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CLINICAL RESEARCH / KLİNİK ARAŞTIRMA

Comparison of Electrocardiographic Parameters in Young and Middle-aged Patients Presenting with non-ST Myocardial Infarction

ST Yükselmesiz Miyokard Enfarktüsü ile Başvuran Genç ve Orta Yaşlı Hastalarda Elektrokardiyografik Parametrelerin Karşılaştırılması

Songül Usalp[1], Ramazan Gündüz[2]

[1]University of Health Sciences Turkey, Sancaktepe Şehit Prof. Dr. İlhan Varank Education and Research Hospital, Clinic of Cardiology, İstanbul, Turkey
[2]Manisa City Hospital, Clinic of Cardiology, Manisa, Turkey

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Abstract

Objective: In this study, we aimed to examine the relationship between young and middle-aged patients and frontal QRS-T angle (FQRS-T A) by evaluating the demographic, clinical features and electrocardiographics (ECGs) of patients who presented with non-ST elevation myocardial infarction (NSTEMI).

Methods: The study was planned retrospectively, and 396 patients, young age (20-45 years, n=158) and middle-aged (46-65 years, n=238) who applied to the emergency department with chest pain and were diagnosed with NSTEMI underwent coronary angiography for the first time. The FQRS-T A is calculated by the frontal plane QRS axis and the T axis (FQRS-T A=QRS-T axis) from a 12-lead plane ECG.

Results: Hypertension (HT) (p<0.001) and diabetes mellitus (DM) (p<0.001), serum glucose (p=0.007), serum high-density lipoprotein cholesterol (HDL-C) level (p=0.005), SYNTAX score (p<0.001) and FQRS-T A (p<0.001) were higher in the middle-aged group. In multivariate analysis showed HT [odds ratio (OR): 4.084, 95% confidence interval (CI) (2.234-7.465), p<0.001], DM [OR: 1.452,95% CI (1.288-7.465), p=0.018], low HDL-C level [OR: 0.972, 95% CI (0.951-0.994), p=0.012], FQRS-T A [OR: 0.990, 95% CI (0.980-0.993), p<0.001], was determined as a possible independent risk factor for NSTEMI in middle-aged patients group. Analyzes showed that the optimal cut-off value for the degree of FQRS-T A to predict a middle-aged NSTEMI was >32.5%, with a sensitivity of 62% and a specificity of 52% (area under the curve: 0.633, 95% CI 0.579-0.687, p<0.001).

Conclusion: In our study, FQRS-T A was found to be higher in middle-aged NSTEMI patients, and it was found to be a possible independent risk factor for NSTEMI.

Keywords: Frontal QRS-T angle, non-ST segment elevation myocardial infarction, electrocardiography

Öz

Amaç: Bu çalışmada ST yükselmeli olmayan miyokard enfarktüsü (NSTEMI) ile başvuran hastaların demografik, klinik özellikleri ve elektrokardiyografilerini (EKG) değerlendirerek genç ve orta yaşlı hastalar ile frontal QRS-T açısı (FQRS-T A) arasındaki ilişkiyi incelemeyi amaçladık.

Address for Correspondence/Yazışma Adresi: Songül Usalp MD, University of Health Sciences Turkey, Sancaktepe Şehit Prof. Dr. İlhan Varank Education and Research Hospital, Clinic of Cardiology, İstanbul, Turkey
Phone: +90 507 853 21 53 **E-mail:** dr.songulusalp@hotmail.com
ORCID ID: orcid.org/0000-0001-9572-5431

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Öz

Yöntem: Çalışma retrospektif olarak planlandı ve acil servise göğüs ağrısı şikayeti ile başvuran ve NSTEMI tanısı alan genç yaş (20-45 yaş, n=158) ve orta yaşlı (46-65 yaş, n=238), ilk kez koroner anjiyografi yapılan toplam 396 hastaya alındı. FQRS-T A, standart bir 12 derivasyonlu yüzey EKG'sinden frontal düzlem QRS ekseni ve T ekseni [FQRS-T A=QRS ekseni-T ekseni] formülünden hesaplandı.

