ISSN: 1813-1638

The Medical Journal of Tikrit University

Available online at: www.mjotu.com

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Keywords:

TMT … Treadmill Test
IHD… Ischemic Heart Disease
DTS … Duke Trwadmill Score

A R T I C L E I N F O

Article history:

Received 12 Aug 2021
Accepted 10 Oct 2021
Available online 5 Dec 2021

The Relationship of Electrocardiographic Changes, Coronary Angiographic Finding and Duke Treadmill Score In Positive Treadmill Test Patients

ABSTRACT

Ischemic heart disease is a leading cause of death worldwide which may present as a stable ischemic heart disease . The diagnosis depend on history and clinical examination in addition to electrocardiography and echocardiography. In patients with normal electrocardiography and echocardiography and have low to intermediate risk of ischemic heart disease, we need another tools like exercise stress test which include duke treadmill score as a composite score to evaluate the patient with ischemic heart disease. SYNTAX score is an angiographic scoring system that is widely used to evaluate the severity and complexity of cardiovascular disease in catheterization laboratory.

The aim to look at the prevalence of ischemic heart disease and its culprit electrocardiography changes during or after exercise and calculate duke treadmill score. Then after prospectively looking at coronary angiographic findings and its syntax score. To assess if there any anatomical association between positive electrocardiographic changes, coronary angiography and duke treadmill score.

A cross sectional study, out of 280 patients who attended exercise treadmill test unit in Saladin General Hospital during the period from June 2017 to June 2019, one hundred patients of them had positive stress test. sixteen patients refused coronary angiography and complete analysis done for 84 patients.

In this study, two-third of patients with positive treadmill test were with significant lesions which more significant in gender, high BMI, and smoking and residual one third with the normal result or no significant lesion. In this study, there is no association between ST depression and culprit lesion in angiography except in complex coronary diseases which give an extensive ST depression in stress time.

In this study, there is a significant association between high-risk duke treadmill test and the extent of coronary artery disease ($p < 0.0001$) and a significant relation between duke treadmill score and syntax score (p 0.0001).

DOI: http://dx.doi.org/10.25130/mjotu.27.2021.34

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Introduction:

Ischemic heart disease is one of the most common leading cause of death among human races[1] and responsible about 31% of death worldwide [2].It may present as stable angina as patient had limited blood and oxygen supply to the myocardial tissue leading to ischemia and chest pain occur when the oxygen demand increases, such as during exercise [3].

The diagnosis of ischemic heart disease as the cause of chest pain with normal electrocardiography requires the use of a careful clinical history as well as addition investigations such as exercise stress testing as a widely used and not expensive method for initial evaluation of patients with intermediate pre-test probability of ischemic heart disease[4]. Coronary angiography is the gold standard test for diagnosis of ischemic heart disease with high probability like patients with positive exercise stress testing [5,6]

Duke Treadmill Score (DTS) is a composite score based on the calculating formula including ST-segment depression, chest pain and exercise duration. It gives an accurate prognostic information for the evaluation of patients with suspected ischemic heart disease[7,8] The equation for calculating the Duke treadmill score is as follows: DTS = exercise time - (5 x ST deviation) - (4 exercise angina). The DTS was grouped into low-risk (with a score of ≥ +5), moderate-risk (with scores ranging from -10 to +4), and high-risk (with a score of ≤ -11) categories.[9]

The positive result consider as 1 mm or greater or 0.1 mV(1mm) or greater of horizontal or downsloping ST-segment depression in three consecutive beats 60 to 80 milliseconds after the J point or ST-segment elevation as greater or 0.1 mV of the J point in three consecutive beats, without pathologic Q waves.[9]

SYNTAX score (SS) is an angiographic scoring system that is widely used to evaluate the severity and complexity of cardiovascular disease (CAD) . It is used in assessment the long-term outcomes of CAD and in the

selection of the way of treatment. Its efficacy has been demonstrated in various studies[10,11].

In the study we aim to look at the prevalence of ischemic heart disease (IHD) in exercise tread mill test positive patients by looking to culprit electrocardiography (ECG) specifically ST segment depression during or after exercise and duke score. Then after prospectively looking at coronary angiographic findings and its syntax score. To assess if there any anatomical association between positive ECG changes, coronary angiography and DTS.

Patients and Methods:

A cross sectional study, including 280 patients with chest pain with intermediate probability for ischemic heart disease as stable angina who attended exercise treadmill test (TMT) unit in Saladin General Hospital during the period from June 2017 to June 2019, one hundred patients of them had positive stress test. sixteen patients refused coronary angiography and complete analysis done for 84 patients.

History of general information and risk factors was taken. A conventional 12 Lead resting ECG and echocardiography was done. Assess the patients if there is any contraindication for treadmill stress test. Medications that interfere with the test (Digitalis, nitrates, beta blockers and calcium channel blockers) were withdrawn for 72 hours before the procedure. All the patients were fully instructed regarding the entire procedure of the TMT and all of them was had instructions to be fasting and avoid heavy exercise and smoking in last 12 hours before procedure. Patients encouraged to exercise to their maximum capacity. A defibrillator and other cardiopulmonary resustative equipments were ready for emergencies.

