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CASE REPORT

Coil embolization of pseudoaneurysm as a complication of excimer laser coronary angioplasty: insights from intravascular ultrasound and optical coherence tomography findings

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Abstract
The occurrence of pseudoaneurysm in the coronary artery is rare and can develop after percutaneous coronary interventions. To date, the optimal therapy, including conservative, surgical, and endovascular therapies, for pseudoaneurysm in the coronary artery remains unclear. Here, we report a case of pseudoaneurysm arising as a complication of excimer laser coronary angioplasty, which was successfully treated with stent-assisted coil embolization, after which optical coherence tomography revealed complete healing of the pseudoaneurysm. This report highlights the feasibility of stent-assisted coil embolization for coronary pseudoaneurysms involving bifurcation.

Keywords Coil embolization · Coronary pseudoaneurysm · Excimer laser angioplasty · Intravascular ultrasound · Optical coherence tomography

Introduction

Coronary artery aneurysms (CAAs) are defined as coronary dilations with a diameter > 1.5 times that of normal arteries [1]. Recently, CAAs were reported as a complication of percutaneous coronary interventions [1]. However, a consensus regarding the optimal therapy for coronary pseudoaneurysms, including surgical and endovascular therapy with polytetrafluoroethylene (PTFE)-covered stent, has not been reached. However, the PTFE-covered stent is incompatible in cases involving bifurcations. Thus, stent-assisted coil embolization, which can preserve the blood flow of the side branch when treating a pseudoaneurysm involving bifurcation, has emerged. However, the pathological changes and intravascular imaging findings are rarely reported.

Case presentation

A 57-year-old man with diabetes mellitus and hypertension was admitted for anterior acute myocardial infarction. Emergent coronary angiography (CAG) revealed occlusion of the diagonal branch (branch 1, Fig. 1a). Despite performing repeat dilation using the kissing balloon technique between branch 1 and branch 2, acute occlusion recurred in both branches (Fig. 1b). As the efficacy of excimer laser coronary angioplasty (ELCA) compared to balloon angioplasty was previously reported [2], ELCA was performed on branch 2 (Fig. 1c) to eliminate thrombus. Angiography after the second ablation revealed coronary perforation of branch 2 (Fig. 1d). Hemostasis was attained by long inflation using a perfusion balloon (Ryuseki 2.5 × 20 mm; KANEKA MEDICAL, JAPAN) (Fig. 1e).

Follow-up CAG after 18 days revealed a large pseudoaneurysm (4.8 × 7.0 mm as measured with quantitative coronary arteriography, Fig. 1f). At the patient's discretion, we decided to treat the pseudoaneurysm using endovascular therapy.

After inserting two wires into both diagonal branches, intravascular ultrasound (IVUS) was performed over the wire in branch 2, confirming that the pseudoaneurysm comprised a thin wall and wide neck, and was located very close to the bifurcation with branch 1 (Fig. 2a). Thus,

