

The effect of contrast dye injection and balloon inflation on QTc and QTc dispersion in 12 leads surface ECG during PTCA

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Abstract

BACKGROUND: Considering that determining the effect of both contrast dye injection and balloon inflation on electrophysiological parameters would help us to predict the ischemic event during PTCA, the aim of this study was to determine the effects of these factors on QTc and QTc dispersion during PTCA in Isfahan.

METHODS: In this cross-sectional study, consecutive patients undergoing elective PTCA in Chamran hospital in Isfahan enrolled. All patients were in sinus rhythm. A 12-lead electrocardiogram was continuously recorded before (baseline) and during PTCA after dye injection and balloon inflation. QTc and QT dispersion was calculated in all 12 leads of electrocardiogram during the mentioned times and compared with each other.

RESULTS: 33 patients with mean age of 49.1 ± 16.2 years were studied. Anatomic distribution of the coronary artery stenosis was as follows: left anterior descending artery (LAD) in 76.7% patients, left circumflex (Cx) in 16.6% and right coronary (RCA) in 6.66%. Mean of QTc at baseline, after contrast dye injection and after balloon inflation was 423.9 ± 28.5 , 437 ± 29 and 437 ± 22 msec, respectively ($P < 0.05$). Mean of QTc dispersion at baseline, after contrast dye injection and after balloon inflation was 92.3 ± 7.2 , 95.4 ± 8.3 and 93.75 ± 7.5 , respectively ($P > 0.05$).

CONCLUSION: The findings of this research supports the fact that during PTCA a transient myocardial ischemia occurs but further studies is recommended to accurately determine the stages at which ischemia occurred and the extent of its effect of it on cardiac depolarization and repolarization periods.

Keywords: PTCA, QTc, QTc Dispersion, Balloon Inflation, Contrast Dye Injection.

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Introduction

Electrocardiographic (ECG) measurements are widely used as a non-invasive method in electrophysiological evaluation. QT intervals (QTc) are simple and available electrocardiographic parameters of cardiac depolarization and repolarization periods. QTc and QTc dispersion reflect the ventricular repolarization time and homogeneity. QTc dispersion is considered as an index for the heterogeneity of ventricular refractoriness.^{1,2} Evidences indicated that QTc varies in 12 leads of ECG, creating QT dispersion, which represents the regional difference in repolarization.³

The concept of QT dispersion and identifying the abnormalities of ventricular repolarization using ECG measurement dates back to 1990.³ Thereafter many studies assessed the utility and predictive value of this

measurement for different cardiac diseases. According to many studies in this field, increased QT dispersion can be seen in acute myocardial infarction, after myocardial infarction, left ventricular hypertrophy (LVH) of various origins, heart failure, dilated cardiomyopathy, long QT syndrome of various genotype, hypertension and aortic stenosis.⁴⁻⁸ In addition, it had been indicated that QT dispersion undergoes dynamic changes during some cardiac procedures such as balloon inflation during angioplasty, exercise stress testing, atrial pacing or during reperfusion following angioplasty. It increased due to transient ischemia induced during mentioned procedures.⁹⁻¹³

Percutaneous transluminal coronary angioplasty (PTCA) is one of the most important and widely used

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procedures which is used in patients with coronary artery diseases. Balloon inflation can cause a unique model of transient and reversible myocardial ischemia and change the cardiac autonomic balance because of immediate reperfusion induced during procedure.¹⁴ It is also suggested that using contrast media during this procedure may increase QT dispersion.¹⁵

Considering that determining the effect of both contrast dye injection and balloon inflation on electrophysiological parameters would help us to predict the ischemic events during PTCA, the aim of this study was to determine the effect of these factors on QTc and QTc dispersion during PTCA.

Materials and Methods

In this cross-sectional study, consecutive patients aged 30-65 years, undergoing elective one-vessel percutaneous transluminal coronary angioplasty (PTCA) procedures in Chamran hospital in Isfahan were enrolled. All patients were selected randomly. All enrolled patients had previously undergone angiography and had angiographic evidence of significant stenosis of >70% in the proximal or mid-portion of a single major coronary artery. Those with 100% coronary stenosis were not enrolled. All patients were in sinus rhythm. Patients with a history of taking drugs such as anti-arrhythmic, anti-psychotic, and anti-depressant drugs which may modify the QTc and QTc dispersion, electrolyte imbalance, long-term QT syndrome and interventricular conduction delay were excluded.

The study protocol was approved by the Ethics Committee of Isfahan University of Medical Sciences. Written informed consent was obtained from all studied patients.

Considering that we could not include appropriate matched control subjects in order to evaluate the effect of contrast dye injection and balloon inflation, the effect of mentioned factors on QTc and QT dispersion was compared with baseline electrocardiographic findings of each patient before the procedure. This would reduce the effect of confounder variables.

A 12-lead electrocardiogram was recorded continuously before (baseline) and during PTCA after dye injection and balloon inflation.

During procedures, a temporary pacemaker was

placed in the apex of right ventricle of each patient, in standby mode for the treatment of probable arrhythmia.

The contrast medium used during PTCA was urographin 76% (Schering-Germany).

