Original Article

Study of Corrected QT Dispersion in Acute ST-elevation Myocardial Infarction (Thrombolysed/Non-Thrombolysed) Patients and its Prognostic Significant During Hospital Stay

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Abstract

Introduction: In the electrocardiogram, the QT interval reflects the duration of depolarization and repolarization of the ventricular myocardium thus reflects changes in local myocardial milieu. Dispersion of repolarization is thought to reflect regional heterogeneity of the recovery process within the myocardium, which believed to be important in the genesis of ventricular arrhythmias.

Purpose of Study: The purpose of the present study was to predict the risk of life-threatening ventricular arrhythmias and other cardiac complications after acute ST-elevation myocardial infarction (STEMI) event with using rate adjusted corrected QT (QTc) dispersion as one of the cheapest modalities and non-invasive investigation, which may reflect as a prognostic marker.

Materials and Methods: The present study had been carried out in the Department of Medicine, NSCB. Medical College and associated Hospital, Jabalpur, Madhya Pradesh, India, from March 2017 to August 2018. This was a case–control prospective observational study. The targeted populations were 60 cases of both sexes with the age group of ≥18–≤70 years, and age- and sex-matched 60 apparently healthy control subjects.

Results: Mean QTc dispersion was increased in patients of acute MI compared to control subjects; which were found statistically highly significant. The mean QTc dispersion remained consistently high in a group of patients with cardiac complications in comparison to patients without cardiac complications on day 1 up to discharge. The mean QTc dispersion was found high in patients who were died compared to who were survived on day 1.

Conclusion: It could be concluded that QTc dispersion measurement may provide a potentially simple, cheap, and non-invasive method of identification of patients with acute MI (STEMI) at risk of development of ventricular arrhythmias and also relates to the prognosis in that patients and the future may prove to be an independent predictor of death.

Key words: Arrhythmia, Electrocardiogram, Myocardial infarction, Prognosis, QT interval

INTRODUCTION

In the electrocardiogram (ECG), the QT interval reflects the duration of depolarization and repolarization of the ventricular myocardium thus reflects changes in local myocardial milieu. Dispersion of repolarization is thought to reflect regional heterogeneity of the recovery process within the myocardium, which believed to be important in the genesis of ventricular arrhythmias.

The purpose of the present study was to predict the risk of life-threatening ventricular arrhythmias and other cardiac complications after acute STE myocardial infarction (STEMI) events with using rate adjusted corrected QT dispersion (QTcD) as one of the cheapest modalities of investigation and may reflect as a prognostic marker.

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Various studies have been carrying out to evaluate the predictive markers of poor prognosis after acute STEMI event, but there are still lacunae in medical science that it has little to offer in ascertaining the likely prognosis of patients with acute coronary syndromes particularly STEMI in terms of morbidity and mortality, once the acute event has occurred. The present study has chosen to overcome with these lacunae of current knowledge to find them in hospital, cheapest and non-invasive method of future prediction of cardiac complications after acute STEMI event.

Hence, it would be hypothesized that the QTcD interval could be helpful as an earliest in hospital bedside predictor of life-threatening arrhythmias and death after the acute STEMI event.

However, to further clarification of this fact and to find out the strong correlation of QTcD with worse cardiac outcome after an acute STEMI events; we have to included large numbers of patient's data in the study and consideration of randomized control trials along with the long follow up period.

MATERIALS AND METHODS

Place of Study
The present study had been carried out in the Department of Medicine at Netaji Subhash Chandra Bose Medical College and Hospital, Jabalpur, Madhya Pradesh, India, between the periods of March 2017 and August 2018.

Type of Study
The present study was a case–control prospective observational study.

Aims and Objectives of the Study
Primary objectives
The primary objectives are as follows:
1. To diagnose the patients (cases) with acute STEMI on the basis of their characteristic clinical symptoms, signs, and physical examination with typical ECG changes of STEMI and/or positive cardiac biomarkers.
2. To study the temporal profile of QTcD recorded by surface ECG in patients admitted with acute STEMI during their 7 days of hospital stay or before discharge and comparing them with age- and sex-matched healthy control subjects.
3. To study the effects of thrombolysis on QTcD in patients admitted with acute STEMI during their hospital stay.
4. To study the prognostic significance of QTcD in acute STEMI patients during their hospital stay.

