

Association of Body Dysmorphic Disorder with Leptin Levels in Patients with Normal Weight Undergoing Liposuction: A Matched Case Study

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Background: Liposuction is the most common aesthetic surgical procedure performed globally. Some of the patients with normal weight who seek liposuction may suffer from body dysmorphic disorder (BDD). Leptin, which is mainly produced by adipose tissue, may be associated with this condition. The aim of this study was to determine the prevalence of BDD and leptin levels in patients with normal weight seeking liposuction.

Methods: Thirty-two nonobese women who sought liposuction were matched with 32 healthy volunteers by age and body mass index. Blood biochemistry, leptin levels, and BDD-Yale–Brown Obsessive-Compulsive Scale (BDD-YBOCS) questionnaires were evaluated and compared between the groups.

Results: Patients who underwent liposuction had significantly higher median (interquartile range) of total BDD-YBOCS scores than healthy volunteers [25 (22–27) versus 12 (8–20); $P < 0.001$]. Overall, 28 (87.5%) patients had total BDD-YBOCS scores of >20 , whereas 10 (31.5%) volunteers had scores of >20 . Patients with total BDD-YBOCS scores of >20 had significantly lower levels of serum leptin [12.43 (7.15–16.98) ng/ml versus 15.57 (9.59–22.28) ng/ml; $P = 0.043$].

Conclusions: Patients who underwent liposuction had a significantly higher total score of BDD-YBOCS than healthy volunteers matched by sex, age, and body mass index. Subjects with higher BDD-YBOCS scores had significantly lower serum leptin levels. (*Plast Reconstr Surg Glob Open* 2019;7:e2482; doi: [10.1097/GOX.0000000000002482](https://doi.org/10.1097/GOX.0000000000002482); Published online 28 October 2019.)

BACKGROUND

Liposuction, also known as lipoplasty or suction-assisted lipectomy, is the most common aesthetic surgical procedure performed in the United States; nearly 300,000 procedures are performed annually.^{1,2} Recent advances in liposuction techniques have made it possible to remove considerable amounts of subcutaneous adipose tissue. Liposuction in the Western countries and Oriental countries have some differences; people who seek liposuction

in the Western countries are more obese, have higher body mass index (BMI), and have more excessive fat deposits that concern them and drive them to want to remove their excess fat tissues.³ On the other hand, in the Oriental countries, most people who seek liposuction are not obese and their BMIs are within the normal range.^{4,5} However, liposuction is still popular in these countries.

Body dysmorphic disorder (BDD) may make this group of people unsatisfied with their bodies. People with BDD feel ugly, cannot bear to look at themselves, and are convinced that their face, physique, or skin is disfigured. The prevalence of BDD in the general population of 1.7%–2.4% is still underdiagnosed⁶ and may be more prevalent in patients who opt for cosmetic surgery than that in the general population. People with BDD suffer from excessive preoccupation and anxiety about an imaginary or a negligible defect in their appearances.⁷ These patients may consult a dermatologist, or even a plastic surgeon, to get closer to their ideal of beauty.

BDD is usually evaluated using a questionnaire as a diagnostic tool.⁸ Despite the frequently underdiagnosed and underreported cases, it was recently reported that

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the prevalence of BDD in patients undergoing cosmetic surgeries ranged from 2.21% to 56.67% and that 76.09% of them are females.⁹ In 2015, the annual statistics of the American Society for Aesthetic Plastic Surgery reported that the number of cosmetic procedures increased by 2% from that in 2014, which was approximately 15 million procedures performed in the United States alone.¹⁰

Fat or adipose tissue removed by liposuction is a source of many autocrine and endocrine hormones. Leptin is one of the important endocrine hormones produced by the adipocytes.¹¹ Leptin, a 167-amino acid protein transcribed from the *ob* gene, was originally cloned in the mouse during research directed at identifying the molecular defects in an obesity-prone strain, the *ob/ob* mouse. The name leptin originated from the Greek word *leptos*, which means thin. The human leptin gene is on chromosome 7q31.¹² Leptin is produced mainly in the white adipose tissue with very small amounts found in brown adipose tissue. It was identified for the first time in 1994 and provided the molecular basis to the lipostatic theory of energy balance regulation that was proposed 40 years earlier.¹³ The theory assumed the existence of a circulating factor, generated in proportion to body fat stores, which transmits a signal to the brain that, in turn, elicits changes in food intake and energy expenditure. However, in addition to food and energy, previous studies have demonstrated that leptin plays a role in mood disorders as well; leptin levels tend to be lower in patients with mood disorders than in those without mood disorders.¹⁴ No previous study has investigated the relationship between BDD and leptin levels in Oriental subjects with normal weight who seek liposuction.

