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The Relation of SYNTAX Score with Carotid Plaque Morphology in Patients Who Undergoing Coronary By-pass Surgery

Süleyman Hilmi Aksoy[1], **Oğuzhan Birdal**[2], **Işıl Yurdaışık**[3]

[1] Department of Radiology, Hisar Hospital Intercontinental, Istanbul, Turkey
[2] Department of Cardiology, Faculty of Medicine, University of Atatürk, Erzurum, Turkey
[3] Department of Radiology, University of Istinye, Gaziosmanpasa Medical Park Hospital, Istanbul, Turkey

ABSTRACT

Introduction: Although there are many studies assessing the relationship between carotid artery ultrasound findings and coronary artery disease, the relationship between carotid plaque types and the complexity of coronary lesions is not assessed. We aimed to examine the relationship between the SYNTAX score and carotid plaque morphology.

Patients and Methods: We retrospectively screened patients who underwent carotid Ultrasound before the coronary artery bypass graft operation between 2015 and 2020. Syntax score was calculated by two independent interventional cardiologists with online SYNTAX score calculator (www.syntaxscore.com). The lesions of carotid arteries by ultrasound were classified as fibrous, calcific and mixed plaques.

Results: A total of 407 patients were enrolled. Median age was 65 (58-71) years and 81.6% of patients were male. We used multinomial logistic regression to test the association between plaque types and syntax score. The syntax score was associated with calcified plaque both in right (odds ratio 1.04, 95% CI 1.01-1.07, p= 0.006) and left internal carotid artery (odds ratio 1.04, 95% CI 1.02-1.06, p= 0.004). However, the syntax score was not associated with fibrous (odds ratio 0.97, 95% CI 0.94-1.01, p= 0.155 for right and odds ratio 0.99, 95% CI 0.96-1.02, p= 0.759 for left carotid artery) and mixed plaque types (odds ratio 1.02, 95% CI 0.98-1.06, p= 0.168 for right and odds ratio 1.00, 95% CI 0.96-1.04, p= 0.791 for left carotid artery).

Conclusion: SYNTAX score may provide an idea for carotid plaque morphology prediction. Especially higher SYNTAX score may be a predictor of calcific carotid plaque.

Key Words: Carotid plaque morphology; coronary artery by-pass surgery; coronary artery disease; SYNTAX score; ultrasound.

Koroner Baypas Ameliyatı Olacak Hastalarda SYNTAX Skorunun Karotis Plak Morfolojisi ile İlişkisi

ÖZ

Giriş: Karotis arter ultrason bulguları ile koroner arter hastalığı arasındaki ilişkiyi değerlendiren birçok çalışma olmasına rağmen karotis plak tipleri ve koroner lezyonların karmaşıklığı arasındaki ilişki değerlendirilmemiştir. Bu çalışmada, SYNTAX skoru ile karotis plak morfolojisi arasındaki ilişkinin incelenmesi amaçlanmıştır.

Hastalar ve Yöntem: Çalışmada, 2015-2020 yılları arasında koroner arter baypas greft operasyonu öncesi karotis ultrasonu yapılan hastalar geriye dönük olarak tarandı. SYNTAX skoru, çevrim içi SYNTAX skor hesaplayıcısı (www.syntaxscore.com) ile iki bağımsız girişimsel kardiyolog tarafından hesaplandı. Ultrason ile karotis arter lezyonları şu şekilde sınıflandırıldı: fibroz, kalsifik ve mikst plaklar.

Bulgular: İncelemeye toplam 407 hasta alınmıştır. Ortanca yaş 65 (58-71) yıl ve hastaların %81.6'sı erkektir. Plak türleri ve SYNTAX skoru arasındaki ilişkiyi test etmek için multinomial lojistik regresyon kullanılmıştır. SYNTAX skoru, hem sağda (Odds oranı 1.04, %95 CI 1.01-1.07, p= 0.006) hem de sol internal karotid arterde (Odds oranı 1.04, %95 CI 1.02-1.06, p= 0.004) kalsifiye plak ile ilişkilendirilmiştir. Bununla birlikte, SYNTAX skoru, fibröz (sağ için Odds oranı 0.97, %95 CI 0.94-1.01, p= 0.155 ve sol karotid arter için Odds oranı 0.99, %95 CI 0.96-1.02, p= 0.759) ve mikst plak ile ilişkili saptanmamıştır (Odds oranı 1.02, %95 CI 0.98-1.06, sağ için p= 0.168 ve sol karotid arter için Odds oranı 1.00, %95 CI 0.96-1.04, p= 0.791).

