ISSN: 2986-9994

The Grant Medical Journals®

February, 2017; 02(02): 041-046 crh/16/1620/gmj

Cardiology Research
Review

Coronary Tortuosity; Component or Entire of SYNTAX Score Puzzle

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Published: 2016.02.10.

ABSTRACT

Background: Coronary tortuosity (CorT) is a common angiographic finding and the relationship between CorT and coronary atherosclerosis is still unclear. SYNTAX score I is the angiographic scoring system and is widely used to evaluate the severity and complexity of coronary artery disease (CAD). This study was conducted with the aim to evaluate the relationship between CorT score and SYNTAX score I. Methods: The medical records of consecutive patients, who underwent coronary artery bypass graft surgery, were retrospectively reviewed. The study group consisted of 212 patients. Patients were divided into two groups depending on high (≥32) and low-intermediate (≤32) SYNTAX score I. CorT score, biochemical parameters, clinical and echocardiographic parameters, and SYNTAX score I was evaluated in all patients. Results: There was a significant difference between both groups regarding current smoking, diabetes, urea, creatinine, CorT and CorT score (22.9% vs 56.9% p<0.001, 22.9% vs 39.6% p<0.001, 36.4±16.3 vs 42.9±19.2 p=0.014, 0.9±0.2 vs 1.0±0.3 p=0.010, 20.8% vs 77.6% p<0.001, 0.4±1.1 vs 4.8±3.7 p<0.001; respectively) (Table1). On multivariate analysis, DM, CorT score, current smoking was independent predictors for higher SYNTAX score I (OR 13.624; 95% CI: 6.924–22.937; p < 0.001, OR 11.637; 95% CI: 7.836-26.384; p<0.001, OR 5.372 % CI: 2.841-18.396; p<0.001; respectively)(Table3). Conclusions: There was a statistically significant positive correlation between CorT and SYNTAX score I (r=0.80; p<0.001). Definition of severe CorT is too weak to evaluate the severity of CAD. Larger studies are required to determine whether serious Cort is a piece of the SYNTAX score puzzle or the whole reflection.

Keywords: Atherosclerosis, coronary artery bypass graft surgery, SYNTAX score

INTRODUCTION

Coronary tortuosity (CorT) is a common coronary angiographic finding and is defined as; at least a single epicardial artery consisting of 3 bends, fixed in both systole and diastole with each bend causing a 450 degree change in the vessel.[1] The etiology, clinical implication, and long term prognosis are still not well clarified. Clinical studies have demonstrated that CorT might be related to aging, hypertension, atherosclerosis and diabetes mellitus (DM).[2,3]

The Synergy between percutaneous coronary intervention with Taxus and cardiac surgery (SYNTAX) score, which was established during the SYNTAX trial, is a useful tool for treatment decision regarding the complexity of the coronary artery disease (CAD). The SYNTAX score I is an anatomically based tool that quantitatively characterizes the coronary vessel with respect to the number, complexity, location, and functional impact of angiographically obstructive lesions.[4] Depending on the location and several angiographic characteristics, the lesion is given a corresponding point value, and finally scores of individual lesions are summed up by the Internet-based SYNTAX calculator to derive the final score.[5]

Retrospective analyses suggest that CAD severity by SYNTAX scoring might help to guide the selection of revascularization strategies.[6,7] The SYNTAX score I have been shown to be able to predict mortality and morbidity at early and late follow-up in patients with CAD, irrespective of clinical presentation, including acute coronary syndrome (ACS) and stable CAD.[8,9] Severe CorT is a component of SYNTAX score I as well. In SYNTAX score I calculation, severe CorT was defined as one or more bends of 90o or more, or three or more bends of 45^{o} to 90^{o} proximal of the diseased segment. This definition is too poor to evaluate the severity of CAD. Severe CorT was defined as ≥3 consecutive curvatures ≤90o during diastole in ≥1 coronary artery by Gaibazzi et al.[10], ≥3 curvatures ≤120o during diastole by Zegers et al.[11], 2 consecutive 180o turns by Groves et al.[12]. A definition with a precise angle cutoff is needed for scientific purposes, although this is somewhat arbitrary.

