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Evaluation of Electrocardiography Parameters in Renal Colic Patients Admitted to the Emergency Department

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Abstract

Aim: Urinary stone disease is a common cause of comorbidity in the population. It causes an increased sympathetic tone due to pain during renal colic attacks. It is thought that increased sympathetic tone may also trigger vasospasm in coronary arteries and make ischemic changes more pronounced. However, there is no study in the literature that evaluating electrocardiogram parameters in patients with renal colic pain. In this study, the electrocardiogram parameters such as QT corrected for heart rate (QTc) interval, QTc dispersion, T peak-end (Tp-e) interval and Tp-e/QTc that are recorded when the patients are pain-free and during an episode of renal colic attack have been compared.

Materials and Methods: Patients who were clinically suspected of having renal colic and whose diagnosis was confirmed by abdominal computed tomography were included in this prospective observational study. On electrocardiograms in the episode of renal colic attack and when they are painless; QTc interval, QTc dispersion, Tp-e interval and Tp-e/QTc parameters were compared.

Results: Mean age of the 101 patients included in this study was 44.19±14.13 and 48.5% of them were female. Maximum QTc interval, and QTc dispersion parameters were significantly higher during renal colic attacks than pain-free periods. QTc interval was higher for females compared to males.

Conclusion: We found that renal colic pain is associated with increased QTc max and QTc dispersion. QTc interval was higher for females compared to males. These findings suggest that patients with renal colic pain may be under risk for ventricular arrhythmias especially in females.

Keywords: Renal colic, QTc dispersion, ventricular arrhythmias

Introduction

Urinary stone disease is a common cause of comorbidity in the population. The prevalence of this disease is estimated to be around 5%-13%. Due to its high recurrence rate, it has negative economic and social impacts on the society (1).

Patients with urinary stone disease frequently admit to emergency service with flank pain. This pain can range from a mild discomfort to severe enough to require taking a parenteral analgesic. The pain is typically in the form of colic and severe pain paroxysms usually last between 20 and 60 minutes. Pain occurs due to urinary retention and renal capsule stretching after the stone passes from the renal pelvis to the ureter and then the pain rapidly resolves when the stone passes through the urinary system. Urinary stone disease causes an increased sympathetic tone due to pain during renal colic attacks. It is thought that increased sympathetic tone may also trigger vasospasm in coronary arteries and make ischemic changes more pronounced (2,3).

However, there is no study evaluating electrocardiography (ECG) parameters in patients with renal colic pain in the literature.

In our study, we aimed to evaluate whether pain poses a risk for cardiac diseases and malignant arrhythmias as defined by either ventricular tachycardia (VT) or ventricular fibrillation (VF) or atrioventricular block causing hemodynamic compromise or cardiac arrest in patients who admitted to the emergency department with renal colic complain.

Therefore, QT corrected for heart rate (QTc) interval, QTc dispersion, T peak-end (Tp-e) interval and Tp-e/QTc parameters

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of the patients measured both during their renal colic attack and their pain-free period were compared.

Materials and Methods

This study is prospectively conducted in the Department of Emergency Medicine at the Zonguldak Bülent Ecevit University between 15.01.2016-15.07.2016.

Between the specified dates, patients who presented with clinical findings of renal colic and whose diagnosis was confirmed by abdominal computed tomography (CT) were included in this study.

Information on age, gender, height and weight of each patient were collected. Unenhanced abdominal CT was performed in patients with appropriate clinical diagnosis and then CTs were evaluated by a radiologist.

ECG of all patients were taken in the first fifteen minute of the admission. Drugs that did not make ECG changes or were the least risky were used during the treatment. A week after discharged patients are recovered, they come back and their ECGs were repeated. QTc interval, QTc dispersion, T peak - end (Tp-e) interval, Tp-e/QTc values of ECGs in two periods were compared.

Electrocardiographic Evaluation

Standard ECGs were taken from all patients with a sweeping rate of 25 mm/sec and amplitude of 10 mm/mV, using a Nihon Kohden Cardiofax M ECG-1350K, 12-channel electrocardiograph unit (Nihon Kohden, Tokyo, Japan). All ECGs were evaluated by the same researcher who was blinded to the group assignation.

QTc Interval and QTc Dispersiyon Measurement

The QT interval was measured from the beginning of the QRS complex to the end of the T-wave at the level of the T-P isoelectric baseline. QT interval that is corrected for heart rate (QTc) was calculated using Bazett's formula;

$$\text{(QT Interval corrected Bazett} = QTc = QT/\sqrt{RR}) \quad (1)$$

QTc dispersions were determined by calculating the difference between maximum and minimum QTc intervals in different leads (4,5).

Tp-e Measurement

The Tp-e interval was measured from the peak to the end of the T wave in leads V2 and V5. The end of the T wave was defined as the point of intersection of the isoelectric line with the line passing through the T wave. Tp-e/QTc were calculated from these measurements.