Secondary objectives
1. To emphasize QTcD as a newer prognostic marker in acute STEMI (thrombolysed or non-thrombolysed)

patients during their hospital stay (before discharge) to estimate the future outcome of coronary events.

Details of Subject (Cases and Control Group Subjects)
Patient's selection (as case group) was done from the Medical Intensive Cardiac Care Unit of the Department of Medicine who have fulfilled the inclusion and exclusion criteria of the present study and ready to give written informed consent with a diagnosis of acute STEMI; irrespective to received thrombolytic therapy or not.

Age- and sex-matched apparently healthy subjects (as of control group) have been selected from the medicine outpatients department, medical ward and healthy volunteer's participation after taking informed written consent.

Sample Size
Total numbers of cases/patients – $n = 60$ (sixty), and total numbers of control subjects were $n' = 60$ (sixty).

Inclusion Criteria
For case group
1. Patient willing to be a part of the study.
2. Hospital admitted patients of ≥ 18–≤ 70 years of the age group of both sexes who diagnosed with acute STEMI on the basis of typical clinical presentation (angina chest pain), standard ECG criteria, and/or elevated cardiac enzymes/biomarkers like CK-MB/cardiac-specific troponin.
3. Patients with a diagnosis of STEMI, irrespective of received thrombolytic therapy or not during hospital stay were included in the study.

Exclusion Criteria
1. Patients admitted in the MICU with another diagnosis and with an episode of an acute coronary syndrome (ACS) other than ST-elevated MI.
2. Patients with a history of old MI or known coronary artery disease (CAD).
3. Serum potassium (K^+) concentration ≤ 3.5 mEq/L, normal serum calcium value, and other electrolytes disturbances.
4. Patients on medications with anti-arrhythmic and other drugs that could affect or modify QT interval.
5. Patients with rhythm or conduction disorders, such as Wolff-Parkinson-White syndrome, bundle branch block, congenital QT syndromes, complete atrio-ventricular block, Pacemaker rhythm, Sinus nod dysfunction, post CABG status or post PCI status, Cardiomyopathy, valvular heart disease and frequent ventricular or atrial extra-systoles previous to ACS.
6. Typical ECG changes: Less than 7 useful leads for measurement, poor trace definition.
7. Mortality for non-cardiovascular causes.

Laboratory Tests

All the relevant investigations have been carried out in the Department of Pathology, Biochemistry, Radiology, and Cardiology at Netaji Subhash Chandra Bose Medical College and Hospital, Jabalpur, Madhya Pradesh.

Which included:

1. Complete blood cell count, cardiac serum biomarkers, serum lipid profile, blood sugar, serum electrolytes particularly calcium, renal function test (serum urea and creatinine), liver function test and in a selected patient, and thyroid function test
2. Twelve leads ECG
3. Two-dimensional ECG, and
4. Other relevant investigations such as X-ray chest.

Apparatus and Technique used for ECG

1. Each patient underwent a 12-lead ECG at the speed of 25 mm/s and ECG machine set on 1 mV, a 10-mm standardization mark (0.1mV/mm) measured with a ECG machine (Mindray BeneHeart R3/BeneHeart R3A).
2. In the present study, the STEMI is defined as new STE at the J point in at least two contiguous leads ≥ 2 mm (0.2 mV) in men or ≥ 1.5 mm (0.15 mV) in women in leads V_2–V_3 and/or of ≥ 1 mm (0.1 mV) in another contiguous chest or limb leads.[1]

The presence of reciprocal changes (manifested as ST-segment depression in a region that approximates the vector 180° opposite the major vessel of injury) increases the specificity of STE caused by STEMI.[1]

3. To complete the research, the QTc reading of the first ECG after the onset of symptoms of the acute coronary syndrome, and thereafter during their hospital stay was conducted in both cases and control subjects.