Bulgular: Hipertansiyon (HT) (p<0,001) ve diabetes mellitus (DM) (p<0,001), serum glukozu (p=0,007), serum yüksek yoğunluklu lipoprotein kolesterol (HDL-K) düzeyi (p=0,005), SYNTAX skoru (p<0,001) ve FQRS-T A (p<0,001) orta yaş grubunda daha yüksekti. Çok değişkenli analizde HT [olasılık oranı (OR): 4,084, %95 güven aralığı (CI) (2,234-7,465), p<0,001], DM [OR: 1,452, 95% CI (1,288-7,465), p=0,018], düşük HDL-K düzeyi [OR: 0,972, %95 CI (0,951-0,994), p=0,012], FQRS-T A [OR: 0,990, %95 CI (0,980-0,993), p<0,001], orta yaşlı hasta grubunda NSTEMI için olası bağımsız bir risk faktörü olarak belirlendi. Bir alıcı işletim karakteristik eğrisi analizi analiz sonuçları, FQTS-T A için orta yaşlı bir NSTEMI'yi öngörmek için en uygun kesme değerinin >32,5 olduğunu, %62 duyarlılık ve %52 özgüllükle (eğri altındaki alan: 0,633, %95 CI 0,579-0,687, p<0,001) olduğunu göstermiştir.

Sonuç: Çalışmamızda FQRS-T A orta yaşlı NSTEMI hastalarında daha yüksek bulunmuş ve NSTEMI için olası bağımsız bir risk faktörü olduğu saptanmıştır.

Anahtar Kelimeler: Frontal QRS-T açısı, ST yükselmesiz miyokard enfarktüsü, elektrokardiyografi

Introduction

Non-ST elevation myocardial infarction (NSTEMI) constitutes most cardiac patients presenting to the emergency department with chest pain. Severe atherosclerotic plaques lie in its pathogenesis, and the most important factors in the formation of these plaques are risk factors such as age, gender, hypertension (HT), diabetes mellitus (DM), smoking, and obesity. The presence of one or more of these diseases increases cardiovascular mortality and morbidity[1].

However, electrocardiographic (ECG) changes are used to predict cardiac mortality and morbidity. Frontal QRS-T angle (FQRS-T A) is one of these ECG parameters and is defined as the difference in the absolute value of the angles between the QRS and T waves[2]. In other words, the ventricular depolarization wave is represented by the QRS vector and the repolarization wave is represented by the T vector.

The absolute differentiation between these two vectors gives FQRS-T A, which is associated with ventricular arrhythmia, cardiovascular mortality, and sudden cardiac death[2-4].

In this study, we aimed to examine the relationship between young and middle-aged patients and FQRS-T A by evaluating the demographic, clinical features and ECGs of patients who presented with NSTEMI.

Materials and Methods

The study was planned retrospectively, and 396 patients, aged 20-65 years, who applied to the emergency department with chest pain and were diagnosed with NSTEMI underwent coronary angiography (CAG) for the first time.

The patients were divided into two groups: young aged (n=158), 20-45 years and middle-aged (n=238) 46-65 years. When patients were divided into two classes according to their age (young and middle-aged), previous studies were considered[5].

Data from the medical records of all patients were retrospectively reviewed. Those who smoked >1 cigaret per day were defined as current smokers. Fasting plasma blood samples were obtained within the first 48 h after admission to the hospital. Both groups were compared in terms of demographics, clinical characteristics, comorbidities, and laboratory findings.

Electrocardiography: All patients received a 12-lead ECG in the supine position after resting for at least 15 min (GE MAC 1200, USA). Each ECG was taken at a paper rate of 25 mm/s, a gain of 10 mV, and a paper format of 4×2.5R1. The ECG was independently interpreted before coronary intervention by two different cardiologists. QRS duration was described as the time interval from the onset to the end of the QRS complex, and the QT interval was measured from the onset of the QRS complex to the end of the T-wave. The QTc (corrected QT) interval was measured using Bazett's formula[6].

FQRS-T A is the absolute value of the differentiation between the frontal planar QRS axis and the T axis [FQRS-T A = QRS-T axis] and is calculated from a standard 12-lead plane ECG[7]. Where the difference between the vectors exceeds 180 degrees, then the FQRS-T A is measured as 360° minus the absolute value of the difference between the frontal planar QRS and T axis[6,7] (Figure 1).

