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The Value of Exercise Testing in Prediction of Severity of Coronary Artery Disease in Diabetic Patient Along with SYNTAX Score

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Abstract

Object: Exercise tolerance testing, or ETT, is an effective instrument to diagnose which patients have ischemia when activity impacts their electrocardiograms. It can also be used to collect significant information about exercise capacity, exercise-induced arrhythmias, blood pressure and heart rate responses, and symptoms.

Aims: To determine the severity and complexity of CAD, a complete angiographic scoring system is employed intermittently called SYNTAX score. The association between Syntax score and CAD severity in patients with diabetes mellitus is not well-researched in the background.

Methodology: Patients with diabetes who were thought to have coronary artery disease received exercise tolerance testing. Syntax score was used to evaluate positive cases undergoing coronary angiography in order to predict the association. In the cardiology department of the Ibrahim Cardiac Hospital and Research Institute in Dhaka, observational research was performed. Bangladesh, between June 1, 2020, to November 30, 2023. Based on their Duke tread mill scores, 520 patients were included in this study and separated into groups. Diabetic patients with high

Duke Treadmill score (DTS) (≤-11) were included in group I and diabetic patients with medium (-10 to +4) and low Duke Treadmill score (≥+ 5) were included in group II.

Results: Throughout June 1, 2020, and November 30, 2023 in the cardiology department of the Ibrahim Cardiac Hospital and Research Institute in Dhaka, observational research was performed, Bangladesh. There were 520 patients studied and grouped according to their Duke treadmill scores. The mean age of study population was 55.2 ± 9.0 years, ranging from 18 to 75 years. Triple vessel disease patients exhibited a statistically significant (p=0.001) higher SYNTAX score > 22 than SYNTAX score < 22. The probability of developing severe coronary artery disease (SYNTAX score > 22) is more than 5.0 (95% CI = 3.7-7.6) times higher for diabetic patients with DTS < -11 (high-risk group) than for those with DTS ≥ -10 (low & medium risk) (p < 0.001). The considerable adverse relationship among the DTS and SYNTAX scores is evident (r = - 0.583, p 0.0001).

Conclusion: High DTS was found to be strongly connected with the coronary artery disease severity by calculating SYNTAX score. Patients with high Duke Treadmill scores are at increased risk of cardiovascular disease.

Keywords: Exercise Tolerance test; Duke Treadmill score; SYNTAX score; Diabetes.

Introduction

Regarding both, diabetes mellitus is a major contributing factor to a considerable number of deaths worldwide[1]. It is common for diabetics to develop micro- and macro vascular complications during their lifetime, resulting in high medical care costs, reduced quality of life, and higher mortality rates[2].

The International Diabetes Federation (IDF) estimates that By 2045, 700 million individuals will be suffering from diabetes., adding to the 463 million adults who already have the disease worldwide.[3]. Only 35% of global diabetes-related health expenditures go to LMICs, despite their high and growing burden. Without effective preventive measures, health expenditures related to diabetes will increase in the 21st century[4].

Diabetic patients are particularly challenging to treat because of their tendency for unusual symptoms and high rates of silent ischemia in asymptomatic patients. There is a major impact of exercise stress tests in diabetic patients because of these factors: diagnosis and prognosis of diabetes mellitus patients with stress testing[5].

It is possible to regulate the short- and long-term risk of mortality and cardiovascular events in individuals who participate in physical activity by using this data [6-7]. Although the ETT can detect obstructive CAD consistently, its sensitivity and specificity are subpar. [8,9]. The ETT is able to diagnose CAD with a sensitivity of 68% and specificity of 70%[10.] According to a meta-analysis[11]. based on 147 published studies and 24,074 patients who underwent both coronary angiography and ETT, revealed a sensitivity of 68% and a specificity of 77%. Interpretation of ETT data often relies on Duke treadmill score systems (DTS).

Methodology: This thesis study was carried out in the Department of Cardiology, Ibrahim Cardiac Hospital & research institute, Dhaka for a period starting from 1st June,.2020 to 30th November,2023. 520 adult patients of both genders considering inclusion and exclusion criteria , were involved in this investigation Patients were categorized in two groups: group I involving diabetic patients with high Duke trade-mill score(≤-11) and group II were diabetic patients with low & medium Duke trade-mill score(-10 to +4).

Ethical issue

Ethical clearance was taken from Department of Pharmacy, Jahangirnagar University and Ethical Review Board(ERB) of ICHRI(Ref: Ichri/Research/ERC/2023/04) and data collection clearance was obtained from the Academic Training and Development Committee of ICHRI to undertake the present study. Freedom was given all patients to leave the study at any point while it was ongoing, and confidentiality was scrupulously upheld.

