Journal of
Transcatheter Interventions
e-ISSN e-2595-4350

How to cross the uncrossable lesions in chronic total occlusion

Como cruzar lesões intransponíveis na oclusão crônica

Rohit Mody[1iD], Abha Bajaj Nee Sheth[2iD], Lakshay Rastogi[3iD], Debabrata Dash[4iD], Bhavya Mody[5iD], Inderjeet Singh Monga[6iD]

[1] *Department of Cardiology, Max Super Specialty Hospital, Bathinda, Punjab, India.*
[2] *Department of Anatomy, Dr. Harvansh Singh Judge Institute of Dental Sciences & Hospital, Panjab University, Chandigarh, India.*
[3] *Department of Cardiology, Kasturba Medical College, Manipal, India.*
[4] *Department of Cardiology, Aster Hospital, Mankhool, Dubai, Al Quasis, United Arab Emirates.*
[5] *Department of Medicine, Kasturba Medical College, Manipal, Karnataka, India.*
[6] *Department of Cardiology, Command Hospital Chandimandir, Panchkula, Haryana, India.*

DOI: 10.31160/JOTCI202331A20230008

ABSTRACT - Coronary chronic total occlusion occurred in approximately 15 to 20% of patients. The most common challenges associated with successful percutaneous coronary intervention in chronic total occlusion are undilatable and uncrossable lesions. Uncrossable lesions are characterized as those lesions in which the balloon cannot cross the lesion. These types of lesions are commonly seen in calcified and tortuous arteries, and in chronic total occlusion. Various techniques, such as side branch anchoring, rotational, orbital, or laser atherectomy can be used to treat these challenging lesions. In this article, we describe the tips and tricks which can be commonly used to cross uncrossable lesions.

Keywords: Coronary occlusion; Percutaneous coronary intervention; Angioplasty, balloon, coronary; Atherectomy, coronary; Coronary angiography

RESUMO - A oclusão coronariana crônica ocorre em aproximadamente 15 a 20% dos pacientes. Os problemas mais comuns associados à intervenção coronária percutânea bem-sucedida na oclusão crônica são lesões não dilatáveis e intransponíveis. As lesões intransponíveis são caracterizadas como aquelas em que o balão não consegue cruzar a lesão. Esses tipos de lesões são comumente vistos em artérias calcificadas e tortuosas e na oclusão crônica. Várias técnicas, como ancoragem de ramo lateral, aterectomia rotacional, orbital ou a *laser*, podem ser usadas para tratar essas lesões desafiadoras. Neste artigo, descrevemos dicas e truques que podem ser comumente usados para cruzar lesões intransponíveis.

Descritores: Oclusão coronária; Intervenção coronária percutânea; Angioplastia coronária com balão; Aterectomia coronária; Angiografia coronária

INTRODUCTION

Coronary artery chronic total occlusions (CTO) are routinely encountered in a great number of patients presenting with coronary artery disease (CAD) and emerged as the major challenging target lesion for treatment. Approximately one-third of patients undergoing diagnostic coronary angiography are reported with CTO. In comparison to the interventions used in non-CTO stenoses, percutaneous coronary interventions (PCI) in CTO are associated with various drawbacks, such as reduced procedural success, higher complications rate, and greater radiation exposure.[1] However, the latest advancements in interventional techniques used for crossing CTO have led to a marked rise in success rate of percutaneous treatment.[2] With several new advancements and tools, experienced operators can perform CTO-PCI quite successfully in patients.

The most common reason for failure of PCI of CTO is inability to cross the lesion with a guidewire,[3] followed by unsuccessful attempts to cross CTO (uncrossable lesions), reported in 10% of cases.[4] Difficult CTO lesions were the last frontier for PCI, since they required advanced intervention methods, and various devices. Many advanced technologies, such as Corsair® microcatheter, rotational atherectomy (RA), knuckle wire technique (KWT), can be used to treat patients presenting with uncrossable and undilatable lesions. Combination of these technologies can provide successful clinical outcomes in PCI.[5] An algorithm approach should be used for the management of these type of lesions. Knowledge of these advanced methods can potentiate the safety and efficacy of the procedure.[6]