Echocardiography: All patients underwent transthoracic echocardiographic examination with a device using commercially available 4 MHz probes, following the recommendations of the American Society of Echocardiography in the left lateral decubitus position (GE Vingmed, Milwaukee, Vivid 9 Pro, Wisconsin, USA). The left ventricular ejection fraction (LVEF) was calculated according to Simpson's method[8].

NSTEMI Diagnosis and CAG: CAG were performed using the Judkins technique, and all lesions ≥1.5 mm in diameter and causing 50% stenosis in the coronary artery were included in the study[9]. Patients with acute coronary syndrome have a higher troponin level than the 99th percentile reference value before cardiac catheterization, chest pain, or ischemic changes on the ECG, including persistent ST-segment elevations or horizontal or down-sloping ST-segment depression (0.05 mV), T-inversion or dynamic ECG change, or new left bundle branch block[10]. CAG was evaluated by two independent cardiologists.

After CAG, website software (http://www. SYNTAXscore.com) was used to calculate the SYNTAX score. The SYNTAX score was calculated for the following points: Coronary dominance, number of lesions, segment per lesion, total occlusion, bifurcation, trifurcation, aorticosteal lesion, severe tortuosity, calcification, thrombus, diffuse/small vessel disease, and lesion length >20 mm. SS was calculated separately using two interventional cardiologists who did not know the study protocol and patient characteristics[11].

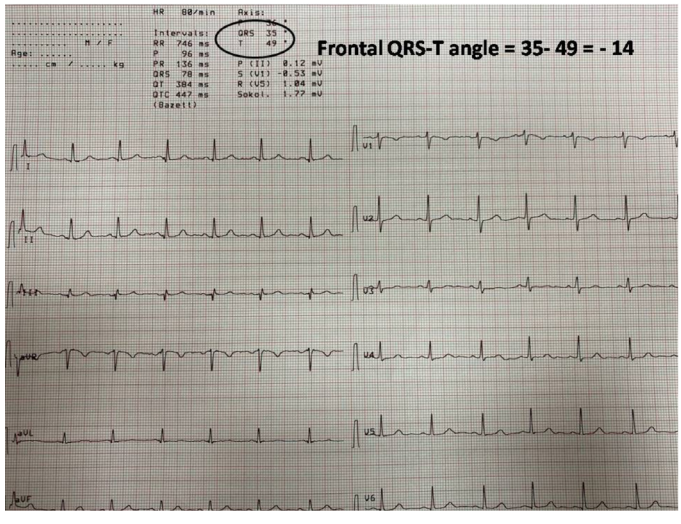

Figure 1. Frontal QRS-T angle measurements on ECG

ECG: Electrocardiogram

Exclusion Criteria: Patients with previous primer coronary interventions, chronic kidney disease, chronic liver disease, heart failure with reduced ejection fraction, moderate to severe valvular heart disease, left or right bundle branch block, pacemaker rhythm on 12-lead electrocardiography, ECGs without clearly analyzeable QRS, and T axis were excluded from the study. Patients outside the age range of 20-65 years were excluded from the study.

The approval was obtained from the Ethics Committee of University of Health Sciences Turkey, Sancaktepe Şehit Prof. Dr. İlhan Varank Education and Research Hospital (decision no: 2021/223, date: 08.12.2021). Written and verbal consent was obtained from all participants. The Declaration of Helsinki was followed in the application of the ethical rules of the study.

Statistical Analysis

Statistical analyzes were performed using SPSS 20.0 (IBM Corporation, Armonk, NY, USA). Continuous variables are presented as the mean ± standard deviation (SD), and categorical variables are expressed as n (number) and percentages (%). Normality assumptions were checked by the Shapiro-Wilk and Kolmogorov-Smirnov test's due to the number of cases in the groups. The baseline characteristics of the young and middle-aged patients were compared using Studen's t-test for continuous variables that were normally distributed and the Pearson's χ^2 test was used for categorical variables. Univariate and multivariate logistic regression analyzes were performed for the association between young NSTEMI patients and possible risk factors. To determine the optimal cutoff of FQRS-T A in a prediction model for young NSTEMI A receiver operating characteristic (ROC) curve analysis was used. A p value of <0.05 was considered significant in all statistical calculations.

