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CASE REPORT

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Primary percutaneous coronary intervention of anomalous origin of a high take-off of right coronary artery arising from ascending aorta with percutaneous cardiopulmonary support in acute myocardial infarction

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Abstract

Coronary angiography of high take-off right coronary artery (RCA) arising from ascending aorta under percutaneous cardiopulmonary support may be more effective at the site distal to RCA ostium rather than proximal. Guide extension catheters (GECs) may be useful to strengthen backup of percutaneous coronary interventions (PCI) system and to contrast coronary lesions clearly during PCI of these RCAs.

KEYWORDS

guide extension catheter, intravascular ultrasound, thrombus aspiration

1 | INTRODUCTION

Coronary angiography (CAG) of high take-off right coronary artery (RCA) arising from ascending aorta (AAo) under percutaneous cardiopulmonary support (PCPS) may be more effective at the site distal to RCA ostium rather than proximal. Guide extension catheters (GECs) may be useful to strengthen backup of percutaneous coronary interventions (PCI) system and to contrast coronary lesions clearly during PCI of these RCAs.

The incidence of anomalous origin of the RCA arising from the AAo is 0.15% in patients undergoing CAG, and the origin usually lies within 2 cm superior to the sinotubular junction (STJ).[1] However, there are a few cases of very high take-off of the RCA arising from the AAo above the STJ.[2-8] CAG of high take-off RCA arising from the AAo poses a challenge due to both unidentified origin and difficult cannulation, and as a result, selective CAG of these RCAs is often unsuccessful on first attempt.[3-5,7,8] Furthermore, primary PCI with PCPS for patients with these high take-off RCAs are rare. We describe a rare case of successful PCI, thrombus aspiration, and stent placement in the setting of PCPS in a patient with ST-elevation myocardial infarction (STEMI) and anomalous origin of a very high take-off of RCA arising from the AAo.

2 | CASE REPORT

A 62-year-old man presented to our institution with out-of-hospital cardiac arrest. Medical history was notable for diabetes mellitus, managed with diet and exercise, and prior smoking history of 32 years with cessation 12 years prior. Prior to cardiac arrest, he complained of continuous chest pain, and collapsed 1-h later. His wife attempted bystander cardiopulmonary resuscitation (CPR) pending arrival of the ambulance. On arrival of emergency medical services, cardiac rhythm revealed ventricular fibrillation, subsequently treated with defibrillation. Unfortunately, he then entered pulseless electrical activity. CPR continued en route to the hospital, but the return of spontaneous circulation (ROSC) was not achieved. On arrival to our institution, PCPS (CAPIOX emergency bypass system, Terumo) with a membrane oxygenator (CAPIOX [LX], Terumo) via the right femoral artery

(15 French [Fr], CAPIOX [X], Terumo) and left femoral vein (21Fr, CAPIOX [X], Terumo) was initiated 21 min later, and ROSC was subsequently achieved. He was hemodynamically stable with fluid administration, and his vital signs were as follows: blood pressure, 113/103 mm Hg; heart rate, 136 bpm; and oxygen saturation, 99%. Electrocardiogram revealed ST-segment elevation in leads II, III, and aVF and ST-segment depression in leads I, aVL, and V1-V6 (Figure 1), consistent with STEMI, and echocardiography immediately after ROSC revealed severe hypokinesis at the left ventricular inferior regions and moderate hypokinesis at other regions with an ejection fraction of about 20%. So emergent CAG with manual injection via the left femoral artery was pursued after aspirin 300 mg was given through a nasogastric tube. His left coronary artery originated from the left sinus of Valsalva and this left CAG was unremarkable. The RCA could not be localized by CAG in the right sinus of Valsalva with 5Fr sized Judkins Right 4, so anomalous origin of the RCA was considered (Figure 2A and Video S1). Although we performed CAG with the same catheter in the anterior side of right sinus of Valsalva, the catheter moved during CAG by chance and CAG revealed anomalous origin of the RCA arising from the AAo a few cm above the STJ anteriorly (Video S2). Although the catheter was far from the RCA ostium, CAG at the same level of the RCA ostium reveled severe stenosis of the proximal RCA with low cardiac output and low blood flow velocity in the AAo (Figure 2B and Video S3). The origin of the RCA was clearly revealed by nonselective CAG at the middle AAo, distal to the RCA ostium, toward the aortic sinus of Valsalva with a 6Fr sized Amplatz Left (AL) 1 guiding catheter (GC) with a side hole (Launcher, Medtronic; Figure 2C and Video S4A,B). The RCA was cannulated at the AAo using this GC. Although a guidewire (ASAHI SION blue, Asahi Intecc) passed this stenosis, the GC disengaged easily because of inadequate backup support. We inserted a GEC (GUIDEPLUS II EL, Nipro) into the proximal RCA to strengthen the backup of the PCI system smoothly. Although the GC still disengaged, CAG from the GEC clearly revealed 99% stenosis of the proximal RCA and massive thrombi of the distal portion of the lesion (Figure 2D and Video S5). Thrombus aspiration was considered to be effective,[9] but the smallest aspiration catheter in our hospital could not pass into the GEC. So the GEC was withdrawn after the GC engaged along the GEC, and some red thrombi were obtained by the first aspiration with a 6Fr Rebirth Pro2 catheter (Nipro). Thrombus aspiration was repeated several times, with some

