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CASE REPORT
Coronary intervention

Excimer laser coronary atherectomy with distal protection for neoatherosclerosis rupture: a case report

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Background Neoatherosclerosis, a prominent contributor to in-stent restenosis (ISR), persists as a formidable challenge during percutaneous coronary intervention. Excimer laser coronary atherectomy (ELCA) and embolic protection devices may help reduce coronary flow disturbance from procedure-related distal embolization.

Case summary A 71-year-old man experienced in-stent neoatherosclerosis rupture–related non-ST segment elevation myocardial infarction. Multidisciplinary intracoronary imaging, including intravascular ultrasound and optical coherence tomography (OCT), suggested that the ISR was caused by a neoatherosclerosis rupture that can potentially lead to distal embolization. Excimer laser coronary atherectomy (fluence, 45 mJ/mm^2 and frequency, 25 pulse/s) using a 1.7 mm concentric catheter was performed with distal protection using Filtrap (Nipro Corporation, Tokyo, Japan), which significantly reduced the volume of the neoatherosclerosis. However, subsequent ELCA on the highest setting (fluence, 60 mJ/mm^2 and frequency, 40 pulse/s) led to a filter no-reflow phenomenon, although OCT revealed a further effective vaporization of the neoatherosclerosis and an apparent reduction of soft tissue compatible with the thrombus. After removing the embolic protection device, drug-coated balloon angioplasty provided optimal results without coronary flow disturbance.

Discussion Excimer laser coronary atherectomy reduces soft plaque and thrombus burden, which can reduce the occurrence of distal embolization in select cases. In the case of this patient, procedure-related distal embolization may have been induced by the heightened photomechanical effects resulting from the use of the highest setting in ELCA under increased intracoronary arterial pressure caused by continuous saline injection during ELCA. Concomitant distal protection during ELCA may be more feasible for preventing coronary flow disturbance in patients with a large amount of neoatherosclerosis.

Keywords Case report • Distal protection • Excimer laser coronary atherectomy • In-stent restenosis • Neoatherosclerosis • Plaque rupture

ESC curriculum 2.1 Imaging modalities • 3.2 Acute coronary syndrome

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Learning points

- A precise evaluation of in-stent restenosis aetiology by intracoronary imaging is important to guide optimal percutaneous coronary intervention procedures, including excimer laser coronary atherectomy and distal protection.
- Concomitant distal protection during excimer laser coronary atherectomy may be more feasible for preventing coronary flow disturbance in patients with large neoatherosclerosis.

