Significant decrease in lipid core burden index following balloon dilation was associated with the leakage of cholesterol crystals in a patient: a case report

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Background
Near-infrared spectroscopy (NIRS) has been used for analysis of the composition of the atherosclerotic plaque in coronary arteries. However, meaning of significant decrease in max lipid core burden index at 4 mm (max LCBI4mm) during percutaneous coronary intervention (PCI) is poorly understood.

Case summary
A 64-year-old male with unstable angina underwent coronary angiography, which demonstrated a hazy tight culprit lesion in the mid-right coronary artery. Pre-intervention NIRS–intravascular ultrasound (NIRS–IVUS) and chemogram showed plaque with high lipid burden at the culprit lesion. Then, we used a distal protection device before PCI because of high max LCBI4mm in the lesion. After pre-dilation with a scoring balloon, repeat NIRS–IVUS interrogation revealed an almost complete disappearance of the yellow signal and decrease in max LCBI4mm (from 537 to 44) significantly, suggesting decrease in the lipid content of the plaque. Finally, a drug-eluting stent deployment followed by inflation of a non-compliant balloon led to an excellent result. After PCI, we detected trapped large amounts of debris on retrieval of the filter. Pathological diagnosis confirmed that trapped material was lipid-rich plaque including cholesterol crystals.

Discussion
This is the first report directly demonstrated that significant decrease in max LCBI4mm at culprit lesion should be associated with the leakage of cholesterol crystals from lipid-rich plaque during PCI in the clinical patient.

Keywords
Case report • Percutaneous coronary intervention • Near-infrared spectroscopy • Histopathological study

Learning points
- Near-infrared spectroscopy (NIRS) can be employed to detect extent and distribution of lipid within native coronary arteries.
- High lipid core burden index (LCBI) measured using NIRS may be associated with distal embolization during percutaneous coronary intervention (PCI).
- Significant decrease in max LCBI should be associated with the leakage of cholesterol crystals from lipid-rich plaque during PCI.

Introduction
Distal embolization during percutaneous coronary intervention (PCI) is a crucial cause of periprocedural myocardial infarction.1-3 Coronary angiography (CAG) has limited capacity to detect the risk for distal embolization. The development of intracoronary imaging techniques provides an opportunity for detail analysis of plaque composition, which could identify lesions at high risk of causing distal embolization.6 Recently, near-infrared spectroscopy (NIRS) has been...
used for analysis the composition of the atherosclerotic plaque in coronary arteries.\textsuperscript{5,6} However, meaning of significant decrease in max lipid core burden index at 4 mm (\textit{max LCBI}_{4mm}) during PCI is poorly understood. Herein, we demonstrated that significant decrease in max \textit{LCBI}_{4mm} during PCI should be associated with the leakage of cholesterol crystals from lipid-rich plaque in the clinical patient using the histopathological study.

### Timeline

| Time | Events |
|------|--------|
| Initial event | Patient presented with concerns for progressive exertional chest pain. Diagnosis of unstable angina. |
| Hospital Day 1 | Coronary angiography showed a hazy tight culprit lesion in the mid-right coronary artery. Pre-intervention near-infrared spectroscopy-intravascular ultrasound showed plaque with high lipid burden at the culprit lesion. Then, we used a distal protection device during percutaneous coronary intervention (PCI) and we detected trapped large amounts of debris on retrieval of the filter. |
| Hospital Day 2 | Pathological diagnosis confirmed that trapped material was lipid-rich plaque including cholesterol crystals. |
| Hospital Day 3 | Patient felt no chest pain and was discharged from hospital. |
| 6 months after discharge | Patient has been free of chest pain since the PCI. |

### Case presentation

A 64-year-old male with hypertension and dyslipidaemia was referred for CAG because of progressive exertional angina. He had been medicated for 2 years with amlodipine (5 mg/day) for hypertension and rosuvastatin (2.5 mg/day) daily for dyslipidaemia. He had previously smoked cigarettes but had quit 40 years ago. Twenty days before admission, he experienced new exertional chest pain, the frequency of which increased within a few days. A local doctor diagnosed unstable angina and referred him to our hospital. He had a blood pressure of 138/84 mmHg, a heart rate of 78 b.p.m., respiratory rate of 14 breaths/min, and oxygen saturation of 100% on room air at arrival. On physical examination, he had regular cardiac rhythm with no heart murmurs. Initial laboratory evaluation revealed total, HDL, and LDL cholesterol values of 208 (normal range: 200–219), 38 (>40) and 106 (120–139) mg/dL, respectively.

