RESEARCH ARTICLE

Corrected QT Interval and Corrected QT Dispersion in Obesity

Aleksandra Milovančev[1,2], Edita Stokić[1,3]

[1]Department of Internal Medicine, Medical Faculty, University of Novi Sad, Novi Sad, Serbia, [2]Department for Cardiology, Institute of Cardiovascular Diseases of Vojvodina, Sremska Kamenica, Serbia, [3]Clinic for Endocrinology, Diabetes and Metabolic Disorders, Clinical Center of Vojvodina, Novi Sad, Serbia

ABSTRACT

Objective: Corrected QT (QTc) interval has been the subject of numerous studies over the past 20 years. However, lately, more importance is given to the QTc dispersion which is also a risk factor for the development of ventricular tachyarrhythmia and sudden cardiac death in obese patients. The aim of our study was to determine whether there is a difference in the length of the QTc interval and QTc dispersion in obese patients compared to healthy normal weight subjects. **Methods and Results:** The study included 109 subjects who were divided into two groups: Obese subjects and healthy normal weight subjects. QTc intervals were calculated using the Bazett's formula. Statistically significant differences were observed between the two groups' anthropometric parameters ($P < 0.01$) and electrocardiographic QT interval parameters. Intervals were significantly longer in obese patients (QT 392.30 ± 28.21 ms vs. 356.29 ± 22.29 ms, QTc 422.82 ± 24.21 vs. 384.26 ± 25.59, QTc max 446.07 ± 30.26 ms vs. 407.84 ± 26.79 ms, and QTc min 396.89 ± 25.90 ms vs. 360.11 ± 24.64 ms). QTc dispersion was not significantly more prolonged (49.18 ± 21.80 vs. 47.73 ± 18.81 ms, $P > 0.05$) in obese patients. **Conclusion:** 24.3% of obese patients have prolonged QTc interval which represents ventricular repolarization disorder. They are in a group of high-risk patients for sudden cardiac death.

Key words: Arrhythmia, electrocardiogram, obesity, QT corrected interval

INTRODUCTION

Persistence of obesity over a long period of time leads to the development of many complications, especially those that occur in the cardiovascular system.[1] Numerous clinical studies suggest that obesity is an independent risk factor for cardiovascular diseases such as hypertension, coronary heart disease, cerebrovascular disease, and heart failure.[2] Increased incidence of sudden death in obese patients is associated with malignant arrhythmias, which are most often caused by prolonged QT interval and was first described 20 years ago.[3] Many studies have shown that obesity can cause prolonged QT interval.[4-7] Prolonged QT interval is a risk factor for sudden cardiac death; it is characterized by prolonged ventricular repolarization that occurs due to a complex interaction between genetic and environmental factors. This leads to a potential substrate for polymorphic ventricular tachycardia and sudden cardiac death.[8] QT dispersion has been of great interest in the past years. Despite that, the significance remains unclear, weather is a marker of electrical vulnerability and can predict cardiac arrhythmias and sudden death or has no clinical usefulness. The results are still contradictory. The aim of our study was to determine whether there is a difference in the length of the corrected QT (QTc) interval and QTc dispersion as predictors of sudden cardiac death in obese patients compared to healthy normal weight subjects.

METHODS

The study included 109 individuals. 74 obese men and women and 35 normal weight healthy subjects belonged to the

Address for correspondence:
Aleksandra Milovančev, Clinic for Cardiology, Institute of Cardiovascular Diseases of Vojvodina, Put doktora Goldmana 4, 21204 Sremska Kamenica, Serbia. Phone: +381 642746046, Fax: +381 21 6622881. E-mail: aleksandra.milovancev@ikvbv.ns.ac.rs

medical and student staff of our department. Obese subjects were recruited from the Department of Endocrinology, Diabetes and Metabolic Disorders, Clinical Center of Vojvodina, Novi Sad. Inclusion criteria were 18–65 years old and body mass index (BMI) ≥30 kg/m^2. We excluded those with a previous history of diabetes mellitus, hypertension, heart, hepatic, kidney, psychiatric, malignant, infectious disorders, electrolyte imbalance, and those taking drugs that can influence QT interval. The study was performed according to the declaration of Helsinki, and informed consent was obtained from all participants. Anthropometric measurements (body weight [BW], body height [BH], and waist circumference [WC]) were done.

