

Two distinct phenotypes of plaque erosion assessed by multimodality intracoronary imaging: a case series

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Background

Pathological studies have reported that patients with acute coronary syndrome (ACS) may have different plaque morphologies at culprit lesions, and one of the underlying mechanisms for ACS is plaque erosion. However, the morphological features of plaque erosion obtained by multiple intracoronary imaging modalities have not been fully elucidated.

Case summary

We experienced two cases with ACS of culprit lesions exhibiting optical coherence tomography (OCT)-defined plaque erosion. Additional examinations using near-infrared spectroscopy (NIRS)–intravascular ultrasound and coronary angiography suggested the presence of two distinct phenotypes of plaque erosion. These two types of erosion differ in the extent of NIRS-derived lipid core burden and coronary angiography-derived luminal surface colour.

Discussion

OCT-defined plaque erosion may not be the unique entity but have at least two distinct plaque morphologies, and NIRS and/or coronary angiography may provide incremental ability of discriminating these plaque phenotypes classified as plaque erosion by OCT.

Keywords

Plaque erosion • Optical coherence tomography • Near-infrared spectroscopy • Intravascular ultrasound • Coronary angiography • Case series

Learning points

- Optical coherence tomography (OCT)-defined plaque erosion may not be the unique entity but have at least two distinct plaque phenotypes.
- Near-infrared spectroscopy and/or coronary angiography may provide incremental ability of discriminating the morphologies of plaque erosion classified by OCT.

Introduction

Pathological studies have reported that three major underlying mechanisms for acute coronary syndrome (ACS) are plaque rupture, plaque erosion, and calcified nodules.^{1,2} Plaque erosion is responsible for one-third of patients presenting with ACS.³ Previous optical coherence tomography (OCT) studies revealed that lipid was less frequently detected in OCT-defined erosion than in plaque rupture.^{4,5} These findings were in line with pathological studies.⁶ Our group

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recently reported the clinical significance of the presence or absence of lipid-rich plaque underneath intact fibrous cap (IFC) in ACS demonstrating that, in ACS patients with culprit lesions with IFC, the presence of lipid-rich plaque was significantly associated with major adverse cardiac events, including cardiac death, non-fatal myocardial infarction, target, and non-target vessel revascularization.⁷ However, the morphological features of plaque erosion obtained by multiple intracoronary imaging modalities have not been fully elucidated. We present two cases presenting with ACS showing OCT-defined plaque erosion with two distinct characteristics assessed by multiple intracoronary imaging modalities including OCT, near-infrared spectroscopy–intravascular ultrasound, and coronary angiography.

Timeline

Timeline	Events
Case 1	
Day 1	A 66-year-old woman presented to the emergency department and was diagnosed with anterior ST-segment elevation myocardial infarction (STEMI). Emergent coronary angiography showed severe stenosis in the proximal left anterior descending artery (LAD). Percutaneous coronary intervention with imaging guidance was successfully performed.
Day 20	She discharged from the hospital after cardiac rehabilitations with an eventless clinical course.
Month 2	She has been free from additional ischaemic events and symptoms during follow-up.
Case 2	
Day 1	A 53-year-old man presented to the emergency department and was diagnosed with anterior STEMI. Emergent coronary angiography showed severe stenosis in the proximal LAD. Percutaneous coronary intervention with imaging guidance was successfully performed.
Day 15	He discharged from the hospital after cardiac rehabilitations with an eventless clinical course.
Month 2	He has been free from additional ischaemic events and symptoms during follow-up.

