

QT Dispersion as a Prognostic Indicator for Myocardial Viability: a Systematic Review

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ARTICLE INFO	ABSTRACT
<p>Article type: Review Article</p> <hr/> <p>Article history: Received: 23- Apr-2015 Accepted: 14- May -2015</p> <hr/> <p>Keywords: Myocardial infarction Myocardial viability QT dispersion</p>	<p>Introduction: QT interval represents duration of ventricular electrical systole, i.e., the time required for completion of both ventricular depolarization and repolarization. QT interval duration normally varies between leads on the electrocardiography due to variation of repolarization and re-excitability of different ventricular regions. QT dispersion, defined as the difference between maximum and minimum of QT interval duration, is considered a strong predictor of myocardial viability in cardiac disorders, particularly in ischemic heart diseases and myocardial infarction (MI). Regarding this, the current systematic review aimed to evaluate QT dispersion measurement as a simple and powerful prognostic indicator for predicting the risk of life-threatening arrhythmia, cardiac sudden death, and ventricular dysfunction in patients with MI. Furthermore, this study attempted to establish the reliability of QT dispersion in assessing the efficacy of reperfusion therapeutic strategies.</p> <p>Materials and Methods: For the purpose of data collection, PubMed was searched for all prospective English trials, using keywords of "QT dispersion", "myocardial viability", and "myocardial infarction" or "MI". Out of the 294 retrieved articles, seven studies met the inclusion criteria.</p> <p>Results: QT dispersion was concluded to be instrumental in predicting the risk of post-MI life-threatening ventricular arrhythmia and cardiac sudden death, as well as assessment of ventricular wall motion and response to reperfusion therapeutic strategies.</p> <p>Conclusion: According to the findings of the reviewed studies, QT dispersion is a reliable, simple, and applicable tool for myocardial viability assessment in patients with MI.</p>

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Introduction

Electrical activity of ventricular systole is reflected as QT interval in electrocardiogram (ECG) tracing. Ventricular systole comprises of two phases, including depolarization and repolarization. Regarding this, any alternation in cardiac electrophysiology, cardiac geometry, autonomic tone (1), pharmacological properties, and electrolyte imbalance (2) can modify repolarization time and thereafter QT interval. Ventricular repolarization time varies for different cells located in diverse regions of the left ventricle (LV), resulting in a regional heterogeneity of repolarization time, which in turn, causes QT interval dispersion in various leads of ECG (3-7). Therefore, QT dispersion reveals normal desynchronization of various parts of myocardium with different excitability recovery times.

With this background in mind, various studies have been carried out to evaluate clinical applicability of QT dispersion (1, 5, 8-16) as it provides valuable information on the risks and/or benefits of therapeutic medication and instruments applied for cardiac recovery after vascular accidents (1, 5, 8, 9, 17).

Furthermore, QT dispersion assessment provides important predictions on dangerous arrhythmia and sudden cardiac death in post-myocardial infarction patients (5, 10, 22, 23). QT interval in a 12-lead standard ECG reflects ventricular repolarization. QT dispersion is defined as the difference between maximal and minimal QT intervals in a 12-lead standard ECG (Figure1).



Figure 1: QT interval dispersion in 12-lead electrocardiography tracing, caused by normal variation of terminal point of T wave in different leads resulting from different terminations of ventricular repolarization.

There are many reports suggesting a negative correlation between QT dispersion and some of heart diseases, particularly malignant arrhythmias (24). QT dispersion measurement is a very simple and non-invasive method for predicting mortality in high-risk patients after a Myocardial Infarction (MI). Resting QT dispersion varies between 30 ms and 60 ms in healthy subjects, whereas it ranges between 60 ms and 80 ms in patients with Coronary Artery Disease (CAD) (25).

Many studies demonstrated a correlation between QT dispersion and size of myocardial ischemia (26); in other words, as repolarization time is prolonged in infarcted myocardium, QT interval becomes longer in ECG (27).

As reported in the literature, QT dispersion values obtained from patients with coronary arterial stenosis after bicycle exercise tests were significantly more prolonged, compared to patients without CAD. The literature proposed QT dispersion measurement as a simple and non-invasive potential prognostic tool in a 12-lead standard ECG for predicting risk of life-threatening arrhythmia in patients with previous MI (27).

There are a number of powerful and validated studies, investigating the relationship between QT dispersion and all-causes cardiovascular mortality, which demonstrated that QT interval corrected for heart rate (QTcd) was a potential predictor of all-cause mortality and a weak predictor of cardiovascular mortality. However, QT dispersion was reported to be only a significant predictor of cardiovascular mortality (28).