How to cite this article:
Mody R, Sheth AB, Rastogi L, Dash D, Mody B, Monga IS. How to cross the uncrossable lesions in chronic total occlusion: a case series. J Transcat Intervent. 2023;31:eA20230008. https://doi.org/10.31160/JOTCI202331A20230008

Corresponding author:
Rohit Mody
Max Super Speciality Hospital Mansa Rd, Guru Ki Nagri
151001 – Bathinda, Punjab, India
E-mail: drmody_2k@yahoo.com

Received on:
Jun 6, 2023

Accepted on:
Sep 4, 2023

CASE REPORTS

Case 1

A 73-year-old female patient came with history of angina (AOE) and dyspnea upon exertion, both grade 3. The left ventricle ejection fraction was 35%, showing regional wall motion abnormality in the right coronary artery (RCA) territory.

Angiography showed RCA CTO with J-CTO score 2.

The lesion was crossed with XTA (Asahi® Kasei; Chiyoda-Ku, Tokyo, Japan) wire. The NIC Nano® (SIS Medical; Winterthur, Switzerland) CTO balloon 0.8x8mm was tried to cross the lesion, but failed (Figure 1A), and other CTO balloons also failed. The workhorse wire was exchanged by a rota-wire, and then drilling was done with 2.5mm rota burr at 150 thousand rotations per minute (Figure 1B). The lesion was crossed successfully with a rota burr. Finally, two drug-eluting stents (DES) (3.5x20mm SMT Supraflex Cruz™ SMT, Surat, Gujrat, India, and 3.5x34mm Resolute™ Integrity, Medtronics, Minneapolis, Minnesota, United States) were deployed from distal to proximal lesion and post-dilated with 3.5x15mm non-compliant balloon (Figure 1).

Case 2

A 61-year-old male with a history grade 3 AOE and left ventricular (LV) dysfunction. The patient left ventricle ejection fraction was 36% showing regional wall motion abnormality in the left anterior descending (LAD) artery territory.

Angiography revealed CTO in mid-LAD with J-CTO score 2.

An initial unsuccessful attempt was made to cross the occluded lesion in LAD by using different CTO balloons (Figure 1D). A Corsair® microcatheter (Asahi®) crossed the lesion and a rota floppy wire was placed (Figure 1E). Atherectomy was employed with a 2.5-mm rota burr at 200 thousand rotations/minute. The lesion was crossed successfully with this technique, and finally, two DES (2.5x22mm Resolute™ Integrity and 2.75x30mm Resolute™ Integrity) were deployed in the patient with post-dilation with 3x15mm NC balloon (Figure 2F).

Case 3

A 74-year-old diabetic, hypertensive and obese male patient with history of AOE grade-3 with normally functioning LV.

Angiography confirmed CTO in RCA.

