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CORONARY, PERIPHERAL, AND STRUCTURAL INTERVENTIONS

CLINICAL CASE

A Giant Coronary Aneurysm Formation After RCA CTO Recanalization

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ABSTRACT

Formation of a coronary artery aneurysm (CAA), especially a giant CAA, after percutaneous coronary intervention for chronic total occlusion (CTO) is a rare complication. Therapeutic approaches include surgical procedure, covered stent, and medical treatment. Here, we report a 47-year-old man readmitted due to chest distress who had undergone right coronary artery CTO recanalization 6 months earlier. Diagnostic coronary artery angiography revealed a giant aneurysm at the stented middle segment of the right coronary artery; it was >20 mm in diameter. This is the first report on a secondary giant CAA after CTO recanalization that was subsequently excluded with deployment of a covered stent. (JACC Case Rep. 2025;30:103321) © 2025 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/).

HISTORY OF PRESENTATION

A 47-year-old male patient with a history of hypertension was readmitted to the hospital due to chest discomfort and dyspnea after a percutaneous coronary intervention (PCI) for chronic total occlusion (CTO) lesions in the right coronary artery (RCA) and severe stenosis in the left circumflex artery 6 months earlier. The patient had experienced fever symptoms 1 week after discharge from his previous hospitalization; he was diagnosed with acute pericarditis and treated accordingly. However, he subsequently developed chest distress and dyspnea without any apparent correlation with physical activities, but these symptoms worsened during activity. A transthoracic echocardiography revealed an ejection fraction of 58% and a cystic echo measuring approximately 35 × 30 × 40 mm at the atrioventricular groove connected to the RCA, raising suspicion of aneurysm formation. In addition, the cardiac computed tomography angiography (CTA) revealed a circular high-density shadow around the stented middle segment of the RCA, which was suspected to be formation of an aneurysm (Figure 1). Baseline laboratory work-up showed normal results. Electrocardiogram results showed slight changes in the ST-T-wave at different time points (Figure 2).

TAKE-HOME MESSAGES

- The use of multimodal imaging, such as echocardiography and coronary CT imaging, plays a vital role in preliminary GCAA diagnosis.
- IVUS results revealed that formation of GCAA is strongly associated with the most vulnerable vessel site in the diffused dissection created by CTO PCI hybrid techniques.

PAST MEDICAL HISTORY

The patient had a past medical history of treatment for coronary heart disease and hypertension at local clinics for >5 years and a 20-year history of smoking,

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ABBREVIATIONS AND ACRONYMS

CAA = coronary artery aneurysm

CAG = coronary angiography

CPA = coronary pseudoaneurysm

CS = covered stent

CTA = computed tomography angiography

CTO = chronic total occlusion

DES = drug-eluting stent

GCAA = giant coronary artery aneurysm

IVUS = intravascular ultrasound

PCI = percutaneous coronary intervention

RCA = right coronary artery

1 pack per day. There was no evidence of Kawasaki disease or vasculitis, and no family history of diseases.

DIFFERENTIAL DIAGNOSIS

The cause of the patient's chest discomfort during the second admission at 6 months may be attributed to symptoms indicative of aneurysm formation or ongoing ischemia. The echocardiogram examination indicated suspicion for coronary artery aneurysm (CAA) development. To accurately determine the presence of an aneurysm, it is crucial for the patient to undergo diagnostic procedures such as coronary angiography (CAG) and intravascular ultrasound (IVUS).

INVESTIGATIONS

CAG revealed the presence of a patent stent in the proximal region of the RCA, along with a large aneurysm located at the middle section of the stent. The size of this aneurysm, as visualized by contrast medium, measured approximately 24 × 30 mm in diameter, leading to inadequate filling of the distal vessels (**Figures 3A to 3B**). This aneurysm exceeded 20 mm in diameter and was classified as a giant CAA (GCAA).

