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Case report

"Putting it all together": Highlighting the global approach to chronic total occlusion revascularization

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ABSTRACT

Preprocedural planning and advanced imaging is vital to achieve a consistent and high level of success for complex coronary chronic total occlusion (CTO) revascularization. Various practice patterns exist around the world when performing coronary artery CTO revascularization. This case report highlights a fusion of global practices in CTO intervention and integration of advanced imaging to achieve successful revascularization.

1. Introduction

Procedural techniques for chronic total occlusion (CTO) revascularization vary across the world; operators in the US favor the device-based hybrid approach[1] with use of the subintimal space, operators from the Asia-Pacific region advocate a wire-based approach to CTO percutaneous coronary intervention (PCI) with intent to stay within the true lumen of the vessel, and operators in Europe adopt either of these approaches. Such variability arises from practice patterns, the availability of equipment (e.g. specialized CTO wires and antegrade dissection and reentry catheters), and the cost of dedicated equipment. Showcasing integration of these international skill sets for successful revascularization of a complex CTO is the intent of this case report.

Certain validated tools, such as the J-CTO score, predict complexity of the procedure independent of the approach.[2] A score $\geq$3 is a predictor of a more complex procedure. However, there remains a clinically unmet need where patients with the most pressing clinical indication have the most challenging anatomy. They are denied revascularization because of a perceived high risk–benefit ratio of the procedure.

This case report highlights the need to combine skill sets and techniques from around the world to achieve complete revascularization for more patients with complex coronary CTOs, "putting it all together."

2. Case

A 73-year-old male with a prior history of coronary artery bypass grafting suffered an out-of-hospital cardiac arrest while on vacation. Return of spontaneous circulation (ROSC) was achieved after bystander chest compressions and defibrillation. Post-ROSC electrocardiogram did not reveal injury pattern. Coronary angiography revealed an atretic left internal mammary artery and patent grafts to the diagonal, obtuse marginal, and right coronary arteries. Proximal left anterior descending artery (LAD) was chronically occluded. The mid and distal LAD filled via a saphenous vein graft to a diagonal (Fig. 1a and b). No interventions were undertaken and the patient was recommended continued medical treatment. An automatic implantable defibrillator was implanted for secondary prevention and he was discharged back to the care of his primary cardiology team.

About 6 weeks later, a myocardial perfusion scan was performed, which demonstrated a large completely reversible myocardial perfusion defect in the anterior wall. The estimated myocardium at ischemic risk was 14% of the left ventricular mass. Based on the prior angiogram, the J-CTO score of the LAD CTO was estimated at 4 (due to a blunt stump, fluoroscopic calcification, bending within the CTO body, and a lesion length >30 mm).

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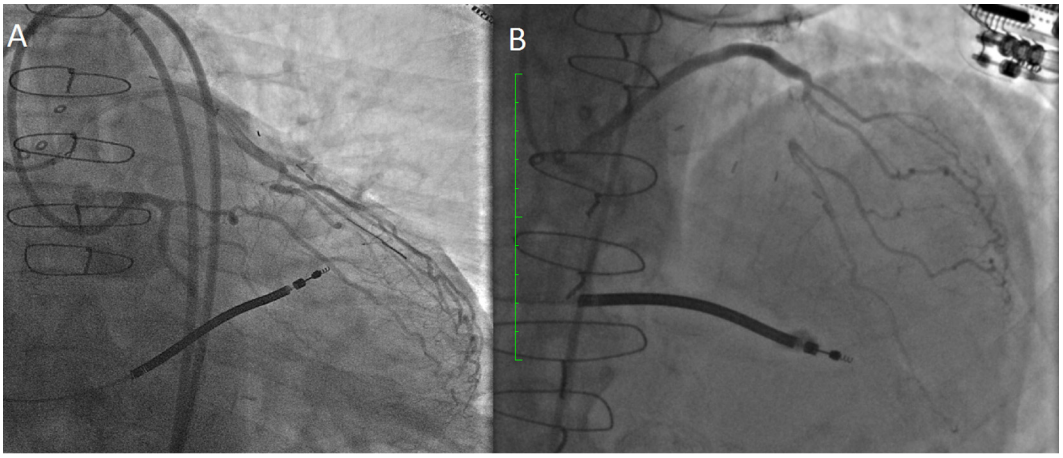

Fig. 1. CTO of the LAD that fills retrograde via collaterals from a saphenous vein graft to a diagonal branch in LAO caudal (A) and AP cranial (B) views.