Monophasic Action Potential (MAP) detection is an invasive technique for recording the heterogeneity of action potential in different regions of the heart. MAP is the first method to show the inhomogeneity of repolarization, which provides a potential substrate for ventricular reentry arrhythmias. Besides, QT dispersion

prolongation is demonstrated to be associated with alteration in MAPs.

In a prospective trial with 313 heart failure patients, QTcd of > 70 ms was found to be significantly correlated with higher mortality rate (29). In another study, QTcd was recognized as an independent predictor of cardiovascular mortality in elderly patients (30). Consequently, prolonged QT dispersion increases risk of CAD, cardiac arrhythmia, and cardiovascular mortality in geriatric patients (30).

Other studies proposed that higher QT dispersion values, stimulated by low-dose of dopamine (10 mg), are associated with myocardial viability in dopamine stress echocardiography (31). Furthermore, it was demonstrated that myocardial viability was conversely correlated with resting QT dispersion (32). These studies also revealed that myocardial viability was positively and negatively correlated with myocardial repolarization and the resulted prolonged QT dispersion, respectively. The patients were concluded to be at high risk of cardiac arrhythmia and ischemic reentry events (32).

The present study reviewed the related literature on clinical application of QT dispersion and confirmed its reliability in predicting myocardial viability after MI.

Materials and Methods

Clinical application of QT dispersion is a topic of increasing interest; as a result, the current study aimed to briefly review the related literature. To this end, PubMed was searched, using the following keywords: "QT interval dispersion", "myocardial viability", and "myocardial infarction" or "MI". Consequently, 294 articles were retrieved, of which the non-prospective trials and those with languages other than English were omitted. Out of the remaining articles, eight studies met the inclusion criteria. The aim of this review was to assess the reliability of QT dispersion in clinical assessment of myocardial viability after MI. Table 1 summarizes the characteristics of the eligible studies.

Table1: Characteristics of the reviewed articles

Reference No.	Authors	Year of publication	Number of participants	Aims of the study	Conclusions
25	Paventi S. et al.	1999	303	To evaluate QT dispersion in patients with acute myocardial infarction (MI), and to assess its relationship with early severe ventricular arrhythmias	(1) QT dispersion increased during acute MI. (2) The values were higher in the early hours, but decreased after thrombolytic therapy. (3) Greater QT dispersion is associated with severe ventricular arrhythmias
33	Muellerleile K. et al.	2008	Not known	To differentiate between viable and non-viable myocardium by magnetic resonance imaging	DE-CMRI was superior in assessing myocardial viability, compared to single-photon emission tomography and positron emission tomography
34	Lancellotti P. et al.	2001	78	To examine the effects of graded dobutamine infusions on QT dispersion early after acute MI and to investigate the relation of dobutamine-induced changes in QT dispersion to wall motion responses	(1) Low QT dispersion on the baseline electrocardiogram is determined by the presence of viable myocardium (2) Dobutamine-induced increase in QT dispersion is associated with viable and jeopardized myocardium. (3) Unchanged QT dispersion during dobutamine stress is a simple marker of extensive necrosis.
35	Gabrielli F. et al.	1997	95	To evaluate QT dispersion in acute and sub-acute MI and clarify the relationship between QT dispersion and myocardial viability	The modifications of QT dispersion can reflect the alterations of myocardial contractility.
36	Bluzaitė I. et al.	2006	Not known	To evaluate the significance and problems of the QT dispersion and heart rate variability in sudden death risk stratification in patients with coronary heart disease	QT dispersion is a significant predictor of cardiovascular mortality.
37	Nakajima T.	1998	34	To clarify and assess the relationship between QT interval dispersion and wall motion abnormalities	(1) QT dispersion in the acute phase of anterior MI indicates recovery of left ventricular (LV) wall motion. (2) Prolongation of the local action potential duration of the myocardium that recovers from severe ischemia may contribute to the increased QT dispersion, which results in inversion of T waves in the acute phase of MI.
38	Bountioukos M. et al.	2004	103	To evaluate the influence of viable myocardium on QT dispersion in patients with severely depressed LV function due to coronary artery disease	(1) There is a negative correlation between QT dispersion and the number of viable segments assessed by <u>dobutamine stress echocardiography</u> . (2) Patients with severely depressed LV function and low QT dispersion probably have a substantial amount of viable tissue. (3) Conversely, when QT dispersion is high, the likelihood of substantial viability is reduced
39	Alici G. et al.	2013	80	To show whether an additional effect of thrombectomy on reducing QT dispersion will be seen in patients undergoing primary percutaneous coronary intervention (PPCI) for ST segment elevation MI	Thrombectomy along with PPCI helps more effective reperfusion at the microvascular level and provides additional prognostic information.
45	Li V.H.	2002	34	To evaluate relationship between QTd and viable myocardium in patients with prior MI and severe LV dysfunction	There was no relationship between QT dispersion and viability in patients with MI and severe LV dysfunction

