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Original Article

Patterns of Coronary Artery Occlusion in Acute Coronary Syndrome Patients Undergoing Coronary Angiography in a Cardiac Center of a Low-Middle Income Country

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Abstract

Objectives: This study aims to identify and describe the patterns of coronary artery occlusion in patients with acute coronary syndrome (ACS) undergoing coronary angiography, with a particular focus on the association of traditional cardiovascular risk factors with disease severity.

Methodology: This descriptive, cross-sectional study included 174 ACS patients who underwent coronary angiography between December 30, 2020, and June 30, 2021, at Hayatabad Medical Complex. Patient demographics, clinical presentations, and angiographic findings were systematically analyzed. Statistical analysis, including chi-square tests, was performed to explore associations, with significance set at $p<0.05$.

Results: The mean age of the study population was 57.4 years, with 70.1% male and 29.9% female participants. Single vessel disease (SVD) was the most common coronary artery pattern, present in 43.7% of patients, followed by double vessel disease (DVD) in 33.3% and triple vessel disease (TVD) in 23.0%. The left anterior descending (LAD) artery was most frequently involved, accounting for 58.6% of cases, followed by the right coronary artery (RCA) in 35.1% and the left circumflex artery (LCx) in 25.9%. Significant associations were found between traditional cardiovascular risk factors—hypertension, diabetes, and smoking—and more severe disease, highlighting their role in disease progression.

Conclusion: Single vessel disease, particularly involving the LAD artery, emerged as the predominant pattern of coronary occlusion among ACS patients in this study. The strong association of hypertension, diabetes, and smoking with increased disease severity underscores the importance of early and targeted interventions, such as blood pressure control, smoking cessation, and diabetes management, to improve clinical outcomes and reduce the burden of coronary artery disease.

Keywords: Acute Coronary Syndrome, Coronary Angiography, Single Vessel Disease, Risk Factors, LAD Artery, Multi-Vessel Disease, Hypertension, Diabetes, Smoking

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INTRODUCTION

Acute Coronary Syndrome (ACS) remains one of the leading causes of morbidity and mortality globally, with Pakistan being no exception. ACS results from the sudden occlusion of coronary arteries, typically due to plaque rupture or thrombosis. The extent and location of coronary artery occlusion are directly associated with patient prognosis, making it crucial to understand the patterns of artery involvement in ACS patients [1]. This knowledge is essential for the timely and appropriate management of ACS, ultimately improving patient outcomes.

Coronary artery disease (CAD) is increasingly prevalent in Pakistan, with rising rates of both mortality and morbidity. Despite this growing burden, region-specific data on CAD, particularly in Peshawar, remain scarce. Recent studies indicate that coronary angiography, also known as cardiac catheterization, is the gold standard for diagnosing CAD and identifying coronary blockages. The patterns of coronary artery occlusion vary depending on a range of factors, including age, gender, comorbidities, and genetic predispositions. Early intervention remains a cornerstone of improving ACS outcomes, reinforcing the importance of understanding these patterns for effective clinical management [2].

While the overall burden of CAD continues to rise in Pakistan, its patterns remain poorly understood, especially at a regional level. Previous research has highlighted the left anterior descending (LAD) artery as the most commonly affected artery in South Asian populations, a trend that contrasts with patterns seen in Western countries. For instance, studies conducted in Karachi have found that the LAD artery is most frequently involved, followed by the right coronary artery (RCA) and left circumflex artery (LCx) [3]. Understanding the region-specific patterns of coronary artery occlusion is crucial for devising effective prevention and treatment strategies.

This study, conducted at Hayatabad Medical Complex in Peshawar, aims to explore the patterns of coronary artery occlusion in ACS patients undergoing coronary angiography. By providing insights into the incidence and distribution of coronary artery lesions, this research seeks to inform therapeutic interventions and contribute to local clinical practice. With its state-of-the-art angiographic facilities, the Cardiology Department at Hayatabad Medical Complex is well-equipped to generate valuable data that can align with national clinical guidelines and inform best practices in the region.

