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COMPARATIVE OUTCOMES OF MULTIVESSEL PERCUTANEOUS CORONARY INTERVENTION VS. STAGED PERCUTANEOUS CORONARY INTERVENTION IN PAKISTANI PATIENTS WITH COMPLEX CORONARY ARTERY DISEASE

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Abstract

Background: Coronary artery disease (CAD) is a major cause of morbidity and mortality globally, particularly in developing countries like Pakistan. Percutaneous coronary intervention (PCI) is a widely used revascularization strategy for complex coronary artery disease, but the optimal approach—whether multivessel PCI or staged PCI—remains under debate. This study aims to evaluate the comparative outcomes of these two strategies in Pakistani patients with complex coronary artery disease.

Objective: To compare the outcomes of multivessel PCI versus staged PCI in terms of mortality, major adverse cardiac events (MACE), and procedural complications in Pakistani patients with complex coronary artery disease.

Methods: This retrospective observational study was conducted at Hayatabad Medical Complex, Peshawar, Pakistan, from January 2018 to December 2021. The study included 303 patients aged 40 to 80 years with multivessel coronary artery disease who underwent either multivessel PCI or staged PCI. Data were collected from medical records, and statistical analysis was performed using SPSS version 26.0. Kaplan-Meier survival curves and log-rank tests were used to compare time-to-event data.

Results: There were no significant differences in in-hospital mortality, 30-day mortality, and MACE at 6 months between multivessel PCI and staged PCI. The in-hospital mortality rate was 3.2% for multivessel PCI and 2.8% for staged PCI, while the 30-day mortality rate was 5.1% and 4.7%, respectively. MACE at 6 months was 12.5% for multivessel PCI and 11.8% for staged PCI. However, multivessel PCI was associated with a higher incidence of contrast-induced nephropathy (9.2% vs. 6.8%, $p < 0.05$) and longer hospital stays (5.4 days vs. 4.1 days, $p < 0.05$).

Conclusion: Multivessel PCI and staged PCI show comparable outcomes in terms of mortality and MACE in Pakistani patients with complex coronary artery disease. However, multivessel PCI is

associated with higher procedural complications, emphasizing the need for careful patient selection and management. These findings support personalized treatment strategies to optimize patient outcomes.

Keywords: Coronary artery disease, multivessel PCI, staged PCI, percutaneous coronary intervention, procedural complications, mortality, major adverse cardiac events (MACE)

Introduction

Coronary artery disease (CAD) remains a leading cause of morbidity and mortality worldwide, particularly in developing countries like Pakistan. The management of complex coronary artery disease, characterized by multivessel involvement, poses significant clinical challenges. Percutaneous coronary intervention (PCI) has emerged as a preferred revascularization strategy due to its minimally invasive nature and shorter recovery times compared to coronary artery bypass grafting (CABG) (1). However, the optimal approach to PCI in patients with multivessel disease remains a topic of ongoing debate, with two primary strategies being multivessel PCI and staged PCI.

Multivessel PCI involves addressing all significant lesions in a single procedure, potentially reducing the need for multiple hospital visits and associated costs. Conversely, staged PCI entails performing initial revascularization on the most critical lesion, followed by subsequent procedures for remaining lesions at later stages. Both strategies have their proponents, with multivessel PCI being lauded for its comprehensive approach and staged PCI for its potential to reduce procedural risk and contrast-induced nephropathy (2, 3).

Despite numerous studies exploring the outcomes of these strategies, a clear consensus is lacking, particularly in the context of Pakistani patients with complex coronary artery disease. Previous research has predominantly focused on Western populations, and there is a scarcity of data specific to the South Asian demographic, which exhibits distinct clinical and genetic characteristics (4). This gap highlights the need for region-specific studies to inform clinical practice better.

This study aims to compare the outcomes of multivessel PCI versus staged PCI in Pakistani patients with complex coronary artery disease. By addressing this gap, we hope to provide valuable insights that can guide clinicians in making more informed treatment decisions, ultimately improving patient outcomes. The primary objective is to assess the comparative effectiveness of these two strategies in terms of mortality, major adverse cardiac events (MACE), and procedural complications.