Selection criteria:

Inclusion criteria

- Age 18 - 75 years.
- A diagnosis of type 2 diabetes mellitus, as per WHO criteria and who was treated with dietary restrictions and / or oral

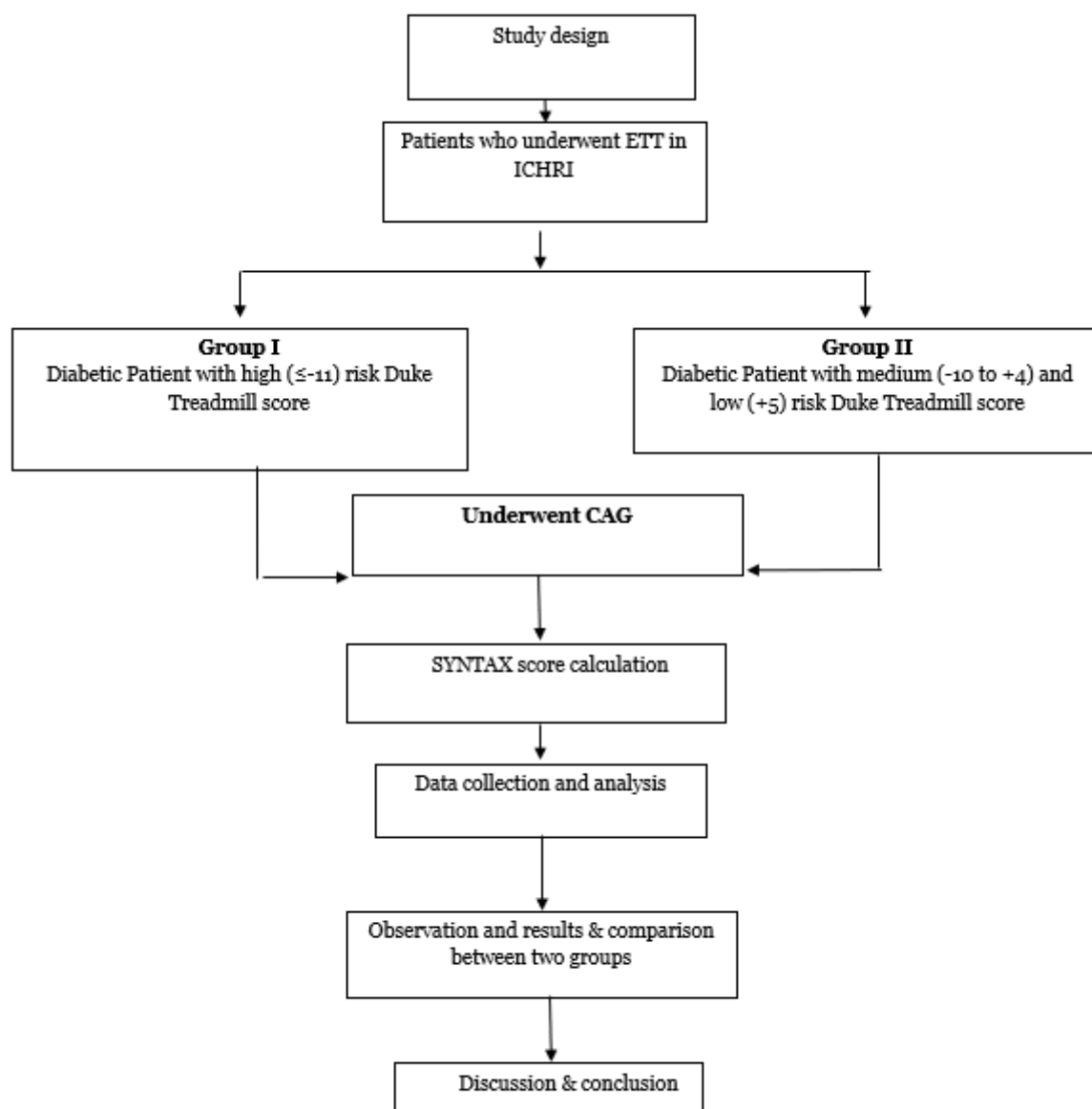hypoglycemic agents and / or insulin for at least 6 months.

- Those who were willing to do exercise tolerance test (ETT)

- Positive stress test patients who would perform coronary angiogram

- Previous CABG / PCI

- Renal Failure (eGFR<30)

- COPD, valvular heart disease, dilated cardiomyopathy (EF<45%)

- Physical disabilities

- Unwilling to participate.

