Original Article

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THE QT DISPERSION: A CURSOR OF EFFECTIVE REPERFUSION AFTER CORONARY ANGIOPLASTY

Sadia Mubarak, Syed Muhammad Imran Majeed*, Muhammad Alamgir Khan, Madiha Sarwar***, Bushra Riaz******

Poonch Medical College, Rawalakot, Azad Jammu and Kashmir, Pakistan, *Surg Gen / DGMS (IS) Medical Directorate GHQ, Rawalpindi Pakistan, ***Army Medical College, National University of Medical Sciences (NUMS) Pakistan, ****Rawal Institute of Health Sciences Islamabad, Pakistan

ABSTRACT

Objective: To find the effect of ischemia on QT dispersion in coronary artery disease patients and to compare QT dispersion before and after percutaneous transluminal coronary angioplasty.

Study Design: Quasi experimental study

Place and Duration of Study: Department of Clinical Cardiac Electrophysiology, Armed Forces Institute of Cardiology / National Institute of Heart Diseases (AFIC / NIHD), Rawalpindi, Dec 2013 to Nov 2014.

Material and Methods: 40 Patients having coronary artery disease with at least one stenotic lesion of greater than 70% of the vessel lumen were included. Patients with diabetes mellitus, systemic arterial hypertension, structural heart diseases and bundle branch block were excluded. DMS 300 4A Holter monitors were used to obtain 12 lead digital ECG recordings pre and post angioplasty. CardioScan premium luxury software was used for the analysis of QT dispersion.

Results: There were 39 male and 1 female patients with mean age of 55.20 ± 8.03 years. QT dispersion in coronary artery disease patients (46.6 ± 11.20 ms) was significantly increased as compared to normal reference value of 33.4 ± 2.3 ms (p-value < 0.001). After reperfusion QT dispersion was decreased significantly from 46.53 ± 11.47 ms to 35.60 ± 11.34 ms (p-value < 0.001)

Conclusion: Patients with coronary artery disease have prolonged QT dispersion; however, successful reperfusion decreases it significantly.

Keywords: Coronary artery disease, Holter monitoring, Myocardial ischemia, QT dispersion.

INTRODUCTION

QT dispersion is defined as the difference between the longest and the shortest QT intervals on 12 lead surface ECG[1]. It was realized in early 1990s that a multi-lead ECG is actually an electrical recording from different areas of the heart therefore measuring multi-lead difference of QT intervals can give an instantaneous measure of ventricular repolarization heterogeneity[2]. QT dispersion reflects spatial dispersion of ventricular repolarization and refractoriness. It differentiates electrically homogenous myocardium from heterogenous areas. This kind of electrical dissimilarity which may arise due to myocardial ischemia leads to increased dispersion of ventricular refractory period offering an ideal substrate for ventricular arrhythmias[3].

Myocardial repolarization difference is increased between ischemic and normal areas in coronary artery disease patients and this transmural heterogeneity of repolarization can be measured by QT dispersion analysis[6]. Accordingly, an increased QT dispersion can be considered as an indication of underlying myocardial ischemia[7]. In severe myocardial ischemia, altered electrical potentials can precipitate lethal ventricular arrhythmias which may lead to sudden cardiac death[4]. Ischemia can cause increased dispersion of repolarization which creates the electrophysiological conditions acting as substrate required for reentry impulse arrhythmias. Increase in spatial dispersion of repolarization and shortening of refractory period in the vicinity of ischemic area develops high tendency for reentrant arrhythmias[1]. Electrical activity is altered in

Correspondence: **Dr Sadia Muibarak,** Asst Prof of Physiology, Poonch Medical College, AJK, Pakistan
Email:sadia.smcian@gmail.com

ischemic regions leading to slowing of cardiac impulse and prolongation of the duration of action potential. Consequently, repolarization becomes slow and heterogenous process which may lead to ventricular arrhythmias due to triggered activity and development of reentry circuits[5] Alteration in ionic balance across the sarcolemma leads to shortening of refractory period and delayed conduction which causes dispersal of action potential duration in ventricular ischemic and nonischemic myocardial cells leading to increased QT dispersion[1,3,6].

