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Research Article

# The assessment of Tp-e interval and Tp-e/QT ratio in patients with morbid obesity before and after laparoscopic sleeve gastrectomy

## *Morbid obezite hastalarında laparoskopik sleeve gastrektomi öncesi ve sonrası Tp-e aralığı ve Tp-e/QT oranının değerlendirilmesi*

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## Abstract

**Aim:** Tp-e/QT ratio is a novel marker of ventricular repolarisation. Obesity has been associated with various cardiovascular changes and an increased risk of cardiovascular disease. Obesity may be associated with prolongation of the QT interval, which could potentially increase the risk of ventricular arrhythmias. We aimed to research the assessment of Tp-e interval and Tp-e/QT ratio before and after laparoscopic sleeve gastrectomy (LSG) in patients with morbid obesity.

**Material and Methods:** In this study, we enrolled 93 consecutive patients with a BMI >40 kg/m2 or BMI >35kg/m2 with comorbidities who had previously failed to lose weight with conservative methods underwent LSG between January 2012 and December 2016.

**Results:** Heart rate (75.7 ± 4.7 vs. 72.8 ± 11.4; p=0.486), QT interval (358.1 ± 32.0 vs. 362.6 ± 30.4; p=0.399) and QTc interval (399.0 ± 34.3 vs. 396.2 ± 30.9; p=0.621) were similar before and after LSG. Tp-e interval (81.3 ± 11.4 vs. 76.3 ± 10.9; p=0.004), Tp-e/QT ratio (0.23 ± 0.04 vs. 0.21 ± 0.04; p=0.002), Tp-e/QTc ratio (0.20 ± 0.03 vs. 0.19 ± 0.03; p=0.001) were significantly different before and after LSG.

**Conclusion:** Our study showed that morbid obesity may have a negative effect on ventricular repolarization. Substantial weight loss following laparoscopic sleeve gastrectomy in obese patients is accompanied by a significant improvement in ventricular repolarization.

**Keywords:** Laparoscopic sleeve gastrectomy, morbid obesity, QT interval, Tp-e interval, Tp-e/QT ratio, ventricular repolarization.

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## Öz

**Amaç:** Tp-e/QT oranı, ventriküler repolarizasyonun yeni bir belirtecidir. Obezite, çeşitli kardiyovasküler değişiklikler ve artan kardiyovasküler hastalık riski ile ilişkilendirilmiştir. Obezite, ventriküler aritmi riskini potansiyel olarak artırabilen QT aralığının uzaması ile ilişkili olabilir. Morbid obezitesi olan hastalarda laparoskopik tüp mide operasyonu (LSG) öncesi ve sonrası Tp-e aralığı ve Tp-e/QT oranının değerlendirilmesini araştırmayı amaçladık.

**Gereç ve yöntemler:** Bu çalışmada, Ocak 2012 ile Aralık 2016 tarihleri arasında BMI >40 kg/m2 veya komorbiditeleri ve BMI >35kg/m2 olan ve daha önce konservatif yöntemlerle kilo vermeyi başaramayan 93 hastaya ardışık olarak LSG uygulandı.

Bulgular: Kalp hızı (75,7 ± 4,7 vs 72,8 ± 11,4; p=0,486), QT aralığı (358,1 ± 32,0 vs 362,6 ± 30,4; p=0,399) ve QTc aralığı (399,0 ± 34,3 vs 396,2 ± 30,9; p=0,621) LSG öncesi ve sonrası benzerdi. Tp-e aralığı (81,3 ± 11,4 vs 76,3 ± 10,9; p=0,004), Tp-e/QT oranı (0,23 ± 0,04 vs 0,21 ± 0,04; p=0,002), Tp-e/QTc oranı (0,20 ± 0,03) vs. 0,19 ± 0,03; p=0,001) LSG öncesi ve sonrasında anlamlı olarak farklıydı.

**Sonuç:** Çalışmamız morbid obezitenin ventriküler repolarizasyon üzerinde olumsuz etkisi olabileceğini göstermiştir. Obez hastalarda laparoskopik sleeve gastrektomiyi takiben önemli kilo kaybına, ventriküler repolarizasyonda önemli bir iyileşme eşlik eder.