Apparatus and Technique used to Calculate QTcD

1. The analyzed ECG was conducted within the 1st week after the acute MI. First, the heart rate was calculated from the ECG strip.
2. QT interval – is corresponds to the total duration of ventricular depolarization (all myocytes).
3. Using the magnifying lens, QT dispersion was calculated for all patients as the difference between the longest (QT maximum) and the shortest QT (QT minimum) interval recorded by standard 12-lead ECG.
4. The QT interval was corrected using Bazett's formula (QTc = QT/square root of R-R interval in seconds).[2]
5. QTcD was defined as the difference between the maximum and minimum QTc for a given heart rate.
6. So, QTcD = QTc maximum-QTc minimum.

The normal value of RR interval is 0.6–1.2 s.

When entering the QT-interval and the RR-interval in millimeters, make sure the ECG was recorded at a speed of 25 mm/s. Normal values for QTc are between 300 and 450 ms and reported values of QT dispersion vary widely, for example, normal values from 10 to 71 ms.

Procedures used for Data Collection

1. Detailed medical and surgical illnesses history and clinical/physical examination of both study groups have been carried out.
2. Patients (cases) serum sample for cardiac biomarkers study has been taken and their serial ECG recordings were done on the day of admission, day-1, day-2, and day-7 or at discharge for QTc D calculation and observation of cardiac complications during patient's hospital stay.
3. All the data have been recorded using structured schedule (case report form) and entered for tabulation in Microsoft Excel Sheet.

Statistical Analyses

Relevant patients data were collected and have stored into the computer software for its proper validation, check for errors, coding and decoding, etc., and, all the data were analyzed with the help of IBM Statistical Package for the Social Sciences – Statistics – 20.0 software for windows. For comparing more than two means; appropriate univariate and bivariate analysis and ANOVA test have been applied. For analysis of hypothesis according to the type of data, i.e., continuous and categorical; Student's *t*-test and χ^2 tests have been applied.

For the ratio and interval data following the normal distribution, the most common descriptive statistics were mean and standard deviation and for data not following the normal distribution, it was median and range.

P value is the level of marginal significance within the statistical hypothesis test representing the probability of the occurrence of a given event. The critical value for the level of significance of the results was considered at <0.05 levels.

RESULTS

- In patients of STEMI the mean age among case group was 53.22 ± 12.6 years and in the control group it was 54.48 ± 10.6 years.
- In present study, out of total number of cases ($n = 60$), 35 (58%) were male and 25 (42%) were female. In control group ($n' = 60$), 36 (60%) were male and 24 (40%) were female subjects.
- The maximum number of cases has anterior wall STEMI in 33 (55%) followed by Inferior wall STEMI

in 17 (28.3%), mixed wall STEMI in 8 (13.3%), and posterior wall STEMI in 2 (0.30%) of cases. None of the cases was found with lateral wall STEMI and right ventricular wall STEMI during the study period.

- The predominant risk factor in STEMI patients was hypertension in 22 (37%) followed by diabetes mellitus in 16 (27%), smoking/tobacco in 5 (8.3%), alcohol intake in 2 (3.3%), and dyslipidemia in 2 (3.3%). About 13 (21%) of cases were found without any apparent or known risk factor.

- It has been observed that mean QTcD on was the highest in case group subjects (thrombolysed or not-thrombolysed patients) on day-1 in comparison to control group subjects on day-1 (baseline) as 118 ± 50.82 ms versus 45.33 ± 29.49 ms, respectively. The independent *t*-test value in two different groups of individuals was observed 9.58. The difference of QTcD measurement between control subjects and cases with acute STEMI found highly significant, ($P < 0.0001$).

- In patients with acute STEMI; irrespective to received thrombolytic therapy the mean QTcD was found to be highest at the time of admission (on day-1) was 118 ± 50.82 ms and it was decreasing subsequently with the course of disease as 105 ± 54.82 ms at day-2 and day-3, and 105 ± 39.12 ms at day-7 or on discharge although the difference observed was not found statistically significant.