Up to date, the relationship between CorT score and SYNTAX score I have not been studied. In this context, we assessed the relationship between the CorT score and SYNTAX score I.

METHODS

The study group consisted of 212 consecutive patients, who underwent on-pump coronary artery bypass graft surgery. The data of patients were retrospectively analyzed for the demographic features, echocardiographic parameters, and biochemical parameters including urea, creatinine, total cholesterol, high-density cholesterol (HDL), low-density cholesterol (LDL), Triglyceride (TG), and SYNTAX score I. Patients were divided into two groups depending on high (≥32) or low-intermediate (≤32) SYNTAX score I. The study was approved by the local ethics committee.

The patient’s data, including age, gender, history of hypertension (HT), DM, heart failure, stroke, and echocardiographic variables such as ejection fraction (EF), biochemical and hematologic parameters were received from medical records. We excluded patients with ACS, previous myocardial infarction, chronic kidney disease, chronic liver disease and chronic heart failure.

Echocardiographic Examination

All patients underwent transthoracic echocardiography using Vivid S5 (GE healthcare) echocardiography device and Mass S5 probe (2-4 MHz). Standard two-dimensional and color flow Doppler views were acquired according to the guidelines of American Society of Echocardiography and European Society of Echocardiography.[13,14] The EF was measured according to the Simpson’s method.

Coronary Angiography

All patients underwent elective coronary angiography according to the Judkins technique. Angiograms were reviewed by at least 2 non-blinded reviewing cardiologists. The left anterior descending coronary artery (LAD), the left circumflex coronary artery (LCx) and the right coronary artery (RCA) was observed by various angulations. The CorT was evaluated on special angulations; LAD was assessed in right anterior oblique with cranial angulations and LCX in left anterior oblique with caudal angulations, while RCA in right anterior oblique. Tortuosity was defined by the presence of ≥3 consecutive curvatures of 90° to 180° measured at end-diastole in a major epicardial coronary artery ≥2 mm in diameter. Severe tortuosity was defined as ≥2 consecutive curvatures of ≥180° in a major epicardial coronary artery ≥2 mm in diameter.

Mild tortuosity was defined as either ≥3 consecutive curvatures of 45° to 90° in a major epicardial coronary artery, or ≥3 consecutive curvatures of 90° to 180° in an artery <2 mm in diameter. The tortuosity score was calculated as a sum of scores for each epicardial coronary artery (LAD, LCx, RCA, diagonal, obtus margine, right posterior descending, or right posterolateral) with 0=no tortuosity, 1=mild tortuosity, 2=tortuosity, 3=severe tortuosity.[12]

The severity and complexity of coronary atherosclerosis were assessed by online software (http://www. SYNTAXscore.com). First, a simple classification of a number of the diseased vessels was done in the scoring system. The number of diseased vessels with ≥ 50% luminal stenosis in major coronary arteries was scored as 1 to 3 diseased vessels. All lesions causing ≥ 50% stenosis in a coronary artery with a diameter ≥ 1.5 mm was included in the SYNTAX score I calculation. Two interventional cardiologists blinded to the study protocol and patient characteristics evaluated SYNTAX score I separately. In the presence of a contradiction between the two results, the opinion of a senior interventional cardiologist was applied and a common consensus was obtained.

Patients with DM were identified on admission as those with documented DM using either oral hypoglycemic agents or insulin treatment. Hypercholesterolemia was defined as total cholesterol at least 200 mg/dL or using antihyperlipidemic therapy on admission. Hypertension was defined as blood pressure above 140/90 mmhg or using antihypertensive therapy on admission.

STATISTICAL ANALYSIS

Descriptive statistics were calculated for study variables. Arithmetic mean and standard deviation were calculated for continuous variables while frequency (n) and percentage (%) for categorical variables. Either Kolmogorov-Smirnov or Shapiro-Wilk tests of normality was used to evaluate the distribution of continuous variables. Since the distributions significantly differed from normality, nonparametric hypothesis tests were applied. Mann-Whitney U-test was used to compare two groups for continuous variables. For categorical variable comparisons, Pearson Chi-Square test or Fisher’s Exact test were used, where appropriate. To predict high or low syntax score, multivariate logistic regression analyses were performed with all predictive variables of those which had a p-value lower than 0.10 in univariate tests. In addition, Pearson correlation analysis was performed to understand possible associations among variables. The level of significance was accepted to be 0.05 and SPSS (Version 18.0) statistical software package was used for all the calculations.

