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【 CASE REPORT 】

Healed Erosion: The Role of Pre-interventional Optical Coherence Tomography in a Patient Clinically Suspected of Having Unstable Angina with Coronary Spasm

Hiroki Okabe, Shinjo Sonoda, Yutaro Naka, Koshi Setoyama, Konosuke Inoue, Toshiya Miura, Reo Anai, Yuki Tsuda, Masaru Araki and Yutaka Otsuji

Abstract:
A 46-year-old man complained of chest pain at rest for the past three months. His symptoms gradually exacerbated and were suspected of being due to unstable angina. A coronary angiogram revealed focal tight stenosis at the proximal left anterior descending coronary artery with gross spastic coronary findings. Optical coherence tomography (OCT) revealed layered low-intensity structures with microvessels and the accumulation of macrophages, which indicated progressive stenosis with multiple-layered organized thrombus caused by coronary erosion. We treated the stenosis using a drug-coated balloon instead of drug-eluting stents. There was no restenosis, and OCT revealed good plaque healing at follow-up. This case suggests that the pre-interventional OCT plaque morphology can have a positive impact on the revascularization strategy.

Key words: healed plaque, optical coherence tomography, drug-coated balloon, coronary spasm

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Introduction

Plaques underlying coronary thrombi in acute coronary events may have different features, and the most common phenotypes are plaque rupture and plaque erosion (1). In addition, the number of healed ruptures and erosion sites correlates with the severity of stenosis (2). The influence of culprit plaque characteristics in patients undergoing revascularization remains an important issue, and different plaque morphologies might be more or less amenable to different treatments. Optical coherence tomography (OCT) is an intravascular imaging technique that can help visualizing detailed structures in the coronary arterial walls.

Case Report

A 46-year-old man complained of chest pain at rest lasting for 3 months. His symptoms gradually worsened and appeared not only at rest but also with effort. Although there were no abnormal findings on an electrocardiogram and echocardiography, myocardial perfusion scintigraphy showed broad ischemia in the territory of the left anterior descending coronary artery (LAD). Although he had no coronary risk factors and was not taking any medication, he was suspected of having unstable angina.

His blood pressure and heart rate were 110/57 mmHg and 57 beats/min, respectively, with a regular pulse. Oxygen saturation was maintained at 98% on room air. There were no abnormal findings on a physical examination. The patient's laboratory data also showed no abnormalities. An urgent coronary angiogram (CAG) before intracoronary isosorbide dinitrate (ISDN) revealed focal tight stenosis at the proximal LAD with gross spastic coronary findings (Fig. 1A). Coronary spasms may have been involved due to obvious vasodilatation after ISDN (Fig. 1B). OCT revealed layered low-intensity structures with microvessels and the accumulation of macrophages (Fig. 2A). As neither plaque rupture nor superficial lipid or calcification was seen, the plaque was considered to have healed based on the multiple-layered organized thrombus formation (Fig. 3). The minimal lumen area (MLA) was 0.7 mm^2. OCT reflected tight steno-

The Second Department of Internal Medicine, University of Occupational and Environmental Health, Japan
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Correspondence to Dr. Shinjo Sonoda, s-sonoda@med.uoeh-u.ac.jp

