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Prediction of coronary artery disease severity in lower extremity artery disease patients: A correlation study of TASC II classification, Syntax and Syntax II scores

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Abstract

Background: *Lower extremity arterial disease (LEAD) is a well-established risk factor for concomitant coronary artery disease (CAD). There are no published data combining all three lower limb arterial segments (aortoiliac, femoropopliteal and below the knee vessels) in order to estimate CAD severity in LEAD patients. Herein has been derived a new scoring system for this purpose, which uses the well-known TASC II classification, Syntax score and, for the first time in medical literature, a Syntax II score.*

Methods: *The study population consisted of 178 patients who underwent lower limb and coronary diagnostic angiography for assessment of LEAD and CAD at the same session. Syntax and Syntax II scores were calculated. TASC II classifications of the lower limb arteries were done. A new scoring system, called "Total Peripheral Score" (TPS), for lower limbs was also calculated.*

Results: *A positive correlation was found between TPS and Syntax score and a less prominent positive correlation between TPS and Syntax II score ($p < 0.001$). A cut-off value of '6' for the new score was found for estimating high risk subgorup of CAD (Syntax score > 32; $p < 0.001$). Critical femoropopliteal arterial segment stenosis was the most predictive lower limb arterial zone for presence of severe CAD (Syntax score > 32; $p = 0.011$).*

Conclusions: *Taking into account all lower limb arterial segments for predicting CAD during lower limb arterial angiography was recommended. A TPS of more than '6' is the practical cut-off value for estimating severe CAD. Femoropopliteal arterial critical stenosis is the most predictive arterial zone for estimating severe CAD.* (Cardiol J 2017; 24, 5: 495–501)

Key words: peripheral artery, Syntax score, TASC classification

Introduction

Coronary artery disease (CAD) and lower axtremity artery disease (LEAD) share the same vascular risk factors, and coexist in approximately 40% of patients. In clinical practice, if one vascular region is affected, there has been a trend to screen the other vascular areas [1, 2]. Currently, there are some noninvasive tests to screen for LEAD, such as the ankle brachial index (ABI) duplex ultrasound for patients with established CAD. In claudicant patients, after an evaluation using noninvasive tests, digital subtraction angiography (DSA) is the most common diagnostic modality for the confirmation of LEAD, as well as for planning therapeutic options. However, in patients with LEAD, there is no consensus in terms of screening tests for CAD. Typically, screening is done on an individual basis. One of the major limiting factors is that these patients cannot participate in certain exercises due to

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claudication; therefore, dobutamine echocardiography, single photon emission computed tomography (SPECT) or magnetic resonance imaging (MRI) with pharmacological stress may be used. The decision to conduct coronary angiography on a LEAD patient is based on symptoms (angina pectoris) and abnormal findings from an electrocardiogram, stress echocardiography, positive SPECT or MRI findings or computed tomography.

The aim of this study was to determine if any data obtained during lower limb peripheral artery diagnostic angiography could provide evidence of patients with a high risk of CAD in addition to the clinical criteria (e.g., angina pectoris, dynamic ECG changes). The determination of which lower limb arterial segment critical stenosis is the most predictive arterial zone for estimating severe CAD was also sought. Although there are few studies in this regard, they have been conducted by evaluating only the aortoiliac segment via Trans-Atlantic Inter-Society Consensus (TASC) II classification and the extent of CAD was only evaluated using the Syntax score [3, 4].

In this research, it was decided to use the new anatomic and clinical Syntax II score along with the original Syntax score. A simple scoring method was created (Total Peripheral Score [TPS]) by including all of the lower limb arterial segments (aortoiliac, femoropopliteal and below the knee [BTK] vessels) in the same formula to evaluate the actual extent of the lower extremity artery disease.

