Original Article

PRECLINICAL INDICATORS AND DIAGNOSTIC APPROACHES TO MYOCARDIAL INFARCTION IN YOUNG ADULTS-ORIGINAL ARTICLE

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ABSTRACT

Background: Myocardial infarction [MI] in young adults is increasingly recognized as a major public health concern. Unlike older populations, MI in young adults often arises from a complex interplay of traditional and non-traditional risk factors and may remain clinically silent until an acute event occurs. **Objective:** This review aims to summarize the preclinical indicators, underlying pathophysiological mechanisms, and current diagnostic approaches relevant to early identification of myocardial infarction risk in young adults. **Methods:** A narrative review of published literature focusing on myocardial infarction in individuals aged 18–45 years was conducted. Studies addressing pathophysiology, risk factors, screening tools, and diagnostic strategies were analyzed. **Results:** Preclinical indicators such as endothelial dysfunction, autonomic imbalance, subclinical atherosclerosis, inflammatory biomarkers, and genetic predisposition play a critical role in the early development of myocardial infarction in young adults. Diagnostic tools including electrocardiography, biochemical markers, imaging modalities, and risk stratification models aid in early detection, though their routine use in asymptomatic individuals remains debated. **Conclusion:** Early recognition of preclinical indicators combined with targeted diagnostic strategies can improve risk stratification and prevention of myocardial infarction in young adults. Incorporating physiology-based screening approaches may reduce morbidity and mortality in this population.

Keywords: myocardial infarction, young adults, preclinical indicators, screening, diagnosis, cardiovascular risk

INTRODUCTION

Myocardial infarction [MI] has traditionally been considered a disease of older adults; however, recent epidemiological trends demonstrate a rising incidence among young adults worldwide [1].

Young-onset MI is associated with significant long-term morbidity, psychosocial impact, and economic burden due to loss of productive years [2].

Unlike older patients, young adults often present with fewer comorbidities, atypical symptoms, and distinct etiological mechanisms, leading to delayed diagnosis and underestimation of cardiovascular risk [3].

Pathophysiologically, myocardial infarction in young adults involves both atherosclerotic processes and non-atherosclerotic mechanisms such as coronary artery spasm, spontaneous coronary artery dissection, thrombophilia, and substance-induced endothelial injury [4].

Importantly, many of these processes begin years before clinical manifestation, creating a window for early detection through identification of preclinical indicators.Preclinical cardiovascular changes such as endothelial dysfunction, autonomic imbalance, low-grade inflammation, and subclinical plaque formation have been recognized as early contributors to myocardial injury [5].

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Advances in diagnostic modalities and biomarker assessment have improved the ability to detect these early changes. This review focuses on the preclinical indicators and diagnostic approaches relevant to myocardial infarction in young adults, emphasizing the importance of early risk identification and preventive strategies.

MATERIALS AND METHODS

This study was designed as a cross-sectional observational study with an analytical review component, aimed at identifying preclinical indicators and diagnostic approaches related to myocardial infarction in young adults. The study was conducted in the Department of Physiology in collaboration with the Department of Cardiology at a Gandhi Medical college and hospital over a period of 12months [January 2023 to December2023].

A total of 120 young adults aged 18–45 years were included in the study. Group A [At-risk group]: 60 young adults with one or more cardiovascular risk factors such as smoking, obesity [BMI ≥25 kg/m^2], family history of premature coronary artery disease, dyslipidemia, or sedentary lifestyle. Group B [Control group]: 60 apparently healthy age- and sex-matched individuals without known cardiovascular risk factors. Among the control group, 36 participants were male and 24 were female, while the at-risk group comprised 38 males and 22 females. Participants were selected using a convenience sampling method from General outpatient department

Inclusion Criteria- No previous history of myocardial infarction or established coronary artery disease

Exclusion Criteria- Known cardiovascular disease or con-

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genital heart disease, Chronic systemic illness [renal failure, liver disease, autoimmune disorders], Acute infections or inflammatory conditions, Pregnant women

All participants underwent detailed clinical history and anthropometric measurements- Blood pressure recording,Resting 12-lead electrocardiography [ECG],Heart rate variability [HRV] analysis Laboratory investigations including lipid profile, fasting blood glucose, and high-sensitivity C-reactive protein [hs-CRP]. Ethical clearance was obtained from the Institutional Ethics Committee, and written informed consent was taken from all participants.

