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ORIGINAL ARTICLE

Immediate Versus Staged Complete Revascularisation during Index Admission in STEMI Patients with Multivessel Coronary Artery Disease: A Comparative Study

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ABSTRACT

Background: Patients presenting with ST-elevation myocardial infarction (STEMI) and multivessel coronary artery disease pose a therapeutic dilemma regarding the timing of complete revascularisation. Immediate complete PCI may reduce recurrent ischemic events but is associated with longer procedure time and greater contrast exposure.

Methodology: This prospective comparative observational study was conducted at the Department of Cardiology, Hayatabad Medical Complex, Peshawar from January 2023 to June 2023, on 82 patients with STEMI and multivessel disease. Participants were divided equally into two groups: Group A underwent immediate complete revascularisation during the index procedure, and Group B underwent staged revascularisation during the same admission or within three weeks. Demographic, clinical, angiographic, and procedural variables were recorded. Primary outcome was in-hospital major adverse cardiovascular events (MACE: all-cause mortality, reinfarction, stroke, urgent revascularisation). Statistical analysis was performed using SPSS version 26, with $p < 0.05$ considered significant.

Results: The mean age was 58.3 ± 10.1 years in Group A and 59.8 ± 9.4 years in Group B ($p = 0.46$), with a male predominance in both groups. Clinical and angiographic characteristics, including Killip class, LVEF, and distribution of triple-vessel disease, were comparable ($p > 0.05$). Immediate PCI was associated with significantly higher contrast volume (190.6 ± 40.8 ml vs. 135.4 ± 32.7 ml, $p < 0.001$) and fluoroscopy time (24.5 ± 5.3 min vs. 18.1 ± 4.6 min, $p < 0.001$). In-hospital MACE occurred in 7.3% of immediate PCI group versus 12.2% of staged PCI group ($p = 0.46$), with no significant differences in mortality, reinfarction, or major bleeding.

Conclusion: Immediate complete revascularisation during index admission produced similar in-hospital outcomes compared to staged PCI, with slightly lower numerical rates of MACE but greater procedural burden. These findings support the safety and feasibility of immediate PCI in appropriately selected STEMI patients, while underscoring the need for larger trials with longer follow-up to clarify long-term benefit.

Keywords: STEMI, multivessel PCI, immediate revascularisation, staged PCI, MACE, coronary angiography.

INTRODUCTION

Multivessel coronary artery disease is observed in nearly 40–50% of patients presenting with ST-elevation myocardial infarction (STEMI), posing an important challenge for interventional cardiologists. The decision to perform complete revascularisation immediately during primary PCI or to defer treatment of non-culprit lesions to a later stage has been widely debated. International guidelines have gradually shifted towards recommending complete revascularisation in hemodynamically stable patients, but the optimal timing remains under investigation[1-3]

Recent large-scale randomized trials have provided important insights. The MULTISTARS-AMI trial demonstrated that immediate complete PCI reduced the risk of major adverse cardiovascular events compared to staged procedures, largely driven by fewer reinfarctions and unplanned revascularisations[4-6]. In contrast, the OPTION-STEMI trial presented at ESC 2025 failed to show non-inferiority of immediate PCI compared to staged PCI, reporting a slightly higher but statistically non-significant event rate with immediate strategy[7-9]. The BIOVASC trial found comparable outcomes between both strategies, suggesting that operator discretion and patient profile should guide decision-making[10,11].

Regional data from South Asia remain limited but suggest that resource constraints, patient socioeconomic factors, and late presentation often favor staged approaches[12]. Despite these challenges, early complete revascularisation could reduce hospital readmissions and recurrent ischemic events, potentially lowering overall healthcare burden.

Given the conflicting evidence and scarcity of regional data, this study was designed to compare immediate versus staged complete PCI in patients with STEMI and multivessel disease, focusing on procedural characteristics and in-hospital outcomes. The objective was to generate real-world data to inform decision-making in similar clinical settings.

