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CASE REPORT
Coronary intervention

Intravascular ultrasound system-guided bail-out stent implantation for iatrogenic aortocoronary dissection: a case report

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Background Iatrogenic aortocoronary dissection (ACD) is a rare but potentially devastating complication of cardiac catheterization. We describe a case of an iatrogenic ACD following catheter engagement and balloon inflation of the proximal right coronary artery (RCA) during an elective percutaneous coronary intervention (PCI).

Case summary An 81-year-old woman presented with an acute inferior wall ST-elevation myocardial infarction. Emergent coronary angiography revealed the three-vessel diseases. Primary PCI for the culprit lesion of the occluded mid-circumflex artery was successfully performed. After 10 days, an elective PCI for the residual RCA lesions was performed. After the balloon inflation of the proximal RCA, iatrogenic ACD was detected. Intravascular ultrasound-guided stent implantation sealing an entry tear prevented further dissection. The post-operative course was uneventful, and the patient was discharged 1 week later. Follow-up cardiac computed tomography revealed a disappearance of the aortocoronary intramural haematoma.

Discussion This case emphasizes the importance of prompt detection and intervention for iatrogenic ACD. Heart team discussion is essential to determine whether cardiovascular surgery or percutaneous management should be performed. Bail-out stent implantation sealing an entry tear is frequently used and effective, and an intravascular ultrasound system would help to recognize the morphology of ACD, contributing to the safe procedure.

Keywords Iatrogenic aortocoronary dissection • Intravascular ultrasound system • Bail-out stenting • Percutaneous coronary intervention • Case report

ESC curriculum 2.1 Imaging modalities • 3.4 Coronary angiography • 3.1 Coronary artery disease

Learning points

- Iatrogenic aortocoronary dissection (ACD) is a rare but potentially devastating complication of cardiac catheterization.
- Iatrogenic ACD arises from catheter engagement, retrograde coronary dissection due to balloon inflation, contrast injection, and wiring.
- The management of iatrogenic ACD requires prompt decision-making and intervention. Heart team discussion is essential to determine whether cardiovascular surgery or percutaneous management should be performed.
- Bail-out stent implantation sealing an entry tear is frequently used and effective, and an intravascular ultrasound system would help to recognize the morphology of ACD, contributing to the safe procedure.

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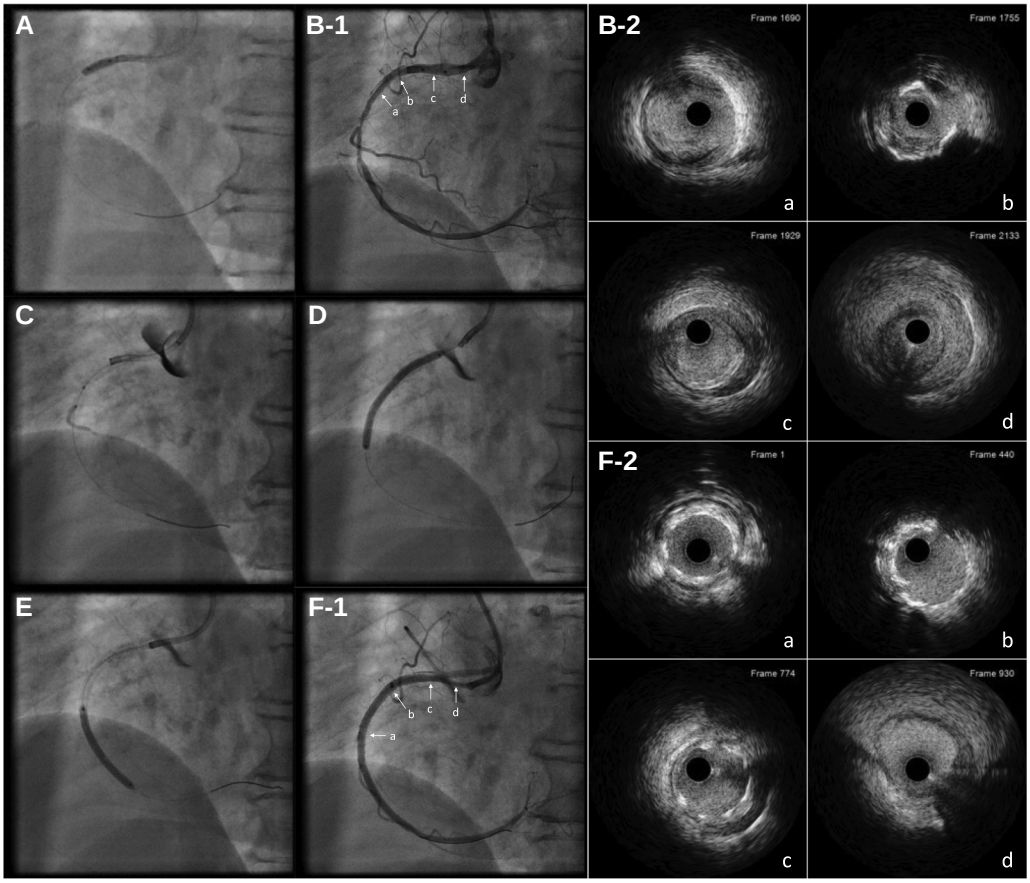
Introduction