The subjects wearing light indoor clothes and no shoes BW and BH were measured using calibrated beam-type balance to the nearest 0.1 kg and Harpenden anthropometer to the nearest 0.1 cm, respectively, and BMI was calculated (BMI = BW/BH^2 [kg/m^2]). WC was measured using a flexible tape to the nearest 0.1 cm at the level midway between the lowest point on the rib margin and the highest point on the iliac crest. To ensure the accuracy of measurement, subjects were told not to eat or drink within 4 h of the test, not to exercise within 12 h prior the test, to urinate within 30 min of the test, and not to consume alcohol within 48 h.

All of the patients in the study group underwent a standard resting 12-lead surface electrocardiogram (ECG) record at a paper speed of 25 mm/s and gain of 10 mm/mV. The ECGs were analyzed by one reader who was unaware of the characteristics of the subject. The reader was trained to obtain the minimum of intra variability of measurements. The ECG parameters were measured manually using a graduated lens. QT intervals were measured from the beginning of the QRS complex to the visual return of the T-wave to the isoelectric line. QT intervals and R–R intervals were measured in all of 12 derivations in three consecutive cardiac cycles and then averaged. The longest QT was accepted as the QT max interval, and the shortest QT was accepted as the QT min interval. The difference between the QTc max and QTc min was defined as QTc dispersion. All the intervals were corrected by the Bazett formula = QT interval/√ (RR interval). Statistical analyses were performed using the SPSS (version 11.0) software.

RESULTS

The study included 109 patients (73 females and 36 males) who were divided into two groups: A group of obese subjects (n = 74, 19 males and 55 females) and a group of normal weight healthy subjects, (n = 35, 17 males and 18 females). The average age of obese patients was 41.78 ± 10.71 years of life versus the normal weight group 38.65 ± 6.52 years (P > 0, 05). The characteristics of the study population are listed in Table 1. We observed anthropometric parameters: BH, BW, BMI, and WC. BW of obese patients was 140.78 ± 31.74 kg versus control group 71.24 ± 12.51 kg. BMI was 49.52 ± 9.67 versus 22.95 ± 2.36 kg/m^2. WC was 131.38 ± 22.02 cm, while the average waist size of the control group was 74.89± 7.5 cm. Statistically significant differences (P < 0.01) were found in BW, BMI, and WC in the studied groups. Electrocardiographic intervals were significantly longer in obese patients (QT 392.30 ± 28.21 ms vs. 356.29 ± 22.29 ms, QTc 422.82 ± 24.21 vs. 384.26 ± 25.59, QTc max 446.07 ± 30.26 ms vs. 407.84 ± 26.79 ms, and QTc min 396.89 ± 25.90 ms vs. 360.11 ± 24.64 ms). QTc dispersion was not significantly more prolonged (49.18 ± 21.80 vs. 47.73 ± 18.81 ms, P > 0.05) in obese patients. HR was not significantly different between the groups (70, 61 ± 10.47 vs. 70, 60 ± 10.34, P > 0.05). From these data, we conclude that there is a statistically significant difference (P < 0.01) for all the QT electrocardiographic parameters except QTc dispersion. There are no statistically significant differences in QTc between genders (P > 0.05) in our study [Table 2]. The prevalence of prolonged QTc interval (over 440 ms) was 24.32% in a group of obese patients [Figure 1]. The normal weight group had no individuals with prolonged QTc interval.

DISCUSSION

The prevalence of prolonged QTc interval over 440 ms was 24.32% in obese patients. In a group of 1029 obese patients, Frank *et al*. analyzed QTc interval and the prevalence of prolonged QTc interval, and they had very similar results as in our study; the prevalence was 28.3%.[3] In a large population study, Straus *et al*.[9] demonstrated that prolonged QTc interval in the elderly is associated with a threefold increased risk of sudden cardiac death, which is mostly caused by ventricular tachyarrhythmias. The assessment of risk factors that lead to sudden cardiac death is a major challenge in search for the diagnostic and therapeutic approach to reduce this risk.[10] In the Rotterdam study,

