Karya J Health Sci. 2023; 4(3): 220-226
ARAŞTIRMA MAKALESİ/RESEARCH ARTICLE doi: 10.52831/kjhs.1342510 e-ISSN:2717-9540

KARYA JOURNAL OF HEALTH SCIENCE

journal homepage: www.dergipark.org.tr/kjhs

EVALUATION OF EATING QUALITY AFTER LAPAROSCOPIC SLEEVE GASTRECTOMY

LAPAROSKOPİK SLEEVE GASTREKTOMİ SONRASI BESLENME KALİTESİNİN DEĞERLENDİRİLMESİ

Gülşah Kaner[1], Çağla Ayer[1*], Tuba Yalçın[1]

[1]Department of Nutrition and Dietetics, Faculty of Health Sciences, İzmir Katip Çelebi University, İzmir, Türkiye

ABSTRACT

Objective: This study aims to evaluate the tolerance to different types of foods after laparoscopic sleeve gastrectomy (LSG).

Method: This cross-sectional study was carried out with a total of 77 patients aged 18-65 years. Patients were divided into three groups according to the time after LSG operation (Group 1=<6th month, Group 2=from 6th to <12th month, and Group 3=from 12th to 24th month). The quality of alimentation questionnaire was used to assess food tolerance.

Results: The mean total food tolerance score (FTS) of patients was 20.83±3.66. Total FTS showed no statistical differences between the groups (p=0.23). After LSG, a statistically significant relationship was determined between the consumption of legumes, green leafy vegetables, and other vegetables and the FTS. The FTS increased as time passed after LSG (p<0.001). Patients reported poor tolerance to red meat (53.2%) and carbohydrates such as rice (36.4%), and bread (35.1%) after LSG. Good tolerance to fish (84.4%), white meat (70.1%), and salad (62.3%) were determined. The tolerance of bread, pasta, and rice increased gradually from group 1 to group 3 (p<0.05). A low level of negative correlation was determined between abdominal pain (r=-0.263), abdominal bloating (r=-0.234), legume consumption (r=-0.297), and FTS.

Conclusion: Food tolerance for different types of food was lower in the first 6 months and increased as time passed after LSG. This situation suggests that individuals attach importance to adequate and balanced nutrition and prefer healthy food choices.

Key Words: Alimentation Questionnaire, Food Tolerance, Laparoscopic Sleeve Gastrectomy, Obesity

ÖZ

Amaç: Bu çalışma, laparoskopik sleeve gastrektomi (LSG) sonrası farklı besin türlerine toleransı değerlendirmeyi amaçlamaktadır.

Yöntem: Bu kesitsel çalışma, 18-65 yaş arası toplam 77 hastanın katılımı ile gerçekleştirilmiştir. Hastalar LSG operasyonu sonrası sürelerine göre üç gruba (Grup 1=<6. ay, Grup 2=6. aydan <12. aya kadar ve Grup 3=12. aydan 24. aya kadar) ayrılmıştır. Besin toleransını değerlendirmek için beslenme kalitesi anketi kullanılmıştır.

Bulgular: Hastaların ortalama toplam besin tolerans skoru (BTS) 20.83±3.66'dır. Toplam BTS, gruplar arasında istatistiksel olarak farklılık göstermemiştir (p=0.23). LSG sonrası baklagiller, yeşil yapraklı sebzeler ve diğer sebzelerin tüketimi ile BTS arasında istatistiksel olarak anlamlı bir ilişki saptanmıştır. LSG süresi arttıkça BTS puanı da artmıştır (p<0.001). Hastalar LSG sonrası kırmızı et (%53.2), pirinç (%36.4) ve ekmek (%35.1) gibi karbonhidratlara karşı zayıf tolerans bildirmiştir. Balık (%84.4), beyaz et (%70.1) ve salata (%62.3) toleransının iyi olduğu belirlenmiştir. Ekmek, makarna ve pirince olan tolerans 1. gruptan 3. gruba doğru kademeli olarak artmıştır (p<0.05). Karın ağrısı (r=-0.263), karın şişkinliği (r=-0.234), bakliyat tüketimi (r=-0.297) ve BTS arasında düşük düzeyde negatif korelasyon saptanmıştır.

Sonuç: Farklı besin türlerine karşı toleransın, LSG sonrası ilk 6 ayda daha düşük olduğu ve sonrasında arttığı belirlenmiştir. Bu durum bireylerin yeterli ve dengeli beslenmeye önem verdiklerini ve sağlıklı besin seçimlerini tercih ettiklerini düşündürmektedir.

Anahtar Kelimeler: Beslenme Anketi, Besin Toleransı, Laparoskopik Sleeve Gastrektomi, Obezite

INTRODUCTION

Obesity is one of the most common life-threatening diseases. It is the new epidemic of the 21st century [1]. The World Health Organization (WHO) reported that there were approximately 1.9 billion overweight and more than 650 million adults with obesity worldwide in 2016 [2]. According to the Türkiye Nutrition and Health Survey 2019, the prevalence of overweight and obesity is 23.8% to 42.0% in men and 28.5% to 33.1% in women [3].

Diet, exercise, cognitive behavioral therapy, and pharmacotherapy are some of the ways to help patients lose weight [4]. Today, it is believed that one of the most effective treatments in the fight against obesity is the bariatric surgery [5]. The ultimate aim of bariatric surgery is to lose weight and resolve obesity-related comorbidities to improve psychosocial functioning and quality of life. There are various procedures in the surgical treatment of severe obesity. Laparoscopic sleeve gastrectomy (LSG) has proven to be effective in weight loss and resolution of comorbidities [6]. According to the International Federation for the Surgery of Obesity and Metabolic Disorders, LSG was the most frequently performed procedure worldwide, followed by Roux-en-Y gastric bypass [7].

