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CASE REPORT
Cardiovascular imaging

In vivo optical coherence tomography visualisation of coronary artery embolism caused by BioGlue in a middle-aged woman with Marfan syndrome who underwent the Bentall procedure: a case report

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Background Coronary artery embolism caused by BioGlue is a rare complication; therefore, its diagnosis and treatment remain undefined.

Case summary A 47-year-old woman underwent ascending aortic replacement and coronary artery bypass grafting (CABG) for type A acute aortic dissection involving the right coronary artery ostium in 2017. Subsequently, she was diagnosed with Marfan syndrome. Five years later in 2022, she underwent aortic arch replacement, the Bentall procedure, and repeat CABG because of aortic root enlargement and aortic regurgitation progression. Twelve days after surgery, coronary computed tomography angiography (CCTA) revealed left anterior descending (LAD) artery stenosis, whereas pre-operative CCTA was normal. On post-operative day 13, coronary angiography revealed 99% LAD artery stenosis. Intravascular ultrasound (IVUS) showed a non-echoic mass with clear margins, and optical coherence tomography (OCT) demonstrated a crystalloid mass. Both images suggested that the embolus was inorganic matter, suspected as being the surgical adhesive BioGlue. We could not remove the embolus by repeated thrombectomy; therefore, drug-eluting stent implantation was performed. Seven months after surgery, she had no symptoms, and CCTA confirmed stent patency.

Discussion To our knowledge, this is the first case report to describe BioGlue embolism observed by OCT. We performed an *in vitro* study using a blood vessel model, and the obtained OCT image was very similar to the *in vivo* image. Although BioGlue embolism is a rare complication, it should be considered in cases of perioperative myocardial infarction of uncertain aetiology, and coronary imaging is useful for diagnosis.

Keywords BioGlue • Coronary artery embolism • Optical coherence tomography • Intravascular ultrasound • Case report

ESC curriculum 2.1 Imaging modalities • 7.5 Cardiac surgery • 3.1 Coronary artery disease • 2.4 Cardiac computed tomography • 9.1 Aortic disease

Learning Points

- Coronary embolism caused by BioGlue has been reported as a rare complication, and diagnosis is often made based on pathological findings or intravascular ultrasound.
- Optical coherence tomography is useful for differential diagnosis in cases of perioperative myocardial infarction of uncertain aetiology.

