ORIGINAL ARTICLE

OPTICAL COHERENCE TOMOGRAPHY GUIDANCE IN THE MANAGEMENT OF ACUTE CORONARY SYNDROME BASED ON PLAQUE MORPHOLOGY

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Background: Acute coronary syndrome (ACS) is one of the leading causes of death worldwide. It is characterized by the formation of coronary artery thrombus which can be either due to plaque rupture, plaque erosion or rupture of a calcific nodule. The aim of study was to assess the plaque morphology leading acute coronary syndrome using OCT and to guide management based on its findings. It was an observational study, conducted at Rawalpindi Institute of Cardiology from Jan to Dec 2019. **Methods**: Fifty patients meeting the inclusion criteria were included in the study. OCT procedure was performed following intracoronary injection of 100–150 ug of nitroglycerine. The imaging catheter (OFDI dragon view) of the OCT device (Terumo Luna wave OFDI, Tokyo, Japan) was inserted into the culprit artery. Blood clearance was achieved by injecting diluted iodinated contrast at the rate of 5 ml/sec. Imaging acquisition was obtained following automated pullback at the rate of 25 mm/sec. Pathologies like stent under deployment, mal-apposition, strut fracture, plaque erosion, plaque rupture were assessed by the operating interventionist well versed with the OCT technology and lesion assessment. Data analysis was done using the SPSS version 26. Categorical variables were presented as counts and percentages while continuous variables as mean±SD. **Results:** A total of 50 patients were included in the study. The mean age was 49.24±11.92. Majority of the patients were male comprising 78.0% of the cases. Plaque rupture was the most common underlying pathology seen in 32.5% of the patients and exclusively in STEMI patients which required stent deployment. Thin cap fibroatheroma was seen in 27.9% of the cases while lipid rich plaque in 23.2% of the cases; again, requiring stent deployment. 9.3% of the cases had plaque erosion while 4.6% had calcific nodule and only 2.3% had intramural hematoma which were treated conservatively. 42.8% of the stent thrombosis patients had under-deployed stents requiring balloon dilatation while 14.2% had mal-apposed stent again requiring balloon dilatation. In contrast 14.2% each had neo-atherosclerosis, stent strut fracture and uncovered stent struts as the underlying pathology for stent thrombosis each requiring stent deployment. **Conclusion**: OCT guided PCI in cases of acute coronary syndrome is a valuable modality that gives insight into the underlying pathology of the disease process and also guides in proper management.

Keywords: Optical coherence tomography OCT; Acute coronary syndrome (ACS); Plaque morphology

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INTRODUCTION

Acute coronary syndrome (ACS) is one of the leading causes of death worldwide.[1] It is characterized by the formation of coronary artery thrombus which can be either due to plaque rupture, plaque erosion or rupture of a calcific nodule.[2] Among cases of ACS in the setting of stent thrombosis; the final pathway of thrombus formation in the coronary artery stented segment related to the procedure can be the result of stent under deployment, edge dissection, geographical miss or neo-atherosclerosis.[3] The management of acute coronary syndromes in either of the scenarios; de novo or stent thrombosis depend on the underlying cause. Stenting would mostly be needed in most cases of plaque rupture and a ruptured calcific nodule while plaque erosion can safely be managed with just thrombus aspiration and pharmacological plaque stabilizing and antiplatelet agents.[4] When it comes to the causes stent thrombosis; stenting is required in most cases of edge dissection, geographical miss and neo-atherosclerosis while balloon dilatation is required in most cases of under deployed stents.[5]

Coronary angiography has limitations in a way that it only helps in assessing coronary artery luminal narrowing and fails to visualize the underlying plaque morphology and hence fails to identify the root cause of the luminal narrowing or thrombus formation among cases of acute coronary syndromes.[6] Optical coherence tomography (OCT) using infrared rays for image acquisition provides an excellent visualization and subsequent analysis of coronary artery plaque due

to its improved axial and spatial resolution.[7] This analysis is of great help is not only knowing the underlying pathology of acute coronary syndrome but also helps in guiding the subsequent management of such patients.

Due to these limitations of coronary angiogram, proper management of certain cases of acute coronary syndrome and stent failure cannot be undertaken. OCT on the other hand due to its improved resolution not only gives an insight about the underlying pathology in such cases of ACS and stent failure but also guides about the proper management hence reducing the subsequent complications.[8]

The purpose of this study was to retrospectively analyse the percutaneous coronary intervention procedures for patients of acute coronary syndrome in which OCT was performed and to see how it guided in proper diagnosing and managing these patients.

MATERIAL AND METHODS

This observational study was conducted at the department of Interventional Cardiology, Rawalpindi Institute of Cardiology.

Inclusion criteria

- Patients aged >18 years
- Patients presenting with acute coronary syndrome both de novo or as a result of stent thrombosis.
- Properly performed OCT run with more than 70% analysable frames.

Exclusion criteria

- Patients with nephropathy.
- Patients presenting with cardiogenic shock.

Following approval of the ethical review committee, 50 patients meeting the inclusion criteria were included in the study. Written informed consent was taken from each of the participant.

