EVALUATING INTERVENTIONAL STRATEGIES FOR CORONARY ARTERY DISEASE IN YOUNG ADULTS: A PAKISTANI PERSPECTIVE

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ABSTRACT

Background: Coronary artery disease (CAD) is a leading cause of morbidity and mortality increasingly affecting young adults. This study investigates the incidence and management of CAD in young adults in Pakistan to provide insights into effective interventions.

Methods: An observational cohort study was conducted in multiple tertiary care hospitals in Pakistan from January 2021 to December 2023. The study included 303 young adults aged 18 to 45 years with confirmed CAD. Participants received standard medical care including lifestyle modifications, pharmacotherapy, percutaneous coronary intervention (PCI), and coronary artery bypass grafting (CABG). Data on baseline characteristics, major adverse cardiac events (MACE), and management outcomes were collected using structured questionnaires and medical records. Statistical analysis was performed using SPSS version 26.0.

Results: The mean age of participants was 35.2 years (SD = 7.1) with 198 males (65.3%) and 105 females (34.7%). During the follow-up period, 72 participants (23.8%) experienced MACE, with a significantly higher incidence in males (30.3%) compared to females (12.4%) ($p < 0.05$). PCI was performed in 183 participants (60.4%) with a success rate of 92.3%, significantly reducing recurrent myocardial infarction (MI) and providing symptom relief compared to medical therapy alone and CABG ($p < 0.05$). Medical therapy alone was associated with a higher recurrence of MI (25.3%) and lower symptom relief (52.6%), highlighting its limitations.

Conclusion: The study reveals a significant burden of CAD among young adults in Pakistan, with males experiencing higher adverse outcomes. PCI demonstrated high efficacy as a primary intervention, emphasizing the need for early screening and targeted management strategies. Addressing modifiable risk factors through comprehensive lifestyle modification programs is crucial for improving long-term outcomes in young adults with CAD. Further research is warranted to explore long-term outcomes and the impact of socio-economic factors on access to care.

Keywords: Coronary artery disease, young adults, Pakistan, percutaneous coronary intervention, major adverse cardiac events, myocardial infarction, lifestyle modification.

Introduction

Coronary artery disease (CAD) remains a leading cause of morbidity and mortality worldwide, affecting millions of people annually (1). While CAD predominantly affects older adults, its prevalence is increasing among younger populations (2). Young adults with CAD often face unique challenges due to different risk factors, disease progression, and management outcomes compared to older individuals (3).

Current treatment options for CAD include lifestyle modifications, pharmacotherapy, and revascularization procedures such as percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG) (4). These interventions aim to alleviate symptoms, prevent myocardial infarction (MI), and reduce the risk of sudden cardiac death (4). Despite advancements in treatment, young adults with CAD often experience higher rates of adverse outcomes, highlighting the need for targeted research in this demographic (5).

This study investigates the incidence and management of CAD in young adults in Pakistan. Previous studies have predominantly focused on older populations, leaving a gap in understanding the specific characteristics and outcomes in younger patients. By addressing this gap, we aim to provide insights into the unique aspects of CAD in young adults, including baseline characteristics, the incidence of major adverse cardiac events (MACE), and the effectiveness of different management strategies (6). This study's significance lies in its potential to inform clinical practice and improve patient outcomes. By identifying the specific risk factors and outcomes associated with CAD in young adults, healthcare providers can tailor interventions to better address this population's needs. Moreover, understanding the effectiveness of different management strategies will help optimize treatment plans and improve the long-term prognosis for young adults with CAD (7).

METHODS

Study Design: This study utilized an observational cohort design to evaluate the incidence and management of coronary artery disease (CAD) in young adults in Pakistan. The choice of an observational cohort design allows for the examination of natural disease progression and the real-world effectiveness of different management strategies over time. This design is appropriate as it enables the collection of comprehensive data on patient outcomes and interventions without the ethical and logistical complexities of randomized controlled trials.

