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ADVANCED

TECHNICAL CORNER

New CTO-Specific IVUS

AnteOwl Success in Previously Failed CTO Case Treated With Navifocus IVUS

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ABSTRACT

The newer chronic total occlusion-specific intravascular ultrasound AnteOwl WR-based 3-dimensional wiring technique using the tip detection method allowed us easily to succeed in treating chronic total occlusion lesions that were previously unsuccessfully treated using Navifocus WR intravascular ultrasound. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2020;2:961–5) © 2020 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

We present a model of a chronic total occlusion (CTO)-specific intravascular ultrasound (IVUS) system, Navifocus WR (Navi-IVUS; Terumo Corp., Tokyo, Japan), in 2012 (1). Our clinical experience with Navi-IVUS-guided wiring indicated that 3-dimensional (3D) wiring is important for accurate guidewire control in percutaneous coronary intervention (PCI) for CTO (2). Therefore, we developed a tip detection method and produced AnteOwl WR IVUS (AO-IVUS; Terumo Corp.) (3). AO-IVUS is an upgraded version of Navi-IVUS with an added pullback transducer system to standardize real-time IVUS-based 3D wiring using the tip detection method. We recently reported its efficacy in experimental CTO lesions (3) and began using AO-IVUS in clinical practice in October 2019 (4).

LEARNING OBJECTIVES

- To understand the tip detection method to enable real-time IVUS-based 3D wiring.
- To control the CTO stiff guidewires accurately according to the 3D wiring methods.

HISTORY OF PRESENTATION

A 50-year-old man with an old inferior myocardial infarction had continued to receive outpatient treatment with optimal medical therapy. The patient had effort angina pectoris secondary to a residual CTO lesion in the midportion of the left circumflex coronary artery (LCX).

PAST MEDICAL HISTORY

The patient had a history of inferior myocardial infarction, and the culprit lesion in the right coronary artery had been recanalized by emergency PCI 1 year previously. Given his residual effort angina, PCI was performed on the residual CTO lesion in the LCX on day 20 after emergency PCI (**Figure 1A**). Because there

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The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the *JACC: Case Reports* author instructions page.

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ABBREVIATIONS AND ACRONYMS

3D = 3-dimensional

AO-IVUS = AnteOwl WR intravascular ultrasound

CTO = chronic total occlusion

IVUS = intravascular ultrasound

LCX = left circumflex coronary artery

Navi-IVUS = Navifocus WR intravascular ultrasound

PCI = percutaneous coronary intervention

were no retrograde channels and the exit site was the bifurcation lesion, an antegrade wire escalation strategy, including parallel wiring and Navi-IVUS-guided wiring, was applied. However, the guidewires could not be passed through the CTO lesion, and a huge subintimal space was created (Figures 1B and 1C).

DIFFERENTIAL DIAGNOSIS

Chronic heart failure was considered as a differential diagnosis.