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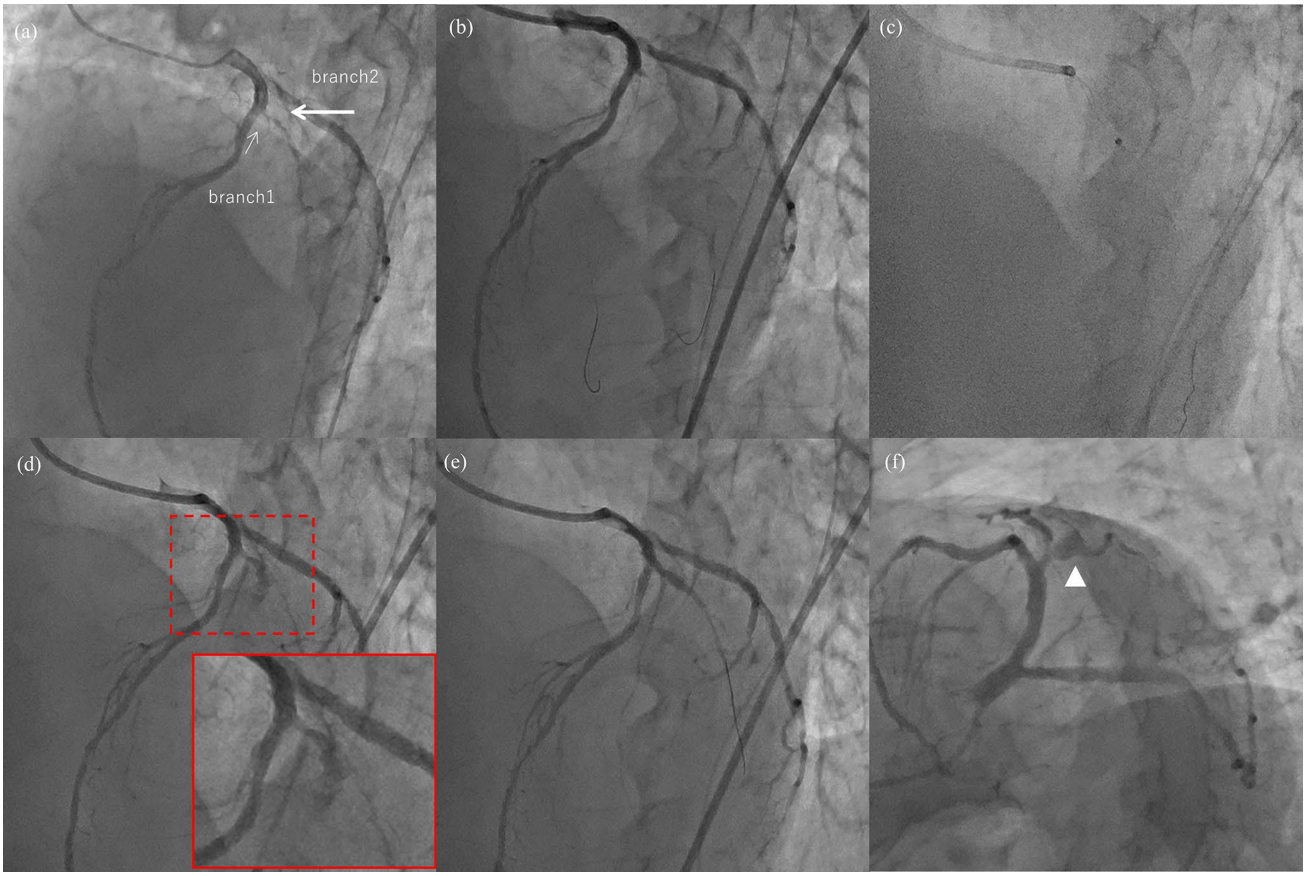

Fig. 1 **a** Emergent coronary angiography (CAG) showing occlusion of the diagonal branch (fine arrow, branch 1) and severe stenosis of the other sub-branch (large arrow, branch 2). **b** Acute occlusion of both branches. **c** Excimer laser coronary angioplasty. **d** Excimer laser angioplasty-caused perforation. **e** Final angiogram. **f** Repeat angiography after 18 days showing a large pseudoaneurysm (arrowhead)

stent-assisted coil embolization was deemed the only solution. After advancing a microcatheter (Excelsior™ SL-10; Stryker, Japan) into the pseudoaneurysm, we implanted a bare-metal stent (BMS) (Kaname 3.0 × 15 mm; Terumo, Japan) across branch 1 (Fig. 2b) at nominal pressure (9 atm) to avoid deformation of the microcatheter jailed with stent struts; subsequently, seven coils (target coil 7.0 × 200 mm, 6.0 × 200 mm, 5.0 × 150 mm, 5.0 × 100 mm, 3.0 × 100 mm, 3.0 × 100 mm, 2.0 × 80 mm; Stryker, Japan) were released inside the pseudoaneurysm (Fig. 2c). On IVUS, coils were seen as a series of bright points or arcs within the stent (Fig. 2d–f). Final angiography revealed complete exclusion of the pseudoaneurysm without coil herniation and patency of both branches (Fig. 2g).

At 1-year follow-up, CAG revealed good flow in both branches (Fig. 3a), and optical coherence tomography (OCT) revealed that a layer of intimal proliferation had completely covered the stent strut, and the implanted coils were almost not seen at all (Fig. 3b–e).

Discussion

The previous case reports described coil embolization of coronary pseudoaneurysm after balloon angioplasty or stent implantation [3]. Here, we present a case of successful coil embolization to treat a coronary pseudoaneurysm arising as a complication of ELCA, and which pre- and post-procedural IVUS and OCT at the chronic phase revealed the healing process of the pseudoaneurysm.

