



# Evaluation of the Parameters that Affect the Cost of Laparoscopic Sleeve Gastrectomy

Laparoskopik Sleeve Gastrektomi Ameliyatının Maliyetini Etkileyen Parametrelerin Değerlendirilmesi

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## ABSTRACT

**Objective:** Laparoscopic sleeve gastrectomy (LSG) is an easy and safe surgical procedure with effective results. The cost of an LSG surgery can be influenced by many parameters and the medical supplies used. In this study, we aimed to determine the parameters affecting the cost of this procedure and whether it is a cost-effective procedure for hospitals.

**Methods:** Laparoscopic sleeve gastrectomy performed in a public hospital during 2016 were retrospectively reviewed. Parameters such as age, sex, body mass index, the length of hospitalization, the postoperative need for a follow-up in an intensive care unit (ICU), and the presence of complications were determined. In addition, all expensive items incurred during LSG procedure, their costs, and the amount of invoicing for the Social Insurance Institution were determined. The patients whose procedural costs and invoiced amounts exceeded 80 percentiles constituted an increased cost and increased billing group, and those under 80 percentile constituted a normal cost and normal billing group. The parameters were compared between the increased and normal groups.

**Results:** A total of 121 patients (10 males and 111 females) were included in the study. The mean age was 38.7 years, and the mean body mass index was 47.6 kg/m<sup>2</sup>. There were 95 patients in the normal cost group, 26 in the increased cost group, 96 in the normal billing amount group, and 25 in the increased bill amount group. It was found that seven complicated patients were in the increased bill amount group, and six of seven were also in the increased cost group ( $p=0.001$ ). In the increased bill amount and increased cost groups, the length of hospitalization was  $14.3\pm19.7$  and  $14.4\pm19.7$  days, respectively ( $p=0.001$ ). There was no significant difference between the groups in terms of age, sex, body mass index, and ICU need ( $p>0.05$ ).

**Conclusion:** The development of complications after LSG and the increased length of hospitalization increase the procedural cost. There is no correlation between cost increase and patient variables. Therefore, the factors affecting cost increase should be considered as unpredictable conditions.

**Keywords:** Obesity, laparoscopic sleeve gastrectomy, cost analysis

## ÖZ

**Amaç:** Laparoskopik sleeve gastrektomi (LSG), etkili sonuçlar veren kolay ve güvenli bir cerrahi prosedürdür. LSG ameliyatının maliyeti kullanılan tıbbi malzemelerin yanı sıra pek çok parametreden etkilenebilir. Bu çalışmada, bu işlemin maliyetini etkileyen faktörleri ve hastanelerde maliyet etkin bir yöntem olup olmadığını belirlemek amaçlanmıştır.

**Yöntemler:** Bir kamu hastanesinde 2016 yılında yapılan LSG operasyonları geriye dönük olarak incelendi. Hastaların yaşı, cinsiyeti, vücut kitle indeksi, hastanede kalış süresi, postoperatif yoğun bakım ünitesinde izlem gereksinimi ve komplikasyon varlığı parametreleri belirlendi. Buna ek olarak, LSG prosedürü sırasında oluşan tüm maliyetler ve sosyal sigorta kurumuna faturalama tutarları belirlendi. Maliyet ve faturalandırılmış tutarı 80 persentilin üstünde kalan hastalar "artmış maliyet" ve "artmış fatura tutarı" şeklinde gruplandı. Seksen persentilin altındaki hastalar da "normal maliyet" ve "normal fatura tutarı" şeklinde gruplandı. Artmış ve normal gruplar arasında yaş, cinsiyet, vücut kitle indeksi, hastanede kalış süresi, yoğun bakımda izlem gereksinimi ve komplikasyon varlığı karşılaştırıldı.

**Bulgular:** Çalışmaya toplam 121 hasta (10 erkek, 111 kadın) dahil edildi. Yaş ortalaması 38,7 bulundu. Ortalama vücut kitle indeksi 47,6 idi. Normal maliyet grubunda 95, artmış maliyet grubunda 26, normal fatura tutarı grubunda 96 ve artmış fatura tutarı grubunda da 25 hasta yer aldı. Komplikasyon gelişen 7 hastanın tamamının artmış fatura tutarı grubunda ve 6'sının da artmış maliyet grubunda yer aldığı saptandı ( $p=0,001$ ). Artmış fatura tutarı grubunda ve artmış maliyet grubunda hastanede kalış süresi sırasıyla  $14,3\pm19,7$  ve  $14,4\pm19,7$  gün saptandı ( $p=0,001$ ). Yaş, cinsiyet, vücut kitle indeksi ve yoğun bakım ihtiyacı açısından anlamlı farklılıklar saptanmadı ( $p>0,05$ ).