Exclusion Criteria

Patients with hypertension, diabetes mellitus, coronary artery disease, heart failure, valvular disease, arrhythmia, malignancy, chronic renal failure, metabolic diseases, electrolyte disorders, urinary system infections were excluded from the study.

Patients with high blood pressure at the time of admission were also excluded from the study.

Ethics

The research was submitted to the Research Ethics Committee of the Zonguldak Bülent Ecevit University, and approved under certificate number 2015-135-16/12. In this study, all processes complied with guidelines of the Declaration of Helsinki. Informed consent was received from all patients in the study.

Statistical Analysis

All statistical analyses were performed using SPSS software version 20.0 (SPSS Inc., Chicago, IL). Continuous variables were expressed as a mean ± standard deviation. Numbers and percentages were used for categorical variables. The categorical variables were compared using χ^2 test or Fisher's Exact test. For continuous variables the assumption of normality is checked using Shapiro-Wilk normality test. For continuous variables that are normally distributed, paired sample t-test and Student's t-test were used for comparisons as appropriate. A p value of <0.05 was considered as statistically significant.

Results

One hundred and one patients were included in the study and 49 of them were female. Average age was 44.19±14.13. The average height of the patients was 166.07±18.1, their average weight was 76.65±14.06.

Among all, 3.0% of the patients were underweight [Body Mass Index (BMI) <18.5], 28.7% of them were in normal range (18.5-24.9), 40.6% of them were overweight (25-29.9) and 27.7% of them were obese (BMI >30).

ECG parameters of renal colic patients during attack and pain-free periods were compared.

Maximum QTc interval (427.81±34.02 ms vs. 419.26±33.27 ms, p=0.005), and QTc dispersion (38.01±23.50 ms vs. 31.29±26.09 ms, p=0.049) were significantly higher during renal colic attacks compared with pain-free periods. However, there was no significant difference between during attack and pain-free periods in terms of QTc interval (407.94±30.74 ms vs. 409.13±24.84 ms, p=0.621), and minimum QTc interval (389.76±30.45 ms vs. 388.47±28.48 ms, p=0.653) (Table 1).

Table 1. ECG parameters of renal colic patients during attack and pain-free period				
ECG parameters	**Measurement time**	**Mean**	**SD**	**p value***
QTc	During the attack	407.94	30.74	0.621
	Pain-free period	409.13	24.84	
QTc maximum	During the attack	427.81	34.02	0.005
	Pain-free period	419.26	33.27	
QTc minimum	During the attack	389.76	30.45	0.653
	Pain-free period	388.47	28.48	
QTc dispersion	During the attack	38.01	23.50	0.049
	Pain-free period	31.29	26.09	
Tp-e	During the attack	77.90	14.32	0.291
	Pain-free period	76.39	14.86	
Tp-e/QTc rate	During the attack	0.19	0.04	0.190
	Pain-free period	0.19	0.04	
*Paired sample t-test, ECG: Electrocardiography, QTc: QT corrected for heart rate, Tp-e: T peak - end, SD: Standard deviation				

ECG parameters by gender during attack and pain-free period were compared using Student's t-test and given in Table 2 and Table 3 respectively. There was significant difference in QTc measurement during the attack by gender. QTc measurement during the attack for females was 416±35.1 while for males, it was 401±24.4. Among the measurements taken during the pain-free period, there was a significant difference in QTc interval by gender. The mean QTc interval for females was 417±24.9 while the mean QTc interval for females was 402±22.5.

Discussion

In our study, the repolarization indicators on the ECG that can be used to determine the risk for cardiac diseases and malignant arrhythmias in both healthy people and those with structural heart disease were examined.

We evaluated QTc dispersion and T-peak interval in patients with renal colic. QTc dispersion can be used as a non-invasive marker of sudden cardiac death and ventricular arrhythmia.

Table 2. Comparisons of ECG parameters measured during the attack by gender			
	Female	**Male**	**p value***
	Mean (SD)	**Mean (SD)**	
QTc	416 (35.1)	401 (24.4)	0.015
Minimum QTc	396 (32.7)	385 (27.6)	0.070
Maximum QTc	432 (35.3)	424 (32.7)	0.236
QTc dispersion	36.3 (24.7)	39.6 (22.4)	0.482
Tp-e	79.2 (13.7)	76.8 (14.9)	0.400
Tp-e/QTc rate	0.19 (0.04)	0.19 (0.04)	0.970
*Paired sample t-test, ECG: Electrocardiography, QTc: QT corrected for heart rate, Tp-e: T peak - end, SD: Standard deviation			

T peak-end interval is considered as the ventricular repolarization distribution index and when it is prolonged, it can result in the development of ventricular arrhythmia.