Optical coherence tomography procedure was performed following intracoronary injection of 100-150 ug of nitroglycerine. The imaging catheter (OFDI dragon view) of the OCT device (Terumo Lunawave OFDI, Tokyo, Japan) was inserted into the culprit artery. Blood clearance was achieved by injecting diluted iodinated contrast at the rate of 5 ml/sec. Imaging acquisition was obtained following automated pullback at the rate of 25 mm/sec. The images were digitally stored for analysis.

All images were assessed for quality and artefacts. In cases of images with artefacts compromising image analysis a repeat OCT run was taken. Measurements of vessel diameter, luminal narrowing, lesion length were measured using the in-built software. Pathologies like stent under deployment, mal-apposition, strut fracture, plaque erosion, plaque rupture were assessed by the operating interventionist well versed with the OCT technology and lesion assessment.

Data analysis was done using the SPSS version 26. Categorical variables were presented as counts and percentages while continuous variables as mean±SD.

RESULTS

A total of 50 patients were included in the study. The mean age was 49.24±11.92. Majority of the patients were male comprising 78.0% of the cases. The baseline characteristics of the patients are shown in table-1.

As seen in the table I most of the patients (56.0%) were hypertensive while 42.0% each were smokers and diabetics. Only 28.0% had dyslipidaemia. In addition, among the acute coronary syndrome presentations 38.0% had acute STEMI, 28.0% had NSTEMI and 20.0% had unstable angina. In only 14.0% of the cases OCT was performed for assessment of acute stent thrombosis.

Plaque morphology in the de novo acute coronary syndrome cases (n=43) and the subsequent intervention based on OCT findings is shown in table-2.

As seen in the table-2; plaque rupture was the most common underlying pathology seen in 32.5% of the patients and exclusively in STEMI patients which required stent deployment. Thin cap fibroatheroma was seen in 27.9% of the cases while lipid rich plaque in 23.2% of the cases; again, requiring stent deployment. 9.3% of the cases had plaque erosion while 4.6% had calcific nodule and only 2.3% had intramural hematoma which were treated conservatively.

Images of findings in table-2 are shown below. The underlying pathology among the stent thrombosis patients (n=7) and the subsequent management based on OCT findings is shown in table-3.

As seen in the table-3, 42.8% of the stent thrombosis patients had under-deployed stents requiring balloon dilatation while 14.2% had mal-apposed stent again requiring balloon dilatation. In contrast 14.2% each had neo-atherosclerosis, stent strut fracture and uncovered stent struts as the underlying pathology for stent thrombosis each requiring stent deployment.

Images of the pertinent findings in table 3 are shown below:

Figure-7 shows under deploys stent. As seen in 7 (a) the actual vessel size is 4.55 mm and a 4 mm stent was deployed but later images showed it was under deployed/under expanded stent. It was then post dilated to an appropriate size with a balloon.

Table-1: Baseline characteristics

Patient characteristics	(n; %)
Age (years; Mean±SD)	49.24±11.92
Gender	
Male	39; 78.0%
Female	11: 22.0%
Co morbidities	
Diabetes	21; 42.0%
Hypertension	28; 56.0%
Smoking	21; 42.0%
Dyslipidaemia	14; 28.0%
Type of acute coronary syndrome (ACS)	
ST elevation myocardial infarction 'de novo' (STEMI)	19; 38.0%
Non-ST elevation myocardial infarction (NSTEMI)	14; 28.0%
Unstable angina (UA)	10; 20.0%
Stent thrombosis	7; 14.0%
Culprit artery	
Left anterior descending artery (LAD)	21; 42.0%
Left circumflex artery (LCX)	12; 24.0%
Right coronary artery (RCA)	17; 34.0%

Table-2: Plaque morphology in the de novo ACS cases with management

Plaque morphology	n (43); %	Intervention
STEMI		
Plaque rupture	14; 32.5%	Stented
Plaque erosion	4; 9.3%	Treated conservatively
Intramural hematoma (IMH)	1; 2.3%	Treated conservatively
NSTEMI and UA		
Thin cap fibroatheroma	12; 27.9%	Stented
Lipidic plaque	10; 23.2%	Stented
Calcific nodule	2; 4.6%	Stented

Table-3: Underlying pathology in stent thrombosis patients with management

Underlying pathology	N (7); %	Intervention
Under-deployed stent	3 (42.8%)	Balloon dilatation
Mal-apposed stent	1 (14.2%)	Balloon dilatation
Neo-atherosclerosis	1 (14.2%)	Stented
Strut fracture	1 (14.2%)	Stented
Uncovered stent struts	1 (14.2%)	Stented

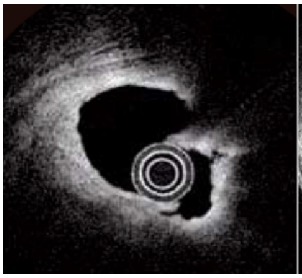

Figure-1: Plaque rupture

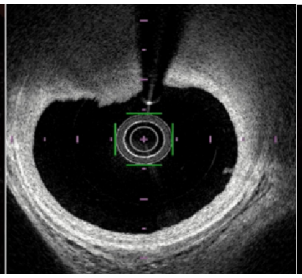

Figure-2: Plaque erosion

Figure-3: Thin cap fibroatheroma (TCFA)