We hypothesized that the presence of BDD and its severity would be associated with more depressive and emotional symptoms and some impairment in psychosocial functioning that may be related to leptin levels. Therefore, this study aimed to determine the prevalence

of BDD in people with normal weight seeking liposuction and leptin levels in this group of people.

MATERIALS AND METHODS

Prospective Study

A total of 72 nonobese women (BMI < 30 kg/m²) who underwent liposuction were screened at the outpatient Departments of Plastic and Reconstructive Surgery and General Surgery, Phramongkutklao Hospital, Bangkok, Thailand (Fig. 1). Patients were eligible for the surgical procedure if they fulfilled the inclusion and exclusion criteria summarized in Table 1. Of them, 40 patients were excluded from the study owing to non-fulfillment of the inclusion criteria (20 patients), loss to follow up (18 patients), and inappropriate blood sampling (2 patients). The remaining 32 patients who underwent liposuction were enrolled as cases, and 32 healthy volunteers matched for age, sex, and BMI were enrolled as controls.

All patients underwent ultrasound-assisted liposuction (vibration amplification of sound energy at resonance) at the Department of Plastic and Reconstructive Surgery, Phramongkutklao Hospital, between December 2014 and 2018. Preoperatively, the patients underwent comprehensive medical evaluation to exclude general contraindications to the procedure. None of the patients were taking drugs that could affect glucose or lipid metabolism, body weight, or body composition, both before and during the study. The patients were evaluated in the week before the surgery and 30 days after the surgery. This study was approved by the Ethics Committee of the Faculty of Tropical Medicine, Mahidol University, and the Institutional Review Board of Phramongkutklao Hospital, Bangkok, Thailand. Before enrolling in the study, all patients and volunteers who agreed to participate provided

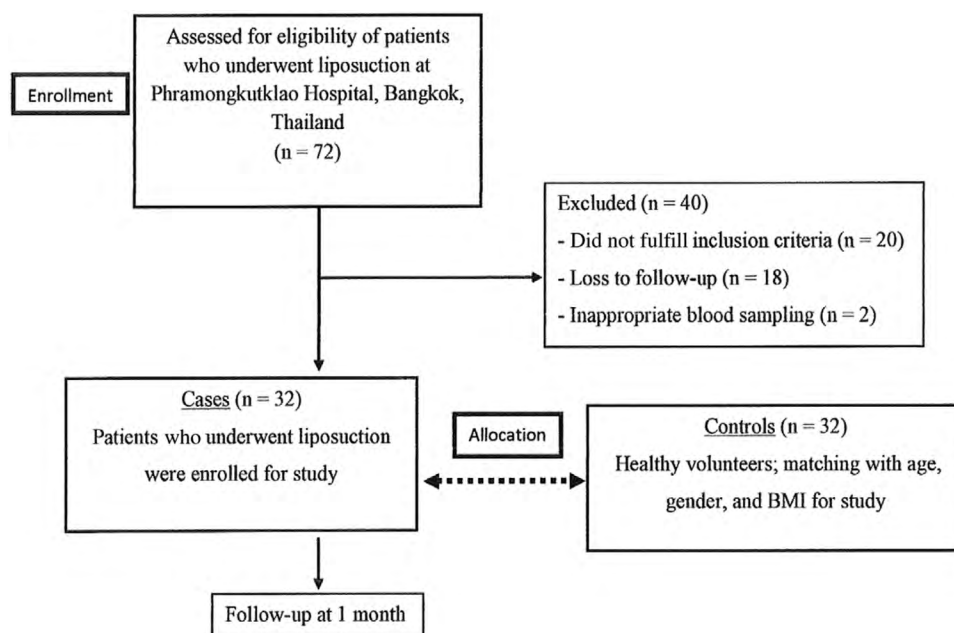


Fig. 1. Flow diagram of participants throughout the study.

Table 1. Inclusion and Exclusion Criteria for Ultrasound-assisted Liposuction

Inclusion criteria	
Female sex	
BMI < 30 kg/m ² with peripheral distribution of fat	
Stable body weight (weight change <20% in the last 6 mo)	
ASA class 1 or 2	
Exclusion criteria	
Pregnancy or lactating female	
Previous history of liposuction	
History of bleeding disorder	
Current use of antiplatelet or anticoagulant drugs	

informed consents. They were free to participate or withdraw at any point of time. All information, including the laboratory data, of the participants was confidential and stored in a secure place.

