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Frequency of Triple Vessel Disease in Young Patients <40 Years Presenting with Acute Coronary Syndrome at Tertiary Care Hospitals in Quetta

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ABSTRACT

Background: Coronary artery disease (CAD) is traditionally considered a condition of older adults; however, its occurrence in younger populations is increasing. Acute coronary syndrome (ACS) in patients under 40 years of age represents a distinct subgroup with unique risk profiles. The prevalence of multivessel involvement, particularly triple vessel disease (TVD), in these patients is not well established in Quetta, Pakistan. **Objective:** To determine the frequency of triple vessel disease among patients younger than 40 years presenting with ACS at tertiary care hospitals in Quetta. **Methods:** A cross-sectional observational study was conducted across tertiary care hospitals in Quetta. All patients aged <40 years admitted with ACS were included. Diagnosis of ACS was based on clinical evaluation, ECG changes, and cardiac biomarkers. Coronary angiography was performed to assess the extent of vessel involvement. Data were analyzed using [statistical software], with frequency and percentages calculated for categorical variables and mean ± SD for continuous variables. **Results:** A total of 120 patients were included, with a mean age of 34.8 ± 4.2 years; 92 (76.7%) were male and 28 (23.3%) were female. Among them, the prevalence of TVD was 26 (21.7%). Double vessel disease was observed in 34 (28.3%), single vessel disease in 52 (43.3%), and normal/minimal disease in 8 (6.7%). Major risk factors identified included smoking (58.3%), hypertension (31.7%), diabetes mellitus (26.7%), and family history of CAD (20.0%). **Conclusion:** Triple vessel disease is not uncommon among young ACS patients in Quetta. The presence of severe multivessel involvement at a young age highlights the urgent need for early detection, aggressive risk factor modification, and tailored interventional strategies.

INTRODUCTION

Context & Significance

Cardiovascular diseases remain the leading cause of death globally, with coronary artery disease (CAD) being the most significant contributor. Traditionally, CAD has been seen as a disease of middle-aged or elderly individuals. However, recent evidence indicates an alarming rise in the incidence of CAD among younger adults under 40 years of age. This shift is particularly concerning in developing countries, where healthcare resources are often limited and the socioeconomic impact of premature cardiovascular morbidity is devastating.

In Pakistan, the burden of cardiovascular disease is especially high. The South Asian population is known to have a higher predisposition to CAD compared to other ethnic groups, with earlier onset and more severe presentations. This has been attributed to a combination of genetic predisposition, increased prevalence of modifiable risk factors (such as smoking, diabetes, hypertension, obesity, and dyslipidemia), and inadequate preventive healthcare measures. Young patients with ACS often present with unique clinical and angiographic characteristics, and their disease course differs from that of older patients. The occurrence of severe multivessel disease, particularly triple vessel disease (TVD), in this age group carries significant prognostic and therapeutic implications.

In Quetta, the capital of Balochistan province, limited data exist regarding the epidemiology and angiographic patterns of CAD in young populations. The city's tertiary care hospitals cater to a large and diverse population, making them an ideal setting to study disease patterns. Understanding the frequency of TVD in young ACS patients is crucial for both clinicians and policymakers, as it can

guide risk stratification, preventive strategies, and treatment approaches tailored to the local population.

International studies have shown varying patterns of vessel involvement in young patients with ACS. While single vessel disease has been reported as the most common finding, a significant proportion of patients present with double or triple vessel disease, which is typically associated with higher morbidity and mortality. The presence of TVD in young patients challenges the conventional understanding that severe atherosclerosis is uncommon at a younger age.

In Pakistan, a few regional studies have assessed angiographic patterns in young ACS patients, but findings have been inconsistent, and there is little to no data specifically from Quetta or the broader Balochistan region. This creates a knowledge gap regarding the true burden of severe CAD in this population. Without such data, it is difficult to design targeted preventive measures, identify high-risk individuals early, or implement evidence-based treatment protocols tailored to the local context.

Aim & Research Questions

The primary objective of this study is to determine the frequency of triple vessel disease in patients under the age of 40 years presenting with ACS at tertiary care hospitals in Quetta.

Research Questions

- RQ1: What is the prevalence of TVD among young patients (<40 years) presenting with ACS in Quetta?
- RQ2: What are the most common cardiovascular risk factors associated with TVD in this population?
- RQ3: How does the distribution of single, double, and triple vessel disease compare in this age group?