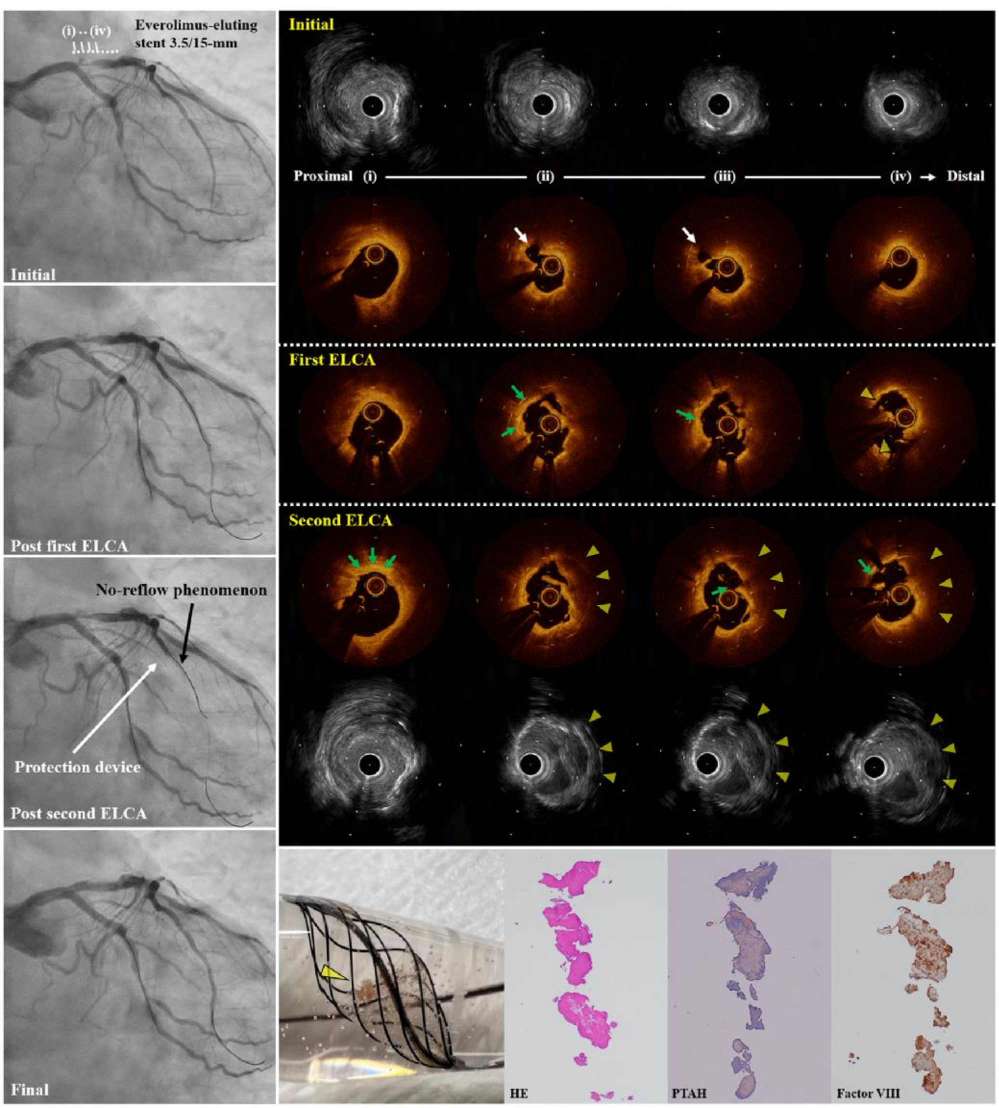
Introduction

Neoatherosclerosis, a prominent contributor to in-stent restenosis (ISR), persists as a formidable challenge in this era of drug-eluting stents. Percutaneous coronary intervention (PCI) for neoatherosclerosis, especially in cases of lipidic neoatherosclerosis, has poor cardiovascular outcomes, primarily due to distal embolization–related periprocedural myocardial infarction and a high prevalence of target lesion failure.[1,2]

Excimer laser coronary atherectomy (ELCA) is a procedure that uses a xenon-chloride monochromatic exciter laser to produce bursts of ultraviolet light at 308 nm. This intervention is valuable for modifying atherosclerotic plaques via various effects, including photochemical, photothermal, and photomechanical. Excimer laser coronary atherectomy is reportedly effective in reducing soft plaque and thrombus burden, which can reduce distal embolization in select cases.[3]

Herein, we describe the case of a patient with in-stent neoatherosclerosis rupture–related non-ST segment elevation myocardial infarction, for which ELCA with distal protection helped prevent prolonged coronary flow disturbance caused by distal embolization.

Summary figure



Case presentation

A 71-year-old man presented to our emergency department with persistent chest pain. The patient had multiple coronary risk factors (hypertension, dyslipidaemia, and current smoking habit) and hypothyroidism, for which he was taking aspirin 100 mg/day, lansoprazole 15 mg/day, benidipine 6 mg/day, pravastatin 10 mg/day, and tyradine 62.5 μg/day. He had experienced exertional angina pectoris and underwent PCI with a 3.5/15 mm cobalt-chromium everolimus-eluting stent (Xience V, Abbott Vascular, CA, USA) implantation in the proximal left anterior descending artery (LAD) 13 years prior. A follow-up coronary angiography (CAG) performed 1 year later showed no signs of ISR.

