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ORIGINAL ARTICLE

Clinical Importance of Tp-e Interval, Tp-e/QT Ratio and Tp-e/QTc Ratio in Blunt Trauma Patients

Künt Göğüs Travmalı Hastalarda Tp-e Aralığı, Tp-e/QT Oranı ve Tp-e/QTc Oranının Klinik Önemi

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ABSTRACT

Objective: Diffirents complications can develop after blunt chest trauma. Potentially destructive arrhythmias may develop after blunt chest trauma. In this study, our main objective is to evaluate the risk of cardiac arrhythmia in patients with blunt chest trauma using the Tp-e interval, Tp-e/QT ratio, and Tp-e/QTc ratio as a potential marker of cardiac arrhythmia.
Materials and Methods: Our study is in the form of a single-center, prospective case-control study and consists of all patients who applied to the emergency department with blunt chest trauma between 15.01.2022 and 15.06.2022. 12-lead ECG recordings at a paper speed of 50 mm/sec. were taken from all participants, and Tp-e interval, QT interval and the parameters obtained by their ratio to each other (Tp-e/QT, Tp-e/QTc) were compared between the groups. Patients were shared according to trauma severity and parameters were compared.
Results: Tpe/QT ratio in trauma patients was found statistically significantly higher than the control group (0.23±0.03 vs. 0.19±0.03, p<0.001). In addition, the Tpe/QTc ratio in trauma patients was statistically significantly higher than the control group (0.21±0.02 vs. 0.17±0.02, p<0.001). In addition, when the analysis of age, gender and BMI, which are the factors affecting trauma severity, was performed, no significant difference was found in terms of QT interval, Tp-e/QT and Tp-e/QTc.
Conclusıon: Based on the results of our study, we verified that the Tp-e interval in the ECG, Tp-e/QT ratio, and Tp-e/QTc ratio might indicate possible arrhythmia in patients who presented to the emergency department with blunt thoracic trauma, and this was unrelated to the severity of the trauma.

Keywords: Tp-e interval, Tp-e/QT ratio;Tp-e/QTc ratio ; chest trauma

ÖZ

Amaç: Künt göğüs travması sonrası birçok komplikasyon gelişebilmektedir. Bu hastalarda potansiyel ölümcül olabilecek aritmi görülebilmektedir. Biz bu çalışmada künt göğüs travmalı hastalarda kardiyak aritmi riskini Tp-e aralığı, Tp-e/QT oranı ve Tp-e/QTc oranını kullanarak potansiyel kardiyak aritmi belirteci olarak kullanılabilirliğini göstermeyi amaçladık.
Gereç ve Yöntem: Çalışmamız tek merkezli prospektif olgu-kontrol şeklinde 15.01.2022 -15.06.2022 tarihleri arasında acil servise künt göğüs travması ile başvuran tüm hastalardan oluşmaktadır. Tüm katılımcılardan kâğıt hızı 50 mm/sn hızda 12 derivasyonlu EKG kaydı alınmış olup Tp-e interval, QT aralığı ve bunların birbirine oranlanmasından elde edilen (Tp-e/QT, Tp-e/QTc) parametreler gruplar arasında karşılaştırıldı. Hastalar travma şiddetine göre gruplandırılıp parametreler karşılaştırılmıştır.
Bulgular: Travma hastalarındaki Tpe/QT oranı kontrol grubuna göre anlamlı yüksek saptanmıştır (0,23±0.03 vs. 0.19±0.03, p<0.001). Ayrıca Travma hastalarındaki Tpe/QTc oranı kontrol grubuna göre anlamlı yüksek saptanmıştır (0.21±0.02 vs. 0.17±0.02, p<0.001). Ayrıca travma şiddetine etki eden faktörlerin analizi yapıldığında yaş,cinsiyet, BMI, QT interval, Tp-e/QT ve Tp-e/QTc açısından anlamlı farklılık saptanmadı.
Sonuç: Çalışmamızdaki sonuçlara dayanarak acil servise künt toraks travması ile başvuran hastalarda EKG'de Tp-e aralığı, Tp-e/QT oranı ve Tp-e/QTc oranının oluşabilecek aritminin bir göstergesi olabileceğini ve bunun travma şiddeti ile ilişkisiz olduğunu saptadık.

