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CASE REPORT
Coronary heart disease

Tip detection-antegrade dissection and reentry using intravascular ultrasound in chronic total occlusion intervention: first human case report

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Background It has been considered impossible to perform antegrade dissection and reentry (ADR) by simply puncturing with a guidewire using the intravascular ultrasound (IVUS) observation without the support of the Stingray system.

Case summary A 78-year-old man suffered from effort angina pectoris due to a chronic total occlusion (CTO) lesion in the left circumflex coronary artery. A retry percutaneous coronary intervention for the CTO lesion was attempted at our hospital. The J-CTO score was 3. The first guidewire entered the subintimal space. We moved onto Stingray-ADR using the angiographic observation, but the guidewire could not be led into the true lumen. AnteOwl WR-IVUS (AO-IVUS) observation revealed a distal true lumen in which the inner lumen was maintained 5 mm beyond the CTO exit. We decided to perform the tip detection-ADR using the AO-IVUS observation. The tip detection method allowed the tip of the penetration wire to puncture the wall between the subintima and the true lumen in an exactly vertical direction, resulting in the successful creation of a reentry point. The CTO lesion was dilated with one drug-eluting stent, and normal antegrade blood flow was achieved.

Discussion Since the tip detection method enables accurate punctures, it may allow for ADR by simply puncturing using a guidewire. Due to this method being performed using the IVUS observation, it is likely more reliable than Stingray-ADR using the angiographic observation.

Keywords Case report • Coronary intervention • Chronic total occlusion • Antegrade dissection and reentry • IVUS-based tip detection method

ESC Curriculum 3.3 Chronic coronary syndrome • 2.1 Imaging modalities • 3.1 Coronary artery disease

Learning points

- To recognize that AnteOwl WR-intravascular ultrasound-based three-dimensional wiring using the tip detection method can allow reentry without a reentry device in chronic total occlusion (CTO) percutaneous coronary intervention.
- To control the CTO stiff guidewires accurately according to the tip detection method.

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Introduction

In chronic total occlusion (CTO), percutaneous coronary intervention (PCI), antegrade dissection and reentry (ADR) using the Stingray system (Stingray-ADR; Boston Scientific, Natick, MA, USA) has been widely used, but it does not have a high level of accuracy because it is a procedure using the angiographic observation.[1] It has been considered impossible to perform ADR by simply puncturing with a guidewire using the intravascular ultrasound (IVUS) observation without the support of the Stingray system.

We developed AnteOwl WR-IVUS (AO-IVUS; Terumo Corp., Tokyo, Japan), which has a short tip and a pullback transducer system and devised a tip detection method to standardize IVUS-based three-dimensional (3D) wiring.[2,3] This method has been established to accurately advance guidewires inside the intraplaque in CTO lesions. However, while performing it, we first found that the tip detection method allows for ADR because the wall between the subintima and the true lumen can be punctured at the intended part in an exactly vertical direction using the IVUS observation. We named this method 'tip detection-ADR (TD-ADR)'.

Timeline

6 months ago	He began to feel chest pain on exertion.
3 months ago	He was diagnosed with effort angina pectoris by cardiac computed tomography.
Day 1	The patient was admitted to our hospital.
Day 2	The retry percutaneous coronary intervention for the chronic total occlusion in the left circumflex coronary artery was performed.
Day 3	No significant increase in myocardial enzymes was observed.
Day 4	He was discharged in favourable clinical course.
1 month later	The chronic total occlusion in the left anterior descending coronary artery was recanalized with an additional percutaneous coronary intervention.
7 months later	In outpatient follow-up, he was asymptomatic and blood pressure was 132/84 mmHg, and no change was observed in the electrocardiogram.

Case summary

A 78-year-old Asian man with an old inferior myocardial infarction suffered from effort angina pectoris due to CTO lesions in the left circumflex coronary artery and left anterior descending coronary artery. His significant past medical history was dyslipidaemia. PCI was performed on the CTO lesion in the left circumflex coronary artery at another hospital (*Figure 1A*). During antegrade wire escalation, a guidewire seemed to enter the subintimal space angiographically (*Figure 1B*) and could not be passed through the CTO lesion.