MANAGEMENT

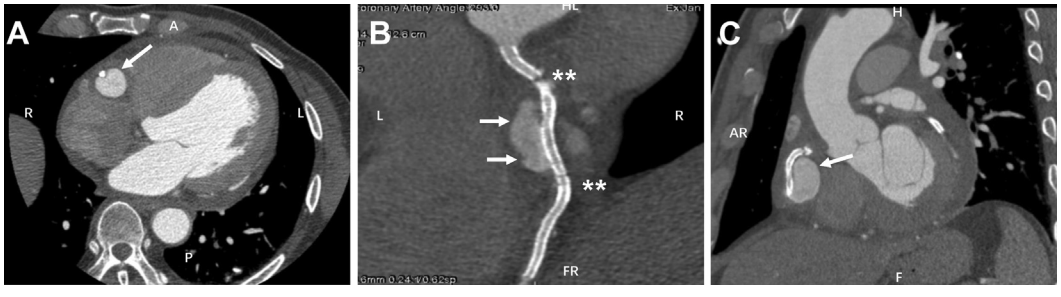
The aneurysm was visualized by IVUS, which revealed a vessel structure with 3 unclear layers connected to the RCA via stents. Due to the high risk involved, the surgical team declined excising the GCAA or performing coronary artery bypass surgery. However, considering the patient's symptoms related to the GCAA and the location of the aneurysm target lesion in a relatively straight segment of the RCA with no big side branches, we opted for using covered stent (CS) treatment.

The guidewire Sion (Asahi Intecc) was slid through the opposite wall of the aneurysm into the distal vessel in the left anterior oblique view. Without a commercial polytetrafluoroethylene CS available, a self-made polyurethane CS, using an appropriate length of 3M Tegaderm Transparent Film Dressing (3M Company) on a 3.5 × 38 mm drug-eluting stent (DES) (**Figure 3C**) as previously described,[1] was deployed from the RCA proximal to the distal portion. Complete CAA exclusion was confirmed by angiography and also with good distal vessel visualization (**Figures 3D to 3E**).

We again reviewed the previous PCI process and the IVUS results. First, a 3.5 × 38 mm DES was deployed in the left circumflex artery. CAG of the proximal RCA CTO showed no stump with big branch and CTO length >20 mm and with collateral channels (**Figures 4A and 4B**). The retrograde procedure recanalized the RCA CTO with retrograde and antegrade knuckled wire and reverse controlled antegrade and retrograde tracking techniques; the angiograms showed diffused severe dissection (**Figures 4C and 4D**). The final results indicated a TIMI flow grade 3 after deployment of 3 DESs (**Figures 4E and 4F**).

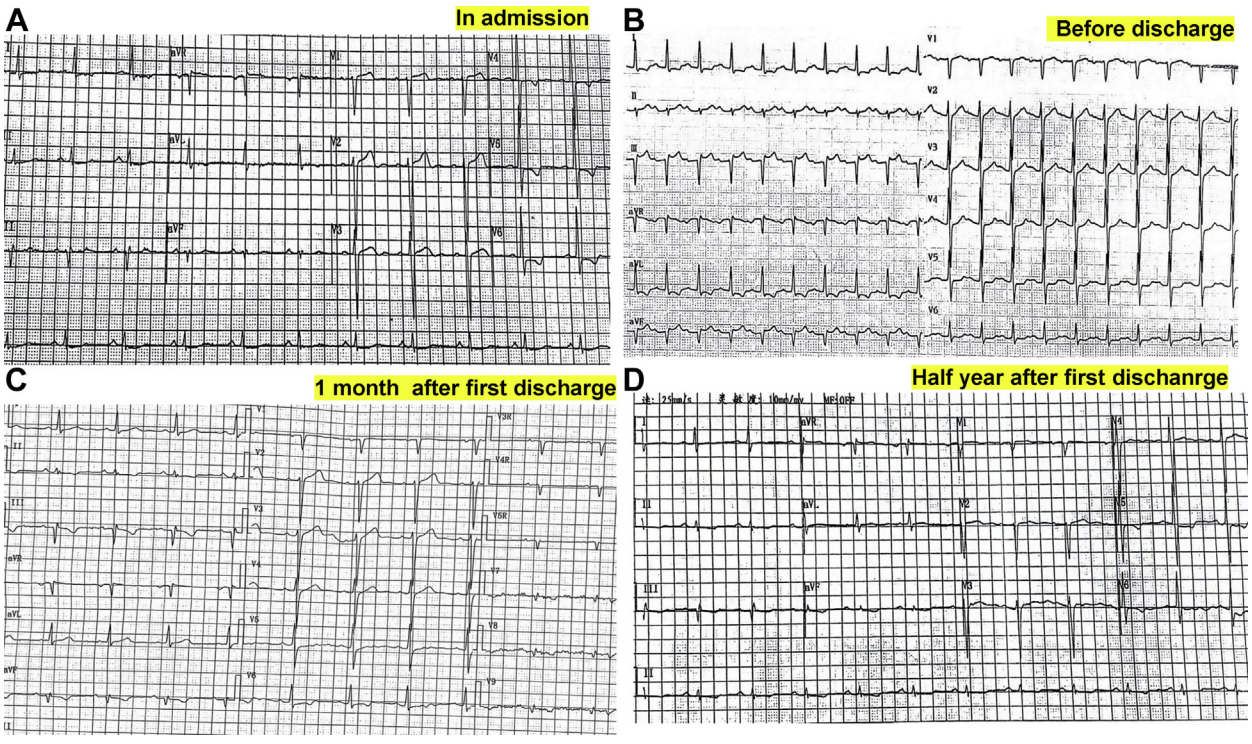
IVUS was performed during both procedures for this case. After RCA CTO recanalization, IVUS images identified the wire location and the most vulnerable dissection injury in the vessel medial layer (**Figure 5A and 5B**). Additionally, IVUS was utilized to measure

