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Electrocardiographic and Echocardiographic Differences between Very Young and Older Adults with First Acute Myocardial Infarction

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Abstract **Original Research Article**

***Background*:** Acute myocardial infarction (AMI) traditionally affects older adults, but recent trends show increasing prevalence in very young adults. This shift requires comparing diagnostic features across age groups. This study compares electrocardiographic and echocardiographic differences between very young (≤30 years) and older adults (≥50 years) with first acute myocardial infarction. ***Methods*:** This cross-sectional study was conducted in tertiary hospitals in Dhaka, Bangladesh, including the Department of Cardiology at Dhaka Medical College & Hospital, Sir Salimullah Medical College & Mitford Hospital, National Institute of Cardiovascular Diseases (NICVD), and Bangladesh Specialized Hospital (BSH) from July 2022 to December 2023. The study enrolled 160 first AMI patients divided into Group I (≤30 years) and Group II (≥50 years), each with 80 patients. Data collection included structured interviews, clinical evaluation, ECG, and echocardiographic assessments. Statistical analysis used SPSS v26.0, with significance at $p<0.05$. ***Results*:** STEMI was more common in very young adults (61.3% vs. 46.3%), while anterior infarction was more frequent among older patients (18.8% vs. 5.0%, p=0.007). Median LVEF was higher in Group I (47%) than Group II (43%, p=0.046), showing better preserved LV function. However, older patients had "good" systolic function (EF ≥50%). Ventricular fibrillation occurred only in the younger group, while complete heart block was more frequent among them. Most ECG and arrhythmic complications showed no significant age-related differences. ***Conclusion*:** This study reveals age-related differences in ECG and echocardiographic profiles among AMI patients, emphasizing the need for age-adapted diagnostic and management strategies.

Keywords: Acute Myocardial Infarction, STEMI, NSTEMI, Echocardiography, Electrocardiogram.

INTRODUCTION

Acute myocardial infarction (AMI) is still a major reason for morbidity and mortality globally, with millions of cases reported annually and a high burden on the health care system [1]. Although previously regarded as the disease of the middle-aged & older [2, 3]. In South Asia, this trend is more visible as in this region, there is a need for an age-stratified knowledge of the clinical, electrocardiographic (ECG), and echocardiographic profile of AMI [4, 5].

Young adults presenting with AMI have very different risk factors, clinical presentation, and disease progression in comparison to older equivalents. Common risk factors like diabetes, hypertension, and obesity are less common in younger patients. Instead, smoking, dyslipidemia, a positive family history, and an increase in serum homocysteine level [6]. Several studies on South Asians have shown that these patients tend to have improved in-hospital outcomes [7, 8].

Electrocardiographic analysis is very important for rapid diagnosis of AMI [9, 10]. Instead, NSTEMI might be more prevalent among older people with complicated atherosclerotic plaques and advancement of collateral [11]. Additionally, older patients usually present with anterior infarctions and greater ECG abnormalities, a better prognostic outcome [12].

Echocardiography further enhances the diagnostic procedure by assessing left ventricular (LV) systolic function, wall motion abnormalities, and ejection fraction (EF). Age-related differences in echocardiographic features can be observed, with younger patients usually having better preserved LV function and less remodeling [13]. In contrast, older adults may show lower EF, extensive regional wall motion abnormalities, and increased incidence of diastolic dysfunction [14].

Despite this apparent distinction, there is a lack of studies that systematically compare ECG and echocardiographic Characteristics of young (≤30 years) and older adults (≥50 years) presenting with their first episode of AMI. Previous studies from Bangladesh and surrounding areas have mainly been concerned with risk factors or angiographic findings, and little has been done on the diagnostic features, which are age-stratified [6-15]. The majority of such studies are also hampered by small sample sizes or single-center designs, thus affecting the ability to extrapolate their results across the board.

This study was designed to compare electrocardiographic and echocardiographic findings in very young and older individuals suffering their first acute myocardial infarction. This research aims to define the main variations between infarction type, location, ECG abnormalities, and LV systolic function, based on two completely different age groups. The knowledge of these differences is critical for early detection and age-specific risk stratification, and modification of the management strategy, especially for resource-limited settings like Bangladesh, where cardiovascular disease is a growing public health threat.

Objective

The objective of this study was to compare the electrocardiographic and echocardiographic characteristics between very young (≤30 years) and older adults (≥50 years) experiencing their first acute myocardial infarction.