Anahtar Kelimeler: Tp-e aralığı, Tp-e/QT oranı; Tp-e/QTc oranı; göğüs travması

Introduction

Trauma is the leading cause of mortality after cardiovascular diseases and malignancy in all age groups (1). Blunt chest injuries increase in parallel with the augmenting in the incidence of traffic accidents. The anterior chest wall and soft tissues are impacted by blunt traumas, and many injuries are benign and do not require hospitalization (2,3). Many complications can originate after blunt chest trauma. The consequence of cardiac arrhythmia is an indicator of cardiac involvement and injury. Studies have displayed that arrhythmia develops after blunt trauma, the major ones being supraventricular tachycardia, atrial fibrillation, ventricular tachycardia, and ventricular fibrillation (4,5). The QT interval, which is the electrocardiographic presentation of ventricular depolarization and repolarization, remains clinically serious as an indicator

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of heart rate-corrected QT (QTc), potentially fatal ventricular arrhythmias, and sudden cardiac death (6). Tp-e interval (Tpe), which is defined as the interval from the peak to the end of the T wave (7,8). Tp-e/QT ratio and Tp-e/QTc ratio are also indicators of cardiac arrhythmias in electrocardiography and are thought to be the most critical indicators of risen mortality risk (9). Investigations have shown that potentially lethal arrhythmias may develop after blunt chest trauma (4). There are few studies in the literature evaluating Tp-e interval, Tp-e/QT ratio, and Tp-e/QTc ratio as headstones of cardiac arrhythmia in patients with blunt chest trauma (3). In this study, we desired to evaluate the cardiac arrhythmia risk in patients with blunt chest trauma, using the Tp-e interval, Tp-e/QT ratio and Tp-e/QTc ratio as a potential cardiac arrhythmia marker.

Materials and Methods

Our investigation was created as a single-center, prospective case-control study, and our study was conducted in a tertiary university hospital. A total of 98 participants, including 48 patients admitted to the emergency department with blunt chest trauma and 50 healthy volunteers as the control group, were included in this study. All patients who were involved in the emergency department with blunt chest trauma between 15.01.2022 and 15.06.2022 constitute our patient occupants.

As exclusion standards; all patients <18 years of age, history of cardiac arrhythmia (atrial fibrillation, bundle branch block, atrioventricular conduction disorder… etc), patients with hypertension or coronary artery disease or heart failure, chronic kidney or liver disease, diabetes mellitus, hyperthyroidism or hypothyroid-like arrhythmia patients with a possible disease, patients with a pacemaker, those who used antiarrhythmic (digoxin, B-blocker, Ca antagonist) drugs, smoking or substance use, patients with tachycardia (>100 beats/minute) or bradycardia (<60 beats/minute), pregnant patients were identified. For patients with blunt thoracic trauma; demographic data such as trauma mechanism, age, gender, vital signs, and trauma mechanism were recorded. Healthy volunteers with similar demographic characteristics would be unsystematically selected from the volunteer patients who applied to the emergency department for reasons other than trauma and cardiac pathology and accepted to participate in the study. Our study population; blood pressure was documented into the systolic and diastolic blood pressure and heart rate data sheet. A 12-lead electrocardiogram (ECG) recording was taken from all participants at a paper speed of 50 mm/sec and 1 mV/cm standardization. The final distance from the beginning of the Q wave to the end point where the T wave turned to the isoelectric line was measured in ms, as the QT interval. Established on the heart rate, the corrected QT interval was calculated with the Bazett formula (QT/√R-R). The standard of the corrected QT (QTc) interval of 3 consecutive beats in each lead was taken as the QTc interval of that lead.

