TURKISH JOURNAL OF SCIENCE
VOLUME IV, ISSUE II, 76-91
ISSN: 2587-0971
http://dergipark.gov.tr/tjos

Normotansif Obez Çocuklarda QT İntervali, QT Dispersiyonu, Düzeltilmiş QT İntervali, Düzeltilmiş QT Dispersiyonu ve Kardiyovasküler Risk Değişkenleri Arasındaki İlişki

The Relation Between QT Interval, QT Dispersion, Corrected QT Interval, Corrected QT Dispersion and Cardiovascular Risk Variables in Normotensive Obese Children

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Geliş Tarihi / Received Date: 9 October 2019
Kabul Tarihi / Accepted Date: 27 October 2019

Öz: Amaç: Bu araştırmanın amacı normotansif obez çocuklarda ventrikül aritmi ve kardiyovasküler mortalitenin erken tanısında QT intervali, QT dispersiyonu (QTd), düzeltilmiş QT intervali (QTc) ve düzeltilmiş QT dispersiyonu (QTcd) duyarlılığının olup olmadığının saptanması ve bu değerlerin başta vücut kitle indeksi (VKİ) olmak üzere kardiyovasküler komplikasyonlar açısından bakılan parametreler ile ilişkilerinin değerlendirilmesi, eğer anlamlı bir ilişki varlığı gösterilirse bu grup çocuklarda ciddi ventriküler aritmi riski olduğuna dikkat çekmektir.
Yöntem: Hasta grubuna Çocuk Endokrinoloji Bilim Dalı'nda ekzojen obezite tanısı ile takip edilen 30 obez çocuk katılırken kontrol grubuna ise Çocuk Kardiyoloji Polikliniği'ne masum üfürüm ön tanısı ile gelip normal bulunan 20 sağlıklı çocuk dahil edildi. Tüm çocukların antropometrik ve kan basıncı ölçümleri alınarak açlık serum lipidleri, glukoz ve insülin düzeyleri belirlendi. Elektrokardiyografik kayıtlar alındı ve QT intervali, QTd, QTc ve QTcd hesaplandı. İki boyutlu ve m-mode ekokardiyografi ile apikal dört boşluk pozisyonunda boşluk genişlikleri değerlendirildi.
Bulgular: Ventriküler aritmi ve kardiyovasküler mortalite erken tanısında EKG kayıtlarından elde edilen QT intervali, QTd, QTc ve QTcd hasta grubunda daha yüksekti, ancak kontrol grubuyla karşılaştırıldığında istatistiksel olarak anlamlı bir fark bulunmadı. Vücut kitle indeksi ve kardiyovasküler komplikasyonlar açısından incelendiğinde, QT intervali ile ilgili bu değerler ile kan lipidleri ve serum insülin seviyeleri arasında pozitif bir ilişki bulunmadı. Ancak artmış sol ventrikül kitlesi, vücut kitle indeksi, sol ventrikül kitle indeksi ve m-mod ekokardiyografik ölçümler beklendiği gibi pozitif korelasyon gösterdi.
Sonuç: Ekzojen obezite tanısı alan normotansif çocuklarda, erişkinlerde olduğu kadar ciddi ventriküler aritmi riski yoktur. Ancak yine de oluşabilecek komplikasyonlar açısından dikkatli olunması, bu grup çocukların ilerleyen yaşlarda oluşacak ciddi ritm bozuklukları açısından yakından izlenmesi gerekmektedir.

Anahtar Kelimeler — Obezite; QT dispersiyonu; ekokardiyografi; kardiyovasküler risk faktörleri; çocuklar.

Abstract: Objective: The goal of this search was to find out whether the sensitivity of QT interval, QT dispersion (QTd), corrected QT interval (QTc) and corrected QT dispersion (QTcd) sensitivity in the early diagnosis of ventricular arrhythmia and cardiovascular mortality in normotensive obese children exists or not and to evaluate their relation with the parameters examined in terms of cardiovascular complications, such as body mass index (BMI) and finally if there is a significant relationship between them, to draw attention to the risk of serious ventricular arrhythmia in this group of children.
Method: 30 obese children were included to patient group who were followed up with exogenous obesity at the Department of Pediatric Endocrinology and 20 healthy children were included to control group who came to the Pediatric Cardiology Polyclinic with the preliminary diagnosis of innocent murmur. Fasting serum lipids, glucose and insulin levels were examined in all children through anthropometric and blood pressure measurements. Electrocardiographic recordings were obtained and QT interval, QTd, QTc and QTcd were calculated. The apical widths in the apical four cavity positions were evaluated with two-dimensional and m-mode echocardiography.

