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ORIGINAL ARTICLE

Clinical Outcomes of PCI in patients with Multivessel CAD

ABDUL BASIT[1], SHAHBAZ ALI SHAIKH[2], ROOMANA KHAWAJA KHAIL[3], SYED KASHIF UR REHMAN[4], AZIZ ULLAH[5], HAFSA[6]
[1]*Consultant Cardiologist, Hayatabad Medical Complex, Peshawar*
[2]*Assistant Professor Cardiology SICVD, Nawab Shah*
[3]*Fellow Electrophysiology Hayatabad Medical Complex, Peshawar*
[4]*Postgraduate Resident, Hayatabad medical Complex, Peshawar*
[5]*Fellow Adult Cardiology NICVD, Karachi*
[6]*Resident Adult Cardiology Hayatabad Medical Complex, Peshawar*
Correspondence to: Aziz Ullah, Email: drazizullahkakar@gmail.com

ABSTRACT

Objective: To determine the clinical outcomes of percutaneous coronary intervention in patients with multivessel coronary artery disease at a tertiary care hospital in Peshawar.

Methodology: This retrospective descriptive study was conducted in the Department of Cardiology, tertiary care hospital, Peshawar, from June 2022 to May 2023. A total of 130 patients with multivessel coronary artery disease who underwent PCI were included through non-probability consecutive sampling. Data were collected from hospital records and analysed using SPSS version 26. Frequencies, percentages, mean and standard deviation were calculated. Chi-square test and independent sample t-test were applied, and a p-value of less than 0.05 was considered significant.

Results: Among 130 patients, 86(66.2%) were male and 44(33.8%) were female. The mean age was 59.35±9.64 years. Major adverse cardiac events occurred in 31(23.8%) patients. In-hospital death was recorded in 7(5.4%) patients, post-PCI myocardial infarction in 10(7.7%), stroke in 5(3.8%), repeat revascularisation in 12(9.2%), stent thrombosis in 4(3.1%), bleeding in 8(6.2%), contrast induced nephropathy in 15(11.5%) and heart failure after PCI in 13(10.0%). PCI strategy was not significantly associated with MACE (p=0.150), while contrast induced nephropathy (p=0.033), higher contrast volume (p=0.001) and higher heart rate (p=0.044) were significantly linked with worse outcomes.

Conclusion: PCI showed acceptable outcomes in multivessel coronary artery disease, but MACE remained clinically important. Renal protection, contrast reduction and close follow-up should be prioritised.

Keywords: Percutaneous Coronary Intervention, Coronary Artery Disease, Multivessel Coronary Disease, Major Adverse Cardiac Events, Contrast Media.

INTRODUCTION

Coronary artery disease is one of the main causes of illness and death across the world. A large number of patients who come for percutaneous coronary intervention have disease in more than one coronary artery. This is called multivessel coronary artery disease. These patients are often at higher risk of death, repeat heart attack, heart failure, repeat hospital stay and repeat revascularisation after PCI[1,2].

Multivessel coronary artery disease is common in patients with acute coronary syndrome. It is also seen in patients with stable angina. In this condition, more than one major coronary artery has important narrowing. This makes treatment more difficult. The doctor must decide whether to treat only the culprit artery or to treat all important blocked arteries[3,4].

PCI has improved a lot in recent years. Better stents, better antiplatelet drugs and safer catheterisation techniques have improved patient outcomes. Still, patients with multivessel disease remain a difficult group. They often have diabetes, hypertension, chronic kidney disease or poor left ventricular function. These factors can increase complications after PCI[5,6].

Recent trials have shown that complete revascularisation can reduce future cardiovascular events in selected patients with multivessel disease. The complete trial showed that treating important non culprit lesions after primary PCI reduced cardiovascular death and myocardial infarction in STEMI patients[7]. Later studies also showed better control of angina and fewer repeat procedures after complete revascularisation[8].

The timing of PCI is still debated. Some patients may benefit from complete PCI during the same admission. Others may need staged PCI after clinical stabilisation. The BIOVASC trial showed that immediate complete revascularisation was not inferior to staged PCI in acute coronary syndrome patients with multivessel disease[9]. The MULTISTARS AMI trial also supported immediate PCI in selected stable STEMI patients[10].

