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Evaluation of the alteration in retinal features following bariatric surgery in patients with morbid obesity

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ABSTRACT

Aim: The aim of the study is to evaluate the effect of bariatric surgery on the retina and choroid in non-diabetic and non-hypertensive patients with morbid obesity using optic coherence tomography (OCT) retrospectively.

Material and Method: Seventy-four eyes of seventy-four patients who have been underwent sleeve gasterectomy for morbid obesity in Balıkesir University Medicine Faculty & February 2019 and November 2020 were evaluated. All participants has a detailed ophthalmologic examination including best-corrected visual acuity (BCVA), intraocular pressure (IOP), slit-lamp biomicroscopy, retinal examination through non-dilated pupil via 90 D fundus lens, the retinal thickness (central, perifoveal, and parafoveal superior/nasal/inferior/temporal quadrants), and choroidal thickness through optic coherence tomography (RTVue XR Avanti, Optovue) in immediate preoperative and postoperative sixth-month. All values were compared.

Results: The macular thickness was increased significantly in all quadrants in postoperative visits ($p<0.05$). There was no change in choroidal thickness with surgery (p:0.898). The change in BMI was found correlated with the postoperative paranasal macular thickness (R:0.273, p:0.024) and mean macular thickness (R: 0.244, p: 0.045). There was no correlation between preoperative BMI, and preoperative/postoperative macular thickness ($p>0.05$). The correlation between preoperative BMI and preoperative choroidal thickness was significant (R: 0.416, $p<0.05$).

Conclusion: In patients with morbid obesity, the retinal thickness increases with an effective BMI change after bariatric surgery while choroidal thickness was not affected. The effective weight loss has a significant effect on retinal structure.

Keywords: Morbid obesity, sleeve gastrectomy, retinal thickness, choroidal thickness, optic coherence tomography

INTRODUCTION

The prevalence of obesity has been a huge burden worldwide in recent years. There are more than 1.9 billion overweight adults over the age of 18, and approximately 650 million of them are obese (1). The diagnosis of obesity and morbid obesity is depended on body mass index (BMI), which is calculated as weight/height2 (kg/m²). The definition of obesity is a BMI over 29.99 kg/m², obese class I BMI 30.00-34.99, obese class II BMI 35-39.99, and obese class III or morbidly obese BMI ≥40 kg/m². Another definition of morbid obesity is a BMI ≥35 kg/m² with concomitant health problems (2). Morbid obesity is associated with significant comorbidities, such as systemic diseases (diabetes mellitus, cardiovascular diseases, hypertension, etc.), and also ocular diseases such as glaucoma, age-related macular degeneration, and cataracts (3,4).

The treatment of morbid obesity with bariatric surgery has been popular in recent years. Besides the effect of weight loss, bariatric surgery provides an improvement in other comorbidities (5). The frequently used technique is sleeve gastrectomy, which is carried out by removing 80% of total stomach volume including the fundus and major curvature of the stomach. As a result of the surgery, the amount of food intake is reduced, and the hormone secretion that increases appetite decreases, and weight loss occur (6).

Obesity is a multisystemic disease, and it affects all tissues as well as the eye. The effects of obesity on ocular tissues have been reported in previous studies (7-9). Especially, the changes in the retina due to microvascular damage and inflammation may be observed. The effect of bariatric surgery on the retina and choroid is still

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controversial. In the light of these information, the aim of this study is to evaluate the changes in retina and choroid after bariatric surgery in patients with morbid obesity at the time of effective weight loss (10). In our opinion, this study has the largest case number in literature which obtain the alterations in retinal structure.

