Original Article

Association between ST-segment depression and angiographic severity of coronary artery disease in patients with non-ST-segment elevation MI

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Abstract

Introduction: Non-ST-segment elevation myocardial infarction (NSTEMI) patients account for a significant proportion of patients hospitalized in coronary care units. The earliest and most straightforward objective data for non-ST-segment elevation acute coronary syndrome (NSTEACS) risk classification is provided by a 12-lead electrocardiogram (ECG). We made an effort to find out the association between the magnitude of ST-segment depression and angiographic severity in NSTEMI patients.

Methods: This cross-sectional study was conducted in the Department of Cardiology of Dhaka Medical College & Hospital, Dhaka, for 12 months following ethical approval. A total of 120 patients with NSTEMI who were admitted during the study period and underwent a coronary angiogram were included in the study. According to the degree of ST-segment depression, patients were divided into three groups: Group I (no or less than 1 mm ST-segment depression), Group II (1-2 mm ST-segment depression), and Group III (> 2 mm ST-segment depression). Angiographic severity of coronary artery disease (CAD) was assessed by 3 scoring systems - Vessel score, Gensini score, and Friesinger index. According to the Gensini score, the severity of CAD was assessed and categorized into two groups: Normal or mild CAD (Gensini score ≤ 36), Significant CAD (Gensini score >36). According to the Friesinger index, the severity of CAD was assessed and categorized into two groups: significant CAD (Friesinger index ≥5) and insignificant CAD (Friesinger index <5). The magnitude of ST-segment depression was compared with the angiographic severity of CAD.

Results: The mean age of the study population was 52.7±10.1 years. Male patients were predominant. Male-female ratio was 4.45:1. Smoking (58.3%) was the most prevalent risk factor, followed by dyslipidaemia (54.2%), hypertension (46.7%) & positive family history of premature CAD (40.8%). Mean Vessel score of NSTEMI patients was 1.3±.0.8, 2.3±0.9, and 2.4±0.8 in Group I, Group II, and Group III, respectively. Mean Gensini score was 29.0±.30.4, 55.4±22.9, and 85.7±39.7 in Group I, Group II, and Group III, respectively. Mean Friesinger index was 5.3±.3.2, 9.7±3.5, and 10.7±3.17 in Group I, Group II, and Group III, respectively. The differences among the groups were statistically significant. The cumulative sum of ST segment depression showed a positive correlation with Vessel score ($r=0.64$; $p< 0.001$), Gensini score ($r=0.72$; $p< 0.001$), and Friesinger index ($r=0.66$; $p< 0.001$).

Conclusion: This study demonstrated a strong correlation between the degree of coronary artery disease and the amplitude of ST-segment depression. The severity of coronary artery disease was also found to be substantially linked with the cumulative amount of ST-segment depression.

Keywords: NSTEMI, ST-segment depression, coronary artery disease severity.

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Introduction

Non-ST elevation myocardial infarction (NSTEMI) is the most common presentation of acute coronary syndrome and a leading cause of hospital admission [1]. It results from non-occlusive thrombus on pre-existing stable plaque, dynamic obstruction, or progressive mechanical obstruction. It may also occur because of severe fixed narrowing of the coronary artery without spasm or thrombosis. Rarely, NSTEMI may be caused by coronary

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dissection or vasculitis [2]. Many of the mechanical, cellular, and molecular factors that contribute to plaque disruption resulting in NSTEMI have been elucidated in recent years.

Some factors modulate the development and complications of NSTEMI. The important factors are [3]: Location and severity of the culprit coronary lesion; extent of the plaque rupture or erosion and extent of collaterals; micro embolization and micro vascular obstruction; platelet aggregability and reactivity, thrombotic factor, and blood viscosity; heart rate, blood pressure, and blood lipid level; catecholamine level (smoking, cocaine, stress).

Patients with NSTEMI typically have more comorbidities, both cardiac and non-cardiac, than patients with STEMI [4]. In patients with NSTE-ACS, in-hospital mortality is 3-5%. It is lower than that of those with STEMI, which comprises 7%. But, at 6 months, the mortality rates are very similar in both conditions, comprising 13% and 12%, respectively. Long-term follow-up showed that the death rates were higher among patients with NSTE-ACS than with STEMI, with a twofold difference at 4 years [5].

