Visualization of Recanalized Coronary Occlusion with Dissection by Optical Frequency Domain Imaging

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A 43-year-old asymptomatic male patient with a positive stress myocardial perfusion imaging result was admitted to our institution. Although no organic lesion was detected by 64-row coronary computed tomography angiography (CCTA), invasive coronary angiography revealed a unique anatomy with a long lesion in the middle of the left anterior descending artery. Optical frequency domain imaging (OFDI) demonstrated the details of the recanalized occlusion with coronary dissection. OFDI provides in vivo coronary images with high spatial resolution and better three-dimensional reconstructions and supports invasive coronary angiography to elucidate infinitesimal and complicated intraluminal morphology that might be missed by CCTA alone.

Keywords: coronary CT angiography, coronary angiography, intravascular imaging

Introduction

Although coronary computed tomography angiography (CCTA) is a validated diagnostic tool to identify and assess organic coronary artery disease with high negative predictive value, some pitfalls in the clinical setting of coronary artery disease exist due to its limited temporal and spatial resolutions and/or morphological features, such as heavy calcification. Optical frequency domain imaging (OFDI), a recently developed intracoronary imaging modality, provides microscopic observation of the coronary artery in humans with high spatial resolutions (7-µm axial resolution and 3-µm transverse resolution) and is safe and feasible both before and after percutaneous coronary intervention compared with intracoronary optical coherence tomography (OCT). Therefore, we applied this imaging modality in a case with complex coronary lesions that could not be detected by CCTA and compared the results with those of intravascular ultrasound (IVUS) imaging.

Case Report

A 43-year-old male patient with recently developed precordial Q waves on an electrocardiogram during a routine annual health check-up and with no previous history of acute coronary syndrome was admitted to our institution. He presented with mildly depressed left ventricular function (left ventricular ejection fraction, 48%) with hypokinesis of the anteroseptal wall on echocardiography and a positive exercise stress myocardial perfusion imaging result (summed stress score, 12 points); however, 64-row CCTA visualized patent coronary arteries, including the left anterior descending artery, without atherosclerotic plaque (Fig. 1). Considering the significant myocardial ischemia caused by exercise, moderately depressed left ventricular function, and professional requirement of physical fitness, we performed invasive coronary angiography and percutaneous intervention. His invasive coronary angiography revealed a unique coronary anatomy with a long lesion (>30 mm) in the middle of the left anterior descending artery (Fig. 2A). The results of OFDI demonstrated the details of the lesion in the axial cross-sectional view (upper panels of Fig. 3), longitudinal cross-sectional view (Fig. 2B), and three-dimensional longitudinal view (Fig. 2C). Simultaneously, we also performed IVUS imaging (lower panels of Fig. 3). We observed the lesion by auto pullback system and identified it by locating the second diagonal branch and the second septal branch in each modality. The lesion comprised a proximal hazy portion (1 and 2 of Fig. 2A: corresponding to Figs. 2B, 2C, and 3), middle slit portion (4 of Fig. 2A: corresponding to Figs. 2B, 2C, and 3), and distal portion with a braid-like appearance (5 of Fig. 2A: corresponding to Figs. 2B, 2C, and 3). In the proximal portion, an OFDI catheter was observed in the center of the vessel surrounded by multiple lumens, similar to a previously reported OCT observation in a patient with spontaneous coronary dissection (SCAD). In the middle portion, a double-barreled lumen was observed, similar to a previously reported observation during an autopsy.
in a patient with SCAD. Moreover, in the distal portion, multiple small channels communicating with each other were visualized, similar to previously reported observations using OCT and histology in patients with recanalization of organized thrombi. Furthermore, a dissection entry was identified (3 in Figs. 2B and 2C, white arrows). However, IVUS revealed the absence of atherosclerotic plaque in the lesion. Based on the abovementioned findings of CCTA, invasive coronary angiography, OFDI, and IVUS, SCAD was diagnosed. Unfortunately, even with the use of OFDI, we could not clearly detect the disruption of “media” in the lesion. We postulated that we could have missed some findings because of the complexity of the lesion due to covering of the site of “disruption of media.” Thus, a drug-eluting stent was successfully implanted under the guidance of OFDI and IVUS that demonstrated an adequate expansion of stent struts without malapposition.