Case presentation

Case 1

A 66-year-old woman with a history of hypertension, dyslipidaemia, and diabetes mellitus presented to the emergency department with acute onset of substernal chest pain lasting 60 min. The electrocardiogram was remarkable for ST-segment elevation in leads V1–4 and reciprocal ST-segment depression in leads II, III, and aVF. She was diagnosed with anterior ST-segment elevation myocardial infarction

(STEMI). Emergent coronary angiography showed severe stenosis in the proximal left anterior descending artery (LAD) (Figure 1A). Pre-procedural OCT images revealed that a smooth luminal surface with thrombus overlying a lipid-rich plaque with IFC at the culprit lesion, categorized as OCT-erosion (Figure 1B) and no evidence of plaque rupture in multiple adjacent frames. Near-infrared spectroscopy–intravascular ultrasound showed an echo-attenuated plaque (Figure 1C) and max lipid core burden index of a 4-mm segment (max LCBI_{4mm}) was 628. Coronary angiography revealed the presence of yellow plaque with superimposing thrombus (Figure 1D). We recognized the culprit lesion as yellow eroded lipid-rich plaque.

Case 2

A 53-year-old man with a history of smoking presented to the emergency department with an episode of chest pain lasting 30 min. The electrocardiogram was remarkable for ST-segment elevation in leads V1–6 and reciprocal ST-segment depression in leads II, III, and aVF. He was diagnosed with anterior STEMI. Emergent coronary angiography showed severe stenosis in the proximal LAD (Figure 2A). Pre-procedural OCT imaging revealed that a smooth luminal surface with thrombus overlying a fibrous plaque with IFC at the culprit lesion, categorized as OCT-erosion (Figure 2B) and no evidence of plaque rupture in multiple adjacent frames. Near-infrared spectroscopy–intravascular ultrasound showed a fibrous plaque (Figure 2C) and max LCBI_{4mm} was 0. Coronary angiography revealed the presence of white plaque with superimposing red thrombus (Figure 2D). We considered the culprit lesion as white eroded plaque without lipid.

Discussion

A recent study demonstrated that plaque erosions accompanied by a non-significant lumen stenosis might be stabilized by potent anti-thrombotic therapy without the need for stent implantation in the setting of STEMI.⁸ Considering the presence of the significant stenosis at the culprit lesions; however, interventional procedures were performed in these two cases.

Coronary angiography is the only intracoronary imaging modality that can evaluate the surface colour of the plaque at the culprit lesion *in vivo*. Coronary angiography provides a clear direct view of the coronary artery with the continuous injection of low-molecular-weight dextran to displace blood close to the tip of angiography (Figure 3). Hayashi *et al.*⁹ reported the colour of plaque erosion in the culprit lesion of ACS patients detected by coronary angiography were light yellow, whereas Ozaki *et al.*¹⁰ reported that the colour of IFC plaque in the culprit lesion of ACS patients detected by coronary angiography contained yellow (light yellow and deep yellow) and white. However, to date, there is no consensus regarding the colours of plaque erosion and the difference in clinical significances among erosion phenotypes, if ever, which may be dependent on the presence or absence of lipid, preserved lumen size and/or the distance between luminal surface and the lipid.

To the best of our knowledge, this is the first description of the presence of distinct phenotypes of plaque erosion evaluated by multiple intracoronary imaging modalities. OCT-erosion may not be the unique entity but have at least two distinct plaque morphologies, and near-infrared spectroscopy and/or coronary angiography may provide