Blood Biochemistry

Fasting plasma glucose levels and serum levels of total cholesterol, triglycerides, and free fatty acid were determined by routine laboratory methods. Leptin and leptin receptor levels were determined by a radioimmunoassay method (sandwich technique) (R and D systems Inc., Minneapolis, MN, USA). All blood examinations were performed and analyzed in the preoperative and 1-month postoperative period in the study group and once in the control group.

Questionnaire

The questionnaires were designed to evaluate a person’s preoccupation with the perceived defect (including time occupied, interference with functioning due to the preoccupation, distress, resistance, and control), associated repetitive behaviors (including time spent, interference with functioning, and distress if the behaviors are prevented, resistance, and control), insight, and avoidance. This form is a 12-item semistructured clinical instrument that assesses the severity of BDD during the past week. It was adapted from the Yale–Brown Obsessive-Compulsive Scale (YBOCS), the most widely used measure of obsessive-compulsive disorder severity. Each question is scored on a 5-point scale (range from 0 to 4), where 0 means least symptom and 4 most symptoms.¹⁵ A total score of 20 was used as the cutoff point to identify BDD. Authors used the Thai version YBOCS, which was initially translated to Thai, and its reliability and validity were checked by Hiranyatheb et al.¹⁶ Questionnaires were assessed preoperatively and 1-month postoperatively in the study group and once in the control group.

Data Analysis

Data were analyzed using SPSS for windows version 18.0 (SPSS Inc., Chicago, IL, USA). Categorical variables were presented as number and percentage. Chi-square test or Fisher’s exact test was used for comparison between the 2 groups. Numerical variables were tested for normality using Kolmogorov–Simonov test. Non-normal distributed data were expressed as median and interquartile range and analyzed by the Mann-Whitney *U* test for 2-group comparisons. Wilcoxon signed-rank test was used for paired samples. The correlation between 2 variables was assessed using the Spearman’s rank correlation coefficient. Cronbach’s alpha was used to estimate the internal consistency and reliability of the questionnaire. A *P*-value of <0.05 was considered statistically significant.

RESULTS

Demographic Data and Laboratory Analysis

The demographic and laboratory data were compared between the groups (Tables 2 and 3). Patients who underwent liposuction had a significantly higher median (interquartile range) of total BDD-YBOCS scores than the healthy volunteers [25 (22–27) versus 12 (8–20), respectively; *P* < 0.001]. There were 28 (87.5%) patients with a total BDD-YBOCS score of >20, whereas 10 (31.3%) volunteers had scores of >20.

Between the patients and healthy volunteers, there were no statistically significant differences in serum leptin levels [12.82 (8.40–2.16) versus 15.48 (9.79–21.11) ng/ml, respectively; *P* = 0.444]; serum leptin receptor levels [17.76 (16.21–22.61) versus 17.02 (14.12–20.33) ng/ml, respectively; *P* = 0.068]; and serum leptin/leptin receptor ratio [0.65 (0.36–1.28) versus 0.75 (0.55–1.39), respectively; *P* = 0.193] (Table 4). Subgroup analysis of leptin parameters was performed between the groups with BDD-YBOCS scores of >20 and those with scores of <20 within the cases compared before and 1 month after liposuction; 18 patients had BDD-YBOCS scores of >20 and 14 patients had scores of <20. Between these groups, the leptin parameters were not significantly different: serum leptin [10.35 (10.93–19.83) versus 14.27 (8.08–21.62) ng/ml, respectively; *P* = 0.896]; serum leptin receptor [20.16 (15.11–25.32) versus 21.18 (17.91–24.17) ng/ml, respectively; *P* = 0.837]; and serum leptin/leptin receptor ratio [0.68 (0.52–1.46) versus 0.39 (0.32–1.09), respectively; *P* = 0.251] (Table 5).