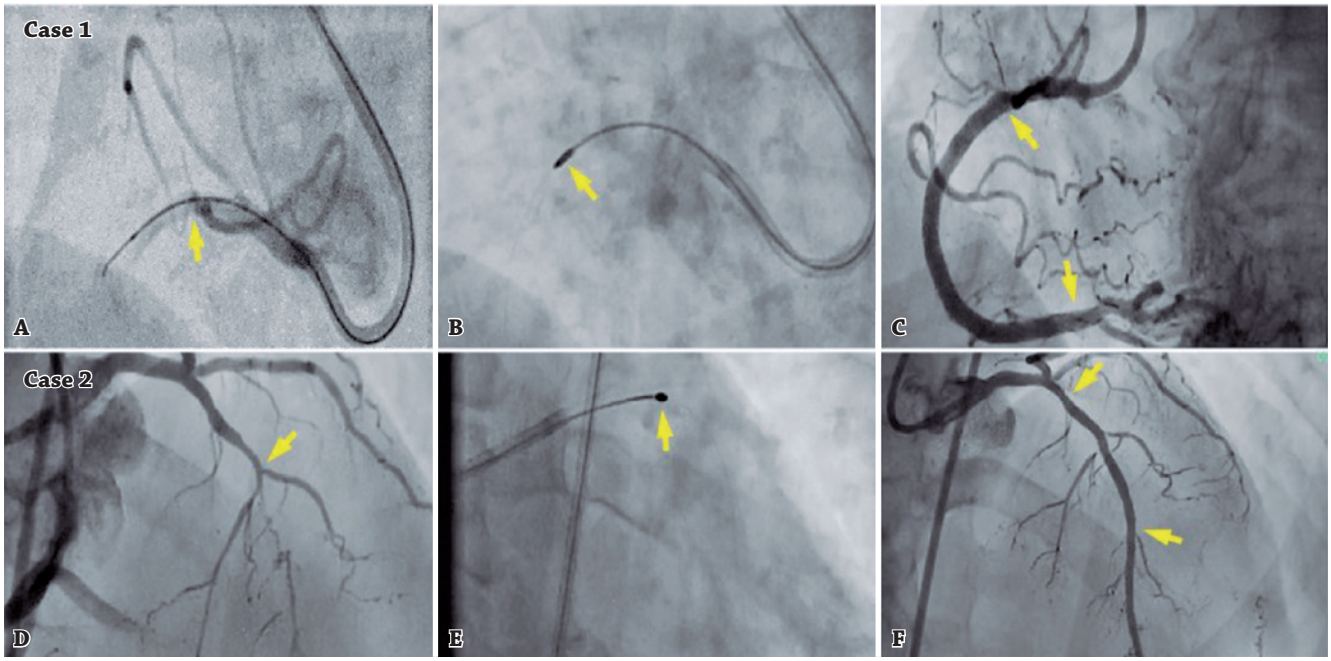

Figure 1. Case 1: uncrossable calcified lesion present in right coronary artery crossed with rota burr. Crossing of occluded right coronary artery by using rota burr. (A) Unsuccessful attempt of crossing occluded lesion present in right coronary artery by using chronic total occlusion balloon. (B) Successful crossing of occluded lesion by using rota burr. (C) Deployment of drug-eluting stent successfully. Case 2: uncrossable lesion in left anterior descending artery crossed with Corsair® microcatheter and rota burr. Corsair® microcatheter and rota used to cross the occluded lesion in left anterior descending artery. (D) Unsuccessful attempt of crossing the occluded lesion present in left anterior descending artery by using balloon. (E) Successfully crossing of occluded lesion by using Corsair® microcatheter and rota burr. (F) Deployment of drug-eluting stent successfully in occluded lesion patient in left anterior descending artery.

