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Original Article

Internal Medicine Section

Impact of Diabetes on Clinical Characteristics and Angiographic findings in Young Adults with ST-Elevation Myocardial Infarction: A Cross-sectional Study

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ABSTRACT

Introduction: The prevalence of diabetes among young patients with ST-Elevation Myocardial Infarction (STEMI) is increasing, but its impact on this population remains understudied. Limited data on diabetes in young patients with STEMI exist. The presence of diabetes among young patients experiencing STEMI deserves special consideration, as it manifests with unique clinical patterns and can significantly impact their active lifestyle.

Aim: To determine the effect of diabetes and associated clinical characteristics in young patients with STEMI.

Materials and Methods: A cross-sectional study was conducted at a tertiary care centre in India between April 2018 and December 2019. Fifty-one STEMI patients aged below 40 years were enrolled and categorised into diabetic (n=23) and non diabetic (n=28) groups based on glycated haemoglobin (HbA1c) levels. Clinical characteristics, laboratory parameters and angiographic findings were compared between the groups. This study analysed continuous variables using Student's t-test and Analysis of Variance (ANOVA) (expressed as mean±SD), and categorical variables using Chi-square or Fisher's exact tests (shown as n, %). A p-value of <0.05 was considered significant.

Results: The mean age was 35.6±3.4 years, with 80.4% male predominance. Diabetic patients showed higher prevalence of dyslipidaemia (p-value=0.009), hypertension (p-value=0.043), and metabolic syndrome (p-value=0.002). They also exhibited significantly higher levels of total cholesterol, triglycerides and Low-Density Lipoprotein Cholesterol (LDL-C). Anterior Wall Myocardial Infarction (AWMI) was predominant in both groups (p-value=0.442). Single-Vessel Disease (SVD) was most common, but Triple-Vessel Disease (TVD) was observed exclusively in diabetic patients (p-value=0.198). The Left Anterior Descending (LAD) artery was the most involved vessel in both groups.

Conclusion: Compared to non diabetic patients, young STEMI patients with diabetes demonstrated a more adverse cardiovascular risk profile and lipid abnormalities.

Keywords: Coronary artery disease, Glucose, Risk factors, Smoking

INTRODUCTION

Acute Myocardial Infarction (AMI) continues to be a significant global health concern, despite its declining incidence in developed nations [1]. Among the various forms of AMI, STEMI stands out as a particularly lethal variant, contributing substantially to cardiovascular mortality rates. The occurrence of STEMI in younger populations is of special interest because of its unusual features and devastating effect on their more active lifestyle [2]. While the literature shows some variation in defining "young" patients, the most widely accepted cut-off age is generally considered to be 45 years and under [3].

Recent literature highlights diabetes and smoking as significant risk factors for STEMI in young patients. While diabetes prevalence is rising across all age groups, young adults have experienced the most pronounced increase [4]. Epidemiological data consistently demonstrate a global upward trend in diabetes mellitus incidence, particularly among younger populations [5]. In a research by Zhou M et al., 26.9% of young STEMI patients were found to have diabetes [6]. Furthermore, previous research indicates that young diabetic patients may face more than triple the risk of developing STEMI compared to their non diabetic patients [4]. These findings underscore the growing importance of understanding and addressing diabetes as a critical risk factor in young patients with STEMI.

Research has demonstrated variations in both risk factor profiles and coronary angiographic findings among patients presenting with STEMI. While numerous studies have explored the clinical characteristics of STEMI patients [1,3], there remains a paucity of data specifically examining the effect of diabetes in young STEMI patients. Understanding the prevalence and impact of diabetes in this demographic could potentially inform more effective management approaches and improve prognostic outcomes for young STEMI patients. Young patients with STEMI who also have diabetes consistently experience worse long-term outcomes, including higher rates of death from both cardiovascular causes and diabetic causes. Therefore, the present study aimed to determine the effect of diabetes and associated clinical characteristics in young patients with STEMI.