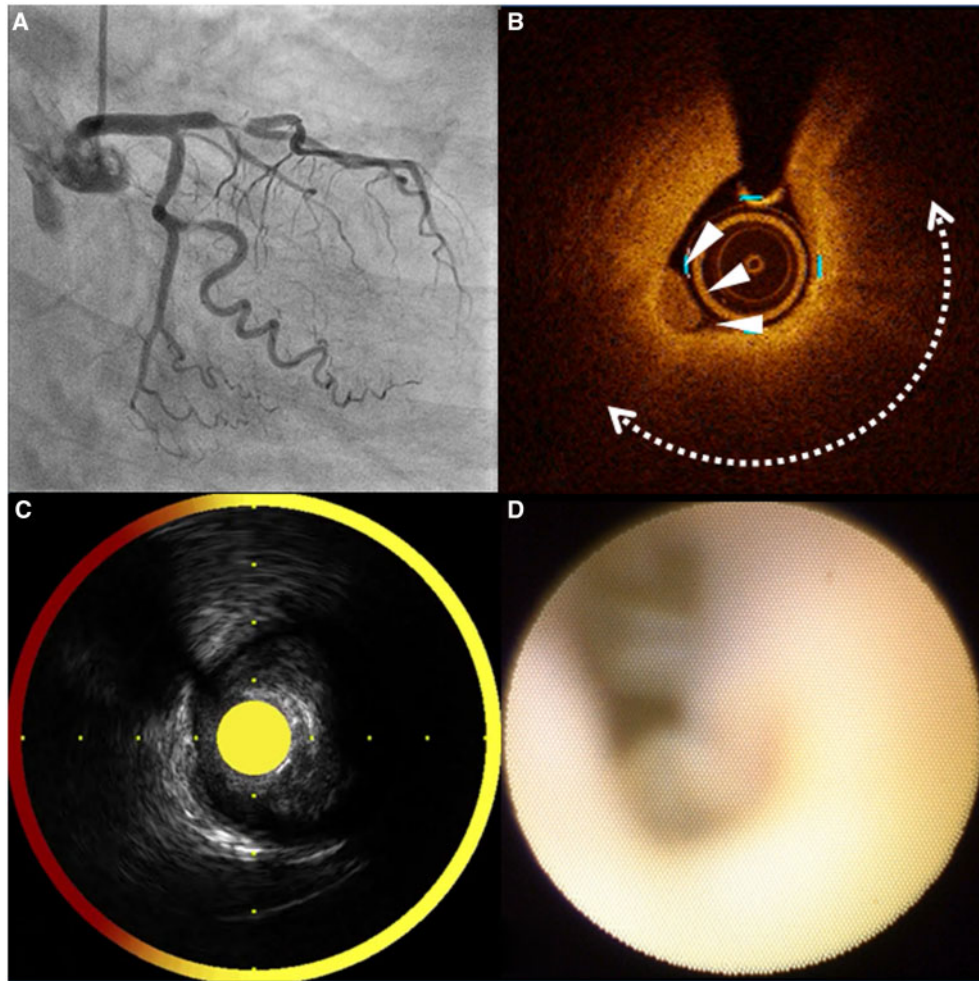
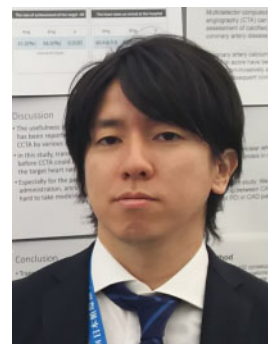


Figure 1 Case 1: A 66-year-old woman presenting with anterior ST-segment elevation myocardial infarction. (A) Coronary angiogram revealed a severe stenosis in the proximal left anterior descending artery. (B) Pre-procedural optical coherence tomography revealed a smooth luminal surface with thrombus (white arrowheads) overlying a lipid-rich plaque characterized by the presence of signal-poor lipid pool (white arc). (C) Pre-procedural near-infrared spectroscopy–intravascular ultrasound image revealed a lipid-rich plaque with echo attenuation. (D) Pre-procedural coronary angioscopy image revealed the presence of yellow plaque with red thrombus.

incremental ability of discriminating these plaque phenotypes classified as erosion by OCT. Recent studies revealed that colour grade of the plaque evaluated by coronary angioscopy is inversely correlated with fibrous cap thickness in lipid-rich plaques.¹¹ In our cases, although OCT identified a plaque with IFC in both cases, the underlying plaque characteristics were distinct between two cases. In Case 1, multimodality imaging concordantly suggested the presence of yellow lipid-rich plaque with high max LCBI_{4mm}. In contrast, in Case 2, multimodality imaging concordantly indicated the presence of white non-lipid-rich plaque without LCBI elevation. Hoshino *et al.*⁷ reported that in patients with ACS caused by non-ruptured plaque, the presence of lipid-rich plaque was associated with subsequent adverse events, primarily driven by more frequent revascularization for recurrent ischaemia. Therefore, the precise identification of patients with ACS caused by plaque erosion accompanied either lipid-rich plaque or non-lipid-rich plaque may provide important prognostic

information and can be used to guide adjunctive therapeutic intervention and management.