MATERIAL AND METHOD

The study followed the tenets of the Declaration of Helsinki, and it was approved by the Balıkesir University Faculty of Medicine Clinical Researches Ethics Committee (Date: 11.08.2021, Decision No:2021/168). The written informed consent was obtained from all participants. In this study, seventy-six (n:76) patients who have been diagnosed with morbid obesity (BMI >40 or ≥35 kg/m² when associated with comorbidities such as arterial hypertension, dyslipidemia, sleep apnea, or diabetes) and performed bariatric surgery between February 2019 and November 2020 at Department of General Surgery in Balıkesir University were evaluated. In each visit, BMI, abdominal circumference (AC), heart-rate, systolic and diastolic blood pressure, blood sugar were recorded. The patients who were candidate for sleeve gastrectomy was consulted to the department of ophthalmology for routine ophthalmic examinations at the immediate preoperative period and postoperative sixth months. The patients who have been performed sleeve gastrectomy were included while two patients who underwent Roux-en-Y gastric bypass and biliopancreatic diversion with duodenal switch were excluded. Other exclusion criteria were being under the age of 18, the refractive error above 2.00 Diopters (D), best-corrected visual acuity (BCVA) under 8/10, axial length more than 24 mm or less than 21 mm, diabetes mellitus, diabetic retinopathy, systemic hypertension, any type of retinopathy history, drug usage that may cause retinopathy (amiadoron, plaquenil, etc.), glaucoma or glaucoma suspect, history of retinal photocoagulation, history of ocular trauma or intraocular surgery, media opacity that may block the imaging of the retina. In the preoperative period, the blood sugar and Haemoglobin A1c (HbA1c) have been investigated, and the patients with blood sugar more that 110 mg/dL or HbA1c more than %5.5 were also excluded.

All included cases were directed to the Department of Ophtalmology and underwent a detailed ophthalmological examination including refractive error, BCVA, IOP, slit-lamp biomicroscopy, retinal examination through non-dilated pupil via 90 D fundus lens. Additionally, the retinal thickness (central, perifoveal, and parafoveal superior/nasal/inferior/temporal quadrants), and choroidal thickness were recorded via optic coherence tomography (RTVue XR Avanti, Optovue). The retinal thickness measurements were automatized while the choroidal thickness was measured manually as described in previous studies. The choroidal images were taken in "Enhanced deep imaging-optical coherence tomography" (EDI-OCT) mode. The cursor was placed above the hyperreflective retina pigment epithelium in the subfoveal area and lined towards the choroid-scleral junction. The vertical length of the line was calculated. Three repeated measurements were applied, and the average value was accepted as choroidal thickness. The choroidal thickness evaluation was performed between 9-10 A.M without smoking cigarettes or alcohol/caffeine consumption at least for two hours to prevent being affected by diurnal rhythm, and environmental factors. The data obtained from patients in the pre&post operative period were compared.

Statistical Analysis

Statistical analyses were performed using the Statistical Package for Social Sciences for Windows V.23 (SPSS, Inc, Chicago, Illinois, USA). All values were reported as mean±standard deviation (SD). The normality of the data distribution was evaluated by the Shapiro-Wilk test. For the difference between the parameters in the first and last examination, paired t-test was used for dependent groups, and the chi-square test was used for parametric values. The relationship between the parameters at the first examination and the anatomical changes was evaluated by regression analysis. Spearman correlation analysis was used to understand the relationship between BMI change and retinal thickness. P-value under 0.05 was accepted statistically significant.

RESULTS

The study was initiated with 77 patients with morbid obesity, but the routine ophthalmological examination data of three patients was absent, so three patients were excluded. Finally, the study was included 74 eyes of 74 cases (F/M:52/22). The mean age of the patients was 31.66±9.65 (21-59) years. In the preoperative and postoperative period, the mean BMI was 43.12±2.13, and 31.71±4.82 kg/m² ($p<0.05$), and AC was 132.97±6.17 and 108.38±6.26 cm ($p<0.05$), respectively. The mean BMI change was 14.71±5.32 (6-26) kg/m². The mean BCVA was 0.98±0.11 and 1.00±0 (p:0.170), IOP was 18.07±3.35 mmHg and 15.40±3.00 mmHg ($p<0.05$) in preoperative and postoperative visit, respectively. The macular thickness was increased significantly in all quadrants in postoperative visits ($p<0.05$). There was no change in choroidal thickness with surgery (p:0.898) (**Table 1**).

