Original Article

Correlation of corrected QT dispersion with the severity of coronary artery disease in patients with acute myocardial infarction

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Abstract

Objectives The aim of the present study is to discover the relationship between QT dispersion and severity of CAD as detected by SYNTAX score in stable patients who suffered acute MI. **Methods** The present study includes 50 patients admitted to Al-Azhar Assuit university hospital and Sohag cardiac center by acute MI. **Results** The patient age group ranged from 49 -70 years with a mean ± SD (58.8 ± 10.1).. 60% were males and 40% were females.. There was no significant difference found between the two studied groups regarding male gender (p-value 0.564). There was no significant difference between the two groups regarding hypertension (p-value 0.774), smoking (p-value 0.569) and dyslipidemia (p-value 0.508). There is no significant difference between the two study groups regarding the troponin (p-value 0.610) and LDL (p-value 0.557).There was no significant difference between the two groups regarding the echocardiographic data (EF p-value 0.243) (RWMA p-value 0.529) . There was highly significant difference between the two group studies regarding the localization of the vessels lesion (p-value <0.001). There was highly significant difference between the two study groups regarding the mean of SYNTAX score (p-value<0.001). **Conclusion** The study found that patient with prolonged QTc dispersion ≥60 milliseconds had more severe involvement of the coronary arteries by atherosclerosis compared to patient with QT c dispersion < 60 milliseconds.

Keywords: QTc dispersion, Acute MI, SYNTAX score.

Introduction

Coronary artery disease (CAD) is a major cause of mortality and this health problem is reaching pandemic in both developed, and developing countries **(1)**.

Now it accounts for almost 1.8 million annual deaths or 20% of all deaths in Europe **(2).**
An increase in QT dispersion is reported to predict the occurrence of life- threatening ventricular tachyarrhythmia and sudden cardiac death in patients with ischemic heart disease (IHD) **(3)**.
Determination of the QT dispersion by means of a standard ECG at rest has been widely used for cardiovascular risk assessment during the last 15 years as one of the recent explanations for the development of life-threatening ventricular arrhythmias. It is based on the prolongation and dispersion of repolarization between neighboring regions of myocardium **(3)**.

QTc dispersion may be of use as a simple, accurate and inexpensive complementary tool for risk stratification in patients with acute MI (**4).**

Various angiographic scoring systems were developed to assess the severity the coronary artery lesion. Recently SYNTAX has been introduced. The SYNTAX score has been designed to better anticipate the risks of percutaneous or surgical revascularization, taking into account the functional impact of the coronary circulation with all its anatomic components including the presence of bifurcations, total occlusions, thrombus, calcification, and small vessels **(5).**

It had been also shown that QT dispersion is significantly increased during spontaneous angina in patients with documented CAD and history of previous MI. QT dispersion was significantly higher during the angina episode compared to the painless conditions **(6)**.
CAD is a major cause of death and a major health problem which requires follow up and proper management to prevent complications such as myocardial infarctions, heart failure and arrhythmia **(7).**

Aim of the Study

The aim of the present study is to discover the relationship between QT dispersion and severity of CAD as detected by SYNTAX score in stable patients who suffered acute MI.

Patient and Methods

Patient selection

The present study includes 50 patients admitted to Al-Azhar Assuit university hospital and Sohag cardiac center by acute MI.

Exclusion criteria

1. Diabetes mellitus
2. Patients with paced rhythm
3. Congenital heart disease
4. Valvular heart disease
5. Atrial fibrillation, bundle branch blocks
6. Intraventricular conduction delays, AV block, sinus node dysfunction,
7. Wolff–Parkinson–White Syndrome
8. Patients taking medications that could affect QT interval such as amiodarone and digitalis
9. Electrolyte imbalance
10. Post CABG status
11. Post PCI status
12. cerebrovascular disease, end stage liver and renal disease

Methods

Each patient was subjected to:

1. **Informed written consent.**
2. **Full history taking** including Name, Age, sex, family history, smoking, addiction, hypertension, diabetes mellitus, and dyslipidemia.
3. **Full clinical examination**.
4. **Laboratory investigations** including (cardiac biomarkers, lipogram, random blood sugar, serum electrolytes: sodium, potassium and calcium, renal functions (serum urea and creatinine).
5. **Twelve leads ECG** The analyzed ECG was conducted within the first week after the acute myocardial infarction. Firstly, heart rate was calculated from the ECG strip. Using magnifying lens, QT dispersion was calculated for all patients as the difference between the longest (QT max.) and the shortest QT (QT min.) interval recorded by standard 12 lead ECG. The QT interval was corrected by using Bazett's formula (QTc =QT/square root of R-R interval in seconds). Corrected QT dispersion was defined as the difference between the maximum and minimum QTc for a given heart rate. Resting 12 lead ECG will be done by Mindray Model Beneheart R3 at a paper speed of 25mm/s and amplification of 10mm/mV.
6. **Trans-thoracic echocardiography** Transthoracic echocardiography performed with GE Vived S5 Echocardiogram using3.5MHz transducer. Echocardiography is now deemed an important and resourceful imaging technique for the management of patients with CAD. Assessment of left ventricular systolic function, diastolic function and wall motion abnormalities.
   Three echo methods are in common clinical usage:
   - Two-dimensional (2-D) or 'cross-sectional'
   - Motion or M-mode
   - Doppler – continuous wave, pulsed wave and color flow.
7. **Coronary angiography** Diagnostic coronary artery catheterizations were done by using Siemens Artis zee 20×20.

Pre cath. assessment
Full history, physical examination and pre Cath. lab including (Creatinine, PT, PC, INR and Serology).

Patient preparation
Coronary angiography will be performed under local anesthesia. The procedure is sterile, and all potential access sites must be disinfected, shaved, and sterilized. At the beginning of the procedure, the patient lays down in supine position on the cardio angiograph table, and is prepared for the procedure in sterile conditions

Pre medication
Anti-allergic, Heparin and lidocaine for local anesthesia

Contrast
Maximum amount= 5(body weight)/s.creatinine.

Approaches
Percutaneous techniques usually from femoral and radial artery were used.
All patients underwent conventional invasive coronary angiography using standard techniques within six months after MI. Images were acquired in optimal projection angles, at 25 frames per second. From the baseline diagnostic angiogram, each coronary lesion producing ≥ 50% diameter stenosis in vessels ≥ 1.5 mm will be scored separately and will be added together to provide the overall SYNTAX score, which will be calculated using the SYNATX score algorithm.
All angiographic variables related to SYNTAX score calculation were computed by two experienced cardiologists who will blind to the current study on angiograms. In case of disagreement, opinion was obtained from the third cardiologist, and the final decision was made by consensus.

Results

The present study includes 50 patients admitted to Al-Azhar Assuit university hospital and Sohag cardiac center by acute MI Between March 2018 till March 2019.

Demographic data and risk factors
1. **Age** ranged from 49 -70 years with a mean ± SD (58.8 ± 10.1).
2. **Gender** 60% were males and 40% were females.

Table (1) Demographic data of the study group

Demographic data	All patients
Count (%)	50 (100%)
Age (years)	
Mean ± SD	58.8 ± 10.1
Male gender	30 (60%)
Female gender	20 (40%)

Risk factors
1. **Systemic Hypertension** 21 hypertensive patients (42%)
2. **Smoking** 28 smoker patients (56%)
3. **Dyslipidemia** 12 patients had history of dyslipidemia (24%)

Table (2) Risk factors of the study group

Risk factors	All patients 50 (100%)
HTN	21 (42%)
Smoking	28 (56%)
Dyslipidemia	12 (24%)

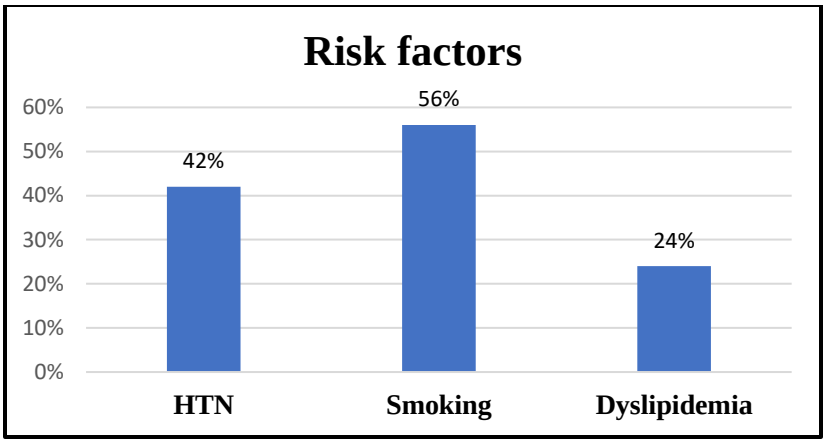

Figure (1) Percentage of positive risk factors among the studied patients.