Results

The mean age of 158 young patients included in the study was (38.8±4.7 years), and the mean age of 238 middle-aged patients was (54.9±5.6 years). 81.6% (n=129) of the young patients and 71.8% (n=171) of the middle-aged patients were male.

HT [97 (40.7%) vs 21 (13.2%), p<0.001] and DM, [75 (31.5%) vs 23 (14.5%), p<0.001], serum glucose (142.1±70.2 vs 124.1±53.4), p=0.007), serum high-density lipoprotein cholesterol (HDL-C) level (40.8±12.2 vs 37.5±10.2, p=0.005), SYNTAX score (8.1±6.4 vs 17.4±8.6, p<0.001) and FQRS-T A (57.3±47.1 vs 35.4±30.2, p<0.001) were higher in the middle-aged group (Table 1, Figure 2).

Table 1. Comparison of the demographic and clinical feature of patients with non-ST-elevation myocardial infarction patients

Variables	Young MI patients (n=158)	Middle-aged patients (238)	p-value
Age (year)	38.8±4.7	54.9±5.6	**<0.001**
BMI (kg/m^2)	24.7±3.7	25.2±4.1	0.124
Sex (male), n, %	129 (81.6)	171 (71.8)	**0.024**
Hypertension ,n, %	21 (13.2)	97 (40.7)	**<0.001**
Diabetes mellitus, n, %	23 (14.5)	75 (31.5)	**<0.001**
Smoking, n, %	120 (75.9)	143 (60.6)	**0.002**
LVEF, %	54.8±7.8	53.9±7.5	0.254
SPAP, mmHg	24.1±9.7	26.3±5.2	0.357
Glucose, mg/dL	124.1±53.4	142.1±70.2	**0.007**
Creatinin, mg/dL	0.8±0.6	0.9±0.8	0.098
Total cholesterol, mg/dL	195.9±52.3	189.7±45.8	0.228
LDL, mg/dL	126.7±44.1	118.7±38.7	0.064
HDL, mg/dL	37.5±10.2	40.8±12.2	**0.005**
Triglyceride, mg/dL	221.4±221.1	191.2±222.6	0.195
TSH, mg/dL	1.8±1.7	1.9±2.1	0.265
Albumin, mg/dL	4.1±0.8	3.9±0.9	0.312
Uric acid, mg/dL	4.8±1.5	5.4±1.43	0.834
Vitamin B12	323.5±158.5	276.7±124.6	0.187
WBC x10^3	10.3±3.9	10.7±4.1	0.675
Hgb, g/dL	14.8±2.6	14.1±2.9	0.567
Heart rate, beat/min	76.8±14.5	75.4±14.7	0.314
QRS duration, ms	88.4±11.8	90.6±13.5	0.097
QT interval, ms	431.4±39.8	454.6±37.9	0.259
Correct QT interval, ms	465.7±45.8	461.8±46.7	0.340
Frontal QRS-T angle	35.4±30.2	57.3±47.1	**<0.001**
SYNTAX score	8.1±6.4	17.4±8.6	**<0.001**

BMI: Body mass index, LVEF: Left ventricular ejection fraction, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, SPAP: Systolic pulmonary artery pressure, TSH: Thyroid-stimulating hormone, WBC: White blood cell count, Hgb: Hemoglobin, MI: Myocardial infarction

In multivariable analysis showed HT [odds ratio (OR): 4.084, 95% confidence interval (CI) (2.234-7.465), p<0.001], DM [OR: 1.452, 95% CI (1.288-7.465), p=0.018], low HDL-C level [OR: 0.972, 95% CI (0.951-0.994), p=0.012], FQRS-T A [OR: 0.990, 95% CI (0.980-0.993), p<0.001], was determined as a possible independent risk factor for NSTEMI in middle-aged patients group (Table 2).

The ROC analyzes showed that the optimal cut-off value for estimating a middle-aged NSTEMI for the FQRS-T A degree was >32.5 with 62% sensitivity and 52% specificity (area under the curve: 0.633, 95% CI 0.579-0.687, p<0.001) (Figure 3).

