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Case report

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Orbital Atherectomy Combined with Lithotripsy in a Right Coronary Artery Chronic Total Occlusion

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A szerző
video-összefoglalója

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Percutaneous coronary intervention (PCI) of chronic total occlusions (CTOs) can be challenging, especially if the CTOs are balloon uncrossable or balloon undilatable. We present a case illustrating that, orbital atherectomy may need to be combined with intravascular lithotripsy for CTOs that are both balloon uncrossable and undilatable.

Keywords: percutaneous coronary intervention, chronic total occlusion, lithotripsy, orbital atherectomy

Introduction

Balloon uncrossable lesions are defined as lesions that cannot be crossed with the first balloon after successful advancement of the guidewire distal to the lesion. Approximately 9% of all chronic total occlusions (CTOs) undergoing percutaneous coronary intervention (PCI) are balloon uncrossable (1). Balloon undilatable lesions are lesions that cannot be dilated despite high-pressure balloon inflation and they represent 8.5% of CTO lesions (2). Several techniques can be used to treat balloon uncrossable and undilatable lesions, such as small balloons, balloon-assisted microdissection, use of various microcatheters, laser and rotational atherectomy (3), intravascular lithotripsy (4), use of guide catheter extensions and guide anchoring techniques. A combination of techniques may be needed, especially for lesions that are both balloon uncrossable and undilatable.

Case Report

An 81-year-old man presented with medically refractory stable angina and worsening left ventricular ejection fraction (LVEF) and was referred for revascularization of a right coronary artery (RCA) chronic total occlusion (CTO, *Figure 1. A*). The patient had undergone coronary artery bypass surgery 18 years prior and numerous percutaneous coronary interventions (PCIs) with recurrent failure of the saphenous vein graft (SVG) to the posterior descending artery (PDA). The most recent in-stent restenosis and PCI of the SVG-PDA with brachytherapy was 7 months prior.
Antegrade wiring of the native RCA was attempted with a Pilot 200 (Abbott Vascular, Chicago, Illinois, USA) guidewire (GW) and a Turnpike microcatheter (Teleflex, Wayne, Pennsylvania, USA). The Pilot 200 crossed from true-to true lumen into the right posterolateral (PL) branch, but a 2.0 mm balloon could not

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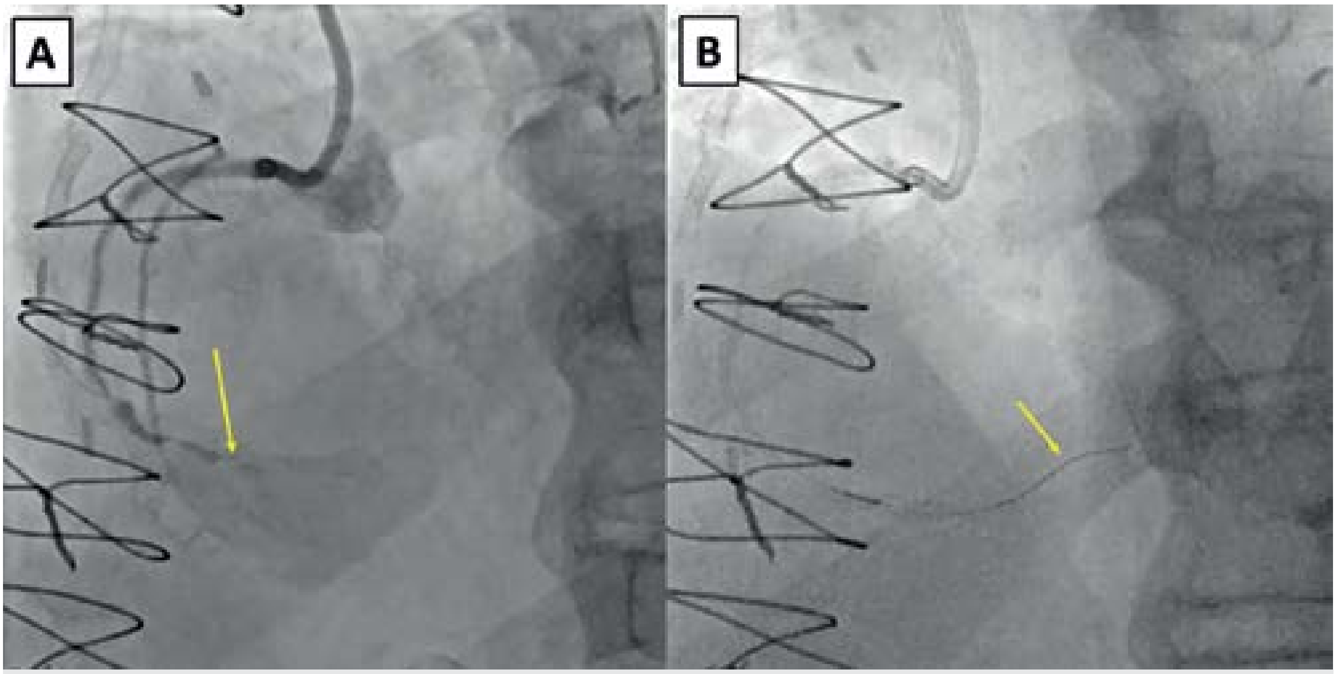