Occlusion of blood supply to myocardial tissue does not lead to spontaneous death of the tissues. A lot of ischemic events can be reversed if detected timely by identifying the ECG changes and assigned blood markers. Reversal of ischemic events can be obtained by proper salvage through reperfusion therapy by means of percutaneous transluminal coronary angioplasty[4,7]. QT dispersion can be applied as a capable prognostic tool to detect future ventricular tachyarrhythmic events which may lead to sudden cardiac death. In various studies it has been noted that QT dispersion increases during phases of ischemic attack[8,9]. Awareness of ischemia induced life threatening ventricular arrhythmias is essential for demarcating the patients with high risk. This study was aimed to find the effect of ischemia on QT dispersion in coronary artery disease patients and to compare QT dispersion before and after percutaneous transluminal coronary angioplasty.

PATIENTS AND METHODS

This was a cross sectional comparative study carried out at department of Cardiac Electrophysiology, Armed Forces Institute of Cardiology in collaboration with Army Medical College, Rawalpindi from April 2014 to August 2014. An official approval was obtained prior to commencement of the study from Ethical Review Committee of Army Medical College. Written informed consent was taken from all the patients undergoing the study. 53 patients with coronary artery disease of either sex and any age were recruited by non-probability convenience sampling. Coronary artery occlusion was diagnosed on the basis of coronary angiography. Patients having significant coronary artery disease with at least one stenotic lesion of greater than 70% of the vessel lumen were included. Patients with diabetes mellitus, systemic arterial hypertension, structural heart diseases and bundle branch block were excluded. DMS 300-4A Holter monitors from 'Diagnostic Monitoring Software (DMS)' company limited USA, were used to obtain 12-lead ECG recording pre and post angioplasty. Successful pre-angioplasty Holter monitoring was performed in 53 patients. In 6 patients angioplasty could not be done as the cardiac catheterization guide wire could not be passed through the occluded artery leading to defective reperfusion. Holter data of 7 patients were discarded due to distorted recordings in more than two leads. Finally we were left with 40 patients who had successful reperfusion and had interpretable pre and post angioplasty ECG recordings. Digital ECG data were transferred to the computer and analyzed by using CardioScan premium luxury software. QT dispersion analysis was carried out by selecting a view of all the 12 leads of ECG from 24 hours Holter monitoring which was devoid of artifacts. Easily measurable T waves were identified and marked. QT intervals of three consecutive beats were defined by vertical lines toggling. QT dispersion was measured as a difference between the maximum and minimum mean QT intervals in three consecutive beats within the entire 12 lead standard ECG. The difference was calculated amid the selected three consecutive beats and averaged. Maximum upper limit of normal QT dispersion was kept at 33.4 ms and the values above this cut off point were considered as prolonged QT dispersion[12]

Statistical analysis was done using computer software IBM SPSS (Statistical package for social sciences) version 22. Qualitative variables were presented as frequency and percentages whereas quantitative variables as mean and standard deviation. QT dispersion in coronary artery disease patients was compared with standard normal values and post angioplasty values using Wilcoxon Signed Rank test.

RESULTS

There were 40 patients with mean age of 55.20 ± 8.03 years and age range from 34 to 68 years. Male to female ratio was 39:1. QT dispersion before angioplasty, in patients with coronary artery disease was 46.53 ± 11.47 millisecond. Nonparametric test 'Wilcoxon Signed Rank test' was used to compare it with reference value or the post-angioplasty QT dispersion as the data did not follow normal distribution (*p*-value < 0.05 on Shapiro Wilk test). The pre-angioplasty QT dispersion was compared with the normal reference value of 33.4 ± 2.3 ms using. The result showed that QT dispersion was significantly increased in patients with coronary artery disease as compared to the normal value in healthy people (p-value < 0.001) as depicted in table-1.

Table-1 Comparison of QT dispersion in coronary artery disease patients with normal value (N=40).

QT dispersion (ms)	Values (mean ± SD)	*p*-value
Patients	46.53 ± 11.47	0.001*
Normal	33.4 ± 2.3	

*p-value significant (< 0.05)
SD = standard deviation, ms = millisecond

Table-2 Comparison of pre and post-angioplasty QT dispersion in coronary artery disease patients (N=40).