Physiology guided PCI has also become important. Fractional flow reserve can help decide whether a narrowing is truly causing poor blood flow. The FLOWER MI trial did not show clear superiority of FFR guided PCI over angiography guided PCI[11]. However, the FRAME AMI and FIRE studies suggested that physiology guided complete revascularisation may improve outcomes in some patients, especially older patients and those with acute myocardial infarction[12,13].

Guidelines now support a patient centred approach. The 2021 ACC AHA SCAI guideline and the 2023 ESC acute coronary syndrome guideline advise that revascularisation strategy should consider disease complexity, diabetes, left main disease, bleeding risk, kidney function and patient stability[14,15]. In complex triple vessel disease, CABG may still be preferred in some patients, but PCI remains a common and practical option in many hospitals.

Evidence from registries and meta analyses also supports the value of complete revascularisation in suitable patients. Studies from 2019 to 2023 showed lower repeat revascularisation and fewer major adverse cardiac events in many patients who had more complete treatment of diseased vessels[16,17]. Yet the benefit is not the same for every patient. The risk of contrast nephropathy, long procedure time, bleeding and stent related problems must be considered[18].

In Pakistan, the burden of coronary artery disease is high and patients often present late. Many patients have diabetes, smoking history, hypertension and poor control of risk factors. Local studies from Pakistan have reported a high frequency of multivessel disease among patients undergoing PCI, including patients treated at tertiary care hospitals in Karachi, Rawalpindi and Peshawar[19,20].

A Pakistani study from Rawalpindi reported better outcomes with FFR guided PCI compared with angiography guided PCI in patients with multivessel coronary artery disease[21]. Another study from Peshawar compared multivessel PCI with staged PCI in complex coronary disease and highlighted the need for local outcome data[22]. These findings are important because local patients may differ from Western trial populations in age, risk profile, access to care and follow up.

In the Department of Cardiology, tertiary care hospital Peshawar, many patients undergo PCI for multivessel coronary artery disease. Local evidence is still limited. Most large trials come from Europe, North America or East Asia. Their results may not fully

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reflect outcomes in our setting. This creates a clear need to study clinical outcomes after PCI in our own patients.

The rationale of this study is to assess real world outcomes of PCI in patients with multivessel coronary artery disease in a tertiary care hospital in Peshawar. This study may help improve local decision making, patient counselling and follow up planning. The objective of this study is to determine the clinical outcomes of PCI in patients with multivessel coronary artery disease presenting to the Department of Cardiology, tertiary care hospital Peshawar.

MATERIALS AND METHODS

Study design: This was a retrospective descriptive study. It was carried out to assess the clinical outcomes of PCI in patients with multivessel coronary artery disease.

Setting and duration: The study was conducted in the Department of Cardiology, tertiary care hospital, Peshawar. The study period was from June 2022 to May 2023.

Sample size and sampling technique: The sample size was calculated by using the WHO sample size formula for prevalence studies, $n = Z^2 P(1-P)/d^2$. The confidence level was kept at 95%. The value of Z was 1.96. The expected proportion was taken as 68.3%, based on a previous study in which complete revascularisation was achieved in 68.3% of patients with multivessel coronary artery disease undergoing PCI[1]. The margin of error was kept at 8%. The calculated sample size was 130 patients. Non-probability consecutive sampling was used. All eligible patients during the study period were included until the required sample size was completed.

Inclusion and exclusion criteria: Patients of either sex, aged 18 years or above, who had multivessel coronary artery disease and underwent PCI during the study period were included. Multivessel coronary artery disease was defined as significant stenosis in two or more major epicardial coronary arteries. Patients with incomplete hospital records, previous CABG, isolated single vessel disease, severe valvular heart disease, cardiogenic shock before PCI, and those who were lost to follow up were excluded from the study.

Data collection procedure: Data were collected from hospital records, catheterisation laboratory registers, discharge files and follow up notes. A structured proforma was used. Information was recorded for age, sex, diabetes, hypertension, smoking, dyslipidaemia, clinical presentation, left ventricular ejection fraction, number of diseased vessels, culprit vessel, number of stents, type of PCI, hospital stay and clinical outcomes. No randomisation or blinding was done because this was a retrospective study.