Iatrogenic aortocoronary dissection (ACD) is a rare but potentially fatal complication of cardiac catheterization, with an estimated prevalence of 0.02–0.08% during diagnostic catheterization and 0.07–0.6% during percutaneous coronary intervention (PCI).[1,2] According to previous studies, iatrogenic ACD tends to arise from catheter engagement, while other ACDs arise from retrograde coronary dissection due to balloon inflation, contrast injection, and wiring.[3] Once iatrogenic ACD is detected, prompt decision-making and intervention are required. Herein, we report a case of an iatrogenic ACD following catheter engagement and balloon inflation of the proximal right coronary artery (RCA) during an elective PCI. Sealing an entry tear by stent implantation prevented further dissection. Furthermore, using intravascular ultrasound (IVUS) contributed to the precise vascular evaluation and safe procedure.

Summary figure



Case presentation

An 81-year-old woman with known hypertension presented with an acute inferior wall ST-elevation myocardial infarction. Emergent coronary angiography revealed the three-vessel diseases (*Figure 1A and B* and Supplementary material online, *Video S1*). Calculated SYNTAX score I was 15. Subsequently, primary PCI for the culprit lesion of the occluded mid-circumflex artery was successfully performed (*Figure 1C*). Statins and dual antiplatelet therapy were initiated. The post-operative course was uneventful.

After 10 days, an elective PCI for the residual RCA lesions was performed through the right radial artery. After the engagement of a 6 Fr Short Amplatz Left 1.0 guide catheter (Launcher, Medtronic, Minneapolis, MN, USA) and wire crossing with a 0.014 inch floppy wire (Runthrough NS, Terumo, Tokyo, Japan), the IVUS (OptiCross HD 60 MHz, Boston Scientific, Natick, MA, USA) system could not pass the proximal RCA stenosis. We dilated the narrowed proximal RCA with a 3.0 × 8 mm non-compliant balloon (NC Emerge, Boston Scientific, Natick, MA, USA) (*Figure 2A*). Angiography revealed dissection of the proximal RCA (*Figure 2B* and Supplementary material online, *Video S2*). The IVUS revealed a longitudinal intraluminal tear of the proximal RCA with an accompanying aortocoronary intramural haematoma. Right coronary artery ostium had a circumferential haematoma. (*Figure 2B* and Supplementary material online, *Video S3*). We identified iatrogenic ACD and planned for preventing further dissection by stent implantation of the entry tear. Additionally, we planned a one-stent implantation covering the entry tear and mid-RCA lesion simultaneously. After dilation of the mid-RCA by a 2.0 × 8 mm non-compliant balloon with the support of a 6 Fr guide extension catheter (HIKYAKU, Kaneka, Tokyo, Japan), angiography showed an ACD extending to the right coronary cusp and new coronary dissection of the right ventricle branch (*Figure 2C*). The IVUS showed an extended intramural haematoma