Clinical diagnosis and ECG data

The clinical diagnosis of the study population in CCU was acute MI, 21 patients presented by NSTEMI (42%) and 29 patients presented by STEMI (58 %).

Table (3) Clinical diagnosis of the study group

Clinical diagnosis of Acute MI	All patients 50 (100%)
NSTEMI	21 (42%)
STEMI	29 (58%)

ECG location of STEMI 29 patients of STEMI (58%), 19 patients presented by anterior STEMI (38%), 10 Patients presented by inferior STEMI (20%).

Table (4) ECG location of STEMI

ECG data	All patients All patients 50 (100%)
ECG location of STEMI	29(58%)
Anterior	19 (38%)
Inferior	10 (20%)

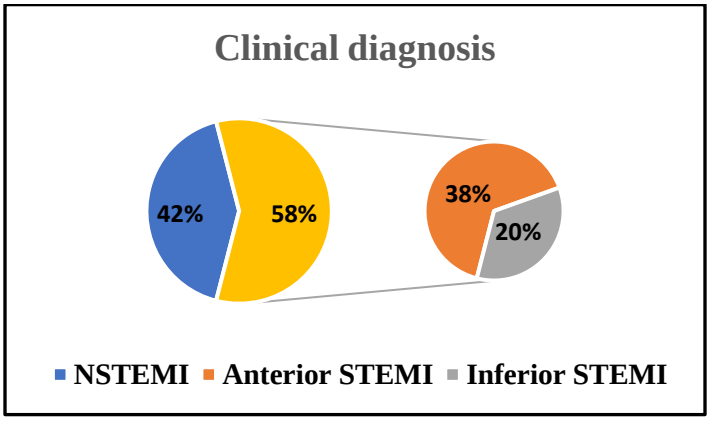

Figure (2) Percentage of clinical diagnosis of Acute MI and percentage of STEMI among the studied patients.

QTc dispersion is the difference between the longest (QTc max.) and the shortest QTc (QTc min.) interval recorded by standard 12 lead ECG. QTc dispersion ranged from 47.9 -89.9 ms with a mean ± SD (68.9 ± 21.0).

Based on QTc dispersion value the patients have been divided into two groups

Group I QTc dispersion <60 milliseconds (ms) (22 patients)
Group II QTc dispersion ≥60 milliseconds (ms) (28 patients)

Table (5) QT dispersion of the study group

ECG data	All patients All patients 50 (100%)
QTc dispersion (ms)	
Mean ± SD	68.9 ± 21.0

Laboratory data
The mean troponin level was 20.2 ± 14.2 and the mean LDL level was 105.7 ± 23.5 among all the study population.

Table (6) Troponin and LDL levels among the group study

Laboratory data	All patients
	50 (100%)
Troponin (ng/dL)	
Mean ± SD	20.2 ± 14.2
LDL (mg/dL)	
Mean ± SD	105.7 ± 23.5

Echocardiographic data
Assessment of left ventricular systolic function by Ejection Fraction (EF %) ranged from 48.7-61.5% with a mean ± SD (55.1 ± 6.4) and regional wall motion abnormalities (RWMA) 36 patients had RWMA (72%).

Table (7) Echocardiographic data of the study group

Echocardiographic data	All patients
Count (%)	50 (100%)
EF (%)	
Mean ± SD	55.1 ± 6.4
RWMA (%)	
	36 (72%)

Coronary angiographic data
50 patients of acute MI had a significant lesion of coronary vessels**,** 18 patients had a Single vessel disease lesion (36%), 20 patients had two vessels disease lesion (40%), and 12 patients had multivessels disease (24%). The Coronary arteries affected included LM (12%), LAD (48%), LCX (32%), RCA (54%) and ramus (4%)**.**