Following admission to our department, his physical examination showed no abnormal findings. He was also haemodynamically stable: blood pressure, 142/82 mmHg and heart rate, 65 b.p.m. Laboratory tests revealed a high low-density lipoprotein cholesterol level of 132 mg/dL (the recommended value for secondary prevention of coronary artery disease in Japan is <70 mg/dL) and slightly elevated troponin-I levels (77.0 pg/mL, normal range of ≤45.2 pg/mL); however, electrocardiography showed no significant ST-T changes. As non-ST-segment elevation myocardial infarction was suspected based on these findings, emergency CAG via the right radial artery was performed, which revealed proximal LAD–ISR and intermediate stenosis in the mid-left circumflex artery (*Figure 1A*). Based on the vulnerable angiographical findings, particularly the presence of rupture, we decided to address the LAD–ISR. Intravascular ultrasound (IVUS) showed a large burden of low-echogenic neointima (*Figure 1B*). Subsequent optical coherence tomography (OCT) revealed low-attenuation signal tissues with invisible stent struts and a small ulcer (*Figure 1C*). These

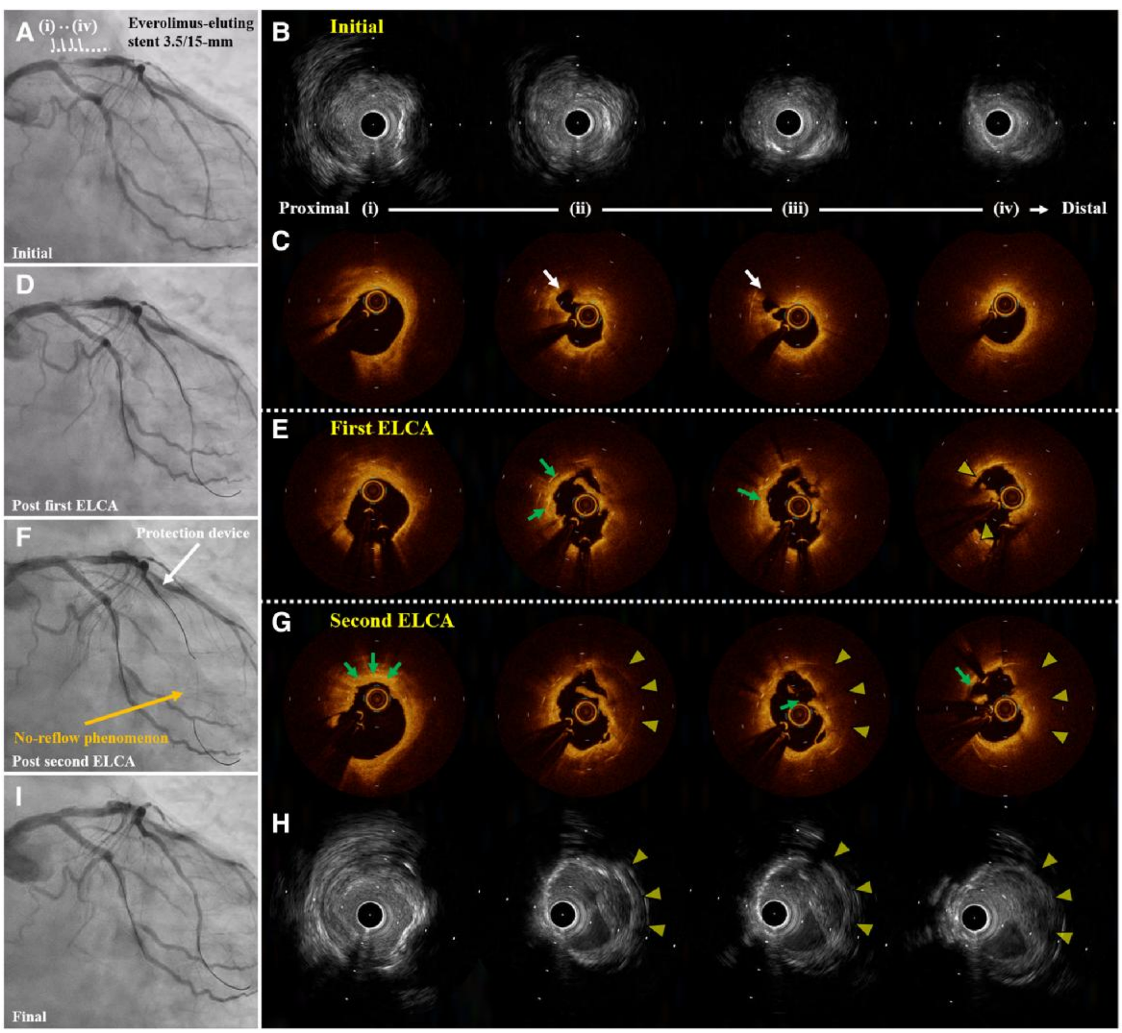