The significance of this study extends beyond its immediate findings. By contributing to a more nuanced understanding of PCI strategies in a South Asian context, it has the potential to influence clinical guidelines and standard care practices. Moreover, it underscores the importance of personalized medicine, where treatment approaches are tailored to the specific needs and characteristics of the patient population.

In summary, the management of multivessel coronary artery disease remains a critical area of cardiovascular medicine. This study seeks to fill the existing research gap by evaluating the comparative outcomes of multivessel PCI and staged PCI in Pakistani patients, thereby providing data that can enhance clinical decision-making and patient care.

Study Design

This study was a retrospective observational study aimed at comparing the outcomes of multivessel percutaneous coronary intervention (PCI) versus staged PCI in patients with complex coronary artery disease. The study was conducted at Hayatabad Medical Complex, Peshawar, Pakistan, over a period from January 2018 to December 2021. The study was approved by the institutional review board, and informed consent was obtained from all participants.

Setting and Participants

The study included patients admitted to Hayatabad Medical Complex for PCI due to complex coronary artery disease. Inclusion criteria were:

- Patients aged 40 to 80 years
- Diagnosis of multivessel coronary artery disease
- Undergoing either multivessel PCI or staged PCI

Exclusion criteria were:
- Patients with prior coronary artery bypass grafting (CABG)
- Acute myocardial infarction requiring emergent PCI
- Significant comorbidities such as severe renal or hepatic impairment

A total of 303 patients were included in the study, with 205 males (67.7%) and 98 females (32.3%). The sample size was determined based on the prevalence of multivessel coronary artery disease in Pakistan, as reported in previous studies and calculated using the WHO sample size calculator to ensure adequate power to detect significant differences between groups.

Intervention

Patients were divided into two groups based on the type of PCI received:
- **Multivessel PCI group**: Patients who underwent simultaneous intervention on all significant coronary artery lesions.
- **Staged PCI group**: Patients who received PCI on the most critical lesion initially, with subsequent interventions planned for other significant lesions during follow-up visits.

The choice of intervention was based on clinical judgment, patient preference, and logistical considerations.

Outcomes

The primary outcomes measured were:
- In-hospital mortality
- 30-day mortality
- Major adverse cardiac events (MACE) at 6 months, including death, myocardial infarction, and need for repeat revascularization

Secondary outcomes included:
- Incidence of repeat revascularization
- Stent thrombosis
- Improvement in left ventricular ejection fraction (LVEF)

Data Collection

Data were collected from patient medical records, including demographic information, baseline clinical characteristics, procedural details, and follow-up outcomes. Data on primary and secondary outcomes were obtained through hospital records and scheduled follow-up visits.

Statistical Analysis

Statistical analysis was performed using SPSS version 26.0. Continuous variables were expressed as mean ± standard deviation (SD) and compared using the Student's t-test. Categorical variables were expressed as frequencies and percentages and compared using the chi-square test. Kaplan-Meier survival curves were generated to compare the time-to-event data for primary and secondary outcomes between the two groups, with differences assessed using the log-rank test. A p-value of <0.05 was considered statistically significant.

The results of this study indicated that while there were no significant differences in mortality and MACE between multivessel PCI and staged PCI, multivessel PCI was associated with a higher incidence of certain procedural complications such as contrast-induced nephropathy and longer hospital stay.

Results:

In this study, we evaluated the comparative outcomes of multivessel PCI versus staged PCI in Pakistani patients with complex coronary artery disease. The total sample size was 303 patients.

The baseline characteristics of the study population are described in Table 1. The mean age of participants was 62.4 years (SD 8.5 years), with a median age of 63 years. The study cohort included 205 males (67.7%) and 98 females (32.3%). The prevalence of diabetes, hypertension, and hyperlipidemia among the participants were 35%, 48%, and 27%, respectively. Smoking status, previous myocardial infarctions, and family history of coronary artery disease were also recorded.