Table (8) Coronary angiographic data regarding number of the diseased vessels

CA data(CAD type)	All patients 50 (100%)
Single-vessel disease	18 (36%)
Two-vessels disease	20 (40%)
Multi-vessels disease	12 (24%)

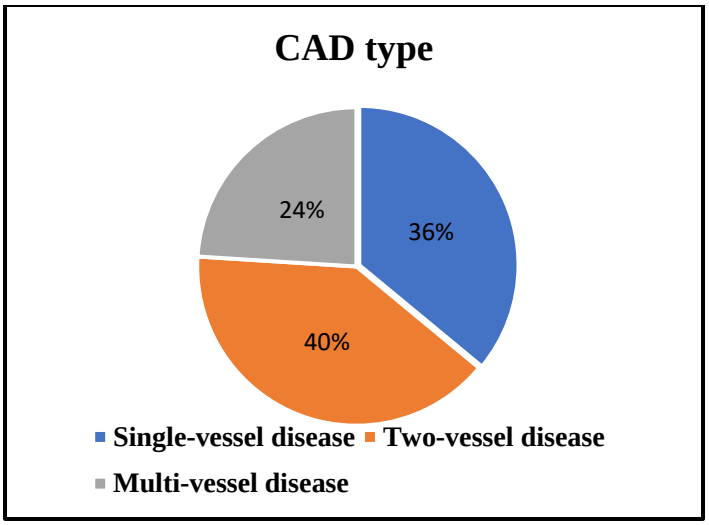

Figure (3) Percentage of coronary angiographic result among the studied patients.

SYNTAX score ranged from 5.4 - 36.8 with a mean ± SD (18.1 ± 8.7).

Table (9) The SYNTAX score of the study group

SYNTAX score	All patients 50 (100%)
Mean ± SD	18.1 ± 8.7

Comparative studies

Comparisons between Patients with QTc dispersion <60 ms (group I) versus those with QTc dispersion ≥60 ms (group II) regarding different variables in the study.

Regarding demographic data and risk factors

1. Age

Group I age ranged from 45.4 to 65.4 years with a mean 55.4 ± 10. 4.

Group II age ranged from 53 .4 to 70. 8 years with a mean 62.1 ± 8.7.

There was significant difference between the two studied groups regarding age (p-value 0.017).

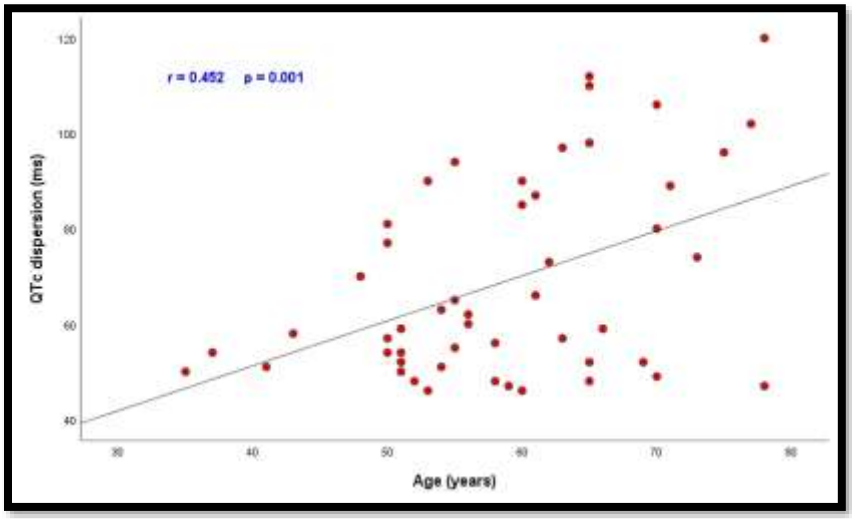

Figure (4) Correlations between QTc dispersion and age.

2. Male gender

Group I: includes 16 males (73 %).

Group II: includes 14 males (50 %).

There was no significant difference found between the two studied groups regarding male gender (p-value 0.564).

3. Hypertension, smoking and dyslipidemia:

Group I: There were 11 hypertensive patients (50%), 15 smoker (68%) and 7 dyslipidemic patients (32%).

Group II: There were 10 hypertensive patients (36%), 13 smoker (46%) and 5 dyslipidemic patients (18%).