Makale Bilgisi/Article Info

Yükleme tarihi/Submitted: 13.08.2023, **Revizyon isteği/Revision requested:** 13.11.2023, **Son düzenleme tarihi/Last revision received:** 14.11.2023, **Kabul/Accepted:** 23.11.2023
***Sorumlu yazar/Corresponding author:** İzmir Katip Çelebi University, Faculty Health Sciences, Department of Nutrition and Dietetics, İzmir, Türkiye
[2*]Email: cagla.dalbay@gmail.com, [1]Email: kanergulsah@gmail.com, [3]Email: tubay25@gmail.com

Many patients reported food intolerance, due to the development of an unwillingness to certain types of food that can cause to vomit or dumping syndrome after bariatric surgery [8]. Food tolerance outcomes differ by type of surgery and time since surgery. LSG is considered easier than other bariatric surgeries as the pylorus is preserved [9]. LSG procedures are associated with the least number of food intolerances and generally do not cause dumping syndrome [8, 10].

Percentage excess weight loss (%EWL) and percentage of excess body mass index (BMI) loss (%EBL) are generally used to report weight loss after bariatric surgery [11]. Other often evaluated success parameters are a resolution of comorbidity and improvement in quality of life [12]. Although these are important factors to consider, we think that it is also important to evaluate food tolerance and dietary habits, as their results may affect comorbidities and quality of life. The objective of the present study was to evaluate the tolerance to different types of foods after LSG during the two postoperative years.

METHOD

This cross-sectional study was carried out with a total of 77 patients aged 18-65 years who underwent LSG between September 2019 and December 2021. According to the sample calculation formula (N=80, (confidence interval) a: 0.05, (frequency of occurrence) p: 0.5, d: 1.0), the minimum number of people to be reached was calculated as 67. 96.25% of the LSG population was reached. Patients were divided into three groups according to the time after LSG operation (Group 1=<6th month, Group 2=from 6th to <12th month, and Group 3=from 12th to 24th month). This grouping was determined according to the frequency of the patients visiting the control. Recruitment took place from a single clinic and LSG was performed by a single surgeon.

The data were obtained using a questionnaire form filled out by the research dietician through face-to-face interviews. Patients completed a questionnaire on demographics, physical activities, dietary habits, weight loss history, vitamin-mineral supplementation, gastrointestinal symptoms, food tolerance, and changes in some food consumption. The patients body composition was evaluated.

The inclusion criteria were: adults with severe obesity BMI>40 kg/m^2 or BMI>35 kg/m^2 associated with comorbidity (diabetes mellitus, hypertension, arthritis, sleep apnea). The exclusion criteria were: cardiac diseases, hypothyroidism, previous bariatric surgery, hiatus hernia, and pregnancy.

Changes in Food Consumption

We used a food frequency questionnaire to evaluate the consumption of various foods before and after the LSG. Participants completed a self-administered validated food frequency questionnaire [13]. For each food, the consumption amount after LSG was subtracted from the amount before LSG, and the change in the consumption amount was calculated. The variation of food consumption frequency results was grouped as “increase”, “decrease” or “not changed”. Trained dieticians performed the interviews.

Food Tolerance Score (FTS)

The quality of alimentation questionnaire was used to assess food tolerance. The questionnaire is divided into four parts. Part 1 evaluates satisfaction with current ability to consume food, and presents answers ranging from “very bad=1” to “excellent=5”. Part 2 has questions relating to the main food of the day, how many meals are made daily, and the patient is fed between them. This section does not enter the score. Part 3 assesses specific food tolerances. This section evaluates how well eight different types of food (red meat, white meat, salad, vegetables, bread, rice, pasta, and fish) are tolerated. In part 3, the questions refers to the ability to be able to eat certain types of food without difficulty, with some difficulty, or not being able to eat. Food tolerance is given between 0 and 16 points: for each specific type of food, 2 points if the patient can eat this type without any particular difficulty, 1 point if he/she can eat it with some difficulties, and 0 points if he/she can not eat it at all. Part 4 evaluates the frequency of vomiting or regurgitation, with a score ranging from 0 to 6. In this section, 0 indicates “daily”, 2 indicates “often (greater than twice per week)”, 4 indicates “rarely (up to twice per week), and 6 indicates “never”. Cumulatively the three sections provide an overall FTS ranging from 0-27, 27 being the highest score, referring to excellent food tolerance [14].

Anthropometric Measurements

Body composition was evaluated using the TANITA BC-532 (Tokyo, Japan) device with the bioelectrical impedance analysis measurement method. Height was measured with a 0.01 cm sensitivity stadiometer with the patient standing, feet side by side, and head in the Frankfort plane. BMI was calculated by dividing body weight (kg) by the square of height (m^2). Data collected pre and post LSG included body weight, BMI, lean body mass (LBM), and fat mass (FM) [15]. In the present study, %EWL and %EBL were also evaluated. The %EWL was defined as “lost weight / (preoperative weight - ideal body weight)”, with ideal body weight usually captured through the Metropolitan Life Tables. The %EBL was defined as “BMI points lost / (preoperative BMI - 25)” [16].

Ethical Approval

The present study was performed by the guidelines laid down in the Declaration of Helsinki and all procedures involving research study patients were approved by the İzmir Katip Celebi University Faculty of Medicine Clinical Research Ethics Committee (on 28-08-2019 and with the decision number of 382). Written informed consent was also provided from all patients.