Table 2. Demographic Data

Variable	Case (n = 32)	Control (n = 32)	<i>P</i>
Baseline characteristics			
Age (y)	33 (28–39)	34 (27–41)	0.561
BMI (kg/m ²)	23.5 (20.1–27.3)	23.9 (22.1–27.8)	0.564
Percent body fat (%)	33.4 (27.9–37.8)	33.8 (31.3–38.3)	0.564
BDD-YBOCS scores	25 (22–27)	12 (8–20)	<0.001
BDD-YBOCS before liposuction ≥ 20; n (%)	28 (87.5)	10 (31.3)	<0.001
BDD-YBOCS after liposuction ≥ 20; n (%)	18 (56.3)	N/A	
Volume of fat removal	1,550 (1,000–1,975)	N/A	

Table 3. Laboratory Findings

Variable	Case* (n = 32)	Control* (n = 32)	P
Hematologic findings			
Hemoglobin (g/dl)	12.8 (11.8–13.3)	12.2 (11.5–13.1)	0.104
Hematocrit (%)	37 (35–39)	39 (37–41)	0.013
White cell counts ($\times 10^3$ cells/mm ³)	7.5 (6.7–8.5)	7.0 (6.1–8.1)	0.145
Absolute neutrophils (cells/mm ³)	4,289 (3,655–4,792)	3,806 (3,144–4,770)	0.265
Absolute lymphocytes (cells/mm ³)	2,649 (2,165–3,206)	2,364 (1,875–2,564)	0.265
Absolute eosinophils (cells/mm ³)	131 (80–180)	204 (103–361)	0.017
Absolute monocytes (cells/mm ³)	408 (341–582)	400 (322–536)	0.872
Absolute basophils (cells/mm ³)	32 (15–52)	43 (31–58)	0.092
Platelet counts ($\times 10^3$ /mm ³)	254.5 (197.5–341.3)	274.5 (240.0–340.8)	0.245
Prothrombin time (s)	12.1 (11.5–13.1)	11.5 (11.1–11.8)	<0.001
INR	0.97 (0.93–1.06)	0.89 (0.87–0.92)	<0.001
Activated partial thrombin time (s)	26.3 (24.3–27.7)	26.4 (24.9–27.4)	0.885
Blood chemistries			
Blood sugar (mg/dl)	78.0 (71.0–91.0)	83.0 (74.5–89.5)	0.362
Blood urea nitrogen (mg/dl)	9.4 (8.3–11.3)	10.0 (8.0–12.6)	0.448
Creatinine (mg/dl)	0.6 (0.5–0.7)	0.7 (0.7–0.8)	<0.001
eGFR (ml/min/1.73 m ²)	119.7 (112.8–126.2)	107.2 (91.8–116.2)	<0.001
Sodium (mmol/l)	139 (138–140)	140 (139–141)	0.019
Potassium (mmol/l)	4.1 (3.9–4.3)	4.2 (3.9–4.4)	0.452
Bicarbonate (mmol/l)	22.7 (21.0–24.2)	27.7 (26.6–29.3)	<0.001
Total bilirubin (mg/dl)	0.4 (0.3–0.5)	0.3 (0.3–0.4)	0.443
Direct bilirubin (mg/dl)	0.1 (0.1–0.2)	0.1 (0.1–0.2)	0.039
Albumin (g/dl)	4.2 (4.0–4.4)	4.4 (4.3–4.6)	0.005
Aspartate aminotransferase (IU/l)	20 (17–24)	18 (16–21)	0.093
Alanine aminotransferase (IU/l)	13 (10–20)	15 (12–19)	0.846
Cholesterol (mg/dl)	188 (176–211)	187 (164–205)	0.413
Triglyceride (mg/dl)	80 (59–106)	111 (81–157)	0.052
High-density lipoprotein (mg/dl)	60 (50–72)	59 (47–68)	0.568
Low-density lipoprotein (mg/dl)	128 (112–140)	130 (101–147)	0.936

INR, international normalized ratio.

Table 4. Leptin Parameters

Leptin Parameters	Case* (n = 32)	Control* (n = 32)	P
Serum leptin (ng/ml)	12.82 (8.40–2.16)	15.48 (9.79–21.11)	0.444
Serum leptin receptor (ng/ml)	17.76 (16.21–22.61)	17.02 (14.12–20.33)	0.068
Serum leptin/serum leptin receptor	0.65 (0.36–1.28)	0.75 (0.55–1.39)	0.193

Table 5. Leptin Parameters among Cases (after Liposuction)

Leptin Parameters	BDD-YBOCS ≥ 20 (n = 18)	BDD-YBOCS < 20 (n = 14)	P
Serum leptin (ng/ml)	10.35 (10.93–19.83)	14.27 (8.08–21.62)	0.896
Serum leptin receptor (ng/ml)	20.16 (15.11–25.32)	21.18 (17.91–24.17)	0.837
Serum leptin/serum leptin receptor	0.68 (0.52–1.46)	0.39 (0.32–1.09)	0.251