The ST-segment depression on admission ECG of patients with NSTEMI is associated with higher adverse in hospital outcome and mortality [6]. Magnitude of ST segment depression was positively correlated with the angiographic severity of CAD in NSTEMI [7]. Patients with ST segment depression ≥2 mm in more than one region were almost 10 times more likely to die within one year than patients with no ST segment depression [8]. The aim of our study was to find out the association between the magnitude of ST-segment depression and angiographic severity in NSTEMI patients.

Methods

This cross-sectional study was conducted in the Department of Cardiology of Dhaka Medical College & Hospital, Dhaka. The study period was 12 months following the approval of the proposal. A total of 120 patients with NSTEMI who were admitted to the Department of Cardiology at Dhaka Medical College and Hospital during the study period and underwent a coronary angiogram were included in the study, provided they met the inclusion and exclusion criteria. Patients with ST-segment elevation in admission electrocardiography (ECG) or appearance of new ST-segment elevation over the course of hospital stay, ventricular hypertrophy, bundle branch block, paced rhythm, Wolf-Parkinson-White syndrome, previous percutaneous coronary angioplasty (PTCA) or coronary artery bypass grafting (CABG) cases, serious comorbid conditions like chronic kidney disease or cerebrovascular disease were excluded from the study. After selection, subjects were thoroughly briefed on the aims, objectives, and procedures of the study, following which informed written consent was obtained from all participants. A pre- tested, semi-structured questionnaire was developed and utilized for data collection. Patients were assessed first by the attending doctor and then evaluated by the principal investigator. Twelve lead standard surface ECG and cardiac biomarker (Troponin–I) were done. ST-segment shifts were measured in all leads at 80 ms after the J point for ST-segment depression. 12-lead ECG was analyzed and divided into three groups: Group 1: <1 mm ST segment depression, Group 2: 1-2 mm (≥ 1 to < 2 mm) ST segment depression in two or more contiguous leads, Group 3:> 2 mm ST segment depression in two or more contiguous leads. The distribution of ST-segment depression was examined in three regions: anterior (V1 to V4), inferior (leads II, III, aVF), and lateral leads (leads 1, aVL, V5, V6). Demographic profile, pulse, blood pressure, body weight, and body mass index (BMI) were measured. Risk factors of ischaemic heart disease (IHD), like hypertension, smoking, dyslipidaemia, diabetes mellitus, obesity, and positive family history of premature coronary artery disease were (CAD) noted. Drug history was taken regarding antiplatelets, anti-ischaemic, antihypertensive, antidiabetic, and lipid-lowering drugs. Baseline laboratory investigation, e.g., cardiac biomarker, serum creatinine, random blood sugar (RBS)/ fasting blood sugar (FBS), ECG, and echocardiography, was done. A coronary angiogram with standard procedure was done in all patients who fulfilled the criteria. Angiographic severity of CAD was assessed by 3 scoring systems - Vessel score, Gensini score, and Friesinger index. According to the Gensini core, the severity of CAD was assessed and categorized into two groups: Normal or mild CAD (Gensini score ≤ 36), Significant CAD (Gensini score >36). According to the Friesinger index, the severity of CAD was assessed and categorized into two groups: significant CAD (Friesinger index ≥5) and insignificant CAD (Friesinger index <5).The magnitude of ST-segment depression was compared with the angiographic severity of CAD. All statistical analysis was performed using the Statistical Package for social science (SPSS) program, version 21 for Windows. Data were presented as frequencies and percentages for categorical variables and as means with standard deviations for quantitative variables. Categorical variables were analyzed by chi-squire test. Quantitative variables were analyzed by t-test or ANOVA. Pearson's correlation test assessed the relationship between the magnitude of ST-segment depression and angiographic severity. The significance of the results, as determined in 95% confidence interval and a value of $p < 0.05$, was considered to be statistically significant.

Results

A total of 120 patients with NSTEMI were included in the study and divided into three groups as mentioned below: Group I (<1mm ST segment depression), Group II (1-2 mm ST segment depression), and Group III (>2 mm ST segment depression).