Statistical Analysis

SPSS 25.0 (SPSS Inc., Chicago, IL, USA) statistical package program was used for the statistical evaluation of the data [17]. The mean ± standard deviation (x±SD) values were calculated, and the qualitative data were shown in numbers (n) and percentages (%). Kolmogorov Smirnov test was used to evaluate compliance of the data to normal distribution. Chi-square test, t-test in independent groups, paired sample t-test, One-Way ANOVA, and Pearson correlation were used in the evaluations. The lowest level of significance was accepted as 0.05 in all statistical tests.

RESULTS

A total of 77 patients were included in this study. The mean age was 37.83±12.23 years. Fifty-seven (74.0%) patients were women, and the mean BMI was 41.01±7.73 kg/m2. The mean total FTS of patients was 20.83±3.66. Total FTS showed no statistical differences between the groups (Group 1=20.00±3.11, Group 2=20.60±3.97, Group 3=21.88±3.73, respectively), (p=0.17). Almost all of the patients (97.4%) reported attempting to lose weight before the surgery. Consulting a dietician (83.1%), going to the gym (74.0%), and consuming herbal tea (40.3%) were the most preferred methods to lose weight. It was determined that 50.6% of patients who received dietician consultation for weight loss before the LSG did not comply with recommendations, and their FTS (20.50±3.68) was lower than those who followed the recommendations (21.15±3.41). However, the differences were not statistically significant (p=0.47) (Table 1).

The symptoms commonly reported after LSG are presented in Figure 1. Constipation (50.6%), hair loss (28.6%), and nausea/vomiting (28.6%) were commonly reported by the patients. Patients with diarrhea (24.00±1.00), reflux (21.67±3.21), and hair loss (21.36±4.13) had the highest FTS. The total FTS is statistically significantly lower in those with abdominal bloating (18.14±4.74) and abdominal pain (16.75±3.09) than those without these complaints (21.10±3.46 and 21.05±3.57, respectively) (p=0.04, p=0.02, respectively) (Figure 1).

Table 1. Patients' baseline characteristics

Variables	n	%	FTS Mean±SD	Statistics
Food tolerance score (FTS)	77	100	20.83±3.66	
Gender				
Female	57	50.6	21.00±3.78	t=0.24
Male	20	49.4	20.92±3.67	p=0.81
Groups				
1 (<6th month)	26	33.8	20.00±3.11	F=1.84
2 (6th-<12th month)	25	32.4	20.60±3.97	p=0.17
3 (12th-24th month)	26	33.8	21.88±3.73	
Body weight loss initiative before LSG				
Yes	75	97.4	20.83±3.67	t=-0.07
No	2	2.6	21.00±4.24	p=0.95
Methods for weight loss**				
Dietician counseling	64	83.1	20.89±4.50	t=0.36; p=0.72
Drug use	27	35.1	21.07±3.28	t=0.46; p=0.65
Herbal products and herbal tea	31	40.3	20.58±3.48	t=-0.48; p=0.63
Detoxes and powder mixtures	8	10.4	19.87±4.05	t=-0.77; p=0.44
Going to the gym	57	74.0	20.85±3.52	t=0.14; p=0.89
Diets found in media and internet	18	23.4	19.83±3.76	t=-1.32; p=0.19
Acupuncture	10	13.0	20.20±5.34	t=-0.58; p=0.56
Compliance with dietician recommendations before LSG				
Yes	38	49.4	21.15±3.41	t=0.73
No	26	50.6	20.50±3.68	p=0.47

**The data was shown as mean± standard deviation (SD) (p<0.05); ** More than one answer has been accepted; LSG: Laparoscopic sleeve gastrectomy*

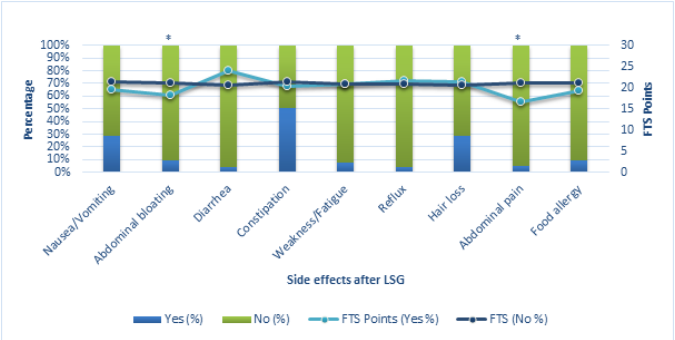

Figure 1. Side effects after LSG and its' relationship between food tolerance score
*(*p<0.05)*

Changes in food consumption after LSG and its relationship between FTS are shown in Figure 2. Patients reported a reduced consumption for pasta (90.9%), rice (89.6%), and dessert with syrup (84.4%) after LSG. However, there is an increase in the consumption of foods such as fish (46.8%), egg (47.6%), and oilseeds (39.0%). After LSG, a statistically significant relationship was determined between the consumption of legumes, green leafy vegetables, and other vegetables and the FTS. The FTS of those who did not change their legume consumption after LSG was 22.10±3.27, and the score of those who reduced their consumption was 19.88±4.01 (p=0.002). Similarly, the FTS of those who did not change their consumption of green leafy vegetables and other vegetables (21.95±3.19 and 21.64±3.82, respectively) was significantly higher than the score of those who reduced their consumption of these foods (18.76±4.12 and 17.81±3.68, respectively) (p=0.01, p=0.008, respectively) (Figure 2).