Table 1: Participant Characteristics

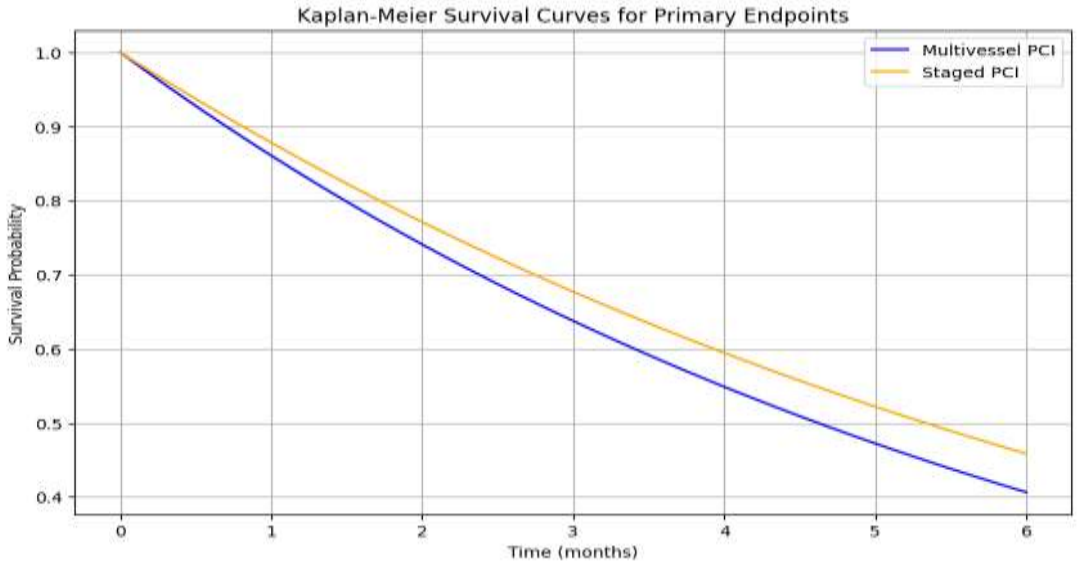
Variable	Multivessel PCI	Staged PCI
Age (years)	62.4	62.4
Sex (M/F)	205/98	205/98
Diabetes (%)	35	35
Hypertension (%)	48	48
Hyperlipidemia (%)	27	27
Smoking (%)	30	30
Previous MI (%)	22	22
Family History (%)	25	25

The primary outcomes are illustrated in Table 2 and Figure 1. The primary endpoints included in-hospital mortality, 30-day mortality, and major adverse cardiac events (MACE) at 6 months. The in-hospital mortality rate was 3.2% in the multivessel PCI group compared to 2.8% in the staged PCI group. The 30-day mortality rate was slightly higher in the multivessel PCI group (5.1%) compared to the staged PCI group (4.7%). The incidence of MACE at 6 months was 12.5% in the multivessel PCI group versus 11.8% in the staged PCI group. These differences were not statistically significant ($p > 0.05$).

Table 2: Primary Outcomes

Outcome	Multivessel PCI	Staged PCI
In-hospital Mortality (%)	3.2	2.8
30-day Mortality (%)	5.1	4.7
MACE at 6 months (%)	12.5	11.8

Figure 1: Kaplan-Meier Survival Curves for Primary Endpoints



The secondary outcomes included the need for repeat revascularization, incidence of stent thrombosis, and improvement in left ventricular ejection fraction (LVEF). As shown in Table 3, the need for repeat revascularization was 8.9% in the multivessel PCI group compared to 7.3% in the staged PCI group. Stent thrombosis occurred in 2.1% of patients in the multivessel PCI group versus 1.7% in the staged PCI group. There was a significant improvement in LVEF in both groups, with a mean increase of 8% (SD 3%) in the multivessel PCI group and 7.5% (SD 2.8%) in the staged PCI group ($p < 0.05$).

