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Association of body mass index with orbital fat volume in lower eyelid blepharoplasty

Iskender Alkın Solmaz[1] and Elif Ertan[2*]

Abstract

Purpose To investigate the relationship between body mass index (BMI) and the volume of orbital fat excised during lower eyelid blepharoplasty.

Methods This retrospective cross-sectional study included 58 patients who underwent bilateral transconjunctival lower eyelid blepharoplasty between January and December 2024. Total orbital fat volume was measured intraoperatively using a graduated cylinder. BMI was calculated from preoperative height and weight and classified according to World Health Organization criteria. Statistical analyses included Pearson correlation, one-way ANOVA with Tukey's post-hoc test, and univariate and multivariable linear regression.

Results The mean age of the patients was 49.2 ± 11.6 years, and the mean BMI was 24.5 ± 3.8 kg/m^2. The mean total orbital fat volume excised was 2.08 ± 0.94 cc. Fat volume differed significantly across BMI categories ($p < 0.001$), with obese and overweight patients having greater excised fat than normal-weight individuals. Pearson correlation demonstrated a strong positive association between BMI and fat volume ($r = 0.592$, $p < 0.001$). In regression analysis, BMI was the only significant predictor of orbital fat volume, explaining 35.1% of the variance ($R^2 = 0.351$).

Conclusion BMI is strongly associated with orbital fat volume excised during lower eyelid blepharoplasty. These findings suggest that systemic adiposity extends to the periorbital region and highlight the relevance of considering BMI in preoperative planning to optimize surgical outcomes.

Keywords Blepharoplasty, Orbital fat, Body mass index, Periorbital adiposity, Eyelid surgery, Oculoplastic.

Introduction

Lower eyelid blepharoplasty is a common surgical procedure performed to reduce signs of aging and improve aesthetic appearance by removing or reshaping excess skin and fat in the lower eyelid region [1]. A key component of this procedure involves the excision or repositioning of periorbital fat pads, commonly referred to as orbital fat. However, the volume of orbital fat excised during surgery can vary considerably between individuals, often depending on the surgeon's intraoperative judgment [2]. The factors contributing to this interindividual variability remain poorly understood.

Body mass index (BMI) is a widely accepted anthropometric measure used to assess general body fat composition. It serves as a critical marker in the evaluation of obesity and fat distribution-related disorders [3]. It has been hypothesized that individuals with higher BMI may exhibit increased fat accumulation not only in the body but also in the facial and periorbital regions. In this context, a potential relationship between BMI and the volume of orbital fat removed during lower blepharoplasty

*Correspondence:
Elif Ertan
elif-ertan@hotmail.com
[1]Department of Ophthalmology, Faculty of Medicine, Istanbul Health and Technology University, Istanbul, Turkey
[2]Department of Ophthalmology, University of Health Sciences, Basaksehir Cam and Sakura City Hospital, Istanbul, Turkey

is of clinical interest. However, there is a notable scarcity of studies investigating this specific association in the current literature.

Recent periorbital imaging and volumetric analysis studies have demonstrated a significant association between BMI and orbital fat volume [4]. These findings suggest that BMI, as a widely used and easily accessible clinical parameter, may serve as a valuable preoperative predictor for estimating orbital fat volume. Incorporating BMI into surgical planning could help minimize intraoperative variability, support personalized surgical approaches, and ultimately enhance the predictability and consistency of aesthetic outcomes in lower blepharoplasty.

The primary aim of this study is to evaluate the relationship between body mass index and the volume of orbital fat excised during lower eyelid blepharoplasty. Understanding this correlation may enhance insights into individual anatomical variations and contribute to more personalized preoperative planning in aesthetic eyelid surgery.

Materials and methods

This retrospective cross-sectional study included patients who underwent lower eyelid blepharoplasty between January and December 2024. The study adhered to the Declaration of Helsinki and was approved by the institutional ethics committee (Approval No: 2025/08 – 03).