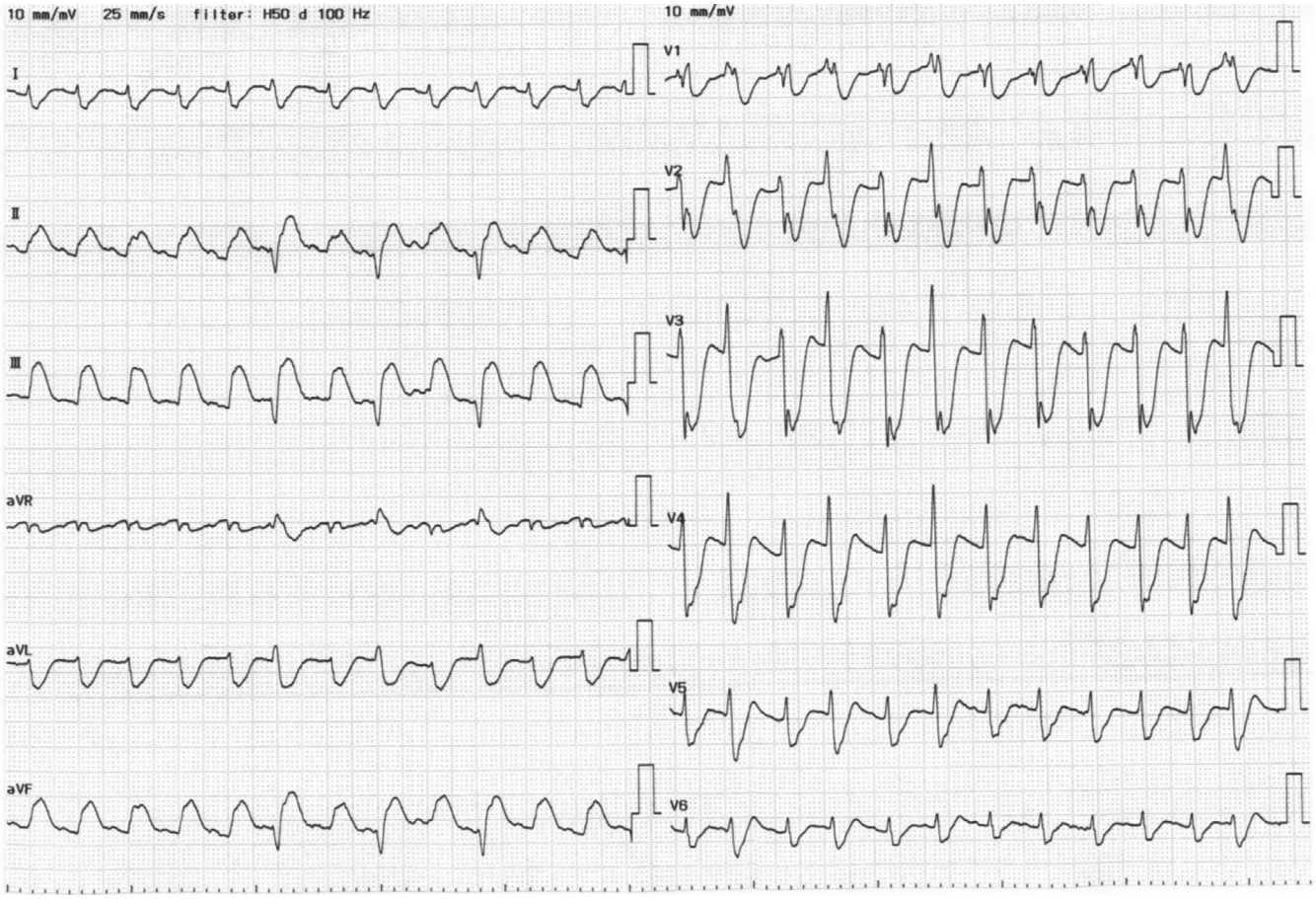

FIGURE 1 Electrocardiogram. The electrocardiogram after return of spontaneous circulation showed ST-segment elevation in leads II, III, and aVF and ST-segment depression in leads I, aVL, and V1-V6