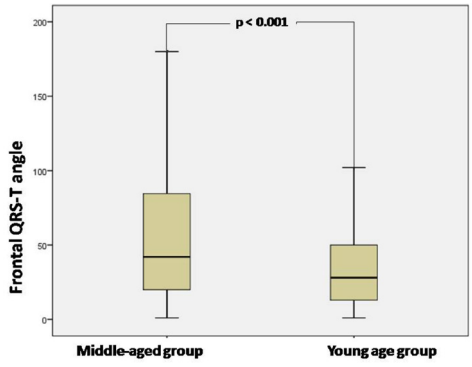

Figure 2. The association between Frontal QRS-T angle and young and middle-aged NSTEMI patients

NSTEMI: Non-ST elevation myocardial infarction

Table 2. The association between middle-aged patients with non-ST-elevation myocardial infarction and possible independent risk factors

Variables	Univariable logistic regression analysis		Multivariable logistic regression analysis	
	OR (95% CI)	p-value	OR (95% CI)	p-value
Sex (male)	0.565 (0.346-0.924)	**0.023**	0.801 (0.440-1.456)	0.466
Hypertension	4.519 (2.665-7.662)	**<0.001**	4.084 (2.234-7.465)	**<0.001**
Diabetes mellitus	2.711 (1.610-4.563)	**<0.001**	1.452 (1.288-3.066)	**0.018**
Current smokers	0.487 (0.311-0.763)	**0.002**	0.675 (0.389-1.170)	0.161
Glucose	0.995 (0.992-0.999)	**0.008**	0.998 (0.991-0.994)	0.356
HDL-C	0.973 (0.954-0.992)	**0.006**	0.972 (0.951-0.994)	**0.012**
Frontal QRS-T angle	0.990 (0.982-0.996)	**<0.001**	0.990 (0.980-0.993)	**<0.001**

HDL-C: High-density lipoprotein cholesterol, OR: Odds ratio, CI: Confidence interval

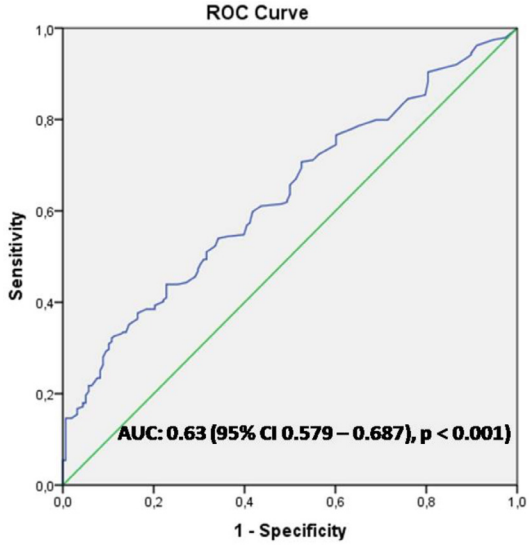

Figure 3. Receiver operating characteristic curves for detecting patients with young NSTEMI, the predictive optimal cut-off frontal QRS-T angle was >32.5 degree, with 62% sensitivity and 52% specificity and area under the curve of 0.633 (95% CI 0.579-0.687, p<0.001)

NSTEMI: Non-ST elevation myocardial infarction, ROC: Receiver operating characteristic, OR: Odds ratio, CI: Confidence interval, AUC: Area under the curve

Discussion

In our study, we found that FQRS-T A was higher in middle-aged patients presenting with NSTEMI than in younger patients. We found that DM, HT, low HDL-C, as well as increased FQRS-T A, were possible independent and significant risk factors for NSTEMI in the middle-aged group.

FQRS-T A is the measurement of the absolute difference between the vectors of depolarization and repolarization of the heart[2]. FQRS-T A can be measured in two ways: spatial and planar frontal methods[2]. While spatial measurements require advanced computer programs, planar FQRST-A can be easily calculated with the values on the ECG. The spatial QRS-T angle was found to predict underlying heart disease more consistently than the FQRS-T A, indicating a better diagnostic benefit[12]. Studies have shown an increased risk of total mortality, sudden cardiac death, or cardiovascular death when the FQRS-T A increases[2,13].

Although FQRS-T A does not have a definite value in predicting cardiovascular mortality, FQRS-T A >90 degrees is an important predictor value for adverse outcomes detected as in the definite study patients with nonischemic cardiomyopathy and New York Heart Association class I to III heart failure[14].