Methods

In this study, angiographic and clinical databases were searched retrospectively, for 956 patients who were assessed via lower limb arteriography in the referenced center between April of 2012 and May of 2016. Of these, patients 178 were enrolled who were assessed using lower limb and coronary angiography in the same session. These patients consisted mostly of claudicants, and were referred by the cardiovascular surgery team for DSA after other noninvasive tests were done, such as the ABI measurements and duplex ultrasound evaluations. Coronary angiography was conducted in these LEAD patients based on their clinical symptoms, including angina pectoris, recent myocardial infarction, ischemic changes found in electrocardiography or segmentary wall motion abnormalities in echocardiography. Coronary angiography was deferred to another session for those patients with chronic kidney disease. All of the cardiovascular risk factors (smoking, diabetes, hyperlipidemia and hypertension) were recorded, and creatinine clearance values were measured.

Approval was obtained from the Local Ethical Board for the study and informed consent was given by all the patients before conducting the coronary and lower limb angiographies. The lower limb angiography was performed transfemorally or transradially with a 5 or 6-French pigtail catheter. For the evaluation of both of the lower extremities, the catheter tip was positioned above the aorta-iliac bifurcation in the distal abdominal aorta. Stenoses of more than 70% were accepted as significant for lower extremity artery disease. In addition, the coronary angiography was performed transfemorally or transradially with 6-French catheters. The coronary and peripheral angiographies were each analysed blindly by two experienced interventional cardiologists.

Each coronary lesion showing a 50% diameter stenosis in a vessel of at least 1.5 mm in diameter was scored separately. They were then added together to provide the overall Syntax score, which was calculated using the Syntax score algorithm [5]. Calculation of the Syntax score is based on evaluation of anatomic parameters such as dominance of coronary system (right or left), location of diseased coronary artery vessel and segment, and presence of total occlusion, bifurcation or trifurcation lesion, severe tortuosity, aorto-ostial lesion, heavy calcification, thrombus, length of lesion (> 20 mm) and diffusely narrowed vessel. The patients were divided into low Syntax score (0–22), intermediate Syntax score (23–32) and high Syntax score (> 32) subgroups. In addition, the Syntax II score was calculated according to the diagram published in the literature [6]. Syntax II score is calculated by integrating clinical parameters such as age, gender, creatinine clearance, left ventricular ejection fraction, presence of left main coronary artery stenosis, chronic obstructive pulmonary disease or peripheral vascular disease. Syntax score evaluates purely anatomic parameters and, in contrast, Syntax II score also includes clinical data of patients for assessment.

With regard to the aortoiliac and femoropopliteal segments, the TASC II classification was used to assess the extension and severity of the disease [7]. For the vessels BTK, the new TASC II classification update was used, which was published in 2015, and added the BTK vessels to this classification system [6]. In addition, a new scoring system was developed for the three arterial segments (aortoiliac, femoropopliteal and BTK), in which a numeric value was used for all of the

Table 1. Calculation of the Total Peripheral Score (TPS) from Trans-Atlantic Inter-Society Consensus (TASC) II classification — TPS is calculated by adding score of each arterial segment (TPS = X + Y + Z).

	Aorto-iliac arterial segment	Femoro-popliteal arterial segment	Below the knee arterial segment
TASC-A lesion	1 point	1 point	1 point
TASC-B lesion	2 point	2 point	2 point
TASC-C lesion	3 point	3 point	3 point
TASC-D lesion	4 point	4 point	4 point
Score of each segment	X	Y	Z

Table 2. Baseline clinical characteristics of the study population (n = 178).

Parameter	Value
Age (mean)	61 ± 11
Male gender	150 (84.3%)
Smoker	101 (56.7%)
Diabetes	60 (33.7%)
Hypertension	78 (43.8%)
Hyperlipidemia	69 (38.7%)
COPD	48 (27%)
Family history of CAD	65 (36.5%)
Creatinine [mg/dL]	0.9 ± 0.2
eGFR [mL/min/1.73 m^2]	89.13 ± 17.21

CAD — coronary artery disease; COPD — chronic obstructive pulmonary disease; eGFR — estimated glomerular filtration rate

lesions (TASC A lesion = 1 point, TASC B lesion = 2 point, TASC C lesion = 3 point, TASC D lesion = 4 point). In total, a scoring value from 0–12 was obtained for each patient, and named the "Total Peripheral Score" (TPS). Scoring of each arterial segment is added to the other segment values and TPS was obtained for each patient (Table 1).