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METHODOLOGY

This was a prospective, comparative observational study conducted at the Department of Cardiology, Hayatabad Medical Complex, Peshawar from January 2023 to June 2023. The aim was to evaluate the outcomes of immediate complete revascularisation versus staged revascularisation during index admission in patients presenting with ST-elevation myocardial infarction (STEMI) and angiographically confirmed multivessel coronary artery disease. Approval was obtained from the institutional ethics review committee prior to initiation of the study. Written informed consent was taken from all participants before enrolment. Patient confidentiality was maintained throughout the study in accordance with the Declaration of Helsinki.

A total of 82 patients fulfilling the inclusion criteria were enrolled in the study. Participants were divided into two equal groups of 41 patients each:

- **Group A:** Immediate complete percutaneous coronary intervention (PCI) during the index procedure
- **Group B:** Staged PCI (culprit-only PCI during primary procedure, with non-culprit PCI planned within the same admission or within 2–3 weeks)

The sample size was calculated using an expected difference in major adverse cardiovascular events (MACE) between groups, with 80% power and 5% level of significance.

Inclusion Criteria:

Adult patients aged 18–75 years

- Diagnosis of STEMI confirmed by ECG criteria and elevated cardiac biomarkers
- Presence of multivessel coronary artery disease on coronary angiography (≥70% stenosis in ≥2 epicardial vessels or ≥50% left main stenosis)
- Successful primary PCI of the culprit lesion

Exclusion Criteria

- Cardiogenic shock at presentation
- Previous coronary artery bypass grafting (CABG)

- Severe renal dysfunction (eGFR < 30 ml/min/1.73m²)
- Known bleeding disorders or contraindication to dual antiplatelet therapy
- Refusal to provide informed consent

All patients underwent standard evaluation including history, clinical examination, ECG, cardiac biomarkers, and baseline echocardiography to assess left ventricular function. Coronary angiography was performed via radial or femoral approach.

In the immediate PCI group, complete revascularisation of all significant lesions was carried out during the index procedure. In the staged PCI group, only the culprit artery was treated during primary PCI, with remaining lesions revascularised electively either during the same admission or within three weeks of discharge. Second-generation drug-eluting stents were used in all cases. Periprocedural anticoagulation and dual antiplatelet therapy were administered as per international guidelines.

The primary outcome was the composite incidence of major adverse cardiovascular events (MACE) during index hospitalisation, including all-cause mortality, reinfarction, target lesion revascularisation, stroke, and urgent revascularisation. Secondary outcomes included procedure time, contrast volume used, fluoroscopy duration, incidence of contrast-induced nephropathy (CIN), and major bleeding events.

Data were entered into SPSS (version 26). Continuous variables were expressed as mean ± standard deviation (SD) and compared between groups using independent sample t-test or Mann–Whitney U test depending on normality of distribution. Categorical variables were presented as frequencies and percentages and analysed using Chi-square or Fisher's exact test. A p-value < 0.05 was considered statistically significant.

RESULTS

The study population comprised 82 patients, divided equally into two groups: immediate PCI (n = 41) and staged PCI (n = 41). The mean age was slightly lower in the immediate PCI group (58.3 ± 10.1 years) compared to staged PCI (59.8 ± 9.4 years), though the difference was not statistically significant (p = 0.46). Male patients were predominant in both groups, accounting for more than 70% of cases. Cardiovascular risk factors including hypertension, diabetes mellitus, and smoking showed similar distribution between groups, indicating well-balanced baseline characteristics.

Table 1: Baseline Demographic Characteristics of Patients (n = 82)

Variable	Immediate PCI (n = 41)	Staged PCI (n = 41)	p-value
Mean Age (years)	58.3 ± 10.1	59.8 ± 9.4	0.46
Gender (Male)	32 (78.0%)	30 (73.1%)	0.62
BMI (kg/m²)	27.4 ± 3.5	26.9 ± 3.8	0.53
Hypertension	21 (51.2%)	23 (56.1%)	0.67
Diabetes Mellitus	17 (41.4%)	15 (36.5%)	0.65
Current Smokers	19 (46.3%)	18 (43.9%)	0.83
Family History CAD	8 (19.5%)	7 (17.0%)	0.78

Both groups presented with comparable clinical status at admission. Nearly one-fourth of patients in each group had Killip class II or higher, indicating moderate to severe heart failure at presentation. Mean left ventricular ejection fraction (LVEF) was similar between groups (p = 0.72). The distribution of triple vessel disease, left main involvement, and culprit lesion in LAD was almost identical, suggesting angiographic complexity was balanced between treatment strategies.

