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Effect of Surgical Revascularization on QT Dispersion Time in Patients Who Do Not Have Necrotic/Fibrotic Myocardium in Transthoracic Echocardiography

Transtorasik Ekokardiyografide Nekrotik/ Fibrotik Miyokart İçermeyen Hastalarda Cerrahi Revaskülarizasyonun QT Dispersiyon Süresi Üzerine Etkisi

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ABSTRACT

Introduction: Prolonged QT dispersion time is known to be associated with cardiac arrhythmias and sudden cardiac death. It was proved previously that electrical heterogenity caused by myocardial ischemia, hypertrophic cardiomyopathy, electrolyte imbalance, heart failure prolongs QT dispersion time. The aim of this study was to investigate the effect of surgical revascularization on QT dispersion time in ischemic patients not having necrotic/fibrotic segments in transthoracic echocardiography.

Patients and Methods: Data of patients treated with surgical revascularization due to coronary artery disease are evaluated retrospectively. 247 patients were enrolled into the study after application of exclusion criteria. Patients' electrocardiographic records were evaluated and values of preoperative (QTcd0), postoperative first (QTcd1), postoperative third (QTcd3) and postoperative seventh (QTcd7) day corrected QT dispersion time calculated and compared with each other.

Results: There were statistically significant differences between QTcd0 (83.6 ± 2.2) and QTcd1 (55.3 ± 1.7), QTcd3 (50.4 ± 1.2) and QTcd7 (45.3 ± 1.1) ($p< 0.001$, $p< 0.001$, $p< 0.001$ respectively). There was also statistically significant difference between QTcd1 (55.3 ± 1.7) and QTcd7

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(45.3 ± 1.1) (p< 0.001), and also between QTcd3 (50.4 ± 1.2) and QTcd7 (45.3 ± 1.1) (p< 0.001). There was no significant difference between QTcd1 (55.3 ± 1.7) and QTcd3 (50.4 ± 1.2) (p= 0.078).

Conclusion: Surgical revascularization of non-necrotic/non-fibrotic ischemic myocardium causes statistically significant decrease in QT dispersion time from the postoperative first day.

Key Words: Ischemia, myocardial revascularization; necrosis; myocardium; echocardiography.

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ÖZET

Giriş: QT dispersiyon süresindeki uzamanın kardiyak aritmiler ve ani kardiyak ölümle ilişkili olduğu bilinmektedir. Miyokardiyal iskemi, hipertrofik kardiyomiyopati, elektrolit dengesizlikleri, kalp yetersizliği gibi durumların sebep olduğu elektriksel heterojenite QT dispersiyon süresini uzatır. Çalışmanın amacı, transtorasik ekokardiyografide nekrotik doku içermeyen iskemik miyokardda cerrahi revaskülarizasyonun QT dispersiyon süresi üzerine etkisini incelemektir.

Hastalar ve Yöntem: Koroner arter hastalığı nedeniyle cerrahi revaskülarizasyon yapılan hastalar retrospektif olarak tarandı. Dışlama kriterleri uygulandıktan sonra 247 hasta çalışmaya dahil edildi. Hastaların elektrokardiyografileri incelendi. Preoperatif (QTcd0), postoperatif birinci (QTcd1), postoperatif üçüncü (QTcd3) ve postoperatif yedinci (QTcd7) gün düzeltilmiş QT dispersiyon süreleri hesaplandı ve birbirleriyle karşılaştırıldı.

Bulgular: QTcd0 (83.6 ± 2.2) ile QTcd1 (55.3 ± 1.7), QTcd3 (50.4 ± 1.2) ve QTcd7 (45.3 ± 1.1) arasında istatistiksel olarak anlamlı fark vardı (sırasıyla p< 0.001, p< 0.001, p< 0.001). QTcd1 (55.3 ± 1.7) ile QTcd7 (45.3 ± 1.1), QTcd3 (50.4 ± 1.2) ile QTcd7 (45.3 ± 1.1) arasında da istatistiksel olarak anlamlı fark mevcuttu (p< 0.001). QTcd1 (55.3 ± 1.7) ile QTcd3 (50.4 ± 1.2) arasında ise istatistiksel olarak anlamlı fark yoktu (p= 0.078).