Table 1. The change of visual acuity, intraocular pressure, BMI, AC, retinal and choroidal thickness in preoperative and postoperative sixth-months after bariatric surgery in morbidly obese patients

	Preoperative (n:74)	Postoperative (n:74)	p value
Body-mass Index (BMI)	43.12±2.13	31.71±4.82	<0.05*
Abdominal Circumference (AC)	132.97±6.17	108.38±6.26	<0.05*
Visual Acuity	0.98±0.11	1.00	0.170
Intraocular Pressure (IOP)	18.07±3.35	15.40±3.00	<0.05*
Central Macular Thickness	231.18±27.31	242.56±29.71	<0.05*
Parafoveal Macular Thickness			
•Superior	305.65±13.74	320.44±16.92	<0.05*
•Nasal	300.76±17.10	309.43±17.64	<0.05*
•Inferior	303.00±20.72	313.81±20.09	<0.05*
•Temporal	295.41±20.07	307.94±19.10	<0.05*
Perifoveal Macular Thickness			
•Superior	276.44±14.27	283.90±12.90	<0.05*
•Nasal	278.59±19.96	274.94±17.88	<0.05*
•Inferior	265.54±19.16	274.94±17.88	<0.05*
•Temporal	267.85±22.33	278.57±21.60	<0.05*
Mean Retinal Thickness	279.40±9.92	289.81±11.19	<0.05*
Subfoveal Choroidal Thickness	250.99±34.35	251.59±22.31	0.898

p value: statittically significance ratio

The change in BMI was found correlated with the postoperative paranasal macular thickness (R:0.273, p:0.024) and mean macular thickness (R: 0.244, p: 0.045). There was no correlation between preoperative BMI, and preoperative / postoperative macular thickness (p>0.05). The correlation between preoperative BMI and preoperative choroidal thickness was significant (R: 0.416, p<0.05).

DISCUSSION

In this study, we investigated the effect of the change in BMI after bariatric surgery on retina and choroid in patients with morbid obesity and resulted that the retinal thickness increases with an effective BMI after surgery while choroidal thickness was not affected. Doğan et al. (11) showed a significant decrease in central and total macular thickness in the third and sixth months after surgery, and the increase was in the normal range. They commented that the increase in macular thickness may be related to the decrease in macular pigment density in the foveal area. Lutein and zeaxanthin locate in the fovea, and play a role as a blue-light filter to block ultraviolet (UV) light. In patients with obesity, the density of macular pigments decreases due to accumulation in the adipose tissue, and the density returns to normal levels after weight loss with bariatric surgery and the macular thickness increases. Similarly, Laigin et al. (8) detected increased macular thickness and no change in choroidal thickness after bariatric surgery. Additionally, they examined the inner and outer layers of the retina and resulted that the main reason for increase in the retinal thickness was related to inner retinal layers while outer retinal layers have not an influence. As known, the balance between vasoconstrictor and vasodilator mediators is disturbed in favor of vasoconstrictors in patients with obesity (12). The vasoconstrictor mediators such as angiotensinogen and endothelin-1 (ET-1), which increase in patients with obesity, cause vasospasm in the microcirculation and return to normal levels with metabolic control after bariatric surgery (13). We think that there is an increase in retinal thickness associated with the increase in microvascular flow. As proof of this thesis, it has been shown that there is an increase in central retinal artery flow after bariatric surgery with Doppler ultrasonographic studies (7). To reveal the effects of vasoactive substances on retinal blood flow, OCT-Angio studies that show the vascular structure of the retina in more detail should be helded. Since the increase in retinal thickness after surgery was still within the normal range, we should consider this not as macular edema, but an atrophic retina recovering normal limits. Thus, systemic inflammation in patients with obesity may cause atrophy in the retina as well as all tissues. The level of systemic inflammatory markers is increased in obesity (14-17). Since we did not compare the data of patients with obesity with controls, it is not possible to claim whether the retina was atrophic in the preoperative period. However, we can comment that the inhibition of inflammation after surgery leads to improvement in the retina.

