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LETTER TO THE EDITOR

3D Reconstructions of Optical Frequency Domain Imaging to Improve Understanding of Conventional PCI

Two-dimensional (2D) Fourier domain optical coherence tomography (FD-OCT) has enhanced our understanding of coronary atherosclerotic disease and is increasingly being used in conventional percutaneous coronary intervention (PCI) to elucidate mechanisms of disease and to improve our understanding of complex coronary anatomy. Prototypes of current generation "real-time" (i.e., peri-procedural) 3-dimensional (3D) FD-OCT are experimental, are still works in progress and have not yet entered conventional clinical practice.

Offline 3D FD-OCT reconstructions have previously been described (1). We have demonstrated the clear progression of this technology since then (Figs. 1 and 2). The 3D FD-OCT reconstructions of patients who underwent conventional PCI from the original first-in-man study of the intracoronary Terumo optical frequency domain imaging (OFDI) system (Terumo Corporation, Tokyo, Japan) are presented (2). The high-speed Terumo OFDI system is capable of acquiring 160 frames/s during the catheter pullback, to a maximum speed of 40 mm/s; all images were acquired with a motorized pullback of 20 mm/s. Manual detection of every strut in each cross section, using bitmap sequences (704 × 704 pixels) generated from prior 2D FD-OCT imaging, were performed and 3D reconstructions generated using volume-rendering software (INTAGE Realia, KGT, Tokyo, Japan).

Figure 1. Acute Coronary Syndrome, Thrombus, ISA

A 62-year-old man presented with post-infarct angina following a late presentation of an anterior myocardial infarction. Coronary angiography revealed a thrombotic, severe mid-left anterior descending vessel lesion. Pre-dilation followed by implantation of a 3.0 × 28.0 mm drug-eluting stent was performed. **Upper figure** demonstrates a longitudinal view of the implantation site of the vessel following 3-dimensional reconstruction. **Middle figures** demonstrate the corresponding fly-through views for the first one-third (looking upstream) and second two-thirds (looking downstream) of the implantation site. **Bottom figures** demonstrate corresponding 2D OFDI frames. Note the large thrombotic burden, especially evident in the middle one-third of the implantation site, thrombus covering the struts and further thrombus located between the struts and the vessel wall at both stent edges. Consequential stent malapposition (incomplete stent apposition [ISA]) and shadowing on the vessel wall induced by the malapposed struts, most evident at the proximal stent edge, are demonstrated **(yellow arrow)**. Glycoprotein IIb/IIIa inhibitors were administered and further post-dilation was performed with a 3.5-mm noncompliant balloon with resolution of the ISA and a significant proportion of the thrombus burden (not illustrated). DIST = distal; OFDI = optical frequency domain imaging; PROX = proximal.

