Optical Coherence Tomography-guided Intervention in STEMI Patients with Normal Looking Coronaries

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ABSTRACT

Optical coherence tomography (OCT) is an increasingly available intracoronary imaging modality that provides high-resolution imaging of coronary arteries and guides operators in percutaneous coronary intervention (PCI) by accurately defining luminal geometry and detailed plaque composition. The two cases under discussion in this report, presented with acute ST elevation myocardial infarction (STEMI) with angiography showing minor narrowing (<30%) with TIMI III flow in which OCT-guided approach was used regarding the management owing to its improved temporal and axial resolution, thus providing proper plaque assessment and subsequent proper management.

Key Words: *ST elevation myocardial infarction (STEMI), Minor coronary artery disease, Optical coherence tomography (OCT).*

INTRODUCTION

Optical Coherence Tomography (OCT), as an imaging modality, has been a revolution in the field of interventional cardiology over the last decade. Using infrared technology, it provides excellent imaging with improved resolution compared to intravascular ultrasound (IVUS).[1,2]

Standard coronary angiography does provide valuable information about the coronary artery lumen but fails to provide information about the underlying plaque morphology.[3] In addition, there is also inter-observer variability regarding the degree of coronary artery narrowing.[4,5] Intracoronary imaging comprising OCT and IVUS do provide valuable information not only about the degree of coronary artery narrowing but also provide valuable information about the underlying plaque morphology and composition.[6]

OCT can be considered as an improved version of intracoronary imaging device with a 10-fold higher resolution than IVUS.[7] This technique, with its improved temporal and axial resolution, provides much improved assessment of plaque morphology compared to IVUS, thus helping in the classification of the different types of atherosclerotic plaques,[8,9] depending on the their composition as predominantly fibrotic or lipidic or mixed plaques.[10,11] Furthermore, this improved resolution with OCT also provides valuable input thus guiding proper stent implantation.[12]

However, there are limited reports of OCT-guided stent implantation in patients with acute myocardial infarction (MI). Here, we present two cases of frequency-domain OCT-guided stenting in one of the patients and leaving one without stenting as the plaque morphology was not suitable for stenting. We are of the opinion that OCT-guided percutaneous coronary intervention (PCI) is a good approach in patients with acute MI who appear to have normal or subcritical coronary artery disease (CAD) on visual assessment of coronary angiography after acute ST elevation MI (STEMI).

Case 1: A 35-year gentleman, hypertensive, smoker, and mildly obese with BMI of 28 Kg/m^2 was referred to Rawalpindi Institute of Cardiology (RIC) for invasive management following anterior STEMI and failed thrombolysis in a peripheral hospital. His ECG showed Qs with ST elevation in anterior leads. He had mild chest discomfort and ejection fraction (EF) was 40%. Coronary angiography was done which showed mild disease in the proximal, left anterior descending artery (LAD) with no stenosis and TIMI III flow and normal left circumflex artery (LCX) and right coronary artery (RCA) (Figure 1).

Based on this finding, the patient was treated conservatively with high dose statin and dual antiplatelet therapy (DAPT) with infusion of Gp IIb IIIa inhibitors. Approximately six hours later, during the hospital stay, he had an episode of central chest pain with sweating and ST elevation in the anterior chest leads. A reinfarct was suspected, so he was brought back to the cath lab for a re-study. A repeat coronary angiogram was done which showed a totally occluded LAD from the proximal course with thrombus (Figure 2).

The LAD was wired with runthrough wire and thrombus aspiration was done using a thrombuster device. Repeat angiogram revealed the same lesion as before *i.e.*, mild irregularity in proximal LAD with TIMI III flow and mild <50% stenosis.

To assess the plaque morphology in detail, OCT was done. It revealed plaque rupture with thrombus with minimum luminal area (MLA) of 4.4 mm^2 (Figure 3).