FIGURE 1 Coronary CT Results About the Coronary Aneurysm



(A) Coronary computed tomography (CT) imaging in the axial view revealed a circular high-density shadow (arrow) around the right coronary artery (RCA) stents. (B) Coronary CT imaging in curve reconstruction showed a cystic high-density shadow (arrow) at the stented middle segment of the RCA. Double asterisks for suspected stent fractures. (C) Coronary CT imaging in multi-plane reconstruction of the oblique sagittal view showed a cystic high-density shadow (arrow) on the right side of RCA stents.

FIGURE 2 Evolution of ECG Results



(A) Electrocardiogram (ECG) at first admission showed normal sinus rhythm and ST-segment depression ≤0.01 mV in leads II/V_5-V_6 and T-wave inversion in leads I/avL/V_4-V_6. (B) ECG on the second day after percutaneous coronary intervention (PCI) for right coronary artery (RCA) chronic total occlusion (CTO) showed ST-segment depression ≤0.01 mV in leads I/aVL/V_5-V_6, ST-segment elevation ≤0.01 mV in leads III/aVF, and T-wave inversion in leads I/aVL. (C) ECG at 1 month after first discharge showed ST-segment depressed ≤0.01 mV in leads II/V_5-V_6, ST-segment elevation ≤0.01 mV in leads V_1-V_2, and T-wave inversion/flat in leads I/aVL/V_5-V_6. (D) ECG at the current admission (6 months after the first discharge) showed ST-segment depressed ≤0.01 mV in leads V_5-V_6, ST-segment elevation ≤0.01 mV in leads V_1-V_2, and T-wave inversion/flat in leads I/aL/V_5-V_6.

the respective distances from extra-plaque site and dissection injury to the RCA ostium (Figure 5C). After the deployment of the three stents, IVUS results showed that the stents expanded and attached well (Figure 6A).

IVUS images confirmed the presence and exclusion of GACC (Figure 6B and 6C), and the total aneurysm length was measured to be approximately 23.33 mm (Figure 6D). Based on these two IVUS findings (Figures 5 and 6), the most vulnerable site in the medial layer was identified at approximately the midpoint of the total aneurysm length. Furthermore, cardiac CT revealed RCA stent fracture, which was confirmed by IVUS imaging (Figure 7).