Results: QT interval, QTd, QTc and QTcd obtained from ECG recordings in the early diagnosis of ventricular arrhythmia and cardiovascular mortality were higher in the patient group, but no statistically meaningful difference was found when compared to the control group. There was no positive correlation between these values related to QT interval and blood lipids and serum insulin levels which were examined in terms of body mass index and cardiovascular complications. However, increased left ventricular mass, body mass index, left ventricular mass index and m-mode echocardiographic measurements showed positive correlation as expected.
Conclusion: There is no risk of severe ventricular arrhythmia in normotensive children diagnosed with exogenous obesity as it is in adults. However, this group of children should be closely monitored for serious rhythm disorders that will occur later in life and care should be taken for potential complications.

Keywords — Obesity, QT dispersion, echocardiography, cardiovascular risk factors, children.

1.INTRODUCTION

Obesity is a major health problem worldwide, leading to serious economic costs and shortening of healthy lifespan [1]. The main problem in obesity is that the energy received is more than the energy consumed. This type of obesity without a defined cause is called primary obesity or exogenous obesity [2,3]. It is known that childhood obesity causes complications such as hypertension, hyperlipidemia, early atherosclerosis, psychosocial, cardiovascular, endocrinological, gastrointestinal, pulmonary, orthopedic and neurological diseases and shortens the life expectancy [4,5].

Structural and functional changes caused by obesity may lead to atrial and ventricular repolarization abnormalities. As a result of these abnormalities, various changes in P wave duration, PR distance, QT interval and QT dispersion (QTd) may occur. Many studies have performed an increase in QT interval and QTd in obese individuals [6,7].

The inter-derivation variability of the QT interval in standard 12-derivation ECG recordings is described as the QTd and it is measured via subtracting process of the minimum QT interval from the maximum QT interval (max QT-min QT). Since standard ECG probes receive signals from different myocardial regions, QTd is stated as "almost" a direct indicator of the regional heterogeneity of ventricular repolarization. It has been reported that prolonged corrected QT interval (QTc) and corrected QT dispersion (QTcd) calculated by correcting the heart rate increase the risk of ventricular arrhythmia [7-9].

The goal of this search was to find out the sensitivity of QT interval, QTd, QTc and QTcd in the early diagnosis of cardiovascular complications such as ventricular arrhythmia in normotensive obese children and to evaluate their relationship with the cardiovascular complication metrics, such as especially body mass index (BMI). Therefore, it was also aimed to draw attention to the risk of serious ventricular arrhythmias in this group of children, if a significant relationship was found.

2. MATERIALS AND METHODS

The study was carried out with the children who had applied to the Department of Pediatric Endocrinology, Faculty of Medicine, Selcuk University with the complaint of weight gain and were evaluated as exogenous obesity as a result of the clinical and laboratory data of the children. The study was started following the approval of application numbered 2013-12/62 from Selçuk University Ethics Committee.

30 obese children aged between 5-17 years without hypertension were in the search. The control group involved 20 healthy and non-obese children of similar age and sex. The parents of all children in the patient and control groups confirmed the informed consent.

Blood lipid and cholesterol levels, fasting blood glucose and basal insulin levels of all obese patients, which had been requested during routine outpatient controls by Pediatric Endocrinology Department, were taken from their files. Fasting blood glucose, blood lipid and cholesterol levels of control group were taken from the files of polyclinical control. High density lipoprotein (HDL) cholesterol levels below 35 mg/dl and low density lipoprotein (LDL) cholesterol levels above 130 mg/dl were accepted as limit values in terms of cardiovascular mortality and morbidity [10]. Triglyceride levels were evaluated according to their age and sex [11].