MATERIALS AND METHODS

A cross-sectional study was conducted at tertiary care centre (Deccan College of Medical Science and Allied Hospitals) in India between April 2018 and December 2019. The study was approved by the Institutional Review Board (IRB No: 2018/21/019), and written informed consent was obtained from all the patients.

Inclusion criteria: A total of 51 patients with STEMI, whose ages were below 40 years, were included in the present study.

Exclusion criteria: Patients with unstable angina, NSTEMI, and stable angina were excluded from the study.

Sample size estimation: The sample size for this study was determined based on the prevalence rate of 25.6% [7] for STEMI

patients. To achieve a power of 80% and a significance level (alpha) of 0.05 for a two-sided test, a sample size of 51 subjects was required. This calculation was performed using a two-sided exact binomial test.

Formula: $n = \{(Z\alpha_{/2} * \sqrt{(p_0 * (1-p_0))} + Z\beta * \sqrt{(p_1 * (1-p_1))})/(p1-p_0)\}^2$

n: sample size

$Z\alpha_{/2}$: Z-score corresponding to the significance level (e.g., 1.96 for a 95% confidence level).

Zβ: Z-score corresponding to the desired power (e.g., 80% power).

p_0: is the known proportion

p_1: is the hypothesised proportion.

Data collection and definition: All patients underwent comprehensive evaluation, including detailed medical history. The STEMI was defined according to international guidelines [8-10] as persistent angina pectoris for ≥20 minutes, accompanied by ST-segment elevation in two contiguous leads: ≥0.25 mV in men below 40 years, ≥0.15 mV in women in leads V2–V3, and/or ≥0.1 mV in all other leads. Diabetes mellitus was classified based on the American Diabetes Association (ADA) [11,12] definitions using HbA1c levels: patients whose HbA1c was ≥6.5% were consider as diabetic. Based on glucose levels, patients were categorised into two groups: diabetes and non diabetes. Smoking history was assessed, including the number of packs consumed per day. All patients underwent electrocardiography, two-dimensional echocardiography and coronary angiography to assess cardiac function and coronary artery status with diabetes. Also, the association between smoking intensity and the extent of Coronary Artery Disease (CAD) was analysed.

STATISTICAL ANALYSIS

Statistical analysis was performed using R software version 4.3.3 (The R Foundation, Vienna, Austria). Continuous variables were expressed as mean and standard deviation and compared using Student's t-test and ANOVA. Categorical variables were presented as numbers and percentages in the tables and compared using the Chi-square test or Fisher's exact test test. All reported p-values were two-sided, with values <0.05 considered as statistically significant.

RESULTS

The study included 51 patients (23 with diabetes and 28 non diabetic), with a mean age of 35.6±3.4 years and predominantly male composition (41, 80.4%). The smoking history, quantified as pack-years, was similar between the two groups (7.2±6.3 vs. 5.5±6.1, p-value=0.354). When categorised, the distribution of pack-years was comparable across both groups (p-value=0.835), with the largest proportion of patients (n=21, 41.2%) being non smokers.

Analysis of cardiovascular risk factors revealed significant differences between diabetic and non diabetic patients in the prevalence of dyslipidaemia (n=15, 65.2% vs. n=8, 28.6%, p-value=0.009), hypertension (n=9, 39.1% vs. n=4, 14.3%, p-value=0.043), and metabolic syndrome (n=7, 30.4% vs. 0, p-value=0.002) [Table/Fig-1]. Diabetic patients exhibited significantly higher levels of total cholesterol (p=0.008), triglycerides (p=0.034), and LDL-C (p-value=0.042). High-Density Lipoprotein Cholesterol (HDL-C) levels were slightly lower in diabetic patients, but this difference was not statistically significant (p-value=0.089). [Table/Fig-2] detailed about laboratory and angiographic profiles in diabetic and non diabetic young patients with STEMI.