- In the present study, it was observed that out of *n* = 60 patients as cases, 34 patients were undergone for thrombolytic therapy and 22 patients were not. Statistically significance and differences observed in mean QTcD of the thrombolysed and non-thrombolysed patients were on day of admission (103.53 ± 36.0 ms vs. 73.02 ± 59.07 ms, $P < 0.01$),

on day-2 (87.06 ± 49.33 ms vs. 128.46 ± 52.21 ms, $P < 0.003$), and on day-7 or at discharge (89.71 ± 38.02 ms vs. 125 ± 31.14 ms, $P < 0.0003$), respectively.

- The mean QTcD in thrombolysed patients group was found to be higher than non-thrombolysed group on day-1 (on admission) which was 103.53 ± 36 ms, thereafter it was decreasing during the course of disease on day-2 (87.06 ± 49.33 ms) and further increased on day-3 (91.18 ± 43.82 ms). The differences observed were found statistically non-significant ($P < 0.014$). Mean QTcD in non-thrombolysed group showed a lower value on day-1 (on admission) which was 73.02 ± 59.07 ms, thereafter it was increases progressively on day-2 (128.46 ± 52.21 ms) onward. The difference observed was found statistically significant ($P < 0.003$) [Table 1]

- The mean value of QTcD on day of discharge in case group was found higher in comparison to the control subjects group, as 105 ± 39.12 ms versus 45.33 ± 29.49 ms, respectively, and this difference was found statistically significant ($P < 0.001$).

- Out of total numbers of cases (*n* = 60); we have observed that 49 (81.66%) of patients were suffering from cardiac complications and 11 (18.33%) of patients have no signs of cardiac complications. The mean QTcD remained consistently high in group of patients with cardiac complications in comparison to group of patients without cardiac complications, as on day-1 (135 ± 58.3 ms vs. 105 ± 40.4 ms), on day-2 (128 ± 45.3 ms vs. 87 ± 54 ms), on day-3 (132 ± 49.3 ms vs. 84 ± 52.8 ms), and on day-7 or at discharge (115 ± 95.53 ms vs. 97.06 ± 32 ms). *P* value has found statistically highly significant on day-2 and day-3 [Table 2]

- In the present study, out of *n* = 60 cases; 4 (6.66%) of patients were died and 56 (93.33%) of patients were

Table 1: Progression of QTc dispersion in patients with STEMI

STEMI patients (*n*=60)	Mean QTc dispersion (ms)			
	Day-1 (on admission)	Day-2	Day-3	At discharge or (day-7)
Non-thrombolysed group (*n*=22)	73.02±59.07	128.46±52.21	123.46±55.28	125±31.14
Thrombolysed group (*n*=34)	103.53±36	87.06±49.33	91.18±43.82	89.71±38.02
t-test	2.65	3.14	2.52	3.85
P value	0.01	0.003	0.014	0.0003

n: Number of patients (cases), QTc: Corrected QT interval, ms: Milliseconds, STEMI: ST-elevation myocardial infarction

Table 2: Comparison of mean QTc dispersion in cases with cardiac complications and cases without cardiac complications

| Group of cardiac complications	Number of cases (*n*=60)	Mean QTc dispersion (ms)			
		Day-1 (on admission)	Day-2	Day-3	At discharge or (day-7)
Patients with cardiac complications	49	135±58.3	128±45.32	132±49.3	115±97.53
Patients without cardiac complications	11	105±40.4	87±54.1	84±43.6	97.06±32
Total	60	*P*<0.02	*P*<0.002	*P*<0.0002	*P*<0.32

n: Number of patients (cases), QTc: Corrected QT interval, ms: Milliseconds

survived after an acute STEMI event and its cardiac complications. The comparative mean QTcD in non-survivor patients was (180 ± 84.46, 137 ± 48.5 ms, and 112 ± 38.6 ms) on day-1, day-2, and day-3, respectively, which observed higher than mean QTcD on similar days among survivors group (113 ± 45.6, 102 ± 54.2, 104 ± 52.29, and 102 ± 38 ms), respectively. This difference was statistically highly significant ($P < 0.001$) [Tables 3 and Graph 1].