Anthropometric measurements and arterial blood pressure measurements were recorded in all cases. Weight measurement was performed with an empty stomach, naked body and empty bladder. Height was measured with a stadiometer. All anthropometric measurements were performed by the same method. BMI was calculated by proportioning the weight (kg) to the square of the height (m) [12]. BMI was calculated by using percentage slice curves prepared according to age and sex. 85-95 cases were considered as overweight while 95 and over cases were evaluated as obese [12,13].

Echocardiographic Examination

All echocardiographic evaluations were performed using the Aplio XV Toshiba model. The apical widths in the apical four-chamber position was evaluated by two-dimensional echocardiography. Left ventricular (LV) outflow tract and interventricular septum (IVS) were examined in the parasternal long axis position. M-mode sections were taken from the papillary muscle level and left ventricular end-diastolic thickness (LVDS), left ventricular end-systolic thickness (LVSS), and septum thickness were measured. M-mode measurements for left atrial and aortic diameters were recorded. Left ventricular mass (LVM) was calculated [14].

Since LVM increases with height growth, LVM index (LVMI) proposed by De Simon et al. [15] were also evaluated. Heart cavity measurements of all subjects were compared with normal values reported for the weight of children.

Electrocardiographic Examination and QT Measurements

After resting for 10 minutes, all children were recorded at the Pediatric Cardiology Policlinic ECG laboratory using standard 12-derivation ECG (Nihon Kohden) recording at 25 mm/sec speed and 10 mm/mV amplitude at rest and lying position to achieve standardization. QTd, QTc interval and QTcd were calculated. The QT interval was described as the distance from the start of the QRS complex to the end of the T wave. Using the same QT waves, the QTc interval for each derivation was calculated with Bazzet formula by correcting for heart rate [16,17]. The difference among the longest QT, QTc and shortest QT, QTc duration in all derivations were calculated and QT and QTc dispersions were found. The effects of clinical characteristics on QT interval, QTd, QTc interval and QTcd were investigated. In addition, it was examined whether there was a meaningful difference in obese children and adolescents group, compared to the control group in terms of ECG findings.

Statistical Analysis

SPSS 16.0 statistical package programme was applied for the statistical analysis. Data were summarized as mean ± standard deviation (SD). Normal distribution analysis of the data was applied by Kolmogorov Smirnov test. Paired t-test was used for comparison of two groups. The differences between the frequencies of categorical variables were investigated by chi-square test. Correlations between variables were calculated using Pearson correlation coefficients. In the study, $p<0.05$ was evaluated as meaningful.

3. RESULTS

General Data

Data on heart rate, gender, age, arterial blood pressure and anthropometric parameters of the patient and control groups were given in Table 1.

Table 1: Data of age and gender, arterial blood pressure, heart rate and anthropometric parameters of the patient and control groups (mean ± SD).

	Patient (n: 30)	Control (n: 20)	p
Age (years)	11,4±2,5	12,7 ±2,6	p=0,087
Gender (M / F)	18/13	10/8	p=0,864
Body mass (kg)	58,9±15,8	41,0±13,9	**p<0,001**
Height (cm)	146,8±11,2	148,3±15,3	p=0,701
BMI (kg / m²)	26,4±4,1	18,2±3,2	**p<0,001**
Waist circumference (WC) (cm)	84,7±10,7	63,3±5,8	**p<0,001**
Hip circumference (HC) (cm)	91,4±11,3	84,9±7,4	**p=0,03**
WC / HC ratio	0,92±0,06	0,74±0,03	**p<0,001**
Systolic blood pressure (mmHg)	106±9	103±6	p>0,05
Diastolic blood pressure (mmHg)	65±7	65±5	p>0,05
Heart Rate (beats / min)	86 ±13	82±13	p>0,05

In the evaluation of demographic data, the mean age of the patient group was 11.4 ± 2.5 years and the control group was 12.74±2.6 years (p = 0.087). In the patient group, 13 (41.93%) of the patients were male and 18 (58.06%) were female, while 10 (55.5%) of the control group were female and 8 (44.4%) were male (p=0.864). In terms of mean age, gender, blood pressure and heart rate, any statistical difference was not determined (p>0.05), and the groups were homogeneous (Table 1).