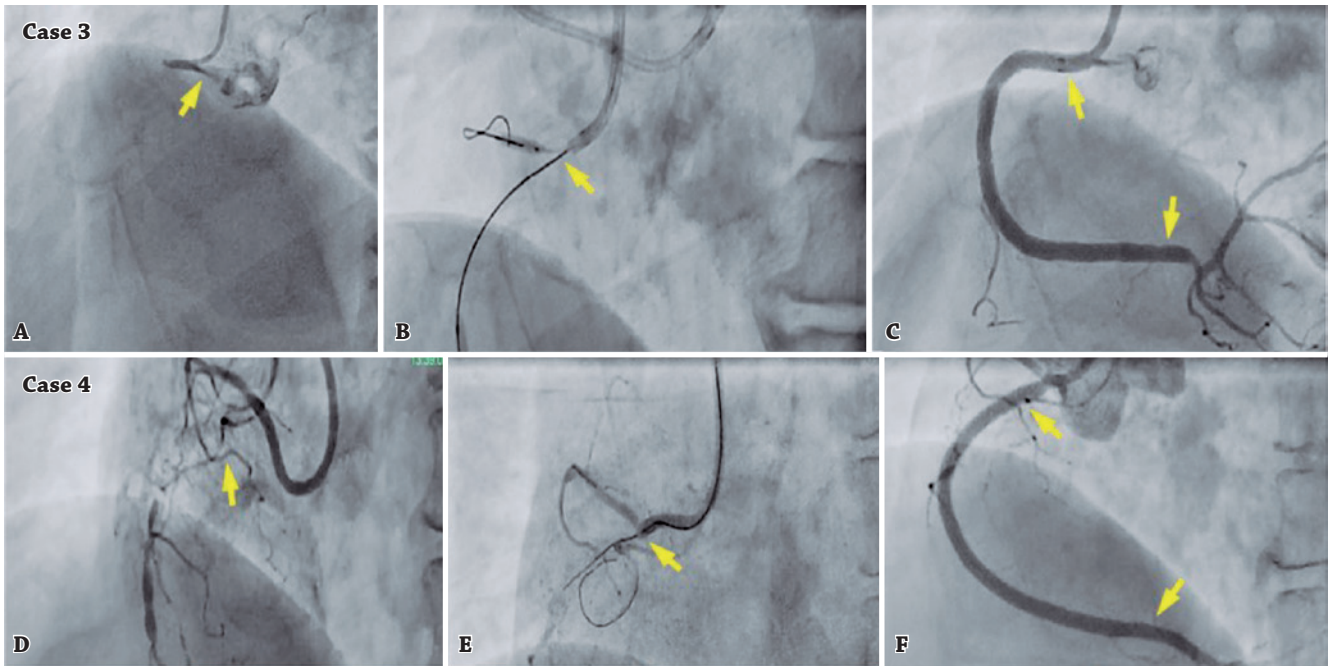

Figure 2. Case 3: Uncrossable calcified lesion in right coronary artery crossed with anchor balloon technique. Crossing of occluded lesion in right coronary artery by using balloon. (A) Balloon was failed to cross the occluded lesion in right coronary artery. (B) Anchor balloon technique was used to cross the occluded lesion. (C) Deployment of drug eluting stent. Case 4: uncrossable calcified lesion in right coronary artery crossed with anchor wire technique. Successful attempt to cross the occluded lesion by using anchor wire technique. (D) Unsuccessful attempt made to cross the occluded lesion in right coronary artery by using the balloon. (E) Successfully crossing of occluded lesion by anchor wire technique. (F) Successful drug eluting stent deployment.

Different CTO balloons were initially used to cross the occluded lesion without success (Figure 2A). Considering this, a workhorse BMW wire was kept in the side branch and a 2.5x10mm non-compliant balloon was inflated in the side branch to anchor the guiding catheter (anchor balloon technique) (Figure 2B). Lesion was successfully crossed with this technique using a GAIA-2 (Asahi®) wire and a NIC Nano (SIS Medical) CTO balloon 0.8x8mm. After the pre-dilation with a 2.5x15mm balloon, two DES (Xience Prime™ 3.5x15mm and Xience Prime™ 3.0x38mm) were deployed in the patient successfully from distal to proximal location, followed by post-dilatation (Figure 2C)

Case 4

A 63-year-old diabetic and hypertensive female patient came with history AOE grade-3 with normal functioning LV.

Angiography confirmed CTO in RCA with J-CTO score of 3.

After an initial failed attempt to cross the occluded lesion in RCA by using different CTO balloons the lesion was anchored (Figure 2D) with a wire in the side branch and was crossed with XTA wire and NIC Nano (SIS Medical) CTO balloon, 0.8x8mm (anchor wire technique) (Figure 2E). The lesion was successfully crossed and pre-dilation performed with a 2.5x15mm balloon. Two DES (SMT Supraflex Cruz™ 2.75x20mm and Resolute™ Integrity 3.5x38mm) were successfully deployed from distal to proximal vessel (Figure 2F).

Case 5

An 85-year-old diabetic and hypertensive patient with history of AOE grade-3 with severe LV dysfunction.

Angiography confirmed CTO in RCA with J-CTO score 1.

After a failed attempt to cross the lesion with different balloon techniques, the proximal cap was ruptured with a 1.5x10mm CTO balloon through balloon assisted microdissection (BAM) (Figure 3A). It got possible to cross the lesion with 1.5mm, 2.0mm and 2.5mm balloons progressively (Figure 3B). Finally, good results were obtained after deployment of two DES (3.0x38mm Xience Prime™ and 3.0x18mm Xience Prime™) from distal to proximal vessel (Figure 3C).

