Case Report

Interventional Cardiology

Use of the retrograde approach for treating a 'balloon-uncrossable' coronary chronic total occlusion

'Balloon uncrossable' chronic total occlusions are lesions that cannot be crossed with a balloon after successful guidewire crossing. We describe a case where the retrograde approach was used to successfully cross and treat a 'balloon uncrossable' chronic total occlusion.

Keywords: chronic total occlusion • complications • outcomes • percutaneous coronary intervention

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'Balloon uncrossable' chronic total occlusions (CTOs) are lesions that cannot be crossed with a balloon after successful guidewire crossing [1]. A recently proposed algorithm summarizes the techniques that can be used to successfully recanalize these challenging lesions (Figure 1). We describe a case where the retrograde approach was used to successfully cross and treat a 'balloon uncrossable' CTO.

Case description

An 89-year-old man with a history of diabetes mellitus and aortic stenosis presented with stable angina and dyspnea on exertion (New York Heart Association class II) despite medical treatment with an angiotensin-converting enzyme inhibitor, a long-acting nitrate, a β-blocker and a diuretic. Coronary angiography demonstrated a heavily calcified mid-right coronary artery (RCA) CTO (Figure 2A & B) and ostial CTO of the left circumflex. Right heart catheterization documented low gradient aortic stenosis with augmentation of cardiac output with dobutamine. A previous attempt to recanalize the RCA CTO as the patient remained symptomatic despite maximal medical treatment 2 months prior was unsuccessful, in spite of successful guidewire crossing, due to failure of balloons to cross the lesion.

Bilateral femoral arterial access was obtained with 8 Fr sheaths. The RCA was engaged with an 8 Fr AL1 guide and the left main with a 6 Fr XB 3.5 guide. The RCA CTO was wired successfully with a Pilot 200 (Abbott Vascular, CA, USA) wire, but a Corsair and a Tornus microcatheter (Asahi Intecc, Nagoya, Japan) could not cross the lesion (Figure 2C) in spite of using a 2.0 × 20 mm anchor balloon in an acute marginal branch (side branch anchor; Figure 2D). Multiple crossing attempts with small (1.20–1.5-mm diameter balloons) failed, as did intentional balloon rupture (grenadoplasty). Multiple passes with a 0.9-mm laser catheter failed to enable subsequent balloon crossing, as did the rotational atherectomy guidewire (Table 1).

Retrograde guidewire crossing was successful with a Fielder FC guidewire (Asahi Intecc) through the first septal into the distal RCA (Figure 2E). Using the reverse controlled antegrade and retrograde tracking and dissection, a Confianza Pro-12 guidewire (Asahi Intecc) crossed into the proximal true lumen and was successfully snared (Figure 2F), enabling advancement of the Corsair catheter into the antegrade guide and externalization of a Viper guidewire (CSI, MN, USA). A 2.0 × 20 mm balloon was easily delivered across the CTO and the RCA was stented with drug-eluting stents (Figure 2G). After postdilation, a perforation at the site of the mid RCA lesion was noted (Figure 2H) and was successfully treated with balloon (3.0 × 10 mm) occlusion at

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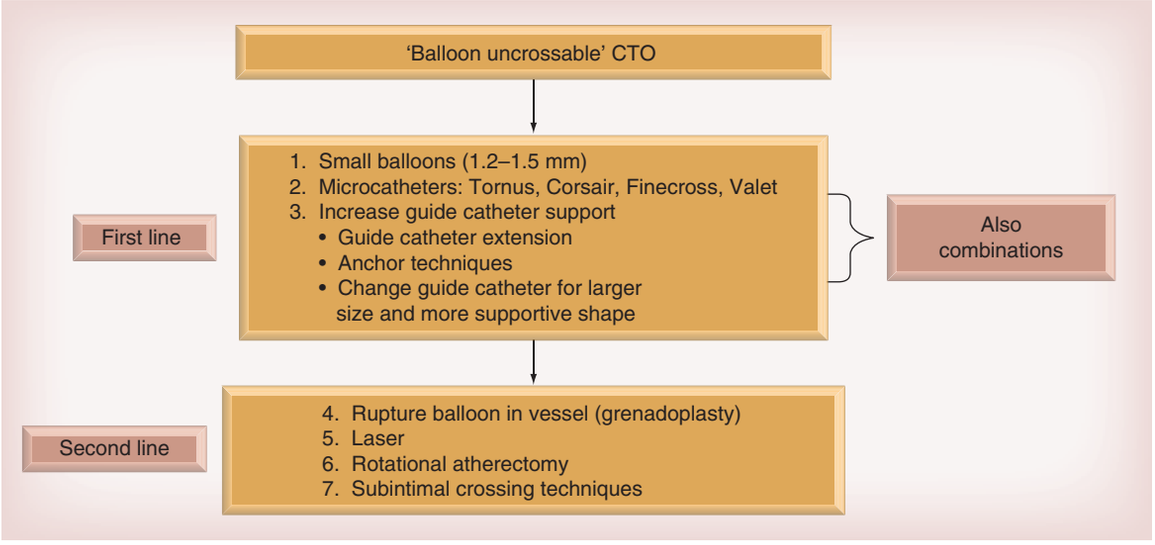

Figure 1. Algorithm for approaching 'balloon uncrossable' chronic total occlusions.
CTO: Chronic total occlusion.
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10 atm for 30 s (Figure 2I). The patient remained hemodynamically stable. The final angiographic result was excellent (Figure 2J), with no residual contrast exravasation, and no pericardial effusion at transthorathic echocardiography. At 1-month follow-up, the patient's symptoms had significantly improved.