Patients whose QTc interval was computed in at least 9 leads were included in the study. The tp-e interval was defined as the distance between the peak of the T wave and the end of the T wave. Tp-e was measured as the length between the projection of the peak of the T wave on the isoelectric line and the projection of the line joining the descending branch of the T wave with the isoelectric line. The QT interval was measured from the beginning of the QRS complex to the end of the T wave in precordial lead V6, which best reflects the transmural axis of the left ventricle. Tp-e/QTc ratios were also documented with these measurements. All measurements were calculated manually by the cardiologist. The associations between the clinical and laboratory results of the patients and the ECG repolarization parameters were discussed. According to internationally received guidelines, the patients were divided into two groups high-energy trauma and low-energy trauma, and the relationship between trauma patients was compared [10].

Statistical Analysis

In the evaluation of the data, the conformity of the variables to the normal distribution was analyzed with the Kolmogorov Smirnov test. An independent two-sample t-test was used to compare groups in normally distributed data. Group comparisons in the variables not normally distributed were examined with the Mann-Whitney U test. The distribution connection between categorical variables was analyzed with the Chi-square test and Fisher's exact test. Pearson correlation test was used for correlation analysis. All statistical analyzes were completed with SPSS software version 21.0 (SPSS Inc., Chicago, IL). A p value of <0.05 was considered statistically significant.

Results

Our study included 48 trauma patients and 50 control group patients who met the inclusion standards. The primary characteristic results of our study are displayed in Table 1. Between the patient and control groups; there was no significant difference in terms of age, gender, BMI, systolic and diastolic blood pressure and heart rate. Tpe/QT and Tpe/QTc parameters obtained by the ratio of the parameters in the electrocardiogram to each other were statistically significantly different between the trauma control groups. Tpe/QT ratio in trauma patients was significantly higher than the control group (0.23±0.03 vs. 0.19±0.03, p<0.001). In addition, the Tpe/QTc ratio in trauma patients was found significantly higher than in the control group (0.21±0.02 vs. 0.17±0.02, p<0.001). Other ECG parameters did not conflict significantly between the groups.

The evaluation of patients and ECG parameters according to trauma severity is presented in Table 2. No significant difference was seen in the comparison of ECG parameters between the groups. When the factors affecting trauma severity were investigated in the findings obtained, no significant difference was discovered in terms of age, gender, body mass index (BMI), QT interval, Tp-e/QT and Tp-e/QTc (Table 3).

Table 1. Baseline demographic characteristics and electrocardiogram parameters of the study population

	Trauma (n=48)	Controls (n =50)	***p* value**
Age (years)	47.11±15.16	48.12±16.94	0.879
Male, n (%)	32 (66.7)	28 (56)	0.279
SBP, mm Hg	139.1±22.92	127.1±17.22	0.065
DBP, mm Hg	83.17±11.92	82.84±15.41	0.905
Heart rate, beats/min	89.47±15.99	82.58±15.60	0.131
BMI (kg/m2)	27.43±5.37	26.55±4.86	0.449
Electrocardiographic measurements			
PR interval (ms)	143.41±18.28	146.48±20.72	0.472
Tpe (ms)	83.15±10.49	71.30±10.80	<0.001
QT (ms)	363.44±31.98	373.6±33.90	0.132
QTc (ms)	399.71±18.66	406.80±25.53	0.121
Tpe/QT	0,23±0.03	0.19±0.03	<0.001
Tpe/QTc	0.21±0.02	0.17±0.02	<0.001
T wave inversion (%)	7 (14.6)	4 (8.0)	0.302
ST depression	3 (6.3)	1 (2.0)	0.208

BMI: Body mass index; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; Tp-e: Transmural dispersion of repolarization; Tp–e/QT: Transmural dispersion of repolarization/QT; Tp–e/QTc: Transmural dispersion of repolarization/corrected QT