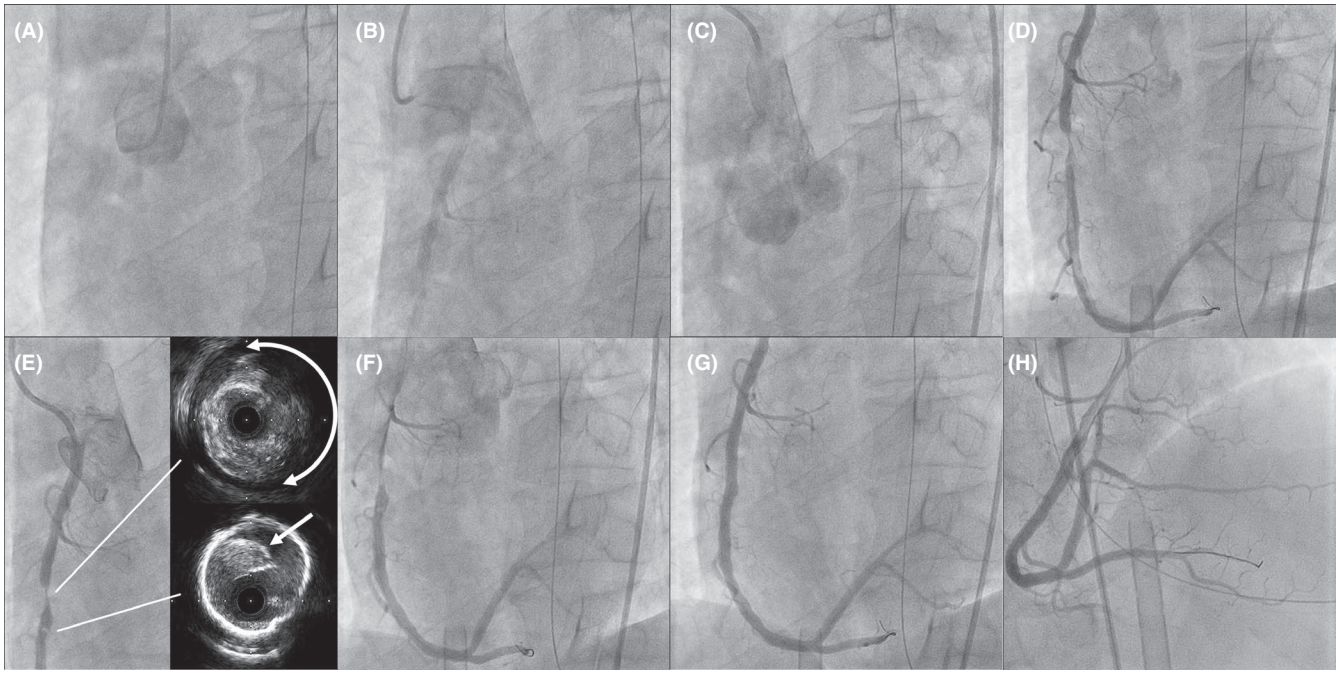

FIGURE 2 Coronary angiograms and intravascular ultrasound (IVUS) images. A, Coronary angiography (CAG) of the right sinus of Valsalva could not demonstrate the right coronary artery (RCA; left anterior oblique [LAO] 45°). B, C, CAG at the same level of RCA ostium and at a site distal to the RCA ostium demonstrated severe stenosis of the proximal RCA (LAO 45°). D, CAG from a guide extension catheter demonstrated 99% stenosis of the proximal RCA with massive thrombi (LAO 45°). E, F, CAG after thrombus aspiration demonstrated 99% stenosis of the proximal RCA with small residual thrombus, but no distal embolization (LAO 45°). IVUS after thrombus aspiration showed a large quantity of attenuated plaque (double arrow) and small residual thrombus (single arrow). G, H, CAG after a drug-eluting stent implantation demonstrated good coronary blood flow and no distal embolization (g: LAO 45°, h: right anterior oblique (RAO) 30° and cranial 30°)