Sonuç: SYNTAX skoru, karotis plak morfolojisi tahmini için bir fikir sağlayabilir. Özellikle yüksek SYNTAX skorlarının varlığı, daha fazla kalsifik karotis plakları ile ilişkili bulunmuştur.

Anahtar Kelimeler: Karotid plak morfolojisi; koroner arter baypas cerrahisi; koroner arter hastalığı; SYNTAX skoru; ultrasound.

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Correspondence

Süleyman Hilmi Aksoy

E-mail: shilmiaksoy@gmail.com
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INTRODUCTION

Atherosclerosis is one of the leading causes of morbidity and mortality in developed countries[1]. Carotid artery disease is a result of atherosclerosis in carotid arteries and often accompanied by coronary artery disease (CAD)[2]. Ultrasonographic (USG) assessment is a feasible and reliable method to assess the carotid arteries and frequently used instrument for diagnosis of carotid artery disease. There are many reports on the relationship between ultrasonographic features of carotid artery lesions and coronary artery disease. Most of these studies are based on measurements of intima media thickness (IMT) measurements. Several studies have demonstrated that there is a relationship between IMT and CAD[3-6]. In a study, the presence of atherosclerotic plaque in the carotid artery was demonstrated to be associated with increased risk of cardiovascular events[7].

The SYNTAX study showed that the SYNTAX score (SX score), which represents lesion complexity, is associated with the prognosis of the patients undergoing coronary revascularization[8]. In a recent study, a significant relationship was found between carotid USG findings and the SX score[9]. However, the relationship between carotid plaque types and the complexity of coronary lesions is not assessed.

In this study, we aimed to examine the relationship between SX score and carotid plaque types.

PATIENTS and METHODS

Study Population

Four hundred seven patients who underwent coronary artery bypass graft (CABG) operation between 2015 and 2020 were retrospectively screened and those with carotid artery USG were included to the study. The coronary angiograms were evaluated, and SYNTAX score was calculated by two independent interventional cardiologists with online SYNTAX score calculator (www.syntaxscore.com). The lesions of carotid arteries were classified as fibrous, calcific and mixed plaques by carotid ultrasound.

The USG reports obtained retrospectively from institutional medical records. Basic demographic characteristics were recorded. The study conforms to the principles of Helsinki Declaration and was approved by our Institutional ethics committee.

Assessment of SYNTAX Score

Based on the initial diagnostic coronary angiogram, each coronary lesion causing a stenosis of ≥ 50% diameter in 1.5 mm vessels was scored individually using the SX score algorithm, which is available on the SYNTAX website were assessed[10]. The patients' SX scores were evaluated by two independent experienced interventional cardiologists who were blinded to carotid-USG findings.

Assessment of Carotid Ultrasonography

The carotid USG records were screened retrospectively. All patients were already evaluated by a radiologist with a high-resolution colour Doppler USG (GE Logiq 9, 5-7 mHz linear probe). The radiologist was blind to the coronary angiographies of the patients. Smooth-surfaced, homogeneous or heterogeneous lesions with high or moderate echogenicity without posterior acoustic shadowing were considered fibrous plaques, while hyperechogenic lesions with posterior acoustic shadowing were classified as calcified plaques (Figure 1). Plaques with both calcific and fibrous plaque characteristics were defined as mixed plaques[11].

Statistical Analysis

All statistical analyses were performed with R-software v. 3.5.1 (R statistical software, Institute for statistics and mathematics, Vienna, Austria) Using 'nnet' and 'lattice'