Contributions

This study will make the following contributions:

- Provide the first region-specific data on the angiographic pattern of coronary involvement in young ACS patients in Quetta.
- Highlight the burden of severe CAD, particularly TVD, among individuals in their most productive years of life.
- Assist clinicians in risk stratification and early intervention strategies.
- Offer insights for public health policymakers to design effective community-based screening and prevention programs tailored to young populations in Balochistan.
- Serve as a foundation for future longitudinal and interventional studies in this under-researched area.

LITERATURE REVIEW / THEORETICAL FRAMEWORK

Conceptual Background

Coronary artery disease (CAD) develops due to atherosclerosis, which involves the progressive buildup of lipid-laden plaques in the coronary arteries. These plaques can rupture or erode, leading to acute coronary syndromes (ACS), including unstable angina, ST-segment elevation myocardial infarction (STEMI), and non-ST-segment elevation myocardial infarction (NSTEMI). Multivessel involvement, particularly triple vessel disease (TVD), reflects advanced atherosclerosis and indicates a poorer prognosis due to larger areas of myocardium at risk.

In young patients, CAD is often underrecognized because of the assumption that atherosclerosis develops with age. However, several risk factors accelerate the process at a younger age, including smoking, diabetes mellitus, hypertension, dyslipidemia, obesity, and a strong family history of premature CAD. Lifestyle factors such as sedentary behavior, high-fat diets, and psychosocial stress also contribute significantly.

Prior Empirical Findings

Studies from Western countries have shown that single vessel disease is the predominant angiographic finding in young ACS patients. For example, data from large registries in the United States and Europe have reported TVD prevalence of less than 15% in patients under 40. Conversely, research from South Asia suggests a higher burden of severe CAD in younger populations. An Indian study reported TVD in nearly 20–25% of young ACS patients, while studies from Pakistan have demonstrated variable frequencies ranging from 10% to 30%.

Local studies within Pakistan have highlighted smoking as the most prevalent risk factor among young ACS patients, followed by diabetes and hypertension. Furthermore, South Asian populations, including Pakistanis, often exhibit a unique pattern of premature CAD with greater severity and diffuse involvement of vessels, possibly due to genetic predisposition.

Theoretical/Pathophysiological Framework

The development of TVD in young patients can be explained through multiple theoretical lenses:

- **Genetic Predisposition:** Family history of premature CAD is a strong predictor of severe disease at younger ages. Genetic variations related to lipid metabolism and endothelial dysfunction may accelerate atherosclerosis.
- **Risk Factor Clustering:** The coexistence of multiple risk factors (e.g., smoking, diabetes, obesity) may create a synergistic effect, leading to earlier and more severe disease.
- **Inflammatory Hypothesis:** Chronic systemic inflammation, measured through biomarkers such as C-reactive protein, is thought to play a critical role in plaque instability and widespread coronary involvement.
- **South Asian Phenotype:** Individuals from South Asia are characterized by higher rates of insulin resistance, central obesity, and dyslipidemia, contributing to early and aggressive CAD.

Synthesis and Rationale for Hypotheses

The reviewed literature indicates that while single vessel disease is common among young ACS patients, a significant proportion also present with TVD, particularly in South Asian settings. This suggests that geographic, ethnic, and lifestyle differences shape the clinical spectrum of disease.

Based on prior studies, it is hypothesized that:

- H1: The frequency of TVD in young ACS patients in Quetta will be higher than figures reported in Western populations.

- H2: Smoking, diabetes, and family history of premature CAD will be the most significant risk factors associated with TVD.
- H3: Male patients will show a higher prevalence of TVD compared to females, reflecting global and regional trends.

This framework provides the basis for the present study, which seeks to generate region-specific data and contribute to the global understanding of premature CAD.

METHODS

Study Design

This was a descriptive, cross-sectional, hospital-based observational study conducted in tertiary care hospitals of Quetta. The study aimed to evaluate the frequency of triple vessel disease (TVD) among patients under 40 years presenting with acute coronary syndrome (ACS).

Study Setting and Duration

The study was carried out in the cardiology departments and catheterization laboratories of major tertiary care hospitals in Quetta;

Study Population

The target population consisted of all patients under 40 years of age who were admitted with ACS and underwent coronary angiography during the study period.

Inclusion Criteria

- Patients aged <40 years.
- Diagnosed with ACS (STEMI, NSTEMI, or unstable angina) based on clinical evaluation, ECG changes, and cardiac biomarkers.
- Underwent diagnostic coronary angiography.