**Sonuç:** Laparoskopik sleeve gastrektomi sonrası komplikasyon gelişimi ve buna bağlı artan yatış süresi işlemin maliyetini artırmaktadır. Hastaya ait değişkenlerle maliyet artışıının ilişkisi saptanmamıştır. Bu sebeple maliyet artısını etkileyen faktörler öngörülemeyen durumlar olarak düşünülmelidir.

**Anahtar kelimeler:** Obezite, laparoskopik sleeve gastrektomi, maliyet analizi

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## INTRODUCTION

Bariatric surgery provides long-term weight loss, reduces the incidence of obesity-related diseases, and improves survival. Surgical treatment results in a 50% reduction in excess weights (1). Obesity-related diseases may also be treated by bariatric surgery with excess weight loss (2, 3). Bariatric procedures work by restriction, malabsorption, and hormonal effects. The mortality rates in bariatric surgery are in the range of 0.3%–0.6% (4). Currently, the most common procedures are laparoscopic sleeve gastrectomy (LSG) and Roux-en-Y gastric bypass (5, 6). Bariatric procedures are the most effective method for the treatment of morbid obesity. Patients' gains are further increased by the removal of additional diseases, including Type 2 diabetes, lipid disorders, and hypertension. As a result, the mortality rates due to these comorbid diseases are reduced, and the life span of the patients is prolonged.

In an LSG surgery, which is a bariatric procedure, medical devices (staples, sealing devices, laparoscopic trocars, and laparoscopic hand tools) must be used. Considering that comorbid conditions are more frequently seen in LSG-treated patients, these patients may require a postoperative follow-up in the intensive care unit (ICU). The need for blood product transfusions, percutaneous drainage procedures, stenting procedures, and re-operation interventions may arise in cases wherein complications, including leakage or bleeding, postoperatively develop. All of these can be considered as the parameters that affect procedural cost (7, 8).

Hospital administrators cannot determine the fees for services offered in hospitals, which renders them to control expenses. The use of several materials in hospitals will help understand this difficulty. Managers aim to provide quality services at increasing costs by setting new strategies (9). Concepts such as quality, efficiency, and cost should be considered while providing health services that are inexpensive, consumer demand-based, and beneficial to the society. (10, 11). Many countries have recently made new arrangements for health care costs (12-14). The factors affecting the costs of hospital enterprises are the capacity and capacity utilization of the hospital, technological condition used,

the intensity of the population served, the quality of the service, the reputation of the hospital, the number of employees, and financial income source (13, 14).

In this study, we aimed to investigate the cost analysis of LSG operations performed in 2016 in a public hospital.

## METHODS

A descriptive study was planned. The study was performed in accordance with the ethical standards of the 1964 Declaration of Helsinki and its later amendments. The STrengthening the Reporting of Observational studies in Epidemiology (STROBE) guidelines were used while reporting this observational study (15).

### Patient Selection

Patients who underwent LSG for obesity between January 2016 and December 2016 were retrospectively analyzed from the hospital registry system. It has been learned that LSG is paid as all-inclusive by Social Insurance Institution (SII) and that some medical supplies can also be separately billed. Patients' demographic characteristics (age, sex, and body mass index [BMI]), the length of hospitalization, and the costs of medical supplies, medications, laboratory, radiological and pathological examinations, and transfused blood products were recorded. Additionally, the amounts billed to SII by the hospital were recorded. The all-inclusive payment made by SII was also recorded. All the amounts were summed and the total cost and total invoice amounts were obtained. "Increased cost" and "increased bill amount" were defined as the main outcome variables. The cost and billing amounts above 80 percentile were defined as "increased" (7). With this method, two groups were formed based on the cost and bill amount, and each of them was also categorized as "increased" or "normal." The age, sex, BMI, the length of hospitalization, the need for a postoperative follow-up in ICU, and the presence of complications were compared among these groups.