METHODOLOGY & MATERIALS

This cross-sectional observational study was conducted in multiple tertiary care hospitals in Dhaka, Bangladesh, including the Department of Cardiology at Dhaka Medical College & Hospital, Sir Salimullah Medical College & Mitford Hospital, the National Institute of Cardiovascular Diseases (NICVD), and Bangladesh Specialized Hospital (BSH). The study was carried out over 18 months from July 2022 to December 2023. A total of 160 patients diagnosed with first acute myocardial infarction (AMI) were enrolled and divided equally into two groups: Group I (≤30 years) and Group II (≥50 years), each consisting of 80 patients.

Sample Selection

Inclusion Criteria:

- Patients diagnosed with first acute myocardial infarction (either STEMI or NSTEMI)
- Age groups ≤30 years (very young adults) and ≥50 years (older adults)

Exclusion Criteria:

- Age between 31 and 49 years
- Previous history of myocardial infarction or coronary revascularization (PCI, CABG)
- Presence of congenital or valvular heart disease
- Known cases of chronic kidney disease (CKD), heart failure, malignancy, gout, or inflammatory diseases such as rheumatoid arthritis (RA), systemic lupus erythematosus (SLE), or osteoarthritis (OA)
- Chronic alcoholism
- Pregnancy

Data Collection Procedure:

Data collection used a pre-formed semi-structured questionnaire based on patient interviews, clinical examination, and investigations. ECG and echocardiographic assessments documented ST changes, arrhythmias, LVEF, regional wall motion abnormalities (RWMA), and diastolic dysfunction. Venous blood samples were collected in the morning after overnight fasting under aseptic conditions to evaluate biochemical markers. Serum uric acid was measured using an enzymatic kinetic method, vitamin D via radioimmunoassay, and homocysteine through fluorescence polarization immunoassay. Tests included fasting lipid profile, troponin-I, CRP, Hb%, serum creatinine, and electrolytes. Data accuracy was verified before entry into the dataset.

Ethical Consideration:

The study was approved by the Ethical Review Committee of Dhaka Medical College. Written informed consent was obtained from participants after explaining the study's objectives, procedures, risks, and their right to withdraw without consequence. Confidentiality was maintained strictly, with access limited to authorized personnel. No financial compensation was provided, and participation was voluntary.

Statistical Analysis:

Data were checked, cleaned, and analyzed using Statistical Package for the Social Sciences (SPSS), version 26.0. Descriptive statistics were presented as

mean ± standard deviation for normally distributed continuous variables, and median for non-normal distributions. Independent t-test and Mann–Whitney U-test compared continuous variables between age groups. Categorical variables were expressed as frequencies and percentages and analyzed using the Chi-square test or Fisher's exact test. A p-value < 0.05 was considered significant.

RESULTS

Table 1: Comparison of types of first AMI, location of infarction, and other ECG changes between two age groups (N=160)

Variables		Group-I (n = 80)	Group-II (n = 80)	p-value
AMI type	STEMI	49 (61.3)	37 (46.3)	0.057
	NSTEMI	31 (38.8)	43 (53.8)	0.057
Location of infarction	Anterior	4 (5.0)	15 (18.8)	0.007
	Inferior	23 (28.8)	21 (26.3)	0.723
	Lateral	0 (0)	2 (2.5)	0.497
ST depression		45 (56.3)	47 (58.8)	0.749
T-inversion		72 (90)	68 (85)	0.339
Pathological Q		48 (60)	36 (45)	0.057
Tachyarrhythmia		7 (8.8)	4 (5)	0.349
AV block		5 (6.3)	5 (6.3)	0.99
BBB		3 (3.8)	3 (3.8)	0.99

Table 1 compares AMI type, infarction location, and ECG changes between very young (Group I) and older adults (Group II). STEMI was more common in younger patients (61.3% vs. 46.3%), while NSTEMI predominated in older adults (53.8% vs. 38.8%), though not statistically significant (p = 0.057). Anterior wall infarction was significantly higher in older adults (18.8% vs. 5%, p = 0.007). Other ECG features, including ST depression, T-wave inversion, pathological Q waves, and arrhythmias, showed no significant differences between groups.