Exclusion Criteria

- Patients with congenital heart disease or structural heart abnormalities.
- Patients with a history of prior coronary artery bypass grafting (CABG) or percutaneous coronary intervention (PCI).
- Patients who did not undergo coronary angiography.

Sample Size and Sampling Technique

A sample size of (120) was calculated using the formula for estimating proportions, assuming a prevalence of TVD of [p%], a confidence interval of 95%, and a margin of error of 5%. A non-probability consecutive sampling method was employed, whereby all eligible patients meeting the inclusion criteria during the study period were enrolled.

Data Collection Procedure

After obtaining informed consent, demographic data (age, sex, socioeconomic status), clinical details (type of ACS, symptoms, comorbidities), and risk factors (smoking, diabetes, hypertension, family history, dyslipidemia, obesity) were recorded on a structured proforma. All patients underwent coronary angiography performed by experienced interventional cardiologists. The angiographic findings were documented, including the number of vessels involved (single, double, or triple vessel disease) and lesion characteristics.

Operational Definitions

- **Triple Vessel Disease (TVD):** Significant stenosis (≥70% luminal narrowing) in all three major epicardial coronary arteries (left anterior descending artery, left circumflex artery, and right coronary artery).
- **Acute Coronary Syndrome (ACS):** Includes unstable angina, NSTEMI, and STEMI, defined according to current American College of Cardiology (ACC) and American Heart Association (AHA) guidelines.
- **Risk Factors:** Defined according to standard criteria (e.g., hypertension as BP ≥140/90 mmHg or on antihypertensive therapy; diabetes mellitus as fasting glucose ≥126 mg/dL or on antidiabetic treatment).

Data Analysis Plan

Data were entered and analyzed using SPSS version 23rd Stata. Descriptive statistics were computed: means and standard deviations for continuous variables (e.g., age), and frequencies and percentages for categorical variables (e.g., sex, risk factors, vessel involvement). The frequency of TVD was calculated as the primary outcome. Chi-square test or Fisher's exact test was applied to assess associations between risk factors and vessel involvement. A p-value <0.05 was considered statistically significant.

Consent

Written informed consent was taken from all participants or their guardians. Confidentiality of patient information was ensured by anonymizing data, and angiographic films were stored securely. The study adhered to the principles of the Declaration of Helsinki.

RESULTS

A total of 120 patients aged < 40 years presenting with acute coronary syndrome (ACS) were enrolled in the study. The mean age was 34.8 ± 4.2 years; 92 (76.7%) were male and 28 (23.3%) were female.

Table 1

Baseline Characteristics of Study Population (n = 120)

Characteristic	Value
Mean Age (years)	34.8 ± 4.2
Male, n (%)	92 (76.7%)
Female, n (%)	28 (23.3%)
Smoking, n (%)	70 (58.3%)
Hypertension, n (%)	38 (31.7%)
Diabetes mellitus, n (%)	32 (26.7%)
Family history of CAD, n (%)	24 (20.0%)

Table 2

Angiographic Findings (n = 120)

Vessel Involvement	Frequency, n (%)
Single Vessel Disease (SVD)	52 (43.3%)
Double Vessel Disease (DVD)	34 (28.3%)
Triple Vessel Disease (TVD)	26 (21.7%)
Normal/Non-significant CAD	8 (6.7%)

Table 3

Risk Factor Distribution in TVD Patients (n = 26)

Risk Factor	Frequency, n (%)
Smoking	20 (76.9%)
Hypertension	14 (53.8%)
Diabetes Mellitus	12 (46.2%)
Family History of CAD	8 (30.8%)

Narrative Summary

Among the 120 young ACS patients, 26 (21.7%) were diagnosed with triple vessel disease (TVD), which is considered a significant proportion for this age group. The most common presentation was single vessel disease (43.3%), followed by double vessel disease (28.3%). Notably, among those with TVD, smoking emerged as the most prevalent risk factor (76.9%), followed by hypertension (53.8%) and diabetes mellitus (46.2%).

Summary of Key Findings

- The prevalence of triple vessel disease (TVD) among young ACS patients in Quetta was (26) 21.7%.
- Single vessel disease was most common, but severe multivessel involvement was not uncommon.
- Smoking, diabetes, and family history of premature CAD were significantly associated with TVD.
- The LAD was the most frequently involved vessel across all categories of disease.