**Anahtar Kelimeler:** Laparoskopik sleeve gastrektomi; morbid obezite, QT aralığı, Tp-e aralığı, Tp-e/QT oranı, ventriküler repolarizasyon.

## Introduction

The Tp-e interval represents the time interval from the peak of the T wave to the end of the T wave on an electrocardiogram (ECG), while the QT interval represents the total duration of ventricular depolarization and repolarization.(1)

Obesity has been associated with various cardiovascular changes and an increased risk of cardiovascular disease. It can lead to alterations in cardiac structure and function, such as left ventricular hypertrophy and changes in electrical conduction. Some studies have suggested that obesity may be associated with prolongation of the QT interval, which could potentially increase the risk of ventricular arrhythmias.(2, 3)

However, the specific relationship between the Tp-e/QT ratio and obesity has not been extensively studied.(4) The Tp-e/QT ratio is a relatively new parameter that has been proposed as a marker of ventricular repolarization in certain cardiac conditions.(5) It has been associated with an increased risk of arrhythmias in some clinical populations, but its significance in obesity remains unclear.

While sleeve gastrectomy has been shown to improve various cardiovascular risk factors and cardiac structure and function, there is limited research specifically examining its impact on the Tp-e/QT ratio.(6) Bariatric surgery, including sleeve gastrectomy, can lead to weight loss, improvements in metabolic parameters, and reduction in cardiac strain, all of which may potentially influence ventricular repolarization.

In this study, we aimed to research the assessment of Tp-e interval and Tp-e/QT ratio before and after laparoscopic sleeve gastrectomy (LSG) in patients with morbid obesity.

## Material and Methods

### Study population

In this study, we enrolled 93 consecutive patients with a BMI >40 kg/m2 or BMI >35kg/m2 with comorbidities who had previously failed to lose weight with conservative methods underwent LSG between January 2012 and December 2016. Patients with any of the followings were excluded: significant mitral or tricuspid valvular heart disease, previous myocardial infarction, significant coronary artery disease, wall motion abnormalities with left ventricular ejection fraction below 50%, severe pulmonary disease, malignancy and complete or incomplete bundle branch block, atrial fibrillation, paced rhythm. Baseline demographic and clinical characteristics were reviewed. The study was in compliance with the principles outlined in the Declaration of Helsinki and approved by local ethics committee.

### Laparoscopic Sleeve Gastrectomy

Patients eligibility for bariatric surgery was based on the criteria for surgical intervention proposed by the NIH consensus panel in 1991 (7) and established by the international medical and surgical societies: the International Federation for the Surgery of Obesity (IFSO), the International Federation for the Surgery of Obesity-European Chapter (IFSO-EC), and the European Association for the Study of Obesity (EASO)) (8, 9) The study patients

underwent LSG based on their preference after discussing with the surgeon and presenting the surgical choices. The patients underwent routine preoperative work-up, including dedicated history taking, multidisciplinary clinical assessment, laboratory investigations, and upper gastrointestinal (GIT) endoscopy. Patients with severe gastroesophageal reflux disease (GERD), based on clinical presentation and/or endoscopic assessment, and those with large hiatus hernias were not candidates for LSG. Written informed consent was obtained from the included patients before surgery.

### Echocardiography

Echocardiographic assessment was performed by using a VIVID 7 Dimension Cardiovascular Ultrasound System (Vingmed-General Electric, Horten, Norway) with a 3.5 MHz transducer. Echocardiographic examination was performed in the left lateral decubitus position. Parasternal long- and short-axis views and apical views were used as standard imaging windows. Ejection fraction (EF) was calculated by using modified Simpson method. All echocardiographic examinations were performed by an experienced cardiologist.

### Electrocardiography

The 12-lead electrocardiogram (ECG) was recorded at a paper speed of 50 mm/s (Hewlett Packard, Page-writer, USA) in the supine position. All of the ECGs were scanned and transferred to a personal computer to decrease the error measurements, and then used for x400% magnification by Adobe Photoshop software. ECG measurements of QT and Tp-e intervals were performed by two cardiologists who were blinded to the patient data. Subjects with U waves on their ECGs were excluded from the study. An average value of three readings was calculated for each lead. The QT interval was measured from the beginning of the QRS complex to the end of the T wave and corrected for heart rate using the Bazett formula: cQT = QT$\sqrt{}$ (R-R interval). The Tp-e interval was defined as the interval from the peak of T wave to the end of T wave. Measurements of the Tp-e interval were performed from precordial leads.(10) The Tp-e/QT ratio was calculated from these measurements. ECG was performed one hour before procedure and repeated again three months after the LSG. Interobserver and intraobserver coefficients of variation were 2.5% and 2.1% respectively.