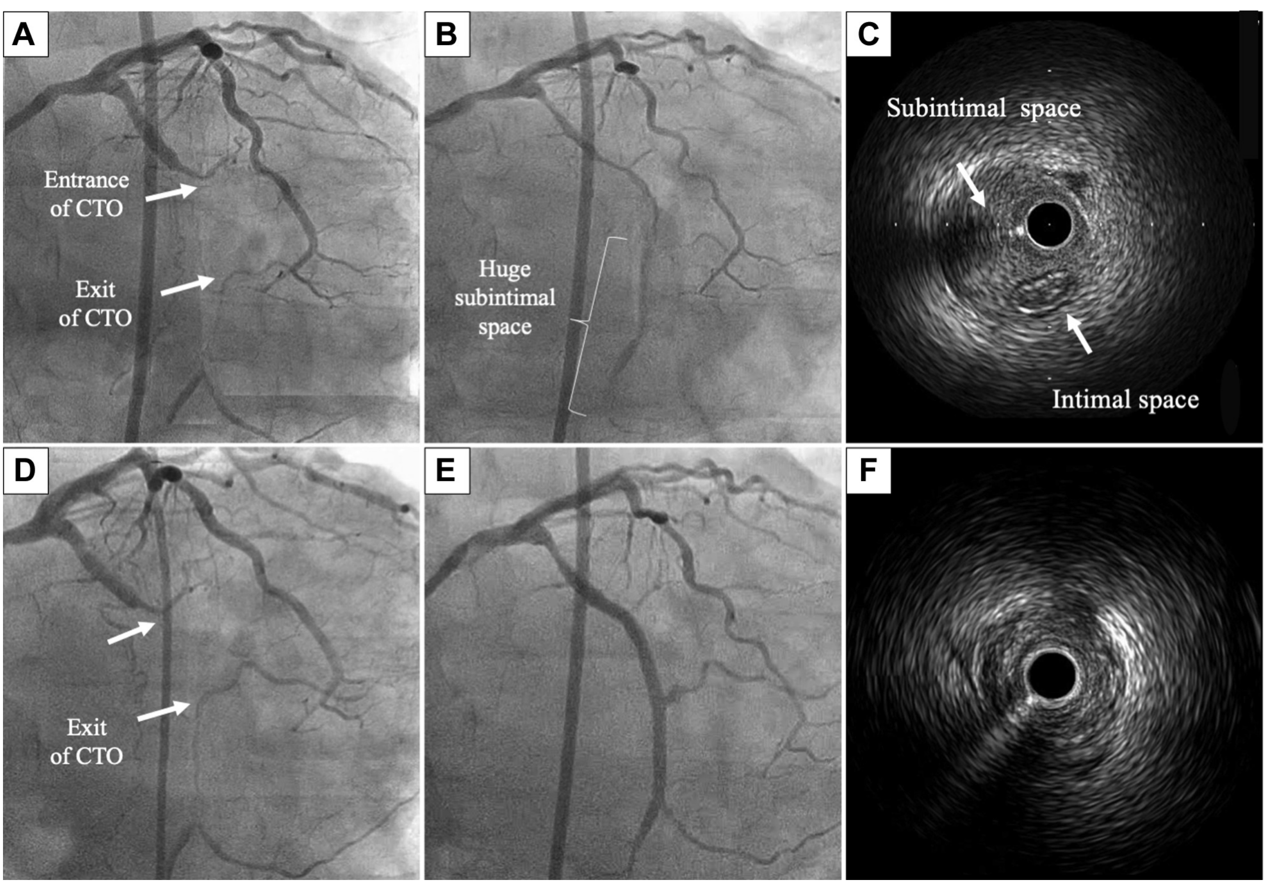
INVESTIGATIONS

Coronary angiography before the retry PCI procedure showed the same angiographic image of the CTO lesion in the LCX as before the first PCI procedure (Figures 1A and 1D).

MANAGEMENT

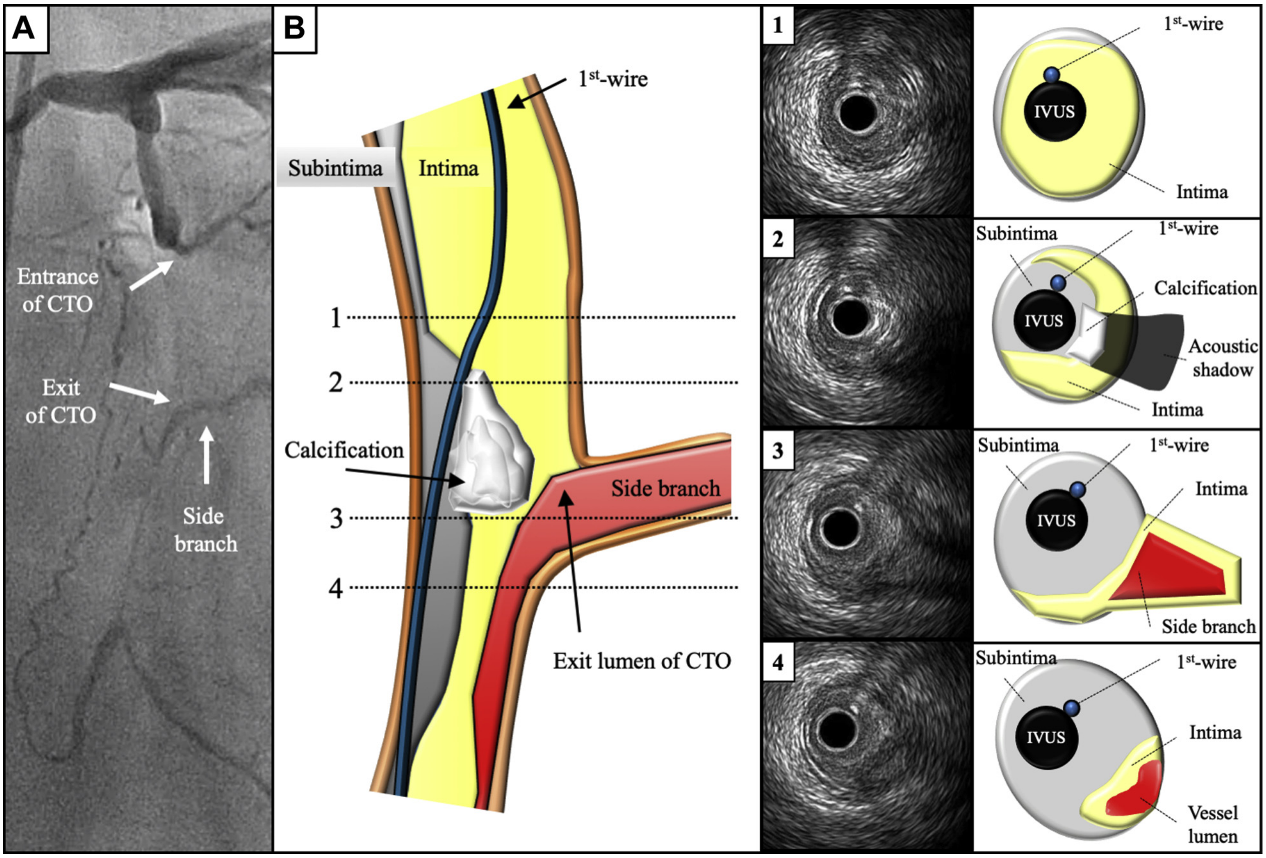
After commencement of the clinical use of AO-IVUS, a retry PCI procedure was performed on the residual CTO lesion in the LCX. An 8-F guide catheter was inserted from the femoral artery. The first guidewire (XT-R, Asahi Intecc Co., Ltd., Aichi, Japan) supported by a Corsair microcatheter (Asahi Intecc) was advanced and seemed to enter the subintimal space created by the previous procedure. The Corsair microcatheter was advanced 3 cm beyond the entrance of the CTO to create a space for the IVUS catheter, and the XT-R guidewire was changed to an Ultimate Bros3 wire (Asahi Intecc) to obtain good support for advancing the IVUS catheter. Figure 2 shows the pre-procedural angiographic image (Figure 2A) and IVUS images (Figure 2B), which revealed that the guidewire entered the subintimal