OUTCOME AND FOLLOW-UP

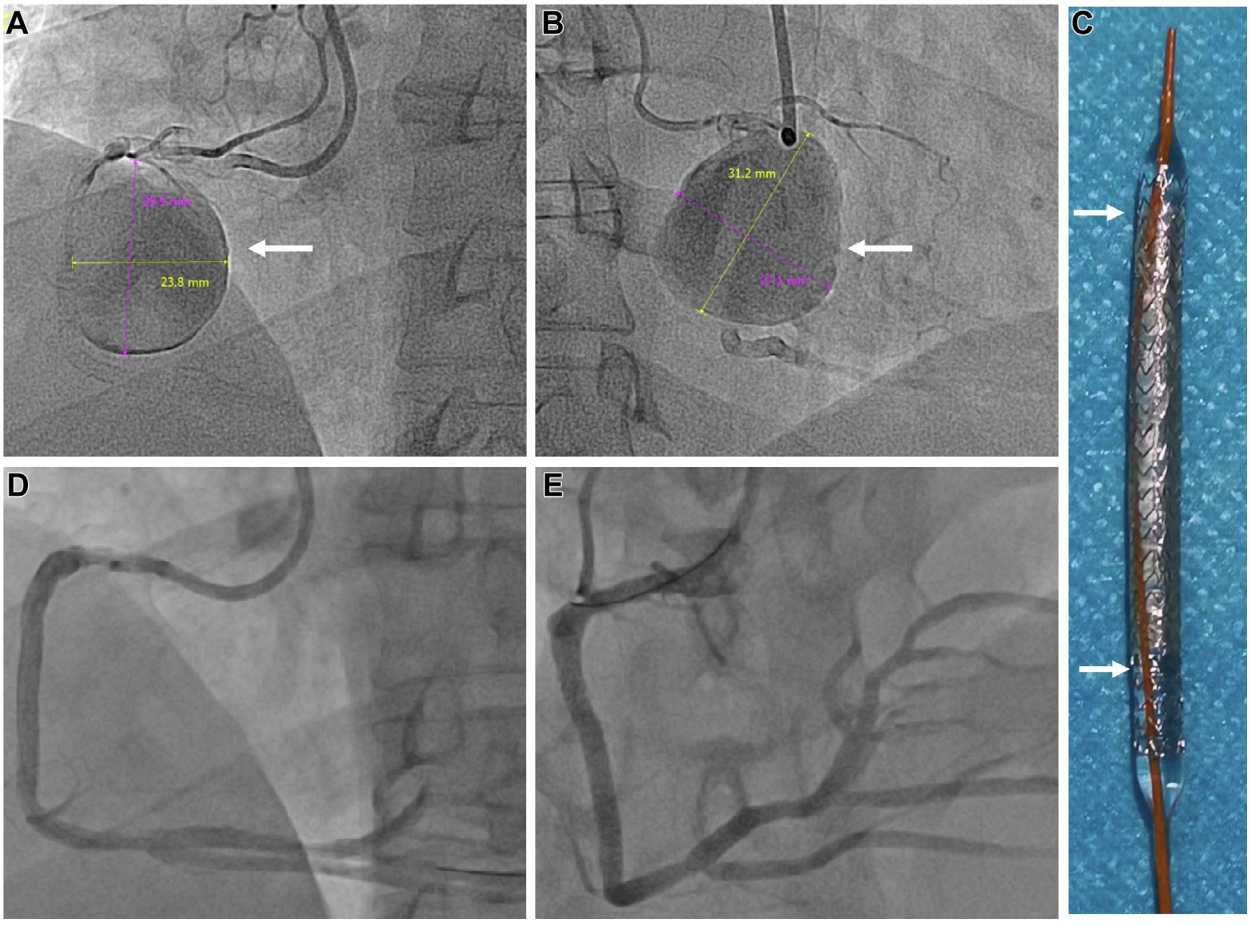
The patient was discharged on clopidogrel and rivaroxaban. Four years after the procedure, the patient currently has mild symptoms.

The diagnostic CAG showed patent RCA stents with no obvious restenosis and no signs of coronary artery ectasia during the first year of follow-up. The cardiac CTA revealed consistent results with the CAG during the second and third years of follow-up (Figure 8).

DISCUSSION

A CAA is defined as an abnormal dilatation of a vessel with a diameter ≥1.5 times that of the adjacent normal vessel.[2] If the CCA diameter exceeds the normal segment diameter by >4 times or the diameter is >20 mm, it can be termed a GCAA; however, there is no clear consensus on the definition.[3] The overall incidence of CAAs is low, with an estimated rate of 3.9% after percutaneous transluminal coronary angioplasty and 0.7% to 3.4% after implantation of DES.[4] However, the rate of aneurysms in the CTO lesions is approximately 10-fold greater than in non-CTO lesions.[5] The clinical presentation of CAAs is