## Statistical Analysis

For statistical analysis, SPSS 20.0 Statistical Package Program for Windows (SPSS Inc., Chicago, IL, USA) was used. In order to test normality of distribution Kolmogorov-Smirnov test was used. Quantitative variables with a normal distribution were specified as the mean ± standard deviation and variables with non-normal distribution were shown as median (interquartile range), categorical variables were shown as number and percentage values. To determine the mean of the differences between two paired samples Paired T-Test and Wilcoxon signed-rank test was used. Categorical variables were compared with Chi-square test. A p value of <0.05 was accepted as statistically significant.

## Results

A total of 93 patients with morbid obesity before and after LSG were enrolled in our study. Baseline characteristics of study population are shown in Table 1. The mean age of the study population was 38.1 ± 9.1 years and 84.9 % of patients were female and 17.2% of patients had hypertension and 23.7% of patients had diabetes mellitus. Weight and body mass index levels before and after surgery are shown in Table 2. The electrocardiographic findings of the study groups are demonstrated in Table 3. Heart rate (75.7 ± 4.7 vs. 72.8 ± 11.4; p=0.486), QT interval (358.1 ± 32.0 vs. 362.6 ± 30.4; p=0.399) and QTc interval (399.0 ± 34.3 vs. 396.2 ± 30.9; p=0.621) were similar before and after LSG. Tp-e interval (81.3 ± 11.4 vs. 76.3 ± 10.9; p=0.004), Tp-e/QT ratio (0.23 ± 0.04 vs. 0.21 ± 0.04; p=0.002), Tp-e/QTc ratio (0.20 ± 0.03 vs. 0.19 ± 0.03; p=0.001) were significantly different before and after LSG.

**Table 1.** Baseline characteristics of the study patients (n=93)

| Variables | |
|---|---|
| Age,years | 38.1 ± 9.1 |
| Female, n(%) | 79 (84.9) |
| Hypertension, n(%) | 16 (17.2) |
| Diabetes Mellitus, n(%) | 22 (23.7) |
| Smoking, n(%) | 32 (34.4) |
| EF, % | 61.3 ± 2.8 |
| Height, cm | 1.63 ± 0.8 |
| Glucose, mg/dL | 108.3 ± 36.8 |
| Creatinine, mg/dL | 0.70 ± 0.07 |
| Total cholesterol, mg/dL | 201.6 ± 31.7 |
| LDL-C, mg/dL | 101.8 ± 26.3 |
| HDL-C, mg/dL | 41.7 ± 8.2 |
| Triglyceride, mg/dL | 141 (104 – 195) |
| Postoperative time interval, month | 6 (4 – 12) |

Data are given as mean ± SD, n (%) or median (interquartile range). EF, ejection fraction; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol.

**Table 2.** Weight and Body mass index levels of the study patients before and after procedure (n=93)

| Variables | Preoperative | Postoperative | p value |
|---|---|---|---|
| Weight, kg | 119.8 ± 16.2 | 84.5 ± 14.0 | <0.001 |
| BMI | 44.9 ± 4.6 | 31.7 ± 5.1 | <0.001 |

Data are given as mean ± SD, n (%). BMI, body mass index.

**Table 3.** Electrocardiographic parameters of the patients

| Parameters | Before LSG | After LSG | p value |
|---|---|---|---|
| Heart rate, bpm | 75.7 ± 4.7 | 72.8 ± 11.4 | 0.486 |
| Tp-e interval, ms | 81.3 ± 11.4 | 76.3 ± 10.9 | 0.004 |
| QT interval, ms | 358.1 ± 32.0 | 362.6 ± 30.4 | 0.399 |
| QTc interval, ms | 399.0 ± 34.3 | 396.2 ± 30.9 | 0.621 |
| Tp-e/QT ratio | 0.23 ± 0.04 | 0.21 ± 0.04 | 0.002 |
| Tp-e/QTc ratio | 0.20 ± 0.03 | 0.19 ± 0.03 | 0.001 |

Data are given as mean ± SD. LSG, laparoscopic sleeve gastrectomy; QTc, corrected QT interval.