The upper limits of normal FQRS-T A were found to be between 45° and 60° before studies in normal individuals[2,13]. In another study in the elderly cohort without cardiovascular disease, the gender-specific upper limits of normal were 39° for women and 81° for men[15,16].

The FQRS-T A varies with gender and age, regardless of whether it is measured spatially or planar frontally. In general, women initially have a smaller angle than men, and the angle widens with age in both sexes. Normal planar frontal angles are usually smaller than normal spatial angles[2]. Women are less at risk of having a heart attack at a young age than men, which may partly explain the narrower FQRS-T A in younger women[17].

In our study, we found that FQRS-T A of more than 32 degrees was associated with NSTEMI in middle-aged patients. Our patient's average age was nearly 54 years, and young patients were 38 years. Differently, our patient's ages were

lower than in other studies, in addition, patients who had not had a heart attack before were included in the study. Therefore, the lower FQRS-T A values in our study may explain why they were found to be lower compared to other studies.

In the EMMACE-1 and 2 studies, 2-year mortality was found to be lower in patients with FQRS-T A <38 degrees compared to those with >104 degrees[18]. In this study, the mean age of the groups was found to be approximately 79 degrees in those with a FQRS-T A >105 degrees and this study included patients with both STEMI and NSTEMI who had previously undergone percutaneous intervention, those with chronic renal failure, those with cerebrovascular accident, and those with left bundle branch block[18].

In a prospective study investigating the prognostic value of FQRS-T A in patients who underwent myocardial revascularization and surgical valve replacement, the mean age of the patient was 68 years, and the patients were followed for an average of 4 years. FQRS-T A <60 degrees normal, >120 degrees abnormal, the interval between these two values was considered as borderline[19]. Abnormal FQRS-T A was found to be an independent predictor of overall and CV mortality in patients with stable coronary artery disease undergoing myocardial revascularization[19]. In a study investigating the relationship between FQRS-T A and SYNTAX score in NSTEMI patients, infarct-related artery and FQRS-T A were found to be independent and significant risk factors for SYNTAX score[20].

In an article investigating the FQRS-T A in ST-segment elevation myocardial infarctions, the authors compared SYNTAX, SYNTAX II, and the residual SYNTAX score with FQRS-T A[21]. The FQRS-T A was found to be higher in the intermediate-high SYNTAX group both before and after the procedure. In this study, the estimated cut-off value of the FQRS-T A was found to be 91, 76.5, and 79.5 degrees, respectively. Age, FQRS-T A, and infarct-related artery were found to be possible predictors of the intermediate-tohigh SYNTAX score[21].

As in other studies showing that the FQRS-T A increases as the severity of coronary artery disease increases, in our study, the SYNTAX II score was found to be higher in the middle-aged patient group with a higher FQRS-T A value.

Study Limitations

As with the others, this study has some limitations. Most importantly, it was a retrospective study. The patients did not have long-term follow-up. The number of patients included in the study was relatively small. In addition, it was not possible to evaluate and compare patients' ECGs with the spatial QRS-T angle because it is not in our computer program. The inclusion of individuals with normal coronary arteries in the article could have made the article more valuable. In this study, the control group consisted of young people (age and gender-matched). However, the use of a young control group against young ACS may adversely affect the results. Since it cannot be guaranteed that people in the control group will not have myocardial infarction in the future, the control group consisting of people who have reached the age limit (in our study, over 45 years old) may be more reliable[22].

Conclusion

In our study, the FQRS-T A was found to be higher in middle-aged NSTEMI patients and was found to be a possible independent risk factor for NSTEMI. cardiac mortality increases with an increase in FQRS-T A. Although the FQRS-T A. is not yet considered a risk factor in patients with NSTEMI, future studies may clarify this issue.

Ethics

Ethics Committee Approval: The approval was obtained from the Ethics Committee of University of Health Sciences Turkey, Sancaktepe Şehit Prof. Dr. İlhan Varank Education and Research Hospital (decision no: 2021/223, date: 08.12.2021).

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: S.U., R.G., Concept: S.U., R.G., Design: S.U., R.G., Data Collection or Processing: S.U., R.G., Analysis or Interpretation: S.U., R.G., Literature Search: S.U., Writing: S.U.

Conflict of Interest: No conflict of interest was declared by the authors.

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