

Percutaneous coronary intervention of chronic total occlusion and bifurcation: Different strategies to succeed

Nicolas Boudou, Olivier Darremont

Interventional Cardiology Department, Clinique Saint Augustin, Bordeaux, France



This editorial accompanies the article on page 24



When treating a chronic total occlusion (CTO), bifurcation lesions are observed in nearly one third of cases.

The presence of a bifurcation within or adjacent (≤ 5 mm) to a CTO has been associated with increased probability of procedural complications, while the loss of relevant side branches has an adverse impact on short- and long-term clinical outcome during CTO percutaneous coronary intervention (PCI) [1–4].

Subintimal shift (SIS) is a potential mechanism of branch occlusion observed during PCI for bifurcation lesions. In the present original article, Gutiérrez-Chico et al. [5] highlight the diagnosis criteria of this complication in the context of CTO PCI in order to sensitize the interventional community.

Subintimal shift is defined as a complete occlusion or worsening $\geq 30\%$ diameter stenosis of a segment of the CTO bifurcation lesion, occurring after balloon inflation or stent deployment.

When considering strategies for crossing CTO involving a bifurcation, operators must consider the risk of side branch (SB) occlusion due to SIS (dissection flap) or plaque shift (carina shift, hema-

toma). The rule is to wire both branches within the distal true lumen, but a sub-intimal crossing may induce a dissection and an intimo-medial flap in front of its carina. The risk increases in case of a sub-intimal tracking with reentry near the bifurcation (5 mm distal or proximal to the carina).

Intracoronary imaging, especially intravascular ultrasound (IVUS) (without dye injection) is recommended for a better understanding of this phenomenon, by showing the guidewire's position: extraplaque, intraplaque into the true lumen or the false lumen.

Thereafter, knowing the intra- or extraplaque wire location prior stent deployment will help the operators to prevent a branch occlusion.

Strategies to cross the CTO and reach both branches and distal true lumen

Since different approaches (antegrade wiring, antegrade dissection and reentry, retrograde wiring and retrograde dissection and reentry) are available to perform the CTO crossing, selected crossing strategies should take the risk of SIS into consideration, based on the location of the CTO segment within the bifurcation:

- True bifurcation where the main branch (MB) is occluded and the SB presents greater than

Address for correspondence: Nicolas Boudou, MD, Clinique Saint Augustin, Center d'Exploration et de Chirurgie Cardio-Vasculaire, 114 Av. d'Arès, 33200 Bordeaux, France, e-mail: boudou.n@iac-saintaugustin.fr

Received: 25.01.2023

Accepted: 25.01.2023

This article is available in open access under Creative Commons Attribution-Non-Commercial-No Derivatives 4.0 International (CC BY-NC-ND 4.0) license, allowing to download articles and share them with others as long as they credit the authors and the publisher, but without permission to change them in any way or use them commercially.

a 50% diameter stenosis lesion, or a bifurcation within the CTO involving both branches;

- False bifurcation where only the MB is diseased: CTO within the proximal MB (1,0,0 Medina lesion) or CTO within distal main branch (0,1,0 Medina lesion).

This is why the global CTO crossing algorithm [6] and the EuroCTO Club consensus [7] recommends the use of the retrograde approach when there is a bifurcation at the distal cap in order to protect or save one of the two branches of the bifurcation.

A major SB should be wired to prevent its occlusion by using specific devices such as dual lumen microcatheter [8], especially if two stents are necessary.

For antegrade crossing, particularly when the bifurcation lesions are located at the distal cap (1,0,0 or 1,0,1 Medina lesion), strategies with antegrade dissection using the Knuckle wire, ADR, or STAR (subintimal tracking and reentry) techniques should be avoided.

Ideally, subintimal tracking should be limited, as far as possible, to a side branch.

In cases where a retrograde approach has been selected with CTO at the distal MB (0,1,0 or 0,1,1 Medina lesion), it may be safer to perform a retrograde crossing with Reverse CART assisted by a guide catheter extension to avoid a retrograde sub-intimal crossing in front of the carina.

Moreover, an IVUS guided wiring is also an option to minimize the risk of SIS.

What should the operator do in case of SIS

In case of SIS, different options are available to the operator:

- Intracoronary imaging is an excellent tool to understand the location of the intimo-medial flap in front of its carina, before stenting;
- In some cases, a stent strategy towards the bifurcation may be an option provided that the dissection can be sealed without compromising a branch.