The patient was admitted to our hospital 1 month later for a retry procedure for the CTO lesion. He was independently mobile, and had received optimal medical therapy consisting of antiplatelet medication. The physical examination revealed the following: blood pressure, 122/72 mmHg and heart rate, 57 bpm. There were no cardiac murmur and pulmonary rales. The electrocardiogram displayed abnormal Q-waves in lead II, II, aVF. Echocardiography showed inferior wall motion hypokinesis with an ejection fraction of 57% and no significant valvular heart disease. The blood test showed that creatinine level was 1.01 mg/dL (normal values 0.70–1.20 mg/dL), and N-terminal pro-brain natriuretic peptide level was 114.7 pg/dL (normal values $<$ 125 pg/dL). A presumptive diagnosis of effort angina pectoris due to the CTO lesions was made by electrocardiogram and echocardiography which showed the viability of the anterior and posterior walls. We planned to perform only the antegrade approach because there were no interventional retrograde channels. The procedure was performed from the femoral approach with an 8-Fr guiding catheter. An XT-R wire (Asahi Intecc Co., Ltd., Aichi, Japan) supported by a Finecross microcatheter (Terumo Corp.) seemed to enter the subintimal space angiographically, which was confirmed by AO-IVUS (*Figure 2A and B*). Then, the AO-IVUS-based 3D wiring was performed (*Figure 2B*), but the guidewire could not be advanced because of a huge calcified wall at the transition site. Although the true lumen beyond the CTO exit was not clearly visible angiographically, we moved onto Stingray-ADR using an angiographic observation (*Figure 2C*). Using Confianza-20 g (Asahi Intecc) and XT-R wires, five attempts of the stick-and-swap technique were performed, but the guidewire could not be led into the true lumen under the angiographic observation (*Figure 2D*).

IVUS observation revealed a distal true lumen in which the inner lumen was maintained 5 mm beyond the CTO exit (*Figure 3A*). We decided to perform TD-ADR using the AO-IVUS observation. The Confianza-20 g supported by the Finecross was advanced at the site where we attempted reentry (*Figure 3E*). The tip detection method allowed the tip of the Confianza-20 g to puncture the wall between the subintima and the true lumen in an exactly vertical direction (*Figure 3B–E*; Supplementary material online, *Video S1*), resulting in successful reentry (*Figure 3F*). The CTO lesion was dilated with one drug-eluting stent, and normal antegrade blood flow was achieved (*Figure 2F*). The patient was discharged on post-operative day 2.

Discussion

Various reentry techniques have already been reported,[1] and the standard strategy is the Stingray-ADR. But, there can be problems in visualizing the target because all of the techniques depend on angiographic images. Compared with them, TD-ADR enables the puncture to be at a more proximal part and allows a pinpoint puncture of the intended part in the vertical direction, because the target and the guidewire tip are clearly visible using the IVUS observation (*Figure 4*). The global CTO algorithm has recently been reported (*Figure 5A*),[4] but we hope that it will be changed to the following algorithm including the use of AO-IVUS (*Figure 5B*). The procedural details are shown in Supplementary material online, *Video S2*. When the antegrade approach is continued after the failure of

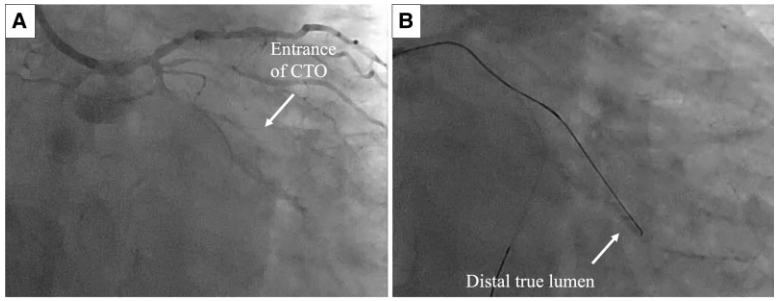

Figure 1 Angiographic images in first coronary intervention for the CTO lesion in the left circumflex coronary artery. Angiographic images (*A*) prior to and (*B*) during the procedure at another hospital. CTO, chronic total occlusion.

