and instructions for use can be found in the product labeling supplied with each device.

### Indications for Use:

#### • Lower Extremity (LE) Interventions

The SpiderFX embolic protection device is indicated for use as a guidewire and embolic protection system to contain and remove embolic material in conjunction with the TurboHawk™ Peripheral Plaque Excision System, either during standalone procedures or together with PTA and/or stenting, in the treatment of severely calcified lesions in arteries of the lower extremities. The vessel diameter at the filter basket placement site should be between 3.0 mm and 6.0 mm.

#### • Carotid Interventions

The SpiderFX embolic protection device is indicated for use as a guidewire and embolic protection system to contain and remove embolic material (thrombus/debris) while performing angioplasty and stenting procedures in carotid arteries. The diameter of the artery at the site of filter basket placement should be between 3.0mm and 7.0mm.

#### • Saphenous Vein Graft (SVG) Interventions

The SpiderFX embolic protection device is indicated for use as an embolic protection system to contain and remove embolic material (thrombus/debris). The device also acts as the guidewire while performing percutaneous transluminal coronary angioplasty or stenting procedures in coronary saphenous vein bypass grafts with reference vessel diameters of 3.0mm to 6.0mm. The safety and effectiveness of this device as an embolic protection system has not been established in the cerebral vasculature.

**CAUTION:** Federal (USA) law restricts this product for sale by or on the order of a physician.

## TrailBlazer™ support catheter reference statement

**Important Information:** Indications, contraindications, warnings and instructions for use can be found in the product labeling supplied with each device.

**Indications for Use:** TrailBlazer support catheter are percutaneous, single lumen catheters designed for use in the peripheral vascular system. TrailBlazer™ support catheters are intended to guide and support a guide wire during access of the vasculature, allow for wire exchanges and provide a conduit for the delivery of saline solutions or diagnostic contrast agents.

**CAUTION:** Federal (USA) law restricts these devices to sale by or on the order of a physician.

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