Case 6

A 63-year-old diabetic, male patient with history of AOE grade-2 and dyslipidemia.

Angiography showed CTO in RCA with J-CTO score 1.

The CTO lesion was approached with an antegrade wire XTA which was unable to access the true lumen (Figure 3D). After this, antegrade crossing of XTA wire was successfully done with a retrograde landmark reference from LAD through the collaterals (Figure 3E). Finally, two DES (2.5x38mm Xience Prime™ and 3.0x44mm SMT Supraflex Cruz™) were deployed in the patient (Figure 3F).

Case 7

A 56-year-old diabetic and hypertensive patient with history of AOE and LV dysfunction. The patient presented with 40% LV ejection fraction.

Angiography revealed left circumflex artery CTO with JCTO score of 1.

There was an 100% lesion in left circumflex artery (Figure 4A), which was tried to cross with XTA wire but failed and a knuckle was made (Figure 4B) and lesion entered true lumen with KWT. Finally, successful deployment of the two DES (2.5x38mm Xience Prime™ and 2.5x18mm Xience Prime™) from distal to proximal lesion was achieved (Figure 4C).

Case 8

A 65-year-old diabetic and hypertensive patient with family history of CAD and AOE grade-3.

Angiography shows CTO in RCA with J-CTO score 2.

The Guidezilla™ support antegrade capture technique was used to cross the occluded lesion in RCA (Figure 4E). An antegrade GAIA-2 (Asahi®) wire was crossed through the lesion and a retrograde wire was advanced with KWT (Figure 4D). Two microcatheters were used for externalization of the retrograde wire. The lesion was pre-dilated with 1.5-mm, 2.0-mm and 2.5-mm balloons (Figure 4E). Afterwards, a successful deployment of two DES (2.5x38mm Xience Prime™ and 3.0x44mm SMT Supraflex Cruz™) from distal to proximal lesion was performed in the patient (Figure 4F).

