Balloon-Assisted Dislodgement of a Trapped Directional Atherectomy Catheter During Treatment of In-Stent Restenosis

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Abstract: Stenting of femoropopliteal lesions is associated with longer patency rates compared with traditional balloon angioplasty, especially in long lesions. However, these long, stented segments are subject to neointimal hyperplasia and restenosis over the long term. Directional atherectomy had been contraindicated in restenotic stented lesions due to the potential risk of cutter entrapment on stent struts during atherectomy. With the advent of concurrent imaging during atherectomy, this risk can potentially be avoided. Nevertheless, as seen in the case herein, if this situation were to occur in malapposed struts in overlapped segments, techniques such as balloon-assisted dislodgement of an entrapped catheter can be useful to avoid disastrous complications.

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Peripheral artery disease has varied presentations (claudication, rest pain, and various stages of tissue loss) and is associated with impaired quality of life and significant morbidity and mortality.1,2 Management strategy is dictated by clinical presentation and is usually a combination of medical treatment and percutaneous or surgical approaches. Despite improving clinical outcomes and advances in transcatheter therapeutics, as of yet there is no clearly defined "gold standard" for percutaneous strategies in the lower extremity vascular space. Stenting of femoropopliteal lesions is associated with longer patency rates (up to 85% at 1 year) compared with traditional balloon angioplasty, especially in long lesions.3

CASE DESCRIPTION

A 61-year-old man with significant vascular disease presented with a nonhealing wound of the left great toe amputation site (Rutherford VI). He had undergone bilateral superficial femoral artery (SFA) and below the knee (BTK) interventions in the past 2 years. Access was obtained in the right common femoral artery (CFA) with a micropuncture needle (Vascular Solutions) and a short 6Fr sheath (Glide Sheath, Terumo) inserted. After contralateral crossover with an 0.035” wire (Advantage, Terumo) and a 4Fr catheter (Contra Flush, Boston Scientific), digital subtraction angiography revealed aggressive in-stent restenosis (ISR) of 2 overlapping SFA stents (Figure 1) with single diseased posterior tibial artery (PT) runoff to the foot. After review, in the setting of critical limb ischemia (CLI), the decision was made to

Figure 1. (A) ISR of two overlapping SFA stents with plain fluoroscopy, and (B) contrast angiography.
achieve luminal gain utilizing imaging-guided directional atherectomy (DA) (Pantheris, Avinger) and balloon angioplasty of the SFA ISR.

The 6Fr sheath was exchanged for a crossover 7Fr 55cm sheath (Ansel, Cook Medical) over the 0.035” wire. After anticoagulation, the DA catheter was prepped and advanced over a 300 cm 0.014” wire (Fielder XT, Asahi). A thick layer of neointimal hyperplasia was noted on the optical coherence tomography (OCT) imaging with adequate visualization of the stent struts (Figure 2). After a second run of atherectomy, the cutter was closed with intention to remove and empty the receptacle. The OCT imaging shows the cutter to be away from stent struts (Figure 3), but the catheter was unable to be retrieved. On fluoroscopic imaging, the cutter seemed to be hooked onto the proximal edge of the distal stent at the overlap of the stents (Figure 4). Despite multiple attempts, the catheter could not be retrieved with gentle traction.

At this point, the plan was to attempt to dislodge the atherectomy catheter from the stent struts by adjacent balloon inflation. However, there was not enough room to advance a balloon adjacent to the atherectomy catheter. Antegrade left CFA access was then obtained to facilitate wire escalation and advancement of additional catheters and guidewires across the trapped catheter segment. A 300 cm 0.018” wire (V18, Boston Scientific) was advanced along with a 0.018” microcatheter (QuickCross, Spectranetics) past the region where the device was caught on stent struts, and a 3.0 x 60 mm balloon (Advance 18LP, Cook) was inflated adjacent to the catheter (Figure 5) to loosen the atherectomy device from the stent struts. The catheter came loose upon gentle traction after the balloon was deflated. Subsequent angiography revealed no perforation in the SFA but with mangled stent struts (Figure 6).
Balloon angioplasty (6.0 mm x 60 mm Sterling, Boston Scientific) and stenting (6.5 mm x 60 mm Supera, Abbott) was performed to plaster the damaged stent struts against the vessel wall with satisfactory angiographic result (Figure 7). The patient was discharged home the following day without complications.