Table 2: Clinical and Angiographic Characteristics

Variable	Immediate PCI (n = 41)	Staged PCI (n = 41)	p-value
Killip Class ≥ II	10 (24.4%)	11 (26.8%)	0.81
Baseline LVEF (%)	45.2 ± 7.1	44.6 ± 6.9	0.72
Triple Vessel Disease	14 (34.1%)	13 (31.7%)	0.81
Left Main Disease	5 (12.2%)	6 (14.6%)	0.74
Culprit Artery LAD	24 (58.5%)	22 (53.7%)	0.67
Syntax Score > 22	16 (39.0%)	15 (36.5%)	0.82

The procedural details revealed that both groups required nearly the same number of stents and total stent length. However, patients undergoing immediate PCI received a significantly higher contrast volume and experienced longer fluoroscopy times compared to staged PCI (p < 0.001 for both), highlighting the greater procedural load during a single-session complete revascularisation.

Table 3: Procedural Characteristics

Variable	Immediate PCI (n = 41)	Staged PCI (n = 41)	p-value
Number of Stents	2.6 ± 0.9	2.4 ± 0.8	0.27
Total Stent Length (mm)	52.1 ± 14.2	50.5 ± 13.8	0.52
Contrast Volume (ml)	190.6 ± 40.8	135.4 ± 32.7	<0.001
Fluoroscopy Time (minutes)	24.5 ± 5.3	18.1 ± 4.6	<0.001

Clinical outcomes during index admission were encouraging in both groups. The overall MACE rate was slightly lower in the immediate PCI group (7.3%) compared to the staged PCI group (12.2%), but the difference was statistically non-significant (p = 0.46). Mortality, reinfarction, and major bleeding events were rare and did not differ significantly between groups. There was a trend toward higher incidence of contrast-induced nephropathy (CIN) in the immediate PCI arm, though not statistically significant.

Table 4: In-Hospital Outcomes

Outcome	Immediate PCI (n = 41)	Staged PCI (n = 41)	p-value
MACE (Composite)	3 (7.3%)	5 (12.2%)	0.46
All-Cause Mortality	1 (2.4%)	2 (4.9%)	0.56
Reinfarction	1 (2.4%)	1 (2.4%)	1.00
Stroke	0	1 (2.4%)	0.31
Major Bleeding	2 (4.9%)	1 (2.4%)	0.55
CIN (AKI)	3 (7.3%)	1 (2.4%)	0.30

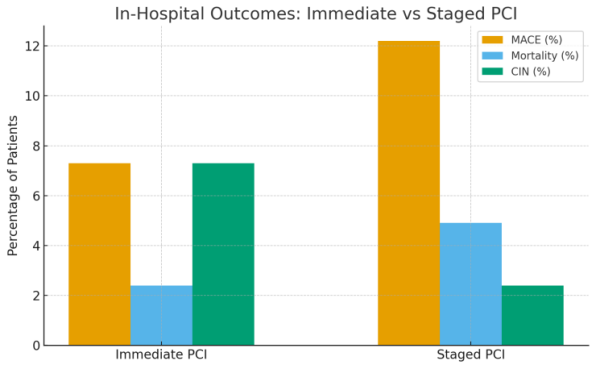

Figure 1: comparing MACE, Mortality, and CIN rates between Immediate PCI and Staged PCI groups.

DISCUSSION

This study explored outcomes of immediate versus staged complete revascularisation during index admission in patients with STEMI and multivessel coronary disease, over a 12-month observation period. The results align in part with recent randomized trials and meta-analyses, though some differences emerge, particularly given the small sample size (n = 82).