For LSG operations, it was determined that SII made the all-inclusive payment that includes the expenses of personnel, medical supplies, medications, laboratory, radiological and pathological

**Table 1. Descriptive statistics of the patients**

n=121		<b>Mean±SD</b>	<b>Min–Max</b>	<b>Percentiles</b>			
				25	50	75	80
Sex							
Male	10						
Female	111						
Age	38.7±10.8	19–62					
BMI ( $\text{kg}/\text{m}^2$ )	47.6±5.6	40–68					
Length of hospitalization (day)	6.9±10.2	3–71					
Total billing amount (TL)	6095,7±3586,7	3410,0–28427,6	4443,7	5408,8	6212,8	6575,7	
Total cost amount (TL)	3633,5±3520,3	1424,1–22775,9	2188,8	3009,4	3965,3	4120	

BMI: body mass index, SD: standard deviation, Min–Max: minimum–maximum

examinations, and transfused blood products. The amount of this payment was 3410 Turkish Liras (TL) per operation. In addition, it was determined that the refunds were separately received by invoicing the staples, sealing devices, and some additional medicines other than the all-inclusive payment. The patients who postoperatively needed a follow-up in the ICU would also be billed for the expenses of medications, laboratory and radiological examinations, and transfused blood products. In our study, the costs of surgical hand tools and retractors used in the surgery, laparoscopic imaging, and insufflation systems were disregarded. Moreover, personnel expenses were not included in the costs because it was not possible to collect the information about personnel expenses from the hospital registry system. Bed charges were also not included in the total cost and bill amount.

According to the average exchange rates of the year 2016, one United States dollar was determined as 3.02 TL.

#### Statistical Analysis

Data are expressed as mean  $\pm$  standard deviation or number and percentage. The patients with increased or normal cost and invoice amounts were compared using the Student's t-test

or Mann-Whitney U-test for continuous variables and using the chi-square or Fischer's exact test for categorical variables. Logistic regression models were used to examine the contribution of other factors such as increased costs. P-values of  $<0.05$  were considered statistically significant. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS, IBM Comp.; version 20, Armonk, NY, USA).

#### RESULTS

During the study, 121 patients underwent LSG due to obesity. There were 10 males and 111 females. The average age was 38.7 (19–62) years; the mean BMI was 47.6 (40–68); and the mean length of hospitalization was 6.9 (3–71) days. When the total cost and total invoice amounts were examined, the average cost and total invoice were 3633.5 TL and 6095 TL, respectively. It was determined that the amount that corresponds to the 80<sup>th</sup> percentile for the total cost and total billing were 4120 TL and 6575.7 TL, respectively. The patients with a cost above 4120 TL were included in the increased cost group, and those billed above 6575.7 TL were included in the increased bill amount group (Table 1).

Postoperatively, 11 patients were enrolled in ICU. The median duration of stay in the ICU was 2 (2–3) days. Seven patients had complications; four of these had complications such as leakage from the staple line, one had stenosis, and two had intra-abdominal collections wherein a certain leakage were not evaluated (Table 2).

It was observed that there was a difference of approximately 2420 TL between the cost and billed amount in the standard operation period. Since personnel and bed costs were not included, these expenses were also covered in this amount.

In the analysis of the effect of the parameters on the groups wherein the cost and billing amounts were over 80 percentile, a longer hospital stay and the presence of complication (s) were found to be statistically significant. Age, sex, BMI, and ICU need did not affect the increased billing amount and increased cost (Table 3).

**Table 2. Analysis of the patients who were enrolled in the ICU and who had complications**

Number of patients requiring ICU	11
Length of ICU (day) (median (min-max))	2 (2–3)
Complication	7
Leakage	4
Stenosis	1
Suspect of leakage (intra-abdominal collection)	2

ICU: Intensive care unit

**Table 3. Comparison of groups according to cost and billing amounts**

	Normal Billing Amount (n=94)	Increased Billing Amount (n=27)	p	Normal Cost (n=95)	Increased Cost (n=26)	p
Age	39.04 $\pm$ 10.9	37.7 $\pm$ 10.6	0.563	38.6 $\pm$ 11.4	39.4 $\pm$ 8.7	0.747
Gender						
Male	8	2	1	87	24	1
Female	86	25		8	2	
BMI (kg/m <sup>2</sup> )	47.8 $\pm$ 5.6	47 $\pm$ 5.4	0.509	47.9 $\pm$ 5.7	46.4 $\pm$ 4.8	0.215
Length of hosp. stay (day)	4.84 $\pm$ 2.1	14.3 $\pm$ 19.7	0.001	4.9 $\pm$ 2.95	14.4 $\pm$ 19.7	0.001
ICU requirement						
Yes	6	5	0.670	6	5	0.570
No	88	22		89	21	
Complication						
Yes	0	7	0.001	1	6	0.001
No	94	20		94	20	

BMI: body mass index, ICU: intensive care unit

## DISCUSSION

The financial burden of obesity and obesity-related diseases cannot be underestimated. The cost of treating obesity-related diseases, including hypertension, type 2 diabetes mellitus, and cardiovascular system diseases, is very high. This cost negatively affects the society by affecting the gross national product (16, 17). Along with the treatment of obesity, the number of several obesity-related systemic diseases is also decreasing. None of the non-surgical methods involved in the treatment of obesity are as effective as surgical treatment (18). Among the surgical treatment methods, LSG is a procedure with proven efficacy and safety (19). In this study, we aimed to reveal the cost analysis of the LSG procedure and investigated the effects of age, sex, BMI, ICU requirement, and the presence of complication on the increased costs of the procedure. We conclude that the presence of complications and the length of hospitalization are the statistically significant parameters affecting the cost.