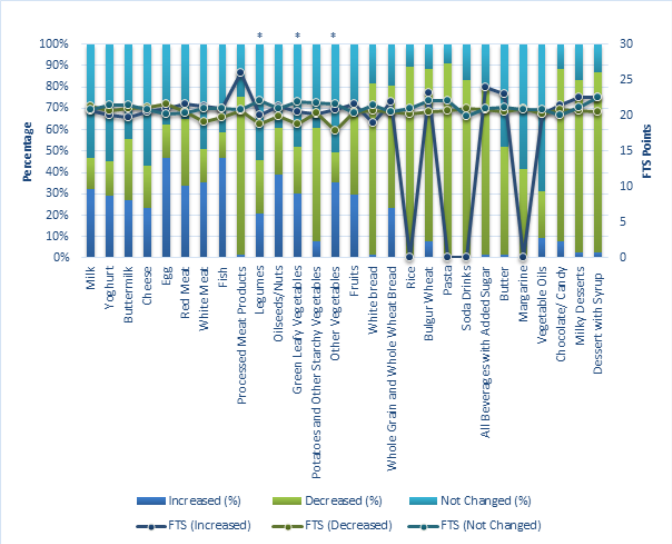

Figure 2. Changes in consumption of various foods after LSG and its' relationship between food tolerance score.
**p<0.05; **According to the post-hoc Tukey test, the difference is between legume consumption "decreased" and "unchanged" groups; **According to the post-hoc Tukey test, the difference is between the consumption of green leafy vegetables "decreased" and "unchanged" groups; **According to the post-hoc Tukey test, the difference is between the consumption of other vegetables "decreased-unchanged" and "decreased-increased" groups.*

The FTS according to groups are displayed in Table 2. When patients rated their overall satisfaction with their ability to eat at present, the score decreased as time passed after LSG. However, the differences were not statistically significant. The total score for food tolerance was 10.58±2.66 points for group 1, 12.08±2.60 points for group 2, and 13.38±2.23 points for group 3. The FTS increased as time passed after LSG, and the differences were statistically significant (p<0.001). The mean score for vomiting frequency was 4.85±1.29, 4.40±1.53, and 4.46±1.82 for the group 1, 2, and 3, respectively. However, the differences were not statistically significant. The total score of the questionnaire was 20.00±3.11, 20.60±3.97, and 21.88±3.73 for group 1, 2, and 3, respectively. Although the total score increases with the increase in the postoperative time, the difference is not statistically significant (Table 2).

Table 2. Food tolerance score according to groups

FTS	Group 1 (n=26)	Group 2 (n=25)	Group 3 (n=26)	Statistics	Total (n=77)
Satisfaction of eating ability	4.58±0.7	4.12±1.01	4.04±0.92	F=2.79 p=0.07	4.25±0.91
Food tolerance	10.58±2.66	12.08±2.60	13.38±2.23	F=8.22 p<0.001*	12.01±2.73
Frequency of vomiting	4.85±1.29	4.40±1.53	4.46±1.82	F=0.62 p=0.54	4.57±1.55
Total score	20.00±3.11	20.60±3.97	21.88±3.73	F=1.84 p=0.17	20.83±3.66
Min-Max	14-26	12-26	13-27		12-27
IQR-25	17.00	18.00	19.00	F=1.84	
IQR-50	20.50	21.00	23.00	p=0.17	
IQR-75	22.25	24.00	24.25		

**The data was shown as mean± standard deviation (SD) (p<0.05); According to the post-hoc Tukey test, the difference is between the "<6th month (Group 1)" and "12th-24th month (Group 3)"; IQR: Interquartile range.*

Patients reported poor tolerance to red meat (53.2%) and carbohydrates such as rice (36.4%), and bread (35.1%) after LSG. Good tolerance to fish (84.4%), white meat (70.1%), and salad (62.3%) was determined (Figure 3.a).

The tolerance of bread, pasta, and rice increased gradually from group 1 to group 3. According to one-way ANOVA, post hoc Tukey test revealed that the difference in food tolerance for bread, pasta and rice was between Group 1 and Group 3. (respectively p=0.01, p<0.001, p<0.001). (Figure 3. b).