When anthropometric measurements were evaluated, it was seen that no statistically meaningful difference between the average height of the two groups (146.86±11.25 cm in the patient group and 148.33±15.31 in the control group) (p=0.701) was found. The average weight of the patient group was 58.9±15.86 kg and the control group was 41.0±13.92 kg, and there was a statistically meaningful difference beween the groups (p<0.001). BMI (26.47±4.10 kg/m² in the patient group and 18.28±3.23 kg/m² in the control group), waist circumference (84.73±10.73 cm in the patient group and 63.39±5.87 cm in the control group) and waist/hip circumference (0.92±0.06 in the patient group and 0.74±0.03 in the control group) were meaningfully higher in the patient group (p<0.001, for all). The average hip circumference (91.42±11.38 in the patient group and 84.94±7.42 in the control group) demonstrated statistically meaningful values between the groups (p=0.03) (Table 1).

The average systolic blood pressure was 106±9 mmHg, the mean diastolic blood pressure was 65±7 mmHg and the heart rate was 86±13/min in the patient group, while systolic and diastolic blood pressures and heart rate were 103±6 mmHg, 65±5 mmHg and 82±13/min in control group, respectively. No statistically meaningful difference was detected between two groups in terms of systolic and diastolic blood pressures and heart rate (p>0.05 for all) (Table 1).

When two groups were compared, as statistically, any significant difference could not be found for the mean values of fasting plasma glucose (92.74±5.74 mg/dl in the patient group and 89.83±14.1 mg/dl in the control group) and basal insulin level (15.56±8.78 µIU/ml in the patient group and 14.33±9.36 µIU/ml in the control group) (p=0.307 and p=0.648, respectively). However, mean of fasting plasma triglyceride level was 119.03±48.6 mg/dl, LDL cholesterol value was 105.82±22.7 mg/dl, HDL cholesterol value was (41.84±7.43 mg/dl) and alanine transaminase (ALT) level was 24.39±14.3 in the patient group, while in the control group, mean of fasting plasma triglyceride, LDL cholesterol, HDL cholesterol and ALT levels were 77.83±24.12 mg/dl, 84.73±14.9 mg/dl, 48.39±7.99 mg/dl and 12.78±3.49, respectively. There was a statistically meaningful difference among the groups (p=0.002, p=0.001, p=0.006 and p=0.002, respectively) (Table 2).

When fasting triglyceride and LDL limit levels were referenced as 11 and 130 mg/dl according to age and sex, 16 (51.6%) and 3 (9.6%) individuals in patient group had high values. In addition when the HDL cholesterol limit level was referenced as 35 mg/dl, 5 (16.1%) individuals in the patient group had low values.

Table 2: Laboratory data of the patient and control groups (mean ± SD).

	Patient (n: 30)	Control (n: 20)	P
Triglyceride (mg / dl)	119,03±48,6	77,8±24,1	**p=0,002**
LDL (mg / dl)	105,82±22,7	84,7±14,9	**p=0,001**
HDL (mg / dl)	41,8±7,4	48,3±7,9	**p=0,006**
Fasting blood glucose (mg / dl)	92,7±5,7	89,8±14,1	p=0,307
Basal insulin level (µIU / ml)	15,5±8,7	14,3±9,3	p=0,648
ALT	24,3±14,3	12,7±3,4	**p=0,002**

Echocardiographic Data

As a result of m-mode echocardiography, end-diastolic diameter (LVDS) was 43.4±5.62 mm in the patient group, whereas 38.94±5.26 mm in the control group with a statistically meaningful difference (p=0.008). In patient group, left ventricular end-systolic diameter (LVES) was 24.1±3.26 mm, left atrial diameter (LA) was 27±3.2 mm, interventricular septum thickness (IVS) was 8.2±0.9 mm, posterior wall thickness was 8.2±1.0 mm and shortening fraction (FS) was 43.71±6.0, while these values were 22.3±4.1, 25.06±3.4, 7.9±0.6, 7.9±0.5 and 41.94±2.8 in the control group, respectively. No statistically meaningful difference was observed between the groups (p=0.09, p=0.05, p=0.2, p=0.2, p=0.6) (Table 3). The aortic annulus (AA) was 24.2±2.3 mm in the patient group and 22.5±3.1 mm in the control group . A statistically meaningful difference was found between the groups (p=0.03).