FIGURE 3 Coronary Aneurysm Excluded After Self-Made Covered Stent Implantation



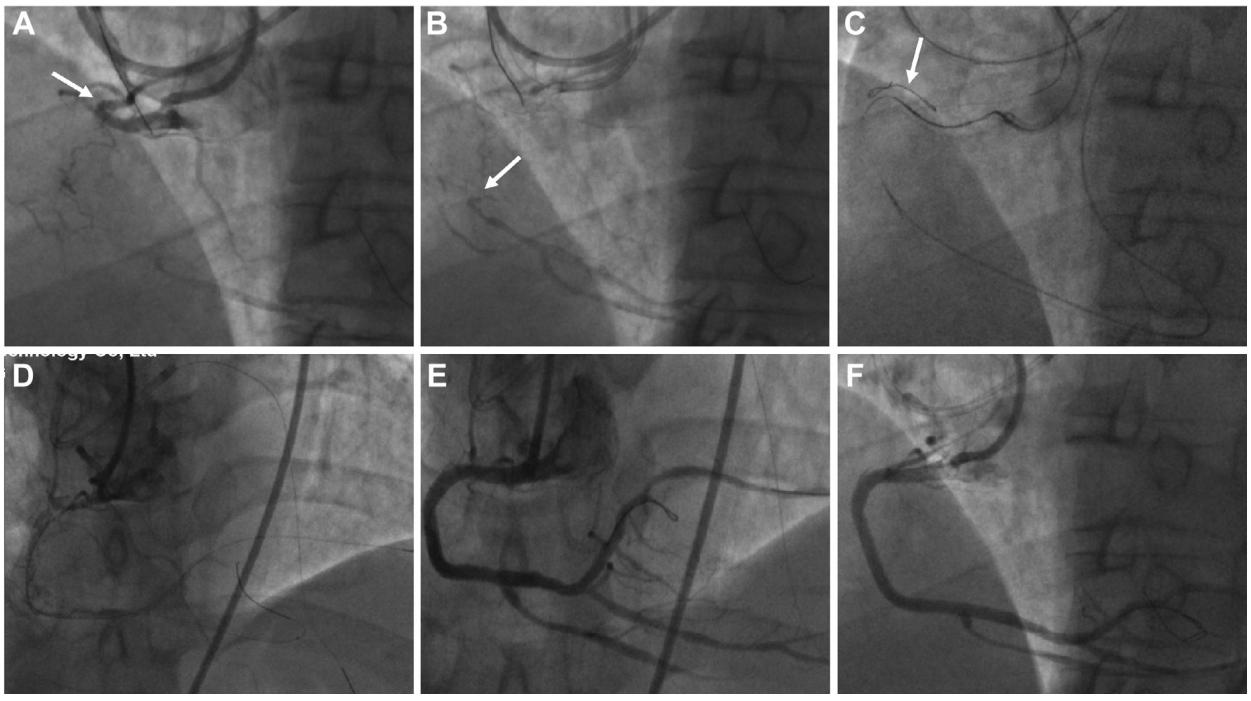
(A) Large aneurysm (arrow) visualization (approximately 24 × 30 mm) at the stented middle segment of the right coronary artery (RCA). (B) Giant aneurysm (arrow) visualization (about 27 × 31 mm) in right anterior oblique (RAO) view. (C) Self-made polyurethane-covered stent by 3M Tegaderm Transparent film Dressing (arrows) on 3.5 × 38 mm stent. (D) The aneurysm was excluded after deployment of a self-made 3.5 × 38 mm covered stent. (E) Aneurysm exclusion shown in RAO view.

mainly asymptomatic or presents with angina pectoris, dyspnea, arrhythmias, and myocardial infarction.[6] GCAAs are more often symptomatic.

Aneurysm formation has been observed from 1 week to 4 years after DES implantation and up to 9 years after bare-metal stent implantation.[7] In addition, CAAs may be discovered incidentally during angiography. In this case report, the patient had developed symptoms within 6 months after the initial PCI procedure. Meanwhile, multimodality imaging techniques, such as echocardiography and cardiac CTA, preliminarily visualized the GCAA. CAG confirmed the existence of an aneurysm >20 mm in diameter as a GCAA.