Application of the hybrid algorithm to the CTO revealed the following characteristics:

1. Ambiguous proximal cap
2. Lesion length >20 mm
3. Absence of usable interventional collaterals
4. Good distal target

The ambiguous or blunt proximal cap favored a primary retrograde approach but there were no usable interventional collaterals. The presence of a previous bypass graft to the diagonal and unclear understanding of the anastomotic relationship between the saphenous vein graft, native diagonal, and the LAD made preprocedure planning of the CTO difficult. A preprocedure computerized tomographic angiogram (CTA) was performed to clarify the anatomical ambiguity associated with both the proximal and distal caps. Aligning and analyzing the multiplanar reconstruction of the CTA with the coronary angiogram in typical views that interventional cardiologists are used to interpreting, like the anteroposterior (AP) cranial and left anterior oblique (LAO) caudal view, helped clarify the anatomy (Fig. 2a and b). The CTA clarified that the large vessel on angiography previously thought to be an intermedius vessel was actually a proximal diagonal artery. It also clarified that the CTO originated 3 mm beyond the LAD ostium.

Based on this information, the decision was made to proceed with intravascular ultrasound (IVUS) guided proximal cap puncture. An Opticross (Boston Scientific, Maple Grove, MN) IVUS imaging catheter was placed in the diagonal and the origin of the CTO within the LAD was visualized and punctured using a Confianza Pro 12 wire (Asahi Intec, Nagoya, Japan) (Fig. 3). After the Confianza Pro 12 punctured the proximal cap and entered the subintimal plane, it was then expanded with a Fielder XT (Asahi Intecc, Nagoya, Japan) wire (Supplemental Video). This entry of the Confianza Pro 12 in the subintimal plane is not unexpected given the bend within the CTO body. The Cross-Boss catheter (Boston Scientific, Maple Grove, MN) was not used to limit the subintimal plane because of a healthy distal target and proximity of the knuckle wire to the distal vessel. The strategy was changed to the hybrid approach using antegrade dissection reentry with the Stingray balloon (Boston Scientific, Maple Grove, MN) and catheter within the mid LAD (Fig. 4). Since subintimal dissection planes created by a knuckle wire cannot be controlled, loss of side branches, such as septal arteries and diagonals, in this case could have occurred. However, when the Stingray system is used to perform dissection reentry, exquisite control can be maintained at the point of reentry. In this case, reentry was performed using orthogonal projections to help the Stingray wire into the true lumen of the LAD using the stick-and-swap technique. The reentry point was proximal to the distal diagonal artery and hence flow