Discussion

'Balloon uncrossable' CTOs are relatively infrequent, but can be challenging to treat. A systematic and escalating utilization of increasingly aggressive techniques can maximize the likelihood of success and has been recently summarized in an algorithm (Figure 1) [1].

Initially one or more 'fresh' small diameter balloons are used to cross, preferably of long lengths, since the mid marker is the highest profile point in the balloon. If the balloons fail to cross they are inflated, as this can sometimes modify the proximal cap and allow advancement of the same or a new balloon. If this fails, various microcatheters, such as the Tornus [2] and Corsair (Asahi Intecc) or Finecross (Terumo, NJ, USA) can sometimes advance through the lesion. Concomitant use of techniques that increase guide catheter support (e.g., use of a guide catheter extension [3,4] and use of side-branch anchoring [5]) can facilitate crossing with balloons of microcatheters [1]. If those maneuvers fail, more aggressive techniques are utilized, such as intentional balloon rupture within the lesion (i.e., 'grenadoplasty' or 'balloon-assisted microdissection' [1]), use of laser [6] and rotational atherectomy (if a Rotawire [Boston Scientific, MA, USA] can be advanced through the lesion) [7]. Since these techniques may carry higher risk for procedural complications, such as coronary perforation or aortocoronary dissection, they should only be applied by highly experienced operators. Finally subintimal crossing techniques can be used in an attempt to cross the lesion through a path of least resistance [1,8]. We recently described a novel 'subintimal distal anchor' technique, in which a second coronary guidewire is advanced through the subintimal space, distal to the occlusion site and is inflated to 'anchor' the guidewire that has crossed into the distal true lumen and facilitate balloon crossing [9]. Another technique, the 'wire-cutting' technique, involves inserting two guidewires (A and B) into the distal true lumen, followed by advancing a balloon over guidewire A to the site of the occlusion abutting the proximal cap. The balloon is then inflated pressing guidewire B between the balloon and the proximal cap, followed by rapid withdrawal of guidewire B that 'cuts' the proximal cap facilitating balloon crossing [10].

Achieving success in CTO percutaneous coronary intervention often requires flexibility and creativity as each CTO is unique. In our case, all of the above techniques failed to enable balloon crossing of the CTO. We hypothesized that retrograde wire crossing and externalization would provide strong support enabling balloon crossing. This could be further facilitated by lesion modification achieved during the reverse controlled antegrade and retrograde subintimal tracking technique application [11]. Our hypothesis proved to be correct and the 'balloon uncrossable' CTO was easily crossed with a balloon, enabling successful stenting of the CTO.

The retrograde approach has revolutionized CTO percutaneous coronary intervention [12,13], but should only be used a 'last-resort' effort to treat 'balloon uncrossable' CTOs for multiple reasons. First, implementation of the retrograde approach requires: availability of appropriate 'interventional' collaterals [12]; local expertise in using