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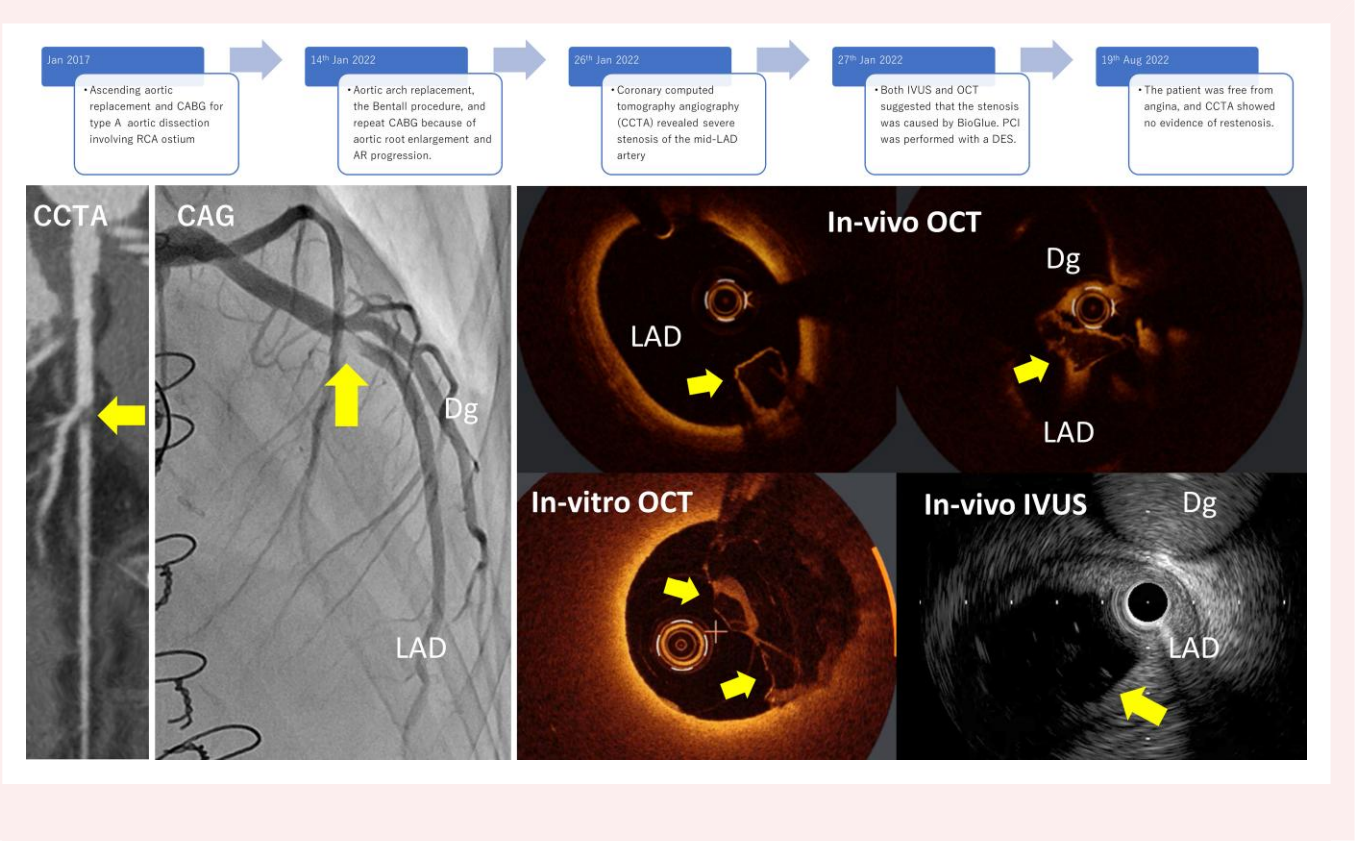
Introduction

BioGlue is a surgical adhesive that is widely used at the site of artificial vascular anastomosis. Cases of embolism caused by BioGlue after surgery have been reported in previous literature.[1,2] Coronary artery embolism is very rare; however, some cases have been reported previously, including suspected cases.[3–8] We present a case of coronary artery embolism due to BioGlue after multiple surgical procedures, which was diagnosed by *in vivo* images obtained by intravascular ultrasound (IVUS) and optical coherence tomography (OCT). The findings were also confirmed in an *in vitro* study.

Summary figure



Case presentation

A 47-year-old woman (weight: 57 kg, height: 171 cm) underwent ascending aortic replacement and coronary artery bypass grafting (CABG) using a saphenous vein graft (SVG) to the posterior descending artery for Stanford type A acute aortic dissection involving the right coronary artery (RCA) ostium in 2017. Although follow-up coronary computed tomography angiography (CCTA) showed that the SVG was occluded immediately after surgery, RCA beyond the occluded site was clearly visualized, suggesting that the collateral vessels from the left coronary artery to the RCA fully developed, and she had no symptoms requiring additional intervention. Subsequently, genetic testing revealed a diagnosis of Marfan syndrome. She had neither a history of atrial fibrillation nor classic coronary risk factors.