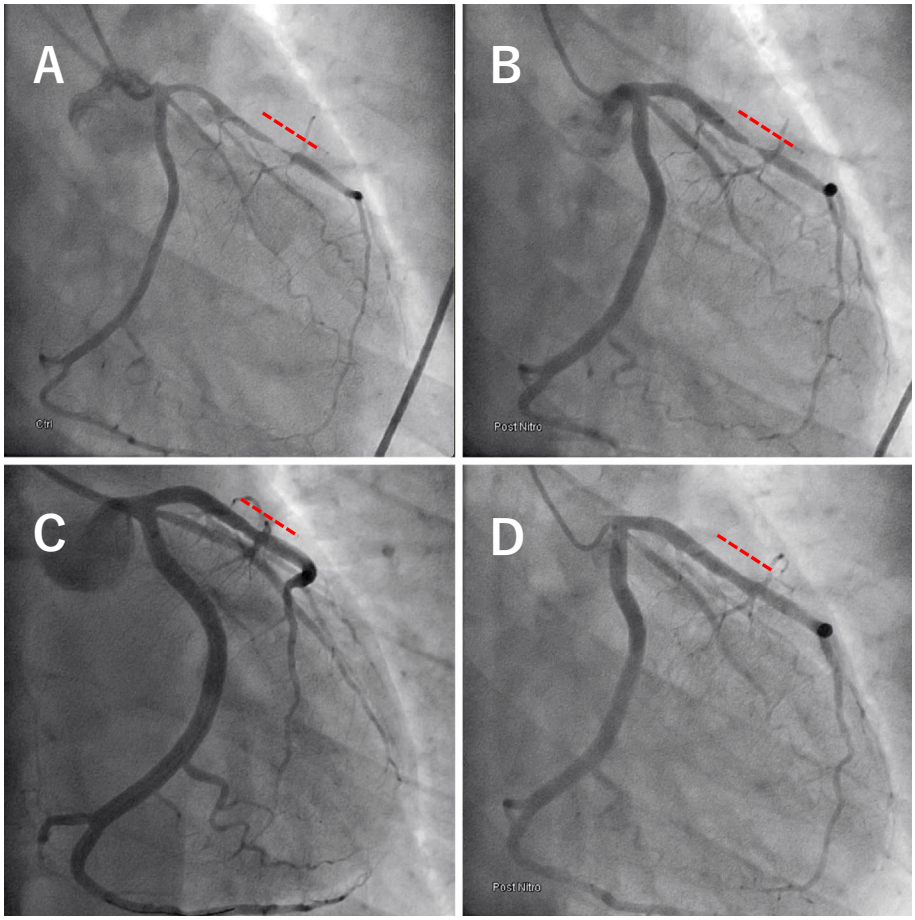

Figure 1. Serial coronary angiography. (A) Control. (B) After ISDN. (C) After DCB. (D) Four-month follow-up. The red dotted line indicates the culprit lesion. ISDN: isosorbide dinitrate, DCB: drug-coated balloon

sis with the accumulation of organized thrombus, which might have been caused by coronary plaque erosion. We treated the stenosis using a drug-coated balloon (DCB) instead of drug-eluting stents (DESs) (Fig. 1C, 2B) with antithrombotic therapy (100 mg of aspirin and 3.75 mg of prasugrel hydrochloride) and calcium antagonist (200 mg/day diltiazem hydrochloride) to control spasms. After balloon dilation, the MLA increased to a satisfactory extent (6.1 mm^2). Four months later, no restenosis was seen on an CAG, and OCT revealed good plaque healing (Fig. 1D, 2C). The one-year clinical follow-up was also good.

Discussion

In this case, OCT showed tight stenosis with the accumulation of organized thrombus caused by coronary plaque erosion. However, intra-mural organizing thrombus caused by localized coronary artery dissection cannot be completely excluded from the differential diagnosis of this case.

Healed plaque is identified by distinct layers of different optical characteristics that signal previous acute events that had undergone healing processes. Some plaques have a healed thrombus overlying fibroatheroma indicating healed plaque ruptures, and others have a multilayered organized thrombus on eroded plaques indicating healed plaque erosion (3). In addition, a previous study reported that erosion is a common feature of OCT in patients with vasospastic angina (4). Pathologically, most plaque erosions accompany underlying atherosclerotic lesions (reported as pathologic intimal thickening in 16%, early fibroatheroma in 50%, and late fibroatheroma in 34% cases) (5). Histologically, one study reported the presence of healed erosions based on distinct layers of dense collagen interspersed with smooth muscle cells and proteoglycans without a necrotic core (2), and another study reported that a lipid core or necrotic core could be found deep within the plaque without any communication with superficial thrombus (6). Therefore, it is most probable that plaque erosion was present at the roof of the healing plaque around this case as a characteristic of the healing plaque due to fibrous plaque and thrombus. Subclinical episodes of thrombosis may contribute to an increase in plaque volume and induce the development of high-degree stenosis (7).