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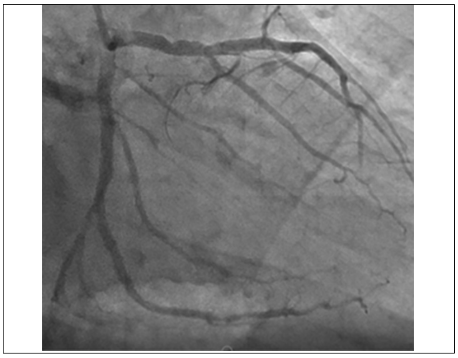

Figure 1: Coronary angiogram showing mild narrowing of left anterior descending (LAD) artery, while rest of the vessels are normal.

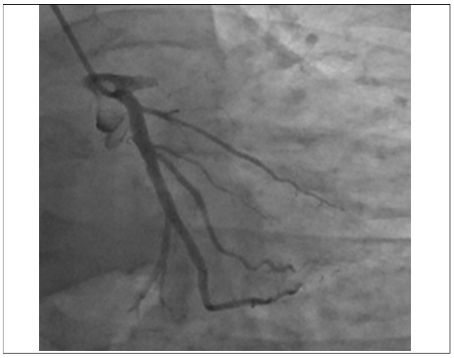

Figure 2: Repeat coronary angiogram showing totally occluded left anterior descending (LAD) artery.

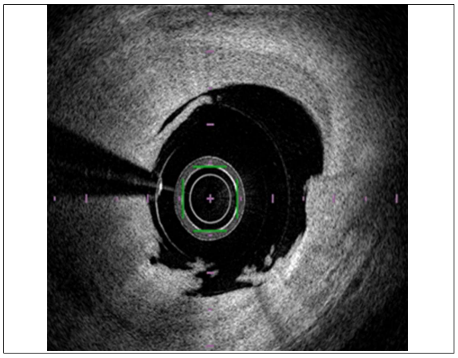

Figure 3: OCT showing minimum luminal arrest of 4.4 mm^2.

Figure 4: Stenting of the left anterior descending (LAD) artery.

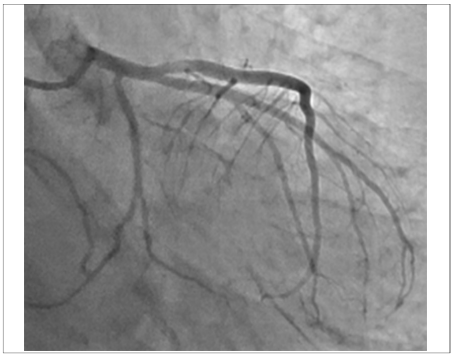

Figure 5: Coronary angiogram showing thrombus in the proximal left anterior descending (LAD) artery.

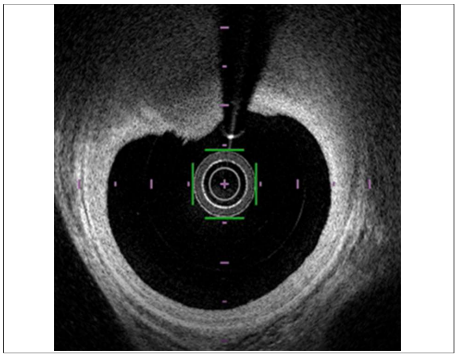

Figure 6: OCT showing thin cap fibroatheroma with no evidence of plaque rupture.

Although there was TIMI III flow with MLA of >4 mm^2 guidelines suggest that such patients can be treated conservatively with no stenting; however, the presence of plaque rupture and the fact that this resulted in a re-infarct, we proceeded with PCI stenting of the LAD lesion (Figure 4).

Case 2: A 35-year man, smoker, presented with three-hour history of chest pain with ST elevations in anterior leads. He was transferred to the cath lab for primary PCI. Coronary angiogram was done, which showed thrombus in the proximal LAD with TIMI III flow (Figure 5).

An initial run of OCT showed heavy thrombus burden which was obscuring the underlying plaque morphology. Manual thrombus aspiration using a thrombuster was done. This was followed by another run of OCT which showed thin cap fibroatheroma with no evidence of plaque rupture (Figure 6). Hence, a diagnosis of plaque erosion was made.

