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EVALUATION OF VENTRICULAR REPOLARIZATION PARAMETERS IN OBESE AND SEVERELY OBESE CHILDREN

OBEZ VE CİDDİ OBEZ ÇOCUKLARDA VENTRİKÜLER REPOLARİZASYON PARAMETRELERİNİN DEĞERLENDİRİLMESİ

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ABSTRACT

Aim: Ventricular arrhythmias are one of the cardiovascular disorders seen in patients with obesity. Electrocardiography (ECG) is a simple and widely used method that enables the evaluation of ventricular depolarization parameters, which are the determinants of ventricular arrhythmias. In this study, we aimed to determine the effect of obesity on ventricular repolarization parameters in children with obesity and compare children who were obese and severely obese.

Material and Methods: In the study, 86 children with obesity and 84 healthy normal-weight children aged 8-18 years were evaluated. Children with obesity were divided into two groups: body mass index (BMI) <35 kg/m2 (obese) were as group 1 and ≥ 35 kg/m2 (severely obese) were as group 2. QT interval, QTc interval, QT dispersion, QTc dispersion, Tp-e interval, Tp-e / QT, and Tp -e / QTc parameters on ECG were compared between groups.

Results: It was determined that the QT dispersion values of the obese group were higher than the control group; however, no significant difference was found in the parameters of QTc interval, QTc dispersion, Tp-e interval, Tp-e / QT, and Tp-e / QTc between the obese group and control group. When children with severely obesity were compared with children with obesity, no significant difference was found between the BMI groups in terms of ventricular parameters.

Conclusions: In our study, we found no significant changes in ECG parameters, which are considered to be predictors of ventricular arrhythmia, except for QT dispersion in children with obesity. Similarly, found no significant difference between children with obesity and severely obesity. Therefore, ıt could be thought pathological phenomena seen on ECGs in children with obesity still need a comprehensive examination.

Keywords: Children, Electrocardiogram, Obesity, QTc dispersion, Ventricular repolarization.

ÖZET

Amaç: Ventriküler aritmiler obezite hastalarında görülen kardiyovasküler bozukluklardan biridir. Elekt-rokardiyografi (EKG), ventriküler aritmilerin belirleyicisi olan ventriküler depolarizasyon para-metrelerinin değerlendirilmesini sağlayan basit ve yaygın olarak kullanılan bir yöntemdir. Bu ça-lışmada obez çocuklarda obezitenin ventriküler repolarizasyon parametrelerine etkisini belirle-meyi ve obez ve ciddiaşırı obez çocukları karşılaştırmayı amaçladık.

Gereç ve Yöntemler: Çalışmada 8-18 yaş aralığındaki 86 obez çocuk ve 84 sağlıklı normal kilolu çocuk değerlendirildi. Obezitesi olan çocuklar vücut kitle indeksine (VKİ) göre iki gruba ayrıldı: VKİ <35 kg/m2 (obez) grup 1ve VKİ ≥ 35 kg/m2 (ciddi obez) grup 2. EKG'de kaydedilen QT ara-lığı, QTc aralığı, QT dispersiyonu, QTc dispersiyonu, Tp-e aralığı, Tp-e/QT ve Tp-e/QTc paramet-releri obez, ciddiaşırı obez ve kontrol grupları arasında karşılaştırıldı.

Bulgular: Obez grubun QT dispersiyon değerlerinin kontrol grubuna göre yüksek olduğu belirlen-di; ancak obez grup ile kontrol grubu arasında QTc aralığı, QTc dağılımı, Tp-e aralığı, Tp-e/QT ve Tp-e/QTc parametrelerinde anlamlı farklılık saptanmadı. Ciddi obezitesi olan çocuklar, obezitesi olan çocuklarla karşılaştırıldığında VKI grupları arasında ventriküler parametreler açısından an-lamlı bir fark bulunamadı.