Figure 1 Coronary angiography and intracoronary images of in-stent restenosis. Coronary angiography: (*A*) initial, (*D*) post-first excimer laser coronary atherectomy, (*F*) post-second excimer laser coronary atherectomy, and (*I*) final. (*B*) Initial intravascular ultrasound shows a large burden of low echogenic neointima. (*C*) Initial optical coherence tomography reveals that in-stent restenosis has low-attenuation signal tissue with invisible stent-struts and a small cavity (white arrows), suggestive of neoatherosclerosis rupture. A comparison of the optical coherence tomography images (*E*) after the first excimer laser coronary atherectomy and (*G*) after the second excimer laser coronary atherectomy. (*H*) Intravascular ultrasound images after the second excimer laser coronary atherectomy. After the second excimer laser coronary atherectomy, organized thrombi are observed within the in-stent restenosis lesion (yellow arrowheads). The green arrows show the effective vaporization by excimer laser coronary atherectomy.

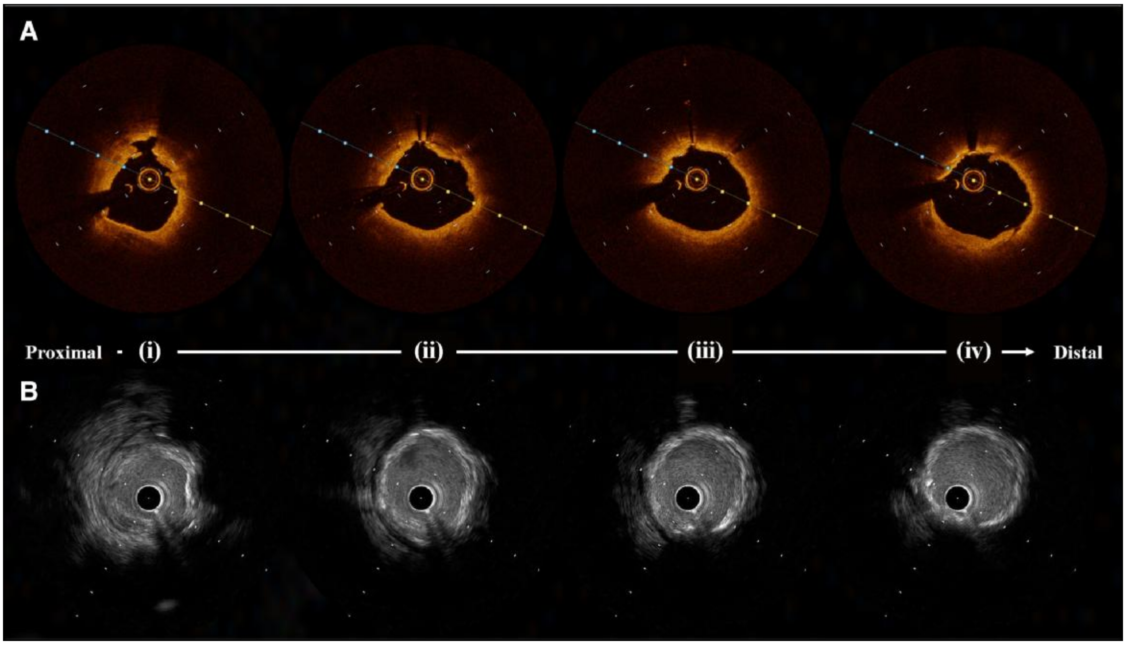


Figure 2 Final optical coherence tomography and intravascular ultrasound images. The final (*A*) optical coherence tomography and (*B*) intravascular ultrasound images reveal sufficient lumen gain in the in-stent restenosis lesion after the percutaneous coronary intervention with excimer laser coronary atherectomy under distal protection. Each image corresponds to (i) through (iv) in *Figure 1*.