The mean value of LVM was calculated by m-mode echocardiography and the results were 116.16 ± 35 g in the patient group and 92.0 ± 27.9 g in the control group. When compared to the control group, it was evaluated as higher in the patient group (p = 0.017).

Table 3: Results of m-mode echocardiographic evaluations of patient and control groups (mean ± SD).

	Patient (n:30)	Control (n:20)	p
LVDS (mm)	43.4±5.6	38.9±5.2	**p=0.008**
LVSS (mm)	24.1±3.2	22.3±4.1	p=0.09
LA (mm)	27±3.2	25.0±3.4	p=0.05
IVS (mm)	8.2±0.9	7.9±0.6	p=0.2
Rear wall (mm)	8.2±1.0	7.9±0.5	p=0.2
FS (mm)	43.7±6.0	41.9±2.8	p=0.6
AA (mm)	24.2±2.3	22.5±3.1	**p=0.03**

Table 4: Comparison of patient and control groups in terms of LVM (mean±SD).

	Patient (n:30)	Control (n:20)	P
LVM (gr)	116,16±35	92,0±27,9	**p=0,017**

Electrocardiographic Data

The electrocardiographic data of the control and patient groups were given in Table 5. No statistically meaningful difference was determined between the electrocardiographic data of groups (p>0.05) (Table 4).

Table 5: Relationship of electrocardiographic findings of patient and control group (mean ± SD).

	HR	QT max	QT min	QTd	QTc max	QTc min	QTcd
Patient (n= 31)	86 (±13)	0,38 (±0,03)	0,31 (±0,03)	0,072 (±0,02)	0,46 (±0,03)	0,36 (±0,03)	0,09 (±0,03)
Control (n= 18)	82 (±13)	0,38 (±0,03)	0,31 (±0,02)	0,065 (±0,01)	0,045 (±0,02)	0,37 (±0,02)	0,08 (±0,02)
P	0,37	0,63	0,75	0,27	0,18	0,64	0,08

HR: heart rate, max: maximum, min: minimum, QTd: QT dispersion, QTcd: QTc dispersion.

Positive correlation was found between BMI and LVES, IVS, LVM, and LVMI (Figure 1-4). LVDS, LVSS, IVS, LVM and LVMI were found to increase with increasing BMI.

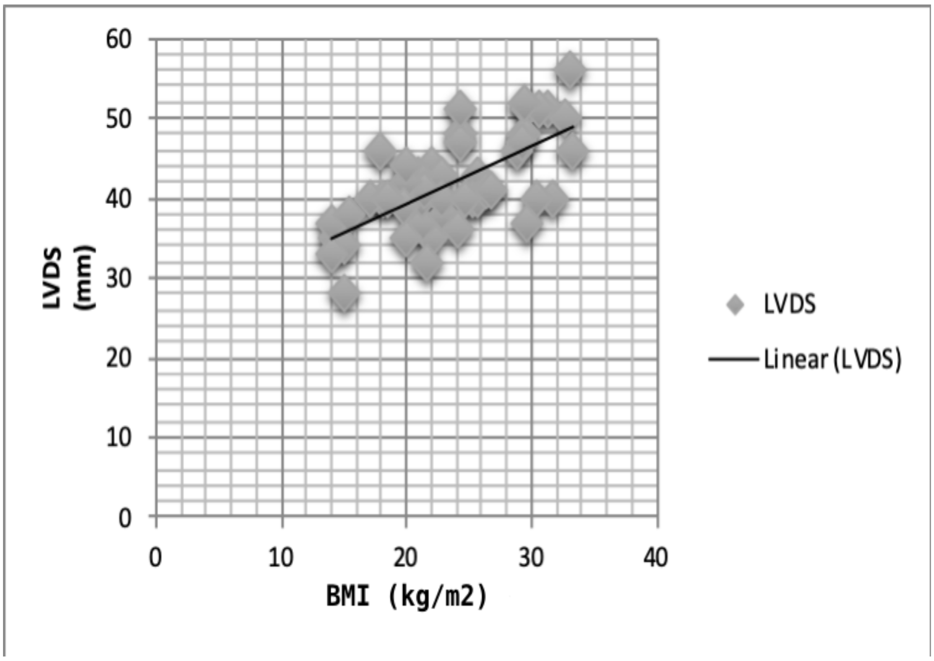

Figure 1: Relationship between LVDS and BMI (p<0.001).

