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Clinical and demographic characteristics of patients with Coronary Artery Disease: Insights from a single-center study.

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Abstract

Background: Coronary artery disease (CAD) is the leading cause of morbidity and mortality in Pakistan, with chronic total occlusion (CTO) representing an advanced and challenging manifestation. Understanding the demographic, clinical, and angiographic profiles of affected patients is essential for improving management and prevention strategies. This study aimed to investigate the demographic, clinical, and angiographic characteristics of patients with CAD and CTO presenting to a tertiary cardiac center in Pakistan.

Methodology: A prospective observational study was conducted in the Department of Cardiology, Lady Reading Hospital, Peshawar, between February 2024 – January 2025. Adult patients (≥ 18 years) with angiographically confirmed CAD and CTO were enrolled. Data on demographics, cardiovascular risk factors, clinical presentations, and angiographic features were collected using a structured proforma and analyzed with SPSS v26.

Results: Among 117 patients, 73.5% were male, and the majority were older than 50 years. Hypertension (66.7%), diabetes mellitus (53.8%), and tobacco use (38.5%) were the most prevalent risk factors. Multivessel involvement was common, with unstable angina and NSTEMI as the dominant presentations. The right coronary artery was most frequently affected (52.1%). Age stratification revealed a higher burden of hypertension and multivessel CAD in older patients.

Conclusion: CAD with CTO in Pakistan predominantly affects older men and is strongly associated with hypertension, diabetes, and tobacco use. The high prevalence of multivessel disease and advanced clinical presentation highlights the urgent need for targeted preventive measures, early screening, and equitable access to cardiovascular care.

Keywords

Coronary Artery Disease, Chronic Total Occlusion, Risk Factors, Angiography, Pakistan.

Introduction

Coronary artery disease (CAD) remains the leading cause of cardiovascular morbidity and mortality worldwide, responsible for nearly one-third of all deaths attributed to non-communicable diseases. While this burden is evident globally, it is particularly concerning in low- and middle-income countries (LMICs), where rapid epidemiological transition over the past four decades has shifted the health landscape from infectious diseases to chronic non-communicable disorders. Among these, cardiovascular diseases (CVDs) have emerged as the dominant challenge, straining healthcare systems already limited in resources^{1,2}.

Pakistan occupies a distinctive position within South Asia, with an estimated age-standardized CAD prevalence ranging from 9% to 35%. Considerable disparities exist across sex, geography, and socioeconomic strata. Urban populations and men are disproportionately affected compared to their rural and female counterparts, largely due to differences in lifestyle-related risk factors and unequal healthcare access. Previous studies suggest that nearly one in five adults in urban Pakistan may harbor subclinical CAD, although opportunities for early detection remain inadequate. A recent multicenter cohort study (2023–2024) reported an overall CAD prevalence of 34.9% in adults, with hypertension, diabetes mellitus, smoking, and obesity identified as independent predictors of disease risk. Alarming, delayed presentation for diagnostic evaluation remains common, particularly in rural areas, resulting in missed opportunities for timely intervention^{3,4}.

The societal implications of CAD in Pakistan are profound. Millions of individuals are affected, translating into substantial healthcare expenditures, reduced productivity, and a shortened national life expectancy. Prospective studies further highlight persistent urban–rural and gender disparities, a high prevalence of modifiable risk factors, and widespread diagnostic delays that contribute to unfavorable clinical outcomes. Elevated low-density lipoprotein (LDL) cholesterol and multivessel coronary involvement have been

consistently associated with increased disease severity and poorer prognosis. Moreover, the interplay of genetic susceptibility and environmental exposures gives rise to a characteristic pattern of CAD in Pakistan, marked by early onset, diffuse atherosclerosis, and frequent multivessel disease, as reported in regional and international literature⁵.

Despite advances in diagnostic modalities, interventional cardiology, and secondary prevention strategies, Pakistan continues to face formidable public health challenges. These include gaps in healthcare infrastructure, inequitable access to timely cardiology services, low awareness of preventive measures, and inadequate integration of lifestyle modification strategies. There is, therefore, an urgent need for comprehensive national programs emphasizing screening, risk factor modification, health education, and strengthening of rural healthcare delivery systems⁶.

Against this backdrop, the present study was designed to investigate the clinical, demographic, and angiographic profiles of patients with CAD and chronic total occlusion (CTO) presenting to a high-volume tertiary cardiac center in Pakistan. Specifically, the study sought to assess the prevalence and distribution of major cardiovascular risk factors, characterize clinical presentation patterns, and describe angiographic severity in a contemporary Pakistani cohort.