Sonuç: Çalışmamızda obez çocuklarda QT dispersiyonu dışında ventriküler aritminin belirleyicisi olduğu düşünülen EKG parametrelerinde anlamlı bir değişiklik bulamadık. Benzer şekilde obezi-tesi olan çocuklar ile ciddiobezitesi olan çocuklar arasında da anlamlı bir fark bulunamadı. Bu nedenle obez çocuklarda EKG'lerde görülen patolojik olayların hala kapsamlı bir incelemeye ihti-yacı olduğunu düşünmekteyiz.

Anahtar Kelimeler: Çocuk, Elektrokardiyogram, Obesite,QTc dağılımı,Ventriküler repolarizasyon.

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INTRODUCTION

Obesity is an epidemic health problem that is increasing in children and adolescents in our country and all over the world (Sanyaolu, Okorie, Qi, Locke, & Rehman, 2019). According to American Academy of Pe-diatric's (AAP) clinical practice guideline about childhood obesity, obesity is among common pediatric chronic diseases (Hampl et al., 2023). The complexity of the underlying mechanisms and diversity of etio-logical causes of obesity including genetic, physiological, environmental, and socioeconomic contributions becomes some important difficulties in the management of obese children treatment and follow-up.

Obesity is related to many comorbidities even childhood period, such as hypertension, insulin resistance, hyperli-pidemia, fatty liver, type 2 diabetes, orthopedic problems, and decreased self-confidence (Styne et al., 2017). Also, cardiovascular alterations are repoted in even childhood nearly one-third of children with obesity and the mainly seen cardiovascular alterations in obese children are reported as endothelial dys-function, increased intima-media thickness, increased blood pressure, and reduced myocardial functions (Bluher et al., 2015).

It is reported that increased risk of arrhythmias and sudden death are reported in obese patients even in the absence of structural heart disease (Ashraf & Baweja, 2013). Tachyarrhythmias are one of the cardiovascu-lar disorders seen in patients with obesity. Ventricular repolarization changes seen in patients with obesity are stated as an important factor for ventricular arrhythmic events, mortality, and sudden death. Ventricu-lar tachyarrhythmias can be seen secondary to ventricular repolarization changes such as QT interval pro-longation in patients with obesity. Therefore, it is very important to identify potential objective determi-nants of ventricular arrhythmias. There are many arguments about which ECG changes in obese children are significant. QT interval, QTc, QTd, QTcd, Tp-e interval, Tp-e /QT and Tp-e /QTc ratio in various clini-cal situations, and ventricular arrhythmic events and sudden have been shown to predict death (Monitillo, Leone, Rizzo, Passantino, & Iacoviello, 2016). Early recognition of obesity and prevention of these impor-tant complications are of vital importance even during childhood period.

The present study aimed to evaluate the effect of obesity on ventricular repolarization parameters at ECG (QT interval, QT dispersion, QTc interval, QTc dispersion, Tp-e interval, Tp-e / QT, and Tp -e / QTc) in children with obesity, also to compare children with obesity and severely obesity.

MATERIAL AND METHODS

Study population

Eighty-six obese children aged 8-18 years were followed in the pediatric endocrinology outpatient clinic between January 2018 and November 2022. Eighty-four healthy children were included the study as a control group. Patients with additional heart disease on ECG, left ventricular systolic dysfunction, a history of arrhythmia, drug use, and patients with comorbidities were excluded from the study.

The height and weight of obese children and the control group were measured using a stadiometer with standard approved devices. The same pediatric nurse measured the height and weight three times, and average values were recorded. The height SDS, weight SDS, and BMI SDS were calculated using ÇEDD (Çözüm using Olcay Neyzi values) (Demir, Ozen, Konakci, Aydin, & Darendeliler, 2017). Ambulatory blood pressure measurements were made at rest using age-appropriate blood pressure measurement cuffs surrounding two-thirds of the arm.

Patients with a BMI ≥95th percentile for age and sex were defined as obese, and patients with BMI ≥120% 95th or a BMI ≥35 kg/m2 were defined as having severely obesity (Hampl et al., 2023). In the control group, healthy children of the same age and sex with a BMI <85th percentile were selected.