FIGURE 1. A. Right coronary artery (RCA) chronic total occlusion (CTO); B: The Pilot 200 wire crossed from true-to true lumen to the posterolateral (PL) branch

follow *(Figure 1. B)*. The Turnpike microcatheter was advanced into the PL *(Figure 2. A)*. The Pilot 200 wire was exchanged for a Viper flex tip guidewire and multiple runs of orbital atherectomy were performed with a 1.25 mm crown (Cardiovascular Systems, Inc., St. Paul, Minnesota, USA, *Figure 2. B*). A 2.0 mm balloon subsequently crossed and the lesion was predilated. A 3.0 mm balloon was delivered through a guide extension but the lesion was balloon undilatable and could not be dilated with additional non-compliant (NC) balloons inflated up to 26 atm *(Figure 3. A)*. Orbital atherectomy was repeated but the lesion remained undilatable. Intravascular lithotripsy (IVL, Shockwave Medical Inc., Santa Clara, California, USA) was performed with a

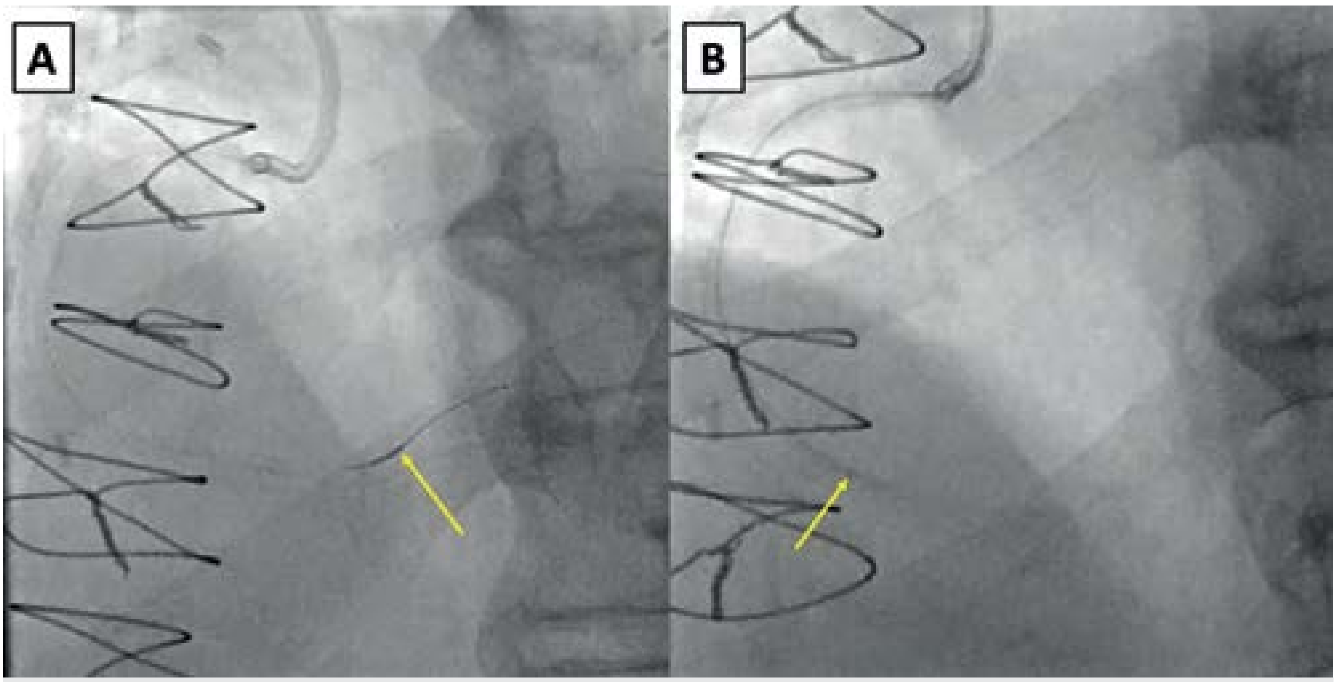

FIGURE 2. A: The Turnpike microcatheter crossed the balloon uncrossable lesion; B: Orbital atherectomy with a 1.25 mm crown