Exclusion criterion

- Acute Coronary Syndrome

STUDY FLOW CHART

Study design

↓

Patients who underwent ETT in ICHRI

↓

Group I
Diabetic Patient with high (≤-11) risk Duke Treadmill score

Group II
Diabetic Patient with medium (-10 to +4) and low (+5) risk Duke Treadmill score

↓

Underwent CAG

↓

SYNTAX score calculation

↓

Data collection and analysis

↓

Observation and results & comparison between two groups

↓

Discussion & conclusion

Results

- This study, designed to predict the degree of coronary artery disease (CAD) in diabetic patients, included a total of 520 diabetic patients from the Ibrahim Cardiac Hospital Research Institute (ICHRI). Nearly 70% of the patients were > 50 years age

(54.8% 51 – 65 years and 29.8% 36-50 years age group) with the patients' mean age remained 55.2 ± 9.0 years . A male preponderance was observed among the patients with the male (76.9%)-to-female (23.1%) ratio being roughly 3: 1.

- Hypertension was the leading risk factor which was 85.34% in group-I and 81.94% in group-II. Dyslipidaemia, family history of ischemic heart disease, smoking history and obesity were insignificant (p=0.102,0.239,0.142, 0.207) in both group of patients.

- Exercise Tolerance Test (ETT) revealed that the mean exercise period was 6.1 ± 1.9 (range: 1.04 – 13.2) minutes. Nearly half (51.29%) of the patients achieved ≥ 7 METs and one third (31.9%) of the patients, target heart rate (THR) was achieved and in about 87.5% of the cases (Table-I)

• Exercise period (min) :	mean	6.1 ± 1.9

Table I. Comparison of Exercise Tolerance Test parameters

	Duke Treadmill Score		
	Group-I N=232	Group-II N=288	P value
Target Heart Rate			
Achieved	74(31.90%)	180(62.5%)	0.001
Not achieved	158(68.10%)	108(37.5%)	
Metabolic Equivalents(METs)			
<7	119(51.29%)	60(20.83%)	0.001
>7	113(48.71%)	228(79.17%)	
Symptom during Stress test			
Limiting	203(87.5%)	20(6.94%)	0.001
Non-limiting	4(1.72%)	15(5.21%)	
No symptom	25(10.78%)	253(87.85%)	

Data were analyzed using Chi-square ($χ^2$) Test.p value reach from Chi-square ($χ^2$) Test, p value significant ≤0.05.

- The CAG findings revealed that over one-quarter (27.5%) of the patients had Triple vessel diseases (TVD), 19.8% Double vessel diseases (DVD), and 22.5% single vessel diseases (SVD) . The presence of TVDs including LM (left main) lesion was observed in 10.4% of the patients. While non- flow limiting coronary artery which comprises normal, mild, moderate CAD was observed in 19.8% of the cases.

- Table II shows patients with triple vessel disease and left-main with or without coronary artery disease had higher SYNTAX score> 22 than SYNTAX score ≤ 22 which was(p>0.001) statistically significant and SVD, DVD and non-flow limiting coronary artery were more common in SYNTAX<22 which were statistically significant

Table: II Angiogram Findings according to SYNTAX score

Angiogram Findings	SYNTAX >22	SYNTAX ≤ 22	P value
Single vessel disease (SVD)	6 (5.12%)	111 ((94.82%)	0.001
Double vessel disease (DVD)	24 (23.30%)	79 (76.70%)	0.020
Triple vessel disease (TVD)	93 (65.03%)	50 (34.97%)	0.001
Left main disease with or without other vessel	53 (69.73%)	23 (30.27%)	0.001
Non-flow Limiting Coronary artery	5 (4.85%)	98(95.15%)	0.001

Data were analyzed Fisher Exact Test.p value reach from Fisher Exact Test, p value significant ≤0.05

SYNTAX Score:

Based on angiographic features of the coronary arteries, SYNTAX score was calculated which ranged from lowest 2 to highest 52.5. About 87.85% of the patients had low SYNTAX scores (≤ 22) suggestive of less complexity or absence of CAD in group-II, 41.81% intermediate SYNTAX scores (suggestive of moderate complexity of CAD), and 15.52% high syntax scores (indicative of severe complexity of CAD) in group-I which is statistically significant(p=0.001)(Table III).