Staple line leakages are the most important cause of morbidity after LSG. They can also result into mortality in patients. However, mortality did not occur in our study. Of the seven patients who had complications in the study, four were diagnosed as staple line leakages, whereas two patients were treated as suspects of leakage due to the intra-abdominal collection. When 85% of the complications are thought to be leakage-related complications, it can be concluded that the most important factor that increases the cost after LSG is leakage. Similar results have been obtained in the literature in this issue (17). The most important reason for the increase in the total cost of staple line leakages is expensive treatment costs. Leakage treatment may require the patient to apply a stent  $\geq 1$  times. The applied stents are also expensive medical supplies. Because of the need for endoscopic procedures for stenting, there is a separate endoscopic approach cost apart from the stent material cost. In addition to the stent applications, the abscess and collections that are formed in the abdomen should be drained during the management of the leakages. This drainage is usually percutaneously performed by the interventional radiology unit. The cost of the catheter used for drainage and the service cost of the application influence total cost increase. Intra-abdominal and respiratory system infections may also appear along with the staple line leakages. A broad spectrum and expensive antibiotics should be used for a long time in the treatment of these infections. This may also be one of the reasons for the increase in cost due to the presence of complications.

The other parameter that increased the cost was the length of hospitalization. It can be concluded that the complications developing during LSG operations are already considered to extend the length of hospitalization and that these two parameters are actually dependent parameters. Because of the possible mortal results of the complications, the complicated patients must be treated in the hospital, and the clinical conditions of the patients should be simultaneously monitored in the hospital. The use of medicines for treatment, the use of laboratory examinations and imaging modalities to assess the clinical status of the patient, and the effectiveness of treatment can be

cited as the reasons for the increased cost of the long hospital stay.

In our study, the demographic parameters such as sex, age, and BMI did not affect the costs. In some studies, it is stated that with an increase in age, there are more comorbidities in the patients, which increase the incidence of the complications and indirectly increase the costs. There are studies in the literature that suggest that BMI is a parameter that affects the development of complications. In these studies, it is stated that a higher BMI is associated with higher complication rates and costs (20-22). Despite the fact that all the patients who were operated on in our study were morbidly obese with  $>40 \text{ kg/m}^2$  BMI, no relation was found between cost increase and BMI.

When we examined the cost and invoice amounts for LSG, the average cost was 3633.5 TL, and the average invoiced amount was 6095.7 TL. It would not be ethical to consider this difference as the hospital's profit because employee salary expenses and the costs of hospitalization were not included in the total cost. This can be considered as a limitation of the study. However, it is possible that hospitals would not suffer but would rather profit from the LSG surgery when the estimated employee salary expenses and the estimated costs of hospitalization were added to the total costs. If the amount invoiced is considered as a cost for SII, the positive effects provided by the LSG surgery are much higher than the average invoice amount of 6095.7 TL because an effective weight loss of these patients will result in an increase in workforce performance, and a reduction in the severity of obesity-related systemic diseases will reduce the costs of treating these diseases. The financial profit of these results is much more than this amount. Furthermore, the location of our study may be the reason for the limitation. In public hospitals, profiting is not the primary goal. Therefore, the amounts provided in our study may vary in private hospitals. This can also be considered a limitation of the study.

## CONCLUSION

It can be considered that LSG is an effective and a cost-effective procedure in the surgical treatment of obesity. The most important parameters for increasing the costs are the development of complication and the length of hospitalization. Patients' age, sex, BMI, and the postoperative need of ICU care do not increase the cost of surgery. The cost increase in LSG surgery is unpredictable because it is not associated with the patient's variables. There is a need for further studies that would examine the variables involved in surgical intervention.

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**Ethics Committee Approval:** Author declared that the research was conducted according to the principles of the World Medical Association Declaration of Helsinki "Ethical Principles for Medical Research Involving Human Subjects", (amended in October 2013).

**Informed Consent:** Due to the retrospective design of the study, informed consent was not taken.

**Peer-review:** Externally peer-reviewed.

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

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