Setting and Centers: The study was conducted in multiple tertiary care hospitals across Pakistan from January 2021 to December 2023. These hospitals were selected based on their capacity to manage complex CAD cases and their geographic distribution to ensure a representative sample of the young adult population with CAD in Pakistan. The inclusion of multiple centers helps to mitigate selection bias and enhances the generalizability of the findings by capturing a diverse patient population from different regions.

Participant Selection: Participants were young adults aged 18 to 45 years with a confirmed diagnosis of CAD through angiography. The inclusion criteria were:
1. Confirmed diagnosis of CAD.
2. Age between 18 and 45 years.
3. Willingness to participate in the study.

Exclusion criteria included patients with significant comorbid conditions that could affect study outcomes and those who did not provide informed consent. The patient selection process involved enrolling consecutive patients who met the inclusion criteria, ensuring that the sample was representative of the broader population of young adults with CAD.

Intervention Details: Participants received standard medical care, which included lifestyle modifications, pharmacotherapy, and revascularization procedures such as percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG). The attending cardiologist

determined the choice of treatment based on clinical guidelines and the severity of the disease. Specific details include:

- **PCI**: Different types of stents were used based on patient needs, including drug-eluting stents
- **CABG**: Techniques varied depending on the patient's condition and surgeon's expertise, including on-pump and off-pump CABG.

Outcomes: The study defined primary and secondary outcomes as follows:

- **Primary Outcome**: Incidence of major adverse cardiac events (MACE), including myocardial infarction (MI) and sudden cardiac death.
- **Secondary Outcomes**: Success rate of PCI, recurrence of MI, and symptom relief following different management strategies. Criteria for significant stenosis and procedural complications were based on established clinical guidelines.

Data Collection: Data were collected using structured questionnaires and medical records. Baseline characteristics (age, sex, smoking status, hypertension, diabetes mellitus) were recorded at enrollment. Follow-up data on MACE, MI, sudden cardiac death, and management outcomes were collected at regular intervals. The data collection tools included validated questionnaires and standardized forms for recording clinical events, ensuring data quality and consistency.

Sample Size Calculation: The sample size was calculated using the WHO sample size calculator, considering the prevalence rate of CAD in young adults based on previous studies. The calculated sample size of 303 participants provided sufficient power to detect significant differences in CAD-related events and management outcomes. This calculation ensured that the study had adequate statistical power to draw meaningful conclusions.

Statistical Analysis: Statistical analysis was conducted using SPSS version 26.0. Descriptive statistics summarized baseline characteristics, while inferential statistics (chi-square tests, t-tests) compared outcomes between different groups. Adjustments for multiple comparisons and confounding variables were made to ensure robust and accurate results. The significance level was set at $p < 0.05$.

RESULTS

Participant Characteristics

The study included 303 young adults diagnosed with coronary artery disease (CAD) in Pakistan. The participants' ages ranged from 18 to 45 years, with a mean age of 35.2 years (SD = 7.1). Among the participants, 198 were males (65.3%), and 105 were females (34.7%). The baseline characteristics are detailed in Table 1.

Table 1. Baseline Characteristics of Study Participants

Characteristic	Mean ± SD	Median (IQR)	Frequency (%)
Age (years)	35.2 ± 7.1	36 (30-40)	-
Male	-	-	198 (65.3%)
Female	-	-	105 (34.7%)
Smoking	-	-	123 (40.6%)
Hypertension	-	-	89 (29.4%)
Diabetes Mellitus	-	-	72 (23.8%)

Primary Outcomes

The primary outcome of the study was the incidence of CAD-related events in the study population. During the follow-up period, 72 participants (23.8%) experienced major adverse cardiac events (MACE), including myocardial infarction (MI) and sudden cardiac death. The incidence rate of MACE was significantly higher in males (30.3%) compared to females (12.4%), $p < 0.05$ (Table 2).