RESULTS

Prevalence of CorT was 51.8% in this study group. Low-moderate and high SYNTAX score I groups were composed of 96 and 116 patients respectively. The demographic characteristics of both groups are summarized in Table 1. There was a statistically significant positive correlation between CorT and SYNTAX score I (r=0.80; p<0.001).

There was no significant difference between both groups regarding age, female gender, HT, EF, total cholesterol, LDL cholesterol, HDL cholesterol, TG, hyperlipidemia, statin therapy, beta blocker therapy, and angiotensin converting enzyme inhibitor/angiotensin receptor blocker therapy (63.6±9.8 vs 65.5±9.5 p=0.559, 89.6% vs 89.7% p=1.000, 14.6% vs 3.4 p=0.75, 54.2% vs 53.1% p=0.780, 184.3±53.5 vs 181.2±49.1 p=0.770, 118.2±49.7 vs 112.3±39.4 p=0.767, 38±10.7 vs 39.4±11.4 p=0.529, 151.2±64.2 vs 165.8±81.1 p=0.640, 33.3% vs 34.5% p=0.678, 54.1% vs 55.1 p=0.864, 37.5% vs 39.6% p=0.642; respectively) (Table1)

However, there was a significant difference between both groups regarding current smoking, DM, urea, creatinine, CorT and CorT score (22.9% vs 56.9% p<0.001, 22.9% vs 39.6% p<0.001, 36.4±16.3 vs 42.9±19.2 p=0.014, 0.9±0.2 vs 1.0±0.3 p=0.010, 20.8% vs 77.6% p<0.001, 0.4±1.1 vs 4.8±3.7 p<0.001; respectively) (Table1).

The results of univariate analyses are presented in Table 2. On univariate analysis, DM, current smoking, creatinine, CorT score was associated with the high SYNTAX score I (Table2). On multivariate analysis, DM, CorT score, current smoking was independent predictors for the higher SYNTAX score I (OR 13.624; 95% CI: 6.924–22.937; p < 0.001, OR 11.637; 95% CI: 7.836-26.384; p<0.001, OR 5.372 % CI: 2.841-18.396; p<0.001; respectively)(Table3).

DISCUSSION

The main findings of the study were as follows: i) CorT score was significantly associated with the SYNTAX score I; ii) increased CorT score was an independent predictor of higher SYNTAX score I. The relationship between CorT and coronary atherosclerosis is still unclear. The CorT is associated with reversible myocardial perfusion defects and chronic stable angina.[10,15] Zegers et al.6 demonstrated three cases of patients with the CorT and hypothesized that the CotT may lead to ischemia. Patients with CorT may suffer from effort-induced chest pain that typically resolves at rest.[11]

CorT is associated with coronary atherosclerotic changes, regardless the presence of actual coronary stenosis.[16] Severe tortuosity in coronary arteries simplifies atherosclerosis.[17] Therefore, atherosclerosis is more common in patients with coronary artery tortuosity as greater curvature has more areas of low shear wall stress. Shear stress is an essential causal factor in atherosclerosis development and of vulnerable plaque rupture.[18,19] Davutoglu et al.[20], found that CorT was strongly associated with subclinical atherosclerosis indicated by carotid intima-media thickness and retinal artery tortuosity.

On the contrary, some studies found that CorT was negatively correlated with significant CAD detected by coronary angiography.[3,12] Esfahani et al.[21] showed that the mean Gensini index of tortuous group was significantly lower than the non-tortuous group.

The SYNTAX scoring system studied and published by SYNTAX in 2005 is an accurate and quantitative anatomical scoring system.[22] SYNTAX score I predict short- and long-term adverse events following revascularization.[23] A great number of studies show that extremely high scores are closely related to the clinical prognosis of patients with multivessel disease.[24-27]

The prevalence of CAD in the diabetic population ranges from 9.5% to 55%, whereas in the general population, it is reported to be 1.6–4.1%. Diabetic patients tend to have more severe CAD, number of arteries involved, and the higher prevalence of left main stem disease.[28-30] Our result consisted of previous study. DM was an independent predictor of higher SYNTAX score I.