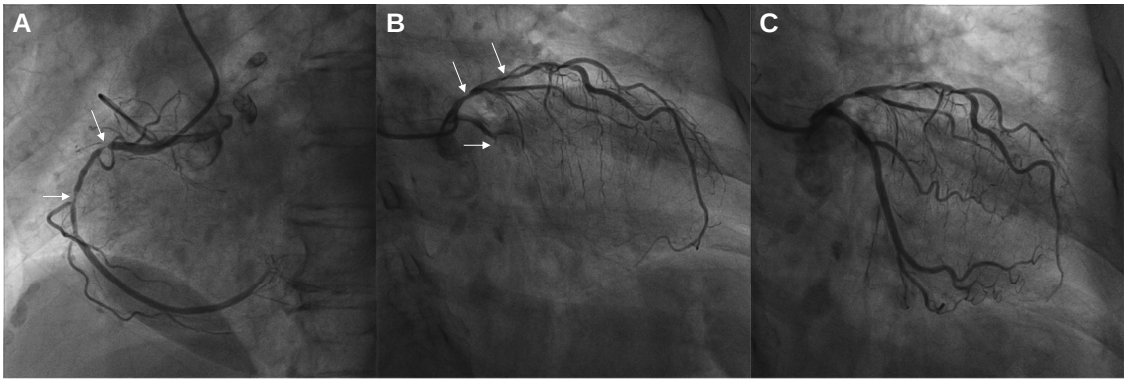


Figure 1 Emergent coronary angiography reveals the three-vessel diseases. (*A*) Right coronary artery with tandem lesions (white arrows). (*B*) Left coronary artery with an occluded mid-circumflex artery and left anterior descending artery stenosis (white arrows). (*C*) Coronary angiography after the primary percutaneous coronary intervention for the culprit lesion of the occluded mid-circumflex artery.