Table 2: Echocardiographic Left Ventricular Measurements Between Two Age Groups (N=160)

Parameter	Group-I (≤30 years) Median (mm/%)	Group-II (≥50 years) Median (mm/%)	p-value
LVIDd (mm)	42	42	0.182
LVIDs (mm)	28	28	0.705
LVEF (%)	47	43	0.046

Table 2 compares echocardiographic parameters between younger (Group I: ≤30 years, n = 80) and older (Group II: ≥50 years, n = 80) acute MI patients. Median LVIDd was 42 mm in both groups (p = 0.182), and median LVIDs was also the same at 28 mm (p = 0.705). However, Group I had a significantly higher median LVEF of 47% compared to 43% in Group II (p = 0.046), indicating relatively better-preserved systolic function in the younger cohort.

Table 3: Left Ventricular Systolic Function Categories between Two Age Groups (N=160)

LV Systolic Function	Group-I (n = 80) Frequency (%)	Group-II (n = 80) Frequency (%)	p-value
Good (EF ≥50%)	4 (5)	16 (20)	0.023
Mild dysfunction (EF 40–49%)	62 (77.5)	48 (60)	
Moderate dysfunction (EF 30–39%)	8 (10)	11 (13.8)	
Severe dysfunction (EF <30%)	6 (7.5)	5 (6.3)	

Table 3 shows the distribution of LV systolic function based on EF categories. In Group I (≤30 years), 4 patients (5%) had good systolic function (EF ≥50%), compared to 16 patients (20%) in Group II (≥50 years), with the difference being statistically significant (p = 0.023). The majority in both groups had mild dysfunction (EF 40–49%): 62 patients (77.5%) in Group I and 48 patients (60%) in Group II. Moderate dysfunction (EF 30–39%) was seen in 8 patients (10%) and 11 patients (13.8%) in Group I and Group II, respectively. In comparison, severe dysfunction (EF <30%) occurred in 6 patients (7.5%) in Group I and 5 patients (6.3%) in Group II.

Table 4: ECG-Related Complications in Very Young (Group I) and Older Adults (Group II) with First AMI (N=160)

ECG-Related Complication	Group-I (≤30 years) Frequency (%)	Group-II (≥50 years) Frequency (%)	p-value
Tachyarrhythmia	9 (11.3)	6 (7.5)	0.401
Ventricular Tachycardia (VT)	6 (7.5)	6 (7.5)	
Ventricular Fibrillation (VF)	3 (3.8)	0 (0)	
Bradyarrhythmia	14 (17.5)	11 (13.8)	0.536
1st degree AV block	2 (2.5)	3 (3.8)	
2nd degree AV block	1 (1.3)	2 (2.5)	
Complete Heart Block (CHB)	8 (10.0)	3 (3.8)	
Bundle Branch Block (BBB)	3 (3.8)	3 (3.8)	

Table 4 shows ECG-related complications in both age groups. Tachyarrhythmia and bradyarrhythmia were slightly more frequent in younger patients, but not statistically significant (p = 0.401 and 0.536, respectively). Ventricular fibrillation occurred only in the younger group (3.8%), and complete heart block was more common in younger patients (10% vs. 3.8%). Other conduction blocks and BBB were similar between groups.

DISCUSSION

This study aimed to compare electrocardiographic and echocardiographic characteristics of very young (≤30 years) and older adults (≥50 years) presenting with their first AMI, for the demonstration of age-related differences in patterns of infarction, ECG changes, and LV systolic function.

It was noteworthy that in younger patients, there was a greater frequency of ST-elevation myocardial infarction (STEMI), and in older people, non-ST-elevation myocardial infarction (NSTEMI) prevailed. This is consistent with the findings of Alexander *et al*., who reported that young STEMI patients of the Tamil Nadu STEMI program frequently presented with thrombotic occlusions and less extensive atherosclerosis [10]. The high prevalence of STEMI among the younger population may be a reflection of acute plaque rupture without prior collateral accommodation. At the same time, older patients with higher chronic atherosclerotic burden are better predisposed to develop NSTEMI because of partial occlusions or supply-demand incongruities (Al-Khadra) [16].

Anterior wall infarction was much more common in our cohort among older patients. It was consistent with Anjum *et al*., who reported extensive anterior infarct in older age groups secondary to diffuse atherosclerosis of the left anterior descending artery [14]. On the other side, the younger patients were more likely to have inferior infarctions or non-anterior localizations. This may be explained by variable coronary involvement patterns among young patients, with common single-vessel disease involving right coronary pathologies (Pandey *et al*.,) [8].