Definitions and study variables: The main outcome was major adverse cardiac events. It included death, myocardial infarction, repeat revascularisation and stroke during hospital stay or follow up. Procedural success was defined as successful stent placement with final TIMI III flow and no major in-hospital complication. Bleeding was recorded if it was documented in the clinical file. Contrast induced nephropathy was defined as a rise in serum creatinine after PCI, as recorded in the hospital record.

Medication: Patients received standard treatment according to hospital protocol. This included aspirin, clopidogrel or ticagrelor, statins, beta blockers, ACE inhibitors or ARBs, nitrates and anticoagulation when indicated. The choice of medicine depended on the patient's clinical condition and treating cardiologist's decision.

Handling of missing data: Missing data were checked before analysis. Files with missing key outcome data were excluded. For minor missing variables, available case analysis was used. No assumed values were entered. This was done to keep the results transparent and reliable.

Statistical analysis: Data were analysed using SPSS version 26. Mean and standard deviation were calculated for continuous variables such as age and hospital stay. Frequency and percentage were calculated for categorical variables such as sex, diabetes, hypertension, smoking, vessel involvement and outcomes. The chi-square test was used to compare categorical variables. The independent sample t-test was used for continuous variables where required. A p-value of less than 0.05 was taken as statistically significant.

Ethical considerations: Approval was obtained from the Ethical and Research Committee of the institute before data collection. As this was a retrospective record based study, no direct patient contact was made. Patient names and hospital registration numbers were kept confidential. Informed consent was not required because only past hospital records were reviewed. No animal subjects were involved in this study.

RESULTS

A total of 130 patients with multivessel coronary artery disease who underwent PCI were included in the analysis. The study period was from June 2022 to May 2023. The results are presented in the same order as the study objective and the methods. Continuous data are shown as mean±standard deviation, while categorical data are shown as frequency with percentage. A p-value of less than 0.05 was considered statistically significant.

Table 1 shows the demographic profile and main baseline clinical features of the patients. The mean age was 59.35±9.6447 years. There were 86(66.2%) males and 44(33.8%) females. Hypertension was the most common comorbidity and was present in 71(54.6%) patients, followed by dyslipidaemia in 56(43.1%) patients and diabetes mellitus in 47(36.2%) patients.

Table 2 presents the clinical presentation, angiographic profile and PCI related features. STEMI was the most common presentation and was seen in 48(36.9%) patients. Two vessel disease was present in 84(64.6%) patients and three vessel disease was present in 46(35.4%) patients. Culprit only PCI was performed in 52(40.0%) patients, multivessel PCI in 47(36.2%) patients and staged PCI in 31(23.8%) patients. Procedural success was achieved in 126(96.9%) patients.

Figure 1 shows the distribution of PCI strategy in the study population. Culprit only PCI was the most frequent approach, followed by multivessel PCI and staged PCI.

Table 3 shows the clinical outcomes after PCI. MACE occurred in 31(23.8%) patients, with a 95% confidence interval of 17.3% to 31.9%. Repeat revascularisation was noted in 12(9.2%) patients, myocardial infarction after PCI in 10(7.7%) patients and in-hospital death in 7(5.4%) patients. These findings show that most patients had a good short term outcome, but almost one in four patients had at least one adverse cardiac event.

Figure 2 displays the frequency of the main clinical outcomes. MACE was the most common combined outcome, while heart failure after PCI, bleeding and repeat revascularisation were the leading individual events.

Table 4 shows the association between selected clinical and procedural variables and MACE. PCI strategy was not significantly associated with MACE, $\chi^2 = 3.791$, $p = 0.150$. Complete revascularisation was also not significantly associated with MACE, $\chi^2 = 0.753$, $p = 0.385$. This means that, in this dataset, the type of PCI strategy alone did not clearly separate patients with and without adverse events.

Contrast induced nephropathy was significantly associated with MACE, $\chi^2 = 4.526$, $p = 0.033$. Clinically, this suggests that patients who developed renal injury after contrast exposure had a higher risk of poor cardiac outcomes. Access site showed a near significant association with MACE, $\chi^2 = 3.478$, $p = 0.062$, but this did not reach the usual level of statistical significance.