Sonuç: Nekrotik/fibrotik doku içermeyen iskemik miyokardın cerrahi olarak revaskülarizasyonu postoperatif birinci günden itibaren QT dispersiyon süresinde anlamlı kısalmaya neden olmaktadır.

Anahtar kelimeler: Iskemi; miyokardiyal revaskülarizasyon; nekroz; kalp kası; ekokardiyografi.

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INTRODUCTION

QT dispersion, a measure of interleads QT variability, represents the regional nonuniformity of ventricular repolarization. An increased QT dispersion time is thought to be a possible risk factor for malign ventricular arrhythmias and sudden cardiac death[1,2]. QT dispersion time is defined as the difference between the longest and shortest QT intervals in 12-lead electrocardiography (ECG)[3]. Previous studies have been reported that prolongation of QT dispersion time is associated with acute or remote myocardial infarction (MI), myocardial ischemia, hypertrophic cardiomyopathy, heart failure, electrolyte disturbances and morbid obesity [4-9].

Several studies have demonstrated that, reperfusion of necrotic/fibrotic segment including ischemic myocardium reduces QT dispersion time[10-13]. However, there is limited data about effect of surgical revascularization on QT dispersion time in patients who do not have necrotic/fibrotic myocardium in transthoracic echocardiography.

The aim of this study was to investigate the effect of surgical revascularization on QT dispersion time in ischemic patients who do not have necrotic/fibrotic myocardium in transthoracic echocardiography.

PATIENTS and METHODS

Subjects for this study were drawn retrospectively from medical records of 857 patients, who hospitalized with coronary artery disease and treated with surgical revascularization at cardiology service between September 2008 and May 2012. Exclusion criteria were as follows; a) a QRS witdh > 0.10 second, b) histroy of previous MI, c) using any one of the class I or class III antiarrhythmic drugs during preoperative, peroperative or postoperative periods, d) having a previous or concomitant valvular surgery, e) having akinetic, dyskinetic or aneursymal segment in left ventricle according to 17 segment evaluation recommendation model of American Echocardiography Society, f) incomplete surgical revascularization, g) having a rhythm other than normal sinus rhythm, h) having electrolite imbalance. After application of the exclusion criteria, 247 patients (88 women and 159 men) were included in the study.

Measurement of QT Dispersion

For the measurement of QT interval, standard 12 lead surface ECG recordings were used (Hewlet Packard Pagewriter 200i) which were obtained at a paper speed of 25 mm/sec and gain of 10 mm/mV in the supine position and breathing freely but not allowed to speak during the ECG recording. QT interval was measured from the begining of the QRS complex to the end of the T wave which was defined as the return to the TP baseline (between the end of the T wave and the following P wave) in all derivations. QT measurements were not made in leads where T wave could not be reliably determined. All included patients have at least 8 leads where QT intervals reliably measurable. QT dispersion was defined as the difference between the maximum and minimum QT interval. All QT dispersions were corrected for the heart rate by dividing by the square root of the R-R interval according to the Bazett's formula (QT/√R-R)[14].

All the included patients files were numbered seperately. Three different cardiologists, who do not know the operation date of the patients, evaluated all the ECG recordings in the patients files. Corrected QT (QTc) dispersion times of all ECG recordings calculated by three different cardiologists seperately. After that, average QTc dispersion time value for each ECG recording is calculated. Thus, we obtained the QTc dispersion time data which we used in this study. Afterwards, we obtained preoperative, postoperative first, postoperative third, and postoperative seventh day's QTc dispersion time according to operation time.