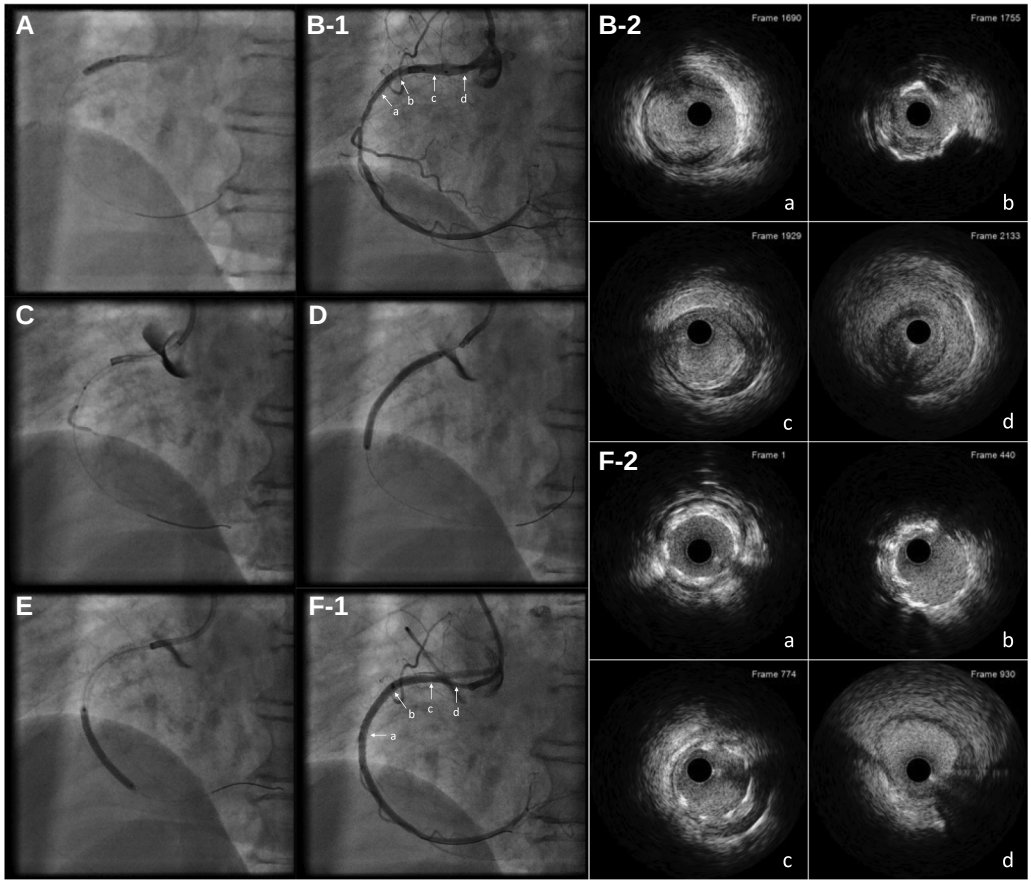


Figure 2 Elective percutaneous coronary intervention for the residual right coronary artery (RCA) lesions. (*A*) A 3.0 × 8 mm non-compliant balloon inflation for the narrowed proximal RCA. (*B-1*) After balloon inflation. Angiography showing coronary dissection of the proximal RCA. (*B-2*) Intravascular ultrasound (IVUS) images. Longitudinal intraluminal tear at the proximal RCA with an accompanying aortocoronary intramural haematoma. Right coronary artery ostium has a circumferential haematoma. (*C*) After a 2.0 × 8 mm non-compliant balloon inflation for the mid-RCA. Angiography showing an aortocoronary dissection extending to the right coronary cusp and new coronary dissection of the right ventricle branch. (*D*) A 2.75 × 38 mm drug-eluting stent (DES) is deployed at the proximal RCA. (*E*) A 2.5 × 38 mm DES is deployed at the mid-RCA. (*F-1*) Final angiography showing good coronary flow except for the right ventricle branch, with a remaining aortocoronary dissection. (*F-2*) The IVUS showing an expanded stent-lumen area.