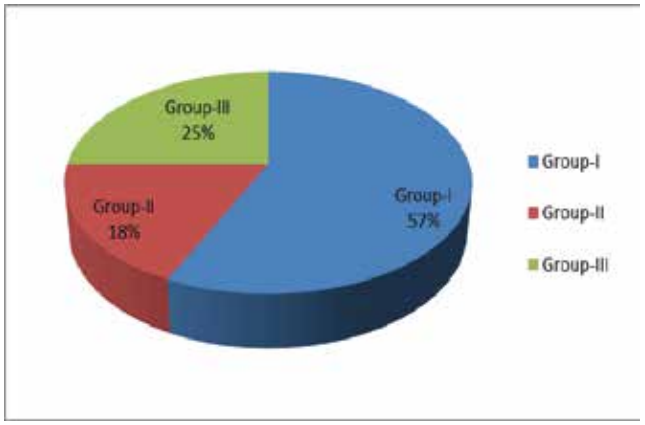


Figure 1: Distribution of the ST depression of the study patients (n=120)

Out of 120 cases, 68 (56.7%) belong to group I, 22 (18.3%) to group II, and the remaining 30 (25%) to group III (Figure 1).

Baseline characteristics of all groups were given in Table 1. The maximum number was found in the age group of 51-60 years in all three groups. The mean (±SD) age was 50.3 ±6.1, 53.9±8.7, and 56.0 ± 10.3 years in group I, group II, and group III, respectively. The age difference was statistically significant (p=0.01) among the three groups, which means that with increasing age, there is an increased chance of the magnitude of ST segment depression. Male patients were predominant among the study patients. Male-female ratio was 4.45:1. No significant (p=0.41) gender difference was found among the groups. Regarding smoking and diabetes, significant differences were found among the three groups except for hypertension, dyslipidaemia, and family history of CAD.

Table 1: Baseline characteristics of the study patients (n=120)

Variables	Group I (n=68) Mean±SD/ n (%)	Group II (n=22) Mean±SD/ n (%)	Group III (n=30) Mean±SD/ n (%)	Total (n=120) Mean±SD/ n (%)	p-value
Age (Mean±SD) year	50.3 ±6.1	53.9±8.7	56.0±10.3	52.7±10.1	0.01
Age category					
31-40 years	9 (13.3%)	4 (18.2%)	6 (20.0%)	19 (15.8%)	
41-50 years	18 (26.5%)	3 (13.6 %)	8 (26.7%)	29 (24.2%)	
51-60 years	30 (44.1%)	10 (45.5 %)	11 (36.7%)	51 (42.5%)	
>60 years	11 (16.2%)	5 (22.7%)	5 (16.7%)	21 (17.5%)	
Gender					0.41
Male	55 (80.9%)	20 (90.9%)	23 (76.7%)	98 (81.7%)	
Female	13 (19.1%)	2 (9.1%)	7 (23.3%)	22 (18.3%)	
Risk factors					
Smoking	32 (47.1%)	16 (72.7%)	22 (73.3%)	70 (58.3%)	0.01
Hypertension	32 (47.1%)	10 (45.5%)	14 (46.7%)	56 (46.7%)	0.99
Diabetes	24 (35.3%)	14 (63.6%)	17 (56.7%)	55 (45.8%)	0.02
Dyslipidaemia	35 (51.5%)	12 (54.5%)	18 (60%)	65 (54.2%)	0.73
Family history of CAD	28 (41.2%)	09 (40.9%)	12 (40%)	49 (40.8%)	0.99

Group I = (<1 mm no ST depression); Group II= (1-2 mm ST depression); Group III = (>2 mm ST depression); SD: standard deviation; CAD: coronary artery disease.

Table 2: Distribution of the study patients by Vessel score

Vessel score	Group I (n=68) No. (%)	Group II (n= 22) No. (%)	Group III (n=30) No. (%)	Total (n=120) No. (%)	p-value
0	8 (11.8%)	1 (4.5%)	0 (0.0%)	9 (7.5%)	
1	38 (55.9%)	3 (13.6%)	5 (16.7%)	46 (38.3%)	
2	17 (25.0%)	7 (31.8%)	9 (30.0%)	33 (27.5%)	
3	5 (7.4%)	11 (50.0%)	16 (53.3%)	32 (26.7%)	
Mean ± SD	1.3±.0.8	2.3±0.9	2.4±0.8	1.7±0.9	**<0.001**

Group I = (<1 mm no ST depression); Group II = (1-2 mm ST depression); Group III = (>2 mm ST depression; SD: standard deviation.