As suggested by Ojeda et al. [4], bifurcation lesions in CTO can be approached similarly to regular bifurcation lesions, for which provisional stenting is considered the technique of choice.

However, in case of a large and complex SIS with two wires in both distal true lumen,

a two-stent bifurcation technique could be the best option. The key point is to treat the bifurcation without guidewire exchange, with no guidewire removal prior stenting: systematic T-stenting, DK-crush, culotte...

In this original article, Gutiérrez-Chico et al. [5] emphasizes how to understand the risk of SIS as a potential mechanism of a branch occlusion in PCI for CTO involving bifurcation, by presenting clinical cases and providing tips and tricks for a successful resolution of this complication.

Conflict of interest: None declared

References

1. Adachi Y, Kinoshita Y, Murata A, et al. The importance of side branch preservation in the treatment of chronic total occlusions with bifurcation lesions. *Int J Cardiol Heart Vasc.* 2021; 36: 100873, doi: [10.1016/j.ijcha.2021.100873](https://doi.org/10.1016/j.ijcha.2021.100873), indexed in Pubmed: [34568542](https://pubmed.ncbi.nlm.nih.gov/34568542/).
2. Guan C, Yang W, Song L, et al. Association of acute procedural results with long-term outcomes after CTO PCI. *JACC Cardiovasc Interv.* 2021; 14(3): 278–288, doi: [10.1016/j.jcin.2020.10.003](https://doi.org/10.1016/j.jcin.2020.10.003), indexed in Pubmed: [33541539](https://pubmed.ncbi.nlm.nih.gov/33541539/).
3. Guo Y, Peng H, Zhao Y, et al. Predictors and complications of side branch occlusion after recanalization of chronic total occlusions complicated with bifurcation lesions. *Sci Rep.* 2021; 11(1): 4460, doi: [10.1038/s41598-021-83458-9](https://doi.org/10.1038/s41598-021-83458-9), indexed in Pubmed: [33627677](https://pubmed.ncbi.nlm.nih.gov/33627677/).
4. Ojeda S, Pan M, Gutiérrez A, et al. Bifurcation lesions involved in the recanalization process of coronary chronic total occlusions: Incidence, treatment and clinical implications. *Int J Cardiol.* 2017; 230: 432–438, doi: [10.1016/j.ijcard.2016.12.088](https://doi.org/10.1016/j.ijcard.2016.12.088), indexed in Pubmed: [28041711](https://pubmed.ncbi.nlm.nih.gov/28041711/).
5. Gutiérrez-Chico JL, Cortés C, Ayoub M, et al. Subintimal shift as mechanism for side-branch occlusion in percutaneous treatment of chronic total occlusions with bifurcation lesions. *Cardiol J.* 2023; 30(1): 24–35, doi: [10.5603/CJ.a2021.0079](https://doi.org/10.5603/CJ.a2021.0079), indexed in Pubmed: [34231874](https://pubmed.ncbi.nlm.nih.gov/34231874/).
6. Wu EB, Brilakis ES, Mashayekhi K, et al. Global chronic total occlusion crossing algorithm: JACC state-of-the-art review. *J Am Coll Cardiol.* 2021; 78(8): 840–853, doi: [10.1016/j.jacc.2021.05.055](https://doi.org/10.1016/j.jacc.2021.05.055), indexed in Pubmed: [34412818](https://pubmed.ncbi.nlm.nih.gov/34412818/).
7. Galassi AR, Werner GS, Boukhris M, et al. Percutaneous recanalisation of chronic total occlusions: 2019 consensus document from the EuroCTO Club. *EuroIntervention.* 2019; 15(2): 198–208, doi: [10.4244/EIJ-D-18-00826](https://doi.org/10.4244/EIJ-D-18-00826), indexed in Pubmed: [30636678](https://pubmed.ncbi.nlm.nih.gov/30636678/).
8. Pyxaras SA, Galassi AR, Werner GS, et al. Dual lumen microcatheters for recanalisation of chronic total occlusions: a EuroCTO Club expert panel report. *EuroIntervention.* 2021; 17(12): e966–e970, doi: [10.4244/EIJ-D-21-00291](https://doi.org/10.4244/EIJ-D-21-00291), indexed in Pubmed: [34338644](https://pubmed.ncbi.nlm.nih.gov/34338644/).