DOI: https://doi.org/10.70749/ijbr.v3i7.1776

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://ijbr.com.pk
ISSN: 2960-2793/ 2960-2807

Prevalence of Multivessel Coronary Artery disease in Patients Undergoing Primary Percutaneous Coronary Intervention for Acute ST-Elevation Myocardial Infarction at A Tertiary Care Hospital

Mohib Ullah Khan[1], Tariq Rahim[2], Kashif Ali Khan[2], Jawad Ahmad[2], Syed Muzammil Shah[2], Tariq Shah[2], Hamad Ali Shah[2]

[1]Department of Cardiology, Lady Reading Hospital, Peshawar, Pakistan

ARTICLE INFO

Keywords: Multivessel coronary artery disease, STEMI, primary PCI, prevalence, Pakistan.

Correspondence to: Tariq Rahim, Department of Cardiology, Lady Reading Hospital, Peshawar, Pakistan.
Email: tariqsohana.88@gmail.com

Declaration

Authors' Contribution: All authors equally contributed to the study and approved the final manuscript.

Conflict of Interest: No conflict of interest.

Funding: No funding received by the authors.

Article History

Received: 04-06-2025 Revised: 25-06-2025
Accepted: 07-07-2025 Published: 15-07-2025

ABSTRACT

Background: Multivessel coronary artery disease (MCAD) substantially influences the clinical outcomes of patients with ST-segment elevation myocardial infarction (STEMI) who undergo primary percutaneous coronary intervention (PPCI). Nevertheless, data on the prevalence and clinical characteristics of multivessel disease in the Pakistani population are limited to a few studies. **Objective:** This study aimed to quantify the prevalence of MCAD in patients with STEMI undergoing PPCI and to identify the patient characteristics associated with MCAD at Lady Reading Hospital, Peshawar, Pakistan. **Methods:** This retrospective cohort study comprised of 450 consecutive patients diagnosed with acute STEMI who underwent PPCI at the Lady Reading Hospital in Peshawar between January and May 2025. Multivessel disease (MVD) was characterized by the presence of ≥70% stenosis in at least two major epicardial vessels or (≥50%) stenosis in the left main artery (LMA) in conjunction with one other vessel. This study analysed the clinical and angiographic findings. **Results:** The mean age of the study population was categorized as (53.4 ± 9.7) years, with a male predominance of 56.4%. (MCAD) was identified in 305 patients, accounting for 67.8% (95% CI: 63.5-72.1%) of the cohort. Patients diagnosed with MCAD were significantly noted older, having a mean age of (54.3 ± 10.0) compared to (51.4 ± 8.7) years in those without MCAD (P =0.003). The prevalence of diabetes mellitus (52.1% vs. 28.3%, P <0.001), hypertension (60.7% vs. 48.3%, P =0.018), and current smoking (35.1% vs. 20.7%, P =0.003) was predominantly higher in the MCAD group. Independent predictors of MVD included diabetes mellitus (OR 2.89, 95% CI: 1.78-4.29), current smoking (OR 2.07, 95% CI: 1.18-3.03), and hypertension (OR 1.76, 95% CI: 1.12-2.44). **Conclusion:** The incidence of MCAD among STEMI patients undergoing PPCI at our tertiary care centre in Pakistan was 67.8%, surpassing that in Western populations. Diabetes mellitus, smoking, and hypertension were the strongest predictors of MVD.

INTRODUCTION

ST-elevation myocardial infarction (STEMI) is acute coronary syndrome, characterized by abrupt thrombotic occlusion of an epicardial coronary artery, leading to transmural ischemia and ST-segment elevation on electrocardiography. Immediate reperfusion is crucial for minimizing infarct size, maintaining left ventricular function, and improving survival rates, highlighting the need for prompt intervention. Primary percutaneous coronary intervention (PPCI) is considered acceptable reperfusion procedure when the door-to-balloon time is < 90 min (Ibanez et al. 2018).