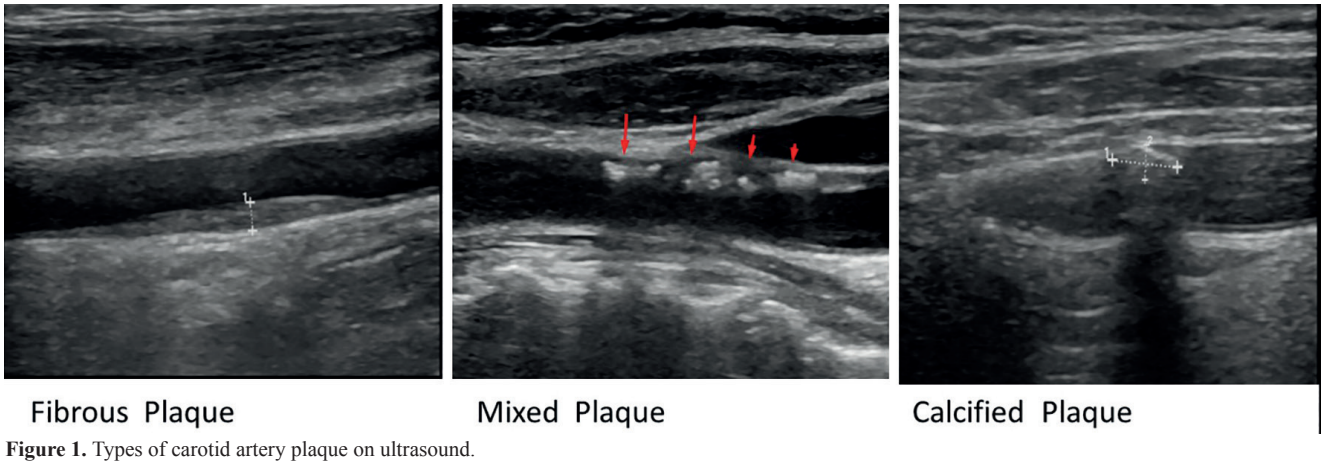

Figure 1. Types of carotid artery plaque on ultrasound.

packages. Continuous variables were presented as median and interquartile range, whereas categorical variables were presented as counts and percentages. Continuous variables were tested by Kruskal-Wallis and categorical variables were tested by chi-square (χ^2) test between carotid plaque types. We used multinomial logistic regression analysis to calculate adjusted odds ratios (OR) and to examine the relationship between the plaque morphologies and candidate predictors for both right and left carotid artery. Candidate predictors (HT, DM, smoking, sex, age and SYNTAX score) to be included in the multinomial model are clinically and biologically plausible.

RESULTS

A total of 407 patients were enrolled. Median age was 65 (58-71) years and 81.6% of patients were male. In overall population, median value for SYNTAX score was 18 (IQR: 13-24.8). Basal characteristics of patients according to the right and left internal carotid artery plaque morphology were demonstrated in Table 1 and Table 2. The frequency of Hypertension and Age were higher in those patients with fibrous and mixed plaques. However, the SYNTAX score were higher in Calcified plaque than fibrous and mixed plaques.

We used two separate multinomial logistic regressions (for right and left carotid systems) to test the association between plaque types and SYNTAX score. The SYNTAX score was associated with calcified plaque both in right (Odds ratio 1.04, 95% CI 1.01-1.07, p= 0.006) and left internal carotid artery (Odds ratio 1.04, 95% CI 1.02-1.06, p= 0.004). However, the SYNTAX score was not associated with fibrous (Odds ratio 0.97, 95% CI 0.94-1.01, p= 0.155 for right and odds ratio 0.99, 95% CI 0.96-1.02, p= 0.759 for left carotid artery) and mixed plaque types (odds ratio 1.02, 95% CI 0.98-1.06, p= 0.168 for right and odds ratio 1.00, 95% CI 0.96-1.04, p= 0.791 for left carotid artery) (Table 3). Adjusted probability of carotid plaque morphologies according to the SYNTAX score were demonstrated in Figure 2 (right system) and Figure 3 (left system).

Table 1. Basal characteristics of patients according to the left internal carotid artery plaque morphology

	Calcified plaque (n= 80)	Fibrous plaque (n= 98)	Mixed plaque (n= 58)	No plaque (n= 171)	p
Age, year	63 (56-71)	65.5 (56-70.3)	68 (65-74.8)	64 (57-71)	< 0.002*
Male, n (%)	65 (81.3)	80 (81.6)	47 (81.0)	140 (81.9)	0.999
Diabetes, n (%)	28 (35.0)	27 (27.6)	18 (31.0)	57 (33.3)	0.708
Hypertension, n (%)	36 (45.0)	57 (58.0)	35 (60.0)	76 (44.0)	0.046*
CAD, n (%)	10 (12.5)	9 (9.18)	8 (13.7)	27 (15.8)	0.490
Smoking, n (%)	39 (48.8)	48 (49.0)	23 (39.7)	78 (45.6)	0.674
Statin, n (%)	19 (23.8)	13 (13.2)	7 (12.1)	27 (15.9)	0.193
SYNTAX score	21.8 (14.8-28)	16 (13-23.8)	17 (13-24)	18 (13-24)	0.013*
Ejection fraction, %	60 (50-60)	60 (50-60)	58.5 (50-60)	60 (50-60)	0.898
PAD, n (%)	1 (1.25)	4 (4.08)	4 (6.89)	3 (1.74)	0.154

CAD: Coronary artery disease, PAD: Peripheral arterial disease.