- In the present study, out of 49 patients with cardiac complications; we have observed bradycardia in 4 (8.1%) of patients followed by ventricular tachycardia in 6 (12.24%) and cardiogenic shock in 6 (12.24%) of patients as the most common cardiac complications. From which the mean QTcD (160 ± 81.98 ms) was found highest on day-1 and onward in patients with ventricular tachycardia [Table 4].

DISCUSSION

After observation of data and results following discussion were made:
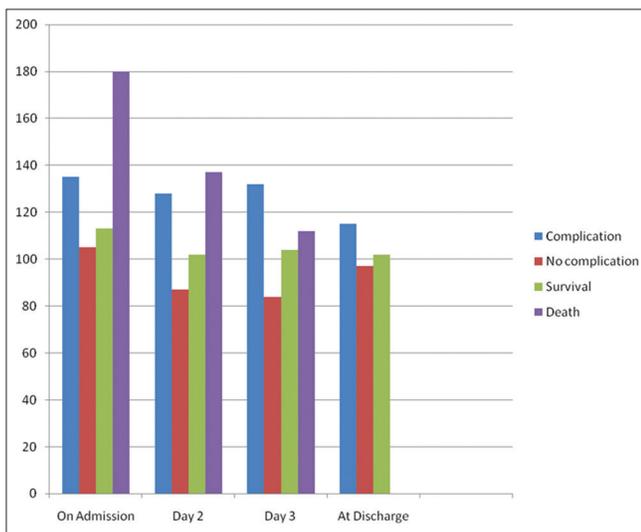
Graph 1: Comparison of mean QTc dispersion in cases with cardiac complications and cases without cardiac complications and who died during a hospital stay, with patients who survived

In the present study, it was observed that in case of group the mean value of age distribution in case group was 53.22 ± 12.6 years and in control subjects group was 54.48 ± 10.6 years, respectively. As *P* value was found statistically nonsignificant; therefore, both study groups were comparable in term of age. The maximum numbers of cases 33 (55%) were belonged to 59–≤70 years of age group and maximum numbers of control subjects 35 (58%) were also belonged to 59–≤70 years of age group.

Chittora *et al.*[3] have been observed in their study that out of 107 patients under study the mean age of males was 57 ± 13 years and that for female was 54 ± 12 years. This study is comparable to the present study.

George *et al.*[4] have been studied 50 patients of CAD, with an age range of 25 and 75 of both sex groups. The overall mean age was 55.10 ± 9.44 years. This is also comparable to the present study groups.

Aziz *et al.*[5] have been observed in their study that the mean age of study subjects was 53.5 ± 10.0 years. In their study, the maximum number of cases was ≥50 years of age (72%); within the STEMI group, the incidence was highest in 51–60 years (36%). This is comparable to the present study.

The low sample size in the present study can vary the results of age distribution (in percentage) from the above-described study results. However, the mean age noted in cases and control subjects was nearly in the same range as described in the above studies.

In present study, out of total number of cases ($n = 60$); 35 (58%) were male and 25 (42%) were female patients. From total numbers of control subjects ($n' = 60$); 36 (60%) were male and 24 (40%) were female; the sex difference in both group subjects was found statistically non-significant ($P < 0.58$).

Chittora *et al.*[3] have been observed in their study that out of 107 enrolled patients, 76 (71%) were males and 31 (29%) were females.