Independent sample t-tests were used for continuous variables, as described in the methodology. Heart rate was higher in patients with MACE compared with those without MACE, 86.58±14.5001 versus 80.31±15.6359 beats per minute, $p = 0.044$. Contrast volume was lower in patients with MACE compared with those without MACE, 150.90±48.3331 mL versus 185.31±53.6426 mL, $p = 0.001$. Age, BMI, systolic blood pressure, LVEF, baseline creatinine, haemoglobin, SYNTAX score and length of hospital stay were not statistically significant at $p < 0.05$.

Confounding variables were reviewed by comparing MACE across age related clinical features, sex, diabetes mellitus, hypertension, chronic kidney disease, clinical presentation, LVEF group, number of diseased vessels, left main disease, timing of PCI

and access site. None of these variables showed a statistically significant association with MACE, except contrast induced nephropathy. The main objective of assessing clinical outcomes after PCI in multivessel coronary artery disease was therefore met, with MACE recorded in 31(23.8%) patients and procedural success achieved in 126(96.9%) patients.

Table 1. Demographic and baseline clinical characteristics of patients (n = 130)

Variable	Result
Total patients	130(100.0%)
Age (years)	59.35±9.6447
Male sex	86(66.2%)
Female sex	44(33.8%)
Body mass index (kg/m²)	26.69±3.7128
Smoking or ex-smoker	20(15.4%)
Diabetes mellitus	47(36.2%)
Hypertension	71(54.6%)
Dyslipidaemia	56(43.1%)
Chronic kidney disease	13(10.0%)
LVEF (%)	46.72±9.9059

Table 2. Clinical presentation, angiographic findings and procedural characteristics (n = 130)

Variable	Result
STEMI	48(36.9%)
NSTEMI	41(31.5%)
Unstable angina	20(15.4%)
Stable angina	21(16.2%)
Two vessel disease	84(64.6%)
Three vessel disease	46(35.4%)
Culprit only PCI	52(40.0%)
Multivessel PCI	47(36.2%)
Staged PCI	31(23.8%)
Complete revascularisation	57(43.8%)
Left main disease	13(10.0%)
Procedural success	126(96.9%)
Radial access	110(84.6%)
SYNTAX score	22.19±7.2921
Contrast volume (mL)	177.11±54.2770

Figure 1. Distribution of PCI strategy

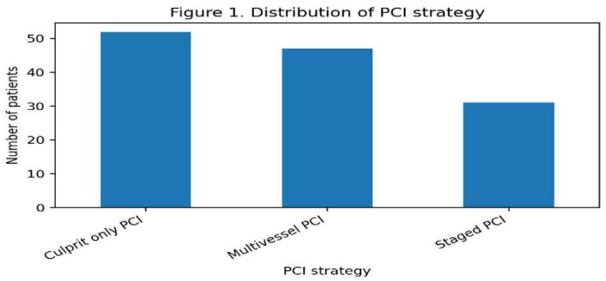

Table 3. Clinical outcomes after PCI with 95% confidence intervals (n = 130)

Outcome	Frequency (%)	95% CI
MACE	31(23.8%)	17.3–31.9
Death	7(5.4%)	2.6–10.7
MI after PCI	10(7.7%)	4.2–13.6
Stroke	5(3.8%)	1.7–8.7
Repeat revascularisation	12(9.2%)	5.4–15.4
Stent thrombosis	5(3.8%)	1.7–8.7
Bleeding	13(10.0%)	5.9–16.4
CIN	11(8.5%)	4.8–14.5
Heart failure	17(13.1%)	8.3–19.9

