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Evaluation of the Relationship between QT Interval in ECG and GRACE Score Amount of Hospitalized Patients with NSTEMI

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Abstract

Background: Non-ST-elevation myocardial infarction (NSTEMI) is a significant component of acute coronary syndrome (ACS) and typically exhibits a relative incidence that is more than double that of ST-segment elevation myocardial infarction (STEMI). Data obtained from the International Long QT Syndrome Registry indicate that the risk of developing malignant arrhythmias in individuals with long QT syndrome is exponentially associated with the duration of the QTc interval. Therefore, the aim of this study was to assess the potential inclusion of prolonged QTc as a prognostic risk factor in NSTEMI patients.

Methods: A cross-sectional study was conducted on patients with NSTEMI diagnosis admitted to the Bu-Ali Hospital of Qazvin between April 2021 and September 2021 by census method. The QT interval was measured in the electrocardiogram at admission. The documented grace score was calculated and its relationship with the corrected QTc interval was estimated using the Hodges formula. Finally, the relationship between QTc and GRACE score was investigated as a prognostic factor in ACS patients. Relationships were assessed by using both the T-test and the chi-square test.

Results: A total of 60 patients (31.7% females, 63.8% males) with a mean age of 63 ± 12.7 years were evaluated. Most of the patients (68.3%) were at low risk regarding the Grace score category. In evaluating the relationship between QTc in the electrocardiogram at admission with total GRACE score, the Pearson correlation results were significant and there was a positive relationship between these two factors ($r = 0.497$, $P < 0.001$).

Conclusion: This study revealed a significant relationship between the QTc interval of patients and the GRACE Score. It was shown patients' QTc can be a predictive factor of patients' mortality.

Keywords: NSTEMI, GRACE, Electrocardiogram, ECG

Conflicts of Interest: *None declared*
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Introduction

Cardiovascular diseases (CVDs) remain a major cause of disability, hospitalization, and mortality and have economic consequences (1).

During the last 30 years, the prevalence rate of acute coronary syndrome (ACS) in China has been increasing significantly (2, 3). A non-ST-elevation myocardial infarction (NSTEMI) is a common manifestation of acute coronary syndrome (ACS) and is observed at a relative incidence more than twice that of ST-segment elevation myocardial

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↑What is "already known" in this topic:
GRACE score is known as a simple model for easy use in the clinical environment to determine the mortality risk of patients, and the evidence shows that it performs better than other ACS mortality risk assessment models. This model can be investigated in both NSTEMI and STEMI patient groups.

→What this article adds:
The heart-rate corrected QT interval (QTc), which represents the time required for all ventricular depolarization and repolarization, is recommended as a mortality predictive factor of patients with NSTEMI because it is easy, safe, widely available, and low cost.

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infarction (STEMI) (4, 5).

The exact causes of NSTEMI are not fully understood; however, several factors can influence its development. These factors include tobacco smoking, physical inactivity, high blood pressure, high cholesterol, diabetes, obesity, and a family history of cardiovascular disease.

The clinical symptoms of NSTEMI patients are highly heterogeneous, ranging from minimal complications to premature death, and the incidence of severe complications varies significantly according to their initial risk class (6).

Because risk assessment is crucial in guiding treatment decisions, guidelines recommend that high-risk patients receive more aggressive treatment following risk stratification upon admission. in high-risk patients following risk stratification at admission (7, 8). Therefore, rapid and accurate risk stratification is essential for early identification of high-risk patients.

The Global Registry of Acute Coronary Events (GRACE) risk score tool was specifically designed to provide an estimate of 6-month mortality among patients admitted for ACS. It is important to accurately predict risk in ACS to ensure appropriate and optimal interventions. The GRACE score is known as a simple model for easy use in the clinical environment to determine the mortality risk of patients, and evidence shows that it performs better than other ACS mortality risk assessment models (9, 10). In addition, the validity of the GRACE score has already been tested in the populations of several countries, and the use of the GRACE score has been suggested by clinical application guidelines (11).

In addition, the electrocardiogram is an attractive tool for risk assessment in patients with ACS due to its easy and safe application, wide availability, and low cost (12). In particular, the Heart rate–corrected QT interval (QTc), which represents the time required for all ventricular depolarization and repolarization, has been shown to be an independent predictor of arrhythmic death after acute myocardial infarction (MI) when prolonged to certain degrees (13).

Data from the International Long QT Syndrome Registry demonstrate that the risk of developing malignant arrhythmias in patients with long QT syndrome is exponentially related to the duration of the QTc interval (14).

Therefore, the aim of this study was to evaluate whether prolonged QTc can be included as a risk factor in the prognosis of NSTEMI patients and thereby improve the long-term management and treatment of NSTEMI patients.