Table 2. Basal characteristics of patients according to the right internal carotid artery plaque morphology

	Calcified plaque (n= 75)	Fibrous plaque (n= 90)	Mixed plaque (n= 64)	No plaque (n= 178)	p
Age, year	63 (58-72)	67 (61-71)	70.5 (65-75)	64 (56-69)	< 0.001*
Male, n (%)	62 (82)	74 (82.2)	50 (78)	146 (82)	0.893
Diabetes, n (%)	26 (34.7)	25 (27.8)	19 (29.7)	60 (33.7)	0.710
Hypertension, n (%)	35 (46.6)	54 (60)	41 (64)	74 (41.5)	0.003*
CAD, n (%)	12 (16)	14 (15.0)	6 (9.37)	22 (12.4)	0.601
Smoking, n (%)	35 (46.7)	44 (48.9)	22 (34.4)	87 (48.9)	0.223
Statin, n (%)	14 (18.7)	13 (14.4)	8 (12.5)	31 (17.4)	0.711
SYNTAX score	22 (15-28.4)	16 (12.3-22.4)	18 (14-26)	18 (13-23.8)	0.003*
Ejection fraction, %	60 (50-64)	60 (51.3-63)	55 (50-60)	60 (50-60)	0.371

CAD: Coronary artery disease.

Table 3. Relationship between the plaque morphologies and candidate predictors nominal

	Right internal carotid artery		Left internal carotid artery	
	Odds ratio, 95% CI	**p value**	**Odds ratio, 95% CI**	**p value**
Age				
No plaque	Ref.		Ref.	
Calcified	1.01 (0.98-1.05)	0.344	0.99 (0.95-1.02)	0.611
Fibrous	1.05 (1.01-1.08)	0.003*	1.03 (1.00-1.06)	0.042*
Mixed	1.11 (1.06-1.16)	< 0.001*	1.11 (1.07-1.16)	< 0.001*
Sex				
No plaque	Ref.		Ref.	
Calcified	0.96 (0.45-2.05)	0.919	1.25 (0.60-2.61)	0.536
Fibrous	0.73 (0.35-1.48)	0.383	0.87 (0.44-1.72)	0.699
Mixed	0.71 (0.32-1.57)	0.411	0.74 (0.31-1.61)	0.417
DM				
No plaque	Ref.		Ref.	
Calcified	0.91 (0.50-1.67)	0.783	1.04 (0.57-1.88)	0.8853
Fibrous	0.59 (0.32-1.06)	0.082	0.63 (0.35-1.13)	0.124
Mixed	0.53 (0.26-1.05)	0.071	0.70 (0.35-1.38)	0.307
HT				
No plaque	Ref.		Ref.	
Calcified	1.21 (0.68-12.14)	0.512	0.96 (0.55-1.69)	0.913
Fibrous	2.48 (1.44-4.27)	0.001*	1.95 (1.15-3.28)	0.012*
Mixed	3.02 (1.58-5.76)	< 0.001*	2.11 (1.11-4.01)	0.021*
SYNTAX				
No plaque	Ref.		Ref.	
Calcified	1.04 (1.01-1.07)	0.006*	1.04 (1.02-1.06)	0.004*
Fibrous	0.97 (0.94-1.01)	0.155	0.99 (0.96-1.02)	0.759
Mixed	1.02 (0.98-1.06)	0.168	1.00 (0.96-1.04)	0.791
Smoking				
No plaque	Ref.		Ref.	
Calcified	0.94 (0.50-1.75)	0.848	0.97 (0.53-1.79)	0.940
Fibrous	1.55 (0.86-2.81)	0.140	1.52 (0.86-2.70)	0.149
Mixed	1.24 (0.61-2.54)	0.541	1.43 (0.70-2.90)	0.316

DM: Diabetes mellitus, HT: Hypertension

DISCUSSION

In our study, we found that patients with higher SX score were likely to have calcified carotid plaque rather than fibrous and mixed plaques when compared to no plaque.

Cardiovascular and cerebrovascular diseases have been the main cause of morbidity and mortality worldwide[12]. CAD, carotid artery disease and peripheric artery disease may coexist. The extensity of atherosclerotic diseases involving both coronary artery disease, carotid artery disease and peripheral artery disease may be associated with increased adverse events[13]. SX score is a scoring system that shows the complexity of coronary artery lesions, and is a strong predictor for major adverse cardiac events (MACE). Yet the role of SX score in determining the carotid plaque morphology is not clear. There are conflicted data on the relationship between the SX score and carotid artery disease. In a the study by Costanzo, et al. the incidence of carotid lesions was shown to be high in patients with multi-vessel disease, but the SX score did not predict carotid atherosclerosis[2]. According to the study conducted by Akansel, et al. it was suggested that patients with an SX score of > 27 should be screened for carotid disease before CABG[14]. In another study, the relationship between carotid US findings and SX score, no significant relationship between SX score and intima- media thickness (IMT) was demonstrated[15]. In another study Ikeda, et al. investigated the relation between