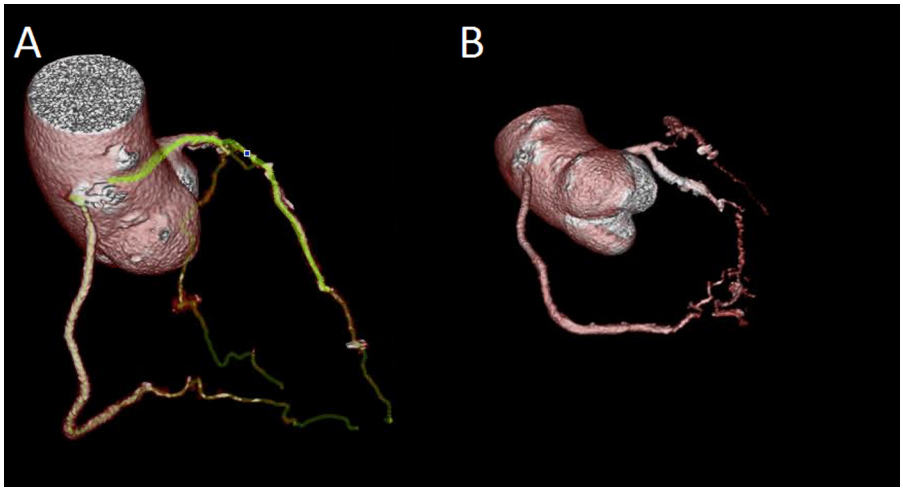

Fig. 2. 3D CT reconstruction showing the course of the occluded LAD in AP cranial (A) and LAO caudal (B) views.

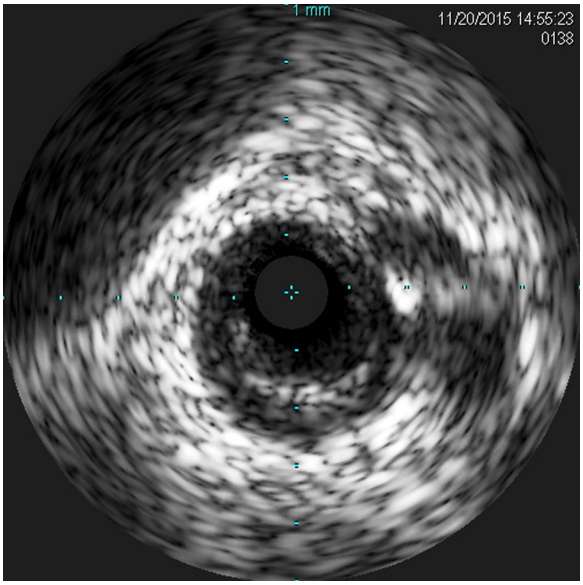

Fig. 3. Intravascular ultrasound (IVUS) of the proximal cap of the LAD CTO imaged from the native diagonal artery bifurcation.

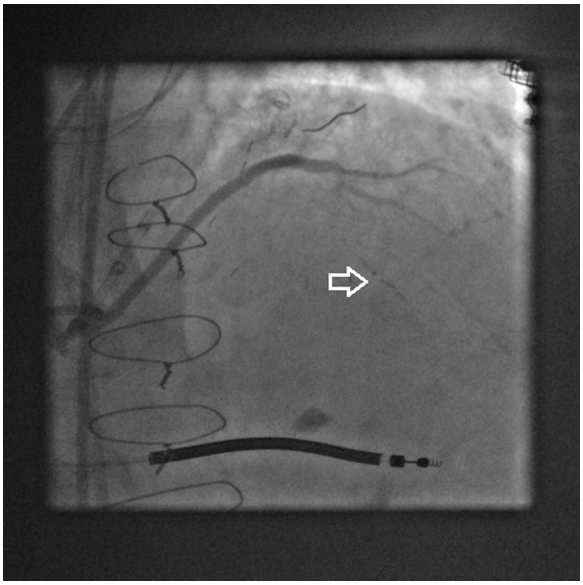

Fig. 4. Reentry into the mid LAD true lumen using the Stingray balloon (arrow).

within this diagonal was preserved. Such preciseness in the reentry technique would not have been possible with the knuckle wire. Once reentry was confirmed, 2 drug-eluting stents were implanted and the CTO PCI was completed (Fig. 5a and b).

3. Discussion

CTO PCI is often underutilized,[3] and many patients are denied revascularization because of complex anatomy, ambiguous proximal cap, and unusable interventional collaterals. Even "expert" operators only consider the approach they are most familiar with, lessening chances of success in complex cases.