Despite a comprehensive review of the existing literature [4], no prior studies have specifically described coronary artery occlusion patterns in the Peshawar region. While studies from other parts of Pakistan, such as Karachi and Punjab, have provided some insight into CAD patterns, regional variations in lifestyle, cultural practices, and genetic predispositions highlight the need for localized research [5]. This study aims to address this gap by examining a representative sample of patients from Hayatabad Medical Complex, offering region-specific data that can enhance clinical decision-making.

The growing burden of cardiovascular disease in Pakistan underscores the urgent need to understand the specific patterns of coronary artery involvement in ACS patients. By generating localized data, this study aims to support clinicians in improving interventional outcomes and inform public health initiatives designed to reduce the prevalence of CAD. The primary objective of this study is to determine the patterns of coronary artery occlusion in ACS patients who underwent coronary angiography at Hayatabad Medical Complex between December 30, 2020, and June 30, 2021. Through the analysis of coronary artery lesion distribution, this study seeks to provide actionable insights that can guide individualized treatment plans and enhance patient outcomes.

METHODOLOGY

Study Design: This was a descriptive, cross-sectional study conducted to delineate the characteristics of coronary artery occlusion patterns in patients with acute coronary syndrome (ACS). The design aimed to provide a snapshot of patient demographics, clinical presentations, and angiographic findings, focusing on untreated coronary artery disease (CAD) patterns in a representative population.

Ethics: The study protocol was reviewed and approved by the Ethical and Research Committee of Hayatabad Medical Complex, Peshawar. All procedures were conducted in accordance with the Declaration of Helsinki and ethical guidelines for research involving human subjects. Written informed consent was obtained from all participants after explaining the study's objectives, procedures, and their right to withdraw at any time without affecting their medical care. Patient confidentiality was strictly maintained by anonymizing all data.

Setting: The research was conducted at Hayatabad Medical Complex, a tertiary care hospital in Peshawar, Pakistan. The study was carried out over six months, from December 30, 2020, to June 30, 2021. This timeframe ensured a diverse and adequate sample size and minimized potential seasonal variability in ACS presentations.

Participants: The study included adult patients aged 18 years or older, of both genders, who were diagnosed with acute coronary syndrome (ACS), including unstable angina, NSTEMI, or STEMI, and undergoing coronary angiography during the study period. Patients with a history of prior percutaneous coronary intervention (PCI) or coronary artery bypass graft (CABG), significant valvular heart disease, chronic kidney disease stage 4 or higher, pregnancy, or those who declined to provide informed consent were excluded from the study. These exclusion criteria were implemented to ensure a focused population consisting of individuals with untreated coronary artery disease (CAD) patterns, while also prioritizing patient safety.

Variables: The study included several key variables for analysis. Demographic variables encompassed age, gender, and comorbidities such as hypertension, diabetes, smoking status, and family history of coronary artery disease (CAD). Clinical variables were centered on presenting symptoms, laboratory findings (including cardiac biomarkers and lipid profiles), and angiographic outcomes. The primary outcome variables focused on coronary artery stenosis patterns, categorized as Single Vessel Disease (SVD), Double Vessel Disease (DVD), or Triple Vessel Disease (TVD), along with the involvement of the Left Main Stem (LMS) artery.

Data Sources/Measurement: Data were collected using a standardized proforma. The process included recording demographic details, clinical presentations, and laboratory findings at admission. Coronary angiography was performed using standard procedures, and the angiographic findings were categorized as follows:

- Single Vessel Disease (SVD): Significant stenosis (≥70% luminal diameter narrowing) in one major coronary artery.
- Double Vessel Disease (DVD): Significant stenosis in two major coronary arteries.
- Triple Vessel Disease (TVD): Significant stenosis in three major coronary arteries.
- Left Main Coronary Artery Disease (LMS): Defined as ≥50% luminal diameter narrowing.