Considering the diagnosis of plaque erosion with no evidence of plaque rupture, the lesion was not stented and treated medically with DAPT and high dose statin. Again in this case, OCT assessment of plaque morphology helped in proper management of the patient as we came to know the exact diagnosis and that stent was not required.

DISCUSSION

Although coronary angiography is frequently used to evaluate patients with CAD, it has its limitations as it only provides a two-dimensional assessment of the coronary artery lumen with difficulty in assessment of degree of stenosis in intermediate lesions with a substantial inter observer variation.[13] Here, we evaluated how frequency-domain OCT changed our strategy during PCI in the setting of acute STEMI with no or minor stenosis on coronary angiography. In recent years, OCT technology has advanced from time-domain OCT to frequency-domain OCT, which offers benefits of rapid image acquisition of long segment within a few seconds without the need of proximal balloon occlusion. Further, frequency-domain OCT provides 10-times greater resolution than IVUS and offers feasible assessment of underlying plaque morphology and composition.[13]

Virmani *et al*.[14] while assessing the culprit coronary artery after and acute coronary event, compared OCT, IVUS, and coronary angioscopy, and found that OCT was the most sensitive among the three modalities in defining the underlying lesion as either plaque erosion, plaque rupture and also the presence of thin cap fibroatheroma. Additionally, OCT can distinguish between red and white thrombi, which are frequently observed in unstable plaque.[15]

Most MIS arise as a result of plaque rupture or plaque erosions, leading to thrombus formation, thus occluding a coronary artery. Atheromatous plaque rupture initiates an inflammatory response in which the resulting thrombosis and a subsequent coronary vasospasm

compromises coronary artery blood flow substantially. With selective coronary angiography, the proportion of MI patients with normal or near-normal coronary arteries is between 1% and 12%.[16] This could be due to either underlying smooth coronary artery on angiogram with no or minimal endoluminal irregularities or non-significant (<30%) stenosis. In a retrospective analysis, 1.1% with proven MI had no luminal irregularities.[17]

As discussed above, standard coronary angiography has its limitations as it only provides a two-dimensional view of the coronary artery lumen, and the extent of disease found post mortem often differs from that diagnosed angiographically.[18,19]

The prognosis of STEMI with minor coronary artery stenosis and normal looking coronary artery on a coronary angiogram is not as benign as reported by early cohort studies and as commonly assumed by physicians.[20] There have been studies done over the last few years, which have shown rates between 0.1 and 2.2% for all-cause mortality during admission and between 2.2 and 4.7% at 12 month follow up.[21] In addition to this, the results of the ACUITY trial[22] showed a higher adjusted risk of mortality at 1 year (5.2 *vs.* 1.6%; HR 3.44, CI 1.05-11.28; p = 0.04) in patients with STEMI with minor coronary artery stenosis when compared with non-STEMI patients with obstructive CAD. Based on these studies, it is recommended that such lesions be stented in the setting of acute MI to reduce morbidity and mortality.[22]

STEMI, in majority of the cases, is secondary to atherosclerotic plaque rupture or erosion.[23] In cases with minor coronary artery disease and TIMI III flow on a coronary angiogram such morphology is not assessed by coronary angiogram. OCT with its improved resolution provides valuable information about the plaque morphology. Interestingly, both these clinical pathologies require different treatment strategies especially when associated with minor narrowing of the coronary arteries. The former will require stenting; while in the latter, you can get away with stenting with favorable long-term outcomes.[24] In these two cases, the etiologies of acute MI varied based on the OCT findings. Plaque rupture was stented while in the case with plaque erosion, no stenting was required as such patients have good outcomes when treated conservatively.[25] The two patients were also followed up in the out patient department (OPD) at 3- and 6-month interval and were stable with medical treatment.

So, imaging-guided treatment strategy becomes important in patients with STEMI and normal looking coronaries arteries on conventional angiography and OCT is more useful when defining plaque morphology and deciding treatment strategy as compare to IVUS.

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