The CAG findings revealed a hazy, tight culprit lesion in the mid-right coronary artery (RCA) (Figure 1A, yellow arrow, Video 1). Pre-intervention near-infrared spectroscopy-intravascular ultrasound (NIRS–IVUS) (Makoto Intravascular Imaging System, Infraredx) and chemogram showed plaque with high lipid burden [max lipid core burden index at 4 mm (max \textit{LCBI}_{4mm}), 537] at the culprit lesion (Figure 1A). We then applied a distal protection device (Filtrap II 5 mm, Nipro) before percutaneous coronary intervention (PCI) because of the high max \textit{LCBI}_{4mm} in the lesion. After crossing another guidewire across the right ventricular branch as a protection wire, pre-dilation was performed with a scoring balloon (Angiosculpt 3.5 \times 10 mm, AngioScore) (Figure 1B) because NIRS–IVUS also revealed that almost the entire circumference of the calcified lesion was located at the proximal side of the culprit lesion (Supplementary material online, Figure S1). Repeat NIRS–IVUS interrogation revealed disappearance of the yellow signal and a significant decrease in max \textit{LCBI}_{4mm} from 537 to 44, suggesting decreased lipid content in the plaque (Figure 1C). Finally, a drug-eluting stent (Xience Sierra 4.0 \times 33 mm, Abbott) was deployed followed by inflation of a non-compliant balloon (Poweresd NC 4.5 \times 8 mm, Nipro), which led to excellent results at the lesion site (Figure 1D, Video 2). Final angiography confirmed a well-expanded stent without distal embolization (Video 3). After PCI, the retrieved filter contained large amounts of trapped white debris (Figure 2A). Pathological findings confirmed that this material was lipid-rich plaque including cholesterol crystals and inflammatory cells (Figure 2B).

This patient developed acute coronary syndrome (ACS) and had an LDL cholesterol value of 106 mg/dL despite 2 years of therapy with rosuvastatin (2.5 mg/day). We therefore doubled the dose of rosuvastatin to 5 mg to achieve target LDL cholesterol levels <70 mg/dL. He was discharged on post-PCI Day 2. One month after discharge, laboratory findings showed total, HDL, and LDL cholesterol values of 142, 52, and 62 mg/dL, respectively. The patient has remained free of chest pain since the PCI (for 6 months).

### Discussion

Occurrences of no-reflow and periprocedural myocardial infarction can be associated with major adverse events.\textsuperscript{1–3} Near-infrared spectroscopy was developed for the determination of the chemical composition of plaques with the intention of identifying lipid cores within the atherosclerotic lesions.\textsuperscript{5,7,8} Recently, NIRS and IVUS were combined in a single catheter to provide the user with information on both the composition and structure of plaques simultaneously.\textsuperscript{5,9,10} Because the NIRS–IVUS catheter is a little thicker and less flexible than conventional IVUS catheters, we selected a short Amplatz left 0.75 (6 Fr) guiding catheter, which provided excellent backup, and the NIRS–IVUS catheter was passed through the thigh lesion without pre-dilation.

Because the reference diameter of the right coronary artery was very large (~4.0 mm), we considered that the culprit lesion might include a large lipid core and examined the lesion using NIRS–IVUS. In our patient, NIRS–IVUS revealed the culprit lesion was attenuated plaque with a large lipid core (max \textit{LCBI}_{4mm} = 537), suggesting high risk of distal embolization during PCI. Indeed, previous study demonstrated that the incidence post-PCI myocardial infarction was
significant higher at 50% among patients with max LCBI_{4mm} > 500 vs. 4.2% with LCBI_{4mm} < 500 (P = 0.0002).\textsuperscript{11} We therefore deployed a filter wire in the distal RCA before ballooning, which resulted in trapping large amounts of debris on the retrieved filter. Finally, the filter wire prevented distal embolization during PCI and angiography confirmed optimal results without delayed coronary flow. These findings suggested that NIRS–IVUS should be actively applied for patients with ACS and large plaque to avoid the no-reflow phenomenon occurring during PCI.

Several reports have described a relationship between a decreased level of LCBI during PCI and no reflow.\textsuperscript{9,11,12} In addition, autopsy studies of patients who died due to fatal no reflow, have found extensive cholesterol crystal emboli plugs in distal coronary arteries.\textsuperscript{11,12} These findings indirectly suggested that a decreased LCBI is associated with cholesterol crystal leakage from atherosclerotic plaque during PCI. Here, we detected a significant decrease in max LCBI_{4mm} at a culprit lesion during PCI and pathological findings confirmed that material trapped on the filter wire after PCI comprised lipid-rich plaque including cholesterol crystals and inflammatory cells.

**Conclusion**

These findings are the first report of evidence of a direct association between a significantly decreased max LCBI_{4mm} at a culprit lesion during PCI and cholesterol crystal leakage from lipid-rich plaque in a clinical patient.

**Lead author biography**

Soshi Moriya received the MD degree from Kitazato University, Kanagawa, Japan in 2016 and subsequently underwent his specialty training in Internal Medicine and Cardiology at Juntendo University, Tokyo, Japan. Currently, his research interest is mainly focused on multimodal cardiac imaging, in particular in ischaemic heart diseases and heart failure.
Supplementary material

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

**Video 1** The coronary angiography before percutaneous coronary intervention demonstrated a hazy tight culprit lesion in the mid-right coronary artery.

**Video 2** The coronary angiography after stenting suggested there might be trapped material on the filter without no flow.

**Video 3** The coronary angiography after the Filtrap retrieval demonstrated the well-expanded stent without distal embolization.

**Figure 2** After percutaneous coronary intervention, we detected trapped large amounts of lipid-rich plaque on retrieval of the filter. (A) Large amounts of debris on retrieval of the filter were detected. (B) Pathological study demonstrated that the debris was lipid-rich plaque including cholesterol crystals and inflammatory cells (haematoxylin–eosin stain).
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Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: The authors confirm that 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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