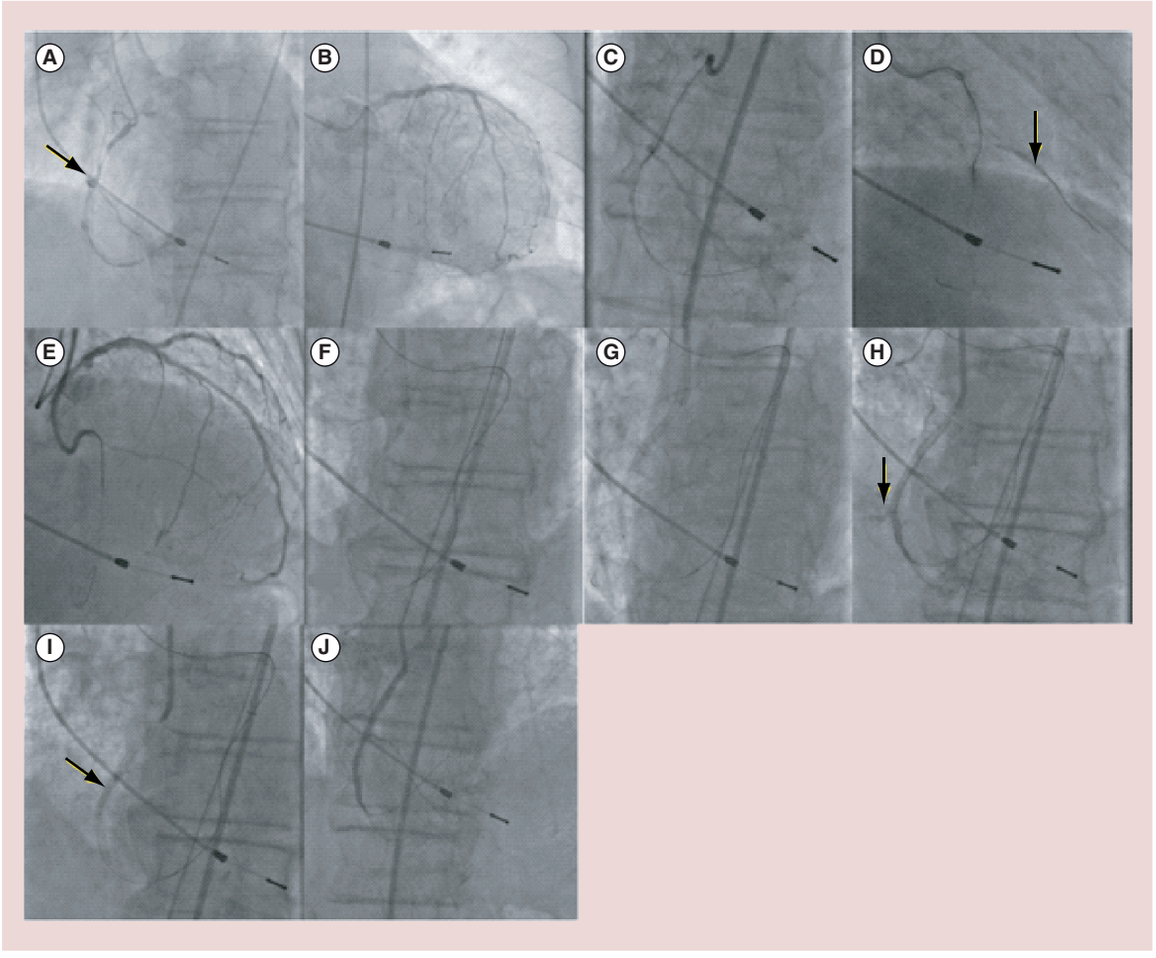

Figure 2. Step-by-step interventional management of a 'balloon uncrossable' chronic total occlusion. (A) Right coronary artery chronic total occlusion (CTO; arrow) with **(B)** filling of the distal right coronary artery via collaterals from the left anterior descending artery. **(C)** The right coronary artery CTO was successfully crossed with a Pilot 200 guidewire (Abbott Vascular, CA, USA), but **(D)** a microcatheter or balloon could not be advanced through the lesion in spite of using a side branch anchor technique (arrow) and a guide catheter extension. **(E)** Retrograde crossing of the first septal collateral was achieved with a Fielder FC guidewire (Asahi Intecc, Nagoya, Japan), followed by **(F)** crossing with a Corsair microcatheter (Asahi Intecc). After wire externalization, **(G)** the CTO was successfully predilated and stented. **(H)** A perforation was noted after stent postdilation, which sealed off after **(I)** repeat balloon inflation, **(J)** with an excellent final result.

the retrograde approach; availability of dedicated equipment, such as microcatheters and long guidewires [12]; and not exceeding the radiation and contrast limits during the antegrade part of the procedure [12]. Second, the retrograde approach has inherent risks, such as donor vessel injury, ischemia, myocardial infarction [14] and collateral vessel perforation (which is of special concern when epicardial collaterals are being used) [15]. A small perforation occurred during stent postdilation in our case, although it is unclear whether it was related to use

Table 1. Summary of antegrade crossing attempts that failed to cross the chronic total occlusion in our case.

No. of attempt	Strategy
1	Corsair and Tornus microcatheter (Asahi Intecc, Nagoya, Japan)
2	Anchor balloon in side branch
3	Small diameter balloons
4	Grenadoplasty: intentional balloon rupture
5	Laser catheter

of the retrograde approach or to the antegrade crossing attempts [16].

Conclusion & future perspective

In summary, the retrograde approach can be a useful 'last-resort' technique for successfully recanalizing 'balloon uncrossable' CTOs.

Financial & competing interests disclosure

ES Brilakis receives: consulting honoraria/speaker fees from Sanofi, Janssen, St Jude Medical, Terumo, Asahi Intecc, Abbott Vascular and Boston Scientific; and a research grant from Guerbet. His spouse is an employee of Medtronic. The authors have no other relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript. This includes employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties.

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Informed consent disclosure

The authors state that they have obtained verbal and written informed consent from the patient/patients for the inclusion of their medical and treatment history within this case report.

Executive summary

- 'Balloon uncrossable' chronic total occlusions can be challenging to treat.
- Using a stepwise treatment algorithm can optimize the likelihood of successfully recanalizing these lesions.
- The retrograde approach can be a useful 'last-resort' technique for successfully recanalizing 'balloon uncrossable' chronic total occlusions.

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