Bias: Potential biases, such as selection bias, were minimized by including all eligible patients presenting with ACS during the study period. Data collection procedures and analysis were standardized to avoid measurement bias.

Study Size: The sample size was determined based on the average monthly patient flow in the Cardiology Department, ensuring the inclusion of sufficient cases to achieve meaningful statistical analysis. A total of 150 patients meeting the inclusion criteria were included in the final analysis.

Quantitative Variables: Continuous variables included age, duration of symptoms, and laboratory findings. Categorical variables included gender, comorbidities, clinical presentations, and angiographic findings.

Statistical Methods: Data analysis was conducted using SPSS version 26. Continuous variables, such as age and laboratory findings, were summarized as means with standard deviations, while categorical variables, including comorbidities and clinical presentations, were presented as frequencies and percentages. To assess associations between categorical variables, such as hypertension, diabetes, and smoking, and the severity of coronary artery disease (CAD), the chi-square test was employed. For continuous variables, such as age, comparisons between groups with varying disease severities were performed using the independent t-test. A significance level of $p<0.05$ was used to determine statistical significance. This analysis provided valuable insights into the demographic and clinical predictors of CAD severity, as well as the distribution of coronary artery disease patterns in the study population.

RESULTS

Participants: The study included a total of 174 patients diagnosed with acute coronary syndrome (ACS) who underwent coronary angiography at Hayatabad Medical Complex. The mean age of the participants was 57.4 ± 10.3 years. The majority of patients (65.5%) were between the ages of 50 and 70 years, with a larger proportion of males (122/174, 70.1%) compared to females (52/174, 29.9%). The study population had a high prevalence of comorbidities, with hypertension being the most common (56.3%), followed by diabetes mellitus

(48.3%), smoking (39.7%), and a family history of coronary artery disease (CAD) (32.8%).

Descriptive Data: Table 1 presents the demographic and clinical characteristics of the study population. The age distribution showed that 22.4% of patients were younger than 50 years, 65.5% were between 50 and 70 years, and 12.1% were older than 70 years. Among the clinical characteristics, hypertension was present in 56.3% of patients, diabetes mellitus in 48.3%, smoking in 39.7%, and a family history of CAD in 32.8%.

Table 1: Demographic and Clinical Characteristics of the Study Population

Characteristic	Summary
Age (years)	
< 50	39 (22.4%)
50-70	114 (65.5%)
> 70	21 (12.1%)
Gender	
Male	122 (70.1%)
Female	52 (29.9%)
Hypertension	98 (56.3%)
Diabetes Mellitus	84 (48.3%)
Smoking	69 (39.7%)
Family History of CAD	57 (32.8%)

Outcome Data: The angiographic analysis revealed that Single Vessel Disease (SVD) was the most prevalent form of coronary artery disease, affecting 43.7% (76/174) of patients. Double Vessel Disease (DVD) was observed in 33.3% (58/174) of the cases, while Triple Vessel Disease (TVD) was identified in 23.0% (40/174) of patients. These findings highlight the varying degrees of coronary artery involvement in the study population, with SVD being the most common, followed by DVD and TVD.

Table 2: Association between Risk Factors and Severity of Coronary Artery Disease

Risk Factor	SVD (%)	DVD (%)	TVD (%)	p-value
HTN	34 (34.7%)	36 (62.1%)	28 (70%)	<0.01
DM	32 (32.7%)	29 (50.0%)	23 (57.5%)	<0.05
Smoking	26 (26.5%)	23 (39.7%)	20 (50%)	<0.05
Family History of CAD	21 (21.4%)	19 (32.8%)	17 (42.5%)	<0.05

The left anterior descending (LAD) artery was the most frequently affected, with ≥70% stenosis identified in 58.6% (102/174) of patients. The right coronary artery (RCA) had significant stenosis in 35.1% (61/174) of patients, while the left circumflex artery (LCx) was involved in 25.9% (45/174). The left main coronary artery (LMS) showed involvement in 6.9% (12/174) of patients. These results illustrate the diverse patterns of coronary artery involvement in ACS patients.