Five years later in 2022, the diameters of aortic arch and aortic root increased to 50 and 53 mm, respectively, with moderate to severe aortic regurgitation. Because myocardial perfusion imaging with single photon emission computed tomography suggested reversible myocardial ischaemia in the distribution of RCA, the patient underwent aortic arch replacement, the Bentall procedure, and repeat CABG (SVG to the RCA). Anticoagulation using unfractionated heparin followed by a vitamin K antagonist was initiated and well-controlled. She had a favourable recovery after surgery with no chest pain or signs of heart failure. The patient was extubated on post-operative day 3, and walking rehabilitation was initiated on post-operative day 4. On post-operative day 12, we performed follow-up CCTA to assess the patency of SVG and anastomosed left main coronary artery, which is routinely done after CABG in our hospital. Unexpectedly, we found severe stenosis of the mid-left anterior descending (LAD) artery, whereas preoperative CCTA was normal (*Figure 1*). She had no chest pain, and her blood pressure was 101/56 mmHg, heart rate was 98 beats/min, body temperature was 36.4°C, and oxygen saturation was 98% in room air. On physical examination, she had a regular heart rhythm with mechanical click and no murmur. Although cardiac enzyme did not increase significantly, electrocardiogram showed new ST-segment depression in leads V5 and V6 and transthoracic echocardiography (TTE) revealed a new asynergy at the anteroseptal wall without any signs of infective endocarditis. Taken together, post-operative coronary embolism was suspected, and the potential embolic sources were intracardiac thrombus, vegetations, or surgical adhesive agents, such as BioGlue. Coronary angiography (CAG) was performed on day 13 after surgery. Because residual dissection involved the descending aorta and the brachiocephalic artery, we chose left radial artery access, but the catheter could not advance due to the radial loop. Finally, we managed to perform CAG via the left brachial artery.

Coronary angiography revealed 99% stenosis with a translucent area at the mid-LAD artery (*Figure 2A*). Intravascular ultrasound showed a large, almost non-echoic mass with clear margins and slight echo attenuation at the stenotic site, while no atheromatous changes were found throughout the LAD artery (*Figure 2C–F*, Supplementary material online, *Videos S1*). Since we could not determine the nature of the occlusive material based on the findings from IVUS alone and

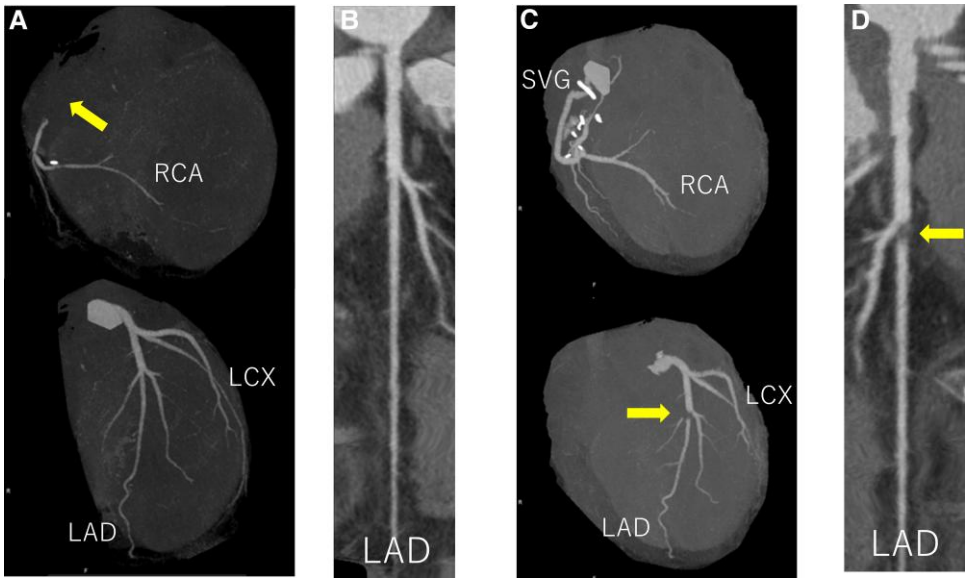


Figure 1 (*A* and *B*) Coronary computed tomography angiography (CCTA) before 2nd surgery showing no stenoses or atherosclerotic changes in LAD artery. Native RCA was occluded at ostium (arrow) but well-enhanced in the middle to distal portions. (*C* and *D*) CCTA after 2nd surgery showing severe stenosis of the mid-left anterior descending (LAD) artery (arrow). RCA, right coronary artery; LAD, left anterior descending; LCX, left circumflex; SVG, saphenous vein graft.