Table III Distribution of patients by SYNTAX Score

SYNTAX Score	DUKE TREADMILL SCORE Group			P-value
	Group-I (n=232)	Group-II (n=288)		
≤ 22 (low)	99(42.67%)	253(87.85%)		0.001
23 – 32(Intermediate)	97(41.81%)	30(10.42%)		
≥ 33 (High)	36(15.52%)	5(1.74%)		

Data were analyzed using Chi-square (χ^2) Test.p value reach from Chi-square (χ^2) Test, p value significant ≤0.05

**Association between DTS and SYNTAX Score:**

More than 78% of the patients. Patients with diabetes who are defined as high-risk (DTS < -10) carry more than 5.0 (95% CI = (3.7-7.6)-fold higher probability of moderate to severe CAD (SYNTAX score > 22) when compared to low and medium risk patients with DTS ≥ -10. (p < 0.001) with SYNTAX scores > 22 had DTS **(**Dukes Treadmill Score) < -11 compared to only 42.24% of the patients with SYNTAX ≤ 22 (Table IV).

Table IV: Association between Duke treadmill score(DTS) and SYNTAX score

DTS	SYNTAX Score		RR (95% CI of RR)	p-value
	> 22	≤ 22		
≤-11 (High risk)(n=232)	129(81.1%)	103(28.5%)	5.3(3.7-7.6)	< 0.001
≥ -10 (Low & medium risk)(n=288)	30(18.9%)	258(71.75		

*Data were analyzed using **Chi-squared (χ^2) Test;** figures in the parentheses denote corresponding **%.**

Within 520 patients 97.9% had no complication,1% had electrolyte imbalance,0.8% had thrombocytopenia,0.2% had hematoma and develop arrhythmia (Fig.-I).

Fig:-I. Distribution of patients by their complication (n = 520)
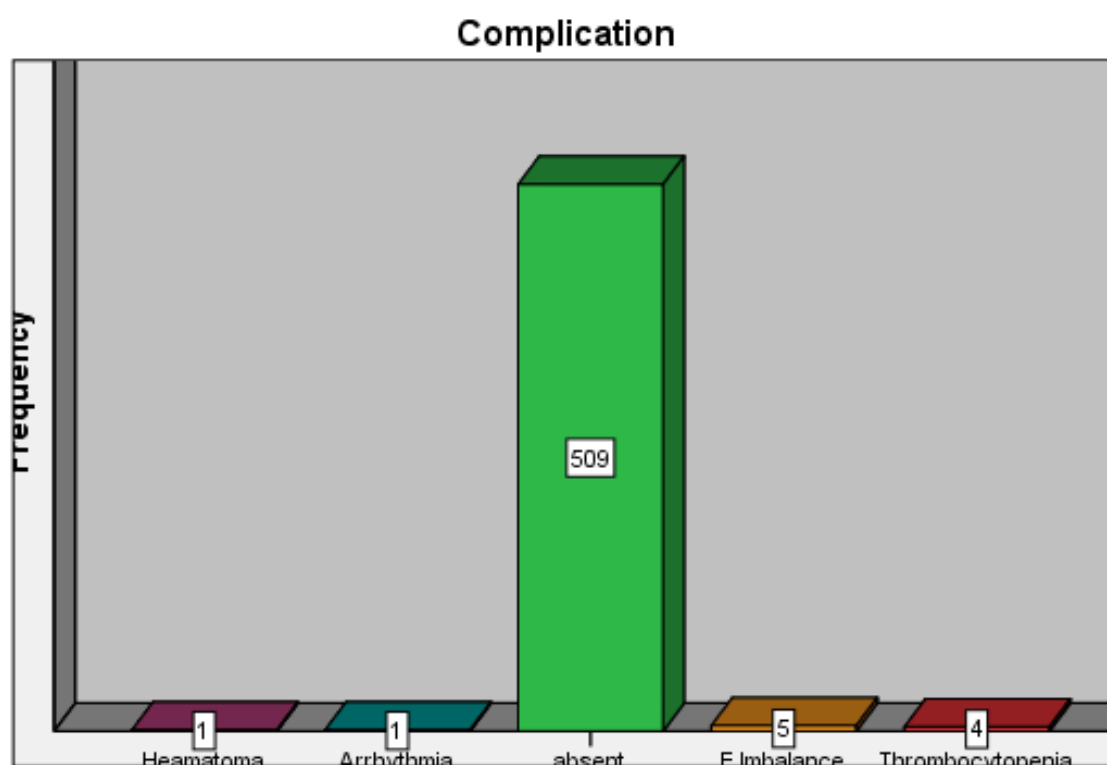
Discussion

This prospective observational study was done to detect degree and complexity of coronary artery disease by SYNTAX score in high, medium and low duke treadmill test in diabetic patients.