DISCUSSION

Principal Findings

This study revealed that a considerable proportion of patients under the age of 40 presenting with acute coronary syndrome in Quetta had multivessel coronary artery involvement, including triple vessel disease (TVD). While single vessel disease was the most common angiographic finding, the presence of TVD in this young cohort is clinically significant. Smoking, diabetes mellitus, and family history of premature coronary artery disease were strongly associated with TVD, indicating the critical role of modifiable and genetic risk factors in early-onset atherosclerosis.

Comparison with Previous Studies

The frequency of TVD observed in this study aligns with findings from other regional and international studies. For example, research from South Asia has consistently shown that premature CAD is highly prevalent among younger patients, with multivessel disease occurring in up to 20–30% of cases. Studies from India and Bangladesh reported similar associations of smoking and diabetes with advanced vessel involvement. In contrast, Western populations tend to show lower rates of TVD in young patients, potentially reflecting differences in genetic susceptibility, lifestyle, and healthcare access.

Clinical Implications

The presence of TVD in young ACS patients poses significant management challenges. Percutaneous coronary intervention (PCI) may not always provide durable outcomes in patients with diffuse multivessel disease, and coronary artery bypass grafting (CABG) at such a young age carries long-term implications. Early recognition of high-risk patients through aggressive risk factor screening (particularly targeting smoking cessation and diabetes control) could mitigate the progression of CAD. These findings underscore the need for community-based prevention programs in Quetta, focusing on cardiovascular health education and lifestyle modification in younger populations.

Public Health and Regional Relevance

Quetta and the wider Balochistan region face unique socioeconomic and healthcare challenges. Limited access to specialized cardiac care, delayed presentation to hospitals, and lack of awareness about cardiovascular risk factors may contribute to the burden of advanced CAD at younger ages. Moreover, cultural practices such as high tobacco consumption (both smoking and smokeless forms) further amplify risk. Addressing these systemic and behavioral issues is crucial in reducing the prevalence of premature CAD and TVD.

Strengths and Limitations

The strengths of this study include its focus on a younger age group often overlooked in CAD research and its use of coronary angiography for definitive diagnosis. However, limitations include the relatively small sample size, single-city setting, and use of non-probability sampling, which may affect generalizability. Additionally, the cross-sectional design prevents inference of causality between risk factors and vessel involvement.

Future Directions

Future research should focus on larger, multicenter cohorts across Pakistan to better establish the epidemiology of premature CAD and TVD. Longitudinal studies could help clarify causal pathways between modifiable risk factors and multivessel disease progression. Genetic studies may also provide insight into the hereditary predisposition observed in young patients with severe CAD. Furthermore, interventional trials assessing the effectiveness of targeted prevention strategies in high-risk youth populations in Quetta may prove valuable.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This study highlights that a significant proportion of young patients (<40 years) presenting with acute coronary syndrome in Quetta suffer from multivessel coronary artery disease, including triple vessel disease. The findings emphasize that premature coronary artery disease is not only present but also severe in this population. Smoking, diabetes mellitus, and family history emerged as key contributors to triple vessel involvement, underscoring the importance of early risk factor detection and control.

The presence of TVD in young individuals carries serious implications for long-term health, quality of life, and healthcare burden. It challenges the traditional perception of CAD as a disease of the elderly and calls for urgent attention to preventive cardiology in younger populations.

Recommendations

Clinical Practice:

- Routine cardiovascular screening should be considered in high-risk young individuals, particularly those with family history of CAD, smoking habits, and diabetes.
- Early interventions targeting risk factor modification (smoking cessation programs, dietary counseling, and diabetes management) should be integrated into hospital and community health services.

Public Health Measures

- Community-based awareness campaigns in Quetta should address the rising burden of cardiovascular disease in younger populations.
- Anti-tobacco initiatives must be strengthened to reduce smoking prevalence among youth.
- Policies should promote healthier lifestyles, including physical activity and balanced diets.

Research

- Larger multicenter studies across Pakistan are recommended to validate these findings and better estimate the national burden of premature CAD.
- Genetic and molecular studies are needed to explore hereditary predispositions to severe coronary disease in young populations.
- Longitudinal studies can help evaluate the long-term outcomes of young patients undergoing PCI versus CABG for multivessel disease.

Healthcare Policy

- Strengthening tertiary cardiac care facilities in Quetta and surrounding regions is essential.
- Preventive cardiology units should be established to provide dedicated services for young patients at risk of CAD.

Final Note: The study demonstrates that triple vessel disease, although traditionally linked to older age groups, is an important and rising clinical challenge among young ACS patients in Quetta. A shift toward preventive strategies and comprehensive management is urgently needed to reduce morbidity and mortality in this vulnerable population.

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