Section: Cardiology

Original Research Article

CLINICAL OUTCOMES OF OPTICAL COHERENCE TOMOGRAPHY-GUIDED VERSUS ANGIOGRAPHY-GUIDED PERCUTANEOUS CORONARY INTERVENTION IN ACUTE CORONARY SYNDROME

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ABSTRACT

Background: Optical coherence tomography (OCT) is an advanced intracoronary imaging modality that enables detailed assessment of coronary plaque morphology and stent deployment during percutaneous coronary intervention (PCI). OCT-guided PCI may improve procedural optimization and reduce adverse cardiovascular outcomes compared to conventional angiography-guided PCI in patients with acute coronary syndrome (ACS). **Materials and Methods:** This prospective observational comparative study included 40 patients with ACS undergoing PCI, divided into conventional angiography-guided PCI (n=20) and OCT-guided PCI (n=20) groups. Baseline demographic, clinical, angiographic, procedural, and follow-up outcomes were assessed and compared between groups. Pre- and post-procedural OCT findings were also evaluated in the OCT-guided PCI group. **Result:** Mean age was 54.26 ± 9.41 years in the conventional PCI group and 57.21 ± 6.29 years in the OCT-guided PCI group. Male predominance was observed in both groups (90.0% vs 80.0%). Fibrofatty plaque was the most common pre-OCT finding (60.0%), while post-OCT assessment demonstrated edge dissection in 15.0% and malapposition in 10.0% of patients. At follow-up, 95.0% of patients in the OCT-guided PCI group were asymptomatic compared to 70.0% in the conventional PCI group (p=0.020). Chest pain was lower in the OCT-guided PCI group (5.0% vs 30.0%). Stent thrombosis/restenosis occurred in 25.0% of patients in the conventional PCI group. **Conclusion:** OCT-guided PCI demonstrated better symptomatic follow-up outcomes and enabled detailed assessment of plaque morphology and stent-related abnormalities, suggesting its potential role in improving PCI optimization in ACS patients.

INTRODUCTION

Acute coronary syndrome (ACS) is one of the most common cardiovascular emergencies and continues to be a major cause of morbidity and mortality worldwide. It includes a spectrum of clinical conditions such as ST-elevation myocardial infarction (STEMI), non-ST-elevation myocardial infarction (NSTEMI), and unstable angina, all of which result from sudden reduction in coronary blood flow due to plaque rupture, plaque erosion, or thrombus formation within the coronary arteries. Early diagnosis and prompt restoration of coronary blood flow are essential to reduce myocardial damage, prevent complications, and improve survival outcomes in these patients.[1]

Percutaneous coronary intervention (PCI) has become the cornerstone of treatment in patients with ACS, especially in those with significant coronary artery obstruction. Over the years, advances in stent technology, antiplatelet therapy, and procedural techniques have considerably improved the success rates of PCI. Conventionally, PCI is performed under fluoroscopic angiographic guidance, which provides a two-dimensional outline of the coronary lumen and helps in identifying the site and severity of coronary artery stenosis. Although coronary angiography remains the standard imaging modality during PCI, it has several limitations. Angiography cannot accurately assess plaque composition, thrombus burden, vessel wall characteristics, or detailed stent-vessel interaction. In addition, complications such as stent malapposition, underexpansion, edge dissection, or residual thrombus may remain undetected on angiography alone.[2]

To overcome these limitations, intracoronary imaging modalities such as intravascular ultrasound (IVUS) and optical coherence tomography (OCT) have been increasingly utilized during PCI procedures. Among these, OCT has emerged as a valuable imaging technique because of its very high spatial resolution, allowing near-histological visualization of coronary artery structures. OCT uses infrared light to generate detailed cross-sectional images of the coronary vessel lumen and wall, enabling precise assessment of plaque morphology, thrombus characteristics, calcification, fibrous cap thickness, and stent apposition. This detailed imaging capability can assist operators in selecting appropriate stent size and length, optimizing stent deployment, and identifying procedural complications requiring further intervention.[3,4]

Several clinical studies and meta-analyses have suggested that OCT-guided PCI may improve procedural optimization and reduce adverse cardiovascular outcomes compared to angiography-guided PCI alone.[5-7] Better stent expansion and detection of residual abnormalities may reduce the risk of restenosis, stent thrombosis, recurrent ischemia, and repeat revascularization.[8,9] OCT is particularly useful in ACS patients, where complex plaque morphology and thrombus burden may influence procedural success and long-term outcomes.[10,11] Despite these potential advantages, the routine use of OCT in daily clinical practice remains limited due to factors such as cost, availability of equipment, operator expertise, and additional procedural time.