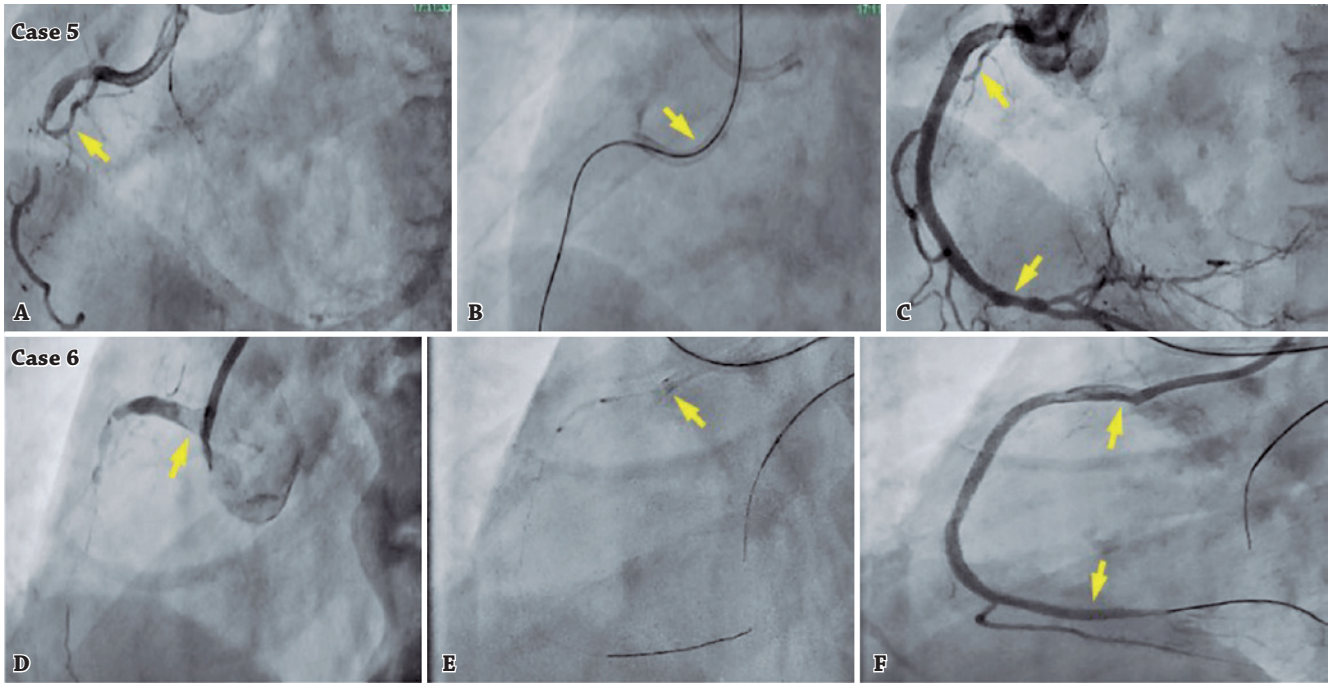

Figure 3. Case 5: uncrossable calcified lesion in right coronary artery crossed with balloon assisted microdissection technique. The occluded lesions in right coronary artery were crossed employing this technique. (A) Balloon used to cross the occluded lesion in right coronary artery failed. (B) Balloon assisted microdissection technique used to cross the occluded lesion in right coronary artery. (C) Successful drug eluting stent deployment. Case 6: uncrossable calcified lesion in right coronary artery crossed with retrograde landmark technique. Antegrade crossing with retrograde landmark reference used to cross the occluded lesion. (A) Unsuccessful attempt made to cross the occluded lesion in right coronary artery by using balloon. (B) Occluded lesion in right coronary artery was crossed successfully by using antegrade crossing with retrograde landmark. (C) Successful drug eluting stent deployment.