Tp-e/QT, Tp-e/QTc ratios were calculated so that QTc dispersion and T-peak interval parameters were not affected by heart rate (4-9).

The values of QTc dispersion and QTc maximum in the renal colic patients during the renal colic attack and the pain-free periods were compared and statistically significant differences were found (p=0.049, p=0.005 respectively). There was significant difference in QTc measurement during the attack and pain-free period by gender. QTc interval was higher for females compared to males. Changes in other ECG parameters observed were not statistically significant.

It is thought that renal colic pain may possibly cause cardiac effects through two mechanisms.

Table 3. Comparisons of ECG parameters measured during pain-free period by gender			
	Female (n=48)	**Male (n=53)**	**p value***
	Mean (SD)	**Mean (SD)**	
QTc	417 (24.9)	402 (22.5)	0.001
Minimum QTc	392 (29.6)	385 (27.3)	0.206
Maximum QTc	424 (33.2)	415 (33.1)	0.192
QTc dispersion	32.8 (27.4)	29.9 (25.0)	0.573
Tp-e	75.6 (14.3)	77.1(15.5)	0.604
Tp-e/QTc rate	0.18 (0.036)	0.19 (0.039)	0.299
*Student's t-test, ECG: Electrocardiography, QTc: QT corrected for heart rate, Tp-e: T peak - end, SD: Standard deviation, n: Number			

In renal colic; pressure in the collecting system and ureteral spasm cause the release of prostaglandins, which are the primary mediators of pain. Prostaglandins produced by many cells are involved in systemic and vascular inflammation.

Of the prostaglandins divided into different types according to their structural and functional properties; the imbalance between TxA2, a potent platelet aggregation agent and vasoconstrictor, and prostacyclin, a potent inhibitor of vasodilator and platelet aggregation, has been blamed as the mechanism that initiates thrombus formation in coronary blood vessels (10,11).

Furthermore, prostaglandins initiate sympathetic stimulation through the central nervous system. Sympathetic afferent fibers spread along the inferoposterior and anterior wall of the left ventricle stimulate the sympathetic activation of the heart.

It is thought that sympathetic activation makes ischemic symptoms more pronounced by making vasoconstriction in coronary arteries. This may cause ventricular arrhythmias. QT dispersion also emerges as an indicator of early ventricular arrhythmias on the ECG (12,13).

In our study the differences between QTc dispersion and QTc maximum values during renal colic attack and pain-free periods are found to be statistically significant. However, there were no statistically significant differences in T-wave peak-to-end interval (Tp-e interval) and Tp-e/QT ratios, which are other markers of ventricular arrhythmia and repolarization heterogeneity.

QTc interval was significantly higher for females compared to males during renal colic attack and pain-free periods. In patients with renal colic, it is possible to say that women are more at risk for malignant arrhythmias than men. Studies showing an increased risk of coroner's artery disease in women with urinary stone disease also support our data (14-16).

To the best of our knowledge there is no study on ECG in renal colic attacks in the literature.

For this reason, we compared our study results with several studies that similarly examine ECG parameters in other diseases with pain attacks similar to the renal colic attacks.

In the study conducted by Duru et al. (17), ECG was evaluated in migraine patients, another disease characterized by recurrent pain attacks, and it was found that the QTc max, QTc interval and QTc dispersion were significantly longer during the attack compared to the pain-free period.

In another study comparing the QT-QTc maximum and QT-QTc dispersion of the control group and migraine patients, it was found that the dispersion was significantly higher and the QT-QTc minimum dispersion was significantly lower (18).

In the QT dispersion study on fibromyalgia, which is a non-inflammatory disease characterized by widespread pain foci in the body and progresses with pain attacks; it was determined that the QTc dispersion was shorter (19).

Yazıcı et al. (20) found no significant difference between fibromyalgia and control groups in terms of QT dispersion and conventional echocardiographic parameters.

Study Limitations

Although the QTc dispersion is significantly higher in the ECGs since the patients are not followed for a long time, it has not been determined whether ventricular arrhythmia, which is a clinical reflection, occurred.

Conclusion

We conclude that renal colic pain is associated with increased QTc maximum and QTc dispersion.

This finding suggests that patients with renal colic pain may be under risk for ventricular arrhythmias. QTc interval was significantly higher for females compared to males during renal colic attack and pain-free periods. It is possible to say that women are more at risk for malignant arrhythmias than men.

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Ethics

Ethics Committee Approval: The research was submitted to the Research Ethics Committee at the Zonguldak Bülent Ecevit University, and approved under certificate number 2015-135-16/12.

Informed Consent: Informed consent was received from all patients in the study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Medical and Surgical Practices: A.C.H., H.H., Concept: A.C.H., H.H., Design: A.C.H., H.H., Data Collection and/or Processing: A.C.H., H.H., Analysis and/or Interpretation: A.C.H., H.H., Literature Search: A.C.H., H.H., Writing: A.C.H., H.H.