Table 3: Clinical Presentation and Outcomes of ACS Patients

Clinical Presentation	Total	Intervention (PCI/CABG)	Medical Management
Unstable Angina	56 (32.2%)	28 (50%)	28 (50%)
NSTEMI	72 (41.4%)	46 (63.9%)	26 (36.1%)
STEMI	46 (26.4)	34 (73.9%)	12 (26.1%)

Main Results: The study identified significant associations between traditional cardiovascular risk factors and the severity of coronary artery disease. Hypertension was strongly linked to more severe disease, with 62.1% of patients with Double Vessel Disease (DVD) and 70.0% of those with Triple Vessel Disease (TVD) having a history of hypertension ($p<0.01$). Diabetes Mellitus was also associated with greater disease severity, as 50.0% of patients with DVD and 57.5% with TVD had diabetes ($p<0.05$). Smoking was more prevalent in patients with higher disease severity, with 39.7% of patients with DVD and 50.0% with TVD having a smoking history ($p<0.05$). Additionally, a family history of coronary artery disease (CAD) was more common in those with severe disease, with 42.5% of patients with TVD reporting a family history of CAD ($p<0.05$).

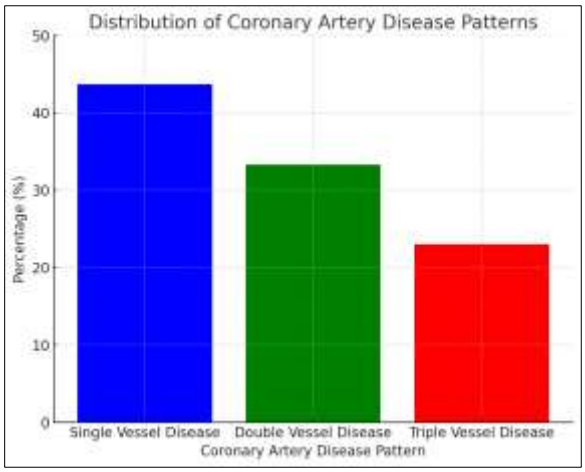

Figure 1: Distribution of Coronary Artery Disease Patterns

The clinical presentation of acute coronary syndrome (ACS) varied across the study population. Unstable Angina was observed in 56 patients, accounting for 32.2% of the cohort. Non-ST-segment elevation myocardial infarction (NSTEMI) was the most

prevalent, affecting 72 patients, or 41.4% of the population. ST-segment elevation myocardial infarction (STEMI) was present in 46 patients, representing 26.4% of the study group.

In terms of intervention, patients with STEMI had the highest rate of percutaneous coronary intervention (PCI), with 73.9% undergoing the procedure. In contrast, only 50% of patients with unstable angina were treated with PCI or coronary artery bypass grafting (CABG), while the rest were managed medically.

DISCUSSION

This study provides valuable insights into the patterns of coronary artery disease (CAD) among acute coronary syndrome (ACS) patients undergoing coronary angiography, particularly in the context of Pakistan, where regional data on CAD patterns remain sparse. The findings highlight the predominance of single vessel disease (SVD), which was observed in 43.7% of the patients, and a notable high frequency of left anterior descending (LAD) artery involvement (58.6%), underscoring distinct features of CAD presentation in the Pakistani population.

Among the study participants, single vessel disease was the most common pattern of coronary artery occlusion, followed by double vessel disease (DVD) in 33.3% and triple vessel disease (TVD) in 23.0%. The LAD artery emerged as the most frequently affected, with significant stenosis in 58.6% of patients. This was followed by the right coronary artery (RCA) in 35.1% and the left circumflex artery (LCx) in 25.9%. These findings emphasize the unique distribution of coronary artery involvement in the region and have important clinical implications for risk stratification and treatment planning [4].