Methods

A cross-sectional study was conducted on patients with NSTEMI diagnosis admitted to the Bu-Ali Hospital of Qazvin, Iran, between March 2021 and August 2022 by census method. This research was designed with the approval of the Research Ethics Committee of Qazvin University of Medical Sciences, Iran with the number IR.QUMS.REC.1399.485. All patients who were referred to the hospital with angina pectoralis and increased cardiac troponin with impression NSTEMI during this period are included in the present study. NSTEMI patients taking drugs that prolong the QT interval, those with electrolyte disturbances leading to QT prolongation and severe heart failure Ejection Fraction (EF) below 20%, and those who had Left bundle branch block (LBBB) or Right bundle branch block (RBBB) in ECG were excluded from the study.

This project adhered to all principles of the protocols and guidelines recommended by the Helsinki Convention regarding ethics in research: all participants gave informed consent. After obtaining the consent form, the patients were included in the study. As the frequency of ischemia in the group of patients is 0.65, the sample number of 60 people was calculated for this research.

At the beginning of admission, ECG data were collected by two physicians who were blinded to the patient's clinical statuses. Patient data including age, gender, smoking, Hypertension (HTN), Diabetes Mellitus (DM), Dyslipidemia (DLP), family history of CVD, GRACE score, Troponin, EF in ECG before discharge, QTc were collected during hospitalization.

The QT interval on ECG was measured as the time elapsed from the beginning of the QRS wave to the point where the T wave returned to its baseline on ECG. In fact, QT was measured in lead 2 or v5. The QT interval is calculated and then corrected by the following formula and considered as QT corrected:

"Hodges formula: QTC = QT + 1.75 (heart rate –)60"

GRACE score is known as a simple model for easy use in the clinical environment to determine the mortality risk of patients. In fact, the GRACE score system has 8 evaluation parameters, which are: age, heart rate (HR), systolic blood pressure, kilip class, serum creatinine level, history of cardiac arrest, ST deviation in ECG, and increased cardiac biomarkers (15). Then we divided the patients according to the calculated score into 3 groups including: low-risk patients if the GRACE score was 1-108 and moderate risk with a GRACE score of 109-140 and high risk with a GRACE score of more than 140.

Finally, the relationship between QTc and GRACE score was investigated as a prognostic factor in ACS patients.

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 18.0 (IBM Corp., Armonk, NY, USA). Descriptive data are reported by the frequency with percent and mean with standard deviation. The Shapiro-Wilk and Levene tests were used to assess the variables for normality and variance homogeneity preconditions. Student's t-test was used to compare the two groups' means, and the Mann-Whitney U test was used if the preconditions were not met. The chi-square test was used for categorical data. A significance level of less than 0.05 was considered.

Results

A total of 60 patients (31.7% females, 63.8% males) with a mean age of 63 ± 12.7 years were evaluated. About 50% of patients had hypertension, 18.3% DM, 23.3% DLP and 21.7% had a family history of CVD. Most of the patients (68.3%) were at low risk regarding the Grace score category. Patients' characteristics are reported in Table 1.

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Table 1. Patients' characteristics

Variable	Level	N (%)
Gender	Male	41 (63.8)
	Female	19 (31.7)
Smoking	Yes	25 (41.7)
	No	35 (58.3)
HTN	Yes	30 (50)
	No	30 (50)
DM	Yes	11 (18.3)
	No	49 (81.7)
DLP	Yes	13 (21.7)
	No	47 (78.3)
Family history of CVD	Yes	13 (21.7)
	No	47 (78.3)
GRACE score	1-108 (Low Risk)	41 (68.3)
	109-140 (Moderate Risk)	11 (18.3)
	141-372 (High Risk)	8 (13.3)
	Total	100.9 ± 29.23
Troponin	-	4.62 ± 8.18
EF in ECG before discharge	-	45.4 ± 11.3
QTc	-	409.7 ± 25.38

HTN: Hypertension; DM: Diabetes Mellitus; DLP: Dyslipidemia; CVD: Cardiovascular disease; EF: Ejection Fraction

In evaluating the relationship between QTc in the electrocardiogram at admission with total GRACE score, the Pearson correlation results were significant, and there was a positive relationship between these two factors (r = 0.497, $P < 0.001$). Also, according to the results of the ANOVA test, the relationship between QTc in the qualitative levels of GRACE score was significant ($P = 0.008$). There was the highest difference in QTc was observed between the low and high-risk groups (Table 2).

In assessing the association of QTc with the quantitative factors studied, there was a significant

positive correlation between QTc and age (r = 0.37, $P = 0.004$) and EF (r = -0.644, $P < 0.001$), but no significant results were observed in relation with Troponin (r = 0.248, $P = 0.056$).

In assessing the association of QTc with qualitative factors in Table 3, there was a significant relation between QTc and the family history of cardiovascular disease ($P = 0.019$).

Out of patients, five patients had a history of arrhythmia, of which two patients expired with high QTc.