Statistical analysis

The data were analysed using the SPSS version 20.0 (IBM Co, Armonk, NY, USA) and MedCalc (Ostend, Belgium) statistical software. The continuous variables were expressed as the mean ± standard deviation (SD), and the categorical variables were expressed as percentages. A comparison of the Syntax and Syntax II scores among the LEAD subgroups was made using a one-way analysis of variance (ANOVA) with a post hoc Tukey test. Correlation and regression analyses were done between the Syntax, Syntax II and TPS values, and a p-value of less than 0.05 (2-tailed) was considered to be significant.

Table 3. Baseline angiographic characteristics and calculated scores of the study population.

Parameter	Value
Distribution of diseased coronary vessels:	
Normal	43 (24.2%)
One vessel disease	54 (30.3%)
Two vessel disease	50 (28.1%)
Three vessel disease	31 (17.4%)
LMCA disease	16 (9.0%)
Aortoiliac segment TASC II classification:	
Normal	92 (51.7%)
TASC A	26 (14.6%)
TASC B	25 (14.0%)
TASC C	16 (9.0%)
TASC D	19 (10.7%)
Femoropopliteal TASC II classification:	
Normal	66 (37.1%)
TASC A	26 (14.6%)
TASC B	38 (21.3%)
TASC C	29 (16.3%)
TASC D	19 (10.7%)
Below the knee vessels TASC II classification:	
Normal	66 (37.0%)
TASC A	49 (27.5%)
TASC B	34 (19.1%)
TASC C	13 (7.3%)
TASC D	16 (8.9%)
Mean TPS	3.8 ± 2.5
Mean Syntax score	15. ± 6
Mean Syntax II score	38 ± 9
Syntax groups:	
Low (score = 0–22)	131 (73.6%)
Intermediate (score = 23–32)	17 (9.6%)
High (score > 32)	30 (16.9%)
Treatment of CAD patients (n = 135):	
Optimal medical therapy	57 (42.2%)
PTCA and/or stent	49 (36.3%)
Surgery	29 (21.5%)

LMCA — left main coronary artery; TASC — Trans-Atlantic Inter-Society Consensus; TPS — Total Peripheral Score; CAD — coronary artery disease; PTCA — percutaneous transluminal coronary angioplasty

Table 4. Distribution of low, intermediate and high Syntax subgroups according to three lower limb arterial segment stenoses.

Variable	Low risk group (score = 0–22) (n = 131)	Intermediate risk group (score = 23–32) (n = 17)	High risk group (score > 32) (n = 30)	P
Aortoiliac segment:				0.03
Normal	20 (15.2%)	3 (17.6%)	1 (3.3%)	
TASC A	13 (9.9%)	2 (11.7%)	1 (3.3%)	
TASC B	8 (6.1%)	1 (5.8%)	0 (0.0%)	
TASC C	3 (2.2%)	0 (0.0%)	3 (10.0%)	
TASC D	1 (0.7%)	1 (5.8%)	4 (13.3%)	
Femoropopliteal segment:				0.01
Normal	20 (15.2%)	2 (11.7%)	0 (0.0%)	
TASC A	12 (9.1%)	1 (5.8%)	1 (3.3%)	
TASC B	8 (6.1%)	0 (0.0%)	1 (3.3%)	
TASC C	4 (3.0%)	1 (5.8%)	3 (10.0%)	
TASC D	2 (1.5%)	0 (0.0%)	4 (13.3%)	
Below the knee vessels segment:				0.04
Normal	19 (14.5%)	3 (17.6%)	1 (3.3%)	
TASC A	9 (6.8%)	2 (11.7%)	2 (6.6%)	
TASC B	8 (6.1%)	1 (5.8%)	2 (6.6%)	
TASC C	3 (2.2%)	0 (0.0%)	4 (13.3%)	
TASC D	1 (0.7%)	0 (0.0%)	3 (10.0%)	
Mean Total Peripheral Score	3.2 ± 2.2	4.6 ± 2.9	6.0 ± 2.4	0.001