QT dispersion (ms)	Values (mean ± SD)	*p*-value
Pre-angioplasty	46.53 ± 11.47	0.001*
Post-angioplasty	35.60 ± 11.34	

*p-value significant (< 0.05)
SD = standard deviation, ms = millisecond

Pre and post-angioplasty QT dispersion values were compared as shown in table-2.

DISCUSSION

Results of our study demonstrate a significant increase in QT dispersion in patients with coronary artery diseases as compared to the reference values in health people. Prolonged QT dispersion in these patients is attributed to ischemia related changes. Electrical activity is altered in ischemic regions leading to slowing of cardiac impulse and prolongation of the duration of action potential. Consequently, repolarization becomes slow and heterogenous process which may lead to ventricular arrhythmias due to triggered activity and development of reentry circuits[2].

Gatzoulis et al conducted a study in 31 patients with unstable angina. They measured the QT dispersion during angina as well as after pain was relieved by abolishing myocardial ischemia. They reported that QT dispersion during angina was significantly higher 83 ± 33

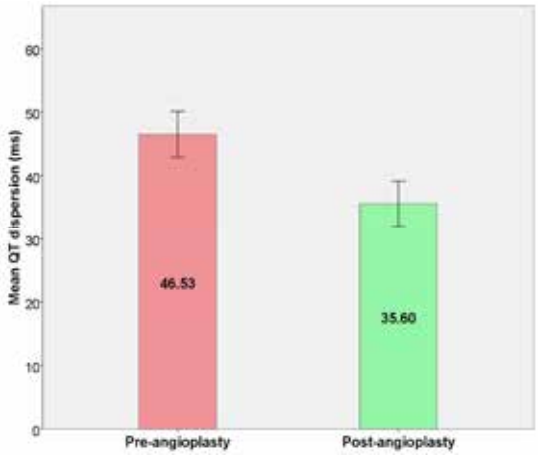

Figure: Comparison of pre and post-angioplasty QT dispersion.

Analysis showed that QT dispersion was significantly decreased after coronary angioplasty (*p*-value < 0.001). Graphical comparison of pre and post-angioplasty QT dispersion is shown in fig-1.

versus 58 ± 23 ms, p < 0.001) as compared to the value after the pain was relieved. We compared QT dispersion before and after angioplasty in patients with coronary artery disease. Results of our study showed that QT dispersion was significantly decreased after angioplasty. Successful reperfusion attained by angioplasty decreased ventricular repolarization heterogeneity by restoring ionic especially potassium and pH imbalance[5]. Cetin et al conducted a study to determine the difference between pre and post-angioplasty QT dispersion[6]. They recruited 114 patients of coronary artery disease and found that post-angioplasty QT dispersion was significantly decreased within 24 hours of reperfusion (65.6±9.8 versus 53.4±11.6 ms, *p* < 0.001). Similarly Monshizadeh et al carried out a research on 45 patients with coronary artery disease undergoing angioplasty[7]. They analysed QT dispersion 6 hours before and 6 hours after the angioplasty. They reported that QT dispersion was decreased after angioplasty as compared to the initial values (55 ± 20 versus 42 ± 9 ms, *p* = 0.001).

Alasti et al studied 96 patients to evaluate the effects of reperfusion on QT dispersion[8]. They recorded QT dispersion before and 24 hours after angioplasty from 12 lead standard ECG. They also found that post-angioplasty QT dispersion was significantly decreased (68 ± 4 versus 80 ± 4 ms) as compared to the pre-angioplasty dispersion (*p* = 0.001). Similarly Aydinlar et al conducted pre and post angioplasty analysis of QT dispersion in 26 patients with single vessel disease[9]. They recorded pre-angioplasty QT dispersion as 52.2 ± 3.5 milliseconds whereas pos-angioplasty QT dispersion as 42 ± 3.9 milliseconds. The difference between pre and post-angioplasty QT dispersion values was found to be significant (p = 0.03). They concluded that QT interval dispersion, shortens with effective reperfusion after angioplasty[9].