Standard TMT was done by using a motorized treadmill according to Bruce protocol. The heart rate, blood pressure and electrocardiograms were recorded at the end of each stage of exercise, immediately before, within and after stopping the exercise and for each minute for at least 3 minutes in the

recovery phase. Duke treadmill score (DTS) was applied after the patient finishing the test can to assess risk stratification.

After finishing of TMT, the patients with positive result send for coronary angiography, then angiographic analysis done by using syntax score and compare the result with ECG changes and DTS for each one.

Statistical Analysis:

The data of TMT were analyzed by application of Microsoft excel program and statistical package for social Sciences (SPSS) Version 25. Outcomes of analysis were arranged in scales variables (means and standard deviation) Independent sample t-test was used to compare between tow means. Person correlation test was used to assess expected relationships between different variable. The level of significance result (p value) was set as ≤ 0.05.

Results

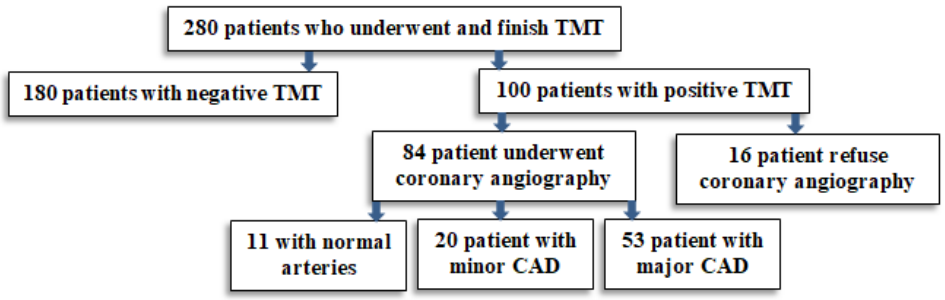

Figure -1. Flowchart of patients who have TMT.

Table-1. characteristics of the patients who underwent coronary angiography.

Characters	Total number	Normal arteries (N = 11)	Minor CAD (N = 20)	Significant CAD (N= 53)	P-value
Male	47	3 (27%)	10 (50%)	34 (61%)	**0.045**
Female	37	8 (73%)	10 (50%)	19 (36%)	
Hypertension	46	5(45%)	12(60%)	29(55%)	0.74

Diabetes mellitus	21	1(9%)	4(20%)	16(30%)	0.28
Hyperlipidemia	38	6(55%)	10(50%)	22(42%)	0.64
Smoker	38	2(18%)	6(30%)	30(56%)	**0.019**
Chest Pain	20	2(18%)	8(40%)	10(19%)	0.14
Body mass index					
Normal	15	4(36%)	3(15%)	8(15%)	0.228
Over weight	35	2(18%)	4(20%)	29(55%)	**0.006**
Obese	34	5(45%)	13(70%)	16(30%)	**0.024**

CAD = coronary artery disease

Table -2. Correlation of electrocardiographic changes with coronary angiographic finding in positive treadmill test patients.

Coronary Arteries	Extensive	Anterior	Anter-lateral	Anter-inferior	inferior	Total	p-value
LAD	0	4	6	0	0	10	0.18
LCX	0	0	3	0	1	4	0.65
RCA	0	2	2	0	4	8	0.35
LAD,LCX	0	2	8	1	4	15	0.66
LAD,RCA	0	0	1	0	1	2	0.90
LCX,RCA	0	2	0	0	0	2	0.13
3 VD	0	2	4	0	2	8	0.95
LMS + 3 VD	2	0	0	0	2	4	**0.0001**
TOTAL	2	12	24	1	14	53	**0.012**

LAD= left anterior descending artery, LCX left circumflex artery , RCA right

coronary artery , 3VD = 3 vessel diseases , LMS = left main stem artery.

Table- 3. Association between Duke treadmill score and coronary arteries involvement.

Coronary Arteries	DTS ≥ +5	DTS -10 to +4	DTS ≤ -11	Total	*p*-value
LAD	0	10	0	10	**0.0001**
LCX	0	4	0	4	
RCA	1	7	0	8	
LAD,LCX	0	9	6	15	
LAD,RCA	1	1	0	2	
LCX,RCA	0	2	0	2	
3 VD	0	1	7	8	
LMS + 3VD	0	0	4	4	
TOTAL	2	34	17	53	

DTS = duke treadmill sore, LAD = left anterior descending artery, LCX = left circumflex artery , RCA = right coronary artery , 3VD = 3 vessel disease, LMS = left main stem artery.

Table – 4. Characteristic of angiographic finding in various duke treadmill test groups.