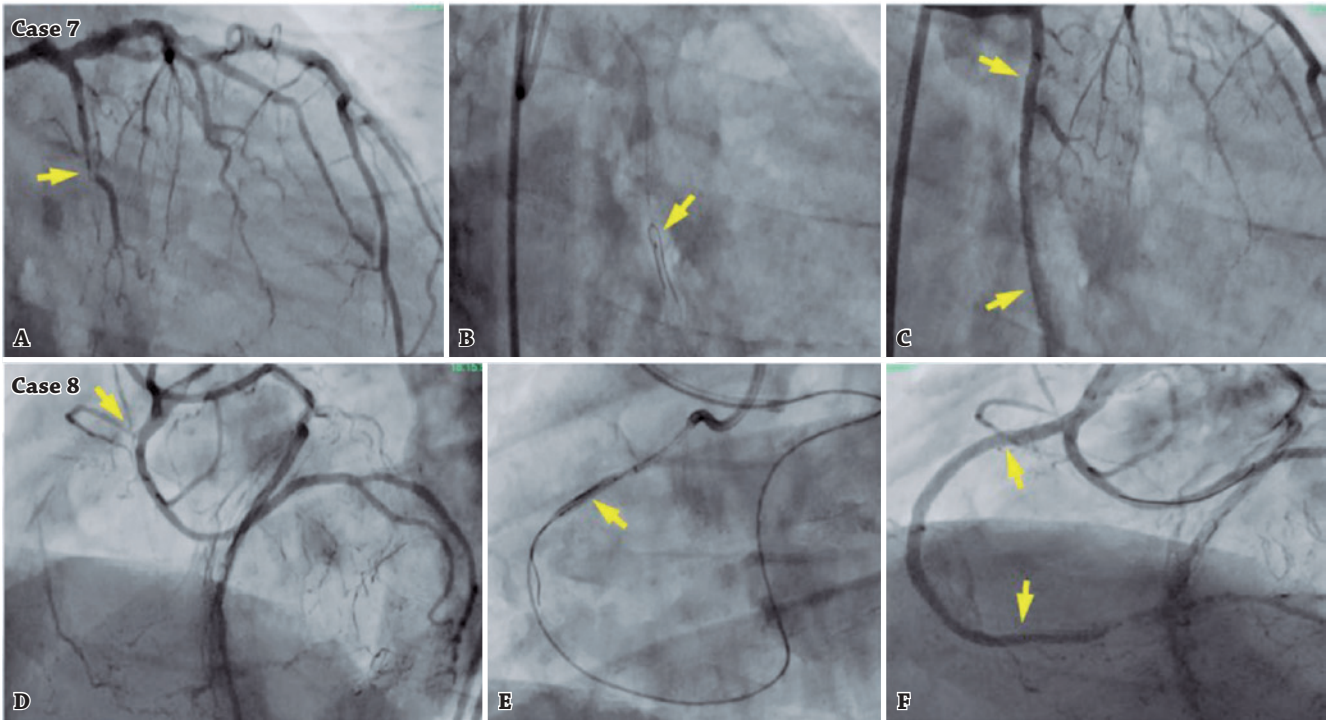

Figure 4. Case 7: calcified lesions in left circumflex artery crossed with knuckle wire technique (Star technique). Uncrossable calcified lesions in left circumflex were crossed with knuckle wire technique (Star technique). (A) Unsuccessful attempt made to cross the occluded lesion in left circumflex by using balloon. (B) Occluded lesions successfully crossed by using wire knuckled with Star technique. (C) Successful drug eluting stent deployment. Case 8: uncrossable calcified lesion in right coronary artery crossed with Guidezilla™ support. Occluded lesion in right coronary artery was successfully crossed by using Guidezilla™ support. (D) The balloon initially used to cross the occluded lesion failed. (E) Occluded lesion was successfully crossed by Guidezilla™ support. (F) Successful drug eluting stent deployment.

DISCUSSION

Uncrossable and difficult-to-dilate lesions are very challenging to manage. The incidence rate of major complications in patients with uncrossable CTO is similar to that of patients who did not have balloon-uncrossable CTO.[4] Various techniques like RA, Corsair® microcatheter, anchor wire technique, anchor balloon technique, BAM and KWT can be used to manage these lesions.

Balloon uncrossable and difficult-to-dilate lesions promote a major potential barrier to successful revascularization. Various basic principles can be adopted to guide-catheter support and several adjunctive techniques for crossing the occluded resistant lesions raise the likelihood of successful lesion crossing. In patients presenting with uncrossable and difficult-to-dilate lesions, rota-wire can be used instead of workhorse wire to facilitate the passage of balloon.[7] If rota-wire is unable to cross the occluded lesions, microcatheters like Corsair® can also be used.[8] Furthermore, anchor balloon technique can also be used to provide greater support, through a balloon inflation in a side branch.[9] Balloon-assisted microdissection technique is also quite useful in uncrossable proximal lesions.[10] Furthermore, a landmark reference with retrograde wire is quite helpful in cases where distal anatomy is ambiguous.[11] Finally, Guidezilla™ support antegrade capture technique can also be used, in which a Guidezilla™ extension catheter can be used to capture the retrograde wire.[12] The management of balloon uncrossable CTO is shown in table 1.[13]

This case series provides few commonly used tips and tricks to handle uncrossable lesions and hence to complete the procedure in an easy way. Rotational and orbital atherectomy, anchor balloon technique, BAM technique, knuckle wire technique and Guidezilla™ capture technique are some options which can be applied to successfully complete the procedures.

Table 1. Management of balloon uncrossable chronic total occlusion

Augmented guide catheter support	Lesion modification
Larger guide catheter with more supportive shape	Appropriate small balloon (1.20-1.5mm) manipulation
Long arterial sheaths	Intentional balloon rupture
Deep engagement	Microcatheters: Tornus®, Corsair®, Caravel®, Finecross™ and Turnpike®
Guide catheter extension	Excimer laser: ablative and acoustic energy
Buddy wire	Rotational atherectomy
Anchor balloon: side branch, distal target vessel or subintimal at or below lesion site	Seesaw balloon-wire cutting technique
	Multi-wire plaque crushing technique
	Retrograde approach

ACKNOWLEDGMENTS

Thanks to Ms. Nikita Dureja and Mr. Rohit Kumar for assisting us concluding the case series. Figures were edited by Jiwan Singh.

SOURCE OF FINANCING

None.

CONFLICTS OF INTEREST

The authors declare there are no conflicts of interest.