Results

Viability of myocardium after an MI is a considerable and important prognostic factor in patient survival. Assessment of myocardial viability can be performed by powerful and expensive tools, such as magnetic resonance imaging, single-photon emission computed tomography, positron emission tomography, and stress ECG (33). However, many authors have addressed QT dispersion as a simple, inexpensive, and highly available marker for evaluation of myocardial viability in their reports. In the reviewed articles, the ability of QT dispersion in predicting the risk of post-MI life-threatening ventricular arrhythmia and assessment of ventricular wall motion, as well as the response to reperfusion therapy were investigated.

Lancellotti demonstrated that low QT dispersion on the baseline ECG of the patients with MI is associated with viable myocardium; on the other hand, QT dispersion increment, followed by low-dose dobutamine injection, indicated the presence of viable and jeopardized myocardium. Besides, unchanged QT dispersion after dobutamine stress showed extensive necrosis (34). In two studies containing 398 acute MIs, QT dispersion was found to increase in MI and higher values were associated with higher probability of severe ventricular arrhythmia (25, 35). Additionally, QT dispersion and heart rate variability were claimed to predict sudden death risk and other risk stratifications in patients with CAD (36). Recovery of LV dysfunction after acute MI as manifested by the extent of wall motion can be predicted by QTd. Lower QT dispersion was associated with increased chance for recovery of LV wall motion (37).

Conversely, higher QT dispersion reduced the likelihood of substantial viability of myocardium (38).

QT dispersion can also be applied to assess therapeutic trials. Alici demonstrated that patients receiving additional thrombectomy along with Primary Percutaneous Coronary Intervention (PPCI) showed a lower value of QT dispersion, compared to patients undergoing only PPCI (39).

Discussion

Duration of ventricular repolarization is presented by QT interval in ECG tracing. As ventricular repolarization time varies for different ventricular regions, recorded QT interval differs in each of ECG leads owing to regional inhomogeneity of ventricular repolarization. QT dispersion is defined as the difference between the longest and shortest durations of QT interval in a standard 12-lead ECG, which ranges

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from 30 ms to 60 ms in healthy subjects. Recently, many studies have proposed QT dispersion as a simple prognostic tool for detection of myocardial viability in cardiac diseases, particularly ischemic heart disease and acute MI. In this review, myocardial viability in patients with acute MI implicates the risk of life-threatening ventricular arrhythmia and cardiac sudden death, assessment of ventricular wall motion, and recovery of ischemic zone in response to reperfusion therapeutic methods. Nowadays, QT dispersion measurement is thought to be a reliable marker for all the mentioned aspects of myocardial viability estimation in patients with MI (5, 40-44). However, some researchers failed to show this ability for QT dispersion (45). In line with the reviewed articles, previous studies (25, 35, 36) revealed a positive correlation between QT dispersion values and the extent of infarcted zone in patients with previous MI. However, there is some controversy regarding the relationship between QT dispersion and ventricular wall motion as assessed by Dobutamine Stress Echocardiography (DSE). Our reviewed articles (37, 38) suggested a negative correlation between QT dispersion values and regional wall motion during DSE; nevertheless, other studies did not confirm this correlation (46, 47). QT dispersion is an independent, non-invasive, simple, and significant predictor of increased risk of ventricular arrhythmia in MI patients.

Similar to the reviewed studies (25, 35), Perkimiki (48) reported increased susceptibility to reentry ventricular tachycardia in patients with prolonged QT dispersion following MI. These findings are consistent with those of other studies employing QTcd and QT dispersion to improve the accuracy of their studies (40, 49, 50). Assessment of response to reperfusion treatments is another application of QT dispersion. Prolonged QT dispersion rapidly decreased after invasive, intraluminal, and instrumental interventions (39); furthermore, this measure showed chronic decline days and weeks after MI occurrence (25).

Conclusion

The current findings indicted a positive correlation between QT dispersion and risk of ventricular arrhythmia and sudden cardiac death, as well as a negative correlation between the size of infarcted zone and the extent of wall motion as assessed by echocardiography. In this regard, we recommend application of QT dispersion calculation as a simple, non-invasive, and powerful prognostic tool for identification of myocardial viability.

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