Defining the proximal and distal cap anatomy is a critical aspect of a successful CTO PCI. Integrating advanced imaging with tools like CTA and IVUS adds to clarifying anatomical ambiguity. Twenty percent of CTOs have unusable interventional collaterals.[4] Without an image-based strategy for case planning for such cases, success cannot be achieved and perforation risk is higher. In order to boost success rates in these complex cases, preprocedural planning and utilization of advanced imaging are critical.

In the United States, operators rarely use CTA before CTO-PCI, whereas operators in the Asia-Pacific region and Europe use preprocedural CTA frequently. However, data support the use of preprocedural planning with CTA, as it can predict antegrade success rates.[5] This particular case could not have been successfully completed without a CTA, as it clarified the anatomical ambiguity associated with the proximal cap and defined the vessel course. CTA can also determine the degree of calcification in the CTO and negative remodeling within the distal bed, both predictors of failure.[6]

IVUS-guided puncture of the proximal cap is a skill set that is not widely employed. Operators from the Asia-Pacific region are more adept at performing and interpreting intravascular images during CTO-PCI because they use it more often than operators from the rest of the world.[7] In this case, as illustrated in Fig. 3, IVUS-guided puncture provided the necessary confidence to advance a Confianza Pro 12 (Asahi Intec, Nagoya, Japan) into and beyond the proximal cap in spite of anatomical ambiguity related to cap location. This allowed the case to proceed safely, lessening the risk of wire perforation.

Once subintimal access to the LAD was achieved, the application of the hybrid algorithm allowed for safe, effective, and efficient completion of the case.[8] Rather than parallel wiring, which requires an advanced skill set, precise reentry was done with

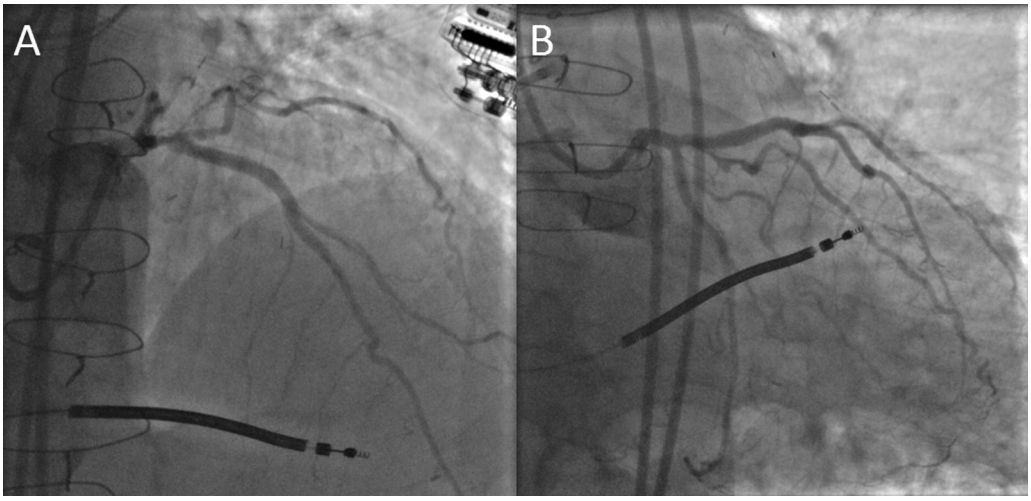

Fig. 5. Final angiogram showing successful revascularization of LAD CTO (AP cranial (A) and AP caudal (B) projections).

the Stingray balloon and wire (Boston Scientific, Maple Grove, MN) within the LAD just past the distal cap. This is an approach that is widely accepted within the continental United States and in certain European countries, but not in the rest of the world.

4. Conclusion

CTO PCI is the final frontier in interventional cardiology. To be able to problem solve effectively, and consistently achieve a success rate exceeding 90%, "interventionalists" need to be "internationalists." They need to shed geographic differences in approaches to CTO-PCI and instead adopt an open-minded, global approach. This case exhibits an amalgam of approaches to achieve a successful outcome, "putting it all together."

Conflicts of interest

The authors have none to declare.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.ihj.2016.04.010.

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