3.0×12 mm balloon, successfully expanding the lesion *(Figure 3. B)*, as confirmed by intravascular ultrasound *(Figure 4. A)*. Three drug-eluting stents (DES) were implanted and the lesion was postdilated with NC balloons with a nice final result *(Figure 4. B).* The SVG was occluded with two Ruby coils (Penumbra Inc. Alameda, California, USA, *Figure 5. A*). Angiography and intravascular ultrasound (IVUS) revealed TIMI 3 flow, well expanded stents in the RCA *(Figure 5. B)* and no antegrade flow in the SVG.

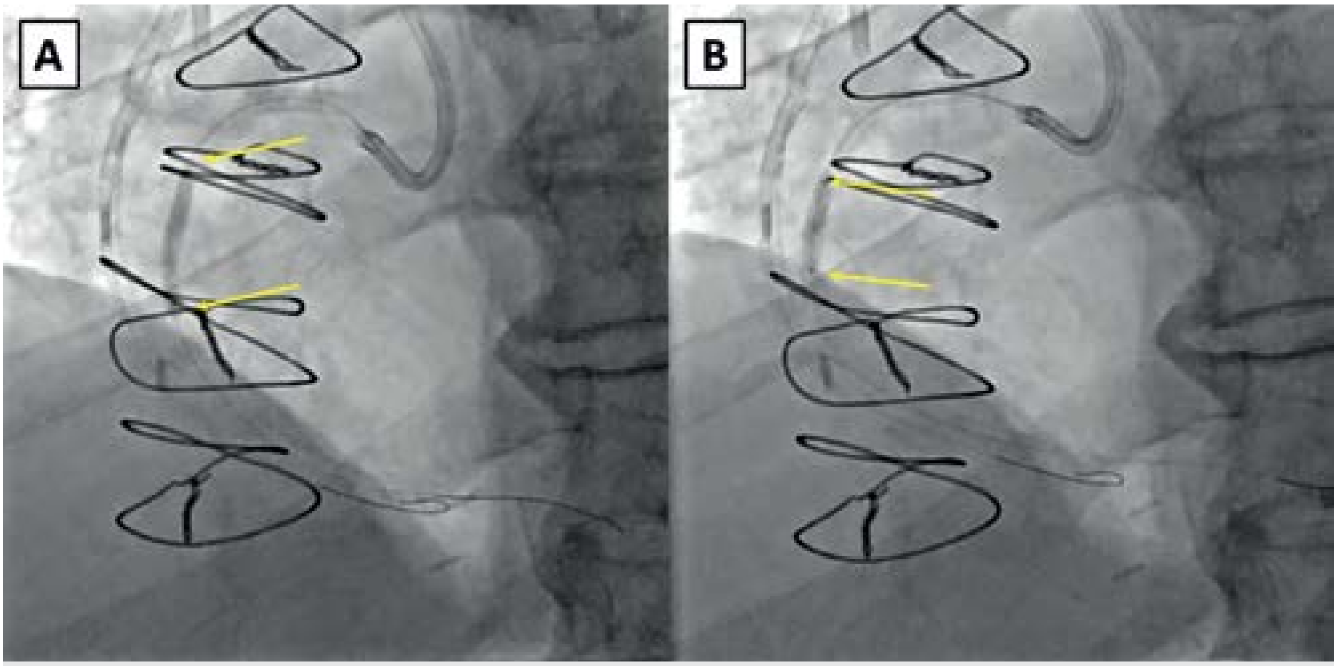

FIGURE 3. A: Balloon undilatable lesion; B: Intravascular lithotripsy with 3.0×12 mm balloon