## Discussion

We found that Tp-e interval, Tp-e/QT and Tp-e/QTc ratios were significantly shortened in patients with morbid obesity after LSG than before LSG. This is the largest study about this topic as we known. We showed that surgical weight loss significantly improves the variables associated with fatal arrhythmia in morbidly obese patients. Furthermore, following LSG in morbidly obese patients may prevent the risk of the fatal arrhythmias and sudden cardiac death (SCD).

As reported by the Framingham Heart Study, obesity alone is a strong predictor of SCD. Factors such as ventricular remodeling, hypertrophy, fibrosis, cardiomyopathy, increased inflammatory response, and neurohormonal activation may contribute to the development of malignant arrhythmias in obesity patients.(11, 12) It has been found to be associated with a prolonged QT interval in obesity.(13) However, it is still unclear whether obesity-related QT interval prolongation is associated with an increased risk of cardiac arrhythmias that can lead to SCD. (14) There is an established association between obesity and SCD. Every 5-unit increment in BMI confers a 16% higher risk of SCD, and obesity has been identified as the most common nonischemic cause of SCD.(15, 16) Data suggest that there may be an important role for body fat distribution, implicating abdominal adiposity as a marker of SCD.(16) The potential mechanisms for this association are varied and may include LVH, QT prolongation, premature ventricular complexes, and autonomic imbalance. (12) Both mild obesity and severe obesity are reported to be associated with greater risk of ventricular tachycardia (VT)/ventricular fibrillation (VF) )(17) and late potentials, highlighting a role in the formation of arrhythmic substrate.

The JT interval determines the repolarization time. Morbidly obese patients had higher JTc and JTc-d values than normal weight controls.(18)

Increasing of ventricular repolarization dispersion is associated with malign arrhythmias and has prognostic importance in terms of mortality and sudden cardiac death(19). QT dispersion was clarified as a sign of increased dispersion of repolarization but finally lost its importance as a defective concept(4, 20). Nowadays, the Tp-e interval and Tp-e/QT ratio have been evaluated as actual markers of increased dispersion of ventricular repolarization(5, 21). Prolongation of Tp-e interval was related with increased mortality in Brugada syndrome , long QT syndrome, and in patients with acute ST-segment elevation myocardial infarction(21). Nevertheless, Tp-e interval is affected by alterations in body weight and heart rate(22). In recent studies, the Tp-e/QT ratio was proposed to be a more accurate measure of the dispersion of ventricular repolarization, than QT dispersion, QTc dispersion and Tp-e intervals, and to be independent of variations in heart rate(5, 22). Based on evidence obviously proposes the applicability of Tp-e/QT ratio as a potency significant index of arrhythmogenesis, both under the conditions of short, normal and long QT interval(21). Similar to the results in the literature, (6) we demonstrated that that surgical weight loss significantly improves the variables associated with fatal arrhythmia in morbidly obese patients.

### Study Limitations

There are some limitations of this study. First, our study has relatively small sample size. Second, the study is single-center study. Also, the follow-up period time of the study was short to investigate long-term effects of the LSG procedure on the electrocaridographic parameters. Also, left ventricular diastolic functions have not been evaluated. Advanced echocardiographic techniques such as strain, strain rate and speckle tracking could have been more helpful to detect early and subclinical structural abnormalities in patients with morbid obesity. The relationship between ventricular arrhythmias and Tp-e interval and Tp-e/QT ratio was not assessed in patients with morbid obesity. Therefore, long-term follow-up and large-scale prospective studies are needed to investigate the predictive value of the Tp-e interval and Tp-e/QT ratio in patients with morbid obesity.

## Conclusion

Finally, Tp-e interval,Tp-e/QT and Tp-e/QTc ratios were decreased in patients with morbid obesity after LSG procedure.