Table 3 showed that the mean (± SD) Gensini Score was 29 ± 30.4, 55.4± 22.9, and 85.7 ±39.7 in group I, group II, and group III, respectively. Mean Gensini Score difference was statistically significant (p<0.001) among the three groups. It indicates higher the magnitude of ST segment depression higher the Gensini score, indicating more severe CAD.

Table 3: Distribution of the study patients by Gensini score

Gensini score	Group I (n=68) No. (%)	Group II (n= 22) No. (%)	Group III (n=30) No. (%)	Total (n=120) No. (%)	p-value
0-20	36 (52.9%)	03 (13.6%)	1 (3.3%)	40 (33.3%)	
21-35	14 (20.6%)	5 (22.7%)	3 (10.0%)	22 (18.3%)	
≥ 36	18 (26.5%)	14 (63.6%)	26 (86.7%)	58 (48.3%)	
Mean ± SD	29.0±.30.4	55.4±22.9	85.7±39.7	48.0±39.7	**<0.001**

Group I = (<1 mm no ST depression); Group II = (1-2 mm ST depression); Group III = (>2 mm ST depression; SD: standard deviation.

Table 4 showed that significant CAD was found in 18 (26.5%) cases in group I, 14(63.6%) cases in group II, and 26 (86.7%) cases in group III. There was statistically significant difference among the groups, which means an incremental rate of significant CAD proportional to the magnitude of ST-segment depression.

Table 4: ST-segment depression and severity of CAD according to Gensini score (n=120)

Significant CAD	Group I (n=68) No. (%)	Group II (n= 22) No. (%)	Group III (n=30) No. (%)	Total (n=120) No. (%)	p-value
Significant (Gensini Score ≥36)	18 (26.5%)	14 (63.6%)	26 (86.7%)	58 (48.3%)	<0.001
Insignificant (Gensini Score <36)	50 (73.5%)	8 (36.4%)	4 (13.3%)	62 (51.7%)	

CAD: coronary artery disease; Group I = (<1 mm no ST depression); Group II = (1-2 mm ST depression); Group III = (>2 mm ST depression; significant CAD = Gensini score ≥ 36; insignificant CAD = Gensini Score < 36.

Table 5 showed that the mean ± SD Friesinger index was 5.3±3.2, 9.7± 3.5, and 10.7 ±3.1 in group I, group II, and group III, respectively. The Friesinger index difference was statistically significant (p<0.001) among the three groups, with the higher the magnitude of ST segment depression higher the Friesinger index, indicating more severe CAD.

Table 5: Distribution of the study patients by Friesinger Index

Friesinger index	Group I (n=68) No. (%)	Group II (n= 22) No. (%)	Group III (n=30) No. (%)	Total (n=120) No. (%)	p-value
0-4	35 (51.5%)	7 (31.8%)	3 (10.0%)	45 (37.5%)	
5-10	29 (42.6%)	5 (22.7%)	10 (33.3%)	44 (36.7%)	
11-15	4 (5.9%)	10 (45.5%)	17 (56.7%)	31 (25.8%)	
Mean ± SD	5.3±.3.2	9.7±3.5	10.7±3.1	7.5±4.1	**<0.001**

Group I = (<1 mm no ST depression); Group II = (1-2 mm ST depression); Group III = (>2 mm ST depression; SD: standard deviation.

In Table 6, significant CAD was found in 15 (68.2%) cases in group I, 27 (90.0%) cases in group II, and 75 (62.5%) cases in group III that found a statistically significant difference among the groups. It means that the incremental rate of significant CAD is proportional to the magnitude of ST-segment depression.

Table 6: ST segment depression and severity of CAD according to Friesinger index (n=120)

Significant CAD	Group I (n=68) No. (%)	Group II (n= 22) No. (%)	Group III (n=30) No. (%)	Total (n=120) No. (%)	p-value
Significant CAD (FI ≥5)	33 (48.5%)	15 (68.2%)	27 (90.0%)	75 (62.5%)	<0.001
Insignificant CAD (FI <5)	35 (51.5%)	7 (31.8%)	3 (10.0%)	45 (37.5%)	

CAD: coronary artery disease; Group I = (<1 mm no ST depression); Group II = (1-2 mm ST depression); Group III = (>2 mm ST depression; significant CAD= (FI ≥5); insignificant CAD= (FI <5); FI: Friesinger index.