Lead author biography



Masao Yamaguchi is a cardiologist at the Tsuchiura Kyodo General Hospital, Ibaraki, Japan and a graduate student at the Department of Cardiovascular Medicine at Tokyo Medical and Dental University, Tokyo, Japan. His main clinical research interest is clarifying the underlying mechanisms of atherosclerosis using intracoronary imaging.

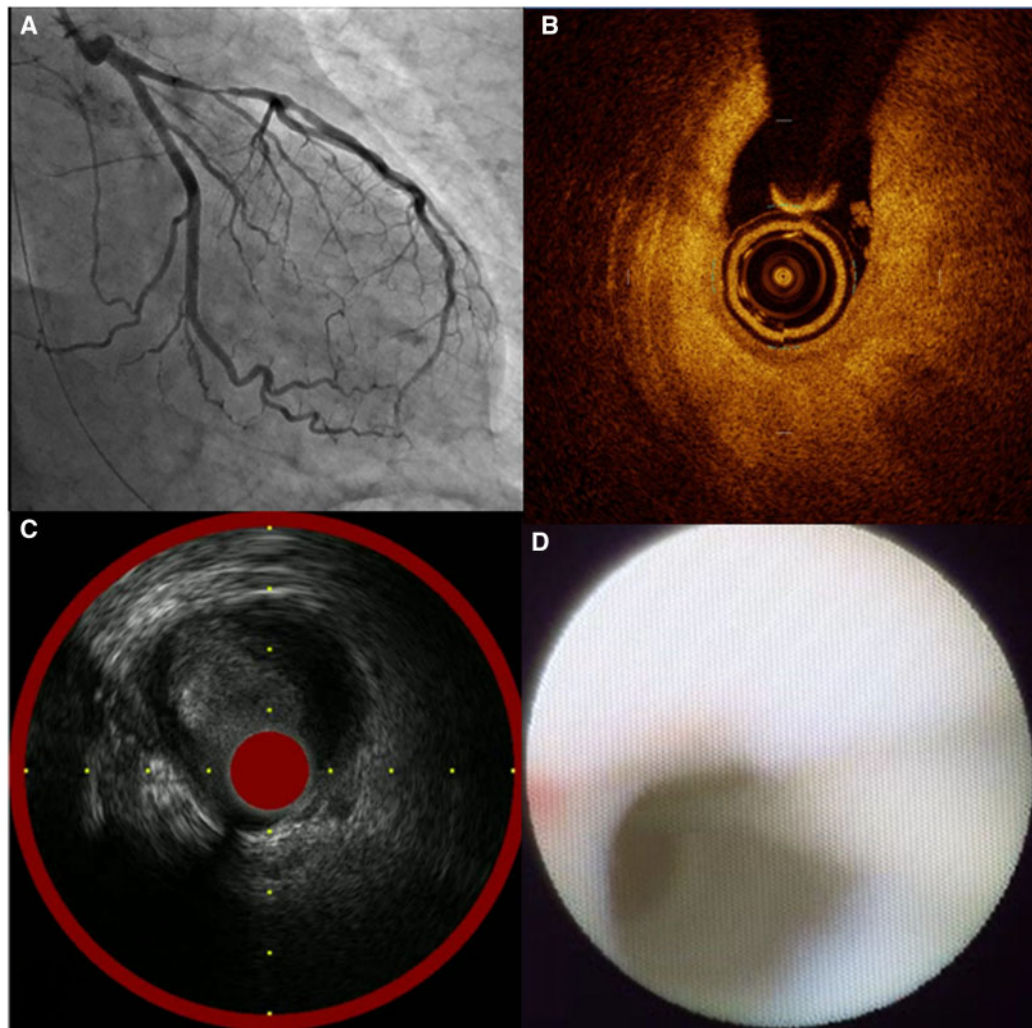


Figure 2 Case 2: A 53-year-old man presenting with anterior ST-segment elevation myocardial infarction. (A) Coronary angiogram revealed a severe stenosis in the proximal left anterior descending artery. (B) Pre-procedural optical coherence tomography revealed a smooth luminal surface with thrombus overlying a fibrous plaque. (C) Pre-procedural near-infrared spectroscopy–intravascular ultrasound revealed a fibrous plaque without lipid. (D) Pre-procedural coronary angioscopy revealed the presence of white plaque with red thrombus.