Table 3: Comparison of mean QTc dispersion in patients who died during a hospital stay, with patients who survived

Group of patients	Number of cases (*n*=60)	Mean QTc Dispersion (ms)			
		Day-1 (on admission)	Day-2	Day-3	At discharge or (day-7)
Survivors	56	113±45.6	102±54.2	104±52.29	102±38
Deaths	4	180±84.46	137±48.5	112±38.6	--
Total	60	*P*<0.001	*P*<0.001	*P*<0.05	

n: Number of patients (cases), QTc: Corrected QT interval, ms: Milliseconds

Table 4: Comparison of mean QTc dispersion in cases with various cardiac complications

Cardiac complications	Total number of patients (*n*=60)	Mean QTc dispersion (ms)			
		Day-1 (on admission)	Day-2	Day-3	At discharge or (day-7)
Sinus tachycardia	4	117±41.13	117±49.92	110±52.28	92±65.51
VT	6	160±81.98	140±37.95	156. ±73.12	128±49.97
SVT	1	170	180	150	150
AF	1	160	170	150	140
Bradycardia	7	137±55.89	134±49.28	140±19.15	130±25.17
Torsade de pointes	0	0	0	0	0
New onset angina	4	122±48.46	115±65.57	90±51	132±28.72
Cardiogenic shock	6	160±49.80	143±44.57	146±8.16	96±40.33
CCF	2	130±00	135±21.21	140±14.14	100±56.57
LVF	4	162±22.17	150±46.90	140±28.28	137±32.02
Cardiac mortality (death)	4	180±84.46	137±48.56	112.±38.62	----
No cardiac complications	11	-	-	-	-

n: Number of patients (cases), QTc: Corrected QT interval, ms: Milliseconds. VT: Ventricular tachycardia, SVT: Supraventricular tachycardia, AF: Atrial fibrillation, CCF: Congestive cardiac failure, LVF: Left ventricular failure

George *et al.*[4] have included a total number of 50 patients with CAD in their study; from which 35 were male and 15 were female subjects with age range between 25 and 75 years.

In present study, maximum numbers of patients (cases) have anterior wall STEMI 33 (55%) followed by inferior wall STEMI 17 (28.3%), mixed wall STEMI 8 (13.3%), and posterior wall STEMI 2 (0.30%). None of the patients have lateral wall and right ventricular STEMI during the study period.

George *et al.*[4] have also been observed that most of the patients have anterior wall STEMI than inferior wall STEMI (58.0% vs. 42.0%), respectively. The results were comparable to the present study.

In the present study, it was observed that out of *n* = 60 cases of STEMI; the predominant risk factor was found as hypertension in 22 (37%) followed by diabetes mellitus 16 (27%), smoking/tobacco 5 (8.3%), alcohol intake 2 (3.3%), and dyslipidemia 2 (3.3%). About 13 (21%) of cases were found without any apparent or known risk factor.

Okin *et al.*[6] have been observed that out of 55 studied patients who suffer a cardiovascular death were similarly older; had higher systolic pressure, higher LDL cholesterol, more albuminuria, and greater prevalence of diabetes and smoking. This result was comparable to the present study.

In the present study, it was observed that QTcD was highest in patients (cases) with STEMI (118 ± 50.82 ms) as compared to control group subjects (45.33 ± 29.49 ms). The difference was statistically highly significant (*P* < 0.0001).

It should be noted that in cases group QTcD was found to be highest at the time of admission (118 ± 50.82 ms) and onward and this difference was maintained throughout the course of hospital stay of the patients. The difference observed was found statistically significant (*P* < 0.0001).

Chittora *et al.*[3] have been observed in their study that QTc dispersion was also high in patients with STEMI (158.44 ± 14.8 ms) as compared to control group subjects (65.130 ± 17.06 ms) the difference was found statistically highly significant (*P* < 0.0001).

Patients with MI may have an inhomogenous ventricular repolarization process. In the setting of anterior wall MI (AMI), the interplay between ischemic living tissue and relatively depolarized dying tissue would create a complex transition period affecting QT interval dispersion. In the early stage of AMI, an increase of QT dispersion would be primarily due to local shortening of action potential. However, within a few hours' prolongation of QT interval could become the dominant feature governing QTc dispersion.