Table 2. Evaluation of the injury severity and electrocardiogram parameters

Variables	High-energy injuries (n=11)	Low-energy injuries (n=37)	***p* value**
PR interval (ms)	141.09±21.76	144.08±17.39	0.795
Tpe (ms)	84.27±13.56	82.81±9.61	0.658
QT (ms)	353.45±41.46	366.41±28.61	0.515
QTc (ms)	404.25±18.61	398.31±18.69	0.286
Tpe/QT	0.20±0.03	0.21±0.02	0.668
Tpe/QTc	0.21±0.03	0.20±0.02	0.668

Tp-e: Transmural dispersion of repolarization; Tp–e/QT: Transmural dispersion of repolarization/ QT ; Tp–e/QTc: Transmural dispersion of repolarization/corrected QT

Table 3. Logistic regression analysis to assess predictors of trauma severity

Variables	OR	(95 % CI)	P value
Age	1.052	0.990-1.118	0.103
Gender	2.41	1.36-3.686	0.311
BMI	1.191	0.968-1.464	0.098
QT interval (ms)	1.003	0.978-1.029	0.815
Tp-e/QT	1.052	0.990-1.118	0.103
Tp-e/QTc	1.752	0.806-2.698	0.969

Tp-e: Transmural dispersion of repolarization; Tp–e/QT: Transmural dispersion of repolarization/QT; Tp–e/QTc: Transmural dispersion of repolarization/corrected QT

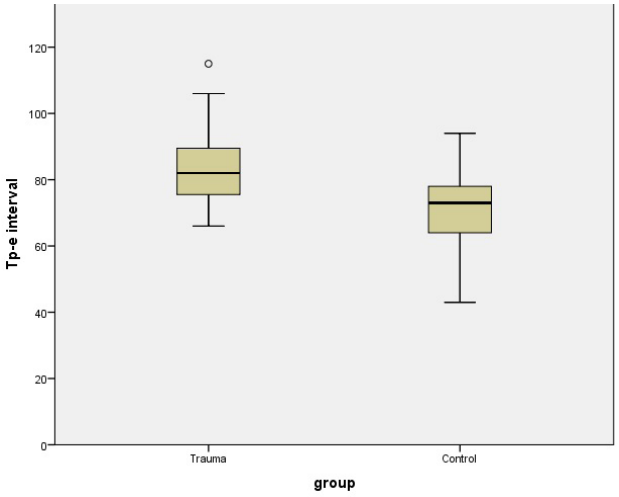

Figure 1. Comparison of the Tp-e interval between the blunt chest trauma and control groups.

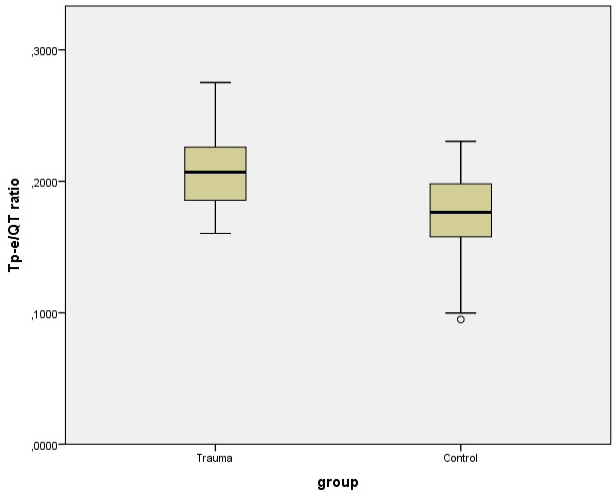

Figure 2. Comparison of the Tp-e/QT ratio between the blunt chest trauma and control groups.