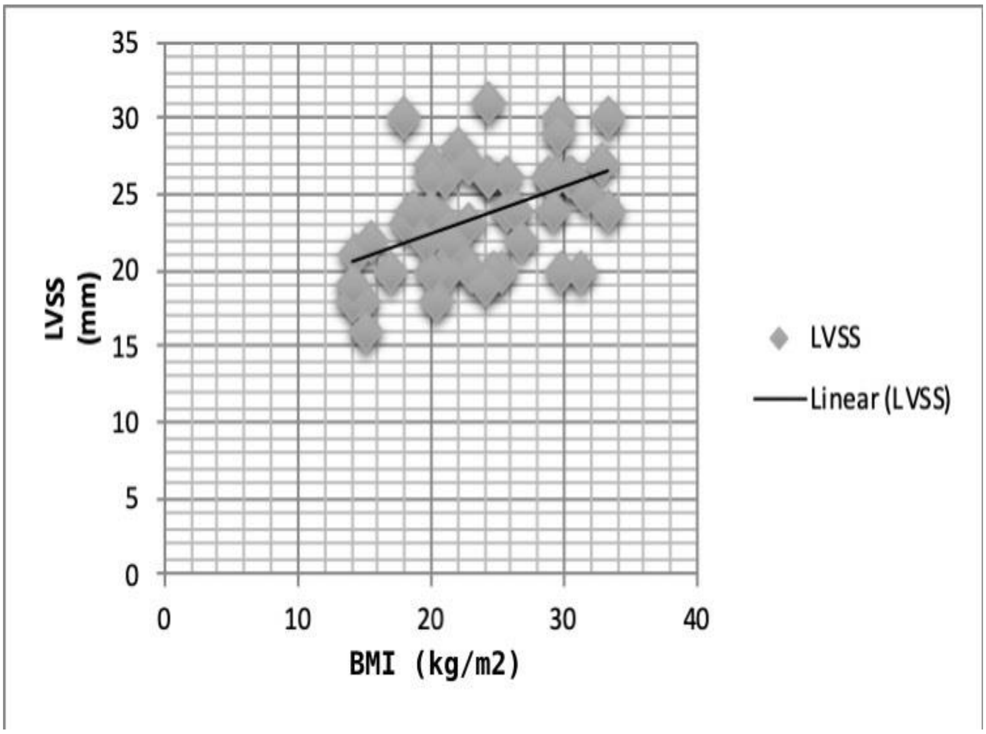

Figure 2: Relationship between LVSS and BMI (p=0.024)

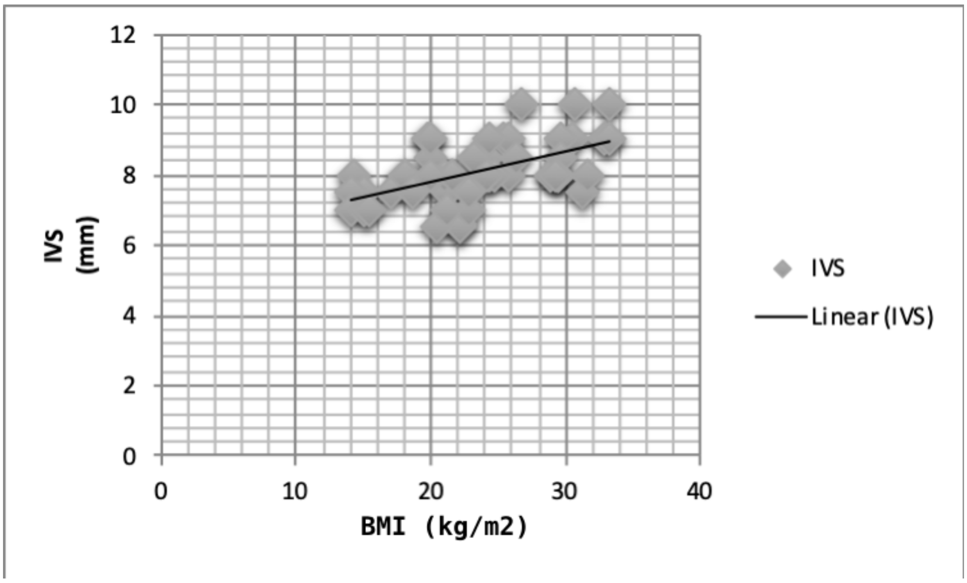

Figure 3: Relationship between IVS and BMI (p<0.001).