Questionnaire Analysis

The internal consistency analysis was performed for all 12 questions of BDD-YBOCS. Using the cutoff value of 20 for the total BDD-YBOCS score, the 64 subjects were divided into 2 groups; 26 had a total BDD-YBOCS score of <20 and 38 had a total BDD-YBOCS score of >20 . The leptin parameters, including serum leptin level (ng/ml), serum leptin receptor level (ng/ml), and serum leptin/leptin receptor ratio were compared between these groups (Table 6). The patients with a total BDD-YBOCS score of >20 had significantly lower levels of serum leptin than those with scores of <20 [12.43 (7.15–16.98) versus 15.57 (9.59–22.28) ng/ml, respectively; $P = 0.043$]. However, there were no statistically significant differences in the serum leptin receptor levels [17.50 (16.00–21.95) versus 17.69 (14.56–21.34) ng/ml, respectively; $P = 0.733$] and serum leptin/leptin receptor ratio [0.88 (0.54–1.46) versus 0.64 (0.36–1.07), respectively; $P = 0.059$] (Table 7).

DISCUSSION

Liposuction was introduced in the 1980s. Currently, liposuction is the most popular cosmetic procedure globally owing to improvements in its safety, patient care, techniques, preoperative assessments, and fluid management. New liposuction techniques have made it possible to remove subcutaneous adipose tissue with fewer complications.¹⁷ Fat, or adipose tissue, is the main tissue removed by the procedure. Adipose tissue is known as a metabolically active organ, which is important in energy balance and contributes to the risk of diabetes. Therefore, the removal of subcutaneous adipocytes via liposuction might directly affect an individual's metabolism and neuroendocrine hormone, leptin, which is produced by fat cells.

Leptin is a hormone predominantly produced by adipose cells; it crosses the blood–brain barrier to act on its receptors in the hypothalamus, which help in regulating energy balance by inhibiting hunger – the opposite function of ghrelin hormone.¹⁸ Previous studies have reported

Table 6. Internal Consistency Analysis: Statistical Summary for BDD-YBOCS Scores among 64 Subjects Including 32 Patients Who Underwent Liposuction (Cases) and 32 Healthy Volunteers with Age, Sex, and BMI Matched (Controls)

	Range	Median (IQR)	Corrected Item–Total Correlation	Cronbach’s Alpha If the Item Is Deleted
Cronbach’s alpha = 0.891				
1. Time occupied by thoughts about body defect	0–4	2 (1–3)	0.724	0.877
2. Interference due to thoughts about body defect	0–4	1 (1–2)	0.736	0.876
3. Distress associated with thoughts about body defect	0–4	2 (1–3)	0.750	0.874
4. Resistance against thoughts of body defect	0–4	2 (1–3)	0.305	0.902
5. Degree of control over thoughts about body defect	0–4	2 (1–2)	0.692	0.877
6. Time spent in activities related to body defect	0–4	1 (1–2)	0.575	0.884
7. Interference due to activities related to body defect	0–4	1 (0–2)	0.777	0.873
8. Distress associated with activities related to body defect	0–4	2 (1–2)	0.763	0.874
9. Resistance against compulsions	0–4	2 (0–3)	0.310	0.903
10. Degree of control over compulsive behavior	0–4	1 (1–2)	0.692	0.878
11. Insight	0–4	1 (1–2)	0.471	0.889
12. Avoidance	0–4	1 (0–2)	0.645	0.880

IQR, interquartile range.

Table 7. Serum Leptin, Serum Leptin Receptor, Serum Leptin/Leptin Receptor Ratio in Relation to BDD-YBOCS Scores Cutoff at 20 among 64 Subjects in the Study

Variable	Serum Leptin (ng/ml)	P	Serum Leptin Receptor (ng/ml)	P	Serum Leptin/Serum Leptin Receptor Ratio	P
BDD-YBOCS scores						
Total BDD-YBOCS scores < 20 (n = 26)	15.57 (9.59–22.28)	0.043	17.50 (16.00–21.95)	0.733	0.88 (0.54–1.46)	0.059
Total BDD-YBOCS scores ≥ 20 (n = 38)	12.43 (7.15–16.98)		17.69 (14.56–21.34)		0.64 (0.36–1.07)	

many interesting facts about leptin and its association with some diseases. One previous report demonstrated that leptin plays a role in the mental status and mood disorders.¹⁴