Discussion

The present study was conducted with the aim of determining the relationship between the QTc rate in the electrocardiogram before hospitalization of NSTEMI patients and the GRACE score as a predictive factor of patients' mortality.

According to the results, there was a significant relationship between QTc and the GRACE score of patients. The age of the patient is one of the determining factors in the formulation of GRACE. There was a significant relationship between patients' age and QTc level. This means the QTc level increased with the age of the patients. On the other hand, there was no significant relationship between the QTc levels of patients with high blood pressure, diabetes, high blood lipids, and smoking.

In this regard, evidence suggests that prolonged QTc intervals can be a useful risk marker for identifying high-risk patients with acute coronary syndrome (16). In Nabati's study, QTc prolongation occurred before any other ECG changes such as ST-segment depression or elevation (16).

In line with our study, Rajvanshi et al. conducted a study aiming to correlate the corrected QT interval with the quantitative level of cardiac troponin-I and its prognostic role in NSTEMI. In this study, 301 NSTEMI patients were investigated and cTnI and QTc levels were measured. In the next step, patients were followed up for 30 days after discharge in terms of occurrence of major adverse cardiac events (MACE) including cardiac death, non-fatal MI and revascularization. The results of this study showed a strong positive correlation between two variables of the maximum QTc interval and cTnI level with a correlation coefficient of 0.637 ($P < 0.001$). The authors of this study stated that QTc-max interval has a strong positive linear correlation with cTnI level and that prolonged QTc is an independent high-risk predictor in the NSTEMI population (17). In another study, Gadaleta et al. recorded a standard 12-lead

Table 2. Mean QTc in term of Grace score level

Variable	Level	Mean	S.D	F-statistic	*P*	Pair-comparison	*P* (Tukey test)
Grace score level	low	403.5	25.08	5.291	0.008 *	Low & moderate	0.245
	Moderate	416.63	23.7			Low & high	0.009 *
	high	431.75	13.3			Moderate &high	0.363

Table 3. Correlation of QTc with qualitative variables

Variable	Level	Mean	S.D	*P* (T-test)
Gender	Male	408.8	26.60	0.705
	Female	411.57	23.09	
smoking	Yes	407.28	21.26	0.531
	No	411.48	28.12	
HTN	Yes	412.13	24.12	0.469
	No	407.33	26.77	
DM	Yes	416.45	16.21	0.335
	No	408.22	26.91	
DLP	Yes	412.5	26.50	0.645
	No	408.8	25.27	
Family history of CVD	Yes	395.23	19.61	0.019
	No	413.74	25.49	

HTN: Hypertension; DM: Diabetes Mellitus; DLP: Dyslipidemia; CVD: Cardiovascular disease

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ECG, measured cardiac troponin-T, and calculated the Thrombolysis in Myocardial Infarction (TIMI) score in 55 patients upon admission. The results of this study showed that QTc prolongation is an independent predictor of cardiovascular risk in patients with non-ST-segment elevation acute coronary syndrome (13). Also, in the observational and prospective study, the prognostic results of QTc obtained at the time of admission of NSTEMI patients in the short and long term showed that it supports the prognostic value of QTc in predicting adverse events in the short and long term of NSTEMI-ACS (18).

In future studies, the relationship between QT interval in ECG and the GRACE score can be investigated in patients who have died.

The limitations of this study were the incompleteness of the file and laboratory reports, the illegibility of the patient tapes in some ECG leads, and troponin checks of patients at different hours.

Conclusion

In this study, a significant relationship was observed between the QTc interval of patients and the GRACE score. It was shown that the patients' QTc interval can be a predictive factor of patients' mortality.

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Ethical Approval

This research was designed with the approval of the Research Ethics Committee of Qazvin University of Medical Sciences, Iran, with the number IR.QUMS.REC.1399.485.

Authors Contributions

Majid Hajikarimi conceived and designed the study protocol; Fatemeh Goodarzi contributed to data collection and execution of experimental tests; Zohreh Yazdi performed statistical analysis; Samira Dodangeh wrote the manuscript draft and also contributed to the creation of the tables; Elham Kia Lashaki**,** contributed to the critical revision of the article.

List of Abbriviations

Cardiovascular diseases (CVDs); Acute Coronary Syndrome (ACS); non-ST-elevation myocardial infarction (NSTEMI); ST-segment elevation myocardial infarction (STEMI); The Global Registry of Acute Coronary Events (GRACE); Heart rate–corrected QT interval (QTc); Myocardial Infarction (MI); Ejection Fraction (EF); Left bundle branch block (LBBB); Right bundle branch block (RBBB); Hypertension (HTN); Diabetes Mellitus (DM); Dyslipidemia (DLP); Major Adverse Cardiac Events (MACE); Thrombolysis in Myocardial Infarction (TIMI)

Conflict of Interests

The authors declare that they have no competing interests.

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