Several studies have shown that DCB treatment is non-inferior to DESs for managing severe stenosis with plaque erosion (small coronary arteries and acute coronary syndromes, including ST-segment elevation myocardial infarction, non-ST segment elevation myocardial infarction, and

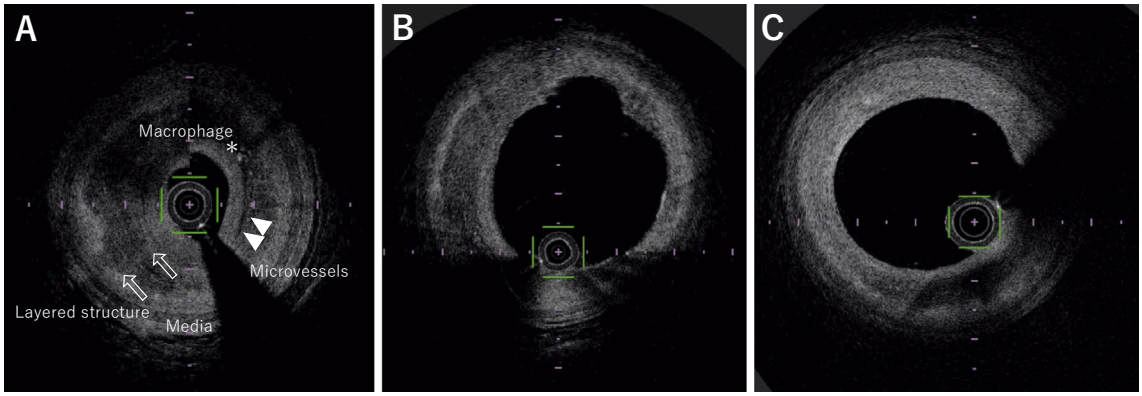

Figure 2. **Serial OCT image. (A) Baseline, layered structure (arrows) with multiple microvessels (arrowheads) and macrophages (asterisk). (B) After DCB. (C) Four-month follow-up.**

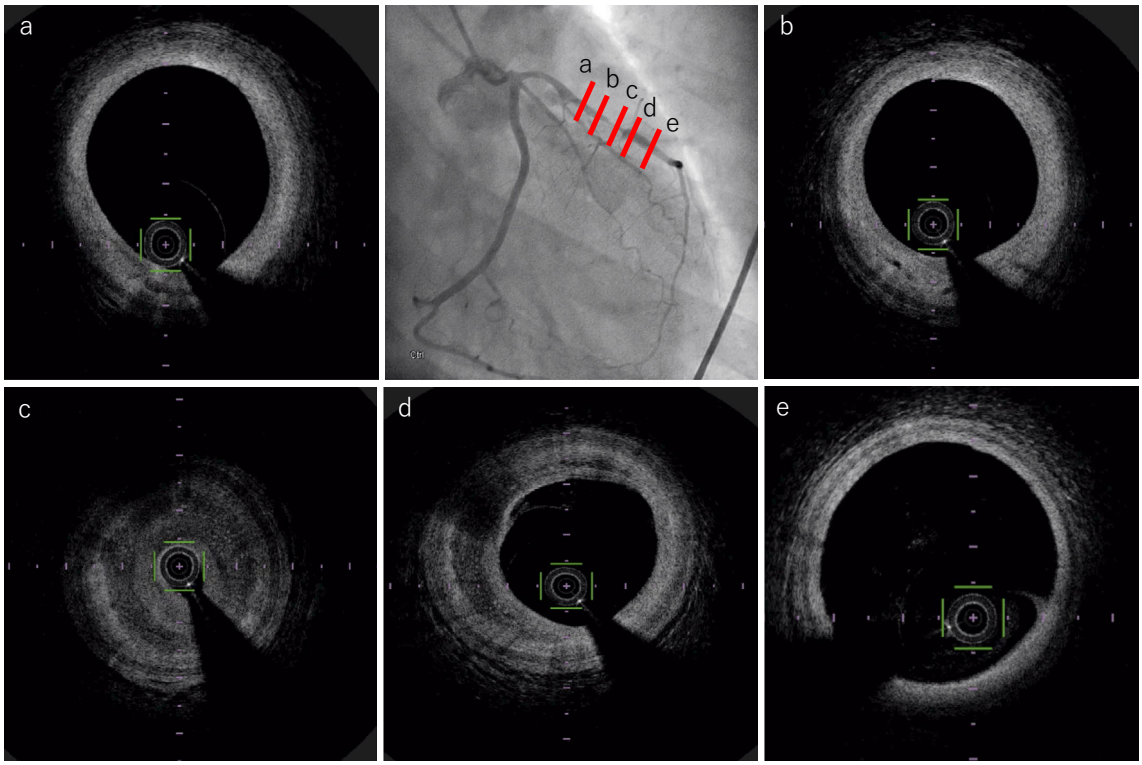

Figure 3. **Detailed OCT frames at the level of the proximal LAD. (a) is the proximal site of the LAD, and (e) is the distal site of the LAD. (c) is the culprit lesion. OCT: optical coherence tomography, LAD: left anterior descending coronary artery**