Positive significant correlation was found between sum of the ST segment depression and vessel score (r=0.64, p<0.001) by Spearman's Rank correlation and the significance level reached by correlation t-test (Figure 2).

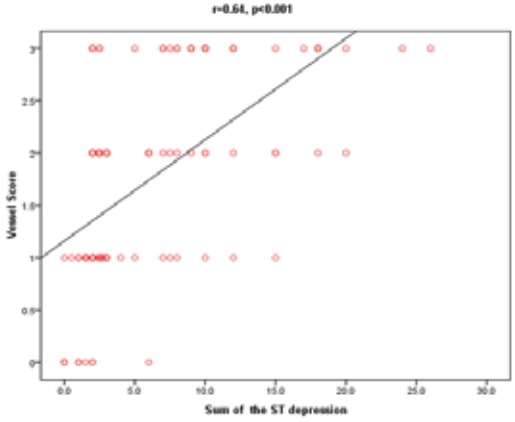


Figure 2: The scatter diagram showing a significant positive correlation (r=0.64) between vessel score and cumulative sum of ST segment depression in the study patients

Positive significant correlation was revealed between sum of the ST segment depression and Gensini score (r=0.72, p<0.001) by Pearson's correlation and the significance level reached by correlation t-test (Figure 3).

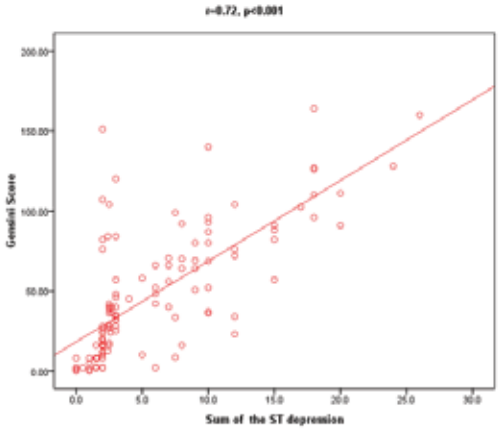


Figure 3: The scatter diagram showing a significant positive correlation (r=0.72) between the Gensini score and the cumulative sum of ST-segment depression in the study patients

Positive significant correlation was revealed between sum of the ST segment depression and Friesinger Index (r=0.66, p<0.001) by Pearson's correlation and the significance level reached by correlation t-test (Figure 4).

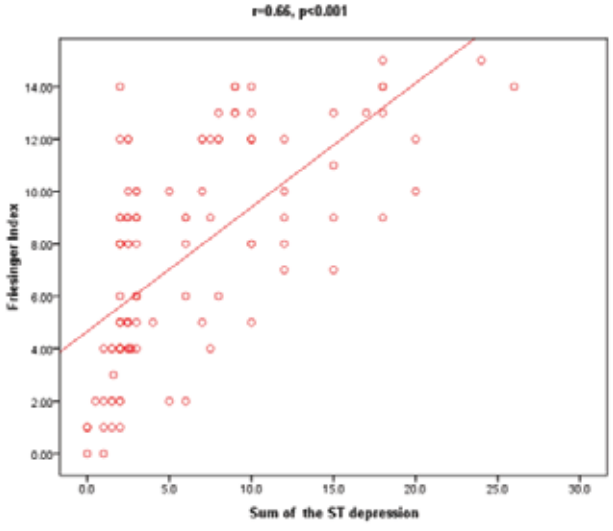


Figure 4: The scatter diagram showing a significant positive correlation (r=0.66) between the Friesinger Index and the cumulative sum of ST-segment depression in the study patients.

Multivariate logistic regression analysis showed that patients with increasing age (>50 years), smoking, diabetes and ST segment depression (>1 mm) are more likely to have severe CAD with the odds ratio being 1.49, 3.16, 2.57 and 7.59 respectively (Table 7).

Table 7: Multivariate logistic regression analysis of having coronary artery disease

Variables of interest	B	p-value	OR	95% CI
Increasing age	0.221	0.03	1.49	1.033 – 2.128
Smoking	1.153	0.04	3.16	1.911 – 8.425
Hypertension	0.627	0.39	1.11	0.258 – 24.274
Dyslipidemia	0.114	0.19	0.85	0.023 – 2.391
Diabetes mellitus	0.944	0.02	2.57	1.123 – 11.007
ST depression	2.023	<0.001	7.59	3.064-18.806

OR: odds ratio; CI: confidence interval.