intracoronary findings suggested that the culprit ISR lesion was caused by neoatherosclerosis rupture, which had the potential to lead to distal embolization. Since balloon angioplasty or direct stent implantation for cases involving a significant amount of vulnerable neointima may lead to plaque shift or stent under-expansion, we opted for ELCA to reduce the neointimal volume as lesion preparation. Excimer laser coronary atherectomy using Spectranetics CVX-300 (Spectranetics, Colorado Springs, CO, USA) was planned with distal protection using a filter-type embolic protection device (c, Nipro Corporation, Tokyo, Japan) and performed using a 1.7 mm concentric catheter with a setting of fluence, 45 mJ/mm^2 and frequency, 25 pulse/s, first ELCA. Optical coherence tomography revealed that the neoatherosclerosis volume had reduced and soft tissue compatible with the thrombus emerged at the distal part of the culprit lesion (*Figure 1D* and *E*). The subsequent ELCA was performed with the highest-setting of fluence, 60 mJ/mm^2 and frequency, 40 pulse/s, second ELCA. However, a filter no-reflow phenomenon occurred. Optical coherence tomography revealed a further effective vaporization of neoatherosclerosis and an apparent reduction in soft tissue volume (*Figure 1F–H*). Thereafter, balloon angioplasty with a 3.0 mm scoring balloon was performed. Sufficient luminal gain was obtained without any coronary flow disturbance; therefore, a 3.5 mm drug-coated balloon (DCB) angioplasty was performed (*Figure 1I*). Final CAG showed optimal results with thrombolysis in myocardial infarction Grade 3 (see Supplementary material online, *Videos S1* and *S2*). In addition, final OCT/IVUS images revealed sufficient lumen gain in the ISR lesion (*Figure 2*). A *post hoc* histopathological evaluation of the distally embolized debris trapped in the embolic protection device with haematoxylin-eosin staining, phosphotungstic acid haematoxylin staining, and immunostaining of Factor VIII, revealed organized white thrombi consisting of fibrin and platelet aggregation (*Figure 3*).

After the PCI, the patient had an uneventful clinical course without periprocedural myocardial infarction. He underwent a 3-month course of dual anti-platelet therapy with aspirin (100 mg/day) and prasugrel (3.75 mg/day) before transitioning to prasugrel monotherapy. Additionally, his lipid-lowering therapy was intensified with rosuvastatin 10 mg/day and ezetimibe 10 mg to reduce his low-density lipoprotein cholesterol level to <70 mg/dL, in accordance with the Japanese guidelines. Myocardial perfusion scintigraphy 1 month later showed no significant ischaemia (see Supplementary material online, *Figure S1*). No recurrent ischaemic events were clinically observed for at least 6 months.

Discussion

This case demonstrated that ELCA effectively reduced the burden of neoatherosclerosis. However, a filter no-reflow phenomenon occurred immediately after the second ELCA procedure, performed at the highest setting. The use of ELCA with distal protection proved effective in preventing coronary flow disturbance caused by distal embolization.

Intracoronary imaging modalities, including IVUS and OCT, are useful in detecting the ISR aetiology and guiding optimal PCI procedures. In-stent neoatherosclerosis with lipid-laden neointima often leads to prolonged coronary flow disturbance owing to distal embolization following balloon angioplasty, resulting in periprocedural myocardial infarction.[2] In this parient, the ISR lesion was evaluated by both IVUS and subsequent OCT images, and these intracoronary images suggested that the culprit lesion was associated with a neoatherosclerosis rupture, which would potentially lead to distal embolization following PCI. Some techniques, such as prolonged perfusion balloon inflation (long inflation), ELCA, and directional coronary atherectomy,