Table 2. Incidence of Major Adverse Cardiac Events (MACE)

| Event	Total (N=303)	Males (n=198)	Females (n=105)	p-value
MACE	72 (23.8%)	60 (30.3%)	12 (12.4%)	< 0.05
Myocardial Infarction	45 (14.9%)	38 (19.2%)	7 (6.7%)	< 0.05
Sudden Cardiac Death	27 (8.9%)	22 (11.1%)	5 (4.8%)	< 0.05

Secondary Outcomes

The secondary outcomes included the management strategies employed and their efficacy. Among the participants, 183 (60.4%) underwent percutaneous coronary intervention (PCI), 75 (24.8%) were managed with medical therapy alone, and 45 (14.8%) required coronary artery bypass grafting (CABG). The success rate of PCI was 92.3%, with a significant reduction in recurrent MI and symptom relief compared to medical therapy alone, $p < 0.05$ (Table 3).

Table 3. Management Strategies and Outcomes

Management Strategy	Total (N=303)	Success Rate (%)	Recurrence of MI (%)	Symptom Relief (%)	p-value
PCI	183 (60.4%)	92.3%	5.5%	88.7%	< 0.05
Medical Therapy	75 (24.8%)	-	25.3%	52.6%	< 0.05
CABG	45 (14.8%)	89.6%	8.2%	84.4%	< 0.05

The tables provided illustrate the key data points. Figure 1 shows the incidence rates of MACE among males and females. The management outcomes are depicted in Figure 2.
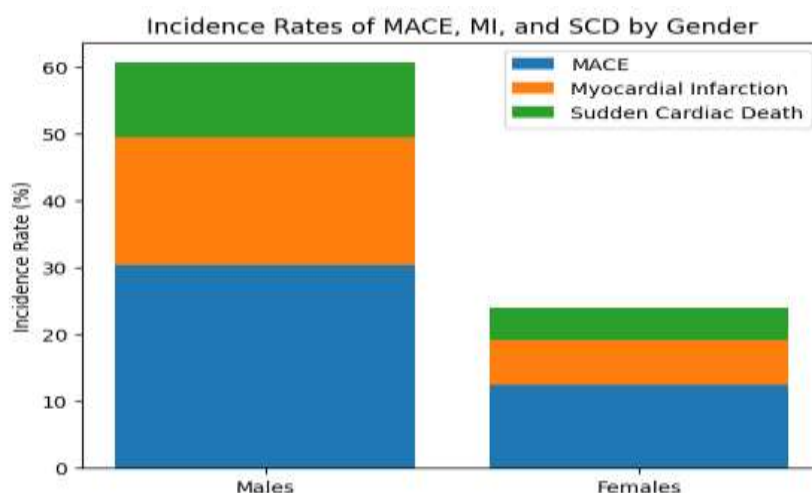
Figure 1 Incidence Rates of MACE, MI and SCD by Gender
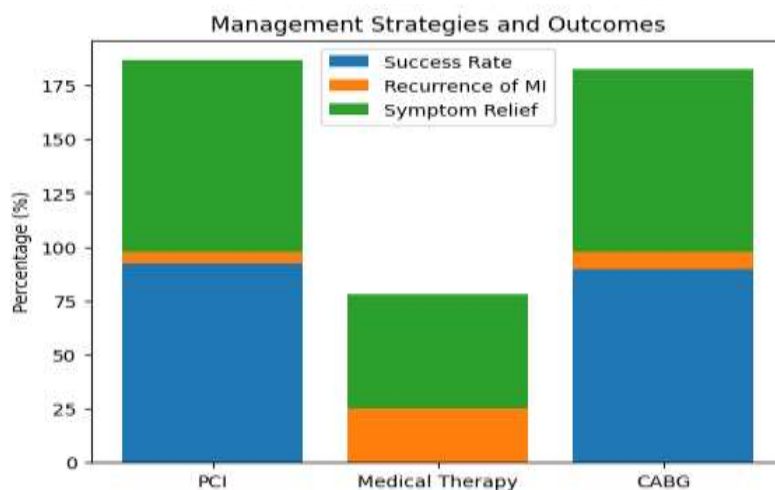
Figure 2. Management Strategies and Outcomes