Multivessel coronary artery disease (MCAD), characterized by ≥70% stenosis in at least two major epicardial vessels or (≥50%) stenosis in the left main artery along with one other vessel, presents a complex clinical scenario that significantly influences both immediate management strategies and long-term prognosis (Mehta et al. 2019). International registries report MCAD prevalence rates ranging from 40-65% in STEMI populations, with recent data from Asia indicating rates as high as 74%. The existence of multivessel disease in patients with STEMI has profound clinical implications, as these patients consistently exhibit worse short- and long-term outcomes than those with single-vessel disease, including increased mortality rates, recurrent myocardial infarction, and a greater need for revascularization procedures (Mamtani et al. 2022).

The prevalence of MCAD in patients with STEMI undergoing PPCI is a crucial determinant of patient outcomes and healthcare resource management. Despite its importance, regional data on the prevalence of MCAD

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during PPCI are limited, particularly in Khyber Pakhtunkhwa, Pakistan. Understanding the local frequency of MCAD is essential for effective resource allocation, optimisation of catheterisation laboratory workflows, and informed clinical decision making. This knowledge has broader implications for patient outcomes, potentially contributing to the improved management of STEMI cases with MCAD, thereby enhancing survival rates and reducing complications in high-risk patient populations (Trends of coronary artery disease in khyber pakhtunkhwa, pakistan: A retrospective study 2019).

This study aimed to evaluate this significant gap in knowledge by assessing the local prevalence of MCAD in patients with STEMI who already underwent PPCI in Khyber Pakhtunkhwa province.

METHODOLOGY

This retrospective cohort study examined consecutive cases of (STEMI) managed through PPCI at Lady Reading Hospital, Peshawar, Pakistan. The study period was from 1 January 2025 to 30 May 2025.

The study population included individuals aged (≥18 years) with a diagnosis of STEMI who underwent PPCI within 12 h of the onset of symptoms. STEMI was diagnosed based on clinical symptoms indicative of myocardial infarction and electrocardiographic evidence of ST-segment elevation (≥1 mm) in two contiguous leads or having a new left bundle branch block. A consecutive non-probability sampling method was used for all eligible cases recorded in the catheterization laboratory database. The expected prevalence, 55%, (95% confidence level), with absolute precision (5%) was calculated using Cochran's formula for sample size. The calculated sample size was 380 patients. To account for potentially incomplete records and missing data, the target sample size was adjusted to 440 patients, with a total of 450 patients ultimately being included.

The inclusion criteria were that patients with a diagnosis of STEMI, those who underwent primary PCI within symptom onset duration of (12 h), individuals with complete angiographic data available, and patients aged ≥ 18 years, were included in this study.

The exclusion criteria were those individuals with history of prior PCI or coronary artery bypass grafting, administration of thrombolytic therapy prior to transfer, presence of significant valvular disease, cardiogenic shock at presentation, and incomplete medical records that impeded comprehensive analysis.

Data were systematically extracted from electronic medical records using a standardised case report form. Multivessel coronary artery disease was characterised by stenosis of ≥70% in at least two major epicardial coronary arteries (left anterior descending (LAD), left circumflex (LCF), and right coronary arteries (RCA) or stenosis of (≥50%) in the left main coronary artery (LMC) accompanied by at least one other vessel with (≥70%) stenosis, as determined through visual angiographic assessment by experienced interventional cardiologists.

The fundamental demographic characteristics encompassed body mass index, age, gender and cardiovascular risk factors such as diabetes, hypertension, smoking, obesity, and a familial predisposition to premature heart disease.

Categorical variables were determined through Descriptive statistics. The primary outcome was the prevalence of MCAD, with a 95% CI. Chi-square tests and t-tests were employed for categorical variables and continuous variables. Logistic regression analysis was performed to identify predictors of multivessel disease, incorporating variables with P-values less than 0.25 from the initial analysis. All analysis were processed through SPSS(*v*-29).