The incidence of ELCA-induced coronary perforation is 0.6–2.8% [4, 5]; however, pseudoaneurysm formation after ELCA-caused coronary perforation has been rarely described [4, 6]. Because the range of laser-induced arterial wall dissolution could be higher than that of balloon-caused arterial tear [5], the likelihood of pseudoaneurysm formation could be higher with a laser. Moreover, a laser-caused pseudoaneurysm could have a more wide neck than a balloon-caused pseudoaneurysm, as shown in the

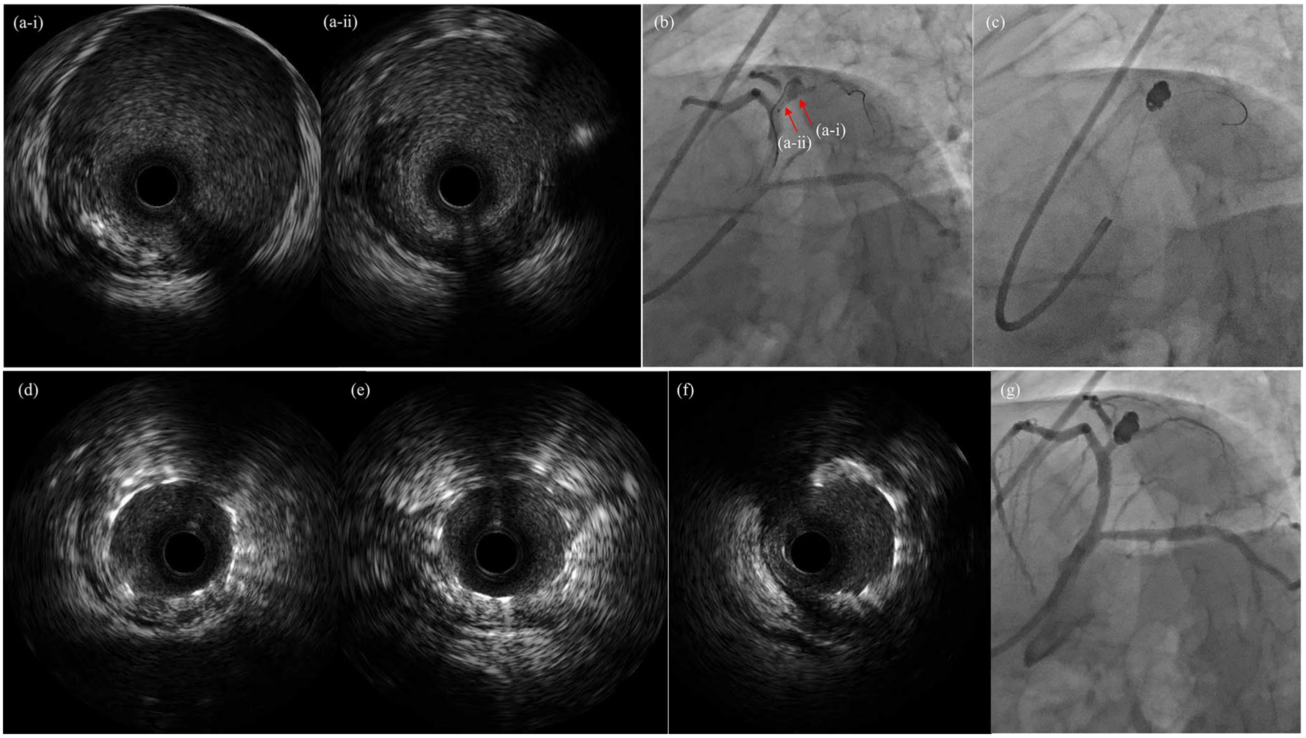

Fig. 2 **a** Intravascular ultrasound (IVUS) images of the pseudoaneurysm. The neck was wide, and the pseudoaneurysm wall had no external elastic membrane during 11–5 o'clock (i). Branch 1 was identified at the 2 o'clock origination (ii). **b** Bare-metal stent was implanted, jailing the microcatheter into the pseudoaneurysm. **c** Pseudoaneurysm was filled with seven coils. **d**–**f** IVUS images of the pseudoaneurysm after coil embolization. The coils overlapped with one another and the stent completely covered the ostium of the pseudoaneurysm. **g** Final angiography revealed complete exclusion of the pseudoaneurysm