Statistical Analysis

All statistical calculations were performed with SPSS software (SPSS, version 14.0, SSPS Inc, Chicago, IL). Differences among the four groups were analyzed by an analysis of variance test. Homogeneity of variances was calculated with the Levene test and the Lilliefors significance correction test. Either the Chi-square or Fisher's exact test was used to analyze categorical variables, where appropriate. Inter-observer agreement was calculated using Fleiss Kappa coefficient. A Kappa coefficient (κ) < 0.40 is considered poor agreement, 0.41-0.60 moderate, 0.61-0.80 substantial, and more than 0.80 near complete agreement. Data are expressed as means ± SD. Differences were considered statistically significant at $p< 0.05$.

RESULTS

A total of 247 patients were evaluated. Demographic, clinical, and echocardiographic characteristics of patients are shown in Table 1. Interobserver agreement data of three different cardiologists for QTc dispersion using the Fleiss Kappa test are shown in Table 2. Overall concordance was substantial (κ= 0.64, CI 95%). QTc maximum, QTc minimum and QTc dispersion values of preoperative, postoperative first, postoperative third and postoperative seventh days are given in Table 3.

Table 1. Demographic, clinical, and echocardiographic parameters of the patients

Characteristics	Findings
Age (years)	56.04 ± 2.2
Gender, n (%)	
Male	159 (64.4)
Female	88 (35.6)
Ejection fraction (%)	55.2 ± 6.5
Systolic pulmonary artery pressure (mmHg)	30.2 ± 8.0
Number of grafts, n (%)	
1	21 (8.5)
2	48 (19.3)
3	128 (51.4)
4	41 (16.2)
5	9 (4.6)
Diabetes mellitus, n (%)	118 (47.7)
Hypertension, n (%)	192 (77.7)
Smoking, n (%)	61 (24.6)
Family history of CAD, n (%)	55 (22.6)
Body mass index (kg/m^2)	29.0 ± 3.5

Prerevascularization QTc dispersion time (QTcd0) was compared with post revascularization first (QTcd1), third (QTcd3), and seventh (QTcd7) day QTc dispersion time.

There were statistically significant shortening in QTc dispersion time among QTcd0 (83.6 ± 2) and QTcd1 (55.3 ± 1.7), QTcd3 (50.4 ± 1.2), QTcd7 (45.3 ± 1.1) ($p< 0.001$).

Table 2. Interobserver agreement data of 3 different cardiologists

	Kappa coefficient (κ)	p
QTcd0	0.63	< 0.001
QTcd1	0.66	< 0.001
QTcd3	0.58	< 0.001
QTcd7	0.71	< 0.001

Table 3. QTc maximum, QTc minimum and QTc dispersion values of preoperative, postoperative first, postoperative third and postoperative seventh days

Date of ECG	QTc maximum (milisecond)	QTc minimum (milisecond)	QTc dispersion (milisecond)
Preoperative	480 ± 1.33	392 ± 1.64	83.6 ± 2.20
Postoperative 1	465 ± 2.11	364 ± 1.89	55.3 ± 1.72
Postoperative 3	432 ± 1.97	373 ± 1.71	50.4 ± 1.22
Postoperative 7	461 ± 1.56	411 ± 2.03	45.3 ± 1.11

There is also statistically significant shortening in QTc dispersion time among QTcd1 (55.3 ± 1.7) and QTcd7 (45.3 ± 1.1), QTcd3 (50.4 ± 1.2) and QTcd7 (45.3 ± 1.1) ($p < 0.001$) (Figure 1). However, there was no statistically significant difference among QTcd1 (55.3 ± 1.7) and QTcd3 (50.4 ± 1.2) ($p = 0.078$) (Figure 2).

DISCUSSION

In our study, we detected a noteworth decrease in QTc dispersion time after surgical revascularization of ischemic nonnecrotic/fibrotic myocardium. Furthermore, this decrease begins early from the postoperative first day.