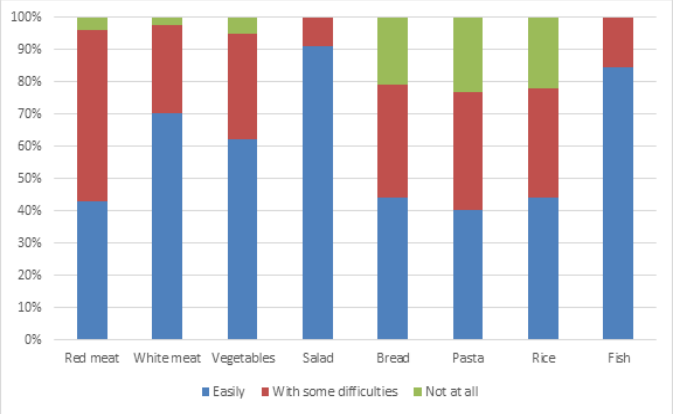

Figure 3.a. Food tolerance for different types of food after LSG

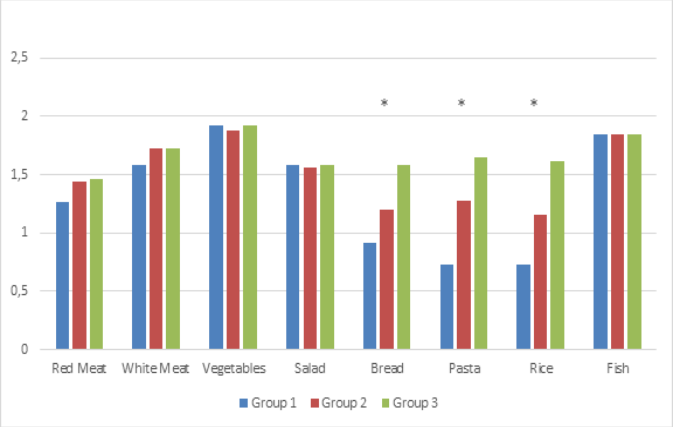

Figure 3.b. Food tolerance for different types of food after LSG
**p<0.05. **According to the post-hoc Tukey test, the difference is between the "<6th month (Group 1)" and "12th-24th month (Group 3)*

Table 3 shows the individual changes in some habits and anthropometric measurements of the patients before and after LSG. It was determined that using supplements, exercising for at least 150 minutes a week, perceive of adequate and balanced nutrition, consumption of 3 main meals, and ≥2 snacks a day increased after LSG.

Patients reported that they reduced their daily consumption of fast food and alcohol. Anthropometric measurements such as body weight, body fat percentage, fat mass, lean body mass, and BMI decreased after LSG (p<0.001). After LSG, the mean EBL (%) was 0.77±0.31 and the mean EWL (%) was 83.52±18.49 (Table 3).

Table 4 shows the factors that may affect the food tolerance of patients after LSG. As a result of the correlation, a low level of negative correlation was determined between abdominal pain (r=-0.263), abdominal bloating (r=-0.234), legume consumption (r=-0.297), and FTS.

Table 3. Changes in some habits and anthropometric measurements of patients before and after LSG

Variables	Before LSG	After LSG	Statistics
	n (%)		
Using supplements	7 (9.09%)	70 (90.91%)	t=18.49 p<***0.001****
Exercising for at least 150 minutes a week	17 (22.1%)	51 (66.2%)	t=7.05 p<***0.001****
Perceived sufficient and balanced nutrition	12 (15.58%)	56 (72.53%)	t=3.82 p<***0.001****
3 main meal	40 (51.95%)	65 (84.42%)	t=-6.98 p<***0.001****
≥2 snack	49 (63.64%)	61 (79.22%)	t=-4.67 p=***0.018****
Consuming fast food everyday	36 (46.8%)	3 (3.9%)	t=-2.43 p<***0.001****
Eating meal outside home during the week	22 (22.8%)	8 (10.4%)	t=-4.50 p<***0.001****
Alcohol consumption	26 (33.8%)	8 (10.4%)	t=-6.35 p<***0.001****
	Mean±SD		
Body weight (kg)	115.08±27.17	84.08±19.80	t=14.26 p<***0.001****
BMI (kg/m^2)	41.01±7.73	30.07±6.64	t=16.78 p<***0.001****
FM (%)	45.06±5.73	33.93±9.12	t=10.22 p<***0.001****
FM (kg)	52.20±15.64	29.39±12.95	t=-1.25 p<***0.001****
LBM (kg)	62.88±14.64	54.67±11.17	t=12.35 p<***0.001****
		Mean±SD	
%EWL		64.14±24.25	
%EBL		75.59±31.23	

**The data was shown as mean± standard deviation (SD) (p<0.05); BMI: body mass index; FM: fat mass; LBM: lean body mass; %EWL: Percentage of excess weight loss; %EBL: Percentage of excess BMI loss.*

Table 4. Correlation of factors affecting food tolerance after LSG

Variables	Food Tolerance Score	
	r	p
Abdominal pain	**-0.263***	0.021
Abdominal bloating	**-0.234***	0.041
Legume consumption	**-0.297***	0.009
Green-leafy vegetables consumption	0.196	0.088
Other vegetables consumption	0.118	0.308

**Pearson correlation analysis was performed.*

DISCUSSION

Bariatric procedures alter the anatomy and physiology of the gastrointestinal system. Alteration in the digestion and absorption of food due to gastrointestinal problems after surgery affected nutritional status, food intake, and diet quality [18]. Gastrointestinal problems may occur in more than 50% of the patients within the first year after surgery. The most common complaints are mainly nausea, vomiting, reflux, and changes in bowel movements such as diarrhea and constipation [19]. The risk of nausea and vomiting after LSG is very common and can be observed in approximately 65% of patients within the first 24 h after surgery [20]. It has been reported that hair loss can be observed in the first year after bariatric surgeries due to rapid weight loss or iron and zinc deficiency [21, 22]. In this study, the most common symptoms after LSG were constipation, hair loss, nausea, and vomiting. The frequency of vomiting was higher in the first six months.

Surgical resection of approximately two-thirds of the stomach in LSG results in a tubular shape and may restrict nutrient intake [23]. A reduction in stomach volume causes abdominal bloating and pain after food intake, which prevents required food intake, and reduces the FTS. In our study, patients with abdominal bloating and pain had significantly lower FTS, whereas patients with diarrhea, reflux, and hair loss had higher FTS. This led us to believe that individuals comply with the nutritional counseling provided by the dietician during the postoperative period.