TASC — Trans-Atlantic Inter-Society Consensus

Results

The clinical and demographic characteristics of the study population are shown in Table 2, and the peripheral and coronary angiographic data and calculated scores are shown in Table 3. The mean Syntax and Syntax II scores were 15 ± 6 and 38 ± 9, respectively, and a comparison of the Syntax subgroups demonstrated mean TPS scores of 3.2 ± 2.2, 4.6 ± 2.9 and 6.0 ± 2.4 for the low, intermediate and high Syntax subgroups, respectively. Moreover, the post hoc analysis showed statistical significance between the low and high risk subgroups ($p < 0.001$). The TASC II distributions of the lesions for the low, intermediate and high risk Syntax subgroups are shown in Table 4. P-values were found to be significant for comparison of low and high risk groups for all the lower limb arterial segments ($p < 0.05$).

After an analysis of the correlation and regression, the findings indicated a moderately positive correlation between the TPS and Syntax (Pearson correlation = 0.467, $p < 0.001$) (Fig. 1). A positive but less prominent correlation was also found between the TPS and Syntax II (Pearson correlation = 0.346, $p < 0.001$) (Fig. 2). An attempt was made to determine if a cut-off TPS value might be used for estimating the high Syntax subgroup patients. After analysing the receiver operating characteristic (ROC) curves, a cut-off value of TPS > 6 estimated presence of obstructive CAD with 75% sensitivity and 77% specificity ($p < 0.001$) (Fig. 3).

An attempt was also made to determine if any specific lower limb arterial segment was more valuable than the other segments in predicting a high score for the Syntax subgroup in LEAD patients. Based on the comparison of ROC curves, it was found that the femoropopliteal segment critical stenosis was the most reliable arterial segment for estimating the Syntax high risk (Syntax score > 32) subgroup (Fig. 4). Although there was no statistical difference between the aortoiliac and femoropopliteal or aortoiliac and BTK vessel segments ($p > 0.05$), a statistical difference was found between

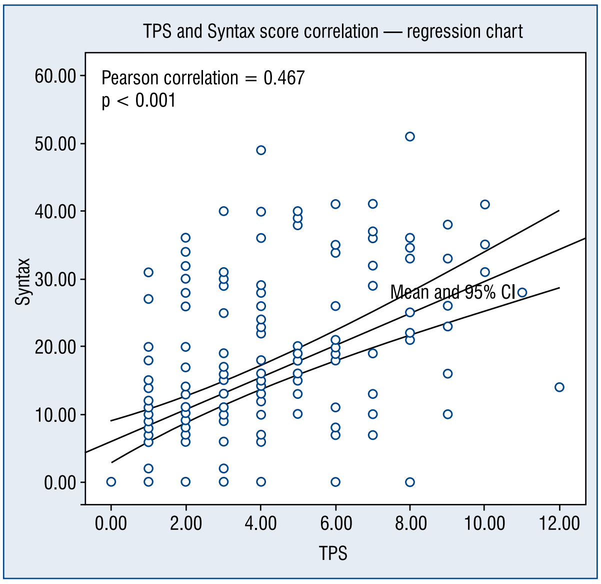

Figure 1. Correlation analysis between the Total Peripheral Score (TPS) and the Syntax score; CI — confidence interval.

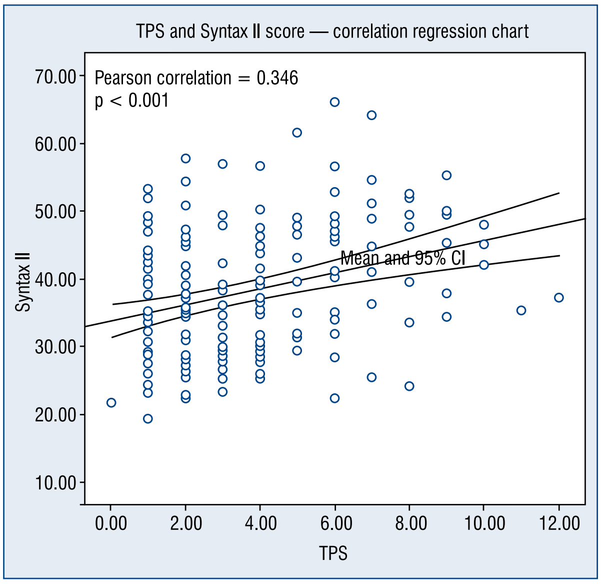

Figure 2. Correlation analysis between the Total Peripheral Score (TPS) and the Syntax II score; CI — confidence interval.