It has long been known that myocardial ischemia, necrosis and fibrosis could prolong QTc dispersion time[6,7]. Higham et al. investigated the unstable angina and acute MI patients. They found that QTc dispersion time was higher in both groups. However QTc dispersion time was significantly longer in MI group than unstable angina group[15]. Successfull revascularization of ischemic myocardium with percutaneous way is thought to cause a decrease in QTc dispersion time. Giedrimiene et al. showed that myocardial ischemia could prolong QTc dispersion time in coronary artery disease (CAD) and succesfull reperfusion by way of angioplasty regardless of number of occluded coronary arteries decreases QTc dispersion time[16]. Kelly et al. also proved that successful angioplasty decreases QTc dispersion time in ischemic patients without ongoing symptomatic ischemia or malignant arrhythmias[17]. Pan et al. investigated the prognostic value of QTc dispersion change following primary percutaneous coronary intervention in acute ST elevation MI. They found that QTc dispersion time significantly decreased after primary percutaneous intervention. Morover, absolute cQT dispersion changes after primary percutaneous interventions were independent predictors of the development of major cardiovascular events in acute ST elevation MI[18].

Effect of thrombolytic therapy on QTc dispersion time is controversial. Mehta et al. showed that QTc dispersion time is not significantly changed after thrombolytic therapy in acute MI[19]. However, in Moreno et al's study successful thrombolytic therapy decreased QTc dispersion time[20].

It is also proved that QTc dispersion time was significantly decreased after surgical revascularization and concomitant aneursymectomy. Gulcan et al. showed that coronary artery bypass grafting and aneurysmectomy

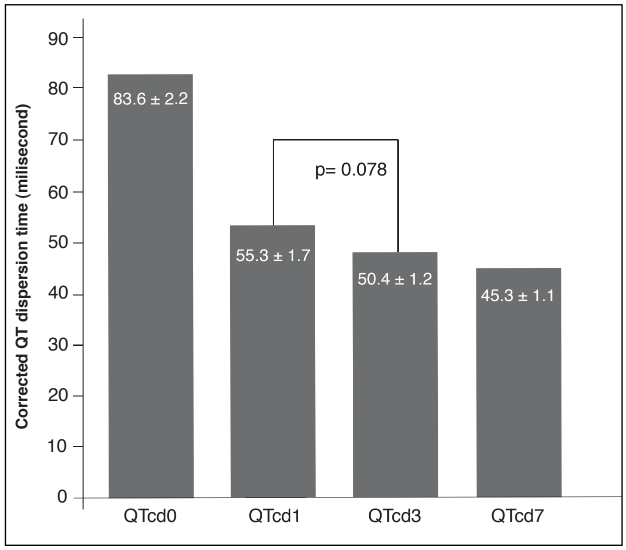

Figure 2. Comparison of QTc dispersion time between QTcd1 and QTcd3. QTcd: Corrected QT dispersion time.

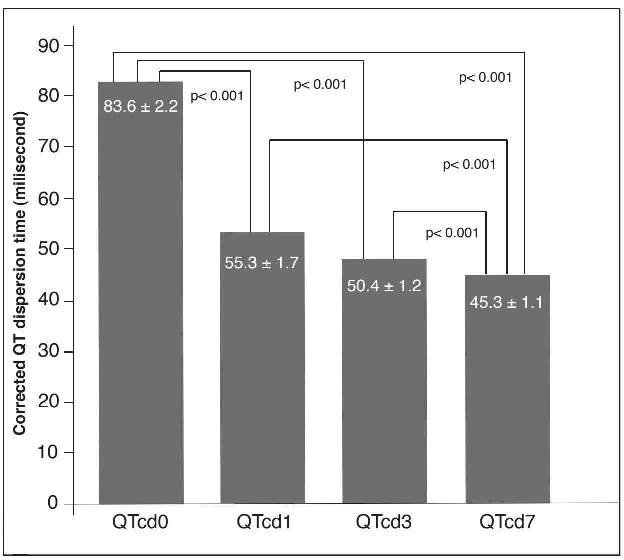

Figure 1. Comparison of QTc dispersion time before and after surgical revascularization. QTcd: corrected QT dispersion time.

decreased QTc dispersion time in moderate or severe left ventricular dysfunction[21]. Kosar et al. also proved that coronary artery bypass grafting and aneurysmectomy improved QTc dispersion time[22].