Angiographic profiles showed a higher prevalence of SVD in diabetic patients (n=14, 60.9% vs. n=15, 53.6%, p-value=0.601) and Double-Vessel Disease (DVD) (n=5, 21.7% vs. n=3, 10.7%, p-value=0.442), while TVD was exclusively observed in diabetic patients (n=2, 8.7% vs. 0, p-value=0.198). The Left Anterior Descending (LAD) artery was the most involved vessel in both groups, with a slightly higher prevalence in non diabetic patients (n=19, 67.9% vs. n=13, 56.5%, p-value=0.405).

Variables	Total (N=51 patients)	Diabetes (n=23 patients)	Non diabetes (n=28 patients)	p-value
Age, years	35.6±3.4	36.6±3.0	34.9±3.7	0.077
Male	41 (80.4)	17 (73.9)	24 (85.7)	0.316
Pack years	6.3±6.2	7.2±6.3	5.5±6.1	0.354
Pack years categories				
0	21 (41.2)	8 (34.8)	13 (46.4)	0.835
1-5	3 (5.9)	1 (4.3)	2 (7.1)	
5-10	10 (19.6)	6 (26.1)	4 (14.3)	
10-15	13 (25.5)	6 (26.1)	7 (25.0)	
15	4 (7.8)	2 (8.7)	2 (7.1)	
Risk factor				
Smoking	30 (58.8)	15 (65.2)	15 (53.6)	0.400
Dyslipidaemia	23 (45.1)	15 (65.2)	8 (28.6)	0.009
Alcohol	26 (51.0)	11 (47.8)	15 (53.6)	0.683
Hypertension	13 (25.5)	9 (39.1)	4 (14.3)	0.043
Metabolic syndrome	7 (13.7)	7 (30.4)	0	0.002
Family history of CAD	8 (15.7)	2 (8.7)	6 (21.4)	0.269

[Table/Fig-1]: Baseline characteristic comparison based on diabetes and non-diabetes among young patients with STEMI.
CAD: Coronary artery disease; The data are represented as n (%) and mean±SD. p-value <0.05 was considered statistically significant

Variables	Total (N=51 patients)	Diabetes (n=23 patients)	Non-diabetes (n=28 patients)	p-value
Total cholesterol, mg/dL	206.5±48.0	225.7±53.4	190.6±37.0	0.008
Triglycerides, mg/dL	179.2±79.6	205.1±95.0	158±57.8	0.034
LDL, mg/dL	131.0±20.1	137.3±21.7	125.9±17.4	0.042
HDL, mg/dL	40.1±4.3	39.0±40.3	41±43.4	0.089
Ejection fraction, %	42.0±6.5	40.3±6.5	43.4±6.2	0.091
Ejection fraction				
<30	3 (5.9)	2 (8.7)	1 (3.6)	0.324
31-40	20 (39.2)	9 (39.1)	11 (39.3)	
41-49	21 (41.2)	11 (47.8)	10 (35.7)	
>50	7 (13.7)	1 (4.3)	6 (21.4)	
HBA1C, %	6.9±1.2	7.8±225.7	6.2±190.6	<0.001
Myocardial Infarction (MI)				
Anterior wall MI	43 (84.3)	18 (78.3)	25 (89.3)	0.442
Inferior wall MI	8 (15.7)	5 (21.7)	3 (10.7)	0.442
Angiographic profile				
SVD	29 (56.9)	14 (60.9)	15 (53.6)	0.601
DVD	8 (15.7)	5 (21.7)	3 (10.7)	0.442
TVD	2 (3.9)	2 (8.7)	0 (0.0)	0.198
Other[#]	12 (23.5)	2 (8.7)	10 (35.7)	0.234
Vessels involved				
LAD	32 (62.7)	13 (56.5)	19 (67.9)	0.405
LCX	5 (9.8)	4 (17.4)	1 (3.6)	0.162
RCA	3 (5.9)	1 (4.3)	2 (7.1)	>0.999
Other[&]	11 (21.6)	5 (21.7)	6 (21.4)	>0.999