Although bariatric surgery has shown good results in controlling obesity, patients undergoing this procedure may have difficulty adapting to food after the surgery. Food intolerance develops, and FTS decreases because of the inability to digest or absorb some nutrients after bariatric surgery [24]. Food intolerance problems are similar in the short term, regardless of the surgical technique used, but tend to improve over time. In a study by Schweiger et al., food tolerance was found to be significantly lower in the early period (3-6 months), and tolerance improved as time passed from the operation [10]. Another study, conducted by Ruiz-Tovar et al., reported food intolerance during the first postoperative year disappeared in the 5th year after LSG [25]. Similarly, in this study, food tolerance for different types of food was lower in the first 6 months and increased as time passed after LSG ($p<0.001$). Although the total score increases with the increase in the postoperative time, the difference is not statistically significant. This suggests that the symptoms improve over time due to the physiological adaptation of the gastrointestinal system and cognitive adaptation of patients [18, 26].

Evidence suggests that patients tolerate most food groups, but the results of studies examining food tolerance after bariatric surgery have been inconsistent [18, 26]. Red meat, poultry, rice, bread, pasta, dairy products, and vegetables are the most commonly reported food intolerances [26]. It has been stated that the poor tolerance of bread, cereals, red and white meat is associated with a reduced intake of these foods [27]. Poor tolerance to red meat during the first postoperative year has also been noted in other studies and was confirmed in our patients [10, 28]. However, in accordance with the results of other studies, this study showed that chicken, turkey, and fish were the easiest foods to consume after surgery [10, 28, 29]. Rice, pasta, and bread are other foods that individuals either consume with difficulty or do not consume in the first year after surgery. These results are in line with the results of Diaz-Lara et al., who examined the food tolerance of individuals after LSG [29]. Two studies evaluated individual tolerance of salads and vegetables after LSG. Both reported that the salad was tolerated with some difficulty during the first 6 months and the tolerance increased as time passed after surgery [10, 28]. In our study, good tolerance to the salad was observed. Since the majority of the participants (68%) were at least six months after the operation, it was thought that tolerance to vegetables increased. In a study evaluating the long-term food tolerance of patients after LSG, the consumption of legumes and vegetables increased in the first year after the operation following the advice of a dietician. However, most patients have problems with the digestion of these foods. On the other hand, it has been reported that five years after surgery, most patients have increased tolerance to these foods and consume more [30]. In this study, we found that the FTS of patients who reduced their consumption of legumes and vegetables also decreased after LSG. It is noteworthy that among legumes with high protein content, only lentils are recommended from the early period; in contrast, the consumption of beans and chickpeas is recommended only from the ninth month [29]. An increase in the FTS of patients after bariatric surgery improves the quality of their eating habits and weight loss [31].

A significant proportion of patients reported poor eating behavior before undergoing bariatric surgery. Skipping meals, eating out more often, and eating fast food was positively related to higher BMI, along with higher energy and fat intake [32]. Adherence to dietary and lifestyle recommendations after bariatric surgery is likely to positively affect weight loss and maintenance [33]. Patients are recommended to consume 3-6 meals per day after surgery. To prevent nausea and vomiting, attention should be paid to the portion consumed and snacks should be consumed. A study reported that the consumption of 3 main meals and at least 1 snack per day resulted in longer satiety [33]. In this study, the perception of adequate and balanced nutrition after surgery and the number of individuals consuming 3 main meals and 2 or more snacks increased.

It has been stated in the literature that there is a tendency to decrease the preference for sweet, fatty, and energy-dense foods, because of changes in taste sensation and food preferences of patients, especially in some bariatric surgery applications. However, whether the taste changes persist over the long term has not been fully evaluated [34]. Changes in taste perception and food preferences after bariatric surgery may be influenced by biological and psychological factors. A previous study reported that patients' interest in sweet and high-fat foods was reduced after the LSG [35]. In this study, patients reported a decreased consumption of desserts with syrup, along with pasta and rice. Fish, eggs, and oilseeds were defined as those whose consumption increased the most after LSG. Additionally, the number of people who consume fast food daily has decreased. This situation suggests that individuals attach importance to adequate and balanced nutrition and prefer healthy food choices.

A recently published systematic review showed that bariatric surgery provides body weight control by causing weight loss with a significant reduction in energy intake [18]. A study conducted by Silva et al. showed that patients had decreased body fat percentage, fat mass, body weight, and BMI regardless of the type of surgery performed [36]. Similarly, in this study, it was determined that there was a significant decrease in the body weight, BMI, body fat %, fat mass, and lean body mass of patients after surgery. The mean %EWL and %EBL are 64.14±24.25 and 75.59±31.23, respectively after LSG.

The mechanisms and causes of nutritional deficiencies after bariatric surgery are multifactorial. It is affected by the type of surgery, preoperative deficiencies, postoperative gastrointestinal symptoms, altered eating behavior, food intolerance, taste changes, and failure to follow dietary recommendations. Some studies have reported a significantly higher prevalence of nutrient deficiencies after LSG [37, 38]. In a study, most patients in the post-LSG period reported changing their eating habits, increasing their physical activity levels, and using supplements [39]. Nutritional supplementation is recommended in patients after bariatric surgery in Türkiye [40]. In this study, in line with the recommendation the use of nutritional supplements increased postoperatively.

Dietary therapy after bariatric surgery encompasses not only nutritional recommendations but also many recommendations regarding physical activity and alcohol consumption, promoting a healthy lifestyle [40]. Physical activity is a vital part of weight management programs aimed at increasing weight loss, maintaining ideal body weight, and preventing chronic diseases [41]. Most patients undergoing bariatric surgery have musculoskeletal problems and chronic diseases that may affect their exercise tolerance and adaptation to daily physical activity. Previous studies have highlighted the importance of exercise programs for promoting postoperative weight loss. It was observed that individuals who were physically active before and after surgery lost more weight and their quality of life increased effectively [42, 43]. Bariatric surgery patients should begin aerobic exercise for 150 min/week and be active with a long-term goal of 300 min/week [40]. In this study, the number of patients who performed sufficient physical activity during the post-surgical period increased. Consistent with our findings, Neunhaeuserer et al. reported a significant increase in physical activity during the post-LSG period [44].