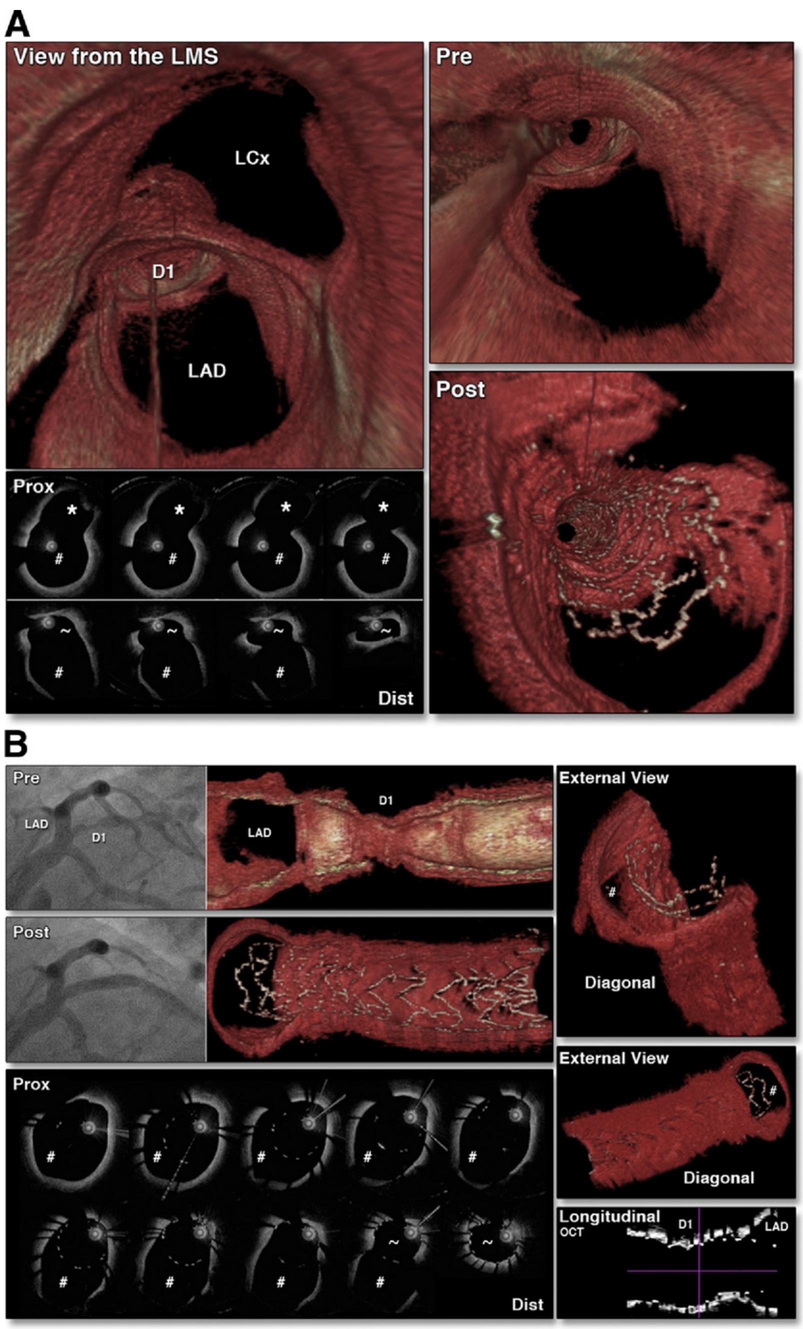

Figure 2. Complex Bifurcation Anatomy (Almost Trifurcation-Like Anatomy), Ostial Lesion, and Overlapping Stents

A 71-year-old man presented with stable angina. Coronary angiography demonstrated a long segment of disease arising from the proximal first diagonal (D1), consisting of severe tandem lesions. The diagonal vessel itself appeared to originate from the proximal left anterior descending artery (LAD), very close to the LAD and left circumflex (LCx) ostia, almost appearing to be a trifurcation. Pre-dilation of the diagonal disease, implantation of overlapping drug-eluting stents (2.5 × 28.0 mm overlapped proximally with a 2.5 × 18.0 mm) and post-dilation with the final deploying balloon were performed. **(A) Left images:** three-dimensional (3D) OFDI reconstruction demonstrates a downstream fly-through view from the proximal left main stem (LMS) showing the LAD-LCx and LAD-D1 bifurcations with corresponding 2D OFDI frames. **Right images:** downstream fly-through views (from the distal LMS into the LAD and diagonal orifices) pre- and post-intervention are illustrated. Note the "overhanging" struts of the diagonal stent into the LAD orifice and the shadow the overhanging stent struts casts on the vessel wall (at 3 o'clock position in **lower right image**). **(B) Left images:** pre- and post-intervention longitudinal 3D reconstructions are shown with the corresponding coronary angiograms **(upper left images)** and 2D OFDI cross-sectional frames **(lower left images)**. **Right images:** The 3D external views of the diagonal vessel showing the struts protruding into the LAD orifice are demonstrated **(upper and middle right images)**, with the respective longitudinal 2D OFDI reconstruction **(lower right image)**. * = LCx; # = LAD; ~ = D1; other abbreviations as is Figure 1.

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NOMENCLATURE FOR 3D FD-OCT RECONSTRUCTIONS

"Fly-through" views indicate a selected still image of an internal view of a vessel looking either downstream (proximal to distal vessel) or upstream (distal to proximal vessel). The fly-through (internal) view of the vessel is akin to the view obtained during endoscopy or angioscopy showing the internal lumen of the vessel.

Longitudinal views are a cutaway view of the vessel down the longitudinal axis with the internal lumen viewed externally.

External views are taken from outside the vessel with views to show the internal vessel at the region of interest.

CONCLUSIONS

We demonstrate the potential complementary clinical role that 3D reconstruction of FD-OCT has over 2D FD-OCT imaging. Instantaneous, real-time 3D FD-OCT rendering of a resolution similar to that seen with offline production would be advantageous before this can potentially enter conventional PCI practice. Validation of 3D FD-OCT is required to help further understand the complexities of these findings, in particular at the bifurcation.

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