[Table/Fig-2]: Laboratory and angiographic profile in diabetic and non diabetic young patients with STEMI.
DVD: Double vessel disease; HbA1C: Glycated haemoglobin; HDL: High density lipoprotein; LAD: Left anterior descending artery; LCX: Left circumflex artery; LDL: Low density lipoprotein; MI: Myocardial infarction; RCA: Right coronary artery; SVD: Single vessel disease; TVD: Triple vessel disease; #Other: Slow flow in LAD and LCX, Thrombus in mid right coronary artery, Recanalized LAD, Ectatic slow flow, Spontaneous dissection of LAD; [&]Other: slow flow in LAD and Lcx, Thrombus in mid right coronary artery, Recanalized LAD, Ectactic slow flow, Spontenous dissection of LAD; The data are represented as n (%) and mean±SD; p-value <0.05 was considered statistically significant

The study examined the relationship between pack-years of smoking and the extent of CAD in the young patient with STEMI [Table/Fig-3]. Among patients with SVD (n=29), 10 (34.5%) were non smokers, while eight of them (27.6%) had smoked for 10-15 pack years, and 7 (24.1%) for 5-10 pack years. [Table/Fig-4] demonstrates angiographic profile in patients with both co-morbidities. A significant association was observed between smoking combined with diabetes and the extent of vessel disease (p-value=0.015). The prevalence of smoking combined with diabetes was highest in TVD patients (100%, 2/2), followed by DVD (37.5%, 3/8) and SVD (34.5%, 10/29) patients.

Pack years	SVD (n=29 patients)	DVD (n=8 patients)	TVD (n=2 patients)	Other (n=12 patients)	p-value
Non smoker	10 (34.5)	2 (25.0)	0	9 (75.0)	0.204
1-5	2 (6.9)	1 (12.5)	0	0	
5-10	7 (24.1)	1 (12.5)	1 (50.0)	1 (8.3)	
10-15	8 (27.6)	3 (37.5)	0	2 (16.7)	
≥15	2 (6.9)	1 (12.5)	1 (50.0)	0	

[Table/Fig-3]: Univariate analysis of pack years of smoking and angiographic profile.
The data are represented as n (%). p-value <0.05 was considered statistically significant DVD: Double vessel disease; SVD: Single vessel disease; TVD: Triple vessel disease

Smoking + Diabetes mellitus	Other (n=12)	SVD n=29	DVD (n=8)	TVD (n=2)	p-value
	0	10 (34.5%)	3 (37.5%)	2 (100.0%)	0.015

[Table/Fig-4]: Angiographic profile in patients with both comorbidities.
The data are represented as n (%); p-value <0.05 was considered statistically significant; DVD: Double vessel disease; SVD: Single vessel disease; TVD: Triple vessel disease

Of the total 51 patients, 11 patients (21.6%) received thrombolysis therapy only, 31 patients (60.8%) underwent thrombolysis with single-stent Percutaneous Transluminal Coronary Angioplasty (PTCA), seven patients (13.7%) underwent thrombolysis with two-stents PTCA, and two patients (3.92%) were treated with Coronary Artery Bypass Grafting (CABGs).

DISCUSSION

The present study demonstrated that among young patients with STEMI, those with diabetes demonstrated higher cardiovascular risk factors and more severe lipid disorders than their non diabetic counterparts. The present study observed 45.09% of STEMI patients having diabetes. While previous studies on young STEMI patients have primarily focused on comparing various risk factors, they have consistently identified smoking, dyslipidaemia, and obesity as predominant cardiovascular risk factors in this age group [3,13]. Traditionally, diabetes and hypertension were observed at lower rates in younger patients, as the incidence of these metabolic risk factors typically increases with age [14]. However, recent research has noted a concerning trend: an increase in the prevalence of diabetes among young STEMI patients [5]. This shift in demographics is particularly alarming given that a recent study done by Mata Marín LA et al., has reported higher mortality rates among young diabetic patients with STEMI [5]. Previous research by Megayl M et al., has demonstrated that diabetes is associated with significantly worse outcomes in patients with STEMI compared to their non diabetic group [15]. Given these trends, it is crucial to gain a deeper understanding of the clinical characteristics of young diabetic patients with STEMI. This knowledge can potentially help doctors provide targeted strategies to mitigate adverse outcomes in these patients.