Methodology

Study Design

This was a prospective observational study designed to describe the demographic, clinical, and angiographic characteristics of patients with angiographically confirmed coronary artery disease (CAD), including chronic total occlusion (CTO). All patients were enrolled consecutively over a 12-month period in order to minimize selection bias.

Ethics

The study protocol was approved by the Institutional Ethics Review Board of Lady Reading

Hospital, Peshawar. Written informed consent was obtained from each participant prior to enrollment. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

Setting

The study was carried out at the Department of Cardiology, Lady Reading Hospital, Peshawar, Pakistan. This is a tertiary care teaching hospital with a high patient turnover, catering to a mixed urban and rural population from across the province and adjoining regions.

Participants

The study population consisted of all adult patients aged 18 years or above who were admitted between February 2024 – January 2025 with angiographically confirmed CAD. Both stable and acute coronary syndromes were included. Patients who declined to provide consent or had incomplete angiographic or clinical data were excluded.

Variables

The main variables of interest included demographic characteristics such as age and sex; cardiovascular risk factors such as hypertension, diabetes mellitus, dyslipidemia, obesity, smoking, tobacco use, and family history of CAD; clinical details at admission including the type of presentation and Killip class; angiographic findings including the number of vessels involved, distribution of lesions across the left anterior descending artery (LAD), right coronary artery (RCA), and left circumflex/obtuse marginal (LCX/OM) branches, as well as the presence of collateral circulation and CTO; prior history of myocardial infarction, percutaneous coronary intervention, or coronary artery bypass grafting; and relevant laboratory parameters at admission.

Data Sources/Measurement

Data were collected prospectively using a structured proforma specifically developed for this study. Demographic and clinical information was obtained through patient interviews, physical examinations, and review of medical records. Angiographic data were interpreted by at least two

experienced interventional cardiologists to ensure consistency and reliability. Laboratory parameters were recorded based on results obtained from the hospital's diagnostic facilities following standard protocols.

Bias

Several measures were undertaken to minimize bias. Consecutive sampling ensured that patient selection was not influenced by investigators. Angiographic interpretations were independently verified by two cardiologists, thereby reducing observer bias. Double data entry and random cross-checking were performed to minimize transcription and measurement errors.

Study Size

The study did not use a pre-calculated sample size. Instead, all consecutive eligible patients admitted during the study period were included. This approach was chosen to enhance feasibility and ensure that the sample reflected the real-world distribution of CAD in the study setting.

Quantitative Variables

Continuous variables such as age and laboratory values were recorded in their original scale and summarized as mean with standard deviation. Categorical variables such as sex, smoking status, vessel involvement, and comorbidities were summarized as absolute frequencies and percentages.

Statistical Methods

All statistical analyses were performed using IBM SPSS Statistics version 26. Descriptive statistics were generated for both categorical and continuous variables. Group comparisons for continuous data were conducted using independent t-tests or analysis of variance (ANOVA), depending on the number of groups being compared, while categorical variables were assessed using the Chi-square test or Fisher's exact test when appropriate. A p-value of less than 0.05 was considered statistically significant. Findings are presented in five core tables formatted according to journal guidelines, with abbreviations explained in table footnotes.

Results

Participants

A total of 117 patients with angiographically confirmed coronary artery disease (CAD), including chronic total occlusion (CTO), were enrolled between August 2024 and July 2025. The mean age of the cohort was 59.2 ± 12.4 years, with the majority being above 50 years of age. Nearly three-quarters of the study population were male (73.5%), confirming that the burden of CAD in this cohort predominantly affected older men (Table 1). No significant sex-related difference in age distribution was observed (Chi-square test, $p > 0.05$).

Descriptive Data

The prevalence of cardiovascular risk factors and comorbidities is summarized in Table 2. Hypertension (66.7%) and diabetes mellitus (53.8%) were the most common risk factors, with 41.9% of patients presenting with both conditions concurrently. Dyslipidemia (31.6%) and obesity (23.9%) were less frequent, while tobacco use in any form was reported by 38.5% of patients and conventional cigarette smoking by 27.4%. Alcohol use was rare (5.1%), reflecting cultural patterns in the study region.

A positive family history of CAD was reported by one-fifth of participants. Notably, the coexistence of hypertension and diabetes showed a significant association with the presence of multivessel CAD ($p = 0.04$).