There was no significant difference between the two groups regarding hypertension (p-value 0.774), smoking (p-value 0.569) and dyslipidemia (p-value 0.508).

Table (10) Comparison between the two studied groups regarding the demographic data

Demographic data	**QTc dispersion < 60 ms**	**QTc dispersion ≥ 60 ms**	P-value (Sig.)
Count	22	28	
Age (years)			
Mean ± SD	55.4 ± 10.4	62.1 ± 8.7	0.017 (S)
Risk factors			
Male gender	16 (73%)	14 (50%)	0.564 (NS)
HTN	11 (50%)	10 (36%)	0.774 (NS)
Smoking	15 (68%)	13 (46%)	0.569 (NS)
Dyslipidemia	7 (32%)	5 (18%)	0.508 (NS)

P< 0.05 is significant. Sig.: significance. SD: standard deviation.

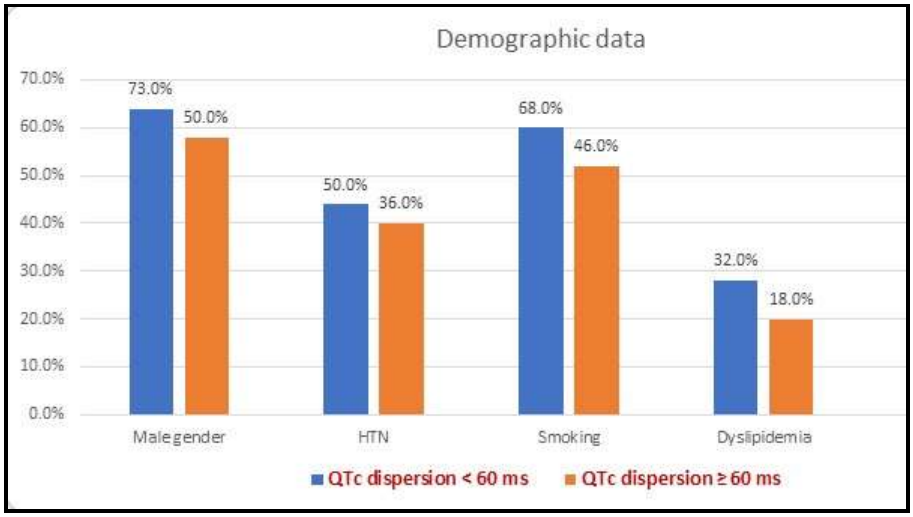

Figure (5) Comparison between the two studied groups regarding the demographic data and risk factors.

Regarding the laboratory data

Group I the mean troponin level was 21.2±13.2 while the mean LDL level was 103.8±20.8.

Group II: the mean troponin level was 19.2 ± 15.3 while the mean LDL level was 107.7 ± 26.3.

There is no significant difference between the two study groups regarding the troponin (p-value 0.610) and LDL (p-value 0.557).

Table (11) Comparison between the two study groups regarding the laboratory data

Laboratory data	QTc dispersion < 60 ms	QTc dispersion ≥ 60 ms	P-value (Sig.)
Count	22	28	
Troponin (ng/dL)			
Mean ± SD	21.2 ± 13.2	19.2 ± 15.3	0.610 (NS)
LDL (mg/dL)			
Mean ± SD	103.8 ± 20.8	107.7 ± 26.3	0.557 (NS)

P< 0.05 is significant. Sig.: significance.

Regarding the echocardiographic data

Group I: the mean ejection fraction was 54.0 ± 5.4 and 19 patients had RWMA (86%).

Group II: the mean ejection fraction was 56.1 ± 7.2 and 17 patients (61%) had RWMA.

There was no significant difference between the two groups regarding the echocardiographic data (EF, p-value=0.243) (RWMA, p-value= 0.529).

Table (12) Comparison between the two studied groups regarding the Echocardiographic data

Echocardiographic data	QTc dispersion < 60 ms	QTc dispersion ≥ 60 ms	P-value (Sig.)
Count	22	28	
EF (%)			
Mean ± SD	54.0 ± 5.4	56.1 ± 7.2	0.243 (NS)
RWMA (%)			
	19 (86%)	17 (61%)	0.529 (NS)

P< 0.05 is significant. Sig.: significance.