Electrocardiography

Standard 12-lead ECG (GE healthcare MAC 2000, 8200W. Tower Avenue, Milwaukee, WI, USA) was performed at 25 mm/sec and 10 mm/mV scale and was measured manually by a single pediatric cardiologist and interpreted as blind without detailed clinical information of the patients. QT interval was measured and QT dispersion (QTd) was obtained by calculating the difference between the longest QT interval (QTmax) and the shortest QT interval (QTmin) on the ECG. Corrected QT interval (QTc) according to heart rate was calculated with Bazett's formula, and QTc was obtained. QTc dispersion (QTcd) was obtained by calculating the difference between the longest QTc (QTc max) and the shortest

QTc (QTc min). The Tp-e interval was defined as the distance from the peak of the T wave to the end of the T wave. Tp-e/QT and Tp-e/QTc ratios were calculated. QT interval, QT dispersion, QTc interval, QTc dispersion, Tp-e interval, Tp-e / QT, Tp-e / QTc parameters were compared between the obese and control groups.

Obesity patients were divided into two groups according to their BMI values. Patients with BMI< 35 kg/m2 (obese) were defined as group 1, and patients with BMI ≥35 kg/m2 (severely obese) were defined as group 2. QT interval, QT dispersion, QTc interval, QTc dispersion, Tp-e interval, Tp-e / QT, and Tp -e / QTc parameters were compared between the BMI groups.

Statistical Evaluation

The Statistical Package for the Social Sciences (SPSS) Ver. 25.0 program was used for data analysis. Histograms and the Kolmogorov-Smirnov test were used to assess the data distribution. Pearson's chi-squared test was employed to assess the association between categorical variables. When comparing two independent groups, the Mann-Whitney U test or Student's t-test was employed based on the data distribution.

Informed consent was received from patients and their parents. Ethics approval was obtained from the Ethics Committee (Project No: 1107). The study protocol is to the ethical guidelines of the 1975 Helsinki Declaration.

RESULTS

As study group 86 children with obesity were included in the study, 54 (62.8%) were female. The mean age of the children with obesity and the control group was in a similar range and was 12.7±3.1 and 12.5±2.9 years. The mean BMI and BMI SDS of the children with obesity were found as 30.6±5.1 and 99.1±1.0 respectively. As expected, the weight, weight SDS, height SDS, BMI, BMI percentile, and BMI SDS of the children with obesity were higher than the control group. The mean systolic blood pressure (SBP) was 123.3±15.1 mm Hg, the mean diastolic blood pressure (DBP) was 70.7±9.6 mm Hg, and the mean heart rate was 89.2±13.5 beats/minute in children with obesity. The mean SBP, DBP and heart rate were statistically higher than the control group.

On the ECG's, it was found that the QT dispersion values of the children with obesity were higher than the control group, and the QT min, QT max, QT interval, and QRS values were lower than the control group; however, no significant difference was found in the parameters of QTc interval, QTc dispersion, Tp-e interval, Tp-e / QT and, Tp-e / QTc between the obese and control groups ($p>0.05$) (Table 1)

Sixteen of 86 children with obesity were severely obese. Age, weight, weight SDS, height, BMI percentile, BMI SDS, insulin, HOMA-IR, triglyceride, and alanine transaminase (ALT) values of those with a BMI value ≥35 kg/m2 were higher than those with a BMI <35 kg/m2, and high-density lipoprotein (HDL) values were found lower than in children with obesity with a BMI <35 kg/m2 ($p<0.005$). When children with obesity were compared according to their BMI values the results are given in Table 2.

When the QT interval, QTd, QTc interval, QTcd, Tp-e interval, Tp-e / QT and, Tp-e / QTc parameters of patients with a BMI value of ≥35 kg/m2 (severely obese) were compared with patients with a BMI of <35 kg/m2, no significant difference was found between the BMI groups. ($p>0.05$) (Table 2).