red thrombi again obtained. CAG after thrombus aspiration still revealed 99% stenosis of the proximal RCA with a small residual thrombus and no distal embolization (Figure 2E and 2F and Video S6). Intravascular ultrasound (IVUS) with the OptiCross system (Boston Scientific) showed a large quantity of attenuated plaque at the stenotic portion, small residual thrombus at the distal portion of the lesion, and thin superficial calcification in the extensive regions but not extrinsic compression of the RCA (Figure 2E and Video S7). After the GEC was inserted into the proximal RCA to strengthen the backup of PCI system again, the culprit lesion was easily treated with placement of a 3.5 × 22 mm drug-eluting stent (Resolute Onyx, Medtronic). IVUS showed a little malapposition at an ecstatic portion and slight tissue protrusion into the stent, but overall there was good stent expansion and the final CAG revealed good coronary blood flow and no distal embolization (Figure 2G and 2H). An intra-aortic balloon pump (IABP) was inserted via the left femoral artery after the PCI system was withdrawn. He received prasugrel 20 mg immediately after the PCI, and aspirin 100 mg/day, and prasugrel 3.75 mg/day after the second day. Peak creatinine kinase (CK) and CK-MB were 5588 and 669 IU/L, respectively. Targeted temperature management (34°C during the first 24 h) was performed for neurologic protection after PCI. PCPS, IABP, and mechanical ventilation were removed on

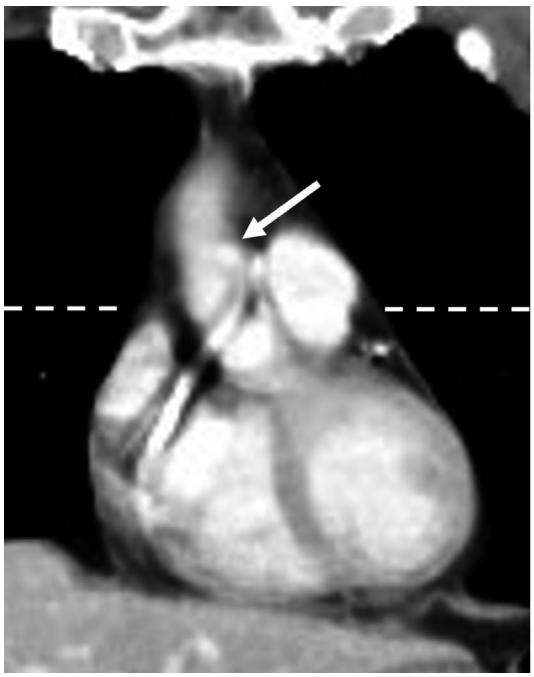

FIGURE 3 Contrast-enhanced computed tomography image of coronal view. The anomalous high origin of the right coronary artery (single arrow) arose from the ascending aorta 2-3 cm above the sinotubular junction level (dashed line) on the anterolateral side without mechanical compression by the great vessels

days 5, 6, and 11, respectively. Postprocedural complications were notable for difficulty walking due to deconditioning and muscle weakness, but no evidence of hypoxic brain injury was noted. The contrast-enhanced computed tomography on day 13 revealed neither neurologic damage nor systemic embolization. The anomalous high origin of the RCA arising from AAo 2-3 cm above the STJ on the anterolateral side was again noted, without mechanical compression by the great vessels (Figure 3 and Video S8). His ejection fraction by echocardiography was improved to 45%. He remained stable and was ultimately transferred to another hospital for rehabilitation on day 36.

3 | DISCUSSION

This case illustrates two important clinical issues. First, CAG of high take-off RCA arising from the AAo under PCPS may be more effective at the site distal to the RCA ostium rather than proximal to the ostium. Second, GECs may be useful not only to strengthen the backup of the PCI system but also to contrast coronary lesions clearly during PCI of these particular lesions.