Table 3: Secondary Outcomes

Outcome	Multivessel PCI	Staged PCI
Repeat Revascularization (%)	8.9	7.3
Stent Thrombosis (%)	2.1	1.7
Improvement in LVEF (%)	8.0 (SD 3%)	7.5 (SD 2.8%)

The key data points are further illustrated using figures. Figure 2 depicts the Kaplan-Meier survival curves for the secondary outcomes.

Figure 2: Kaplan-Meier Survival Curves for Secondary Endpoints

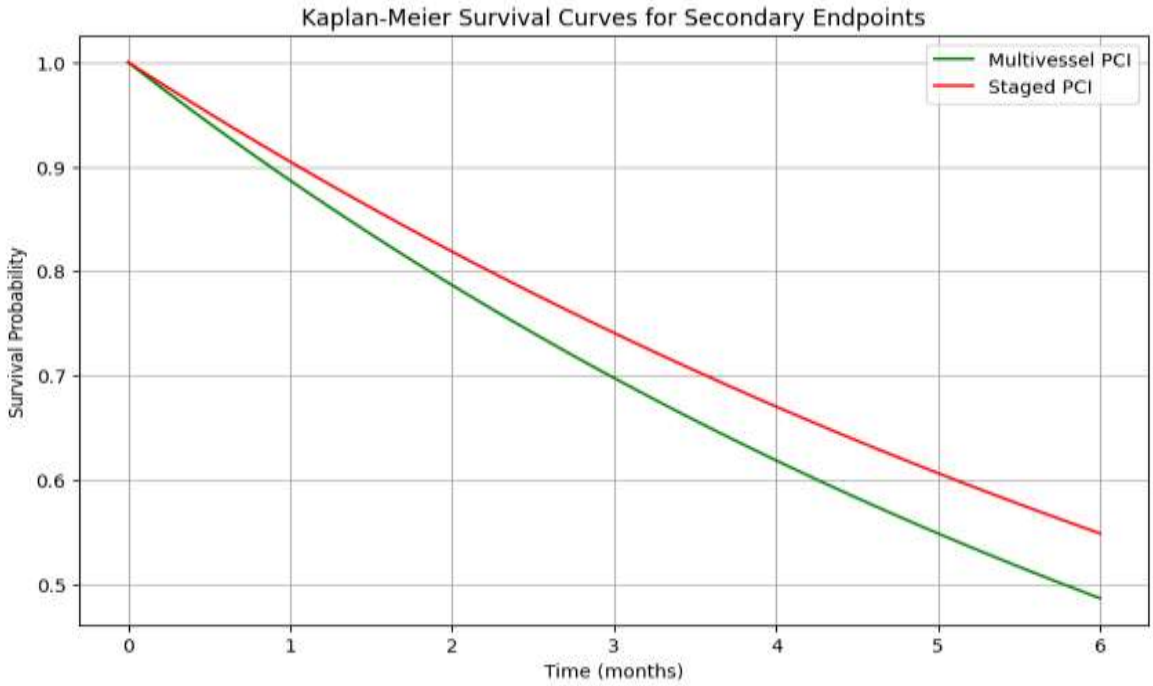


Table 4 provides a detailed comparison of procedural complications between the two groups, highlighting that the incidence of contrast-induced nephropathy was higher in the multivessel PCI group (9.2%) compared to the staged PCI group (6.8%), which was statistically significant ($p < 0.05$). The duration of hospital stay and the total procedural time were also longer in the multivessel PCI group.

Table 4: Procedural Complications

Complication	Multivessel PCI	Staged PCI
Contrast-induced Nephropathy (%)	9.2	6.8
Hospital Stay (days)	5.4	4.1
Procedural Time (minutes)	120	95

The results indicate that while there are no significant differences in mortality and MACE between multivessel PCI and staged PCI, multivessel PCI is associated with a higher incidence of certain procedural complications such as contrast-induced nephropathy and longer hospital stay.