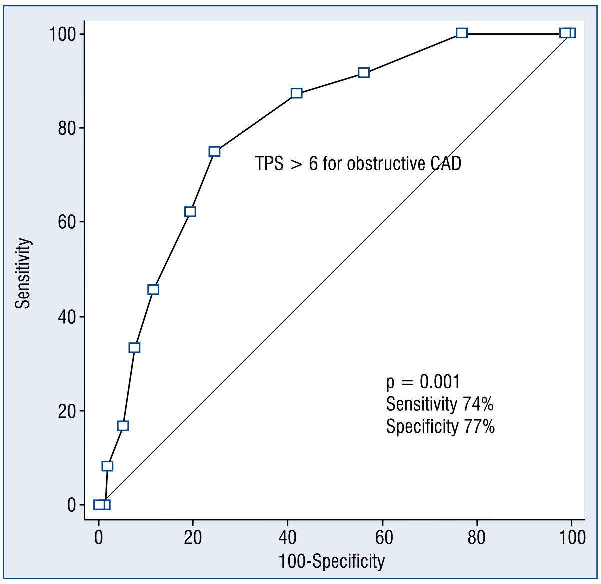

Figure 3. Receiver operating characteristics analysis of Total Peripheral Score (TPS) for presence of obstructive coronary artery disease (CAD).

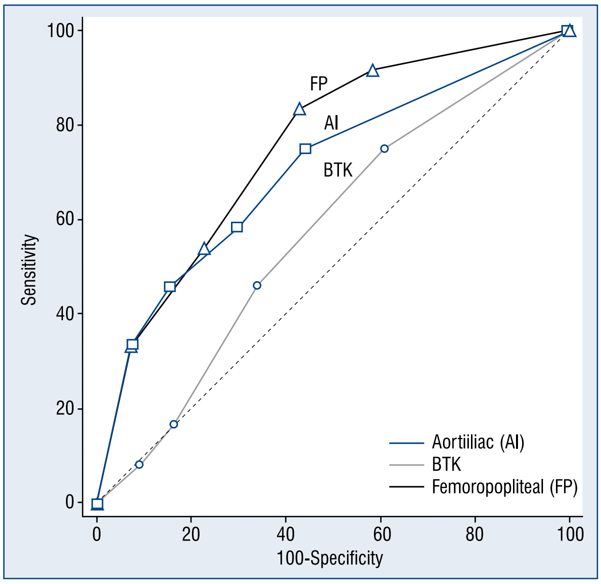

Figure 4. Comparison of receiver operating characteristic curves for aortoiliac, femoropopliteal and below the knee (BTK) arterial segments.

femoropopliteal and BTK vessel segments in terms of sensitivity and specificity of these arterial segments for TPS value '6' in order to estimate high Syntax subgroup (Syntax score > 32; p = 0.011).

Discussion

Atherosclerosis is a systemic disease affecting several arteries at different sites concomitantly. Therefore, the presence of vascular involvement at a given site is associated with a higher risk of its development in other vascular territories [8–10]. Aykan et al. [11] found that patients who have more complex peripheral artery lesions also have more complex coronary lesions. In one study computed tomography coronary angiography was proposed to be effective in detecting CAD in subjects with lower-extremity peripheral artery disease and no cardiac symptoms [12]. Amighi et al. [13] showed the predictive value of renal artery stenosis on adverse cardiovascular events. In addition, other previous studies have shown that patients with LEAD is often present with coronary atherosclerosis, and have an increased risk for adverse cardiovascular events [14]. Jeong et al. [15] found in an autopsy study that, peripheral arteries including the carotid artery can be helpful in clinical prediction of CAD. However, such predictions should also include other risk factors such as age, hypertension, diabetes and dyslipidemia and other relevant clinical conditions. In the present study a moderate correlation between LEAD and CAD was found. This was probably due to the selection process of patients and high premature atherosclerosis rates observed in the study region.