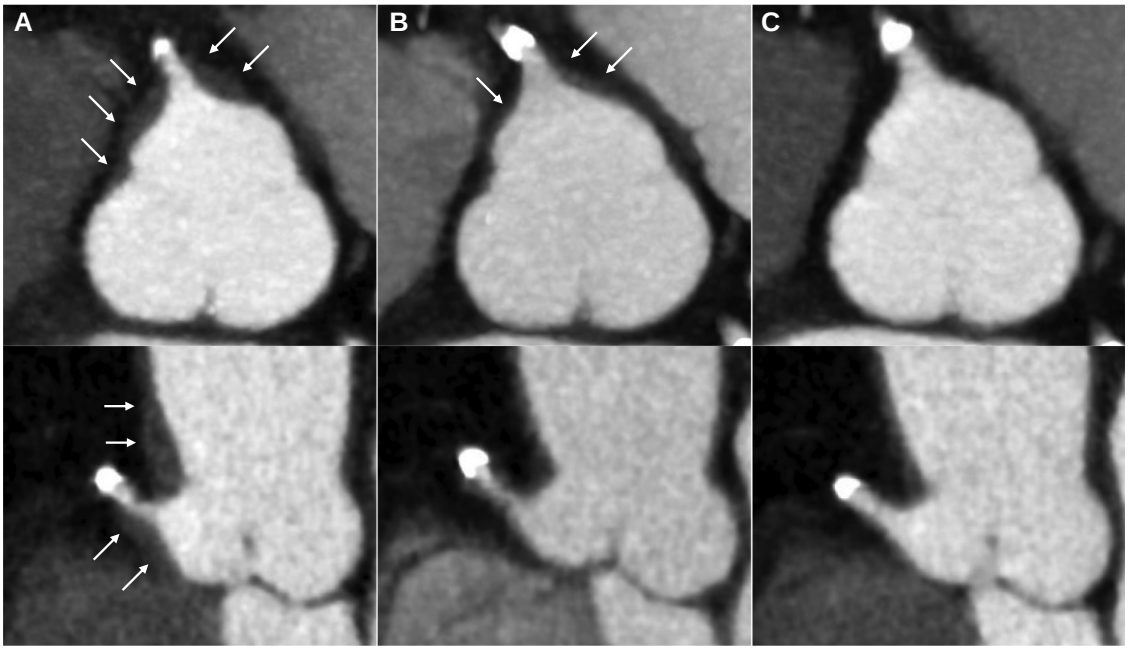


Figure 3 Follow-up coronary computed tomography (CCT). (*A*) Initial CCT performed on the following day of an elective percutaneous coronary intervention showing a residual aortocoronary intramural haematoma (white arrows). (*B*) Follow-up CCT performed 2 weeks later showing a regression of the haematoma (white arrows). (*C*) Follow-up CCT performed 6 months later showing a disappearance of the haematoma.

of the mid-RCA (Supplementary material online, *Video S4*). The position of stent deployment was determined using IVUS marking without contrast injection. The proximal- and distal-patent lumens were positioned using a radiopaque marker. A 2.75 × 38 mm drug-eluting stent (DES) (Synergy, Boston Scientific, Natick, MA, USA) was deployed at the proximal RCA to seal an entry tear and mid-RCA lesion (*Figure 2D*). The IVUS revealed a stent-distal intramural haematoma. Therefore, a 2.5 × 38 mm DES (Synergy, Boston Scientific, Natick, MA, USA) was additionally deployed at the mid-RCA (*Figure 2E* and Supplementary material online, *Video S5*). The IVUS revealed a stent-distal intramural haematoma at the distal RCA (see Supplementary material online, *Video S6*). Angiography revealed a remaining contrast inflow to the false lumen of the right coronary cusp (see Supplementary material online, *Video S7*). Considering the good coronary flow without angiographic obstruction at the distal RCA, conservative treatment of stent-distal haematoma was selected. A 3.25 × 12 mm non-compliant balloon (NC Emerge, Boston Scientific, Natick, MA, USA) was dilated at the proximal RCA to reduce the coronary inflow towards the false lumen by stent expansion. The IVUS revealed an expanded in-stent luminal area (*Figure 2F* and Supplementary material online, *Video S8*). Final angiography showed good coronary flow except for the right ventricle branch, with a remaining but not worsening ACD (*Figure 2F* and Supplementary material online, *Video S9*). The contrast injection was minimized to a total volume of 33 mL, and the haemodynamic status was consistently stable during PCI. The activated clotting time was maintained at 200 s during the procedure. Intraprocedural and post-procedural transthoracic echocardiography revealed good left ventricular wall motion without pericardial effusion or aortic valve regurgitation. The patient was monitored in the cardiac care unit on that day.

The following day, coronary computed tomography (CCT) revealed an aortocoronary intramural haematoma without pericardial effusion (*Figure 3A*). The post-operative course was uneventful. The patient was discharged one week after PCI for RCA. Follow-up CCTs (2 weeks and 6 months after the initial CCT) revealed regression and eventual disappearance of the haematoma (*Figure 3B–C*). Elective PCI for the residual left anterior descending lesions was performed 3 months later. No cardiac events have been recorded during the 18-month follow-up period.

Discussion

Iatrogenic ACD is a rare but potentially devastating complication of cardiac catheterization.[1,2] The most frequent cause is catheter engagement. Other ACDs originate from retrograde coronary dissection due to balloon inflation, contrast injection, and wiring.[3] Iatrogenic ACD is associated with many risk factors, including the female sex, catheter manipulation, cutting- and scoring-balloon, excimer laser coronary angioplasty, complex PCI, PCI for RCA (RCA vs. left coronary artery; 76.7% vs. 23.3%), and vascular status (heavily calcified, proximal lesion, and chronic total occlusion).[3–6]