Because patients having necrotic/fibrotic myocardial tissue are not excluded in the great majority of previous studies, the net effect of revascularization of ischemic myocardium on improvement of QTc dispersion time is not clear. Consequently, effect of surgical revascularization on QT dispersion time in ischemic patients who do not have necrotic/fibrotic myocardium is not well known. In our study, we aimed to investigate the net effect of revascularization of ischemic myocardium on QTc dispersion time. For this purpose all subjects having necrotic/fibrotic myocardial segments in transthoracic echocardiography were excluded. At first sight, it could be thought that resting echocardiography instead of a myocardial stress test is not the correct technique of diagnosing necrotic/fibrotic myocardial segment. For example, if we think of a subject who was excluded from our study because of having an akinetic or dyskinetic segment in resting echocardiography could be included to the study if a myocardial stress test was been applied. In our study design we excluded some subjects who could be included, but we did not include subjects who should be excluded. Exclusion (not inclusion) of these subjects do not decrease the power of our study. Conversely because we aimed to exclude subjects having necrotic/fibrotic myocardium this type of design should increase power and reliability of our study.

In this study, we showed that surgical revascularization of myocardium not having necrotic segments in transthoracic echocardiography decreases QTc dispersion time. This data is similar to the data from the previous studies.

It was proven with previous studies that changes in QTc dispersion time begin from the early minutes of revascularization. Takase et al. studied the effect of exercise induced ischemia on QTc dispersion time. They found that prolongation of QTc dispersion time begins from the third minute of exercise[23]. In another study Ilkay et al. showed that decrease in QTc dispersion time began in the first hour after primary percutaneous intervention in acute MI[24]. We also showed that shortening of QT dispersion time after surgical revascularization begins as early as in the postoperative first day and continues in postoperative third and seventh day.

Major limitation of our study is the detection method of necrotic/fibrotic myocardium. Resting echocardiography is certainly not enough for detection of akinetic/dyskinetic myocardium. Unfortunately, retrospective design of our study did not permit us to use other modalities for detection of necrotic/fibrotic myocardium. However, application of a stress test ,which is more spesific, to patients having critical CAD could cause ethical problems. Fortunately, all echocardiographic examinations were done by well trained cardiologists. Morover, exclusion of patients who have akinetic segments in resting echocardiography but ischemia in a stress test could possibly increase the power of the study.

Study Limitation

Major limitation of our study is the detection method of necrotic/fibrotic myocardium. Resting echocardiography is certainly not enough for detection of akinetic/dyskinetic myocardium. Unfortunately, retrospective design of our study did not permit us to use other modalities for detection of necrotic/fibrotic myocardium. However, application of a stress test ,which is more spesific, to patients having critical CAD could cause ethical problems. Fortunately, all echocardiographic examinations were done by well trained cardiologists. Morover, exclusion of patients who have akinetic segments in resting echocardiography but ischemia in a stress test could possibly increase the power of the study. Another point is the paper speed and gain of the ECG recordings. ECG recordings at a paper speed of 50 mm/sec and gain of 20 mm/mV could be better for QT time measurment. However, retrospective design of the study have obviated this.

In this study, we concluded that surgical revascularization of ischemic non-necrotic myocardium significantly decreased QTc dispersion time. This decrease began as early as the post operative first day. If we consider decrease of QTc dispersion time as an indicator of improved myocardial ischemia, success of surgical revascularization may be evaluated in an easy, fast, and cost effective manner just with evaluation of pre and post operative ECG records.

CONFLICT of INTEREST

None declared.

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