Regarding the CA data

Localization of vessels lesion

Group I there was 13 patients with single-vessel affection (59%), 12 patients with two-vessels affection (45%) and no patient was had a multi-vessels affection.

Group II there was 5 patients with single-vessel affection (28%), 8 patients with two-vessel affection (29%) and 12 patients with multi-vessels affection (43%).

There was highly significant difference between the two group studies regarding the localization of the vessels lesion (p-value <0.001).

Table (13) Comparison between the studied groups regarding the localization of the vessels lesions

CA data	QTc dispersion < 60 ms	QTc dispersion ≥ 60 ms	P-value (Sig.)
Count	22	28	
CAD type			
Single-vessel disease	13 (59%)	5 (28%)	<0.001 (HS)
Two-vessel disease	12 (45%)	8 (29%)	
Multi-vessel disease	0 (0%)	12 (43%)	

P< 0.05 is significant. Sig.: significance.

SYNTAX score

Group I: the mean SYNTAX score was 12.5 ± 5.1.

Group II: the mean SYNTAX score was 23.7 ± 8.1.

There was highly significant difference between the two study groups regarding the mean of SYNTAX score (p-value<0.001).

Table (14) Comparison between two study groups regarding the mean of the SYNTAX score

CA data	QTc dispersion < 60 ms	QTc dispersion ≥ 60 ms	P-value (Sig.)
Count	22	28	
SYNTAX score			
Mean ± SD	12.5 ± 5.1	23.7 ± 8.1	<0.001 (HS)

P< 0.05 is significant. Sig.: significance.

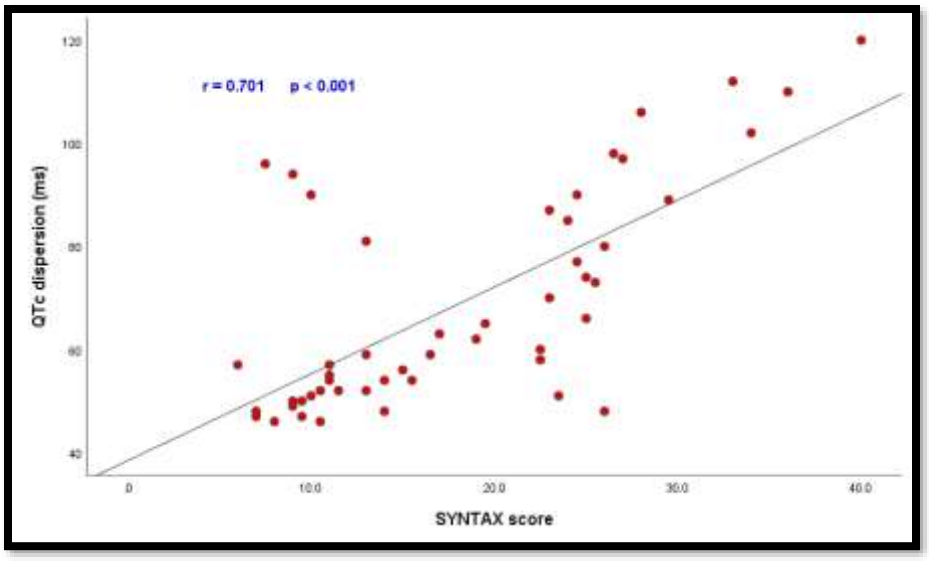

Figure (6) correlation between QTc dispersi

Discussion

CAD is a major cause of death and a major health problem which requires follow up and proper management to prevent complications such as myocardial infarctions, heart failure and arrhythmia **(7).**

Dispersion of the QT interval (QTd) is defined as the difference between the longest and the shortest QT interval in all electrocardiographic leads, which may be possibly measured. That parameter electrocardiographically translates the asynchrony of repolarization of ventricular rows. **(8).**

The main finding of our study was that there is strong positive correlation between QTc dispersion and angiographic severity of CAD detected by syntax score.

And also there is another finding in our study that there is a strong positive correlation between the number of the diseased vessels or the localization of the lesion and the QTc dispersion.