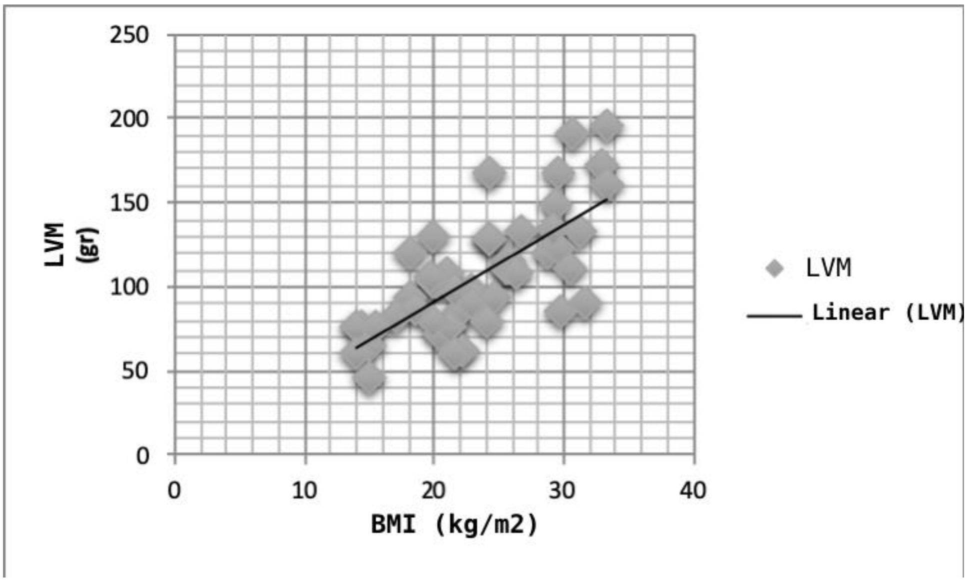

Figure 4: Relationship between LVM and BMI (p<0.001).

No correlation was determined between electrocardiogram results and BMI (p>0.05).

4.DISCUSSION

In the last decades, frequency of obesity increases logaritmically, not only in developed countries but also in developing countries such as Turkey [6]. In adults, obesity is associated with many medical complications which reduce the quality of life and increase the morbidity. Obese children are under potential risk for adult obesity [18]. Sedentary living conditions and unbalanced eating habits, genetic and socioeconomic status play a role in the etiology of obesity. In particular, adolescence obesity has been shown to cause atherosclerosis and associated cardiovascular mortality and morbidity [6,19,20]. It has been reported that the unexplained sudden death rate is 40-60 times and the frequency of ventricular extra systole beats are 30 times higher in obese individuals than the non-obese population [6]. Before the complications of obesity show up, determining the risk factors in the early period and taking the necessary precautions are very important in terms of increasing the quality of public health and reducing health expenses. In the present study, anthropometric, echocardiographic, electrocardiographic and laboratory parameters that can be used in early detection of childhood obesity and complications and their relationships with each other were investigated.

Obesity causes structural and hemodynamic changes in the heart. Excessive fat accumulation increases blood volume and cardiac stroke volume. It is thought that insulin resistance derived from metabolic changes caused by obesity also causes cardiovascular system complications [18]. Increased blood volume and hypertension in obesity, increase the anterior and posterior load and impose a burden on the heart and cause hypertrophy. It has also been reported that obesity-induced hyperinsulinemia leads to myocardial hypertrophy via IGF-1 receptors [21]. Firstly, diastolic function and secondly, systolic function of the heart deteriorates in childhood obesity [22].

Childhood obesity is closely associated with LVI and is considered to be an important cardiovascular risk factor associated with congestive heart failure, stroke, sudden death, coronary artery disease and myocardial infarction [23,24]. Several studies have shown increased LVM in obese children [24-28]. Central fat accumulation has been shown to cause increased LVM and high cardiac output [29]. In our study, the LVM was higher significantly in the patient group than the control group.