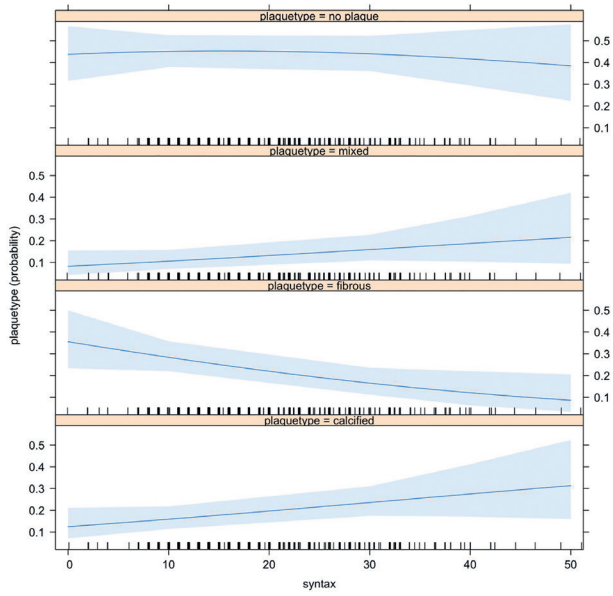

Figure 2. SYNTAX score according to the adjusted probability of plaque morphology in left carotid artery system.

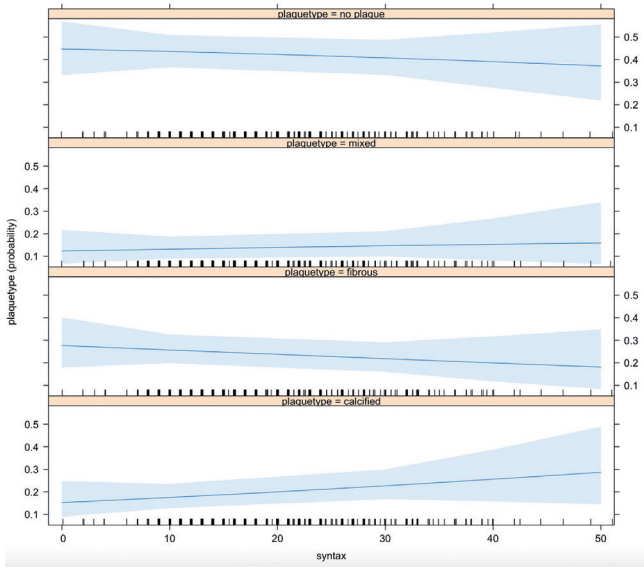

Figure 3. SYNTAX score according to the adjusted probability of plaque morphology in right carotid artery system.

carotid US findings and complexity of coronary artery disease. They have demonstrated that carotid artery plaque score and mean IMT was strong negative predictors for the presence of complex coronary artery lesions[9]. Apart from other studies we have examined the relation between SX score and plaque morphology. Kanadasi, et al. showed that the presence of calcified plaque in common carotid artery could be a predictor for coronary atherosclerosis[16]. In our study, we demonstrated that the patients with higher SX score were more likely to have calcified plaques both in right and left carotid artery.

LIMITATIONS

The first and most important limitation of the study is its' retrospective nature. Secondly the number of patients included to the study was limited. Thirdly, our results could not be generalized to all CAD patients because of sampling conditions based on patients undergoing to CABG and this sampling bias may lead to artefactual association between carotid plaque types and SYNTAX score. Finally, the relationship between plaque type and SYNTAX score could be assessed as two ways.

CONCLUSION

SYNTAX score may predict the carotid plaque morphology on ultrasound in patients who undergoing to coronary artery by-pass surgery. Patients with higher SYNTAX score were associated with more calcified carotid plaque.

Ethics Committee Approval: This study was approved by the Istinye University Ethics Committee (Decision number: 2017-KAEK-120/2/2021.G-20).

Informed Consent: Informed consent was obtained.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept/Design - SA, OB, IY; Analysis/Interpretation - SA, OB, IY; Data Collection - SA, OB; Writing - SA,IY; Critical Revision - SA; Statistical Analysis - OB, SA, IY; Overall Responsibility - SA; Final Approval - All of Authors.

Conflict of Interest: The authors have no conflicts of interest to declare.

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