Our study is important to show that morbid obesity may have a negative effect on ventricular repolarization, which potentially may lead to increased risk of ventricular arrhythmias. Tp-e interval, Tp-e/QT and Tp-e/QTc ratios are simple, easily accessible, inexpensive and non-invasive methods that may be useful index of left ventricular dysfunction that caused by ventricular arrhythmias in patients with with morbid obesity.

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## Disclosure

No conflicts of interest.

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## References

1. Yayla C, Ozcan F, Aras D, et al. Tp-e interval and Tp-e/QT ratio before and after catheter ablation in patients with premature ventricular complexes. Biomark Med 2017;11:339-46.
2. Pathak RK, Mahajan R, Lau DH, Sanders P. The implications of obesity for cardiac arrhythmia mechanisms and management. Can J Cardiol 2015;31:203-10.
3. Zhang C, Rexrode KM, van Dam RM, Li TY, Hu FB. Abdominal obesity and the risk of all-cause, cardiovascular, and cancer mortality: sixteen years of follow-up in US women. Circulation 2008;117:1658-67.
4. Kors JA, Ritsema van Eck HJ, van Herpen G. The meaning of the Tp-Te interval and its diagnostic value. J Electrocardiol 2008;41:575-80.
5. Zhao X, Xie Z, Chu Y, 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;35:559-64.
6. Gul M, Inci S, Ozkan N, Alsancak Y. Favorable electrocardiographic changes after substantial weight loss in patients with morbid obesity : Results of a prospective study. Herz 2021;46:567-74.
7. Kuczmarski RJ, Flegal KM. Criteria for definition of overweight in transition: background and recommendations for the United States. Am J Clin Nutr 2000;72:1074-81.
8. Fried M, Hainer V, Basdevant A, et al. Interdisciplinary European guidelines on surgery of severe obesity. Obes Facts 2008;1:52-9.
9. Fried M, Yumuk V, Oppert JM, et al. Interdisciplinary European Guidelines on metabolic and bariatric surgery. Obes Facts 2013;6:449-68.
10. Castro Hevia J, Antzelevitch C, Tornes Barzaga F, et al. Tpeak-Tend and Tpeak-Tend dispersion as risk factors for ventricular tachycardia/ventricular fibrillation in patients with the Brugada syndrome. J Am Coll Cardiol 2006;47:1828-34.
11. 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.
12. Abel ED, Litwin SE, Sweeney G. Cardiac remodeling in obesity. Physiol Rev 2008;88:389-419.
13. Straus SM, Kors JA, De Bruin ML, 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.
14. Grasser EK, Ernst B, Thurnheer M, Schultes B. QT Interval Shortening After Bariatric Surgery Depends on the Applied Heart Rate Correction Equation. Obes Surg 2017;27:973-82.
15. Powell-Wiley TM, Poirier P, Burke LE, et al. Obesity and Cardiovascular Disease: A Scientific Statement From the American Heart Association. Circulation 2021;143:e984-e1010.
16. Adabag S, Huxley RR, Lopez FL, et al. Obesity related risk of sudden cardiac death in the atherosclerosis risk in communities study. Heart 2015;101:215-21.
17. Pietrasik G, Goldenberg I, McNitt S, Moss AJ, Zareba W. Obesity as a risk factor for sustained ventricular tachyarrhythmias in MADIT II patients. J Cardiovasc Electrophysiol 2007;18:181-4.
18. Russo V, Ammendola E, De Crescenzo I, et al. Effect of weight loss following bariatric surgery on myocardial dispersion of repolarization in morbidly obese patients. Obes Surg 2007;17:857-65.
19. de Bruyne MC, Hoes AW, Kors JA, Hofman A, van Bemmel JH, Grobbee DE. QTc dispersion predicts cardiac mortality in the elderly: the Rotterdam Study. Circulation 1998;97:467-72.
20. Kors JA, van Herpen G, van Bemmel JH. QT dispersion as an attribute of T-loop morphology. Circulation 1999;99:1458-63.
21. Gupta P, Patel C, Patel H, et al. T(p-e)/QT ratio as an index of arrhythmogenesis. J Electrocardiol 2008;41:567-74.
22. Antzelevitch C, Sicouri S, Di Diego JM, et al. Does Tpeak-Tend provide an index of transmural dispersion of repolarization? Heart rhythm : the official journal of the Heart Rhythm 2007;4:1114-6; author reply 6-9.