Figure 2. Clinical outcomes after PCI

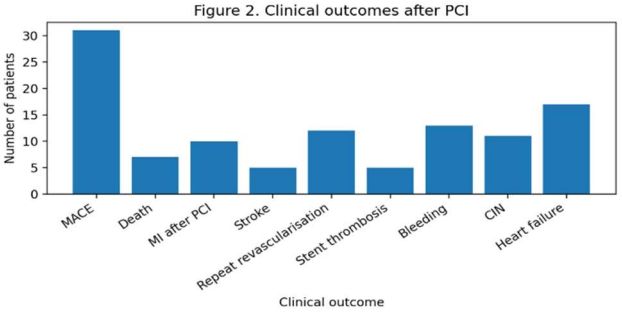

Table 4. Crosstab and chi-square analysis of selected variables with MACE

Variable	MACE Yes by category	χ^2	df	p-value
PCI strategy	Culprit only PCI: 17(32.7%); Multivessel PCI: 8(17.0%); Staged PCI: 6(19.4%)	3.791	2	0.150
Complete revascularisation	No: 20(27.4%); Yes: 11(19.3%)	0.753	1	0.385
Timing of PCI	Index admission: 25(25.3%); Staged during follow-up: 6(19.4%)	0.186	1	0.667
Access site	Femoral: 1(5.0%); Radial: 30(27.3%)	3.478	1	0.062
Contrast induced nephropathy	No: 25(21.0%); Yes: 6(54.5%)	4.526	1	0.033
Clinical presentation	NSTEMI: 8(19.5%); STEMI: 14(29.2%); Stable angina: 5(23.8%); Unstable angina: 4(20.0%)	1.335	3	0.721
Diabetes mellitus	No: 20(24.1%); Yes: 11(23.4%)	0.000	1	1.000
Chronic kidney disease	No: 26(22.2%); Yes: 5(38.5%)	0.922	1	0.337
LVEF group	40-49%: 10(20.8%); <40%: 9(28.1%); ≥50%: 12(24.0%)	0.563	2	0.755

DISCUSSION

The present study assessed clinical outcomes of PCI in 130 patients with multivessel coronary artery disease at a tertiary care hospital in Peshawar. The key finding was that major adverse cardiac events occurred in 31(23.8%) patients. In-hospital death was seen in 7(5.4%) patients, post-PCI myocardial infarction in 10(7.7%) patients and repeat revascularisation in 12(9.2%) patients. These findings show that PCI was a useful treatment option, but the risk of adverse outcomes remained important in this group of patients.

The rate of MACE in this study was clinically important. Large trials have shown that patients with multivessel coronary artery disease have a higher risk of future cardiac events, especially when important non-culprit lesions remain untreated. In the complete trial, complete revascularisation reduced cardiovascular death and myocardial infarction in patients with STEMI and multivessel disease[1]. Our study did not show a significant association between PCI strategy and MACE. This may be due to the smaller sample size, retrospective design and mixed clinical presentation of patients.

Complete revascularisation was not significantly linked with MACE in the present study. This finding was different from several international studies. The BIOVASC trial found that immediate complete revascularisation was not inferior to staged revascularisation in acute coronary syndrome patients with multivessel disease[3]. The MULTISTARS AMI trial also supported immediate multivessel PCI in selected stable STEMI patients[4]. In our setting, the effect of complete revascularisation may have been influenced by renal risk, lesion complexity, late presentation and follow-up differences.

Physiology-guided PCI has been studied widely in patients with multivessel coronary artery disease. The FLOWER-MI trial found no clear superiority of FFR-guided PCI over angiography-guided PCI in myocardial infarction patients with multivessel disease[2]. Other recent studies have suggested that FFR-guided strategies may help select lesions more carefully in some patients[5]. In Pakistan, Khan et al. also reported that FFR-guided PCI may improve decision-making in multivessel coronary artery disease[10]. In the present study, FFR data were not available for all patients, so its effect could not be assessed properly.

Contrast induced nephropathy was significantly associated with MACE in this study. This was an important clinical finding. It shows that kidney injury after PCI was not only a laboratory issue, but was linked with worse patient outcomes. This finding agrees with previous evidence showing that contrast related kidney injury after PCI increases morbidity, hospital stay and adverse cardiac events[17]. It supports careful renal assessment before PCI, use of lower contrast volume and close monitoring of serum creatinine after the procedure.

Higher contrast volume was also significantly associated with MACE. This is understandable because multivessel PCI often needs longer procedure time, more angiographic views and treatment of more than one vessel. Previous research has shown that contrast volume is a modifiable risk factor for contrast associated acute kidney injury after PCI[18]. This has practical value in our hospital setting. Patients with chronic kidney disease, diabetes, older age or low ejection fraction may benefit from staged PCI or contrast saving techniques.