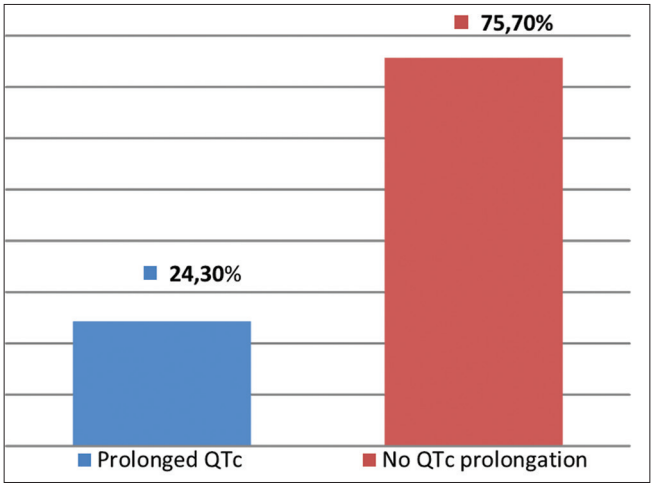

Figure 1: QT corrected in obese group

Table 1: Characteristics of the study population

Variable	Obese $\bar{X} \pm SD$	Normal weight $\bar{X} \pm SD$	*t*-value	*P*
BW (kg)	140,78±31,74	71,25±12,51	16,35	<0,01
BMI (kg/m^2)	49,52±9,67	22,95±2,36	22,28	<0,01
WC (cm)	131,38±22,02	74,89±7,50	14,74	<0,01
QT (ms)	392,30±28,21	356,29±22,29	7,21	<0,01
QTc (ms)	422,82±24,21	384,26±25,59	7,47	<0,01
QTc max (ms)	446,07±30,26	407,84±26,79	6,38	<0,01
QTc min (ms)	396,89±25,90	360,11±24,64	7,03	<0,01
QTc disp (ms)	49,18±21,80	47,73±18,81	0,34	>0,05

BW: Body weight, BMI: Body mass index, WC: Waist circumference, QTc max: Corrected QT maximum, QTc min: QTc minimum, QTcdisp: QTc dispersion

Table 2: Gender QTc differences

Variable QTc	Female	Male	*t*-value	*P*
All	414,20±24,60	402,79±39,16	1,858934	0,06
Obese	422,11±18,64	424,86±36,44	-0,43	0,67
Normal weight	390,05±25,27	378,13±25,20	25,20	0,17

QTc: QT corrected

authors came to the conclusion that the prolongation of QTc interval over 440 ms is associated with an increased risk of cardiovascular morbidity and mortality[11]; in our study, electrocardiographic parameters (QTc, QTc max, and QTc min) in a group of obese patients were significantly prolonged compared to a group of normal weight individuals. Other numerous studies[12-15] suggest that obesity, particularly central type of obesity, is associated with delayed ventricular repolarization that leads to a prolonged QTc interval and QTc dispersion. One of the causes of QTc prolongation may be disbalance of the autonomic nervous system in obesity.[16] Schwartz and Gao in their studies believe that disturbances in sympathetic innervation of the heart lead to a prolonged QTc interval in men and women.[17,18] Other possible mechanisms that contribute to the extension of the QTc interval in obesity may be electrolyte abnormalities. High levels of free calcium and low levels of magnesium can be found in obese patients.[19] However, it is impossible to distinguish whether obesity per se or metabolic disorders associated with obesity affect the QTc interval.[20,21] QTc dispersion in our study was not significantly more pronounced in obese patients group. This is a parameter that is still intensely studied, and conducted studies have conflicting results. In the Japanese study performed on 36 obese patients, QTc dispersion was significantly longer in obese patients than in the control group,[22] whereas in the study from the Girola *et al*., no significant association between QTc dispersion and obese and overweight individuals was found.[15]

Limitations

Our study has small number of subjects to make conclusion on possible arrhythmic risk. Future longitudinal studies are needed to assess the risk of sudden cardiac death and to correlate it with QTc and QTd interval length.

Absolute values of QTc interval in obese subjects in our study are not highly abnormal, but higher values even in normal range like in our study are associated with increased cardiovascular morbidity and mortality.

CONCLUSION

The measurement of QTc interval is a simple noninvasive diagnostic method and combining with other risk factors may be helpful in calculating the cardiometabolic risk in obese patients. Calculation of these ECG parameters should be included in everyday clinical practice, especially in obese patients, because timely diagnosis and treatment helps to reduce the risk of adverse cardiovascular events such as the sudden cardiac death. Of all the QT electrocardiographic parameters, only QTc dispersion in our study was not longer in obese patients group. Further follow-up studies are required to come to a single conclusion if this parameter is significant as the QTc interval.