In present study, it was observed that out of *n* = 60 patients (cases), 34 patients were undergone to thrombolytic therapy and 22 were not. The statistically significant difference was observed in QTc dispersion in the thrombolysed and non-thrombolysed patients on day-1 (on admission) (103.53 ± 36.0 ms vs. 73.02 ± 59.07 ms, *P* < 0.01), on day-2 (87.06 ± 49.33 ms vs. 128.46 ± 52.21 ms, *P* < 0.003), day-3 (91.18 ± 43.82 ms vs. 123.46 ± 55.28 ms, *P* < 0.014), and at discharge (about day-7) (89.71 ± 38.02 ms vs. 125 ± 31.14 ms, *P* < 0.0003).

It was observed that the mean QTc dispersion in thrombolysed group was found to be higher than non-thrombolysed group on day-1 (on admission) (103.53 ± 36 ms) thereafter it was

decreasing in trend during the course of disease on day-2 (87.06 ± 49.33 ms) and increased further on day-3 (91.18 ± 43.82 ms). The difference observed was found statistically nonsignificant ($P < 0.014$).

The mean QTc dispersion in non-thrombolysed group showed a lower value on day-1 (on admission) (73.02 ± 59.07 ms) thereafter, it was progressively increased on day-2 (128.46 ± 52.21 ms) onward. The difference observed was found statistically significant ($P < 0.003$).

Chittora *et al.*[3] have also been observed that patients of STEMI who underwent thrombolysis, and those who were nonthrombolysed; the mean QTc dispersion on day-1 in both groups was observed nearly the same. However, on the day-1 after thrombolytic therapy there was a significant fall in mean QTc dispersion. This difference was also seen in mean QTc dispersion on the day-7.

George *et al.*[4] showed that there was non-significant reduction in QTc dispersion before and after received of thrombolytic therapy, although there was a significant reduction in QT and QTc dispersion in both groups (those treated with thrombolytic therapy and those were treated with primary PCI). They also have noticed that QTc dispersion was shorter in the primary PCI group than in the thrombolytic group patients.

In essence, the determinants of increased QT dispersion during acute MI (AMI) were speed of reperfusion, patency of the infarct-related artery (IRA), and location of AMI. Quick restoration of blood in the IRA post-MI decreases QT dispersion. The study also has shown that post-infarction patients with open arteries have a lower mortality rate than patients with closed arteries. Mortality rates as low as 2.5% have been reported in patients with patent arteries compared with 15% in patients with closed arteries.

Heris *et al.*[7] observed that thrombolytic therapy had no significant effects on QT dispersion. Thus, thrombolytic therapy does not increase the risk of arrhythmia.

In present study, it was observed that comparison of mean QTc dispersion in patients without cardiac complications ($n = 11$) compared to patients with cardiac complications ($n = 49$); after an acute STEMI event. The mean QTc dispersion remained consistently high in group of patients with cardiac complications in comparison to patients without cardiac complications, i.e., on day-1 (on admission) (135 ± 58.3 vs. 105 ± 40.4 ms, $P < 0.02$), on day-2 (128 ± 45.3 vs. 87 ± 54 ms, $P < 0.002$), and day-3 (132 ± 49.3 vs. 84 ± 52.8 ms, $P < 0.0002$), and at day of discharge (day-7) (115 ± 95.53 vs. 97.53 ms). *P* values have been found statistically highly significant on day-2 and day-3.

Chittora *et al.*[3] have also been observed in their study that, out of 107 studied patients of STEMI; 52 patients were developed cardiac complications. However, in patients with various cardiac complications QTc dispersion were found significantly higher as compared to patients without any cardiac complications; on day-0, day-1, day-2, day-3, and day-7.

In the present study, QTc dispersion was observed in patients who died ($n = 4$) compared to patients who survived ($n = 56$) after acute coronary cardiac events like STEMI. The mean QTc dispersion was observed (180 ± 84.46 ms, 137 ± 48.5 ms, and 112 ± 38.6 ms) on day-1 (on admission), day-2, and day-3, respectively, in patients who died, which was higher than mean QTc dispersion on the similar days among survivors (113 ± 45.6 ms, 102 ± 54.2 ms, 104 ± 52.29 ms, and 102 ± 38 ms), respectively. The difference was found statistically significance on day-1 ($P < 0.001$).