This study was approved by the Ethics Review Committee of Lady Reading Hospital and Khyber Medical University. Owing to its retrospective nature and use of de-identified records, informed consent was waived per institutional policies. The data were securely stored with password protection and restricted access.

RESULTS

Baseline Characteristics

During the study period, 450 patients with acute STEMI underwent PCI, fulfilling the inclusion criteria were investigated. The mean age of the cohort was 53.4 ± 9.7 years, with an age range of 35 to 75 years, and 254 (56.4%) patients were men. The demographic profile indicates a relatively younger population than that in Western studies, aligning with the established pattern of premature coronary artery disease observed in South Asian populations.

Table 1

Baseline Characteristics by Multivessel Disease Status

Variable (mean ± SD)	Overall (n=450)	MVD (n=305)	SVD (n=145)	p-value
Age (years)	53.4 ± 9.7	54.3 ± 10.0	51.4 ± 8.7	0.003
Male gender, n (%)	254 (56.4)	170 (55.7)	84 (57.9)	0.736
BMI (kg/m^2)	24.7 ± 4.5	24.7 ± 4.7	24.7 ± 4.1	0.939
Weight (kg)	69.4 ± 11.0	69.5 ± 11.1	69.2 ± 10.8	0.817

MVD = Multivessel disease; SVD = Single-vessel disease; CAD = coronary artery disease

The study cohort comprised numerous individuals exhibiting risk factors for cardiovascular disease. Specifically, diabetes mellitus was identified in 200 patients (44.4%), hypertension in 255 patients (56.7%), current smoking in 137 patients (30.4%), obesity in 265 patients (58.9%), and family history of heart disease in 290 patients (64.4%), while mean body mass index was calculated as 24.7 ± 4.5 kg/m^2.

Table 2

Cardiovascular Risk Factors

Variable, n (%)	Overall (n=450)	MVD (n=305)	SVD (n=145)	p-value<
Diabetes mellitus	200 (44.4)	159 (52.1)	41 (28.3)	0.001
Hypertension,	255 (56.7)	185 (60.7)	70 (48.3)	0.018
Current smoking,	137 (30.4)	107 (35.1)	30 (20.7)	0.003
Obesity,	69.4 ± 11.0	69.5 ± 11.1	69.2 ± 10.8	0.817
Family history CAD	290 (64.4)	205 (67.2)	85 (58.6)	0.094

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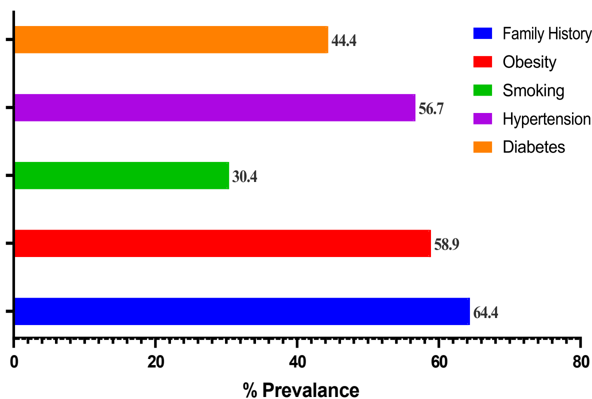
Figure 1

Prevalence of Cardiovascular Risk Factors among 450 Stemi Patients Undergoing Ppci at Lady Reading Hospital, Peshawar



Prevalence of Multivessel Coronary Artery Disease

In a cohort of 305 patients, MCAD was identified, indicating a prevalence of 67.8% (95% confidence interval: 63.5-72.1%). This prevalence is among the highest recorded for MVD in patients with STEMI globally and significantly surpasses previously reported rates in both the international literature and earlier studies conducted in Pakistan.

Angiographic Findings

The distribution of culprit vessels indicated involvement of the left anterior descending artery in 206 patients (45.8%), right coronary artery in 157 patients (34.9%), and left circumflex artery in 87 patients (19.3%).