CONTRIBUTION OF AUTHORS

Conception and design of the study: RM, ABNS, LR, DD, BM and ISM; data collection: RM, ABNS, LR, DD, BM and ISM; data interpretation: RM, ABNS, LR, DD BM and ISM; text writing: RM, ABNS, LR, DD BM and ISM; approval of the final version to be published: RM, ABNS, LR, DD BM and ISM.

REFERENCES

1. Galla JM, Whitlow PL. Coronary chronic total occlusion. Cardiol Clin. 2010;28(1):71-9. https://doi.org/10.1016/j.ccl.2009.10.003 PMID:19962050.
2. Koelbl CO, Nedeljkovic ZS, Jacobs AK. Coronary chronic total occlusion (CTO): A review. Rev Cardiovasc Med. 2018;19(1):33-9. https://doi.org/ doi: 10.31083/j.rcm.2018.01.896
3. Stone GW, Reifart NJ, Moussa I, Hoye A, Cox DA, Colombo A, et al. Percutaneous recanalization of chronically occluded coronary arteries: a consensus document: part II. Circulation. 2005;112(16):2530-7. https://doi.org/10.1161/CIRCULATIONAHA.105.583716
4. Pagnotta P, Briguori C, Mango R, Visconti G, Focaccio A, Belli G, et al. Rotational atherectomy in resistant chronic total occlusions. Catheter Cardiovasc Interv. 2010;76(3):366-71. https://doi.org/10.1002/ccd.22504
5. Bliagos D. Treating the uncrossable lesions. Reviewing the most commonly used techniques for managing balloon-uncrossable coronary lesions. Cardiac Interv Today. 2020;14(5):48-9.
6. Rempakos A, Kostantinis S, Simsek B, Karacsonyi J, Allana S, Egred M, et al. An algorithmic approach to balloon undilatable coronary lesions. Catheter Cardiovasc Interv. 2022;101(2):355-62.
7. Abdel-Wahab M, Richardt G, Joachim Büttner H, Toelg R, Geist V, Meinertz T, et al. High-speed rotational atherectomy before paclitaxel-eluting stent implantation in complex calcified coronary lesions: the randomized ROTAXUS (Rotational Atherectomy Prior to Taxus Stent Treatment for Complex Native Coronary Artery Disease) trial. JACC Cardiovasc Interv. 2013;6(1):10-9. https://doi.org/10.1016/j.jcin.2012.07.017
8. Asahi Intecc USA Inc. Asahi Corsair® Pro. [cited 2023 Jul 21]. Available from: http://www.asahiintecc.com/medical/international/product/mc_cor.php
9. Fujita S, Tamai H, Kyo E, Kosuga K, Hata T, Okada M, et al. New technique for superior guiding catheter support during advancement of a balloon in coronary angioplasty: the anchor technique. Catheter Cardiovasc Interv. 2003;59(4):482-8. https://doi.org/10.1002/ccd.10551
10. Vo MN, Christopoulos G, Karmpaliotis D, Lombardi WL, Grantham JA, Brilakis ES. Balloon-Assisted Microdissection "BAM" Technique for Balloon-Uncrossable Chronic Total Occlusions. J Invasive Cardiol. 2016;28(4):E37-41. PMID: 27031940.
11. Kunkel KJ, Neupane S, Gupta A, Basir MB, Alaswad K. Antegrade versus retrograde techniques for Chronic Total Occlusions (CTO): a review and comparison of techniques and outcomes. Expert Rev Cardiovasc Ther. 2021;19(6):465-473. https://doi.org/1010.1080/14779072.2021.1924677
12. Yew KL, Kang Z. Guidezilla guide extension catheter facilitated the delivery of long and bulky In.Pact Falcon drug-coated balloon for the treatment of chronic total occlusion lesion. Int J Cardiol. 2015;201:220-1. https://doi.org/10.1016/j.ijcard.2015.08.034
13. Mody R, Dash D, Mody B, Goyal R, Chahal A. Tips and tricks for PCI of chronic total occlusions - a review. Rea Int J Card Cardio Med. 2021:31-41. https://doi.org/ 10.37179/rijccm.000011