STATISTICAL ANALYSIS

Data were analyzed using standard statistical software. Continuous variables were expressed as mean ± standard deviation, and comparisons between groups were made using appropriate statistical tests. A p-value <0.05 was considered statistically significant

RESULTS

A total of 120 young adults were included in the study, comprising 60 at-risk individuals and 60 healthy controls. The baseline characteristics of the participants are shown in Table 1

Table 1: Baseline Characteristics of Study Participants

Parameter	At-Risk Group [n = 60]	Control Group [n = 60]	p-value
Age [years]	32.4 ± 6.1	31.8 ± 5.9	>0.05
Male : Female	38:22	36 : 24	>0.05
BMI [kg/m²]	27.6 ± 3.2	22.9 ± 2.8	<0.001
Systolic BP [mmHg]	128.5 ± 10.6	116.3 ± 8.9	<0.001
Diastolic BP [mmHg]	84.2 ± 6.4	74.8 ± 5.7	<0.001

However, body mass index and both systolic and diastolic blood pressure were significantly higher in the at-risk group [p < 0.001]. The distribution of cardiovascular risk factors among the at-risk group is Sedentary lifestyle, overweight/obesity, dyslipidemia, smoking, and family history of premature coronary artery disease were the most commonly observed risk factors.

Table 2: Comparison of Physiological and Biochemical Parameters

Parameter	At-Risk Group	Control Group	p-value
Total Cholesterol [mg/dL]	212.6 ± 34.8	168.4 ± 26.3	<0.001
LDL-C [mg/dL]	138.7 ± 29.5	96.2 ± 21.7	<0.001
HDL-C [mg/dL]	38.6 ± 6.2	48.9 ± 7.4	<0.001
hs-CRP [mg/L]	3.4 ± 1.1	1.2 ± 0.6	<0.001
Fasting Blood Glucose [mg/dL]	104.5 ± 12.3	89.6 ± 9.4	<0.001

Comparison of biochemical and metabolic parameters revealed significantly higher total cholesterol, LDL cholesterol, fasting blood glucose, and hs-CRP levels in the at-risk group, along with lower HDL cholesterol levels [Table 2]. These findings indicate the presence of metabolic and inflammatory alterations in young adults prior to clinical myocardial infarction.

Heart rate variability analysis demonstrated significant autonomic imbalance in the at-risk group, characterized by reduced SDNN and RMSSD values and an increased LF/HF ratio when compared to controls .

Table 3: ECG Findings in Study Participants

ECG Finding	At-Risk Group [n = 60]	Control Group [n = 60]
Normal ECG	44 [73.3%]	58 [96.7%]
Sinus tachycardia	8 [13.3%]	2 [3.3%]
ST-T changes	5 [8.3%]	0
Prolonged QT interval	3 [5.0%]	0

ECG abnormalities were more common in the at-risk group, supporting the role of ECG as a screening tool in young adults.

Electrocardiographic evaluation showed a higher prevalence of subtle abnormalities such as sinus tachycardia, ST-T changes, and prolonged QT interval in the at-risk group, whereas most control participants had normal ECG findings [Table 3].

DISCUSSION

The present study emphasizes the importance of identifying preclinical cardiovascular changes in young adults who are at risk of myocardial infarction. The findings suggest that endothelial dysfunction, autonomic imbalance, and metabolic abnormalities may precede overt clinical manifestations of myocardial infarction by several years.In the current study, young adults with cardiovascular risk factors demonstrated altered physiological and biochemical parameters compared to healthy controls. Similar observations have been reported in previous studies, which highlight that myocardial infarction in young adults is frequently associated with modifiable lifestyle-related risk factors such as smoking, obesity, and dyslipidemia rather than advanced age-related atherosclerosis [6].

Endothelial dysfunction is recognized as an early event in the pathogenesis of atherosclerosis. Ross and Libby described inflammation-mediated endothelial injury as a key contributor to plaque formation and instability, which aligns with the elevated inflammatory markers observed in at-risk young individuals in the present study [7]. Elevated hs-CRP levels have been shown to independently predict cardiovascular events even in younger populations [8]. Autonomic imbalance, reflected by reduced heart rate variability, was evident among participants with risk factors. This finding is consistent with earlier studies by Thayer and Lane, who demonstrated that reduced HRV is associated with increased sympathetic activity and heightened cardiovascular risk [9].

Reduced HRV has also been linked to adverse cardiac outcomes and sudden cardiac death in young adults [10]. Traditional diagnostic tools such as ECG remain essential for detecting acute myocardial infarction but may not be sensitive enough to identify early myocardial injury. Studies by Amsterdam et al. and Greenland et al. have highlighted the role

of combining physiological markers with imaging techniques for improved early detection [11]. In young adults, non-atherosclerotic causes such as coronary artery spasm and spontaneous coronary artery dissection should also be considered, as these conditions may not be detected by conventional screening methods [12].

The findings of this study support previous literature suggesting that targeted screening of high-risk young adults, rather than universal screening, may be a more effective strategy for early identification and prevention of myocardial infarction.

CONCLUSIONS

Myocardial infarction in young adults is a multifactorial condition often preceded by identifiable preclinical indicators. Understanding the underlying pathophysiological mechanisms and applying appropriate diagnostic approaches can facilitate early risk stratification and prevention. A physiology-based, targeted screening approach may play a pivotal role in reducing premature cardiovascular events and improving long-term outcomes in young adults.

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