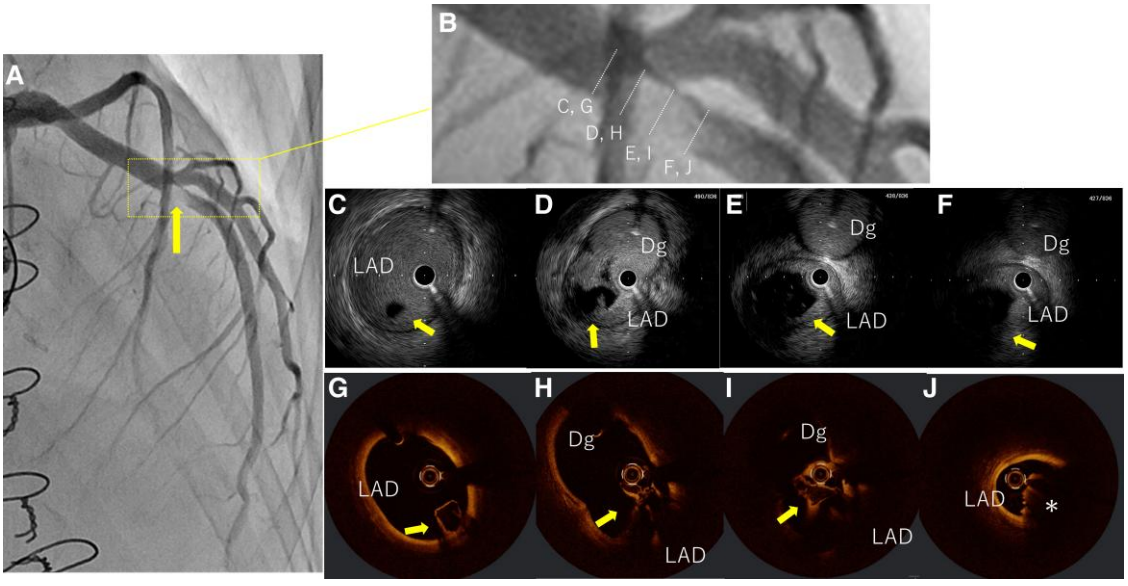


Figure 2 (*A* and *B*) Coronary angiography (CAG) demonstrated filling defect in the mid-LAD artery (arrow). (*C–F*) Intravascular ultrasound images showed a mass with clear margins, almost no echogenicity on the inside. (*G–J*) Optical coherence tomography images revealed a crystal-like structure with no internal signal, and a red thrombus (asterisk) attached to the distal side. LAD, left anterior descending; Dg, diagonal branch.

haemodynamic was stable, we decided to perform an additional OCT analysis. Optical coherence tomography demonstrated a crystalloid mass with clear margins and no internal signal, with a red thrombus attached to the distal part (*Figure 2G–J*, Supplementary material online, *Videos S2*). Both IVUS and OCT images suggested that the embolus was inorganic matter, and it was suspected of being the surgical adhesive BioGlue. Although repeated thrombectomy was performed, we could not remove the embolic material even after using a high-suction aspiration catheter (6 Fr Thrombuster Pro GR, Kaneka, Tokyo, Japan) and a guide extension catheter (6 Fr GUIDEZILLA II,

