

QT Interval Dispersion Changes According to the Vessel Involved during Percutaneous Coronary Angioplasty

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Increased QT dispersion (QTd) is a noninvasive marker of an electrophysiologic abnormality associated with high mortality in coronary artery disease. The purposes of this study were to measure changes in QTd and ST-segment changes immediately before, during and after intracoronary balloon inflation and to determine whether the coronary artery vessel involved and/or the duration of inflation affect(s) QTd. A total of 45 patients (32 men, 13 women, mean age 58 ± 11 years) who were referred for elective percutaneous transluminal coronary angioplasty were included. The mean QT interval dispersions for all patients before the inflation, during the balloon inflation at 60 sec and after the balloon deflation at 5 min were 68 ± 13 ms, 82 ± 16 ms and 71 ± 13 ms, respectively. There was no significant difference between baseline and 5 min after deflation. The increase in QTd during the balloon inflation was significant ($p < 0.01$). There was no significant QTd change in patients with left circumflex artery (Cx) lesions during inflation and after deflation compared with baseline. The differences were statistically significant only in patients with left anterior descending (LAD) lesions and right coronary artery (RCA) lesions at 60 sec during balloon inflation ($p = 0.001$ vs. $p = 0.04$). Acute reversible myocardial ischemia induced by balloon inflation causes an increase in QTd limited to the LAD and RCA vessels. Therefore, when using QTd as a marker of myocardial repolarization abnormality due to acute reversible ischemia, the involved coronary artery vessel must be taken into account.

Key words: QT dispersion ■ coronary artery disease

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INTRODUCTION

QT dispersion (QTd) reflects regional variability in myocardial repolarization. Increased QTd is a noninvasive marker of an electrophysiologic abnormality associated with high mortality in coronary artery disease.¹ During ischemia, QTd increases reversibly² and decreases after percutaneous transluminal coronary angioplasty (PTCA).³ Acute ischemia decreases the resting membrane potential, produces cellular uncoupling and shortens the action potential duration.^{4,5} The purposes of this study were to measure changes in QTd and ST-segment changes immediately before, during and after intracoronary balloon inflation and to determine whether the coronary artery vessel involved affects QTd.

METHODS

Patients

A total of 45 stable angina pectoris patients (32 men, 13 women, mean age 58 ± 11 years) were referred for elective PTCA. All patients had $\geq 75\%$ stenosis in the proximal or mid-portion of a single major coronary artery. None of the patients had total coronary occlusion. The anatomic distribution of the coronary artery stenoses was as follows: the left anterior descending artery (LAD) in 15 patients, the left circumflex (Cx) in 15 and the right coronary (RCA) in 15. Only the patients with dominant Cx and RCA were included in the study. Patients were excluded if they were taking drugs that modified the QT interval, if they had congenital long-QT syndrome, interventricular conduction delay or left ventricular hypertrophy, abnormal serum electrolyte levels and a history of myocardial infarction.⁶⁻⁸ All patients were in sinus rhythm.

Electrocardiographic Analysis

Twelve-lead electrocardiograms (ECGs) were recorded at 50 mm/sec paper speed and were obtained immediately before the first inflation (baseline), during the balloon inflation at 60 sec and 5 min of reperfusion following the first inflation. Only recordings of

the first inflation were used in order to avoid ischemic preconditioning.

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. If a single ECG did not have ≥9 technically adequate leads, the ECG was excluded from use in this study. The QT interval was defined as the average of the QT intervals of three consecutive beats in each of the ECG leads. Dispersion of the QT interval was defined as the difference between the maximal and minimal QT interval measurements occurring in any of the 12 leads on a standard ECG. QT intervals were also corrected for heart rate using Bazett's formula,⁹ and corrected QT interval dispersion was then calculated.

ECGs were evaluated separately by two of the authors, and readings were compared where the differences in interpretation were found. They were resolved by consensus. All patients gave their written informed consents to the study protocol.

Statistical Analysis

Statistical analysis was performed using the Statistical Package for Social Sciences® (SPSS, Chicago, IL), version 11.0 software for Windows.® Data are presented as mean ± SD. Repeated measures of ANOVA and the Bonferroni correction for multiple comparisons were used to test the significance of differences in ECG interval measurements at baseline, during ischemia and during reperfusion for total and each coronary artery vessel involved. Probability values of <0.01 were considered significant.

RESULTS

Each patient underwent successful and uncomplicated coronary angioplasty. The mean QTd for all patients before the inflation, during the balloon inflation at 60 sec and after the balloon deflation at 5 min were 68 ± 13 ms, 82 ± 16 ms and 71 ± 13 ms, respectively. There was an increase in QTd during balloon inflation. QTd was decreased 5 min after the balloon deflation. But there was no significant difference between baseline and 5 min after deflation. The increase in QTd at 60 sec was significant compared to baseline (p<0.001). There was no significant QT interval dispersion change in patients with Cx lesions during inflation and after deflation compared with baseline.