FIGURE 1 Angiographic and IVUS Images During First and Second Procedures



Angiographic images **(A)** pre-procedure and **(B)** post-procedure and **(C)** intravascular ultrasound (IVUS) image during the first procedure. Angiographic images **(D)** pre-procedure and **(E)** post-procedure and **(F)** intravascular ultrasound image during the second procedure. CTO = chronic total occlusion.

FIGURE 2 Pre-Procedural Angiographic and IVUS Images Through the First Guidewire Route



(A) Angiographic image pre-procedure. **(B)** Illustration of the long-axis positional information of intravascular ultrasound (IVUS) images. The **numbers** coincide with the numbered intravascular ultrasound position images. Intravascular ultrasound images and their illustrations after passage of the first guidewire. CTO = chronic total occlusion.

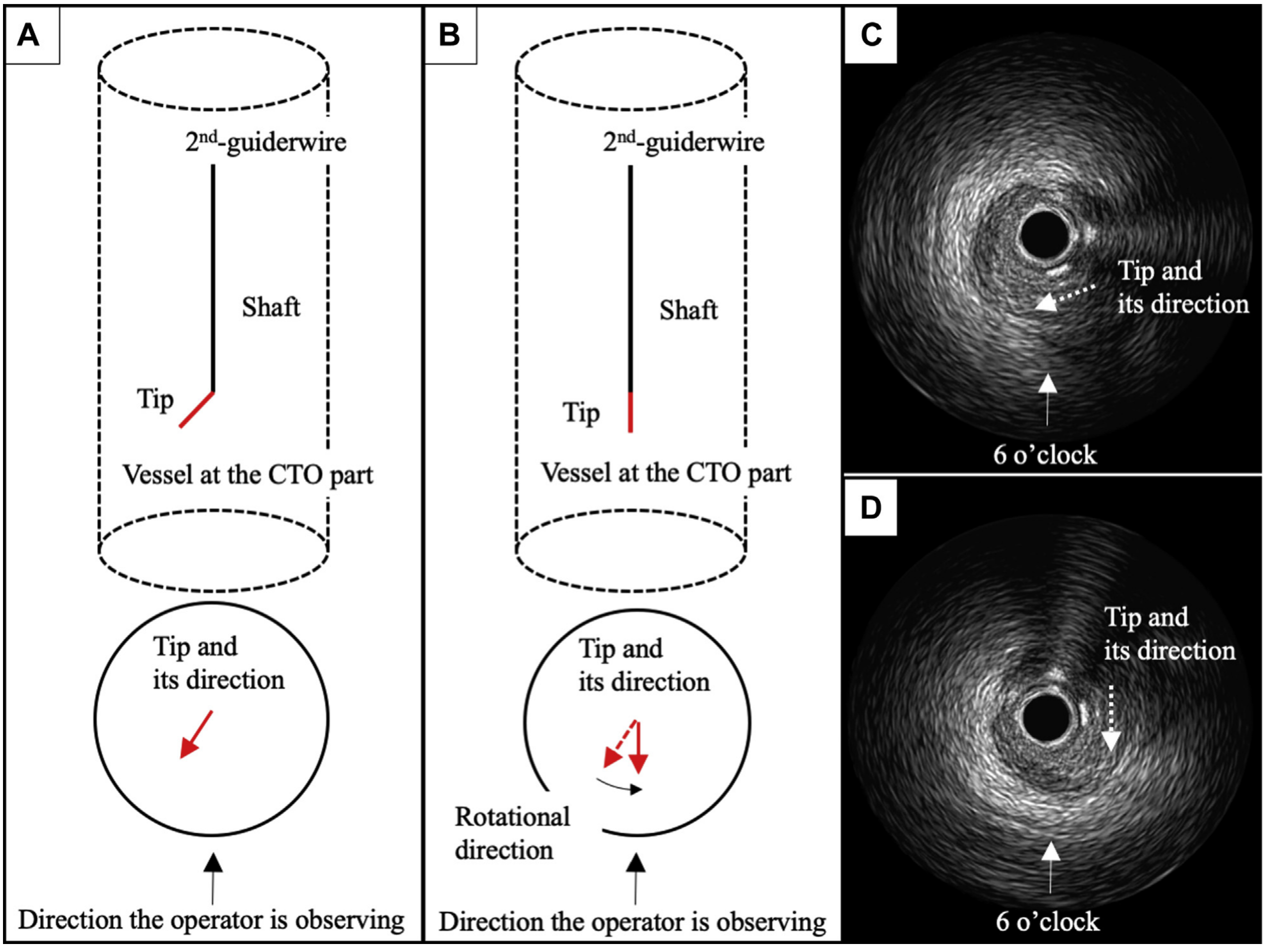
space at the exit site because of the presence of calcification (Figure 2B).

We performed the following 2 steps using the tip detection method: 1) positional information on the vascular structure, such as the intimal space and exit lumen, was transferred from the IVUS image to the angiographic image; and 2) IVUS-based 3D wiring was performed to advance the second guidewire accurately to the exit lumen.

First, Figure 3 illustrates how to transfer the positional information from the IVUS image to the angiographic image. The second guidewire (Confianza-12g, Asahi Intecc) was advanced 1 cm before the transitional site of intimal and subintimal spaces. On the angiographic image, the tip of the second guidewire was facing left (Figure 3A), and it was rotated to place the tip directly facing the operator (Figure 3B). The tip detection method was then performed to determine from which direction on the IVUS image the operator was observing the angiographic image (Figure 3C). The angiographic direction of observation on the IVUS image was rotated to 6 o'clock (Figure 3D) to produce a 3D image of the vascular construction on the angiographic image more easily. It was then simple to recognize that the intima and exit lumen were located on the right side (Figures 4A and 4B).

Second, Figure 4 shows how to perform IVUS-based 3D wiring using the tip detection method. The second guidewire (Confianza-12g, Asahi Intecc) supported by the Corsair, was advanced, and IVUS-based 3D wiring using the tip detection method was performed 1 cm before the exit. The second guidewire was rotated counterclockwise to direct its tip to the intimal area where the exit lumen was located further distally (Figure 4C, *1*). The guidewire was then advanced and entered the exit lumen (Figure 4C, *2*). However, the tip was directed to the side branch, and therefore the guidewire was rotated clockwise to direct its tip to the

FIGURE 3 **Tip Detection Method During Transfer of Positional Information on the Vascular Structure From Angiographic to IVUS Images**



(A and B) Fluoroscopic images of the second guidewire inside the chronic total occlusion (CTO) lesion 1 cm before the transitional site of intimal and subintimal spaces and intravascular ultrasound (IVUS) cross-sectional images of them. **(C and D)** Intravascular ultrasound images and their illustrations during the tip detection method.

main branch (**Figure 4C**, *3*) and was advanced into the distal part of the main branch (**Figure 4C**, *4*). IVUS-based 3D wiring, performed in only 8 min, allowed the second guidewire to be accurately advanced to the exit lumen. The CTO lesion was dilated with 1 drug-eluting stent, and normal antegrade blood flow was achieved (**Figures 1E and 1F**).