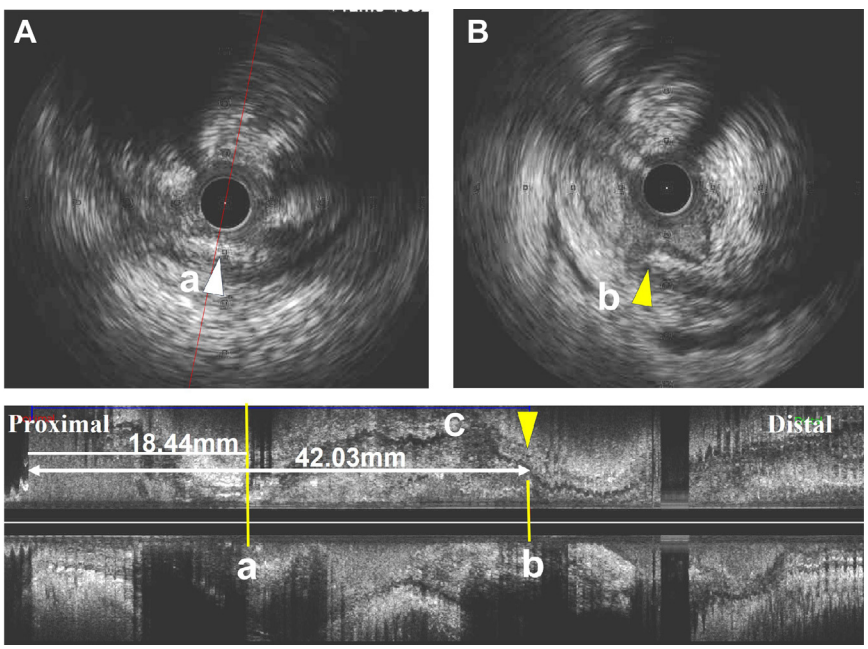
The pathologic mechanism of CAA is most likely multi-factorial in CTO PCI. The use of hybrid techniques in complex cases of CTO may potentially damage the vessel elastic component, leading to a predisposition for gradual lumen enlargement and forming a coronary pseudoaneurysm (CPA).[8] This patient had no history of Kawasaki disease, and we considered that GCAA should be a CPA secondary to medial layer injury caused by the knuckled wire and reverse controlled antegrade and retrograde tracking technique. Jun[5] reported the more severe the dissection, the more likely the occurrence of CAA in CTO PCI and of note, while CAAs occur at a site of dissection. In this case, the vessel's most vulnerable site in the medial layer was measured as close as possible to the mid-point of total aneurysm length, speculating that this serves as the initial site of aneurysm development. The results showed that there was a strong correlation between aneurysm

FIGURE 4 The Procedure of RCA CTO Recanalization



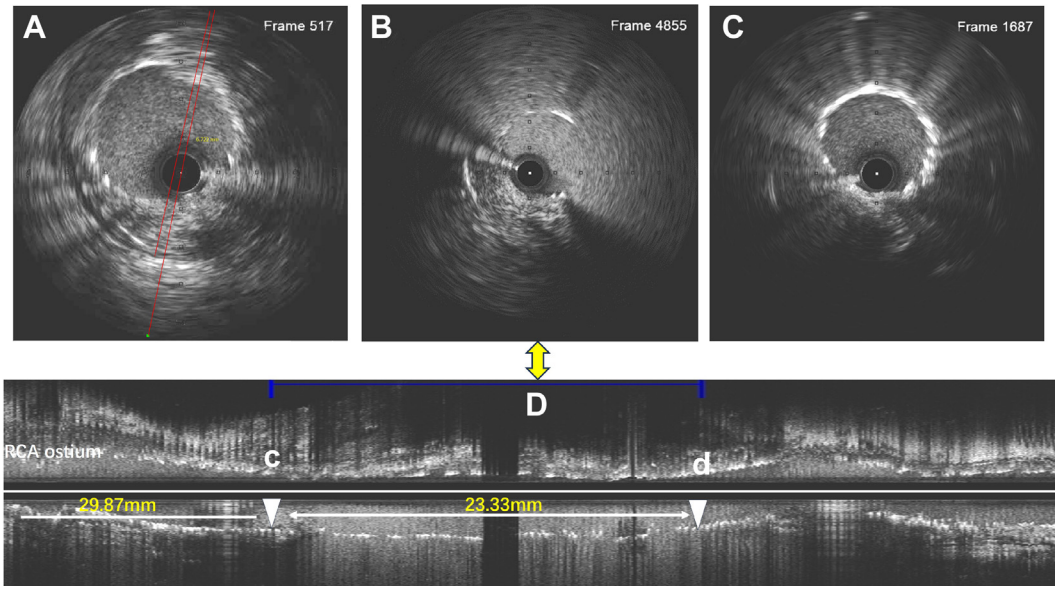
(A) RCA proximal CTO (arrow) with ambiguous entry and with a large branch. (B) Bridging vessels in the proximal RCA to visualize the distal segment of the CTO (arrow). (C) Retrograde knuckled wire (arrow) technique performed during CTO recanalization. (D) Diffuse severe dissection formation after recanalization of the RCA CTO. Abbreviations as in Figure 2.