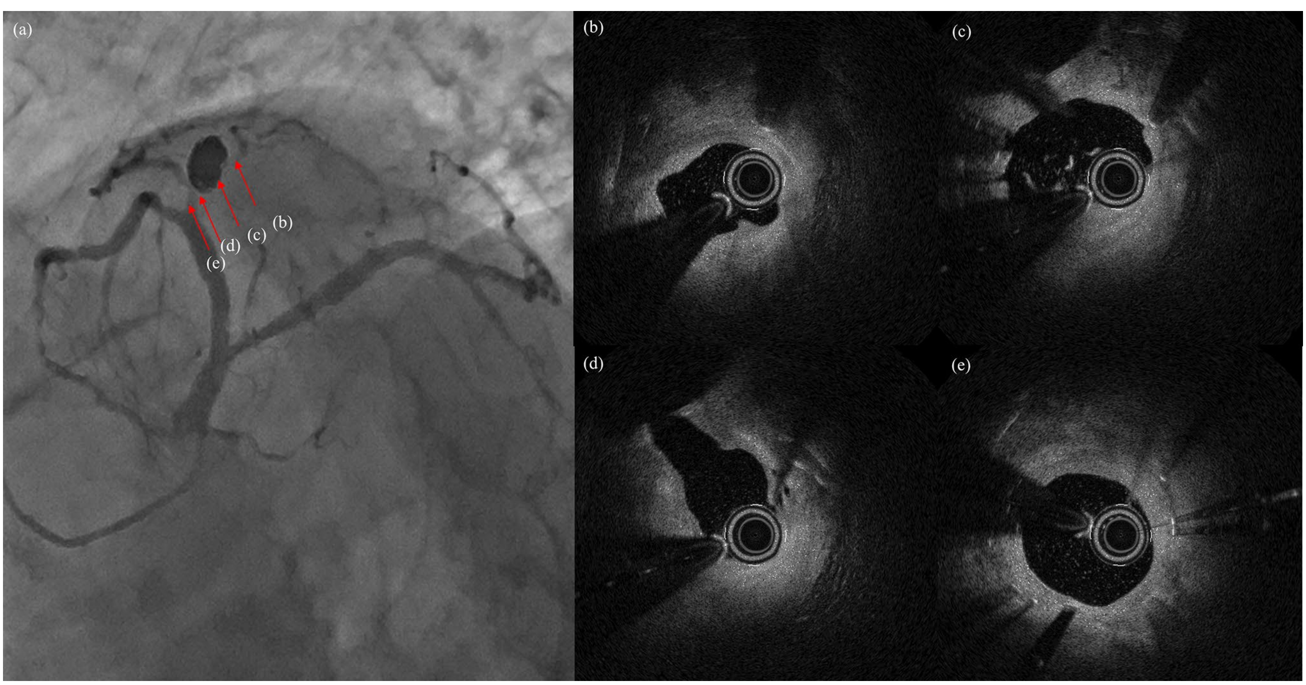

Fig. 3 **a** Follow-up coronary angiography (CAG). **b**–**e** Optical coherence tomography at follow-up CAG. Distal of pseudoaneurysm (**b**), at the site of coil embolization (**c**), bifurcation of branch 1 (**d**), and proximal of pseudoaneurysm (**e**)

IVUS image of this case. PTFE-covered stents may not deliver to distal small vessels and prevent any access to side branches. In addition, the limited length of PTFE-covered stents renders it unsuitable for a wide-neck lesion [7]. Stent-assisted coil embolization is a feasible option in situations, where PTFE-covered stents are anatomically unsuitable. As our case presented all the hallmarks of a difficult anatomy (i.e., small vessel, wide neck, and bifurcation), stent-assisted coil embolization was deemed the only treatment option.

IVUS findings in the acute phase indicated that the stent implanted across the neck offered a metal scaffold to evade prolapse of the coils into the parent vessels and facilitated enhanced resistance to the blood flow into the aneurysm lumen. Typically, thrombi play a crucial role in the healing response to embolotherapy; however, studies investigating the healing response to coil embolization using an animal aneurysm model showed that not only the thrombosis, but also the endothelium layer covered the coils on the luminal surface at the chronic phase [8]. In our case, OCT at the chronic phase revealed that thick intima covered the stent struts and coils, and the pseudoaneurysm was entirely excluded. To date, there have been limited reports describing the pathology or intracoronary imaging findings after coil embolization at the chronic phase. Even in the neurosurgery field, little is known about the in vivo pathological changes and intravascular images after coil embolization at the chronic phase; only angiographic follow-up data and animal experimental data have been reported. Therefore, we can only speculate as to the pathological difference between the coronary circulation and the cerebral artery after stent-assisted coil embolization. Previously, it was reported that late lumen loss in the coronary artery was thicker in the coronary circulation than in the cerebrovascular territory [9–13]. There have also been some case reports describing reduction in the size of CAAs after BMS implantation [14, 15], or the efficacy of double-layer BMS implantation for small CAAs [16]. The potential mechanism of size reduction or even occlusion of CAAs after BMS implantation is as follows: blood flow into the CAA may decrease with the proliferation of neointimal coverage of the stent strut, thereby activating the formation of a thrombosis in the CAA [17]. Because the pseudoaneurysm in our case was bigger than those in which successful treatment with BMS was previously reported, stent-assisted coil embolization was chosen. Considering all of the findings from the literature and the OCT data in our case together, it may not be essential to attain a high-volume embolization ratio, and minimal residual flow may be acceptable.