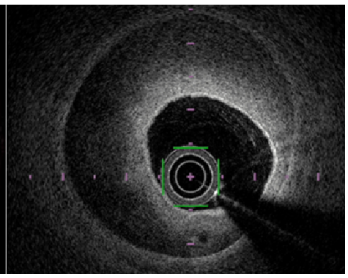

Figure-4: Intramural hematoma (IMH)

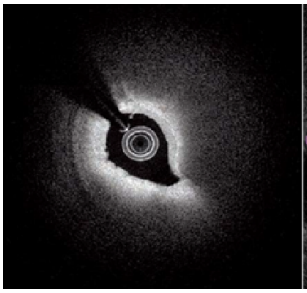

Figure-5: Lipidic plaque

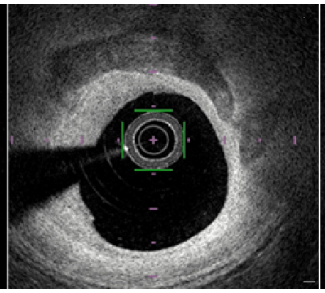

Figure-6: Calific plaque/nodule

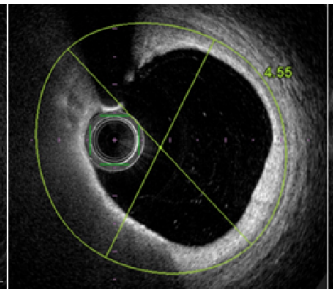

Figure-7: Under deployed stent (a): Vessel size: 4.55mm. (b) Stent size: 3.72mm

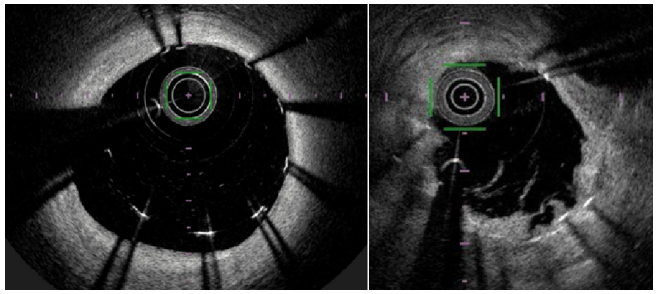

Figure-8: Mal-apposed stent. Stent strut fracture

DISCUSSION

Acute coronary syndrome either de novo or presenting as stent thrombosis is the leading cause of morbidity and mortality world-wide.[1] The exact management depends upon the underlying pathology.[4] Optical coherence tomography with its improved spatial and axial resolution provides an insight into the underlying pathology of these cases thus guiding proper management and reducing subsequent major adverse cerebral cardiovascular outcomes (MACE).[8] In our study by assessing the plaque morphology in ACS cases using the OCT we tried to analyse the underlying pathology of ACS in our population thus guiding us in proper management. We found that the majority of the patients with ACS had plaque rupture as the underlying pathology and was seen exclusively in the acute STEMI subset. Similar results were seen in studies conducted by Higuma *et al.*[9] and Jia *et al.*[10] where plaque rupture was seen as the dominant pathology leading to acute STEMI; 64.3% and 44.0% respectively. In contrast, only 9.3% of the cases had plaque erosion as the underlying pathology leading to acute STEMI which were treated conservatively not requiring stent deployment. Different studies have shown different prevalence of plaque erosion as the cause of ACS. Sato *et al.*[11] found plaque erosion as the underlying cause of ACS in 25.4% of the cases. The plausible reason for slightly lesser prevalence of plaque erosion as the cause of ACS could be the smaller sample size in our study or due to genetic variation in our population warranting larger, multi-centre trials. When it came to the underlying pathology leading to NSTEMI and UA, majority of the cases had either thin cap fibroatheroma or a lipid rich plaque. Similar results were seen in other studies as well which showed unstable lipid rich plaque being the underlying pathology leading to NSTEMI and UA.[12] Mostly such cases require stenting if the lesions cause significant decrease in blood flow. In our study we were also able to assess the underlying pathology of stent thrombosis using OCT. Under- deployed stent leading to stent thrombosis was seen in the majority of these cases (42.8%). Again, our findings were similar to study conducted by *et al*.[13] in which half of the cases of stent thrombosis were due to under-deployed stents. We were also able to see other pathologies of stent thrombosis like mal-apposed stent, neo-atherosclerosis, strut facture and uncovered stent struts but they were seen only in minority of the cases.

CONCLUSION

Optical coherence tomography guided PCI in cases of acute coronary syndrome is a valuable modality that gives insight into the underlying pathology of the disease process and also guides in proper management.

Limitations: The limitations of the study are that it is a single centre study and is non-randomized.

AUTHORS' CONTRIBUTION

WAA: Data collection. HSK: manuscript writing. AN: DATA entry on SPSS and interpretation. HUK: Reference collection. IAA: Contribution in discussion

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