The differences were statistically significant only in patients with LAD lesions and RCA lesions at 60 sec during the balloon inflation (p=0.001 vs. p=0.04). Mean QTd values by coronary artery lesion location are shown in Table 1.

ST-segment deviations evaluated during coronary angioplasty according to coronary artery vessel involved are shown in Table 2. ST elevation was shown in 12 of 15 patients with LAD occlusion, in six of 15 patients with Cx occlusion and in 11 of 15 patients with RCA occlusion. Isolated ST-segment depression was shown in two patients with LAD, in three patients with Cx and in three patients with RCA occlusion. No significant ST-segment change was observed in one patient with LAD, in six patients with Cx and in one patient with RCA occlusion.

DISCUSSION

QTd is defined as the interlead difference between the longest and shortest QT interval on a standard 12-lead ECG, which is a marker of inhomogeneous ventricular repolarization.¹⁰ QTd increases reversibly during ischemia with coronary angioplasty.¹¹⁻¹³ This increase in

Table 1. QT interval dispersion measured by coronary artery occlusion location

	Baseline	Inflation at 60 Seconds	Deflation at 5 Minutes
Total	68 ± 13 ms	82 ± 16 ms*	71 ± 13 ms
LAD	73 ± 15 ms	85 ± 17 ms**	74 ± 16 ms
RCA	69 ± 14 ms	77 ± 12 ms***	70 ± 12 ms
Cx	66 ± 13 ms	71 ± 13 ms	68 ± 10 ms

* p<0.01; ** p=0.001; *** p=0.04 compared to baseline; LAD: left anterior descending artery; RCA: right coronary artery; Cx: left circumflex artery

Table 2. ST-segment deviation observed by coronary artery occlusion location

	# of Patients with ST-Segment Elevation, (%)	# of Patients with Isolated ST-Segment Depression, (%)	# of Patients with No ST-Segment Change, (%)	Total # of Patients
LAD	12 (80.0)	2 (13.3)	1 (6.6)	15
LCx	6 (40)	3 (20)	6 (40)	15
RCA	11 (73.3)	3 (20)	1 (6.6)	15
Total	29 (64.4)	8 (17.7)	8 (17.7)	45

LAD: left anterior descending artery; RCA: right coronary artery; Cx: left circumflex artery

dispersion is presumed to result from a combination of a local repolarization abnormally and altered conduction within ischemic areas.

During acute ischemia, the increase in QTd is known. However, we investigated QTd during PTCA according to the coronary artery vessel involved. In patients undergoing PTCA, we found that the greatest QTd was observable in the LAD lesions. There was no statistically significant change in the lesions of the Cx lesions during inflation and deflation.

The electrocardiographic diagnosis of occlusion of the left circumflex coronary artery may be difficult to establish. The Cx is the dominant vessel in only 10% of humans and is the least frequently affected vessel in myocardial infarction.¹⁴ Schmitt et al.¹⁵ evaluated ST-segment elevation for the ECG diagnosis of acute myocardial infarction in the angiographically documented occluded infarct vessel. In their study, standard leads showed ST elevation in 85% of patients with LAD occlusion, in 46% of patients with Cx occlusion and in 85% of patients with RCA occlusion. Schmitt et al.¹⁶ also investigated ST-segment changes in angiographically documented occlusion of the Cx in the setting of an acute myocardial infarction. They found that ST-segment elevation was shown in 46% of patients, isolated ST-segments depression in 26% of patients and no significant ST-segment depression in 28% of patients in the standard leads. Katsaris et al.¹⁷ examined the surface ECG in the detection of myocardial ischemia during PTCA. They found ischemic ST changes with Cx occlusion occurred less than with LAD and RCA occlusion. Wung et al.¹⁸ found the ST elevations during PTCA with Cx occlusion in 49% of patients. In line with previous studies, we also found that ischemic ST changes occurred less with Cx occlusion than the LAD and RCA occlusion. However, QTd change according to vessel involved was not well defined before, and there was a relatively small number of patients with Cx disease. To our knowledge, there was only one study investigating QTd according to vessel involved. Yunus et al.³ observed that QTd decreased 24 hours after the PTCA and persisted during long-term follow-up (two months) independent of the coronary artery involved. However, QTd during the balloon inflation was not evaluated, and only precordial QTd was examined.

Many investigators found that acute ischemia induced either with the balloon inflation¹¹⁻¹³ or during stress test^{19,20} increased QTd. The change in QTd was related to the extent of coronary artery disease.¹⁹

The present study extends less sensitivity of standard ECG leads for determining myocardial repolarization abnormality due to acute ischemia in Cx-involved coronary vessel disease as ischemic ST changes.

CONCLUSION

Acute reversible myocardial ischemia induced by the balloon inflation causes an increase in QTd limited to the LAD and RCA vessels. Therefore, when using QTd as a marker of myocardial repolarization abnormality due to acute reversible ischemia, the involved coronary artery vessel must be taken into account.

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