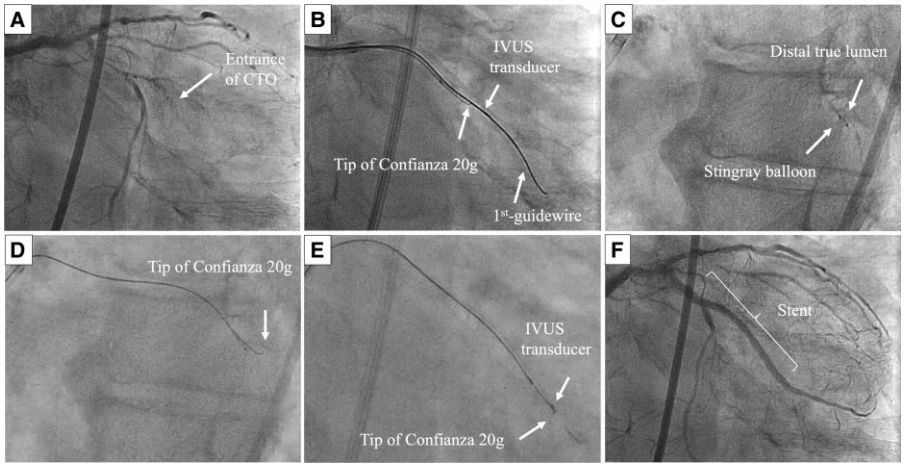

Figure 2 Angiographic images in second coronary intervention for the chronic total occlusion lesion in the left circumflex coronary artery. Angiographic images (*A*) prior to, (*B–E*) during the procedure, and (*F*) after the procedure at our hospital. IVUS, intravascular ultrasound image.

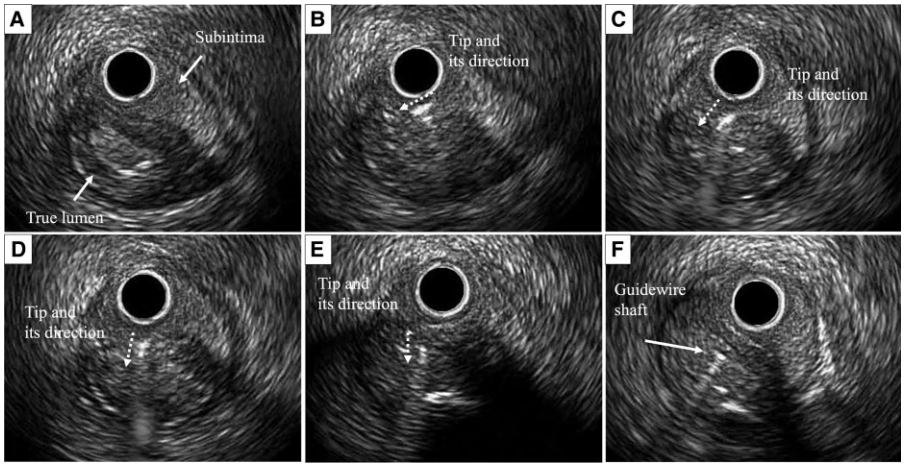

Figure 3 Successful reentry using the tip detection method. Intravascular ultrasound image (*A*) prior to, (*B–E*) during the puncture of the wall between the subintima and the true lumen in a vertical direction using the tip detection method, and (*F*) after the successful puncture.