Aziz *et al.*[5] have been observed in their study that patients who died had a higher QTc interval in comparison to patients who survived after coronary cardiac events.

Study done by Chittora *et al.*[3] have been observed in their study that out of 107 studied patients of STEMI; 5 patients were died due to cardiac complications, in which QTc dispersion was observed significantly higher compared to patients who survived.

Lin *et al.*[8] have been observed that QTc–ER >445 ms independently predicts clinical events in STEMI, providing incremental progression value to an established clinical strong predictor of mortality and heart failure in patients with STEMI.

de Bruyne *et al.*[9] concluded that QTc dispersion is an important predictor of cardiac mortality in older man and women and QT dispersion in 8 leads 0.60 ms was the strongest predictors for cardiac mortality, followed by a history of MI (hazard ratio, 2.0; 95% confidence interval, 1.5–2.5).

In the present study, it was observed that 49 patients among all studied cases of STEMI ($n = 60$) were affected with various cardiac complications during the course of their hospital stay, irrespective of the thrombolysed therapy. The study showed that overall prolong QTc dispersion was associated with increased cardiac complications and mortality.

Chittora *et al.*[3] were observed that mean QTc dispersion following ACS was maximum at admission and then gradually falls till day-7 as the patients clinical condition improves but it remains high in case of development of various complications (namely, hypotension, congestive heart failure, paroxysmal supraventricular tachycardia,

ventricular premature complex, complete heart block, ventricular fibrillation, and death).

George *et al.*[4] have observed that QTc dispersion is significantly greater in patients with MI; who had malignant ventricular arrhythmias than in those without arrhythmia.

Aziz *et al.*[5] have been observed that QTc dispersion is significantly greater in patients with MI; who had arrhythmias than in those without arrhythmia.

Finally, it was observed that the present study results and above-mentioned reference studies data were all suggesting that the QTcD increases in post-MI period and may relate to main arrhythmias and other cardiac complications, and it decreases by measures that relieve coronary ischemia-like thrombolytic therapy which further decreases arrhythmia incidence.

CONCLUSION

After analyzing the data and results finally, we are concluded that in the present study-

1. Overall mean QTcD on was increased in patients with acute ST-elevated MI (118 ± 50.82 ms) compared to age- and sex-matched apparently healthy control subjects (45.33 ± 29.49 ms); this value was found statistically highly significant ($P \leq 0.0001$).
2. The maximum number of patients (cases) belongs to anterior wall STEMI, i.e., 33 (55%).
3. Initially increased mean QTcD value after an acute event of STEMI has started to decrease after 48 h; however, it did not return to normal even on discharge.
4. The QTcD was increased in patients who were thrombolysed (103.53 ± 36 ms) in comparison to non-thrombolysed patients. In thrombolysed group of patients, the mean QTcD showed a progressive decline from the day of admission up to the day of discharge.
5. The mean QTcD remained consistently high in a group of patients with cardiac complications in comparison to patients without cardiac complications on day-1 (on admission) up to the day of discharge. Mean QTcD was significantly increased on day-1 and on day-2.
6. The mean QTcD was highest in patients who were died ($n = 4$) (180 ± 84.46 ms); compared to who were survived ($n = 56$) (113 ± 45.6 ms) on day-1 (on admission).

Finally, it could be concluded that changes in the QTcD are dynamic and may reflect the frequent changing pattern of ventricular excitability. Thus, QTcD measurement may provide a potentially simple, cheap, and non-invasive method of identification of patients of acute MI (STEMI) at risk of development of ventricular arrhythmias and also relates to the prognosis in AMI patients and the future may prove to be an independent predictor of death.

Limitation of the Study

The statistical insignificance if any in the above study was probably attributable to small cohort under study and short duration of follow-up. This was a single center study within our limited resources.

Ethical Issues

The present study work had been done in the Department of Medicine at Netaji Subhash Chandra Bose Medical College and Hospital, Jabalpur, Madhya Pradesh, India. The study work has been approved by the Institutional Ethics Committee.

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