The present study was concordant with Sharafat et al., who studied **Prolonged QTc Dispersion Correlates with coronary artery diseases in Acute ST Elevated Myocardial Infraction (STEMI);** they found a strong positive correlation with the QTc dispersion and increasing number of vessels involvement. They used Friesinger score and Leaman score to assess coronary angiographic severity and there was a strong positive correlation between the QT dispersion and both of Friesinger and Leaman coronary angiographic severity scores. **(4).**

The present study was also concordant with Kee-Joon Choi M.D.,et al Who studied **Change of QT Dispersion after PTCA in Angina Patients**, in which they investigated the short-term effect of percutaneous transluminal coronary angioplasty (PTCA) on QTd in patients with coronary artery diseases (CAD) and no history of previous myocardial ischemia.

They found that QTd decreases in CAD patients with no history of myocardial infraction at 1 month following successful PTCA. This suggests that PTCA facilitates a favourable recovery from inhomogeneous repolarization due to myocardial ischemia. **(9).**

Our study was discordant with Hakan Tikiz, et al, who studied **QT Dispersion in Single Coronary Artery Diseases: Is There a Relation between QT Dispersion and Diseased Coronary Artery or Lesion Localization? .**They observed that patients with single-vessel disease had wider baseline, which further increased significantly with exercise. This finding supports the idea that severity of localized ischemia rather than extent of coronary artery disease would be expected to have a greater effect on inducible QT dispersion. **(10).**

The present study was also concordant with Ulrich Stierle, et al, who studied **Relation between QT dispersion and the extent of Myocardial Ischemia in Patients with three-vessel Coronary Artery diseases,** the patients with coronary artery disease, QT dispersion increased from a baseline value of 39 $\pm$ 7 ms to a peak ischemic stress value of 63 $\pm$ 7 ms Patients with normal coronary arteries showed almost unchanged values of QT dispersion (41 $\pm$ 9 vs. 42 + 7 ms).**(11).**

The present study agreed with another study had done by Yýlmaz, et al, **the association of QT dispersion and QT dispersion ratio with extent and severity of coronary artery diseases.** They found there is association of QT dispersion with extent and severity of coronary artery diseases , In their study the more extent and severe CAD was related to higher QT dispersion.(**12).**

The present study also agreed with Yunus , et al, who studied **The effect of coronary angioplasty on precordial QT dispersion**, they found that QT interval dispersion decreases after successful coronary artery revascularization and increases with restenosis. Therefore, QT interval dispersion may be a marker of recurrent ischemia due to restenosis after PTCA. (**13).**

The present study was concordant with Ouafa Hamza , et al, who studied **QT Dispersion correlation to ST segment Resolution in STEMI patients**, they investigate the effect of revascularization on corrected QT interval (QTc) and QTd in acute STEMI patients and found that in addition to a successful opening of the culprit artery , myocardial reperfusion must be achieved to improve electrical stability and reduce repolarization heterogeneity, recovery of myocardial electrical homogeneity is not immediate and begins 24 hours after revascularization as assessed by QTc and QTd. **(14)**.

The present study also agree with Polychronis Â., et al, who study **effects of Ischemia on QT dispersion during spontaneous anginal episodes**, they found that QT dispersion is significantly increased during spontaneous angina in patients with documented CAD and history of previous myocardial infraction, QT dispersion was significantly higher during the anginal episode compared to the painless conditions. **(6).**

The present study was concordant with Helmy , et al, who studied **Correlation of corrected QT dispersion with the severity of coronary artery disease detected by SYNTAX score in non-diabetic patients with STEMI;** they found that there is a significant positive correlation between corrected QT dispersion and severity of coronary artery disease as assessed by SYNTAX score**. (15).**

Also our study was agreed with Bonakdar H, et al, who made a **Comparison between QT Interval Parameters in Type 2 Diabetic and Nondiabetic Patients with Non-ST Elevation Myocardial Infarction**, they found that type 2 diabetics with NSTEMI have greater QTc max, QTd, and QTc d and these QT parameters may have a relationship with worse cardiac outcomes and poorer prognoses. (**16).**

Conclusion

The study found that patient with prolonged QTc dispersion $\geq$60 milliseconds had more severe involvement of the coronary arteries by atherosclerosis compared to patient with QTc dispersion < 60 milliseconds.

Study Limitations

1. The study group involved a small number of patients.
2. We manually calculated QT d instead computer – assisted QT d calculations.
3. Angiography was evaluated by visual estimation , so there was chance of inter-observers variation of interpretation of the severity of the CAD.

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