REFERENCES

1. Stokic E. *Gojaznost* i Distribucija Masnog Tkiva-Metabolicke Konsekvence. Univerzitetska Naucna Knjiga, Univerzitet u Novom Sadu; 1998.
2. Hubert HB, Feinleib M, McNamara PM, Castelli WP. Obesity as an independent risk factor for cardiovascular disease: A 26-year follow-up of participants in the Framingham heart study. Circulation 1983;67:968-77.
3. Frank S, Colliver JA, Frank A. The electrocardiogram in obesity: Statistical analysis of 1,029 patients. J Am Coll Cardiol 1986;7:295-9.
4. Peter A, Vuković B, Stokić E, Ivković-Lazar T. Long QT

Interval in Obesity. 1st ed. Athens: Balkan Congress on Obesity; 2003. p. 14.
5. Esposito K, Marfella R, Gualdiero P, Carusone C, Pontillo A, Giugliano G, *et al.* Sympathovagal balance, nighttime blood pressure, and QT intervals in normotensive obese women. Obes Res 2003;11:653-9.
6. Kim JA, Park YG, Cho KH, Hong MH, Han HC, Choi YS, *et al.* Heart rate variability and obesity indices: Emphasis on the response to noise and standing. J Am Board Fam Pract 2005;18:97-103.
7. Giraldi FP, Manzoni G, Michailidis J, Scacchi M, Stramba-Badiale M, Cavagnini F, *et al.* High prevalence of prolonged QT interval in obese hypogonadal males. Obesity (Silver Spring) 2011;19:2015-8.
8. Kramer DB, Zimetbaum PJ. Long-QT syndrome. Cardiol Rev 2011;19:217-25.
9. Straus SM, Kors JA, De Bruin ML, van der Hooft CS, Hofman A, Heeringa J, *et al.* Prolonged QTc interval and risk of sudden cardiac death in a population of older adults. J Am Coll Cardiol 2006;47:362-7.
10. Elming H, Holm E, Jun L, Torp-Pedersen C, Køber L, Kircshoff M, *et al.* The prognostic value of the QT interval and QT interval dispersion in all-cause and cardiac mortality and morbidity in a population of Danish citizens. Eur Heart J 1998;19:1391-400.
11. de Bruyne MC, Hoes AW, Kors JA, Hofman A, van Bemmel JH, Grobbee DE, *et al.* Prolonged QT interval predicts cardiac and all-cause mortality in the elderly. The Rotterdam study. Eur Heart J 1999;20:278-84.
12. Esposito K, Nicoletti G, Marzano S, Gualdiero P, Carusone C, Marfella R, *et al.* Autonomic dysfunction associates with prolongation of QT intervals and blunted night BP in obese women with visceral obesity. J Endocrinol Invest 2002;25:RC32-5.
13. Park JJ, Swan PD. Effect of obesity and regional adiposity on the QTc interval in women. Int J Obes Relat Metab Disord 1997;21:1104-10.
14. Corbi GM, Carbone S, Ziccardi P, Giugliano G, Marfella R, Nappo F, *et al*. Free fatty acids and QT intervals in obese women with visceral adiposity: Effects of sustained weight loss over 1 year. J Clin Endocrinol Metab 2002;87:2080-3.
15. Girola A, Enrini R, Garbetta F, Tufano A, Caviezel F. QT dispersion in uncomplicated human obesity. Obes Res 2001;9:71-7.
16. Peterson HR, Rothschild M, Weinberg CR, Fell RD, McLeish KR, Pfeifer MA, *et al.* Body fat and the activity of the autonomic nervous system. N Engl J Med 1988;318:1077-83.
17. Schwartz PJ, Wolf S. QT interval prolongation as predictor of sudden death in patients with myocardial infarction. Circulation 1978;57:1074-7.
18. Gao YY, Lovejoy JC, Sparti A, Bray GA, Keys LK, Partington C, *et al.* Autonomic activity assessed by heart rate spectral analysis varies with fat distribution in obese women. Obes Res 1996;4:55-63.
19. Resnick LM. Calcium metabolism in hypertension and allied metabolic disorders. Diabetes Care 1991;14:505-20.
20. Moss AJ. Prolonged QT interval syndrome. JAMA 1986;256:2985-7.
21. Moss AJ. Measurement of the QT interval and the risk associated with QTc interval prolongation: A review. Am J Cardiol 1993;72:23B-5.
22. Mshui ME, Saikawa T, Ito K, Hara M, Sakata T. QT interval and QT dispersion before and after diet therapy in patients with simple obesity. Proc Soc Exp Biol Med 1999;220:133-8.

How to cite this article: Milovančev A, Stokić E. Corrected QT Interval and Corrected QT Dispersion in Obesity. J Clin Cardiol Diagn 2019;2(1):1-4