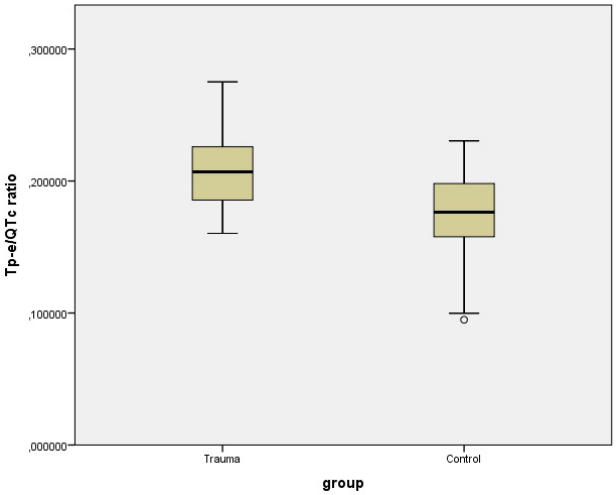

Figure 3. Comparison of the Tp-e/QTc ratio between the blunt chest trauma and control groups.

Discussion

As is known, cardiac lesions that may develop in patients after blunt thoracic trauma can vary in a wide spectrum ranging from an uncomplicated myocardial contusion to major vessel injuries (3,11). It is known that arrhythmias may occur following cardiac injuries that may develop after trauma (12). Our study showed that Tp-e interval, Tp-e/QT ratio, and Tp-e/QTc ratio could indicate an early diagnosis of arrhythmia that may develop after blunt chest trauma. In addition, it was determined that these parameters were not linked to the severity of chest trauma.

Studies have demonstrated that arrhythmia that may occur after blunt chest trauma can be detected early. It is known that it may occur due to perfusion disorder, sympathetic stimulation and excessive conduction of damaged cardiac cells. Myocardial contusion, atrial fibrillation, myocardial rupture, rupture of the interventricular septum, and rupture of the tricuspid valve are the main conditions that can be seen after trauma (14,15). Recently, QT and its corrected QTc value have been explored in the literature as a good indicator of myocardial repolarization aberrations (3,16). Studies have shown that Tp-e/QTc is the myocardial repolarization parameter obtained by separating the time from the peak of the T wave on the ECG to the end of the Tp-e and Tp-e to the QT and QTc values, and it has been described as the transmural dispersion of repolarization. Studies have reported that increased Tp-e interval, Tp-e/QT ratio, and Tp-e/QTc ratio are associated with cardiovascular diseases and ventricular arrhythmias (7-9). Tpe/QT and Tpe/QTc ratio; Brugada syndrome has been associated with many arrhythmic events such as short QT syndrome (9,17). On the other hand, these ratios make it easier to use because they are not influenced by aspects such as body mass index, environmental factors, and heart rate, Tpe and QT interval (18,19).

The new repolarization measurements as Tp-e interval, Tpe/QT ratio, and Tp-e/QTc ratio; the relationship between HT and stroke has been demonstrated in studies (20). Caltekin et al. have stated that increased Tp-e interval, Tpe/QT ratio, and Tp-e/QTc can provide an early assessment of arrhythmia in trauma patients. (3). Tokatli et al. found that the Tp-e interval, Tp-e/QT ratio, and Tp-e/QTc ratio raised in patients with type 2 diabetes compared to the healthy control group. They have concluded that type 2 diabetes leads to increased distribution of transmural repolarization, presenting a risen risk for ventricular arrhythmogenesis (21). Avci et al. found significantly higher Tp-e and Tp-e/QTc values in non-traumatic subarachnoid hemorrhage patients compared to non-bleeding patients for early diagnosis and follow-up of ventricular repolarization changes (22). In a study it has been demonstrated that increased Tp-e interval, Tp-e/QT ratio, and Tp-e/QTc ratio in patients with chronic renal failure can be used to determine ventricular electrical instability in patients undergoing hemodialysis (23). Uçar et al. showed Tp-e intervals, Tp-e/QT and Tp-e/QTc ratios significantly higher in patients with myocarditis than in controls (24). Xiangmei Zhao et al. determined that the Tp-e/QT ratio was statistically significant in predicting major cardiac events after short and long-term observation of patients who underwent percutaneous coronary intervention after ST elevation MI. On the other hand, Tp-e/QT and Tp-e/QTc ratios were also regarded as strong predictors of fatal arrhythmia risk in patients with coronary slow flow and coronary ectasia (25). Hidayet et al. observed that the electrocardiographically evaluated Tp–e interval, Tp–e/QT ratio, and Tp–e/QTc ratio in Behçet's patients were prolonged compared to normal healthy people (26). Our study identified that Tpe, Tpe/QT, and Tpe/QTc ratios were significantly higher in patients with thoracic trauma. In addition, this significance was unlinked to trauma severity.