Discussions

Important findings of this study were: i) The magnitude of ST-segment depression was significantly correlated with the severity of CAD; ii) The cumulative sum of ST-segment depression was also significantly correlated with the severity of CAD; iii) increasing age, diabetes mellitus, smoking and ST-segment depression were the main predictors of severe CAD.

The majority of patients were aged 51-60 years. The mean (±SD) age was 50.3 ±6.1 years in group I, 53.9±8.7 years in group II, and 56.0 ± 10.3 years in group III, respectively. Overall, the age ranged from 31 to 75 years, with a mean age of 52.7±10.1 years. The mean age of this study is closer to that of other studies. The mean age was 57.6 ± 10.1 years [9] and 54.58 years [10] in other studies.

Male patients were predominant. The male-to-female ratio was 4.45:1. A similar male preponderance was found in almost all studies in IHD. The male-female ratio was 5.9:1 [9] and 4.6:1 [10] in other studies. Females are less prone to developing IHD in premenopausal age due to the protective role of estrogen. Smoking as a risk factor of IHD is less common in our country among females, which may explain the male preponderance of IHD.

In this study, it was observed that smoking was the most prevalent (58.3%) risk factor. Among other risk factors for CAD, hypertension was present in 46.7% of patients, dyslipidaemia was present in 54.2% of patients, and a positive family history of premature CAD was present in 40.8% of patients. Akanda et al. [11] found smoking to be the most prevalent (60%) risk factor among the patients of coronary artery disease of the Bangladeshi population. A high prevalence of hypertension in the elderly Bangladeshi population (40-65%) to contribute to CAD was observed in another Bangladeshi study [12]. These differences might be due to variation in lifestyle. Other studies had shown smoking as the highest prevalent risk facto [9,10].

In this study, the mean Vessel score was 1.3±.0.8, 2.3±0.9, and 2.4±0.8 in group I, group II, and group III, respectively. Mean Gensini score was 29.0±.30.4, 55.4±22.9, and 85.7±39.7 in group I, group II, and group III, respectively. Mean Friesinger index was 5.3±.3.2, 9.7±3.5, and 10.7±3.17 in group I, group II, and group III, respectively. The differences among the groups were statistically significant.

A correlation study found that the cumulative sum of ST-segment depression positively correlated with angiographic severity of CAD. Cumulative sum of ST segment depression revealed positive correlation with Vessel score ($r=0.64$; $p< 0.001$), Gensini score ($r=0.72$; $p< 0.001$), as well as Friesinger index ($r=0.66$; $p< 0.001$). In this study, it was found that significant CAD was proportional to the magnitude of ST-segment depression. Significant CAD (Gensini score≥36) was found in 26.5% cases in group I, 63.6% cases in group II, and 86.6% cases in group III. According to the Friesinger index, significant CAD (FI≥5) was found in 33 (48.5%) cases in group I, 15 (68.2%) cases in group II, and 27 (90.00%) cases in group III.

Previous studies in the relevant areas were done in different areas. Ullah et al. [9] found angiographic correlation with lateral (I, avL, V5, V6) ST segment depression. But the present study found angiographic correlation with ST-segment depression of any region in the 12-lead admission ECG. Savonito et al. [13] found that in patients of NSTE-ACS, the cumulative sum of ST segment depression in all ECG leads was a powerful predictor of all-cause mortality at 30 days, independent of clinical variables and correlated with the extent and severity of CAD. In a study of qualitative analysis of ST segment depression and its impact on the outcome of CAD, it was found that patients with ≥2 mm ST segment depression were 6 times more likely to die within one year than patients with no ST segment depression [14].

Although the result of this study supported the hypothesis, there were some facts that might have affected the results. Angiography was evaluated by visual estimation, so there was a chance of inter-observer and intra-observer variation in the interpretation of the severity of CAD. It was single centered study, not generalized in Bangladeshi people, and the sampling method was nonrandomized.

Conclusion

In this study, the magnitude of ST-segment depression was found to be significantly correlated with the severity of CAD. The cumulative sum of ST-segment depression was also found to be significantly correlated with the severity of CAD. This study also showed that increasing age, diabetes mellitus, smoking, and ST-segment depression are the main predictors of severe CAD. Early adequate medical treatment and intervention in these patients may substantially reduce adverse cardiac events.

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