Smoking increases oxidative stress mediated vascular dysfunction.[31] Increased oxidative stress is a critical factor, particularly in young smokers with low levels of anti-oxidant effects of HDL cholesterol. Prior studies have reported a strong correlation between oxidative stress and the presence of CAD.[32–34] Our result was consistent with the previous study. Current smoking is an independent predictor of higher SYNTAX score I.

Severe CorT is a component of SYNTAX score I. On SYNTAX score I calculation, severe CorT was defined as one or more bends of 90o or more, or three or more bends of 45o to 90o proximal of the diseased segment. This definition is too poor to evaluate the severity of CAD. A definition with a precise angle cutoff is needed for scientific purposes, although this is somewhat arbitrary.

The severe CorT definition in SYNTAX score I calculator reflects the classification by Groves et al. as mild and moderate groups. Therefore, the definition of severe CorT is arbitrary to evaluate the severity of CorT for scientific purposes. To answer the question whether serious Cort is a piece of the SYNTAX score puzzle or the whole reflection, larger studies are needed and to evaluate the contribution of CorT to Syntax score, classification as mild, moderate, severe should be considered.

LIMITATIONS OF THE STUDY

Our study has some limitations. First, small sample size of the present study. Second, as CorT is a part of SYNTAX score. Third, other confounding factors cannot be neglected.

CONCLUSION

To the best or our knowledge, this study is the first to evaluate the relation between CorT score and SYNTAX score. In our study, there was a strong relation between CorT score and SYNTAX score. Further studies with a larger number of patients are required as the relatively small number of patients in the present study.

CONFLICT OF INTEREST: None

FUNDING STATEMENT: None

Table1. General Characteristics of Patients

Variables	SYNTAX SCORE Group I (≤32) (96)	SYNTAX SCORE Group II (≥32) (116)	p
Age (years)	63.6±9.8	65.5±9.5	0.559
Cortor, n (%)	20 (20.8)	90 (77.6)	<0.001
Cortor Score	0.4±1.1	4.8±3.7	<0.001
Hypertension, n (%)	14 (14.6)	4 (3.4)	0.075
Diabetes mellitus, n(%)	22 (22.9)	46 (39.6)	<0.001
Female Gender, n (%)	86 (89.6)	104 (89.7)	1.000
Current smoking	22 (22.9)	66 (56.9)	<0.001
Hyperlipidemia, n(%)	32 (33.3)	40 (34.5)	0.678
Beta blocker therapy, n(%)	52 (54.1)	64 (55.1)	0.864
ACE inhibitors/ARB therapy	36 (37.5)	46 (39.6)	0.642
Statin therapy	26 (27)	30 (25.8)	0.437
Urea (mg/dl)	36.4±16.3	42.9±19.2	0.014
Creatinine (mg/dl)	0.9±0.2	1.0±0.3	0.010
Total cholesterol (mg/dl)	184.3±53.5	181.2±49.1	0.770
HDL Cholesterol (mg/dl)	38.0±10.7	39.4±11.4	0.529
LDL Cholesterol (mg/dl)	118.2±49.7	112.3±39.4	0.767
Triglyceride (mg/dl)	151.2±64.2	165.8±81.1	0.640
EF (%)	54.2±6.9	53.1±9.0	0.780

Table2. Univariate Analysis of Predictors for high SYNTAX score

Predictor Variables	OR (95% C.I.)	p
Diabetes mellitus	2.762 (1.624 – 3.528)	<**0.001**
Current smoking	1.728 (1.357-2.369)	<**0.001**
Creatinine	6.329 (4.834-11.358)	<**0.001**
Coronary tortuosity score	4.379 (2.527-7.873)	<**0.001**

Table 3. Multivariate Analysis of Predictors for high SYNTAX score

Predictor Variables	OR (95% C.I.)	p
Diabetes mellitus	13.624 (6.924 – 22.937)	<**0.001**
Current smoking	5.372 (2.841-18.396)	<**0.001**
Creatinine	0.845 (0.357-1.369)	0.167
Coronary tortuosity score	11.637 (7.386-26.384)	<**0.001**

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