Goodhart et al carried out a follow up study in 70 patients with coronary artery disease to analyze the effect of reperfusion on QT dispersion[10]. They measured 12 lead ECG before angioplasty and twice after angioplasty i.e. 12 hours and 6 months after the angioplasty. Pre-angioplasty, 12 hours and 6 months after angioplasty QT dispersion values were recorded to be 77±29, 66±26 and 65±25 milliseconds respectively. They reported that QT dispersion decreased significantly within 12 hours after angioplasty (*p* <0.001) as compared to the initial value before the procedure whereas no significant difference was found between the two recordings after the angioplasty. However, the QT dispersion value recorded 6 months after angioplasty did show some decrease as compared to the recording obtained after 12 hours. This implies that an ongoing diminution in QT dispersion over time can predict better outcome after angioplasty especially sustained vascular patency. While stagnant or increased QT dispersion six months after revascularization predicts persistent left ventricular repolarization defects due to restenosis leading to myocardial ischemia[10].

All the studies mentioned above including ours concluded that QT dispersion increased in myocardial ischemia whereas reperfusion led to drop in its value owing to the beneficial effect on ventricular repolarization homogeneity.

CONCLUSION

Myocardial ischemia increases QT dispersion which may put the patients of coronary artery disease at risk of ventricular arrhythmogenesis whereas reperfusion by percutaneous transluminal coronary angioplasty decreases QT dispersion. It implies that persistently increased QT dispersion after angioplasty is an indicator of augmented risk of arrhythmogenesis. Such patients need to be kept under medical surveillance to avoid arrhythmogenic events leading to adverse outcomes including sudden cardiac death.

CONFLICT OF INTEREST

The study has got no conflict of interest to declare by any author

LIMITATIONS OF STUDY

The study was conducted in a short duration of time using convenience sampling. Therefore, sample size was small and male to female ratio could not be maintained.

AUTHORS CONTRIBUTION

Sadia Mubarak data collection, statistical analysis and drafting the manuscript, Muhammad Alamgir khan conception, study design, statistical analysis and drafting the manuscript, Muhammad Imran Majeed, refining the study design and critical revision.

REFERENCES

1. El-Sherif N, Turitto G. Electrolyte disorders and arrhythmogenesis. Cardiol J. 2011;18(3):233-45.
2. Piranfar MA. The relationship between QT dispersion and ischemic injuries in myocardial isotope scan. Acta Med Iran. 2014;52(5):345-51.
3. Yue W, Wang G, Zhang X, Chen B, Wang X, Huangfu F, et al. Electrocardiogram for Predicting Cardiac Functional Recovery. Cell Biochem Biophys. 2014:1-5.
4. Yang X, Pinto DS, Chakrabarti AK. Optimizing Reperfusion in Patients with STEMI: A Critical Evaluation of Pharmacologic and Non-Pharmacologic Strategies. Am J Cardiovasc Drugs. 2013;13(6):399-406.
5. Bilen E, Yasar AS, Bilge M, Yuksel IO, Aslantas U, Kurt M, et al. Effect of primary percutaneous coronary intervention on myocardial repolarization. J Cardiovasc Med. 2011;12(11):795-9.
6. Cetin M, Zencir C, Cakici M, Yildiz E, Tasolar H, Balli M, et al. Effect of a successful percutaneous coronary intervention for chronic total occlusion on parameters of ventricular repolarization. Coronary artery disease. Coron Artery Dis. 2014 Dec;25(8):705-12.
7. Monshizadeh E, Arefi H, Moghadam M, Hassanijirdehi M. QT dispersion before and after coronary artery angioplasty: A case study from Iran. Ann Cardiol Angeiol . 2012;61(1):27-31.
8. Alasti M, Adel MH, Torfi E, Noorizadeh M, Bahadoram S, Moghaddam MA, et al. QT Dispersion: Does It Change after Percutaneous Coronary Intervention? J Tehran Heart Cent. 2011;6(1):19-23.
9. Aydinlar A, Senturk T, Ozdemir B, Kaderli AA, Aydin O. Effect of percutaneous transluminal coronary angioplasty on QT dispersion and heart rate variability parameters. Cardiovasc J Afr. 2009;20(4):240-4.
10. Goodhart DM, Hubacek J, Anderson TJ, Duff H, Barbeau G, Ducas J, et al. Effect of percutaneous coronary intervention of nonacute total coronary artery occlusions on QT dispersion. Am Heart J. 2006;151(2):529 e1-6.