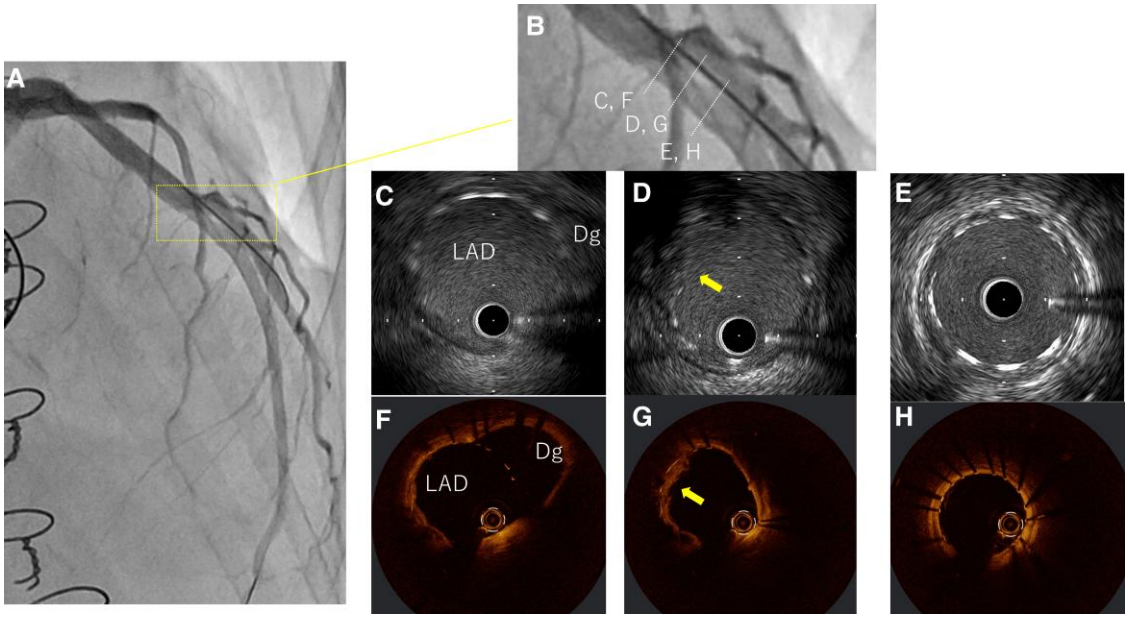


Figure 3 (*A*) CAG after stenting showing complete repair with occlusion of the septal branch. (*C–H*) Both IVUS and OCT images demonstrated fully expanded stent with minor prolapse of thrombus or BioGlue (arrows).