To our knowledge, this is the first report that discusses the histological consideration of stent-assisted coil embolization based on serial data from intravascular imaging. This report suggests the feasibility of stent-assisted coil embolization for coronary pseudoaneurysms involving bifurcation.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical statements All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and later versions.

Informed consent Informed consent was obtained from all patients for being included in the study.

References

1. Syed M, Lesch M. Coronary artery aneurysm: a review. Prog Cardiovasc Dis. 1997;40:77–84.
2. Ilkay E, Karaca I, Yavuzkir M, et al. The effect of interventional treatment in acute myocardial infarction on ST resolution: a comparison of coronary angioplasty with excimer laser angioplasty. Angiology. 2005;56:377–84.
3. Sacca S, Pacchioni A, Nikas D. Coil embolization for distal left main aneurysm: a new approach to coronary artery aneurysm treatment. Catheter Cardiovasc Interv. 2012;79:1000–3.
4. Bittl JA, Ryan TJ Jr, Keaney JF Jr, et al. Coronary artery perforation during excimer laser coronary angioplasty. The percutaneous excimer laser coronary angioplasty registry. J Am Coll Cardiol. 1993;21:1158–65.
5. Holmes DR Jr, Reeder GS, Ghazzal ZM, et al. Coronary perforation after excimer laser coronary angioplasty: the excimer laser coronary angioplasty registry experience. J Am Coll Cardiol. 1994;23:330–5.
6. Shelton ME, Lasala JM. Pseudoaneurysm following successful excimer laser coronary angioplasty of a restenotic left internal mammary artery graft ostial lesion. J Invasive Cardiol. 1994;6:157–9.
7. Yoshida R, Takagi K, Morita Y, et al. Efficacy of simultaneous kissing stent technique using two PTFE-covered stents for severe coronary perforation involving bifurcation. Can J Cardiol. 2018. https://doi.org/10.1016/j.cjca.2018.08.021.
8. Thorell WE, Chow MM, Prayson RA, et al. Optical coherence tomography: a new method to assess aneurysm healing. J Neurosurg. 2005;102:348–54.
9. Buyukkaya R, Kocaeli H, Yildirim N, et al. Treatment of complex intracranial aneurysms using flow-diverting silk(R) stents. An analysis of 32 consecutive patients. Interv Neuroradiol. 2014;20:729–35.
10. Tanigawa J, Barlis P, Di Mario C. Intravascular optical coherence tomography: optimisation of image acquisition and quantitative assessment of stent strut apposition. EuroIntervention. 2007;3:128–36.
11. Ikuta S, Kobuke K, Iwanaga Y, et al. Difference in neointimal coverage at chronic stage between bare metal stent and sirolimus-eluting stent evaluated at stent–strut level by optical coherence tomography. Heart Vessels. 2014;29:320–7.

12. Nishi S, Nakayama Y, Ishibashi-Ueda H, et al. Development of microporous self-expanding stent grafts for treating cerebral aneurysms: designing micropores to control intimal hyperplasia. J Artif Organs. 2011;14:348–56.
13. Kim YS, Lee SW, Yeom JA, et al. Angiographic findings of in-stent intimal hyperplasia after stent-assisted coil embolization: are they permanent findings? J Neurosurg. 2016;124:328–33.
14. Ohtsuka M, Uchida E, Yamaguchi H, et al. Coronary aneurysm reduced after coronary stenting. Int J Cardiol. 2007;121:76–7.
15. Ito K, Isoda K, Daida H. Bare metal stent for a coronary artery aneurysm. Intern Med. 2016;55:315–6.
16. Qiao SB, Li J, Cui JG, et al. Efficacy of bare metal stent for treating focal coronary artery aneurysm complicating with severe stenosis in single coronary artery. Zhonghua xin xue guan bing za zhi. 2018;46:279–83 **(in Chinese)**.
17. Shintani Y, Kawasaki T. The effects of a bare metal stent on the healing of a huge coronary pseudoaneurysm: a case report. Catheter Cardiovasc Interv. 2012;80:621–5.