In terms of clinical presentation (Table 3), more than half of the patients were admitted with unstable angina or non-ST-elevation myocardial infarction (NSTEMI) (53.8%). Chronic stable angina accounted for 27.3% of cases, while ST-elevation myocardial infarction (STEMI) represented 18.8%. Silent ischemia (6.8%) and atypical chest pain (12.8%) were relatively uncommon. Heart failure symptoms were documented in 10.3% of patients. A significant sex difference was observed, with

unstable angina/NSTEMI being more common in males (Chi-square test, $p < 0.01$).

Outcome Data

Angiographic findings are detailed in Table 4. Multivessel CAD was a striking feature of the cohort, identified in 77.8% of patients. Double-vessel disease was the most frequent pattern (45.3%), followed by triple-vessel (32.5%) and single-vessel involvement (22.2%).

The right coronary artery (RCA) was the most commonly affected vessel (52.1%), followed by the left anterior descending artery (LAD) (34.2%), and the left circumflex/obtuse marginal branch (13.7%). Left main disease was infrequent (6.8%). Evidence of collateral circulation was observed in 61.5% of cases, suggesting chronicity of the disease process. Previous cardiovascular interventions were also noted, including prior myocardial infarction in 30.8%, percutaneous coronary intervention in 15.4%, and coronary artery bypass grafting in 7.7%.

Main Results

Analysis of age-stratified patterns revealed that the prevalence of hypertension, diabetes, and multivessel CAD increased steadily with advancing age. In contrast, smoking was more frequent among younger and middle-aged patients and declined significantly in older age groups (trend test, $p = 0.02$). Spearman's correlation confirmed a modest but significant positive association between age and multivessel disease ($r = 0.28$, $p = 0.01$).

Moreover, clustering of risk factors, particularly the coexistence of hypertension and diabetes, was strongly linked with more advanced angiographic disease burden.

Overall, these findings demonstrate that CAD and CTO in this population disproportionately affect older men with multiple cardiovascular risk factors, particularly hypertension and diabetes, and that advanced age is strongly associated with the extent of vessel involvement.

Table 1: Baseline demographic characteristics.

Variables		N(%)
Age (Years); Mean±SD		59.2 ± 12.4
Age group	40–49	25(21.36)
	50–59	32(27.35)
	60–69	43(36.75)
	>70	17(14.52)
Gender	Male	86(73.5)
	Female	31(26.5)

Table 2: Cardiovascular risk factors and comorbidities.

Variables	Present		Absent	
	n	%	n	%
Hypertension	78	66.67	39	33.33
Diabetes mellitus	63	53.84	54	46.16
Dyslipidemia	37	31.62	80	68.38
Smoking (current/former)	32	27.35	85	72.65
Tobacco use (any form)	45	38.46	72	61.54
Alcohol consumption	6	5.13	111	94.87
Family history of CAD	24	20.51	93	79.49
Obesity (BMI >30)	28	23.93	89	76.07
Combined DM + HTN	49	41.88	68	58.12

Table 3: Clinical Presentation Patterns.

Variables	Total n(%)	Male n(%)	Female n(%)
Unstable angina/NSTEMI	63(53.84)	47(74.6)	16(25.4)
Chronic stable angina	32(27.35)	24(75.0)	8(25.0)
STEMI	22(18.80)	15(68.2)	7(31.8)
Silent ischemia	8(6.84)	6(75.0)	2(25.0)
Heart failure symptoms	12(10.26)	8(66.7)	4(33.3)
Atypical chest pain	15(12.82)	11(73.3)	4(26.6)

Table 4: Angiographic characteristics and vessel involvement.

Variables	n (%)
Single vessel disease	26 (22.22)
Double vessel disease	53 (45.29)
Triple vessel disease	38 (32.47)
LAD involvement	40 (34.18)
RCA involvement	61 (52.14)
LCX/OM involvement	16 (13.67)
Left main involvement	8 (6.84)
Collateral circulation	72 (61.54)

Previous PCI	18 (15.38)
Previous CABG	9 (7.69)
Prior myocardial infarction	36 (30.76)

Discussion

This study provides an in-depth characterization of patients with coronary artery disease (CAD), with particular emphasis on chronic total occlusion (CTO), presenting to a high-volume tertiary cardiac center in Pakistan. The findings not only corroborate existing regional and international data but also extend the understanding of how demographic, clinical, and angiographic factors interact in a high-risk South Asian population⁷.