Supplementary material

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

Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as [Supplementary data](#).

Consent: The author/s confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: none declared.

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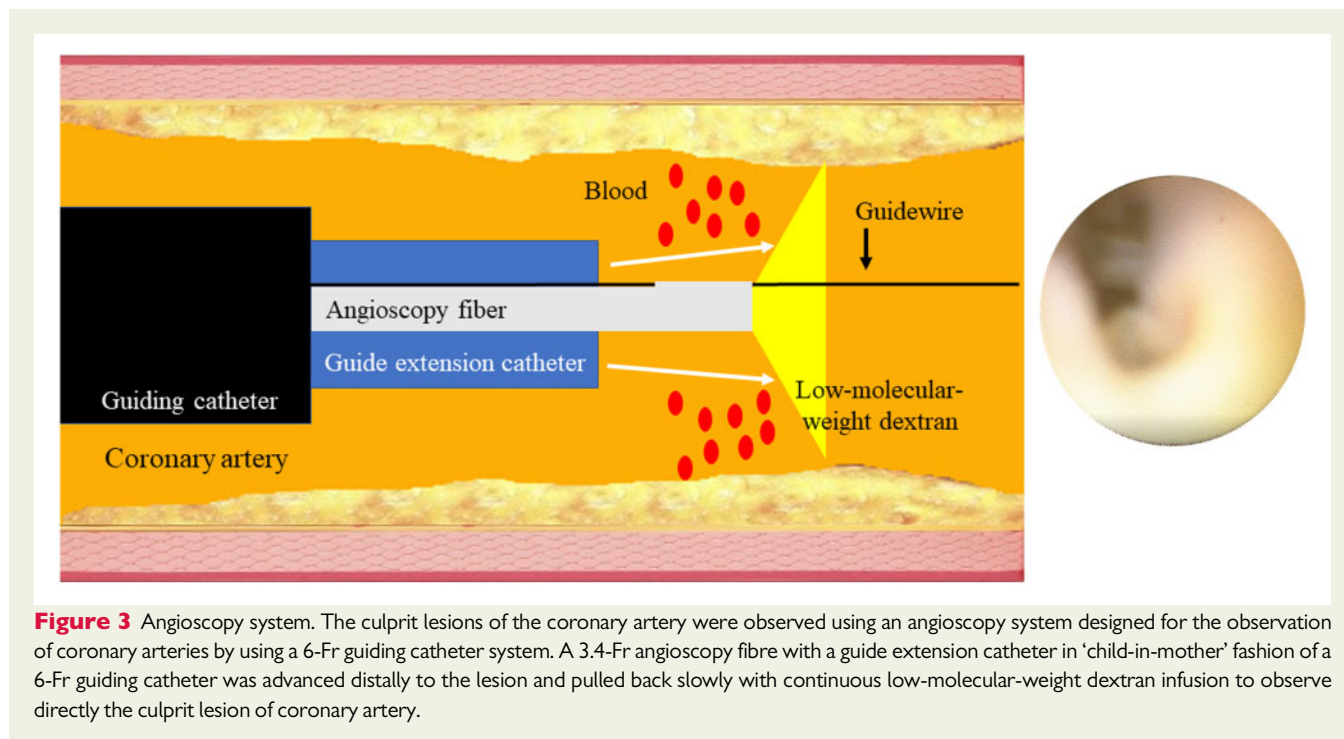


Figure 3 Angioscopy system. The culprit lesions of the coronary artery were observed using an angioscopy system designed for the observation of coronary arteries by using a 6-Fr guiding catheter system. A 3.4-Fr angioscopy fibre with a guide extension catheter in 'child-in-mother' fashion of a 6-Fr guiding catheter was advanced distally to the lesion and pulled back slowly with continuous low-molecular-weight dextran infusion to observe directly the culprit lesion of coronary artery.

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