Coronary artery dissection is a well-recognized catheter-related complication that is classified into six types based on angiographic morphology.[7] The National Heart, Lung, and Blood Institute (NHLBI) classification could predict the risk of acute coronary occlusion. However, this classification is not suitable for cases where retrograde

coronary dissection extends to the coronary ostium, cusp, and ascending aorta.[8] Dunning *et al.* classified ACD into three types according to aortic involvement. Class Ⅰ involves only the coronary cusps. Class Ⅱ involves the cusp and ascending aorta <40 mm, and class Ⅲ involves >40 mm. Nine ACDs were detected among 43 143 cardiac catheterizations (0.02%). Additionally, ACDs were more common during emergent catheterizations than during elective catheterizations (0.19% vs. 0.01%).[9]

Regarding management and prognosis of iatrogenic ACDs, the class Ⅲ Dunning *et al.*'s classification is associated with high mortality despite emergent coronary bypass grafting and aortic repair. Although patients with class Ⅰ and class Ⅱ Dunning *et al.*'s classifications are generally treated with coronary-stenting or conservative management, resulting in favourable outcomes, some require surgical intervention.[3] Once iatrogenic ACD is detected, prompt decision-making and intervention are required, and heart team discussion is essential to determine whether cardiovascular surgery or percutaneous management should be performed. Although bail-out coronary-stenting is frequently used and effective, the procedural details have not been previously well-described. Intravascular imaging devices are established tools for PCI. Intravascular ultrasound provides real-time tomographic assessment of the vascular status.[10] Compared with angiography-guided PCI, IVUS-guided PCI achieves better outcomes in revascularization, major adverse cardiovascular events, and mortality in the setting of DES implantation, even in acute coronary syndrome and complex lesions.[10,11] Considering ACD management, IVUS would be suitable and preferable to optical coherence tomography because injection of flushing agents could aggravate coronary dissection. In this case, angiography after the initial balloon inflation showed coronary dissection of the type C NHLBI classification. However, subsequent IVUS unexpectedly revealed retrograde ACD. Guide catheter selection and manipulation and balloon inflation were the considered causes of coronary dissection. IVUS findings, in which the coronary ostium floated on the circumferential haematoma, were notable. Percutaneous management was selected for iatrogenic ACD of the class Ⅱ Dunning *et al.*'s classification, considering haemodynamic stability. Intravascular ultrasound findings of the entry tear revealed a narrowed lumen area with heavily calcification and a transition from a calcified to a non-calcified plaque, which is a risk factor for coronary dissection.[6] Furthermore, the stenting position was determined using IVUS marking without contrast injection. The IVUS system enabled the evaluation of stent expansion and residual aortocoronary intramural haematoma. Unfortunately, two stents were deployed due to stent-distal intramural haematoma regardless of the IVUS measurement before stenting, although this haematoma could have been overlooked if IVUS was not used. Additionally, the guide extension catheter contributes to contrast media reduction and contrast injection from the distal portion of an entry tear, which would lower the risk of further dissection.[12] The IVUS system and guide extension catheter played important roles in the vascular evaluation and safe procedures.

Post-operatively, dual antiplatelet therapy was continued for one year after ST-elevation myocardial infarction, as the aortocoronary haematoma disappeared after CCT. The CCT is optimal as a less-invasive imaging tool for monitoring ACD and preferable over coronary angiography in terms of the risk of further dissection.

Conclusion

Iatrogenic ACD is a rare but potentially devastating complication of cardiac catheterization. Bail-out stent implantation sealing an entry tear is frequently used and effective, and an IVUS system would help to recognize the morphology of ACD, contributing to the safe procedure.

Lead author biography

Dr Tomoki Fukui graduated from the Chiba University, Japan in 2014. He works as a clinical fellow at the Department of Cardiology, Japan Community Healthcare Organization Osaka Hospital, Japan. He is interested in cardiovascular interventions and echocardiography.

Supplementary material

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

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Consent: The author/s confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patient in line with COPE guidance.

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Data availability

The data underlying this article will be shared on reasonable request to the corresponding author.

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