The arterial bed of the lower limb can be divided into main three parts: aortoiliac, femoropopliteal and BTK vessels. Most previous studies have used the TASC II classification, and mainly, the aortoiliac territory for determining the extent and severity of LEAD [16]. There are limited data including all of the arterial segments for the prediction of CAD, although there have been some complicated and time consuming scores used in the literature [17, 18]. Therefore, the decision was chosen to determine a practical scoring system including all three arterial zones. Moreover, the new TASC II classification update for the BTK vessels, which was advised by the TASC steering committee, was used for the first time in the formula created for this study [19]. Herein derived a total peripheral scoring system (TPS), which ranges from 0 to 12 points. At the same time, an attempt to find out which of these three zones correlated more with the presence of severe CAD (the high risk Syntax subgroup). The aim was to obtain a simple, practical approach to determine which LEAD patients should receive a coronary angiography in the same session as a lower limb diagnostic angiography. The main indications for coronary angiography were symptomatology, positive stress tests, risk factors and a past medical history of CAD.

This study also differs from those previously conducted in terms of using both the Syntax and the Syntax II scores. In addition, a decision was made to take into account the influence of the clinical parameters, in order to calculate the relatively new clinical Syntax II score. Although both scoring systems were positively correlated with TPS, the Syntax score showed a stronger positive correlation when compared to the Syntax II score. This was explained by evaluating purely anatomic parameters with Syntax score and, in contrast, the Syntax II score also includes clinical data of patients. Costanzo et al. [20] also recommended using the Syntax II score for the carotid artery and coronary artery relationship in their recent study, but for peripheral artery disease and CAD, we recommend using the classical Syntax score (based on our study results [20–25].

In order to prevent unnecessary future coronary angiographies, an attempt was made to estimate the obstructive CAD patients. After the ROC, analysis of these patients, a cut-off vaue of 6 was found, with a moderate sensitivity and specificity (74% and 77%, respectively; $p < 0.001$). A comparison of the arterial territories using the analysis of ROC, it was shown that the femoropopliteal artery significant stenosis was the most highly correlated arterial segment for determining a possible high Syntax subgroup patient. The least reliable arterial zone significant stenosis for this estimation were the BTK vessels.

Limitations of the study

The most important limitation of this study was the exclusion of those patients with renal failure. Based on the risk of contrast dye induced acute kidney injury, coronary angiography was not performed during the same session as the peripheral arteriography in these patients. Therefore, there was a risk of underestimating the incidence of CAD. In future studies, the use of carbon dioxide angiography, which has become more favoured over the last few years, may resolve this problem. The retrospective design of this study may present another limitation. A larger number of enrolled patients in the study population can also result in a higher positive correlation to be obtained in future studies. Another limitation of the study was that only 47 of the patients were left main coronary artery or three vessel coronary disease patients; the rest of the patients had one- or two-vessel disease. Syntax score is mainly intended for patients with three vessel disease or left main coronary artery disease.

Conclusions

This study, as far as can be concluded, is the first to derive a simple lower extremity arterial scoring system (TPS) including all the three lower limb arterial segments, from the abdominal aorta to the toe, to estimate the severity of CAD in patients undergoing lower limb diagnostic angiograph This study has found a moderately reliable TPS cut-off value of 6 (or greater) for choosing to perform coronary angiography in the same session with lower limb diagnostic angiography, if the patient is symptomatic (angina or angina equivalent) or has cardiovascular atherosclerotic risk factors. Moreover, it was determined that the most predictive lower limb arterial critical stenosis segment for high Syntax subgroup patients is the femoropopliteal arterial segment.

Conflict of interest: None declared

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