Moreover, while large, randomized trials have demonstrated favourable outcomes with OCT-guided PCI, real-world data from prospective observational studies, particularly in ACS patients, remain limited in many healthcare settings. There is still a need to evaluate whether the use of OCT during PCI translates into improved clinical and angiographic outcomes in routine practice when compared with conventional angiography-guided PCI.[12]

Therefore, the present study was undertaken to compare the clinical and procedural angiographic outcomes of OCT-guided PCI and conventional angiography-guided PCI in patients presenting with ACS.

MATERIALS AND METHODS

Study Design and Setting: This prospective observational comparative study was conducted over a period of 12 months, following approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrollment.

Study Population: A total of 40 patients presenting with ACS and undergoing PCI were enrolled and divided into two groups of 20 each: Group I (Conventional Angiography-Guided PCI) and Group II (OCT-Guided PCI). Allocation to either group was based on the availability of OCT equipment and operator discretion at the time of the procedure.

Inclusion Criteria

Patients aged 18 years and above presenting with ACS, including STEMI, NSTEMI, and unstable angina, with significant coronary artery stenosis (≥70% by visual estimation on angiography) eligible to PCI were included in the study. Only patients providing written informed consent and having native coronary artery lesions suitable for intracoronary OCT imaging were enrolled.

Exclusion Criteria

Patients with cardiogenic shock, hemodynamic instability, severe renal impairment (eGFR <30 mL/min/1.73 m²), heavily calcified lesions, severe vessel tortuosity, total occlusion preventing OCT catheter passage, prior PCI or CABG to the target vessel, known contrast allergy, or unwillingness to provide informed consent were excluded from the study.

Sample Size: A convenience sample of 40 ACS patients undergoing PCI was enrolled during the study period, with 20 patients in each group.

Methods: All patients underwent coronary angiography through the transfemoral or transradial approach using standard techniques. Coronary lesion characteristics, including culprit vessel and severity of stenosis, were assessed by two independent interventional cardiologists. In the conventional PCI group, stent implantation was guided by angiography alone. Pre-dilatation and post-dilatation were performed at the operator’s discretion. In the OCT-guided PCI group, intracoronary OCT imaging was performed before and after stent implantation using a frequency-domain OCT system to assess plaque morphology, thrombus characteristics, stent expansion, apposition, edge dissection, tissue prolapse, and residual thrombus. Stent sizing and deployment were optimized based on OCT findings, and corrective interventions were performed when required. All patients underwent detailed clinical evaluation including demographic details (age, sex), cardiovascular risk factors (hypertension, diabetes mellitus, smoking history), presenting diagnosis classified by territory of involvement based on 12-lead ECG findings as anterior wall MI (AWMI), inferior wall MI (IWMI), inferoposterior wall MI (IPWMI/IPLWMI), or unstable angina, and procedural characteristics including pre-dilatation and post-dilatation status. Standard medical therapy was administered as per current ACS guidelines. Patients were followed up post-procedure for assessment of recurrent symptoms, major adverse cardiac events, stent thrombosis, restenosis, reintervention, and mortality.

Statistical Analysis: Continuous variables were expressed as mean ± standard deviation (SD) and compared between groups using the independent samples t-test. Categorical variables were expressed as frequency and percentage and compared using the Chi-square test or Fisher's exact test, as appropriate.

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A p-value of less than 0.05 was considered statistically significant for all analyses.

RESULTS

Mean age was 54.26 ± 9.41 years in the conventional PCI group and 57.21 ± 6.29 years in the OCT-guided PCI group. Males predominated in both groups (90.0% vs 80.0%). LAD was the most common vessel involved on angiography (55.0% vs 75.0%) and PCI (55.0% vs 70.0%). AWMI was the most frequent diagnosis (50.0% vs 55.0%). Smoking was the commonest risk factor (70.0% vs 80.0%), followed by diabetes mellitus (35.0% vs 30.0%). No significant baseline differences were observed between groups [Table 1].