Heart rate was significantly higher among patients who developed MACE. This may reflect pain, anxiety, heart failure, ongoing ischaemia or poor haemodynamic reserve. A raised heart rate after PCI should not be ignored, especially in patients with multivessel disease. It may help identify patients who need closer observation, better symptom control and careful use of beta blockers when suitable. This finding also supports stronger post-PCI monitoring in the first few days after the procedure.

Diabetes, hypertension, chronic kidney disease, sex, age group, LVEF group, number of diseased vessels and left main disease were not significantly associated with MACE in this study. This does not mean that these factors were unimportant. International guidelines clearly state that these factors should be considered when planning revascularisation[7,8,9]. The non-significant results in the present study may be due to the sample size, short follow-up period and limited number of events.

The findings of this study were generally in line with international guidelines. The 2023 ESC guideline recommends that revascularisation decisions in acute coronary syndrome should consider clinical stability, coronary anatomy, comorbidities and procedural risk[7]. The 2021 ACC/AHA/SCAI guideline also supports an individualised approach, especially in patients with diabetes, complex coronary disease or left main involvement[8]. The present study supports this approach, as procedural and renal factors were more important than PCI strategy alone.

Similar work has been reported from other countries. European and North American trials have compared culprit only PCI, complete PCI, immediate PCI, staged PCI and physiology guided PCI[1,2,3,4,5,6]. These trials helped shape modern practice, but their patients were usually selected under strict trial conditions. Our study reflects real-world practice in Peshawar, where patients may present late and may have uncontrolled risk factors, limited affordability and variable follow-up.

In Pakistan, similar work has been reported, but the evidence is still limited. Local studies have assessed multivessel disease in STEMI, PCI outcomes, incomplete revascularisation and SYNTAX score based risk assessment[10,15,16]. However, fewer studies have focused on real-world clinical outcomes of PCI in multivessel coronary artery disease from tertiary care hospitals in Khyber Pakhtunkhwa. This gives the present study local value.

The originality of this study lies in its local setting and practical focus. It was conducted in the Department of Cardiology at a tertiary care hospital in Peshawar. It included patients treated in routine clinical practice, not under strict trial conditions. The study highlights local outcome patterns after PCI and shows that contrast induced nephropathy, contrast volume and heart rate need special attention in patients with multivessel coronary artery disease.

These findings may influence clinical decision-making. Patients with high renal risk may need hydration, contrast reduction, careful drug review and follow-up renal function testing. Patients needing complex multivessel PCI may benefit from planned staged PCI rather than a long single sitting procedure. Patients with raised heart rate after PCI may need closer observation and early review for pain, heart failure, recurrent ischaemia or medication adjustment.

This study had some limitations. It was retrospective, so it depended on the quality of hospital records. It was a single-centre study with 130 patients, so the findings may not represent all hospitals in Pakistan. Follow-up was limited, and long-term outcomes such as one-year mortality, late stent thrombosis and late repeat revascularisation were not fully assessed. FFR, IVUS, OCT and medication adherence data were also not available for all patients.

Future studies should be prospective and multicentre. They should include longer follow-up and compare culprit only PCI, immediate complete PCI and staged PCI in Pakistani patients. Future research should also include SYNTAX score groups, FFR or IVUS guided PCI, renal protection protocols and adherence to dual antiplatelet therapy. This would help develop stronger local evidence for managing multivessel coronary artery disease in Pakistan.

In conclusion, PCI in patients with multivessel coronary artery disease showed acceptable but clinically important adverse outcomes in this local tertiary care setting. MACE occurred in 31(23.8%) patients. Contrast induced nephropathy, higher contrast volume and higher heart rate were the main findings linked with worse outcomes. These results support careful patient selection, renal protection, contrast reduction and structured follow-up after PCI.

CONCLUSION

This study showed that PCI in patients with multivessel coronary artery disease had acceptable clinical outcomes, but adverse events were still common. MACE occurred in 31(23.8%) patients, with in-hospital death in 7(5.4%), post-PCI myocardial infarction in 10(7.7%) and repeat revascularisation in 12(9.2%). Contrast induced nephropathy, higher contrast volume and higher heart rate were linked with worse outcomes. These findings support careful patient selection, renal protection, contrast reduction and close follow-up after PCI. Larger multicentre prospective studies are recommended to confirm these findings and guide local clinical practice in Pakistan.

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