Eligibility criteria were: lower blepharoplasty for aesthetic purposes, age ≥ 18 years, availability of preoperative anthropometric data, and accurate intraoperative documentation of excised orbital fat. Patients with thyroid eye disease, orbital tumors, prior orbital trauma/surgery, dysthyroid optic neuropathy, other orbital pathology, or incomplete records were excluded.

Demographic and clinical data, including age, sex, weight, height, and BMI, were obtained from patient medical records. BMI was calculated as weight (kg)/height² (m^2) and categorized according to WHO definitions (normal: 18.5–24.9, overweight: 25.0–29.9, obese: ≥30.0) [5].

All procedures were performed bilaterally by a single experienced oculoplastic surgeon (IAS) using the transconjunctival approach. When required, the medial, central, and lateral fat pads were excised, and the total orbital fat volume was immediately measured with a sterile graduated cylinder after blotting excess serum. All measurements were performed by the same experienced surgeon using a standardized protocol: after blotting excess serum, each fat specimen was immediately placed into a sterile graduated cylinder to measure its volume. This approach was applied consistently across all cases to minimize variability. For statistical analysis, the volumes of orbital fat excised from the right and left lower eyelids were recorded separately. The total excised volume was then calculated and used for subsequent analyses. In addition, a correlation analysis between the right and left sides demonstrated a significant positive relationship, confirming the consistency of measurements across both eyelids.

Power analysis with G*Power ($\alpha = 0.05$, two-tailed) showed that, under comparable sample size conditions, the minimum detectable correlation at 80% power was $r \approx 0.37$. The observed BMI–fat volume correlation ($r = 0.592$) and the ANOVA effect size (Cohen's $f \approx 0.74$) both exceeded this threshold, yielding > 99% achieved power.

Statistical analyses were performed with SPSS v25.0 (IBM Corp., Armonk, NY, USA). Normality was assessed with the Kolmogorov–Smirnov test. Data are presented as mean ± SD or median (min–max). Pearson correlation tested the association between BMI and fat volume. Group differences were assessed with one-way ANOVA and Tukey's post-hoc test. Predictive factors were evaluated using univariate and multivariable linear regression including BMI, age, and sex. A p-value < 0.05 was considered statistically significant.

Results

A total of 58 patients who underwent transconjunctival lower eyelid blepharoplasty were included. The mean age was 49.2 ± 11.6 years, and the mean BMI was 24.5 ± 3.8 kg/m^2. According to BMI classification, 13 patients (22.4%) were categorized as normal weight (BMI: 18.5–24.9), 29 (50.0%) as overweight (BMI: 25.0–29.9), and 14 (24.1%) as obese (BMI ≥ 30.0). Two patients were classified as underweight (BMI < 18.5) and excluded from comparative analyses due to the limited sample size. Demographic and clinical characteristics by BMI category are summarized in Table 1.

The mean total orbital fat volume excised was 2.08 ± 0.94 cc. When stratified by BMI groups, fat volume was significantly higher in obese patients (2.58 ± 0.13 cc) compared with overweight (2.23 ± 0.86 cc) and normal weight individuals (1.19 ± 0.74 cc). One-way ANOVA revealed a statistically significant difference across BMI categories ($F = 14.48$, $p < 0.001$). Post-hoc Tukey HSD analysis showed that both obese and overweight groups had significantly greater fat volumes than the normal

Table 1 Demographic and clinical characteristics of the study population by BMI category

BMI Category	n	Age (mean ± SD)	BMI (mean ± SD)	Total Fat Volume (cc, mean ± SD)
Normal weight	13	47.9 ± 10.9	22.5 ± 1.8	1.19 ± 0.74
Overweight	29	53.4 ± 11.9	27.0 ± 1.4	2.23 ± 0.86
Obese	14	49.0 ± 10.8	33.3 ± 2.9	2.58 ± 0.73

weight group ($p < 0.001$), while the difference between overweight and obese groups was not statistically significant ($p = 0.25$).