It was proposed that patients who seek liposuction may have some degree of BDD. Some of them have normal body weight and BMI; however, they still feel the need to undergo liposuction. Therefore, we used a questionnaire to evaluate the mental statuses of subjects in both groups. We chose BDD-YBOCS in our study because the BDD-YBOCS score is a specific instrument that measures the severity of BDD symptoms. It is a short questionnaire and an easy way to evaluate specific information about BDD symptoms; it is accepted as the gold standard for the measurement of BDD.¹⁹

A previous study had reported the use of BDD-YBOCS in patients who sought rhinoplasty and abdominoplasty.²⁰ However, to the best of our knowledge, no previous study has used BDD-YBOCS in patients who sought liposuction.

All the cases in our study were females, which was based on a previous study performed in the United States; it reported that 96.5% of 31,010 patients who underwent liposuction were females.²¹ Most of liposuction cases in the Western countries require a larger volume of liposuction and is opposite to the trend in the Oriental countries, where people have relatively lower BMIs.⁴

Our results demonstrated that the patients who underwent liposuction had significantly higher total BDD-YBOCS scores than the healthy controls. The group of cases had 28 (87.5%) patients with a total BDD-YBOCS score of >20, whereas the control group had 10 (31.3%) volunteers with a BDD-YBOCS score of >20, with 20 being

the cutoff point.²² Therefore, these patients may have some degree of BDD or more concern about their body image when compared with volunteers of similar age, sex, and BMI. In laboratory findings, some parameters were statistically significantly different between these 2 groups, including serum absolute eosinophil count, prothrombin time, international normalized ratio, estimated glomerular filtration rate, and levels of hematocrit, sodium, bicarbonate, direct bilirubin, and albumin; however, none of the variables were clinically significant. Similarly, although the 3 leptin parameters were not statistically significantly different between the cases and controls, the cases had lower serum leptin levels than the controls. Our results are similar to those of Yoshida-Komiya et al; they compared leptin levels in 17 patients with mood disorders and healthy volunteers with normal weight. They found that leptin levels in patients were lower than those in the healthy controls.¹⁴ Similar to their further results, in our study, the leptin levels tended to be lower in the group of cases with BDD than those in the group without BDD [10.35 (10.93–19.83) versus 14.27 (8.08–21.62) ng/ml, respectively]. Most of previous studies reported only leptin levels and other leptin parameters. This study reported leptin, leptin receptor, and leptin–leptin receptor ratio as the leptin parameter; the correlation of leptin and leptin receptor in this study was similar to that in a previous report by Gómez-Bañuelos et al²³ and Popruk et al²⁴; both studies reported negative correlation of leptin and leptin receptor.

Another previous study compared patients with depression with controls paired by sex, age, and BMI. It reported that the serum leptin levels were significantly lower in the patients than those in controls. Furthermore, individuals

with bipolar depression had lower leptin levels than those with unipolar depression and the controls.²⁵ In our study, we also evaluated the serum leptin receptor levels and leptin–leptin receptor ratio; leptin receptor levels were lower in the cases, whereas leptin–leptin receptor ratios were higher.

The overall 64 participants were divided into 2 groups to compare leptin levels according to the BDD-YBOCS scores, and internal consistency analysis (reliability analysis) was performed for the 12 questions of the scale. After identifying a cutoff point of 20 according to a previous study,²⁶ the subjects with scores of <20 had statistically significantly higher serum leptin levels than those with scores of >20 [15.7 versus 12.43 ng/ml, respectively; *P*-value = 0.043]. These results suggest that people who have more anxiety about their body appearance have lower leptin levels, which is similar to the findings of previous studies.^{14,25}

To the best of our knowledge, this is the first study to demonstrate an association between BDD and leptin levels in patient with normal BMI who seek liposuction. Our limitation in this study was the number of dropouts in liposuction case (study group). However, we were aware that the number of dropouts is a limitation. Therefore, we performed case matching after we enrolled all the subjects as per the sample size calculation protocol. Therefore, further studies are warranted to corroborate our findings.

CONCLUSIONS

Patients who underwent liposuction had significantly higher total BDD-YBOCS scores than healthy volunteers matched by sex, age, and BMI. Subjects with higher BDD-YBOCS scores had significantly lower serum leptin levels.

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