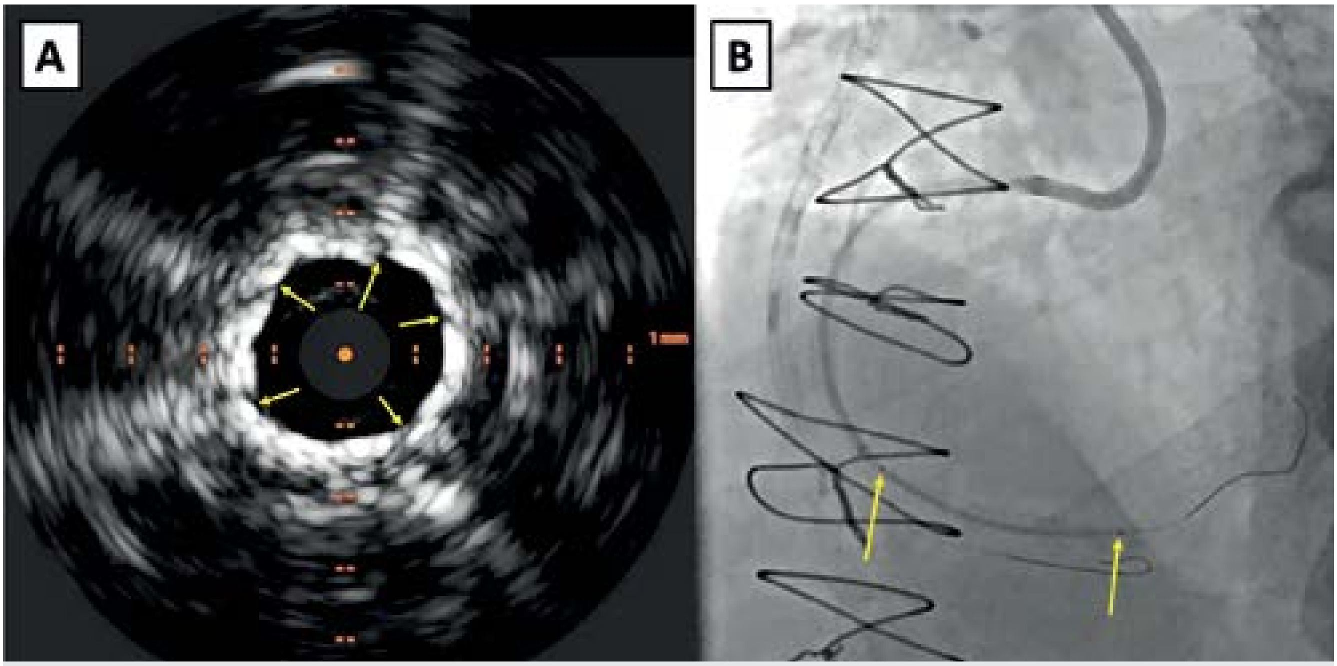

FIGURE 4. A: Intravascular ultrasound (IVUS), arrows indicating the broken calcium after orbital atherectomy and intravascular lithotripsy. B: Implantation of 3 drug-eluting stents (DES)