Pearson correlation analysis demonstrated a strong positive association between BMI and total orbital fat volume ($r = 0.592$, $p < 0.001$). Similar correlations were observed for the right ($r = 0.621$, $p < 0.001$) and left ($r = 0.499$, $p < 0.001$) orbital compartments. These results are presented in Table 2. The linear relationship between BMI and total orbital fat volume is illustrated in Fig. 1.

Univariate linear regression confirmed BMI as a significant predictor of total orbital fat volume ($\beta = 0.090$, $p < 0.001$), explaining 35.0% of the variance (R^2=0.350). In the multivariable model including age and sex, BMI remained the only significant predictor ($\beta = 0.090$, $p < 0.001$), while age ($p = 0.939$) and sex ($p = 0.604$) were not significant. The explanatory power of the model was 35.1% (R^2=0.351). The results of regression analyses are summarized in Table 3.

Table 2 Correlation between BMI and orbital fat volume

Comparison	Pearson *r*	*p*-value
BMI vs. Total Fat Volume	0.592	< 0.001
BMI vs. Right Fat Volume	0.621	< 0.001
BMI vs. Left Fat Volume	0.499	< 0.001

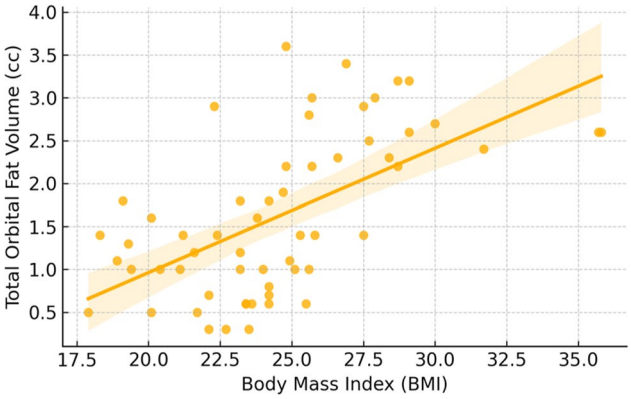

Fig. 1 The relationship between BMI and total orbital fat volume

Table 3 Linear regression models predicting total fat volume

Univariate Linear Regression (BMI only)					
Variable	**β**	**Std. Error**	**t**	***p*-value**	**95% CI**
BMI	0.090	0.015	6.34	<0.001	0.060 – 0.119
Multivariable Linear Regression (BMI, Age, Sex)					
Variable	**β**	**Std. Error**	**t**	***p*-value**	**95% CI**
BMI	0.090	0.015	6.07	< 0.001	0.060–0.121
Age	0.001	0.010	0.08	0.939	-0.018–0.020
Sex (Male)	0.131	0.251	0.52	0.604	-0.372–0.634

Discussion

In this study, a statistically significant positive correlation was observed between body mass index (BMI) and the volume of orbital fat excised during lower eyelid blepharoplasty. These findings suggest that systemic fat accumulation may not be limited to visceral or abdominal compartments, but may also extend to the periorbital region. This emphasizes the importance of considering BMI as a potential factor during preoperative planning in periorbital aesthetic surgery.

Adipogenesis, the process by which preadipocytes proliferate and differentiate into mature adipocytes, is a common mechanism implicated in both obesity and certain orbital pathologies [3]. In particular, studies focusing on inflammatory conditions such as thyroid eye disease (TED) have demonstrated increased adipogenic activity in orbital fibroblasts [6, 7]. Khong et al. highlighted that the expansion of orbital fat in TED patients was closely related to local adipogenesis mechanisms [8], while Lacheta and colleagues confirmed the high adipogenic potential of orbital fibroblasts in vitro [9].

Although these findings originate from studies in the context of TED, they offer valuable insights suggesting that systemic adipogenic processes may also affect orbital fat compartments in the general population. This may partly explain the increased orbital fat volume observed in patients with higher BMI, even in the absence of overt orbital pathology.