FIGURE 5 IVUS Assessment of Medial Layer Injury After RCA CTO Recanalization



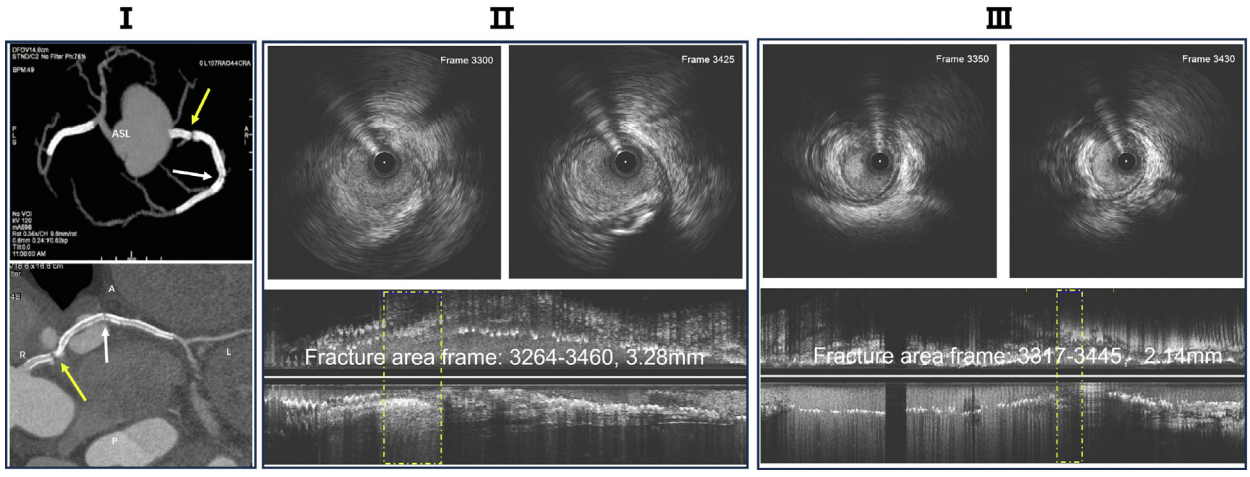
(A) Intravascular ultrasound (IVUS) revealed wire only 1 mm length in extra-plaque tissue ("a") (white arrowhead). (B) IVUS identified the most vulnerable site in the vessel medial tissue ("b") (yellow arrowhead). (C) IVUS longitudinal view. The distance was 18.44 mm from "a" to the RCA ostium. The distance was 42.03 mm from "b" to the RCA ostium. Other abbreviations as in Figure 2.

FIGURE 6 **IVUS Assessed the GCAA**



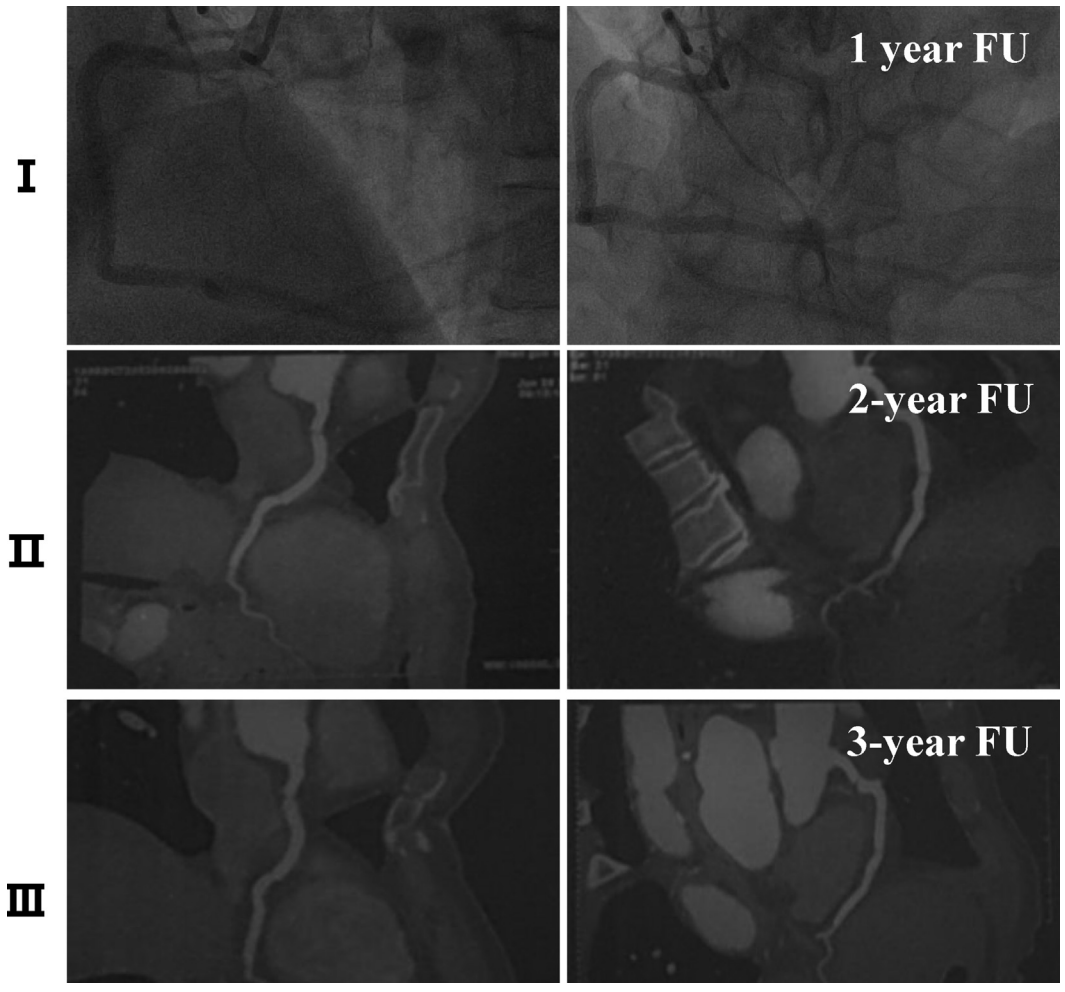
(A) IVUS clearly measured RCA stent expansion and attachment. (B) IVUS images revealed the existence of a giant coronary artery aneurysm (GCAA), which connected to vessels through the strut gaps of the stent. (C) IVUS images showed the aneurysm isolated with vessels after the covered stent was well expanded. (D) IVUS longitudinal view show the overall length of intima interruption (aneurysm length, from "c" to "d") (arrowheads) measured approximately 23.33 mm. Abbreviations as in Figures 2 and 5.