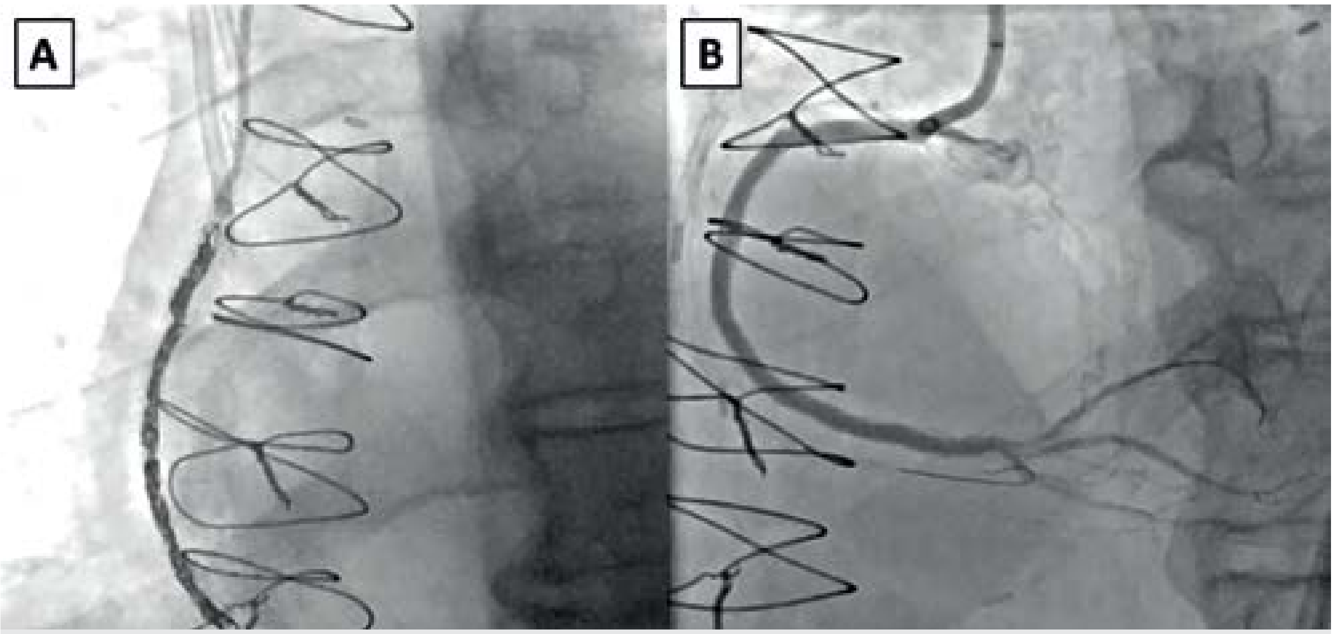

FIGURE 5. A. Saphenous vein graft (SVG) occluded with coiling; B: Final result

Discussion

Approximately 9% and 8.5% of all CTO lesions undergoing PCI are balloon uncrossable (1) or balloon undilatable (2), respectively, and are associated with lower technical success and higher incidence of major adverse events. They often require specialized equipment and operator skills. Our case illustrates that orbital atherectomy may need to be combined with intravascular lithotripsy for lesions that are both balloon uncrossable and undilatable. Occluding the SVG after recanalization of the corresponding native vessel CTO may reduce the risk of native coronary artery stent thrombosis.

Balloon uncrossable and undilatable lesions are often severely calcified. Calcified coronary artery lesions are associated with difficult stent delivery, suboptimal stent expansion, increased periprocedural complications, worse long-term outcomes (higher rates of target vessel and target lesion revascularization and stent thrombosis) (5–7). Two recognized types of coronary calcification are atherosclerotic/intimal and medial artery calcification. Intimal artery calcification is caused by inflammatory mediators and elevated lipid content inducing osteogenic differentiation of the vascular smooth muscle cells. Medial calcification is associated with advanced age, diabetes, and chronic kidney disease (8). Medial coronary calcification was previously considered to be a benign process, but it contributes to arterial stiffness, which increases risk for adverse cardiovascular events (9). Moderate/severe calcification is also a component of the PROGRESS-CTO complication score and it is associated with increased MACE, mortality and pericardiocentesis (10).

Intravascular imaging (IVUS and optical coherence tomography-OCT) are essential to identify the degree and location of calcification, as illustrated by our case. IVUS detects calcification within the deeper layers (media or adventitia) of the vessel wall because of the higher penetration. However, due to acoustic shadowing IVUS only identifies presence of the calcific arch, without offering insights into thickness of a calcium. OCT on the other hand provides additional measurable parameters of calcium, such as calcium area, calcium thickness, calcium length, and calcium 3-dimensional volume (11). These imaging modalities not only identify calcium, but also can assess the likelihood of success of plaque modification techniques, including the distinctive features of calcified plaque modification by lithotripsy compared with rotational atherectomy or orbital atherectomy. OCT analysis has demonstrated that rotational and orbital atherectomy (12) modify calcium in the shape of a relatively smooth lumen with a cylindrical shape (groove) that follows the guidewire course (guidewire bias), with relatively small increases in cross-sectional area (13, 14). Therefore, in tortuous lesions or eccentric plaque, this could lead to tunnel or crater formation, increasing the risk of perforation. Meanwhile, IVL provides circumferential plaque modification, with the potential advantage of uniform energy distribution and thus uniform plaque modification, which could reduce asymmetry and eccentricity (14). Combining orbital atherectomy with IVL could benefit with the treatment of both superficial calcium and deep calcium. Moreover since the deliverability of the IVL balloon is limited, orbital atherectomy could assist with equipment delivery in balloon uncrossable lesions and subsequently IVL can help achieve lesion expansion.

There is limited data on the combination of orbital atherectomy with lithotripsy. A case report presenting a heavily calcified, left main lesion with significant stenosis described the "orbital-tripsy" technique, orbital atherectomy after failed IVL (15). A recently published case series presented eight patients who underwent combined coronary orbital atherectomy and IVL within a single PCI procedure with severely calcified lesions. In these cases, the visually estimated mean percent diameter stenosis by angiography prior to any intervention was 80.5 ± 8.3% and all target lesions had concentric circumferential CAC. There was only one case with a CTO lesion, where procedural success was not achieved initially due to a dissection but was achieved but was after 6 weeks in a second procedure. There were no major cardiac adverse events in hospital or at 30 days (16).

Conclusion

Our case demonstrates that orbital atherectomy may need to be combined with intravascular lithotripsy for chronic total occlusion lesions that are both balloon uncrossable and undilatable.

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Conflicts of Interest

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