Limitations

This study has limitations. Because of its cross-sectional design, changes in FTS of the same patient with time could not be examined.

In addition, we used self-reported data and our sample size is small. Since we only have bioelectrical impedance analysis in the laboratory, we could not use to measure body composition by Dual-energy X-ray absorptiometry. Future research should include a longitudinal study with follow-up. Moreover, adequate study of the long-term FTS of other bariatric surgery procedures is essential.

CONCLUSION

Food intolerance is a common condition observed after bariatric surgery. In our study, food tolerance for different types of food (especially bread, pasta and rice) was lower in the first 6 months and increased as time passed after LSG. Food tolerance increases as the consumption of foods with high fiber content, such as legumes, green leafy vegetables and other vegetables, increased. Compliance with dietitians' nutritional recommendations after LSG is important in increasing food tolerance. Individuals should attach importance to adequate and balanced nutrition and choose healthy food options.

Ethical Approval: *2019/382 Non-Interventional Clinical Trials Ethics Committee of İzmir Katip Çelebi University*

Conflict of Interest: *The authors have no conflicts of interest to declare.*

Funding: *None.*

Acknowledgements: *The authors would like to thank Dietitian Doğa ÖZKAN for her contribution to the access to patients.*

Author Contribution: Concept: *GK,ÇA;* ***Design:*** *GK,ÇA;* ***Data collecting:*** *ÇA;* ***Statistical analysis:*** *ÇA;* ***Literature review:*** *GK,TY;* ***Writing:*** *GK,ÇA,TY;* ***Critical review:*** *GK,TY.*