unstable angina) (8, 9). Permanent vascular stenting leads to an increased risk of late stent thrombosis and an impaired vasomotor function of the target coronary arteries (10-12). Furthermore, vascular healing at the stented segment might be impaired in patients with plaque erosions (13). Recent reports have suggested that DCB may be associated with favorable vascular remodeling after PCI, the theoretical absence of any stent thrombosis, and shortening of the duration of dual antiplatelet therapy (8, 9). For this reason, acute events associated with plaque erosions may not need to be treated with stent implantation. We may need to consider different strategies for their treatment using intravascular imaging guidance. DCB is expected to result in a better healing process than DESs for erosions, even for tight stenotic lesions as in this case. The effect of the underlying plaque morphology on the healing response after PCI should receive focus in the future.

In conclusion, we determined that the lesion to be a tight stenosis due to repeatedly healed erosion and selected treatment with a DCB without stenting. Pre-interventional OCT plaque morphologies had a positive impact on the revascularization strategies applied in the present patient.

Written informed consent was obtained from the patient for publication of this case report and accompanying images.

The authors state that they have no Conflict of Interest (COI).

References

1. Falk E, Nakano M, Bentzon JF, Finn AV, Virmani R. Update on acute coronary syndromes: the pathologists' view. Eur Heart J **34**: 719-728, 2013.
2. Shimokado A, Matsuo Y, Kubo T, et al. In vivo optical coherence tomography imaging and histopathology of healed coronary plaques. Atherosclerosis **275**: 35-42, 2018.
3. Virmani R, Kolodgie FD, Burke AP, Farb A, Schwartz SM. Lessons from sudden coronary death: a comprehensive morphological classification scheme for atherosclerotic lesions. Arterioscler Thromb Vasc Biol **20**: 1262-1275, 2000.
4. Shin ES, Ann SH, Singh GB, et al. OCT-defined morphological characteristics of coronary artery spasm sites in vasospastic angina. JACC Cardiovasc Imaging **8**: 1059-1067, 2015.
5. Yahagi K, Zarpak R, Sakakura K, et al. Multiple simultaneous plaque erosion in 3 coronary arteries. JACC Cardiovasc Imaging **7**: 1172-1174, 2014.
6. Farb A, Burke AP, Tang AL, et al. Coronary plaque erosion without rupture into a lipid core: a frequent cause of coronary thrombosis in sudden coronary death. Circulation **93**: 1354-1363, 1996.
7. Fracassi F, Crea F, Sugiyama T, et al. Healed culprit plaques in patients with acute coronary syndromes. J Am Coll Cardiol **73**: 2253-2263, 2019.
8. Jeger RV, Farah A, Ohlow MA, et al. Drug-coated balloons for small coronary artery disease (BASKET-SMALL2): an open-label randomized non-inferiority trial. The Lancet **392**: 849-856, 2018.
9. Vos NS, Fagel ND, Amoroso G, et al. Paclitaxel-coated balloon angioplasty versus drug-eluting stent in acute myocardial infarction: the REVELATION randomized trial. JACC Cardiovasc Interv **12**: 1691-1699, 2019.
10. Degetekin M, Serruys PW, Stone GW, et al. Long-term follow-up of incomplete stent apposition in patients who received the sirolimus-eluting stent for de novo coronary lesions: an intravascular ultrasound analysis. Circulation **108**: 2747-2750, 2003.
11. Mc Fadden EP, Stabile E, Regar E, et al. Late thrombosis in drug-eluting coronary stents after discontinuation of antiplatelet therapy. Lancet **364**: 1519-1521, 2004.
12. Brott BC, Anayiotos AS, Chapman GD, Anderson PG, Hillegass WB. Severe, diffuse coronary artery spasm after drug-eluting stent placement. J Invasive Cardiol **18**: 584-592, 2006.
13. Hu S, Wang C, Zhe C, et al. Plaque erosion delays vascular healing after drug eluting stent implantation in patients with acute coronary syndrome: an in vivo optical coherence tomography study. Catheter Cardiovasc Interv **89**: 592-600, 2017.