Electrocardiography (ECG) was performed at a paper speed of 50 mm/s. QTc minimum and QTc maximum values were then calculated using Bazett's formula.¹⁶ The QT interval was measured from the onset of the QRS complex to the end of the T wave, defined as the return to T-P isoelectric line. The QT was measured to the nadir of the curve between the T and U waves when the U wave was present. If the end of the T wave could not be reliably determined or when the T wave was isoelectric or of very low amplitude, QT measurements were not made, and these leads were excluded from analysis. QT dispersion which was defined as the difference between maximum and minimum QT interval was calculated accordingly in all 12 leads of electrocardiogram during the mentioned times and compared with each other.

Statistical Analyses

Data was analyzed using SPSS software and is presented as mean \pm SD. Differences in ECG interval measurements at baseline, after contrast dye injection and after balloon inflation was evaluated by repeated ANOVA measures. P value of less than 0.05 was considered as significant.

Results

33 patients (26 men and 4 women) enrolled In this study. Mean age of studied patients was 49.1 ± 16.2 . Angiographic results of patients revealed that 16 (53.3%), 12 (40%) and 2 (6.66%) had one, two and three vessel stenosis, respectively. Anghiographic findings regarding the anatomic distribution of the coronary artery stenosis was as follows: the left anterior descending artery (LAD) in 23 patients (76.7%), the left circumflex (Cx) in 5 (16.6%) and the right coronary (RCA) in 2 (6.66%). All patients underwent successful and uncomplicated PTCA and arrhythmia did not happen in any of the cases.

Mean \pm SD of QTc and QTc dispersion in studied patients at baseline, after contrast dye injection and after balloon inflation is presented in Table 1.

Table 1. Mean \pm SD of QTc and QTc dispersion in studied patients at baseline, after contrast dye injection and after balloon inflation

	Baseline	After contrast dye injection	During balloon inflation	P-value
QTc (msec)	423.9 \pm 28.5	437 \pm 29	437 \pm 22	P < 0.05*
QTc dispersion (msec)	92.3 \pm 7.2	95.4 \pm 8.3	93.75 \pm 7.5	P > 0.05

* P < 0.05 between baseline and after contrast dye injection and between baseline and after balloon inflation

Discussion

In this study the effect of contrast dye injection and balloon inflation on QTc and QTc dispersion during PTCA, was evaluated. The results indicated that comparing to baseline, dye injection and balloon inflation increases QTc significantly, but despite an increasing trend, QTc dispersion was not increased significantly during mentioned steps of PTCA.

Previous studies indicated that ischemia is represented by increased QTc and QTc dispersion.^{17,18} Accordingly, transient ischaemia induced during PTCA has a significant effect on ventricular repolarization in a way that it resulted in a significant increase in both QTc and QTc dispersion. The degree of QT dispersion is so important that in the presence of a proper triggering extrasystole it may cause ventricular arrhythmia.¹⁹

In this study in accordance with studying the effect of balloon inflation on myocardial ischemia ECG parameters, the effect of contrast dye injection was also evaluated. Obtained results indicated that the increase which was observed during balloon inflation was not significantly higher than that observed after contrast dye injection. These findings support the fact that contrast medium used in this procedure has an ischemic and consequently arrhythmic effect, which was clinically observed by cardiologist but has not yet confirmed. It could be suggested that the risk of ischemia during balloon inflation is not significantly higher than the effect of dye injection and the myocardial ischemia induced during balloon inflation is not sufficient to induce a significant effect on QTc and QTc dispersion in addition to contrast dye injection. But studying the effect of balloon inflation separately by deleting the effect of contrast dye injection is recommended.

As mentioned, many reports from patients undergoing PTCA indicated significant alterations of ventricular repolarization after reperfusion which prolonged the QTc and QTc dispersion.^{9,10} The effect is reversible and decreases on reperfusion.

In the current study QTc increased significantly but the increase in QTc dispersion was not statistically significant. This may be due to small sample size or the occlusion time. In a similar study by Nowinski et al in Sweden with an occlusion time of 171 ± 60 s, QTc and QTc dispersion increased significantly.¹⁹ Although in the current study we did not measure occlusion time, but it seems that it was lower, because the base of occlusion time during PTCA was 60 s which increased depending on different cases.

Kajiyama et al, in Japan, studied the role of QT dispersion in PTCA induced ventricular tachyarrhythmia and concluded that intracoronary balloon inflation had no significant effect on QT intervals in patients with stable effort angina, but it increased QT dispersion if ventricular tachyarrhythmia induced during PTCA.²⁰ Considering that ventricular tachyarrhythmia was not reported in studied population before and during PTCA, it could be another explanation for our findings regarding QTc dispersion. However to obtain more informative results further studies with larger sample size is recommended.

In a similar study in Turkey, Kilic and colleagues have investigated the changes in QTc dispersion immediately before, during and after intracoronary balloon inflation. They also studied the relation between QTc dispersion and the involved coronary arteries during PTCA. Their study indicated that balloon inflation during PTCA causes an increase in QT dispersion limited to the LAD and RCA vessels because of acute reversible myocardial ischemia. They concluded that for using QT dispersion as a marker of myocardial repolarization abnormality, the involvement of vessels should also be considered.²¹

One of the limitations of our study was that, though the majority of involved vessels were LAD (76.6%) but we did not evaluate the mentioned relationship.

In sum, although current study had some limitations but the findings of this research support the fact that during PTCA a transient myocardial ischemia occurs, but in order to accurately determine the stage at which the ischemia occurs and the amount and effect of it on cardiac depolarization and repolarization periods, further studies with larger sample size and by abating the effect of contrast dye injection and with consideration of mentioned limitations is recommended.

Conflict of Interests

Authors have no conflict of interests.

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