Table 1. Comparison ECG findings of obese and control children

	Obese (n=86)	Control (n=84)	p
Age	12.7±3.1	12.5±2.9	0.606
Sex (male/female)	32 / 54	24 / 60	0.231
SBP	123.3±15.1	107.1±10.7	**<0.001**
DBP	70.7±9.6	65.1±7.4	**0.002**
Heart rate	89.2±13.5	83.5±11.7	**0.004**
PR	128.4±14.6	127.1±17.2	0.609
QRS	58.5±11.5	72.8±13.0	**<0.001**
QT mean	320.8±21.9	328.6±21.3	**0.019**
QT min	309.8±22.7	319.3±22.2	**0.007**
QT max	331.7±22.4	337.9±22.1	**0.035**
QT dispersion	21.9±10.8	18.6±12.5	**0.011**
QTc mean	391.2±17.7	387.1±16.4	0.125
QTc min	378.1±19.9	374.3±17.3	0.191
QTc max	404.2±19.2	399.9±18.7	0.140
QTc dispersion	26.1±16.7	25.6±14.7	0.984
Tp-e	69.9±11.2	72.5±9.6	0.139
Tp-e/QT	0.21±0.03	0.22±0.03	0.986
Tp-e/QTc	0.17±0.03	0.18±0.02	0.072

DBP: Diastolic blood pressure, **SBP**: Systolic blood pressure

Table 2. Comparison of ECG parameters according to BMI values in obese children (n=86)

	BMI: <35 (n=70)	BMI: ≥35 (n=16)	p
Age	12.2±3.1	15.1±1.9	**0.001**
Sex(male/female)	27 / 43	5 / 11	0.585
SBP	121.6±13.8	130.6±18.3	0.060
DBP	70.2±9.2	72.9±11.4	0.173
Heart rate	89.2±13.8	89.3±12.8	0.960
PR	128±14.7	130.1±14.2	0.718
QRS	58.8±11.2	56.8±12.9	0.505
QT mean	321.7±21.8	316.8±22.6	0.702
QT min	310.4±23.0	307.4±22.0	0.726
QT max	332.9±22.1	326.3±23.6	0.420
QT dispersion	22.6±11.5	18.9±6.3	0.235
QTc mean	391.8±17.1	388.3±20.6	0.411
QTc min	378.2±20.3	377.8±19.2	0.890
QTc max	405.5±18.1	398.8±23.4	0.198
QTc dispersion	27.3±17.5	21.1±11.7	0.269
Tp-e	71.1±10.6	64.8±12.4	0.057
Tp-e/QT	0.22±0.03	0.20±0.04	0.104
Tp-e/QTc	0.18±0.03	0.17±0.03	0.081

BMI: Body mass index **DBP**: Diastolic blood pressure, **SBP**: Systolic blood pressure

DISCUSSION

Childhood obesity is one of the most common pediatric chronic diseases which can affect children and adolescents all around the world. Several cardiovascular comorbidities can be seen in children with obesity (Bluher et al., 2015). Ventricular arrhythmias, which are one of the cardiovascular disorders seen in patients with obesity, can be the cause of sudden death. It is estimated that the rate of sudden cardiac death in people with obesity is higher than in the normal population (Kiess et al., 2020). ECG monitoring is a simple and widely used method that can assist in the evaluation of ventricular depolarization parameters. The present study gives important results on the effect of childhood obesity and severely obesity on ventricular repolarization parameters on ECG.

Obesity and ECG changes are well-studied in adult patients with obesity. On the other hand in children, the effect of obesity on ECG parameters is not well defined with largest studies. In adult patients with obesity, a variety of ECG changes including elevated resting heart rate, S-T depression, prolongation of the PR interval, and QRS duration have been demonstrated in many studies and obesity was found to be associated with a high prevalence of prolonged QT interval (Frank, Colliver, & Frank, 1986; Straus et al., 2006). Moreover, favorable ECG changes have been reported after significant weight loss in adults with morbid obesity (Murat, Sinan, Namik, & Yakup, 2021).