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References

1. Kim S, Chang Y, Sung E, Kang JG, Yun KE, Jung HS, et al. Association between sonographically diagnosed nephrolithiasis and subclinical coronary artery calcification in adults. Am J Kidney Dis. 2018;71:35-41.
2. Al Aseri Z, Suriya OM, Hassan HA. ST segment elevation in a patient presenting with renal colic pain. Saudi J Kidney Dis Transpl. 2011;22:998-1002.
3. Leveridge M, D'Arcy FT, O'Kane D, Ischia JJ, Webb DR, Bolton DM, et al. Renal colic: current protocols for emergency presentations. Eur J Emerg Med. 2016;23:2-7.
4. Izci F, Hocagil H, Izci S, Izci V, Koc MI, Acar RD. P-wave and QT dispersion in patients with conversion disorder. Ther Clin Risk Manag. 2015;11:475-80.
5. Al B, Sucu M, Çavdar M, Yılmaz AD, Yıldırım C, Davutoğlu V. Electrocardiographic Abnormalities in Patients Bitten by Scorpions. Eurasian J Emerg Med. 2009;8:51-5.
6. Cosgun A, Oren H. Variation of the T-wave peak-end interval and heart rate variability values in healthy males and females at various hours of the same day, and relationship of them. J Arrhythm. 2020;36:118-26.
7. Franz MR, Zabel M. Electrophysiological basis of QT dispersion measurements. Prog Cardiovasc Dis. 2000;42:311-24.
8. Rosenthal TM, Masvidal D, Abi Samra FM, Bernard ML, Khatib S, Polin GM, et al. Optimal method of measuring the T-peak to T-end interval for risk stratification in primary prevention. Europace. 2018;20:698-705.
9. Ucar FM, Oztürk C, Yılmaztepe MA. Evaluation of Tp-e interval, Tp-e/QT ratio and Tp-e/QTc ratio in patients with acute myocarditis. BMC Cardiovasc Dis. 2019;19:1-7.
10. Kumar V, Abbas AK, Aster JC. Inflammation and Repair. In: Abbas AK, editor. Robbins & Cotran Pathologic Basis of Disease, New York: E-Publishing Inc; 2021, p. 71-113.
11. Safdar B, Degutis LC, Landry K, Vedere SR, Moscovitz HC, D'Onofrio G. Intravenous morphine plus ketorolac is superior to either drug alone for treatment of acute renal colic. Ann Emerg Med. 2006;48:173-81.
12. Kosmopoulos M, Roukoz H, Sebastian P, Kalra R, Goslar T, Bartos JA, et al. Increased QT Dispersion Is Linked to Worse Outcomes in Patients Hospitalized for Out-of-Hospital Cardiac Arrest. JAHA. 2020;9:e016485.
13. Zipes DP, Barber MJ, Takahashi N, Gilmour RF. Influence of the autonomic nervous system on the genesis of cardiac arrhythmias. Pacing Clin Electrophysiol. 1983;6:1210-20.
14. Reiner AP, Kahn A, Eisner BH, Pletcher MJ, Sadetsky N, Williams OD, et al. Kidney stone and subclinical atherosclerosis in young adults: The CARDIA study. J Urol. 2011;185:920-5.
15. Cheungpasitporn W, Thongprayoon C, Mao MA, O'Corragain OA, Edmonds PJ, Erickson SB. The risk of coronary heart disease in patients with kidney stones: a systematic review and meta-analysis. N Am J Med Sci. 2014;6:580-5.
16. Ferraro PM, Taylor EN, Eisner BH, Gambaro G, Rimm EB, Mukamal KJ, et al. History of kidney stones and the risk of coronary heart disease. JAMA. 2013;310:408-15.
17. Duru M, Melek I, Seyfeli E, Duman T, Kuvandik G, Kaya H, et al. QTc dispersion and P-wave dispersion during migraine attacks. Cephalalgia. 2006;26:672-7.
18. Tosun O, Karatoprak E. Increased QT and P-wave dispersion during attack-free period in pediatric patients with migraine attacks. Cardiol Young. 2019;29:488-91.
19. Yolbaş S, Yıldırım A, Düzenci D, Karakaya B, Dağlı MN, Koca SS. QT dispersion and P wave dispersion in patients with fibromyalgia. Eur J Rheumatol. 2016;3:165-8.
20. Yazıcı S, Yazıcı M, Albayrak S, Makarç S, Kolbaş M, Erbilen E, et al. Fibromiyalji sendromunda kardiyovasküler sistemin değerlendirilmesi: doku doppler ekokardiyografik inceleme [in Turkish]. Düzce Tıp Dergisi. 2010;12:12-7.