The mean age of this studied patients was 55.2±9.0 years and group-I mean age was 55.45±9.45 years, 55.01±8.64 years in group-II. The commonest age group of study patients were 51-60 years age group was 41.7% than the other age group patients. Difference between two age group was not significantly different (p=0.721) for mean age. Fardin M et al. 2022[12] where they reported a nearly comparable age distribution all over five groups: <30, 31-40, 41-50, 51-60, and >60 years. Group-I had a mean age of 58±8.6 years, whereas group-II had a mean age of 61±9.1 years. The mean age discrepancy was statistically significant (p<0.001). Other several studies like Gunaydin ZY et al. 2016,[13] Acar Z et al. 2012[14] , Shehzad A et al. 2023[15] ,Taimur et al.2014[16] showed their mean age was 61±10years, 56±8 years,57years, 48.25±8.7years and 53.46±8.06years respectively .

David R et al. 2018[17] showed mean value of METs in DUKE score≥5 group was 8.78,8.60METs in Duke score was +4to-10 group and 5.55 METs in who had Duke score was ≤11 group which was statistically significant(p<0.016). Taimur et al.2014[16] found in their

study 24.69% achived 1-6.9 Mets51.85% achived 7-10 METs in true positive patients group. This present study showed exercise treadmill test, mean value of METs achieved by study subjects was 7.8±1.9. 51.29% patients of group I had achieved less than 7 METs than group II patients which was statistically significant (p=.001). About 31.9% of group I and 62.5% of group II population achieved target heart rate (THR). THR and Symptom was present during ETT in high risk group I than medium and low risk group of patients which was statistically significant (p=0.001, p=0.001) which was similar to other study likes ROMICAT study,[18] (p<0.04)and insignificant in Sadik VE et al. 2019[17] (p<0.249) .

Sadik VE et al.2019[19] describe their study that single vessel disease(32%) and double vessel disease(44%) more in patients those SYNTAX score<23 which was statistically significant(p<0.001)but triple vessel disease(53%) higher in SYNTAX >23 group patients which was statistically significant(p<0.001). Fardin M et al 2022[12] showed 76.6% had low SYNTAX score,14.3% had intermediate and 1.3% had high Syntax score. Premsagar P et al. 2021[20] described that within 131 patients 55 had normal coronary artery and 76 had abnormal findings(58%) ,within that 115 had low SYNTAX score,11 patient had intermediate SYNTAX score and 6 patient had High SYNTAX score. Our study demonstrated that patients with low SYNTAX score had more non flow limiting coronary artery , single vessel disease(SVD) and double vessel disease(DVD) angio-graphically whereas patients with high SYNTAX score had more triple vessel disease(TVD) and left main(LM) with or without coronary artery disease which (p=0.001)was statistically significant.

In a 2022 [11] study, Fardin M et al.[12] investigated the relationship between patients with intermediate and high Duke scores and the syntax score (SxScore), which measures the complexity and degree of coronary artery disease. The study found no significant difference between the degrees of coronary artery involvement based on syntactic and Duke Scores (p<0.328). According to Premsagar P. et al. 2021[20], there was no link between the DTS and SYNTAX score (Pearson's coefficient: r=-0.113, p=0.200), and the positive yield of aberrant angiography was 58%. . According to our study, diabetic patients with DTS < -11 (high-risk group) have a risk of moderate to severe CAD (SYNTAX score > 22) that is more than 5.0 (95% CI = 3.7-7.6) times higher than that

of patients with DTS ≥ -10 (low & medium risk). (p < 0.001) .

Among patients with high Duke treadmill score(DTS), four patient developed concomitant the thrombocytopenia among patients with low and medium DT score(Duke treadmill score) one patient developed arrhythmia and hematoma with five patients developed electrolyte imbalance which was statistically in-significant (0.299).

According to the current study, high DTS(Duke treadmill score) is positively related to coronary artery disease severity, as measured by the SYNTAX score. Coronary artery disease severity can be predicted for patients who have high DTS(Duke treadmill score)s. By doing this, patients can be divided up into groups for coronary angiography and follow-up therapies that can lower cardiovascular mortality. Therefore, people who need cardiac intervention may benefit from this scoring system.

Conclusion

According to the current study, high DTS(Duke treadmill score) is positively related to coronary artery disease severity, as measured by the SYNTAX score. Coronary artery disease severity can be predicted for patients who have high DTS(Duke treadmill score)s. By doing this, patients can be divided up into groups for coronary angiography and follow-up therapies that can lower cardiovascular mortality. Therefore, people who need cardiac intervention may benefit from this scoring system.

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