Coronary angiography of high take-off RCA arising from the AAo poses a challenge due to both unidentified origin and difficult cannulation.[3-5,7,8] In our case, CAG of this anomalous RCA was successful at the same level of the RCA ostium and at the middle AAo far from the RCA ostium but not at the aortic sinus of Valsalva (Video S1, S3, S4A,B). The blood flow velocity in the AAo under PCPS via the femoral artery and femoral vein was very slow due to low cardiac output, which is expected particularly in patients with severe low cardiac output and blood flow from the AAo to the left ventricle. In our case, contrast flowed from the AAo to the left ventricle during non-selective CAG at the middle AAo, distal to the RCA ostium, toward the aortic sinus of Valsalva, so the blood flow velocity in the AAo was considered to be very low (Video S4A,B). If blood flow velocity in the AAo is low under PCPS, nonselective CAG at the middle AAo, distal to the RCA ostium, toward the aortic sinus of Valsalva with AL catheter may be effective to detect anomalous origin of RCA arising from the AAo. If we could not see the RCA ostium, we tried aortic root injection and aortography with a pigtail catheter. But these angiography might be not effective because these angiography might be barely successful in detecting the origin of RCA arising from AAo as with previous reports.[3-5,7,8] The benefit of GEC utilization to strengthen backup of the PCI system is quite apparent in our case. In our case, the RCA was localized at the anterolateral side of the AAo 2-3 cm above STJ, and an AL catheter inserted from the femoral artery engaged this anomalous high origin of RCA, as in previous reports.[2,5,7] According to a previous report, forward take-off Judkins left guide (FL) 3.0 and femoral curve left (FCL) 3.0 catheters from femoral approach could engage anomalous origin of RCA from ascending aorta above the left sinus of Valsalva.[10] If we used right radial approach in our case, Judkins Right 4 might engage the RCA as a previous report,[8] because rough of the catheter from right femoral approach in AAo is different from the rough from left femoral approach. In our case, however, the AL 1 GC had inadequate PCI backup and the GC disengaged easily when a GW passed the stenotic lesion. We were concerned that stent delivery might be difficult due to inadequate backup or that coronary angiographic findings might not be obtained because of a disengaged GC. It may be beneficial to change the 6Fr AL1 GC to bigger and thicker GCs, but these GCs might be unable to engage in the RCA due to challenging controllability and might injure the proximal RCA with strong bending. Therefore, we inserted a GEC into the proximal RCA and strengthened the backup of the PCI system, and CAG from a GEC clearly revealed the lesion although the GC still disengaged. In our case, tip of the GEC was located at the straight portion of the proximal RCA with enough lumen, so we could perform CAGs with manual injection without the complication of severe vessel dissection. However, if auto-injection is used or tip of GECs locate at the portion of insufficient lumen or strong bending, CAGs from GECs may lead to severe vessel dissection. Therefore, in these situation, it is necessary to use manual injection and to move GECs to the straight portion with enough lumen. In our case, we used the GUIDEPLUS II EL GEC. The unique characteristic of this GEC is its softness, so the GEC may advance with little resistance in the tortuous coronary artery.[11] Furthermore, the lesion had massive thrombi and a thrombus aspiration therapy was initially pursued. However, the smallest aspiration catheter in our hospital could not pass into the GEC, so the GEC was withdrawn. Additionally, thrombus aspiration therapy is at the risk of systemic embolization, particularly when GCs disengage, thus proper GC engagement of the target coronary is essential. Fortunately, in our case, the GC could engage the RCA along the GEC easily, and many red thrombi were aspirated without systemic embolization.

4 | CONCLUSIONS

We describe a rare case of STEMI due to anomalous origin of very high take-off of the RCA arising from the AAo, managed with successful PCI with thrombus aspiration and stent implantation utilizing PCPS. CAG of high take-off RCA arising from the AAo under PCPS may be more effective at sites distal to the RCA ostium rather than proximal to the ostium. Additionally, GECs may be useful not only to strengthen the backup of the PCI system but also to contrast coronary lesions clearly during PCI of anomalous high origin of RCA arising from the AAo. If anomalous origin of the RCA arising from

the AAo is suspected and blood flow velocity in the AAo is low under PCPS, nonselective CAG at the middle AAo, distal to the RCA ostium, toward the aortic sinus of Valsalva with AL catheter may be effective to detect anomalous origin of RCA arising from the AAo. 6Fr AL1 GCs may be helpful in engaging these RCAs, but these GCs may have inadequate backup of the PCI system as with our case. If a GW can pass the stenotic lesion, GECs may be inserted into the proximal RCA easily, allowing for successful PCI with thrombus aspiration and stent implantation without distal and systemic embolization.

CONFLICT OF INTEREST

None declared.

AUTHOR CONTRIBUTIONS

TS: designed the manuscript, collected the data, and reviewed the manuscript. KU and ME: reviewed the manuscript.

ETHICAL APPROVAL

Informed consent was obtained from the patient for the publication of this case report.

DATA AVAILABILITY STATEMENT

The data of this case are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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