**DISCUSSION**

DA utilizes rotating carbide discs to excise atherosclerotic plaque and capture the material in a nose cone or receptacle. DA is usually used in conjunction with balloon angioplasty to minimize plaque shift and avoid stent placement. This form of atherectomy avoids barotrauma, minimizes dissection, and possibly reduces neointimal hyperplasia. Distal embolization remains a significant concern, and the use of an embolic protection device might be prudent, if feasible. SilverHawk, TurboHawk, HawkOne (Medtronic) and OCT-guided Pantheris (Avinger) devices are currently approved by the US Food and Drug Administration and available in the United States.

Initial experience with SilverHawk DA for femoropopliteal lesions was found to be in favor of de novo lesions compared with restenotic lesions (primary patency rates of 74%, 42%, and 49% for de novo, restenotic, and ISR lesions, respectively, at 18 months). The 6 and 12-month rates of survival free target lesion revascularization (TLR) were 90% and 80%, respectively, in the TALON registry (included claudicants and CLI with femoropopliteal and infrapopliteal lesions). In multivariate analysis, significant predictors of TLR at 6 months were lesion length (3-fold increase for lesions > 50 mm), multiple lesions, coronary artery disease needing revascularization, and increasing Rutherford category. The largest prospective study (DEFINITIVE LE) examined the use of the SilverHawk and TurboHawk devices in infrapinguinal lesions in both claudicants and CLI. Reported device success was 89% with bailout stenting in 3.2%. Rates of perforation, distal embolization, and abrupt closure were 5.3%, 3.8%, and 2%, respectively. At 12 months, primary patency rates were 78% in claudicants (95% confidence interval (CI): 74.0% to 80.6%) and the rate of freedom from major amputation was 95% in CLI patients (95% CI: 90.7% to 97.4%). TLR rates were similar in diabetics and nondiabetics.

The Pantheris catheter is a unique DA catheter utilizing OCT imaging to perform more precise plaque excision avoiding injury to the deeper wall structures (adventitia) and normal arterial wall. Histologic analysis of tissue specimens showed either no adventitia (62.4% of samples) or very little adventitia (<1% in 82.9% of the...
samples) in the VISION trial. There is some evidence that disruption of adventitial and medial layers results in a loss of patency and lesion reocclusion. The VISION trial met its primary endpoint, a composite major adverse event rate of 16.6% with clinically driven TLR rate of 7.9% at 6 months. Stenosis reduction was 78.7% ± 15.1% at baseline to 30.3% ± 11.8% after Pantheris alone \( (P<.001) \) and to 22.4% ± 9.9% after Pantheris ± adjunctive therapy (mainly being angioplasty) \( (P<.001) \). There was a 4% rate of device-related events (no major perforations, <1% dissection and 2% distal embolization), and only 5% of patients needed bailout stenting.

In both the above prospective studies, ISR was excluded. Trentmann et al used the SilverHawk device for treatment of ISR in the femoropopliteal segments and had high rates of initial success but saw a drastic drop in patency rates from 86% at 3 months to 25% at 12 months. The rate of major complications was 18%, driven by distal embolization. In small studies, the advantage of debulking neointimal hyperplasia did not prevent recurrent hyperplasia. The pathophysiology of plaque characteristics after directional atherectomy in the de novo lesion and ISR remains elusive. Whether recurrent ISR in these patients is due to inadequate debulking or need for pharmacologic inhibition of neointimal hyperplasia is unknown. There is not enough evidence to establish the safety of directional atherectomy for ISR.

However, being able to visualize the vessel with the lumivascular technology is clearly appealing and suggestive of safe passage. Distal embolization remains a major concern (especially atherectomy for ISR), and questions the need for embolic protection every time (filter was used only in 22% of patients in the DEFINITIVE LE trial). Unprecedented complications can arise, which require expertise and catheter skills and may lead to the possibility of open vascular surgery in these high-risk patients.

DA in ISR lesions have been contraindicated due to the potential risk of cutter entrapment on stent struts during atherectomy. However, with the advent of concurrent imaging during DA, this risk can potentially be avoided. Nevertheless, as seen in this case, despite adequate visualization with OCT imaging, there can be significantly malapposed stent struts in overlapped segments that may still pose a risk for trapping the DA catheter. In such scenarios, the use of adjunctive balloon angioplasty adjacent to the catheter may free the device from the stent struts as demonstrated in this case.

CONCLUSION

In summary, OCT-guidance during DA of ISR provides intravascular real-time visualization of stent struts to avoid trapping the cutter on stent struts. However, if it were to occur in malapposed struts in overlapped segments, one needs to be well-versed on options such as balloon-assisted dislodgement of an entrapped catheter, as employed in this case, to avoid disastrous complications.

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