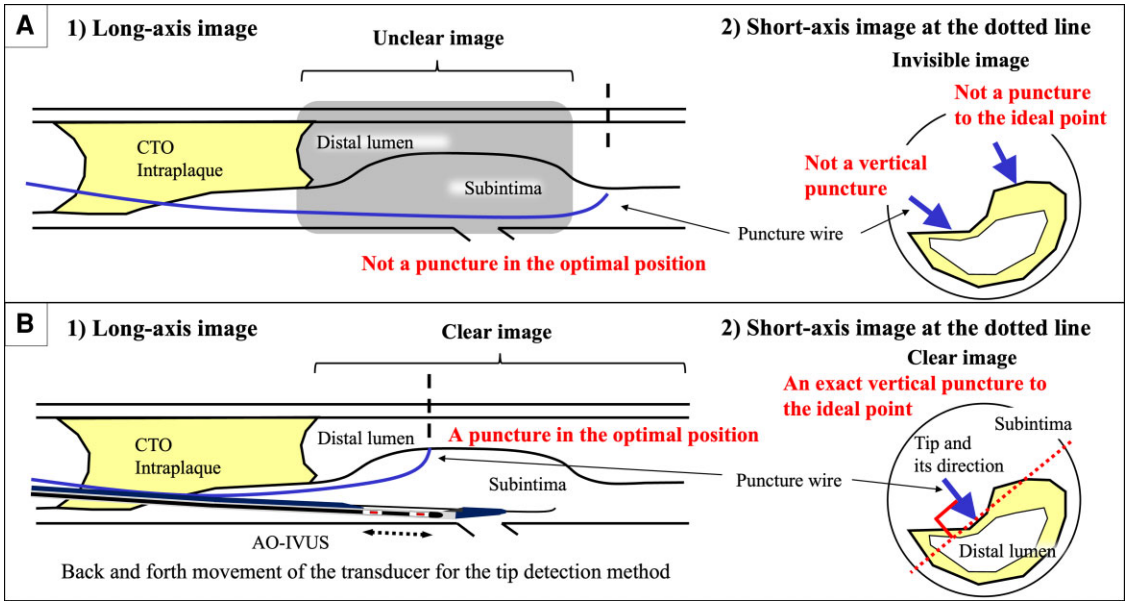

Figure 4 The pros and cons of Stingray-antegrade dissection and reentry and tip detection-antegrade dissection and reentry. Illustrations of (1) long-axis and (2) short-axis procedures for (*A*) Stingray-antegrade dissection and reentry and (*B*) tip detection-antegrade dissection and reentry, respectively. The red words state the pros and cons of these procedures. AO-IVUS, AnteOwl WR-intravascular ultrasound; CTO, chronic total occlusion.

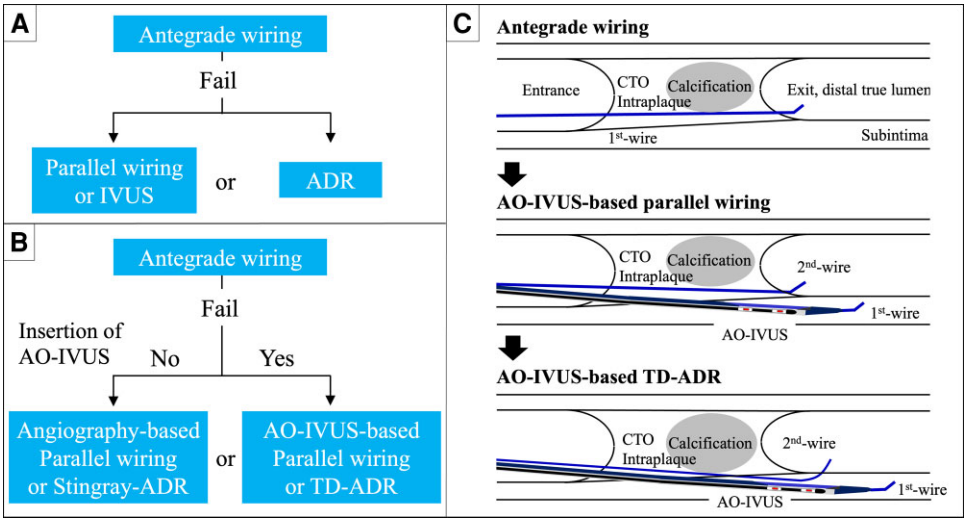

Figure 5 The chronic total occlusion algorithm including the use of AnteOwl WR-intravascular ultrasound. (*A*) The current and (*B*) the new chronic total occlusion algorithms, and (*C*) the flow chart up to tip detection-antegrade dissection and reentry.

antegrade wire escalation, if an IVUS catheter can be inserted into the CTO lesion, AO-IVUS-based 3D wiring will be selected for the guidewire to pass the CTO through the intraplaque route (parallel wiring) or reentry (TD-ADR) to minimize side branch occlusion (*Figure 5B and 5C*; Supplementary material online, *Video S2*). However, if it is difficult to insert an IVUS catheter, the angiography-based parallel wiring or Stingray-ADR will be selected (*Figure 5B*).

Conclusion

AO-IVUS-based 3D wiring using the tip detection method has been established as a method for accurately advancing guidewires inside the intraplaque. However, it can also be utilized to intentionally create a reentry point because an exact vertical directional puncture can be achieved.

Lead author biography

Dr. Satoshi Suzuki was born in Osaka, Japan, in 1985 and graduated from Kansai Medical University in 2012. He is currently a Clinical Fellow in Cardiology at Sakurabashi Watanabe Hospital. His main research interest is the method of PCI for chronic complete occlusive lesions.

Supplementary material

Supplementary material is available at *European Heart Journal – Case Reports* online.

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Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: The authors confirm that written consent for submission and publication of this case report including images and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: A.O. and H.N. have received speaking fees from Terumo Corp (Tokyo, Japan). All other authors have reported that they have no conflict of interest to be declared.

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