Table 3

Tabular Data of Angiographic Findings

Variable	Overall (n=450)	MVD (n=305)	SVD (n=145)	p-value
Culprit Vessel, n (%):				
Left anterior descending	206 (45.8)	142 (46.6)	64 (44.1)	0.623
Right coronary artery	157 (34.9)	104 (34.1)	53 (36.6)	
Left circumflex	87 (19.3)	59 (19.3)	28 (19.3)	

Out of the 305 patients diagnosed with MVD, the majority presented with two-vessel disease, while the remainder exhibited three-vessel disease.

Multivessel vs Single-Vessel Disease

Patients with MVD exhibited significantly different clinical characteristics from those with SVD. The MVD cohort was notably older, with a mean age of 54.3 ± 10.0 years, in contrast to 51.4 ± 8.7 years in the SVD cohort (P =0.003). The distribution of cardiovascular risk factors exhibited significant disparities between the groups. Diabetes mellitus was observed in 159 (52.1%) patients with MVD, in contrast to 41 (28.3%) patients with SVD (P <0.001). Hypertension was more prevalent among the MVD, affecting 185 (60.7%) individuals, than in the SVD group (70 [48.3 %]) (P =0.018). Additionally, current smoking was significantly more common in patients with MVD (107 [35.1 %]) than in those with single-vessel disease (30 [20.7 %]) (p=0.003).

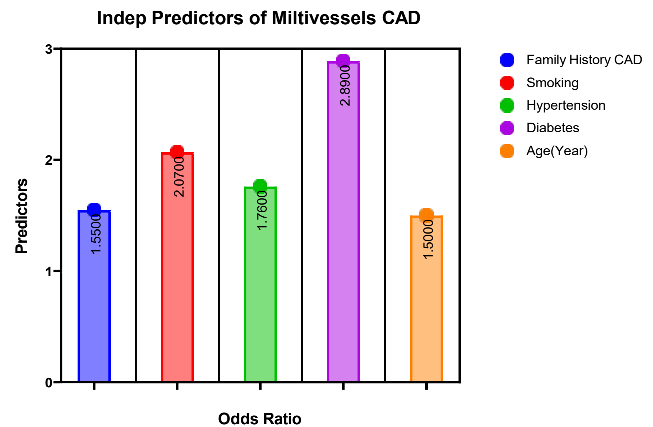
The sex distribution was comparable between the groups, with a predominance of males in both the MVD (55.7%) and SVD (57.9%) cohorts (P =0.736). Additionally, there was no significant difference in the body mass index between the groups (24.7 ± 4.7 vs. 24.7 ± 4.1 kg/m^2, p=0.939).

Independent Predictors of Multivessel Disease

Multivariable logistic regression analysis identified several independent predictors of MCAD. Diabetes mellitus emerged as the most significant predictor, with patients exhibiting nearly three-fold increased odds compared with non-diabetic individuals (OR 2.89, 95% CI: 1.78-4.29, p<0.001). Current smoking was associated with more than a two-fold increase in odds (OR 2.07, 95% CI: 1.18-3.03, p=0.008), whereas hypertension demonstrated a 76% increase in odds (OR 1.76, 95% CI: 1.12-2.44, p=0.012). Additionally, age per year (OR 1.50, p=0.008) and a family history of coronary artery disease (OR 1.55, 95% CI: 0.96-2.13, p=0.078) were associated with PVD, although the latter did not achieve statistical significance.

Figure 2

Nested Plot Showing Independent Predictors of Mcad from Multivariable Logistic Regression Analysis



DISCUSSION

This study documents one of the highest prevalence rates of MCAD among patients with STEMI reported in the international literature, with 67.8% of patients exhibiting significant multivessel disease. This finding significantly surpasses the 40-50% prevalence rates typically observed in Western populations and is notably higher than recent studies from Pakistan, which reported a prevalence rate of 55.7% (Mamtani et al. 2022).