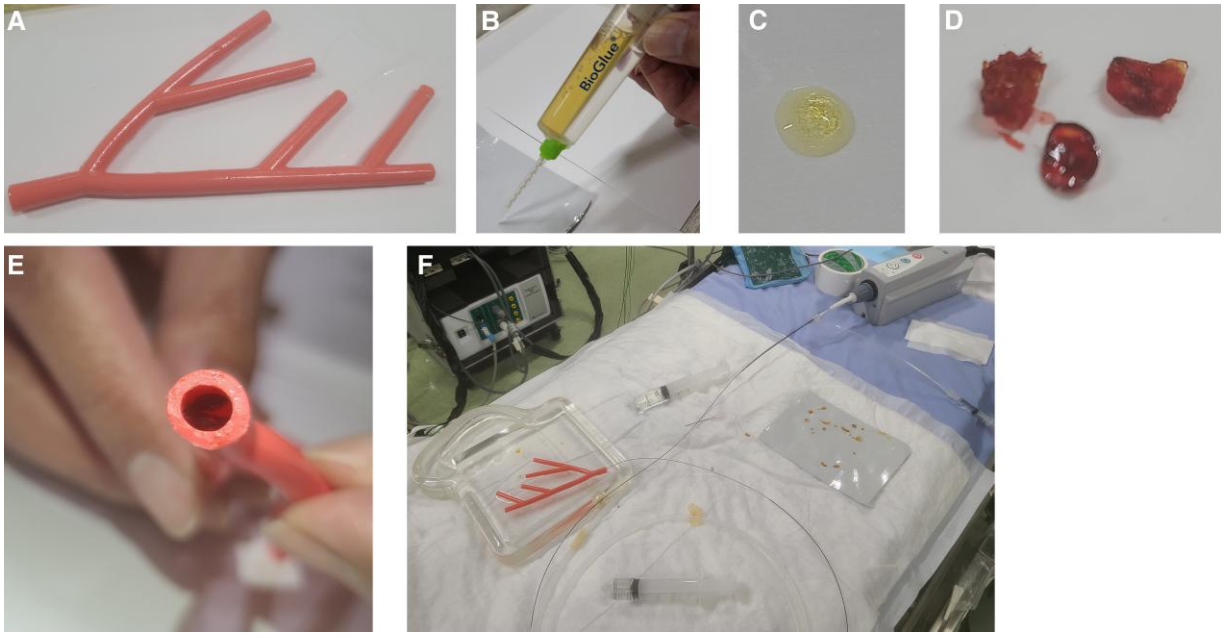


Figure 4 Experimental methods. We used the vessel model (*A*) and BioGlue (*B*). We made a clump of BioGlue (*C*), which was covered with human blood (*D*). After covering with human blood, we put clumps of the BioGlue into the vessel model (*E*) and imaged them by optical coherence tomography (*F*).

Boston Scientific, Marlborough, MA, USA). After multiple balloon dilatations, IVUS and OCT showed that the mass was compressed to some extent, which was accompanied by increased thrombus-like structures in the surrounding area. Because the mass was likely to cause thrombotic occlusion of the LAD artery and future percutaneous revascularization would be difficult due to limited vascular access, we treated the lesion with a drug-eluting stent (Coroflex ISAR NEO 3.5 × 16 mm, NIPRO, Osaka, Japan), resulting in angiographically

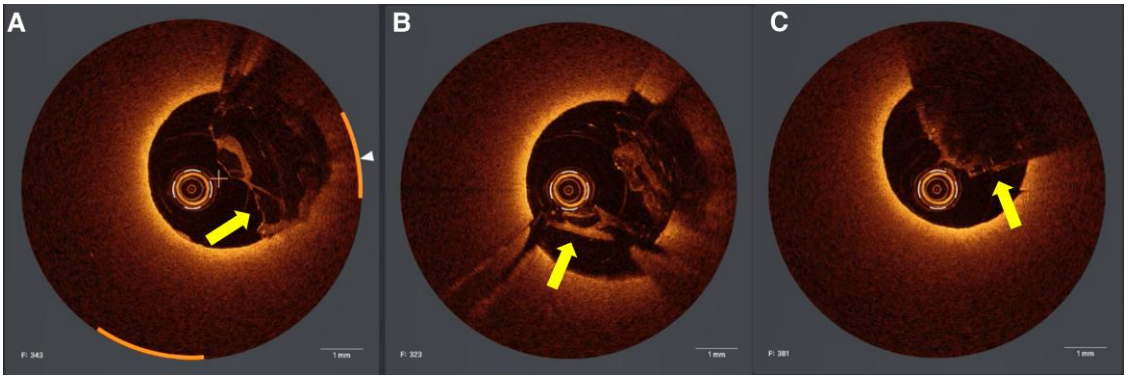


Figure 5 *In vitro* optical coherence tomography (OCT) showing a crystalloid mass with clear margins, no internal signal (*A* and *B*), and red thrombi (*C*), similar to the *in vivo* OCT findings.

complete repair with occlusion of the septal branch (*Figure 3A*) and a fully expanded stent with minor prolapse of thrombus or BioGlue on IVUS and OCT images (*Figure 3C–H*). After the percutaneous procedure, the patient remained asymptomatic and was discharged on day 22 after surgery. Seven months after surgery, CCTA confirmed stent patency.

We also performed an *in vitro* study using a blood vessel model (*Figure 4A*). We created a small grain of polymerized BioGlue according to the manufacturer's instructions and soaked it in human blood (*Figure 4B–D*). The material was placed in the vessel model filled with contrast medium and imaged by OCT (see Supplementary material online, *Figure S4E* and *F*). The obtained OCT image was very similar to the image obtained *in vivo* (*Figure 5*, Supplementary material online, *Videos S3*).