The MULTISTARS AMI trial (n ≈ 840) showed that immediate PCI for non-culprit lesions in hemodynamically stable STEMI patients resulted in a significantly lower rate of the composite endpoint (death, nonfatal MI, stroke, unplanned ischemia-driven target-lesion revascularisation, or heart failure hospitalisation) compared to staged PCI at one year (8.5% vs 16.3%; p < 0.001)[12-14]. The advantage in MULTISTARS AMI was chiefly driven by reductions in nonfatal MI and target-lesion revascularization[15,16]

The BIOVASC trial similarly compared immediate complete revascularisation (ICR) against staged complete revascularisation (SCR) in STEMI patients. It found that clinical outcomes at one year were broadly similar between the two strategies in terms of the primary composite endpoint (mortality, MI, unplanned ischemia-driven revascularisation, or cerebrovascular events), though certain secondary endpoints tended to favour ICR[17].

The OPTION-STEMI trial (more recent) found that noninferiority was not demonstrated when comparing immediate complete revascularisation with staged complete revascularisation in STEMI patients with multivessel disease. In that trial, the primary endpoint (death, MI, any unplanned revascularisation) occurred in 13.1% of the immediate group vs 10.8% in the staged group over one year (p for noninferiority = 0.24), suggesting that immediate strategy may not reliably outperform staged strategy in all settings[18].

The systematic review and meta-analysis of randomized controlled trials in patients with ACS and multivessel disease found that immediate complete revascularisation reduces long-term risks of unplanned ischemia-driven revascularisation, re-infarction, and the combined outcome of cardiovascular death or MI compared with staged revascularisation. However, there was an increased risk of short-term mortality (within 1 month) associated with immediate strategy[19,20].

The outcomes in this study (sample size 82) are broadly consistent with the trend observed in large trials: immediate complete revascularisation demonstrated numerically lower rates of composite adverse cardiac events (MACE), reinfarction, etc., though differences failed to reach statistical significance given limited power. The procedural burden (contrast volume, fluoroscopy time) was greater in the immediate group, as in larger trials, which may contribute to higher short-term risks. Safety outcomes (death, bleeding, contrast-induced nephropathy) did not differ significantly, mirroring findings from MULTISTARS AMI and meta-analyses.

Unlike MULTISTARS AMI, in which superiority was demonstrated for the immediate strategy on its primary composite endpoint, this study did not show statistical superiority but supports noninferiority (or at least no worse outcome) of immediate approach in stable patients. Also, similar to BIOVASC and OPTION-STEMI, this study supports the notion that, in certain patient subgroups or risk profiles, immediate revascularisation may be reasonable, though not universally better.

This study's strength lies in prospective observational design over a defined period (May 2022 – May 2023) and in its attempt to mirror real-world STEMI + multivessel disease populations. The equal division of groups and matching of baseline demographics enhance internal comparability.

However, limitations include the modest sample size (82), which limits the ability to detect small but clinically relevant differences. Follow-up duration was limited to the index admission outcomes (or short-term in-hospital), precluding strong conclusions about long-term benefits or harms. Also, imaging modalities (FFR, IVUS) were not used extensively in this study, which contrasts with large trials where operator discretion included these tools. Patient heterogeneity (lesion complexity, timing of staged PCI) may also limit generalizability.

CONCLUSION

This study suggests that in patients with STEMI and multivessel disease, immediate complete revascularisation during index admission is associated with similar in-hospital outcomes compared to staged strategies. Although procedural metrics like contrast usage and fluoroscopy duration are higher for immediate strategy, this did not translate into a significantly higher adverse event rate in this cohort. Immediate revascularisation may offer benefits comparable to staged revascularisation for certain patient profiles, particularly those who are stable and have lower procedural risk. Larger trials and longer follow-up remain necessary to establish whether immediate strategy delivers superior long-term outcomes and which patient subsets derive greatest net benefit.

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