The notably high prevalence of MVD in our population has significant clinical implications for patient management and resource allocation. Recent evidence from pivotal trials indicates that complete revascularization markedly reduces cardiovascular mortality and myocardial infarction compared with strategies targeting only the culprit lesions (Gershlick et al. 2015). In our cohort, where approximately two-thirds of the patients with STEMI presented with multivessel disease, the potential for clinical benefit from complete revascularization strategies was considerable.

The updated guidelines now offer Class I recommendations for complete revascularization in haemodynamically stable patients with STEMI and MVD (Lawton et al. 2022). Nevertheless, the optimal timing

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remains under investigation, with network meta-analyses suggesting that staged multivessel PCI during index hospitalisation may be the safest approach for these patients. Given the high prevalence of diabetes and complex anatomical presentations in our population, staged approaches may be particularly advantageous in minimising procedural risks while achieving complete revascularization (Shuja et al. 2025).

Our findings indicated a unique cardiovascular risk profile for the South Asian population. The prevalence of diabetes mellitus at 44.4% significantly surpassed global averages and served as the most robust independent predictor of multivessel disease. This observation was consistent with the established knowledge that South Asians possess a genetic predisposition to diabetes and an earlier onset of coronary artery disease (Muniyappa and Narayanappa 2023). The high rates of consanguinity in Pakistani populations likely contribute to the aggregation of genetic cardiovascular risk factors, compounded by lifestyle factors such as dietary patterns high in saturated fats, limited physical activity, and a high prevalence of tobacco use (Hasnain 2024; Safdar et al. 2016). The prevalence of hypertension was 56.7%, and its significant association with MVD underscores the critical importance of blood pressure control in primary prevention. The current smoking rate of 30.4% and its strong association with MVD highlight the urgent need for comprehensive tobacco cessation programs in this region of Brazil (Olinto et al. 2012).

The prevalence of MVD in our study (67.8 %) significantly surpassed the rates reported in major international trials and registries. The complete trial documented a MVD prevalence of approximately 50%, whereas European registries typically report rates between 45% and 55% (Wald et al. 2013). Even within South Asian populations, our findings are notably higher than those of previously reported studies, suggesting either a distinct regional pattern or a potential referral bias at our tertiary centre. This disparity may be attributed to several factors, the tendency for later presentation to medical care in Pakistani healthcare settings, which allows for more extensive plaque development, a higher prevalence of diabetes and metabolic syndrome within our population, a genetic predisposition to more aggressive coronary disease among South Asians and environmental and lifestyle factors specific to the regional population (Alauddin 2004).

The high prevalence of MVD necessitates substantial adaptations within the healthcare system. Complete revascularization procedures are inherently more complex and require longer procedural times, higher contrast volumes, and increased radiation exposure. It is imperative that our cardiac catheterisation laboratories are adequately equipped and staffed to manage this complexity while upholding quality and safety standards.

Study Limitations

This study had several limitations. The retrospective design may have introduced selection bias and restricted the availability of certain clinical variables in the study. Data from a single centre may not be generalisable to other regions of Pakistan with different demographic characteristics, and the study lacked a control group. Visual angiographic assessment, in the absence of quantitative coronary angiography, may introduce subjective variability, although it reflects real-world practice. The lack of long-term follow-up data limits the assessment of complete revascularization strategies and their effects on the clinical outcomes.

CONCLUSION

This study shows a high prevalence of multivessel coronary artery disease (67.8%) in STEMI patients undergoing primary PCI in Pakistan, exceeding the Western and South Asian rates. Diabetes, smoking, and hypertension predict multivessel anatomy, reflecting the cardiovascular risk in Pakistan. The high prevalence, with evidence supporting complete revascularization, suggests that comprehensive treatment may benefit patients with STEMI. Healthcare should focus on diabetes and hypertension screening, tobacco cessation, and lifestyle interventions. Facilities must be equipped for multivessel procedures while maintaining standards. Addressing these challenges is crucial for reducing cardiovascular mortality in Pakistani patients with STEMI and requires a coordinated healthcare response.

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