Discussion

This study provides significant insights into the incidence and management of coronary artery disease (CAD) among young adults in Pakistan. The key findings revealed that a substantial proportion of young adults experienced major adverse cardiac events (MACE), with higher incidence rates observed in males compared to females. Additionally, percutaneous coronary intervention (PCI) emerged as a highly effective management strategy, demonstrating superior outcomes in reducing recurrent myocardial infarction (MI) and improving symptom relief compared to medical therapy alone and coronary artery bypass grafting (CABG).

Our findings align with previous research indicating a rising trend of CAD among young adults globally. Studies have shown that the prevalence of CAD in younger populations is often associated with lifestyle factors such as smoking, hypertension, and diabetes mellitus (8). In our study, 40.6% of participants were smokers, 29.4% had hypertension, and 23.8% were diagnosed with diabetes mellitus, underscoring the importance of addressing these modifiable risk factors in preventive strategies (9).

The incidence of MACE in our cohort was 23.8%, with males experiencing a significantly higher rate (30.3%) compared to females (12.4%). This gender disparity is consistent with findings from other studies, suggesting that males may have a higher susceptibility to adverse cardiac events due to a combination of genetic, hormonal, and behavioral factors (10). Moreover, the mean age of participants was 35.2 years, highlighting the early onset of CAD in this population and the need for early intervention and management (11).

Comparatively, a study conducted in India reported similar incidence rates of CAD among young adults, emphasizing the regional similarities in risk profiles and disease burden (12). Additionally, the success rate of PCI in our study (92.3%) is consistent with outcomes reported in other settings, reinforcing its efficacy as a primary intervention for young adults with CAD (13). However, the recurrence of MI in patients managed with medical therapy alone was significantly higher (25.3%), indicating the limitations of conservative management in this demographic (14).

The implications of our findings for clinical practice are profound. First, healthcare providers should prioritize early screening and identification of CAD risk factors in young adults to implement timely preventive measures. Second, the high success rate of PCI highlights its role as a preferred intervention for young patients with significant coronary artery blockages, necessitating the availability of advanced interventional facilities in tertiary care centers (15). Third, the study underscores the need for comprehensive lifestyle modification programs targeting smoking cessation, hypertension control, and diabetes management to mitigate the risk of CAD in young adults (16).

Future research should focus on longitudinal studies to track the long-term outcomes of young adults with CAD and evaluate the impact of different management strategies on their quality of life and survival rates. Additionally, investigating the genetic and molecular mechanisms underlying the early onset of CAD in this population could provide valuable insights for developing targeted therapies (17). Moreover, studies exploring the socio-economic factors influencing access to care and adherence to treatment regimens in young adults with CAD are essential to address health disparities and improve outcomes (18).

Limitations

Despite the strengths of our study, including a well-defined cohort and comprehensive data collection, certain limitations must be acknowledged. The observational nature of the study limits the ability to establish causality between risk factors and outcomes. Additionally, the study was conducted in tertiary care hospitals, which may not be representative of the general population, potentially introducing selection bias. Furthermore, the reliance on self-reported data for certain variables, such as smoking status, could lead to reporting bias (19). Future studies with larger sample sizes and multi-center collaborations are warranted to validate our findings and address these limitations (20).

Conclusion

In conclusion, the study highlights the significant burden of CAD among young adults in Pakistan and underscores the critical need for early intervention and effective management strategies. The findings advocate for the prioritization of PCI as a primary intervention and emphasize the importance of addressing modifiable risk factors to improve long-term outcomes. Continued research and targeted public health initiatives are essential to combat the rising incidence of CAD in young adults and enhance their cardiovascular health.

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