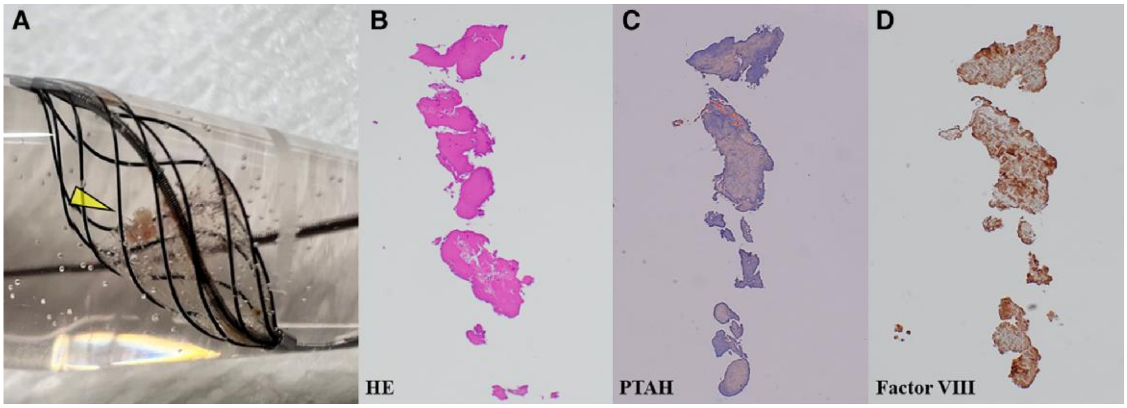


Figure 3 Histopathological evaluation of trapped debris after excimer laser coronary atherectomy. (*A*) Debris trapped by an embolic protection device. (*B–D*) Histopathological evaluation of trapped debris with (*B*) haematoxylin-eosin staining, (*C*) phosphotungstic-acid haematoxylin staining, and (*D*) Factor VIII immunostaining. The debris is composed of organized white thrombi consisting of fibrin and platelet aggregation.

are reportedly useful for preventing distal embolization–related coronary flow disturbance.[4–6] In Japan, ELCA is occasionally performed in ACS, ISR, and chronic total occlusion cases with thrombotic lesions.[5] Excimer laser coronary atherectomy has been reported to help achieve a large lumen gain and reduce the frequency of restenosis.[7] Moreover, a retrospective observational study demonstrated that ELCA might be more compatible with DCB angioplasty for ISR.[8] We opted for the ELCA procedure for lesion preparation because of the large neoatherosclerotic burden; however, there remains no consensus regarding the efficacy of ELCA for neoatherosclerosis. Additionally, since balloon angioplasty following ELCA provided sufficient luminal gain and the angiographic residual diameter stenosis was <30%, we selected DCB angioplasty in our patient. Although reducing the plaque volume may contribute towards preventing distal embolization, distal embolization may occur even during the performance of the ELCA procedure, as observed in the case of our patient.

Distal protection devices are useful for capturing dispersed atherosclerosis debris during PCI in select cases with either thrombotic lesions in acute coronary syndrome or lipidic neoatherosclerosis in ISR.[3,9,10] In patients who have undergone an embolic protection procedure, the tissue characteristics of captured debris have been reported to consist of necrotic debris and platelet thrombus in higher proportions.[11] Evaluation using IVUS showed that lipid volume correlated independently with the amount of captured debris.[12] Given that neoatherosclerosis involves macrophage infiltration and necrotic core formation, the corresponding occurrence of distal embolization is similar to that in native coronary atherosclerosis.[13]

Excimer laser coronary atherectomy can be performed on parallel wires (concomitant use with a conventional wire and an embolic protection device wire), and we performed ELCA by using an embolic protection device. In our patient, a filter no-reflow phenomenon occurred following the second ELCA procedure. The potential causes of distal embolization during the maximum setting include: (i) increased photomechanical effects, and (ii) elevated intracoronary arterial pressure due to continuous saline injection for irrigation during the ELCA procedure.[14] Thus, in some cases of PCI with ELCA for a large thrombotic or neoatherosclerosis burden, the concomitant use of an embolic protection device may be more feasible for preventing prolonged coronary flow disturbance.

Lead author biography

Dr Nobuhiro Watanabe received his licence to practice medicine at Hiroshima University in 2017. He became interested in treatment for acute coronary syndrome and intensive care for severe heart failure during his residency, and he currently works as a physician in the field of interventional cardiology at the Hyogo Prefectural Harima-Himeji General Medical Center, Himeji, Japan. His main area of research is intravascular coronary imaging.

Supplementary material

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

Consent: Informed consent was obtained from the patient for the publication of the case and the accompanying images in line with the COPE guidelines.

Conflict of interest: None declared.

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Data availability

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

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