ORIGINAL RESEARCH

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Relationship Between Duke Treadmill Score and Coronary Artery Lesion Complexity

Abstract

Purpose: The purpose of this study was to investigate the relationship between the Duke Treadmil Score (DTS) and coronary artery disease (CAD) complexity in patients with suspected coronary artery disease (CAD).

Methods: Sixty five patients who had positive exercise testing for CAD were enrolled. Coronary angiography was performed and Syntax score (SxScore), a marker of CAD complexity, was determined. The relationship between DTC and SxScore then evaluated.

Results: There was a strong negative correlation between DTS and SxScore ($r = -0.91$, $p < 0.001$). In addition, patients with higher and intermediate risk as evaluated by DTS had increased SxScore compare to those that were low risk (23 ± 6 , 6 ± 5 and 0 ± 0 respectively).

Conclusions: A strong negative correlation was seen between DTS and coronary lesion complexity. By assessing DTS important information about coronary artery lesion complexity can be obtained before invasive coronary angiography.

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Exercise stress testing is a commonly used and inexpensive method for an initial evaluation of patients with suspected coronary artery disease (CAD). The Duke Treadmill Score (DTS) is a composite index that is based on the results from the exercise test, including ST-segment depression, chest pain and exercise duration, and provides more accurate diagnostic and prognostic information for the evaluation of patients with clinically-suspected ischemic heart disease. [1-3].

The Syntax score (SxScore) is a comprehensive angiographic scoring system that is derived entirely from the coronary anatomy and lesion characteristics (4-5). There is little known about the possible association between DTS and CAD severity and there is no information about the relationship between DTS and CAD severity, as assessed by SxScore. The main purpose of this study was to investigate this relationship.

Materials and Methods

Patients admitted between January and July 2011 to the outpatient cardiology clinic because of chest pain were enrolled in the study. They had no prior cardiovascular disease history and no contraindication for exercise testing. Patients with positive exercise testing according to their exercise ECG parameters or typical chest pain for CAD underwent coronary angiography. Informed consent was obtained from all subjects.

Exercise Treadmill Testing

All patients underwent symptom-limited exercise testing according to the standard Bruce protocol. Resting heart rate, blood pressure and 12-lead ECGs were recorded in the supine and upright positions before exercise. During each minute of exercise, heart rate, blood pressure and ECG were recorded. Exercise testing was discontinued if exertional hypotension, malignant ventricular arrhythmias, marked ST depression (≥ 3 mm), or limiting chest pain was reported. An abnormal exercise ST response was defined as ≥ 1 mm of horizontal or downsloping ST depression (J point ± 80 ms) or ≥ 1 mm of ST-segment elevation in leads without pathological Q waves (excluding aVR lead). Exercise-induced ST-segment deviation was coded to the nearest 0.25 mm for horizontal and downsloping ST-segment depression and ST-segment elevation in a non-Q-wave lead.

Duke Treadmill Score

The equation for calculating the DTS is as follows: $DTS = \text{exercise time} - (5 \times \text{ST deviation}) - (4 \times \text{exercise angina})$. Exercise angina was assessed as one of three levels: 0, none; 1, nonlimiting, and 2, exercise-limiting.

The DTS typically ranges from -25 to +15. These values correspond to low-risk (with a score of $\geq +5$), moderate-risk (with scores ranging from -10 to +4), and high-risk (with a score of ≤ -11) categories.

Coronary Angiography and Syntax Score

Coronary angiography was performed by the Judkins technique. Each angiogram was analysed independently by two experienced interventional cardiologists who were blinded to the patient clinical data. In cases of disagreement, the decision of a third observer was obtained and the final decision was made by consensus. Each coronary lesion producing 50% diameter stenosis in vessels ≥ 1.5 mm was scored separately and added together to provide the overall SxScore, which was calculated prospectively using the SxScore algorithm (6).

Statistical Analysis

Continuous variables were expressed as mean $\pm$ standard deviation (SD) and categorical variables were expressed as percentage. An analysis of normality of the continuous variables was performed with the Kolmogorov-Smirnov test. The Spearman's correlation analysis was used for assessing correlation between SxScore and DTS. Comparing SxScore between groups was done by using the Kruskal Wallis test. The Mann Whitney U test was used as post hoc test after the Kruskal Wallis test. Statistical analysis was performed by using SPSS 14.0 and a p value ≤ 0.05 was considered to be statistically significant.