Previous research has shown that with advancing age, fat distribution tends to shift from superficial subcutaneous compartments toward deeper visceral depots, with a concomitant decrease in total subcutaneous fat mass [10, 11]. This age-related subcutaneous fat loss is considered one of the key contributors to facial aging and is often managed with soft tissue fillers [12]. Clinically, overweight individuals are frequently observed to exhibit deep buccal fat pad atrophy along with submental fat hypertrophy, suggesting that superficial facial compartments may preferentially respond to weight gain [13]. On the other hand, a cadaveric study demonstrated that increases in BMI were associated with a similar enlargement of adipocytes in both superficial and deep cheek compartments, implying a more uniform effect of weight gain across facial fat compartments [14].

The positive correlation observed in our study supports the notion that individuals with higher BMI tend to have greater orbital fat volume excised during lower eyelid blepharoplasty. This finding underlines the importance of including BMI in the preoperative assessment to guide surgical expectations and plan more personalized interventions. Supporting this, one study found that boys aged 4 to 6 years with epiblepharon had significantly higher BMI values compared to those without the condition [15]. Similarly, another study reported that children with epiblepharon had a significantly higher median BMI than those without epiblepharon [16]. Kuo et al. demonstrated a relationship between obesity and exophthalmos

in patients with thyroid eye disease the mean BMI of participants undergoing orbital fat decompression surgery was higher than that of the general population in Taiwan. Moreover, obese patients exhibited significantly more severe proptosis, and those in the obese group who underwent orbital fat decompression had a markedly greater volume of orbital fat removed [17].

Several imaging-based studies have consistently demonstrated a significant positive correlation between BMI and orbital fat volume. For example, recent CT and MRI analyses have shown that orbital fat volume increases with higher BMI across all periorbital compartments [4, 18]. Yoo et al. reported that orbital tissue volume—including orbital fat—progressively increases in proportion to BMI in healthy East Asian populations [18]. Using magnetic resonance imaging, Lohakitsatian et al. demonstrated that increases in BMI were associated with greater orbital fat volume, larger orbital cavity volume, and a tendency toward increased anteroposterior globe position or exophthalmic changes [4]. In contrast to these imaging-derived estimations, our study is unique in providing real-time intraoperative volumetric measurements of excised orbital fat. This direct quantitative approach not only complements and validates prior radiologic findings but also offers clinically relevant evidence that may enhance surgical planning and improve predictability in lower eyelid blepharoplasty.

This study has several limitations. First, the measurement of excised fat volume was performed manually using a graduated cylinder, which may have introduced variability due to operator technique. Second, no histopathological evaluation was conducted on the excised fat, meaning that potential differences in tissue quality—such as the proportion of mature adipocytes or fibrotic content—were not assessed. Another limitation of our study is that the orbital fat compartments (medial, central, and lateral) were not evaluated separately. Instead, the total orbital fat volume was measured. Future studies assessing compartmental differences may provide a more detailed understanding of the relationship between BMI and orbital fat distribution.

Future studies incorporating both histopathological evaluation and quantitative imaging techniques, such as magnetic resonance imaging (MRI), may provide more comprehensive insight into orbital fat characteristics. Moreover, prospective, multicenter studies with larger sample sizes are needed to further clarify the relationship between BMI and orbital fat volume.

Conclusion

This study demonstrated a significant positive correlation between body mass index and the volume of orbital fat excised during lower eyelid blepharoplasty. These findings suggest that BMI is a relevant factor influencing periorbital fat volume and should be considered during preoperative evaluation. Incorporating BMI into surgical planning may improve aesthetic outcomes and patient satisfaction by tailoring the procedure to individual anatomical and systemic characteristics.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
The study protocol was approved by the local ethics committee (Istanbul Health and Technology University 2025/08 – 03).

Consent for publication
Not Applicable.

Competing interests
The authors declare no competing interests.

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