**Discussion**

Recent advances in intracoronary imaging techniques, such as OCT and OFDI, for percutaneous coronary intervention have promoted the mechanisms to diagnose coronary artery disease and improved our understanding of the complex coronary anatomy. However, only limited clinical studies have reported a head-to-head comparison of OCT/OFDI images with IVUS images during coronary intervention, and the clinical utility of OCT/OFDI is still under investigation.

A recanalized image of the occluded coronary artery with thrombus was first described by Cho et al. using OCT and was termed as “a lotus root-like appearance.” However, to the best of our knowledge, this is the first study that visualized the details of the anatomy of recanalized coronary occlusion with SCAD. In cases with SCAD, OCT/OFDI can visualize the detailed specific morphological features, such as double-barreled appearance,
dissection tear, and/or vascular hematoma. Moreover, OCT/OFDI-guided percutaneous intervention for SCAD is presumed to be efficient and safe in achieving adequate stent coverage, expansion, and apposition.9) In our case, OFDI was helpful in determining the landing sites of the stent [proximal portion with multiple lumens (1 and 2 of Fig. 2)] and distal portion with thrombotic semi-occlusion (5 of Fig. 2), which were not clearly visualized by IVUS alone. Conversely, IVUS was needed to establish the diagnosis of SCAD and exclude the possibility of atherosclerotic plaque rupture. The combination of OFDI and IVUS was effective for the percutaneous treatment in our case, and thus might be a preferable method of intracoronary imaging when treating patients with complex coronary lesions, such as coronary dissection.

As an alternative to invasive coronary angiography, CCTA has been widely accepted for the diagnosis of coronary artery disease, and the recent technological developments have improved its spatial (<0.5 mm) and temporal (<150 ms) resolutions.10) Reportedly, a normal CCTA allows clinicians to rule out the presence of significant coronary lesions with a high negative predictive value.1) Thus, CCTA is currently believed to be a valuable technique for triage of low to intermediate pretest probability patients with coronary artery disease. However, the imaging quality of CCTA is limited in patients with obesity, elevated or irregular heart rates, and dense coronary calcification or intracoronary metallic stents with blooming artifacts. Hence, invasive coronary angiography is advantageous in patients with less artifacts and higher spatial (<0.1 mm) and temporal (<10 ms) resolutions. In our case with recanalized occlusion by SCAD, CCTA with 64-row multidetectors could not detect the lesion, although both echocardiography and stress myocardial perfusion imaging revealed abnormalities. Fortunately, the patient was optimally managed with the use of invasive coronary angiography supported by OFDI. Therefore, it is essential to estimate the pretest probability of patients and select adequate imaging modalities to avoid the misdiagnosis of significant coronary lesions with a specific morphology, such as coronary dissection.

Although OCT/OFDI has been reported to be a feasible, effective, and safe intracoronary diagnostic modality in patients with coronary artery disease,2,3) the safety of this procedure mainly depends on the mechanical injury or transient ischemia caused by the imaging catheter or coronary guidewire and requires contrast injection to replace luminal blood for observation. Notably, depending on the coronary pathology, the periprocedural risk of complications is different in each patient. Furthermore, each contrast media injection with a relatively long duration via an automatic contrast injector during OCT/OFDI might increase the risk in patients with fragile lesions, such as coronary dissection, like in our patient. Therefore, intracoronary imaging modalities should not be routinely used in patients with SCAD.

**Conclusion**

OCT/OFDI provides in vivo coronary images with a high spatial resolution and better three-dimensional reconstruction and supports invasive coronary angiography to understand infinitesimal and complicated intraluminal morphology that might be missed by CCTA alone.

**Disclosure Statement**

The authors declare that they have no competing interests.

**Author Contributions**

The major contributors in writing the manuscript: JA, TN
Supervision of the whole work: MT, HT
Final approval of the manuscript: all authors
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