In addition to some limitations in our investigation, the most important limitation observed is the single-center collection of data. However, the impression of arrhythmia development in trauma patients could not be received for a long time and Holter impression could not be made in these patients. We accept that the measurements in our study by a single cardiologist may be a risk in terms of bias. A multicenter study with a larger number of patients and long-term rhythm Holter monitoring is required.

Conclusion

Basing on the outcomes of our investigation, we determined that the Tp-e interval, Tp-e/QT ratio and Tp-e/QTc ratio calculated in the ECG of the patients admitted to the emergency department with blunt thoracic trauma may be an indicator of possible arrhythmia and this is not associated to the severity of the trauma.

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References

1.Emircan Ş, Özgüç H, Aydın Ş, Özdemir A, Cesur EE, Bildik N, et al. Factors Affecting Mortality in Patients With Thorax Trauma. Ulus Travma Acil Cerrahi Derg. 2011;17:329-33.

2.Eghbalzadeh K, Sabashnikov A, Zeriouh M, Choi YH, Bunck AC, Mader N, et al. Blunt chest trauma: a clinical chameleon. Heart. 2018;104(9):719-724.

3.Çaltekin İ. Hidayet Ş. Evaluation of Tp-e interval, Tp-e/QT ratio and Tp-e/QTc ratio in blunt chest trauma patients. Ulus Travma Acil Cerrahi Derg 2020;26:526-530.

4.Mergan İliklerden D, Çobanoğlu U, Sayır F, İliklerden ÜH. Late complications due to thoracic traumas. Ulus Travma Acil Cerrahi Derg. 2022;28(3):328-335.

5.Hadjizacharia P, O'Keeffe T, Brown CV, Inaba K, Salim A, Chan LS, et al. Incidence, risk factors, and outcomes for atrial arrhythmias in

trauma patients. Am Surg. 2011;77:634-639

6.De Veld L, van der Lely N, Hermans BJM, van Hoof JJ, Wong L, Vink AS. QTc prolongation in adolescents with acute alcohol intoxication. Eur J Pediatr. 2022;181:2757-2770.

7.Gupta P, Patel C, Patel H, Narayanaswamy S, Malhotra B, Green JT, et al. T(p-e)/QT ratio as an index of arrhythmogenesis. J Electrocardiol. 2008;41:567-74.

8.Tokatli A, Kiliçaslan F, Alis M, Yiginer O, Uzun M. Prolonged Tp-e Interval, Tp-e/QT Ratio and Tp-e/QTc Ratio in Patients with Type 2 Diabetes Mellitus. Endocrinol Metab (Seoul). 2016;31:105-112.

9.Yayla Ç, Bilgin M, Akboğa MK, Gayretli Yayla K, Canpolat U, Dinç Asarcikli L, et al. Evaluation of Tp-E Interval and Tp-E/QT Ratio in Patients with Aortic Stenosis. Ann Noninvasive Electrocardiol. 2016;21:287-293.

10.Briet JP, Houwert RM, Smeeing DPJ, Dijkgraaf MGW, Verleisdonk EJ, Leenen LPH, et al. Differences in Classification Between Mono- and Polytrauma and Low- and High-Energy Trauma Patients With an Ankle Fracture: A Retrospective Cohort Study. J Foot Ankle Surg. 2017;56:793-796.

11.Scalea TM. Caring for vascular injuries: Training more vascular specialists may not be the answer. J Trauma Acute Care Surg. 2022;92:760-761.