While dyslipidaemia is a well-established risk factor for STEMI, literature has illuminated the complex interplay between diabetes and lipid metabolism, potentially exacerbating cardiovascular risk. Both Type 1 and Type 2 diabetes mellitus with poor glycaemic control have been associated with adverse changes in lipid profiles. Specifically, these changes include elevated serum triglyceride levels, increased Very Low-Density Lipoprotein (VLDL), and decreased HDL-C levels. Moreover, suboptimal glycaemic control can lead to a modest increase in LDL-C, which can be due to the concurrent elevation in triglyceride. Additionally, insulin exerts direct effects on adipose tissue and skeletal muscle, further influencing lipid metabolism [16]. The present study correlates with these findings, demonstrating that diabetic patients with STEMI exhibited higher levels of total cholesterol, LDL-C and triglycerides compared to their non diabetic patients. This study also observed lower HDL-C levels in the diabetic group, consistent with the adverse lipid profile associated with diabetes.

While smoking is a well-established predominant risk factor for young patients with STEMI, the combination of smoking and diabetes potentially leads to more severe complications. Nicotine from cigarette smoking can impair cellular insulin responsiveness, resulting in elevated blood glucose levels [17]. The present study observed that approximately 65.2% of diabetic patients were also smokers, highlighting the frequent co-occurrence of these risk factors. Consistent with previous research on young STEMI patients, this study observed a prevalence of single-vessel involvement in both diabetic and non diabetic groups [1,14]. Specifically, TVD was exclusively observed in patients with diabetes. This finding aligns with research conducted by Megaly M et al., which demonstrated a higher prevalence of TVD among diabetic patients (36%) compared to their non diabetic counterparts (22%) [15]. However, a striking pattern emerged when examining vessel involvement in relation to co-morbidities. All patients presenting with TVD were found to have both diabetes and a history of smoking. This observation suggests a potential synergistic effect between these two risk factors in the development of more extensive CAD.

Left Ventricular Ejection Fraction (LVEF) is a widely used parameter for risk stratification in cardiac patients. In the present study, the mean LVEF across all patients was 42.0±6.5%, with no significant difference observed between diabetic and non diabetic groups. This finding aligns closely with Deshmukh PP et al., study that have reported mild to moderate left ventricular dysfunction in young STEMI patients, with mean LVEF values ranging from 37 to 55% [18]. The observed left ventricular dysfunction can be largely attributed to the high prevalence of AWMI. Most patients in the present study, specifically 84.3%, were diagnosed with AWMI, which corresponds to occlusion in the territory supplied by the LAD artery. This preponderance of AWMI as the most common STEMI pattern was consistent with observations from other studies focusing on young patients with AMI [1,14,18]. Interestingly, present study's angiographic profile revealed a higher prevalence of AWMI and LAD involvement irrespective of diabetic status in young patients. This finding suggests that the LAD artery may be particularly vulnerable in younger individuals experiencing STEMI, regardless of their metabolic profile.

Limitation(s)

The single centre of the study may limit its generalisability. Future multicentre studies with larger sample sizes could further validate these findings. Additionally, long-term follow-up studies are needed to assess the impact of these factors on long-term outcomes in young STEMI patients. The study did not include a comparison group of older STEMI patients or age-matched controls without STEMI, which could have provided additional context for the findings. The combined effect of diabetes and smoking together in young patients with STEMI can give better understanding for future study.

CONCLUSION(S)

Young STEMI patients with diabetes exhibited a more significant cardiovascular risk profile and lipid abnormalities compared to non

diabetic patients. The high prevalence of AWMI and LAD artery involvement across both diabetic and non diabetic groups indicates a particular vulnerability of this vessel in young STEMI patients. SVD was most common among all the patients with STEMI, but TVD occurred only in diabetic smokers. This unique distribution highlights the combined impact of diabetes and smoking on coronary artery involvement.

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