In many studies, BMI and waist circumference measurements were associated with LVM [30-32]. Di Bonito et al. [24] found the connection between LVMI and waist/hip ratio. In another study, LVMI was positively related to height, weight, BMI, fasting insulin level [33]. In the present study, LVM was positively associated with waist/hip ratio weight, BMI, height, waist circumference, and fasting insulin level. No relationship was found between LVM with blood lipids and fasting blood glucose.

In children and adolescents with high body fat content, there are changes in sympathetic and parasympathetic activities which play role in the pathogenesis of many chronic diseases, due to the release of large amounts of inflammatory adipokines into the blood [34,35]. As a result, it is known that obese children have a higher resting heart rate [36]. On the other hand, in some studies, although there was a slight increase in heart rate in obese individuals, it was not found to be statistically significant [30,37,38]. Similarly, in the present study, although the heart rate was higher in the patient group than in the control group, the difference was not statistically significant.

Obesity has undesirable effects on children's lipid and lipoprotein values, which are accepted as important risk factors for coronary heart disease. Sedentary lifestyle, atherogenic diet and genetic factors lead to atherogenic dyslipidemia which is characterized by high triglyceride, LDL, very low density protein (VLDL) levels and HDL levels at very early ages [39]. Measurements of waist circumference or increases in waist/hip ratio positively correlates with triglyceride levels [40]. In particular, hyperinsulinemia and insulin resistance in liver during abdominal obesity cause stimulation of lipogenic enzymes in liver and occurrence of dyslipidemia [41,42]. In many studies, triglyceride and LDL levels were found to be significantly higher in obese children compared to the non-obese control group [43,44] while HDL levels were found to be significantly lower. It was emphasized that this clinical profile was effective in the development of adult atherosclerosis [44,45]. In current study, triglyceride and LDL levels were meaningfully higher and HDL levels were lower in the patient group.

There is a risk of sudden death and ventricular arrhythmia in obese individuals [38]. In the Framingham Heart Study, the annual rate of sudden cardiac death in adult obese men and women was reported to be approximately 40 times higher than in the non-obese population [46]. Many studies have reported changes in cardiac morphology in childhood obesity, too [6,30,47]. Sudden death and ventricular arrhythmias have been reported to be associated with ventricular repolarization anomalies [48]. In many studies, prolonged QT interval is recommended to be used as a predictor of ventricular arrhythmias and potential mortality [8,9]. El- Gamal et al. reported that increased body fat and increased obesity are among the most common causes of QT interval and QTc prolongation [49].

It has been reported that prolongation of QTc and QTcd increase the risk of severe ventricular arrhythmias [7-9]. QTd causes chronic heart failure, left ventricular hypertrophy in adults and ventricular arrhythmia and sudden death in patients with long QT syndrome [38]. In a study, a positive correlation was found between QTcd and serum insulin concentration [38]. It was found that QTc and QTcd increased in obese individuals compared to control group and there was a meaningful relationship between body mass index with QTc and QTcd [50]. While some reports have shown an increase in QT interval and QTd in obese individuals [7,49], there was no correlation between QTd and BMI increase in others studies [51,52]. On the other hand, some studies have shown that short-term weight loss is associated with a decrease in QT duration [50,53].

In this study, QT interval, QTd, QTc and QTcd obtained from the ECG recordings in normotensive obese children were found to be higher than the control group, but no statistically significant difference was found. There was no positive correlation between these values related to QT interval and levels of blood lipids and serum insulin, which are metrics related to BMI and cardiovascular complications.

5. CONCLUSION

Cardiac functions are impaired in obese children. In parallel with the increase in development of obesity in children, the risk of cardiovascular diseases also increases in adulthood. Deterioration of these functions, even in the absence of clinical symptoms, is important for the prevention of possible complications that may occur in the future. Increased BMI is associated with LVM, LVM index and m-mode echocardiographic measurements. Studies on QT interval in obese children are both limited and contradictory in their results. Therefore, further studies are needed to determine ECG findings in terms of ventricular arrhythmia and sudden death risk in obese children without clinical signs.

Conflict of Interest Statement

None declared.

Acknowledgement

We would like to thank all the participants for their contribution in the present study. The current study was obtained from the thesis.

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