Table 1: Baseline Demographic, Clinical and Procedural Characteristics Between Groups

Variable	Category	Conventional PCI	OCT-Guided PCI	P-value
Age (years)		54.26 ± 9.41	57.21 ± 6.29	-
Sex	Female	2 (10.0%)	4 (20.0%)	0.953
	Male	18 (90.0%)	16 (80.0%)	
Coronary Angiography Findings	LAD	11 (55.0%)	15 (75.0%)	0.259
	LAD & LCX	1 (5.0%)	0 (0.0%)	
	LCX	2 (10.0%)	2 (10.0%)	
	RAMUS	0 (0.0%)	1 (5.0%)	
	RCA	6 (30.0%)	2 (10.0%)	
PCI Vessel	Deferred	0 (0.0%)	1 (5.0%)	0.33
	LAD	11 (55.0%)	14 (70.0%)	
	LAD & LCX	1 (5.0%)	0 (0.0%)	
	LCX	2 (10.0%)	2 (10.0%)	
	LM to LAD	0 (0.0%)	1 (5.0%)	
	RAMUS	0 (0.0%)	1 (5.0%)	
	RCA	6 (30.0%)	2 (10.0%)	
Diagnosis	AWMI	10 (50.0%)	11 (55.0%)	0.848
	IPLWMI	1 (5.0%)	1 (5.0%)	
	IPWMI	5 (25.0%)	4 (20.0%)	
	IWMI	2 (10.0%)	1 (5.0%)	
	Unstable Angina	2 (10.0%)	3 (15.0%)	
Pre-dilatation	No	11 (55.0%)	15 (75.0%)	0.256
	Yes	9 (45.0%)	5 (25.0%)	
Post-dilatation	No	10 (50.0%)	11 (55.0%)	0.652
	Yes	10 (50.0%)	9 (45.0%)	
Hypertension	Yes	2 (10.0%)	1 (5.0%)	-
Smoking	Yes	14 (70.0%)	16 (80.0%)	-
T2DM	Yes	7 (35.0%)	6 (30.0%)	-

Fibrofatty plaque was the most common pre-OCT finding 60.0%, followed by plaque rupture in 5 (25.0%). Spotty calcium and red thrombus were each observed in 4 patients (20.0%). Post-OCT findings included edge dissection in 3 patients (15.0%), malapposition in 2 (10.0%), and residual red thrombus in 2 (10.0%) [Table 2].

Table 2: Pre- and Post-OCT Findings in OCT-Guided PCI Group

OCT Assessment	Finding	n (%)
Pre-OCT	Spotty Calcium	4 (20.0%)
	Red Thrombus	4 (20.0%)
	White Thrombus	1 (5.0%)
	Mixed Thrombus	2 (10.0%)
	Fibrofatty Plaque	12 (60.0%)
	Plaque Rupture	5 (25.0%)
Post-OCT	Red Thrombus	2 (10.0%)
	White Thrombus	1 (5.0%)
	Tissue Prolapse	1 (5.0%)
	Edge Dissection	3 (15.0%)
	Malapposition	2 (10.0%)

At follow-up, 19 patients (95.0%) in the OCT-guided PCI group had no complaints compared to 14 patients (70.0%) in the conventional PCI group. Chest pain was lower in the OCT-guided PCI group (5.0% vs 30.0%; p=0.020) [Table 3].

Table 3: Follow-up Clinical Outcomes Between Groups

Follow-up Angiographic Outcome	Conventional PCI	OCT-Guided PCI	P-value
Nil Complaints	14 (70.0%)	19 (95.0%)	0.020
Complaint of Chest Pain	6 (30.0%)	1 (5.0%)	

In the conventional PCI group, stent thrombosis/restenosis occurred in 5 patients (25.0%). Early stent thrombosis occurred in 4 patients (20.0%), late stent thrombosis in 1 patient (5.0%), and mortality due to early stent thrombosis in 1

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patient (5.0%). Reintervention was performed in 5 patients (25.0%) [Table 4].

Table 4: Follow-up Clinical Outcomes in Conventional PCI Group

Clinical Outcome	n (%)
Stent Thrombosis / Restenosis	5 (25.0%)
Early Stent Thrombosis	4 (20.0%)
Late Stent Thrombosis	1 (5.0%)
Mortality Due to Early Stent Thrombosis	1 (5.0%)
Reintervention Performed	5 (25.0%)

DISCUSSION

OCT is an advanced intracoronary imaging modality that helps in better visualization of coronary lesions and stent deployment during PCI in patients with ACS. The present study aimed to compare the clinical and procedural outcomes of OCT-guided PCI and conventional angiography-guided PCI. Overall, OCT-guided PCI showed better follow-up outcomes with fewer symptoms and stent-related complications.

In our study, baseline demographic, clinical, and procedural characteristics were comparable between both groups. Male predominance, LAD involvement, AWMI presentation, and smoking as a major risk factor were commonly observed. Similarly, Abdelmonaem et al. reported a mean age of 57 ± 13 years with male predominance (78%) across both imaging groups, reflecting comparable demographic baseline characteristics.[13] Similarly, Holm et al. reported that 18.5% of the OCT-guided group and 19.3% of the angiography-guided group had bifurcation lesions involving the left main coronary artery, indicating similar baseline characteristics between groups.[8] Similar baseline characteristics across these large trials validate that the study populations are comparable, reinforcing the reliability of outcome comparisons.