The significant associations between the severity of CAD and traditional cardiovascular risk factors such as hypertension, diabetes, smoking, and a family history of CAD were evident in this study. Hypertension, in particular, was strongly associated with more severe forms of CAD, especially DVD and TVD, highlighting the critical role of blood pressure management in reducing disease progression [5]. The association between diabetes and increased CAD severity aligns with existing literature, reinforcing the need for comprehensive management of blood sugar levels in CAD prevention. Smoking also emerged as a prevalent risk factor, with a higher prevalence of smoking among those with more severe coronary disease, emphasizing the importance of smoking cessation in mitigating CAD risk.

These findings are largely consistent with prior research from Karachi, which similarly reported high rates of LAD artery involvement and single vessel disease among ACS patients. However, the higher prevalence of TVD (23.0%) in this study compared to some international studies points to potential regional differences in CAD presentation [6]. For example, studies from India often report a higher prevalence of DVD and TVD, possibly due to differences in the risk factor profiles, socioeconomic conditions, and healthcare access between countries [7]. Similarly, Western populations tend to show a higher prevalence of TVD, often attributed to distinct lifestyle choices, dietary habits, and preventive healthcare measures.

The regional variations in CAD presentation underscore the importance of localized data for understanding the unique burden of CAD in South Asia. This study provides essential insights into the population of Peshawar, where comprehensive data on coronary artery occlusion patterns had previously been lacking. The high prevalence of LAD artery involvement is particularly concerning, as occlusion of this artery is associated with poor prognosis due to its critical role in supplying a large portion of the myocardium. This reinforces the need for targeted early interventions and preventive strategies, especially focusing on modifiable risk factors such as hypertension, diabetes, and smoking. Public health campaigns targeting these risk factors could significantly reduce the severity of CAD and improve long-term outcomes.

Limitations: Despite its valuable contributions, this study has several limitations. As it was conducted at a single center, Hayatabad Medical Complex, the results may not be generalizable to other populations across Pakistan or beyond. While the sample size was adequate for descriptive analysis, it is relatively small, limiting the broader applicability of the findings. Additionally, the cross-sectional nature of the study restricts the ability to establish causal relationships between risk factors and the severity of coronary artery disease (CAD). Future research should aim to overcome these limitations by adopting multicenter approaches with larger, more diverse samples, improving the generalizability and robustness of the findings.

Future Directions: Further studies should explore genetic and biomarker-based predictors of coronary occlusion patterns, which could enhance personalized risk assessment and management of CAD patients in South Asia. Multicenter studies across various regions of Pakistan are also needed to examine regional variations in CAD patterns and their implications for public health strategies. Moreover, evaluating the long-term impact of preventive measures—particularly those targeting modifiable risk factors such as hypertension, diabetes, and smoking—on CAD progression and patient outcomes is critical. These efforts will improve our understanding of CAD and help develop targeted strategies to reduce its burden both in Pakistan and globally.

CONCLUSION

This study underscores the predominance of single vessel disease (43.7%) and the frequent involvement of the LAD artery (58.6%) among ACS patients, with strong associations between CAD severity and modifiable risk factors such as hypertension, diabetes, and smoking. Early intervention, effective risk factor management, and public health strategies tailored to the specific needs of the population are crucial for mitigating the burden of CAD. These findings provide actionable insights for improving clinical practice and developing region-specific public health interventions. Further research is needed to validate these results and explore additional risk factors unique to this population, ultimately enhancing our understanding and management of coronary artery disease.

AUTHORS' CONTRIBUTION

SK, SHAS, and WB: Concept and design, data acquisition, interpretation, drafting, final approval, and agree to be accountable for all aspects of the work. SK, SHAS, and WB: Data acquisition, interpretation, drafting, final approval and agree to be accountable for all aspects of the work.

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