REFERENCES

1. Ray I, Bhattacharya A, De RK. OCDD: an obesity and co-morbid disease database. BioData mining. 2017;10(1):1-11.
2. WHO. Obesity and overweight 2021. Available from: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.
3. Türkiye Beslenme ve Sağlık Araştırması (TBSA), T.C. Sağlık Bakanlığı Halk Sağlığı Genel Müdürlüğü, 1132, Ankara, 2019.
4. Panteliou E, Miras A. What is the role of bariatric surgery in the management of obesity? Climacteric. 2017;20(2):97-102.
5. Di Lorenzo N, Antoniou SA, Batterham RL, et al. Clinical practice guidelines of the European Association for Endoscopic Surgery (EAES) on bariatric surgery: update 2020 endorsed by IFSO-EC, EASO and ESPCOP. Surgical Endoscopy. 2020;34(6):2332-2358.
6. Peterli R, Wölnerhanssen BK, Peters T, et al. Effect of laparoscopic sleeve gastrectomy vs laparoscopic Roux-en-Y gastric bypass on weight loss in patients with morbid obesity: the SM-BOSS randomized clinical trial. JAMA. 2018;319(3):255-265.
7. Angrisani L, Santonicola A, Iovino P, et al. Bariatric surgery and endoluminal procedures: IFSO worldwide survey 2014. Obesity Surgery. 2017;27(9):2279-2289.
8. Stefater MA, Wilson-Pérez HE, Chambers AP, Sandoval DA, Seeley RJ. All bariatric surgeries are not created equal: insights from mechanistic comparisons. Endocrine Reviews. 2012;33(4):595-622.
9. Sundbom M. Laparoscopic revolution in bariatric surgery. World Journal of Gastroenterolgy. 2014;20(41):15135.
10. Schweiger C, Weiss R, Keidar A. Effect of different bariatric operations on food tolerance and quality of eating. Obesity Surgery. 2010;20(10):1393-1399.
11. Montero PN, Stefanidis D, Norton HJ, Gersin K, Kuwada T. Reported excess weight loss after bariatric surgery could vary significantly depending on calculation method: a plea for standardization. Surgery for Obesity and Related Diseases. 2011;7(4):531-534.
12. Karmali S, Stoklossa CJ, Sharma A, et al. Bariatric surgery: a primer. Canadian Family Physician. 2010;56(9):873-879.
13. Soykan AU, Burgut R. Beslenme sıklığı anketlerinin geçerliliği ve güvenilirliği. [Yüksek lisans tezi] [Adana]: Çukurova Üniversitesi; 2007.p.101.
14. Suter M, Calmes J-M, Paroz A, Giusti V. A new questionnaire for quick assessment of food tolerance after bariatric surgery. Obesity Surgery. 2007;17(1):2-8.
15. Pekcan G. Determination of nutritional status. In: Baysal A, editor. Diet handbook. Ankara: Hatiboglu Press; 2008. p. 67-141.
16. Khalifa IG, Tobar WL, Hegazy TO, et al. Food tolerance after laparoscopic sleeve gastrectomy with total antral resection. Obesity Surgery. 2019;29(7):2263-2269.
17. IBMCorp Ibm S. statistics for windows, version 25.0. Armonk, NY: IBM Corp. 2017.
18. Zarshenas N, Tapsell LC, Neale EP, Batterham M, Talbot ML. The relationship between bariatric surgery and diet quality: a systematic review. Obesity Surgery. 2020;30(5):1768-1792.
19. Schlottmann F, Herbella FA, Patti MG. Bariatric surgery and gastroesophageal reflux. Journal of Laparoendoscopic & Advanced Surgical Techniques. 2018;28(8):953-955.
20. Varner KL, March AL. Prevention of nausea and vomiting after laparoscopic sleeve gastrectomy: are we doing enough? AANA Journal. 2020;88(2):142-147.
21. Ruiz-Tovar J, Oller I, Llavero C, et al. Hair loss in females after sleeve gastrectomy: predictive value of serum zinc and iron levels. The American Surgeon. 2014;80(5):466-471.
22. Bobowicz M, Lehmann A, Orlowski M, Lech P, Michalik M. Preliminary outcomes 1 year after laparoscopic sleeve gastrectomy based on Bariatric Analysis and Reporting Outcome System (BAROS). Obesity Surgery. 2011;21(12):1843-1848.
23. Isom KA, Andromalos L, Ariagno M, et al. Nutrition and metabolic support recommendations for the bariatric patient. Nutrition in Clinical Practice. 2014;29(6):718-739.
24. Ağbaba N, Özcan BA. Bariatrik cerrahi sonrası gıda intoleransı. Sağlık ve Yaşam Bilimleri Dergisi. 2020;2(1):16-21.
25. Ruiz-Tovar J, Bozhychko M, Del-Campo JM, Zubiaga L, Llavero C. Food tolerance and quality of alimentation following laparoscopic sleeve gastrectomy calibrated with a 50-Fr bougie: long-term results. Journal of Laparoendoscopic & Advanced Surgical Techniques. 2018;28(6):721-725.
26. Cano-Valderrama O, Sánchez-Pernaute A, Rubio-Herrera MA, Domínguez-Serrano I, Torres-García AJ. Long-term food tolerance after bariatric surgery: comparison of three different surgical techniques. Obesity Surgery. 2017;27(11):2868-2872.
27. Freeman RA, Overs SE, Zarshenas N, Walton KL, Jorgensen JO. Food tolerance and diet quality following adjustable gastric banding, sleeve gastrectomy and Roux-en-Y gastric bypass. Obesity Research & Clinical Practice. 2014;8(2):e183-e91.
28. Ramón JM, González CG, Dorcaratto D, et al. Quality of food intake after bariatric surgery: vertical gastrectomy versus gastric bypass. Cirugia Espanola. 2011;90(2):95-101.
29. Diaz-Lara C, Curtis C, Romero M, et al. Tolerance to specific foods after laparoscopic sleeve gastrectomy. Obesity Surgery. 2020;30(10):3891-3897.
30. Ruiz-Tovar J, Bozhychko M, Del-Campo JM, et al. Changes in frequency intake of foods in patients undergoing sleeve gastrectomy and following a strict dietary control. Obesity Surgery. 2018;28(6):1659-1664.
31. Soares FL, Bissoni de Sousa L, Corradi-Perini C, Ramos da Cruz MR, Nunes MGJ, Branco-Filho AJ. Food quality in the late postoperative period of bariatric surgery: an evaluation using the bariatric food pyramid. Obesity Surgery. 2014;24(9):1481-1486.
32. Bezerra IN, Curioni C, Sichieri R. Association between eating out of home and body weight. Nutrition Reviews. 2012;70(2):65-79.
33. Moizé VL, Pi-Sunyer X, Mochari H, Vidal J. Nutritional pyramid for post-gastric bypass patients. Obesity Surgery. 2010;20(8):1133-1141.
34. Miras AD, Jackson RN, Jackson SN, et al. Gastric bypass surgery for obesity decreases the reward value of a sweet-fat stimulus as assessed in a progressive ratio task. The American Journal of Clinical Nutrition. 2012;96(3):467-473.
35. Coluzzi I, Raparelli L, Guarnacci L, et al. Food intake and changes in eating behavior after laparoscopic sleeve gastrectomy. Obesity Surgery. 2016;26(9):2059-2067.
36. Silva LB, Oliveira BM, Correia F. Evolution of body composition of obese patients undergoing Bariatric Surgery. Clinical Nutrition ESPEN. 2019;31:95-99.
37. Bult MJ, van Dalen T, Muller AF. Surgical treatment of obesity. European Journal of Endocrinology. 2008;158(2):135-146.
38. Buchwald H, Avidor Y, Braunwald E, et al. Bariatric surgery: a systematic review and meta-analysis. Journal of American Medical Association. 2004;292(14):1724-1737.
39. Kafri N, Valfer R, Nativ O, Shiloni E, Hazzan D. Health behavior, food tolerance, and satisfaction after laparoscopic sleeve gastrectomy. Surgery for Obesity and Related Diseases. 2011;7(1):82-88.
40. Sağlık Bakanlığı Sağlık Hizmetleri Genel Müdürlüğü. Obezite ve Metabolik Cerrahi Klinik Protokolü 2021.
41. Amundsen T, Strømmen M, Martins C. Suboptimal weight loss and weight regain after gastric bypass surgery-postoperative status of energy intake,

eating behavior, physical activity, and psychometrics. Obesity Surgery. 2017;27(5):1316-1323.
42. Warburton DE, Nicol CW, Bredin SS. Health benefits of physical activity: the evidence. Canadian Medical Association Journal. 2006;174(6):801-809.
43. Smith LL, Larkey L, Celaya MC, Blackstone RP. Feasibility of implementing a meditative movement intervention with bariatric patients. Applied Nursing Research. 2014;27(4):231-236.
44. Neunhaeuserer D, Gasperetti A, Savalla F, et al. Functional evaluation in obese patients before and after sleeve gastrectomy. Obesity Surgery. 2017;27(12):3230-3239.