The present study showed fibrofatty plaque and plaque rupture as common pre-OCT findings. Post-OCT assessment identified residual thrombus, edge dissection, and malapposition, demonstrating the utility of OCT in procedural evaluation. Similarly, Onea et al. identified intimal discontinuity as the most common morphological mechanism (50%), associated with thrombus in 68.6% of cases, highlighting the diverse plaque phenotypes detectable by OCT in the ACS setting.[14] Similarly, Aguirre et al. reported that plaque rupture accounted for 43.7% of ACS culprit lesions, followed by plaque erosion (31.0%) and calcified nodule (7.9%), with patients presenting with plaque rupture more frequently having white thrombus and more severe underlying lesion stenosis.[15] Regarding post-OCT stent findings, Ahmed et al. reported that OCT-guided PCI was associated with a significantly reduced risk of stent malapposition (RR 0.79; 95% CI 0.71–0.88; $p < 0.0001$) and major edge dissection (RR 0.47; 95% CI 0.34–0.65; $p < 0.00001$) compared to angiography-guided PCI.[7] The identification of residual malapposition and edge dissection by post-stenting OCT assessment enables targeted corrective interventions, which may contribute to a reduced risk of adverse stent-related events.

In this study, the OCT-guided PCI group demonstrated better follow-up outcomes with fewer chest pain symptoms and a higher proportion of asymptomatic patients compared to the conventional PCI group. Similarly, Macherey-Meyer et al. reported that OCT guidance was associated with a 30% lower likelihood of MACE (OR 0.70; 95% CI 0.53–0.93; $p = 0.01$) and significantly decreased cardiac mortality (OR 0.49; 95% CI 0.25–0.96; $p = 0.04$), with OCT-guided patients requiring target lesion revascularization less frequently.[4] Similarly, Sattar et al. reported that OCT-guided PCI was associated with significant reductions in cardiovascular mortality (RR 0.54; 95% CI 0.33–0.89; $p = 0.01$), trial-defined MACE (RR 0.76; 95% CI 0.65–0.89; $p < 0.01$), and stent thrombosis (RR 0.53; 95% CI 0.33–0.87; $p = 0.01$) compared to angiography-guided PCI.[16] Collectively, these data confirm that OCT-guided PCI confers a clinically meaningful reduction in adverse cardiac events and symptomatic recurrence, supporting its adoption in routine ACS management.

The conventional PCI group showed adverse follow-up events including stent thrombosis, restenosis, mortality, and reintervention, indicating less favourable clinical outcomes. Similarly, Ali et al. reported stent thrombosis in only 0.5% of OCT-guided patients compared to 1.4% in the angiography-guided group ($p = 0.02$), with a significantly larger minimum stent area achieved in the OCT group (5.72 mm^2 vs 5.36 mm^2; $p < 0.001$), highlighting the stent optimization benefit of OCT guidance.[1] Likewise, Ezenna et al. demonstrated a 51% relative risk reduction in stent thrombosis and a 25% reduction in myocardial infarction with OCT-guided PCI compared to angiography-guided PCI.5 These findings support the potential role of OCT-guided PCI in improving stent optimization and reducing stent-related complications.

The findings of present study highlight the potential clinical value of OCT-guided PCI in ACS. The use of OCT enabled detailed assessment of plaque morphology and post-stenting abnormalities, while patients undergoing OCT-guided PCI demonstrated more favourable follow-up outcomes compared to conventional angiography-guided PCI.

Limitations: The study was limited by a small sample size, single-centre design, short follow-up duration, and non-randomized patient allocation. Non-randomized allocation based on OCT equipment availability and operator discretion may have introduced selection bias and confounding, limiting causal interpretation of the findings. Detailed comparative long-term clinical outcomes between both groups could not be fully assessed, which may limit the generalizability of the findings.

CONCLUSION

OCT-guided PCI demonstrated favourable short-term symptomatic outcomes and improved procedural assessment compared with angiography-guided PCI in patients with ACS. OCT enabled detailed pre- and post-procedural evaluation of plaque morphology and stent-related abnormalities including edge dissection, malapposition, and residual thrombus, facilitating targeted corrective interventions. These findings suggest that OCT guidance during PCI may improve stent optimization and reduce adverse stent-related events in ACS patients, although larger randomized studies are needed to validate these findings.

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