FIGURE 7 **Stent Fractures in the Proximal and Segments 2 to 3 of RCA**



I: Cardiac computed tomography angiography (CTA) images show stent fractures in the proximal region (white arrows) and segments 2 to 3 (yellow arrow) of the RCA. II: Per IVUS, the length of the RCA proximal stent fracture was about 3.28 mm (yellow dotted box). III: Per IVUS, the length of the RCA segments 2 to 3 stent fracture was about 2.14 mm (yellow dotted box). Abbreviations as in Figures 2 and 5.

FIGURE 8 CAG and Cardiac CTA Images of the RCA at Different FU Times



I: Coronary angiography (CAG) results indicate all stents are patent in 2 views at the 1-year follow-up (FU). II: CCTA images show all stents are patent without aneurysm in the RCA at the 2-year FU. III: CCTA images show all stents are patent without aneurysm in the RCA at the 3-year FU. Abbreviations as in Figures 2 and 7.

formation and severe dissection, which was consistent with the above report.[5] Therefore, IVUS played an important role in revealing the potential mechanism of aneurysm formation. Compared with CAG, IVUS can provide transmural images of the coronary artery to distinguish a true aneurysm and CPA. IVUS results revealed a true 3-layer vessel structure in the RCA after recanalization of the RCA CTO, but for this GCAA, the limitation of IVUS longitudinal scanning distance prevented identification of the outward protrusion of the adventitial layer.

The treatment strategy is individualized and depends on clinical presentation and the aneurysm size, morphology, location, and expansion history. Treatment options included medical management and surgical excision, coronary bypass grafting, and percutaneous intervention. Recently, Somsen et al[9] described a GCAA from the RCA that was treated by surgical intervention. Covered stents may be indicated in the case of very large or enlarging aneurysms. In our case, the giant aneurysm developed within 6 months with symptoms, and the surgeon team considered there was high risk during thoracotomy. Therefore, the CS was deemed the optimal choice, and the aneurysm was invisible with angiography after CS deployment.

The limitation in our case was the utilization of a self-made CS, which carries a higher risk of angiographic restenosis and stent thrombosis.[10] It is therefore advisable to conduct routine follow-up coronary CT or CAG imaging.

CONCLUSIONS

The optimal antiplatelet and anticoagulant therapy served as the cornerstone of treatment. Multimodal imaging in assessing coronary artery aneurysms should be applied, and the crucial role of IVUS in revealing the potential mechanism of GCAA formation should be highlighted.

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