Discussion

Coronary artery occlusion due to BioGlue is a rare complication. Diagnosis is made by autopsy, pathology of the embolic material, IVUS, or clinical findings. To the best of our knowledge, there are six previous reports of coronary embolism due to BioGlue, including suspected cases. One case was diagnosed by autopsy,[3] one by pathology,[4] two by both pathology and IVUS,[5,6] and two were suspected from the clinical course.[7,8] In the present case, coronary atherothrombosis was excluded by pre-operative CCTA findings. There were no risk factors for intracardiac thrombus, such as atrial fibrillation, mitral valve disease, ventricular aneurysm, or poorly controlled anti-thrombotic therapy after aortic valve replacement. Infective endocarditis was unlikely based on clinical and TTE findings. Although the embolic material could not be aspirated, the IVUS findings were consistent with those reported in previous cases of BioGlue embolism.[5,6] The OCT findings were also suggestive of inorganic material. Furthermore, the *in vitro* study demonstrated that the *in vivo* OCT image of the embolus was quite similar to BioGlue. Taken together, it was clear that this coronary event was due to BioGlue embolism. To the best of our knowledge, this is the first case report of BioGlue embolism observed by OCT.

There have been limited reports of intracoronary imaging of BioGlue, which is probably because coronary embolism caused by BioGlue leads to ST-segment elevation myocardial infarction (STEMI) requiring urgent revascularization,[3–6,8] and physicians have insufficient time for detailed observation with intracoronary imaging devices. We completely agree with the idea that early revascularization is most important in patients with STEMI. This case was different from typical coronary embolism, did not lead to STEMI, remained asymptomatic, and haemodynamically stable. There are two possible reasons for this. First, the LAD artery was not completely occluded and some degree of antegrade blood flow was preserved. Second, there were well-developed collateral connections between the RCA and the LAD artery due to SVG occlusion after the previous surgery. Indeed, the occluded septal branch after stenting was well-visualized by injection of contrast agent into SVG (not shown).

In some cases, the aetiology of coronary events is unclear, and IVUS and/or OCT images can be helpful for further investigation.[9] According to the present study and previous reports, BioGlue is visualized as a mass with no or less echogenicity by IVUS,[5,6] which might be confusing with thrombi. Optical coherence tomography can clearly distinguish BioGlue from thrombi. Using OCT as an additional imaging modality to IVUS is useful to make more precise diagnosis in such special situation. The treatment strategy for BioGlue embolism has not been established. Even though it is most ideal to remove the BioGlue from the body, polymerized BioGlue is inelastic, and it is therefore difficult to remove with aspiration catheters. Aspiration with a guide extension catheter or the mother-and-child technique might be effective if the BioGlue embolism is not too large. A coronary filter system should be considered to avoid distal embolization. There have been reports that stenting is effective,[5] but the long-term outcome remains unknown.

The present study has two main limitations. First, the embolus was not diagnosed as BioGlue by histopathology. However, according to pre-operative CCTA, there was less possibility of coronary atherothrombosis, and other thromboembolisms were excluded by abnormal findings on IVUS/OCT. Second, our *in vitro* experimental model did not completely reproduce the *in vivo* environment. However, as we repeated OCT image acquisition of the BioGlue processed by human blood and the images were very similar to those obtained *in vivo*, the embolus was considered as BioGlue.

Conclusions

We experienced a case of coronary embolism caused by BioGlue after the Bentall procedure, which was successfully treated with drug-eluting stent implantation. This is the first report of *in vivo* visualisation of BioGlue by OCT. Although BioGlue embolism is a rare complication, it should be considered in cases of perioperative myocardial infarction of uncertain aetiology. Coronary imaging is useful for differential diagnosis.

Lead author biography

Dr Yukihiro Hamaguchi studied medicine at Kyoto University in Japan. Since 2019, he has been a resident of cardiology at Tenri Hospital. Since 2022, he is working as a cardiologist at the same facility. He specializes in percutaneous coronary intervention and treating structural heart disease.

Supplementary material

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

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Consent: The authors confirm that the 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: None declared.

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Data availability

The data underlying this article are available in the article and in its online Supplementary material.

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