Results

Clinical and demographic characteristics of all patients are summarized in Table 1. Mean age was 56 and most of the patients are male. There was a strong significant and negative correlation between DTS and SxScore ($r = -0.91$, $p < 0.001$) (Figure 1). Also, patients with higher risk and intermediate DTS had increased SxScore (23 ± 6 , 6 ± 5 and 0 ± 0 respectively) compared to those that were low risk (Figure 2). Moreover, angiographical characteristics of patients are summarized in Table 2. Patients with higher DTS had more LAD lesions, bifurcations, chronic total inclusion (CTO) and diffuse disease (Table 2).

Discussion

In present study, significant and positive correlation was demonstrated between DTS and SxScore. Also, there was a significantly increased SxScore in patients with higher risk groups, as

TABLE 1: Baseline characteristics (n= 65)

Age (years)	56 ± 8
Male gender, n (%)	47 (72)
Dyslipidemia, n (%)	33 (51)
Diabetes, n (%)	13 (20)
Smoking, n (%)	34 (52)
Hypertension, n (%)	35 (54)
Family History of CAD, n (%)	19 (30)
Duke Treadmill Score	-2.5 ± 7
Group 1 (≥ 5), n (%)	15 (23)
Group 2 (- 10 to < 5), n (%)	30 (46)
Group 3 (≤ -11), n (%)	20 (31)
Syntax Score	
Group 1	0 ± 0
Group 2	6 ± 5
Group 3	23 ± 6

assessed by the DTS.

The SxScore is widely accepted as a CAD complexity marker and its prognostic value has been demonstrated in different clinical situations. Patients with the highest tertile SxScore have been shown to have significantly more major adverse cardiac events (MACEs) (7,8). Wykrzykowska et al. demonstrated the independent predictive value of SxScore for MACEs and mortality, not only in selected patient groups but also in all CAD treated by percutaneous coronary intervention (9).

There is little information about the relationship between DTS and coronary artery lesion properties. Shaw et al. demonstrated that DTS was effective at diagnosing significant and severe CAD (3). They regarded CAD severity as number of diseased artery rather than morphological and structural properties of coronary arteries. SxScore takes into account different parameters such as lesion location, bifurcation, angulation, diameters and calcification, and it is widely accepted and used as a CAD complexity marker.

Our study has two important clinical implications. Firstly, it may explain why patients with higher DTS have increased MACE because patients with higher risk DTS have increased SxScore, which has a prognostic value. Secondly, since there was a significant positive association between SxScore and

FIGURE 1: Correlation between Duke treadmill score (DTS) and Syntax Score.

FIGURE 2: Syntax score of patients according to the DTS categories. Group 1, low-risk (with a score of $\geq +5$); Group 2, moderate-risk (with scores ranging from -10 to +4); and Group 3, high-risk (with a score of ≤ -11).

TABLE 2: Angiographical characteristics of three study groups

	Group 1	Group 2	Group 3	p*
LAD	0	15	20	<.001
LCX	0	5	14	<.001
RCA	0	7	17	<.001
Aorta Osteal	0	0	3	<.001
Bifurcation	0	7	16	<.001
Diffuse disease	0	3	16	<.001
CTO	0	1	9	<.001

Abbreviations: LAD, left anterior descending artery; LCX, left circumflex artery; RCA, right coronary artery; CTO, chronic total occlusion. * P value by Chi Square test

periprocedural myocardial necrosis (PPI) during percutaneous coronary intervention, which is associated with worse outcomes including death (10-12), it may help clinicians with risk stratifying of their patients, before the patients undergo coronary angiography, and to take necessary measures in order to avoid such complications.

Our study has important limitations. The number of patients is relatively small and our study design is cross-sectional. There-

fore, we cannot confirm whether patients with higher DTS have increased MACE. Moreover, in our study, all patients with low DTS had normal coronary arteries, a somewhat unexpected observation that may be due to the small number of study population.

In conclusion, a significant association was found between DTS and coronary artery lesion complexity. By using DTS, clinicians may have information about their patients' coronary anatomy in advance – information that may assist in planning treatment options.

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