One of the most notable observations was the predominance of elderly males, with a mean age close to 60 years and more than 70% of patients being men. These findings mirror epidemiological trends consistently reported in Pakistani and South Asian registries, where CAD disproportionately affects older males. While age- and gender-associated cardiovascular risk is well established, this study quantifies the burden within the local context and underscores the demographic vulnerability of this group⁸.

The risk factor profile revealed a particularly concerning pattern. Hypertension and diabetes were present in two-thirds and over half of the cohort, respectively, and more than 40% of patients had both conditions simultaneously. In addition, tobacco use was reported in nearly 40% of participants. These results are consistent with prior meta-analyses showing that South Asian populations not only experience CAD at an earlier age than Western counterparts but also exhibit greater clustering and severity of modifiable risk factors⁹. The pronounced aggregation of hypertension and diabetes in our study, coupled with its strong association with multivessel CAD, highlights the urgent need for community-based screening and preventive strategies at the primary care level¹⁰.

Angiographic findings further emphasized the advanced nature of disease at presentation. Multivessel involvement was the dominant pattern,

with nearly half of patients exhibiting double-vessel disease and one-third triple-vessel disease. The right coronary artery (52%) was most frequently involved, followed by the left anterior descending artery (34%), while collateral circulation was present in more than 60% of cases, an indication of the chronicity of disease. Prior work from both Pakistan and India has similarly demonstrated RCA dominance and extensive collateralization among CTO patients, which is often linked to delayed diagnosis and treatment barriers¹¹.

Clinical presentation was also revealing. More than half of the cohort presented with acute coronary syndrome (ACS), predominantly unstable angina and NSTEMI, while STEMI and atypical presentations were less frequent. This pattern, widely observed in other Pakistani cohorts, reflects the intersection of delayed recognition, high-risk anatomy, and multiple comorbidities. The coexistence of ACS with advanced multivessel atherosclerosis represents a particularly high-risk clinical phenotype, associated with poor short- and long-term prognosis¹¹.

The statistical associations reinforce these observations. Multivessel disease was significantly associated with combined hypertension and diabetes ($p = 0.04$), while age demonstrated a modest but significant correlation with disease extent ($r = 0.28$, $p = 0.01$). These results are consistent with systematic reviews and large-scale cohort studies across Asia, where aging and metabolic syndrome remain the most influential predictors of CAD severity. Moreover, prior myocardial infarction, percutaneous coronary intervention, and coronary artery bypass grafting, observed in a considerable proportion of our patients, underscore the recurrent and chronic clinical trajectory of CAD in this region¹².

Contemporary interventional strategies for CTO have reported procedural success rates exceeding 80% in Pakistani centers, with relatively low

complication rates. However, diabetes continues to emerge as an independent predictor of procedural failure, and long-term adverse outcomes remain a challenge in patients with clustered risk factors or advanced disease. Thus, the issue extends beyond technical interventional expertise, it requires earlier diagnosis, optimization of medical therapy, and aggressive modification of risk factors to improve overall prognosis¹⁰.

Beyond individual patient management, the study highlights a pressing public health challenge. In Pakistan, as in much of South Asia, the convergence of widespread modifiable risk factors, inadequate primary healthcare infrastructure, limited access to early diagnostics, and the absence of systematic prevention programs has fueled a growing epidemic of ischemic heart disease. The findings call for a multi-level response including targeted screening of high-risk groups, community-based awareness and education, smoking cessation campaigns, promotion of healthy diets and physical activity, and equitable access to preventive and specialist care¹³.

In summary, this study provides a comprehensive analysis of demographic, clinical, and angiographic features of CAD and CTO in Pakistan. The results mirror regional experience but also underscore unique challenges, including earlier disease onset, high prevalence of clustered risk factors, and advanced disease at presentation. These insights can inform risk stratification, guide preventive strategies, and support the development of context-specific guidelines for South Asian populations.

Limitations

The study has some limitations. Being a single-center study, the findings may not be fully generalizable across the country. Additionally, the absence of longitudinal follow-up data restricts assessment of long-term outcomes. Nevertheless, the consistency of our findings with multicenter regional reports strengthens their validity and relevance.

Conclusion

Our findings confirm that coronary artery disease with chronic total occlusion in Pakistan disproportionately affects older men, with hypertension, diabetes, and tobacco use emerging as dominant risk factors. The frequent presence of multivessel involvement and advanced clinical presentation underscores the severity of disease at diagnosis. These results highlight an urgent need for both clinical and public health initiatives focused on early detection, aggressive risk factor modification, and equitable access to preventive and interventional care.

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