In the literature, the results of studies on ECG changes in children with obesity are controversial. Many ECG studies showed no significant results related to ECG parameters and obesity, whereas some studies showed important ECG changes in children with obesity (Kiess et al., 2020; Sun et al., 2013). To assess prevalence and describe the ECG abnormalities in obese adolescents Salim et al. made a cross-sectional study by recording ECGs of 78 obese adolescents aged 11-15 years from students of high schools. They reported that the prevalence of cardiac abnormalities in obese adolescents is 37%, consisting of heart rhythm abnormalities [sinus tachycardia (17%), sinus arrhythmia (14%), prolonged QTc interval (10%), and prolongation of PR interval (6%)] (Salim, Gunawijaya, & Yantie, 2020). Another study which is performed by Sun et al. on patients aged 5-18 years. They evaluated of anthropometric data, and standard 12-lead ECGs for each participant(Sun et al., 2013). They found that children and adolescents with obesity had ECG changes such as wider QRS duration, longer PR intervals, and a leftward shift of frontal P wave, QRS, and T wave axes, regardless of patients blood pressure, age,and sex (O'Neil et al., 2010). Another study was made by Üner et al., reported no significant difference in QT, QTd, QTc, and QTcd values between the 30 obese and 30 healthy children (Uner, Dogan, Epcacan, & Epcacan, 2014). Yıldırım et al. found no significant differences in QT and QTc in a study of 209 children (including 140 athletes, 38 obese children, and 31 normal weight children), but QTd was found to be significantly higher in athletes and children with obesity in dynamic and combined sports in the control group (Yildirim et al., 2016). In our study, however, we found no statistically significant difference between QT, QTc, and QTc dispersion parameters in children with obesity; we only found a statistically significant difference in the QT dispersion value and heart rate.

Contrary to these studies, Peach et al. made a study on heathy obese volunteers and normal BMI controls. They research on the influence of childhood obesity on distinct ECG parameters. They reported that obesity in healthy children did not cause pathologic ECG phenomena and that pathology should be suspected only if there were clearly abnormal ECG findings even in children with severe obesity (Paech et al., 2018). In the present study, when we compared children who were obese and severelyobese, we found no significant difference in QT, QTc, QT dispersion, and QTc dispersion values.

Tp-e interval, Tp-e/QT, and Tp-e/QTc ratios are also reported to be another sensitive ECG marker for the risk of life-threatening ventricular arrhythmias and sudden death (Gupta et al., 2008). Inanir et al. found that the Tp-e interval and Tp-e/QTc ratio increased in relation to the prolonged QT duration in their study on adult patients with extreme obesity (Inanir et al., 2019). Akkuş et al. found a significant difference between the groups in terms of Tp-e intervals in their study evaluating the effects of obesity on ECG in adolescents (Akkuş, Dibeklioğlu, Özdemir, Baş, & Çiçek, 2022). However, they observed no significant difference in terms of Tp-e/Qtc, and Tp-e/QT ratios (Akkuş et al., 2022). In our study, we found no statistically significant differences in the Tpe interval, Tp-e/QT, and Tp-e/QTc ratios between the obese and control groups. In addition, when we compared children with obesity and children with severely obesity, we found no statistically significant difference in Tpe interval, Tp-e/QT, and Tp-e/QTc ratios.

Study limitation

Our study was designed as a cross-sectional study examining the associations between obesity and ECG parameters. However, long-term interaction was not evaluated.

CONCLUSION

Obesity can cause ECG changes in children. Early recognition of obesity and prevention of cardiac complications are of vital importance even during childhood period. In our study, we found no significant changes in ECG parameters such as QT, QTc, QTcd, Tp-e, Tp-e/QT, and Tp-e/QTc, which are considered to be predictors of ventricular arrhythmia, except for QT dispersion and heart rate in children with obesity. Similarly, we found no significant difference between children with obesity and

severely obesity. Therefore, pathologic phenomena seen on ECGs in children with obesity still need a comprehensive examination. Further studies with larger case series may help to evaluate the long-term interaction of obesity and ECG parameters.

Author Contributions
Plan, design: A.O, E.D.A**; Materials, methods, and data collection:** A.O**; Analysis and interpretation:** E.D.A**; Writing and critical assessment:** A.O.

Conflict of interest
There is no conflict of interest to declare in this study.

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