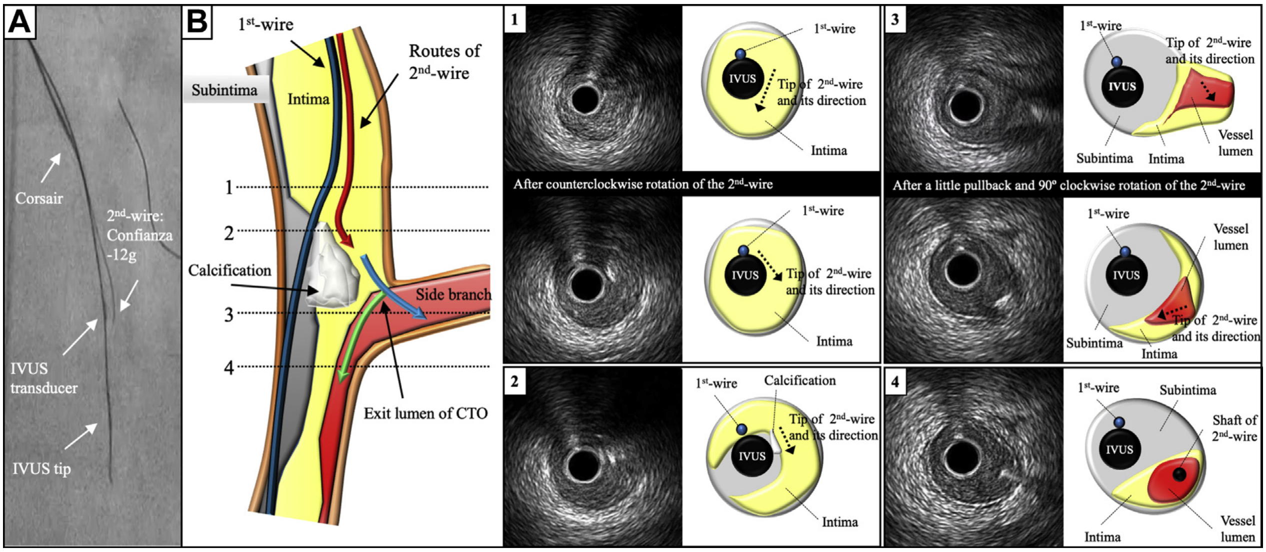
DISCUSSION

AO-IVUS-based 3D wiring using the tip detection method allowed us easily to recanalize a CTO lesion through which the guidewire could not be passed with the Navi-IVUS-based wiring 1 year previously.

For CTO PCI, a short tip with pullback system IVUS, such as AO-IVUS, is desirable to observe the second guidewire in the CTO lesion with minimal vascular damage. Furthermore, this pullback system allows us to perform tip detection, which enables real-time IVUS-based 3D wiring. Since AO-IVUS has become available, the limitations of CTO wiring have been the inability to pass the guidewire because of severe calcification and the inability to control the guidewire as a result of severe bending of the vessel. In such situations, the retrograde approach or antegrade dissection re-entry should be considered.

The first operator and second operator have specific roles during AO-IVUS-based 3D wiring. The second operator uses only the IVUS image to construct the 3D image with the tip detection method and should sequentially tell the first operator which direction and how many degrees to rotate the guidewire to allow it to follow the optimized route in the second operator's mentally created image. The

FIGURE 4 **IVUS-Based 3D Wiring Using the Tip Detection Method**



(A) Angiographic image during the tip detection method. **(B)** Illustration of the long-axis positional information of intravascular ultrasound (IVUS) images. The **red, blue, and green arrows** show the route of passage of the second guidewire. The **numbers** coincide with the numbered intravascular ultrasound position images. Intravascular ultrasound images and their illustrations during the tip detection method. CTO = chronic total occlusion.

first operator mainly uses fluoroscopic imaging to manipulate the guidewire according to the instructions of the second operator. Therefore, it is better for the first operator to recognize where the targeted intimal space and exit lumen are in 3D on the angiographic image. As shown in the present case, the tip detection method is also useful to transfer the positional information on the vascular constructions from the IVUS image to the angiographic image.

We hope that this method will be adopted for clinical use around the world because of the increased international availability of IVUS with a short tip with pullback system, which was first developed in Japan with AO-IVUS.

FOLLOW-UP

The patient was reviewed at 4 months and was found to have no further angina.

CONCLUSIONS

IVUS-based 3D wiring using the tip detection method is simple and will be the most accurate antegrade CTO wiring method.

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KEY WORDS chronic total occlusion, coronary intervention, IVUS-based 3D wiring, tip detection method