Surprisingly, although pathological Q waves were found slightly more often among younger patients, differences were not statistically significant. This is supported by previous studies by Akanda *et al*., who note the variability in ECG features with that age group of patients with AMI [9]. T-wave inversions, ST depressions were similar across groups, a result echoed by Khan *et al*., who reported that ECG abnormality was insensitive as an age-stratified measure of infarct severity without concordance with CT-ray perfusion [11].

As for arrhythmias and conduction disturbances, the frequency of tachyarrhythmia and bradyarrhythmia in younger patients was slightly increased but not statistically significant. Notably, only in the younger group was ventricular fibrillation reported, and complete heart block was also more common in this group. This finding is consistent with findings of Tamrakar *et al*., which showed that arrhythmic complications could be less predictable in younger patients, probably due to autonomic imbalance, high sympathetic tone, or lack of ischemic preconditioning [12].

Echocardiographic comparisons showed that younger patients demonstrated a significantly higher left ventricular ejection fraction (LVEF) when compared to older adults, and this was suggestive of preserved systolic function. This is a very important observation because it may at least explain the lower short-term mortality that is often reported among younger patients suffering from AMI (Malik *et al*.,) [7]. Our findings support those of Gopalakrishnan *et al*., who showed better LVEF and fewer regional wall motion abnormalities in patients under 30 years [13].

But when LVEF is divided into systolic function, a paradox was seen: The median LVEF was higher in the younger group, although the proportion of those with "good" systolic function (EF ≥50%) was significantly lower when compared to older adults. The majority of the younger patients were in mild dysfunction category. This subtle finding may indicate that although global systolic function is preserved somewhat in younger patients, functional consequences of infarcts may be underappreciated because of the

smaller myocardial mass or compensatory hyperkinesis in nonaffected regions (Shah *et al*.,) [17].

Another important aspect to be considered is the probable effect of risk factor profiles. Very young patients are sometimes more likely to smoke, have high serum homocysteine, or be endowed with thrombophilic genetic markers, which are risk factors for acute thrombotic occlusion rather than chronic atherosclerotic disease (Begum *et al*., and Sherpa *et al*.,) [6-18]. These unique pathophysiological mechanisms may cause varied infarct patterns and recovery profiles compared to the older ones, who frequently present with multivessel disease and cause structural remodeling (Laudari *et al*.,) [15].

These age-related differences from a clinical perspective highlight a need for a more individualized diagnostic and therapeutic strategy. For instance, patients of a young age and with STEMI and relatively preserved EF can still have the danger of malignant arrhythmias, as our data on VF denotes. On the other hand, from the age of 50 years, careful monitoring of progressive LV dysfunction and anterior infarctions, related to higher long-term mortality, is necessary (Adhikari *et al*.,) [19].

The findings also reveal the limitations of using either ECG or EF alone in the assessment of AMI's severity across age groups. The inconsistency of absolute EF values in comparison to functional categories revealed in this study implies that integral assessments such as strain imaging or cardiac MRI could be superior at delineating myocardial injury, particularly in younger individuals.

This study reinforces the urgent need for preventive cardiac measures in the younger population. The increasing trend of AMI among this very young age group in South Asia, where modifiable risk factors often trigger this, demands early screening, lifestyle interventions, and public health policy countermeasures for smoking, dyslipidemia, and sedentary behavior.

Limitations and Recommendations

This study was limited by its cross-sectional design, modest sample size, and exclusion of patients aged 31-49 years, affecting generalizability. Advanced imaging, like cardiac MRI or strain echocardiography, was not used to assess myocardial damage. Future research should include larger, multicenter cohorts and longitudinal follow-up to evaluate long-term outcomes. Including intermediate age groups and broader clinical variables may help refine risk stratification. Preventive strategies targeting modifiable risk factors among youth should be prioritized through public health interventions.

CONCLUSION

This study revealed significant electrocardiographic and echocardiographic differences between very young and older adults with first acute myocardial infarction. STEMI was more prevalent in younger patients, while anterior infarction and reduced ejection fraction were more frequent in older patients. Although young patients had better-preserved LV function, they showed higher rates of ventricular fibrillation and complete heart block. These findings underscore the importance of age-specific strategies to improve outcomes across age groups.

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Ethical Approval: The study was approved by the Institutional Ethics Committee.

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