12.Kalogerakos PD, Lazopoulos G, Palioudakis S, Drositis I, Chionidou K, Chalkiadakis G. Pneumorachis associated with persistent tachycardia after blunt thoracic trauma. Asian Cardiovasc Thorac Ann. 2017;25:463-465.

13.Ismailov RM. Trauma associated with cardiac conduction abnormalities: population-based perspective, mechanism and review of literature. European Journal of Trauma and Emergency Surgery. 2010;36:227-232.

14.Ismailov RM, Ness RB, Redmond CK, Talbott EO, Weiss HB. Trauma associated with cardiac dysrhythmias: results from a large matched case-control study. J Trauma. 2007;62:1186-1191.

15.Patel KM, Kumar NS, Desai RG, Mitrev L, Trivedi K, Krishnan S. Blunt Trauma to the Heart: A Review of Pathophysiology and Current Management. J Cardiothorac Vasc Anesth. 2022;36:2707-2718.

16.Kilicaslan F, Tokatli A, Ozdag F, Uzun M, Uz O, Isilak Z, et al. Tp-e interval, Tp-e/QT ratio, and Tp-e/QTc ratio are prolonged in patients with moderate and severe obstructive sleep apnea. Pacing Clin Electrophysiol. 2012;35:966-972.

17.Yamaguchi M, Shimizu M, Ino H, Terai H, Uchiyama K, Oe K, et al. T wave peak-to-end interval and QT dispersion in acquired long QT syndrome: a new index for arrhythmogenicity. Clin Sci (Lond). 2003;105:671-676.

18.Junttila E, Vaara M, Koskenkari J, Ohtonen P, Karttunen A, Raatikainen P, et al. Repolarization abnormalities in patients with subarachnoid and intracerebral hemorrhage: predisposing factors and association with outcome. Anesth Analg. 2013;116:190-197.

19.Ozturk U, Ozturk O. Relation between index of cardioelectrophysiological balance and stroke severity in patients with acute ischemic stroke. Niger J Clin Pract. 2020;23:768-774.

20.Demirtas D, Sumbul HE, Bulut A, Demirtas AO, Gulumsek E, Koca H, et al. Tp-e interval, Tp-e/QT and Tp-e/QTc ratio in hypertensive patients with primary aldosteronism. Clin Exp Hypertens. 2020;42:93-98.

21.Tokatli A, Kiliçaslan F, Alis M, Yiginer O, Uzun M. Prolonged Tp-e Interval, Tp-e/QT Ratio and Tp-e/QTc Ratio in Patients with Type 2 Diabetes Mellitus. Endocrinol Metab (Seoul). 2016;31:105-112.

22.Avci A, Acehan S, Avci BS, Gulen M, Bulut A, Satar S. QTc, Tp-e interval and Tp-e/QTc ratio in patients with nontraumatic subarachnoid hemorrhage. Am J Emerg Med. 2020;38:2458-2459.

23.Karaagac K, Yildiz A, Tenekecioglu E, Ozluk OA, Kanat S, Yilmaz M. Tp-e Interval and Tp-e/QT Ratio in Chronic Renal Failure Patients Requiring Hemodialysis. J Clin Anal Med 2016;7: 222-225.

24.Ucar FM, Ozturk C, Yılmaztepe MA. Evaluation of Tp-e interval, Tp-e/QT ratio and Tp-e/QTc ratio in patients with acute myocarditis. BMC Cardiovasc Disord. 2019;19:232.

25.Zhao X, Xie Z, Chu Y, Yang L, Xu W, Yang X, et al. Association between Tp-e/QT ratio and prognosis in patients undergoing primary percutaneous coronary intervention for ST-segment elevation myocardial infarction. Clin Cardiol. 2012;35:559-564.

26.Hidayet Ş, Demir V, Turan Y, Gürel G, Taşolar MH. Evaluation of Tp-e interval, Tp-e/QT ratio, and Tp-e/QTc ratio in patients with Behçet's disease. Anatol J Cardiol. 2019;22:85-90.