According to the results, there was no significant change in choroidal thickness after surgery. Since we did not compare choroidal thickness measurement in the preoperative period with the control group, we could not exactly claim about the changes in choroidal thickness in obesity. Gönul et al. (9) compared the patients with morbid obesity with control group and found that choroidal thickness was increased in patients with obesity compared to the normal population. Similarly, in this study, although patients with obesity were not compared with the control group, a significant correlation was found between preoperative BMI and subfoveal choroidal thickness even if we could not study on controls (R: 0.416, p<0.05). The increased choroidal thickness may be associated with venous congestion. Consistent with our results, Bulus et al. (18) showed that the choroidal thickness increase in patients with obesity, and that BMI and subfoveal choroidal thickness were correlated. The authors attributed this to the increased leptin and obesity-related inflammatory factors in patients with obesity.

Yumusak et al. (19) also found a positive correlation between BMI and choroidal thickness. In patients with obesity, the intraorbital fat volume may expand likewise visceral adipose tissue, and it may lead to an increase in venous pressure, and an increase in choroidal thickness which is fed by the veins. After surgery, the decrease in choroidal venous congestion with decreased intraorbital pressure is expected (20). In this study, the change in choroidal thickness was not significant even the IOP was decreased significantly. In contrast, it has been shown that the choroidal thickness is not different from the normal population (21), or thinner (11,22,23) in previous studies. This result can be associated with the follow-up duration. The postoperative measurements were recorded at sixth-month when the structural changes initiate (10). Since the changes in choroidal thickness may occur in a long time (24), we think that the different results may be obtained if a longer follow-up time was required. In contrast to our results, Dogan et al. (11) found a significant increase in choroidal thickness even in the immediate postoperative period. The controversial results may be related to the difference in choroidal measurement methods, and the choroidal thickness is also affected by many environmental factors (19). We measured choroidal thickness in accordance with the diurnal rhythm, and without smoking cigarettes or alcohol/caffeine consumption in order to minimize the effect of choroidal thickness. Additionally, the multivariate regression analysis was helded to reveal the relationship between preoperative choroidal thickness, and preoperative BMI, AC, central macular thickness to support our results. The preoperative BMI was found significantly correlated with preoperative BMI and AC (respectively; R:0.383 p:0.024, R: 0.264 p: 0.015). The evaluation with new methods, such as OCT-A may be useful in determining the vascular density and flow index to reach more reliable results.

There are a few limitations of this study. First of all, the relatively small number of patients with single-center limits the diversity of data. Also, the sub-analyses about the retinal layers (inner/outer) were not performed. We have not compared the preoperative data of patients with morbid obesity with the control group, so we could not comment that whether the preoperative results were in the normal range. Additionally, the choroidal thickness measurements were made manually, because the device has not an automatic software to quantify choroidal thickness. To deal with this, three repetitive measurements in two different visits were recorded, and the average of values was accepted as correct. Although the follow-up period was six months when the effective weight loss was achieved, the long-term results were not concluded.

CONCLUSION

We evaluated the effect of bariatric surgery on the posterior segment in patients with morbid obesity by excluding the influence of diabetes mellitus and hypertension which are frequently encountered as risk factors for retinopathy. The thickening in all retinal quadrants was detected after bariatric surgery while choroidal thickness had no change. The multi-center studies with larger series are needed for more reliable results.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Balıkesir University Faculty of Medicine Clinical Researches Ethics Committee (Date: 11.08.2021, Decision No:2021/168)

Informed Consent: The written informed consent was obtained from all participants.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The author has no conflicts of interest to declare.

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Author Contributions: The author declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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