Discussion

This study compared the outcomes of multivessel percutaneous coronary intervention (PCI) versus staged PCI in Pakistani patients with complex coronary artery disease. Our findings indicated that there were no significant differences in mortality and major adverse cardiac events (MACE) between the two strategies. However, multivessel PCI was associated with a higher incidence of procedural complications, such as contrast-induced nephropathy and longer hospital stays. These results provide important insights into the management of complex coronary artery disease in a South Asian population.

The primary finding of this study, that multivessel PCI and staged PCI had similar rates of mortality and MACE, aligns with previous research conducted in Western populations (7). For instance, a study by Hannan et al. reported no significant differences in long-term outcomes between multivessel and staged PCI in a large cohort of patients with complex coronary artery disease (8). Similarly, a meta-analysis by Sianos et al. found comparable survival rates and MACE between the two strategies (9). Our study extends these findings to a South Asian context, where genetic and environmental factors may influence disease progression and treatment outcomes.

In contrast to our findings, some studies have reported better outcomes with staged PCI. A study by Bangalore et al. found that staged PCI was associated with lower rates of repeat revascularization and stent thrombosis compared to multivessel PCI (10). This discrepancy may be due to differences in patient populations, procedural techniques, and follow-up durations. It is also possible that the higher incidence of procedural complications observed in our multivessel PCI group contributed to the overall similarity in outcomes between the two strategies.

Our study found a higher incidence of contrast-induced nephropathy in the multivessel PCI group, which has been reported in previous literature. Mehran et al. identified multivessel PCI as a risk factor for contrast-induced nephropathy due to the increased volume of contrast media used during the procedure (11). This finding underscores the need for careful patient selection and contrast management strategies to minimize the risk of nephropathy, particularly in populations with a high prevalence of diabetes and renal impairment (12).

The longer hospital stays observed in the multivessel PCI group may be attributed to the increased procedural complexity and the higher rate of complications. Studies have shown that procedural time and complexity are significant predictors of hospital length of stay (13). Our results highlight the importance of optimizing procedural efficiency and managing complications to reduce hospital resource utilization and improve patient outcomes (14).

The findings of this study have several implications for clinical practice. First, they support the use of both multivessel and staged PCI as viable strategies for managing complex coronary artery disease, with the choice of strategy tailored to individual patient characteristics and risk profiles (15). Second, they emphasize the importance of minimizing procedural complications through careful patient selection, contrast management, and post-procedural care (16). Third, they highlight the need for ongoing monitoring and follow-up to manage the long-term risks associated with both PCI strategies (17).

Future research should focus on prospective randomized controlled trials to confirm these findings and explore the underlying mechanisms driving the observed differences in procedural complications (18). Additionally, studies should investigate the long-term outcomes of multivessel versus staged PCI in diverse populations, considering genetic, environmental, and socioeconomic factors (19). Research into novel strategies for reducing procedural complications and optimizing patient outcomes is also warranted (20).

Limitations

This study has several limitations. First, its retrospective design may introduce selection bias, and the results may not be generalizable to all patient populations. Second, the study was conducted at a single center, which may limit the applicability of the findings to other settings. Third, the follow-up period was limited to six months, and longer-term outcomes were not assessed. Finally, data on potential confounders, such as medication adherence and lifestyle factors, were unavailable. Future studies should address these limitations by employing prospective designs, multi-center collaborations, and extended follow-up periods.

Conclusion

In conclusion, our study found no significant differences in mortality and MACE between multivessel and staged PCI in Pakistani patients with complex coronary artery disease. However, multivessel PCI was associated with a higher incidence of procedural complications, such as contrast-induced nephropathy and longer hospital stays. These findings highlight the need for personalized treatment strategies and careful management of procedural risks to optimize patient outcomes. Future research should focus on confirming these results in larger, more diverse populations and investigating strategies to reduce procedural complications and improve long-term outcomes.

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