Major CAD	All patients (N = 53)	DTS ≥+5 (N = 2)	DTS -10 to +4 (N = 34)	DTS ≤ -11 (N =17)	p-value
LMS	4	0	0	4	**0.01**
LAD	38	1	20	17	**0.007**
LCX	33	0	16	17	**0.0001**
RCA	25	2	12	11	**0.044**

CAD = coronary artery disease ,DTS duke treadmill sore , LMS = left main stem artery , LAD= left anterior descending artery, LCX left circumflex artery , RCA right coronary artery.

Table – 5. Correlation of duke treadmill score and severity of coronary artery disease.

Coronary artery disease (N = 84)	DTS ≥ + 5 (N = 5)	DTS -10 to +4 (N = 62)	DTS ≤ -11 (N =17)	*p*-value
Normal arteries (N =12)	2	10	0	0.004
Minor CAD (N =19)	1	18	0	
Major CAD (N = 53)	2	34	17	

CAD coronary artery disease , DTS duke treadmill test

Table – 6. Association between duke treadmill score and syntax score.

SYNTAX Score (N=53) (Mean ± SD)	DTS ≥ +5 (N = 2)	DTS -10 to +4 (N = 34)	DTS ≤ -11 (N=17)	*p*-value
SYNTAX <22 (N = 27) (14.74 ±4.5)	2	25	0	0.0001
SYNTAX 22-32 (N=15) (28.1±3.7)	0	9	6	
SYNTAX ≥33 (N =11) (35±1.18)	0	0	11	

DTS = duke treadmill score

Discussion

The exercise treadmill test is used to assess the ability of persons to tolerate increased physical activity while ECG, hemodynamic, and symptomatic responses are monitored for the development of myocardial ischemia, electrical instability. It remains an inexpensive test and well trusted in the

general population as a first diagnostic test for patients with an intermediate risk of having CAD.

In this study, 280 patients underwent TMT. One hundred, patient (35.7%) of them was positive which is not far away from 47% as a result of Shashi study[12]. Twelve of one hundred (12%) patients refuse catheterization compare to 5.2% in Jan Eriksson et al study [13] and 42.4% in andriany et al study [14] in poor societies.

In this study, from all treadmill test results of patients with a positive result, two-third of them were with significant lesion and residual one third with the normal result or no significant lesion and this result is similar to Renato etal[15] and kamur study[16]. The dominant percentage (73%) of normal coronary arteries was females. One-quarter of males and half of the females were normal or without significant lesions which similar to Stanley's results[17].

The exercise test is important to detect early CAD in patients with stable ischemic heart disease but significantly more in gender, high BMI, and smoking in this study which different from Amit et al study[18] which considers diabetes or combined more than one risk factor are more important than others. The difference between the results of these studies may be due to the limited small sample size.

The mechanisms beneath the ST-segment shifts with sub-endocardial ischemia remain unclear. MacLachlan et al shown that ST elevation is associated with the trans-mural ischemic boundary, while ST depression is associated with the lateral ischemic boundaries.[19] In this study, there is no correlation between ST depression and culprit lesion except in LMS and 3VD disease which give an extensive ST depression in stress time. The loss of correlation in this study is similar to haraphongse's study[20], daniel's study[21], and Shashi's study[12]. But different from the results of young study [21] which conclude that ST-segment depression on 12 lead exercise electrocardiography was a good predictor of the site of myocardial ischemia with single vessel ischemia

when ST-segment depression developed in the single lead group. However, ST-segment depressions in multiple lead-groups suggested that the perfusion defect involved the apical area and did not predict the site of myocardial ischemia.[22]

DTS used widely in the prediction of CAD and give a non-invasive clinical information. In Acar et al[23] , the average of DTS value was –2.5 ± 7 while it was –4.97 ± 4.94 in this study. The lower DTS values in this study may be due to the difference in the number of patients and small sample of this study.

The results of the this study reveal that the DTS provides a significant information about the presence and severity of coronary disease by correlating the presence of exercise-induced ischemia, with the presence and extent of significant coronary lesions which similar to the results of many studies [23-26.]

In this study, there is a significant association between high-risk DTS and the extent of CAD ($p < 0.0001$). This finding is consistent with the results of Acar et al[12] who concluded that there is a strong correlation between high-risk DTS and coronary lesion complexity. Shaw et al[8] also found a significant association between high-risk DTS with extensive and significant CAD. They consider CAD severity depend on the number of diseased arteries rather than the degree of stenosis of each coronary artery.

In the present study, the number of vessels involved was more in the intermediate group and high-risk DTS score group patients as compared to the low group. This result is compatible with results of another study in the USA; Kwok et al study [27], in regard to three-vessel involvement .

The SYNTAX score used in the evaluation of angiographic severity of coronary lesions and the decision-making process of intervention. The SYNTAX score and DTS score present information about prognosis. While DTS is expected to be low and SS to be high in patients with severe CAD, the number of studies demonstrating a

comprehensive evaluation of both these two risk stratification methods is limited[28]

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