Research Article / Araştırma Makalesi

Optimization of Trocar Sites in Laparoscopic Sleeve Gastrectomy: Experience From 4.450 Cases

Laparoskopik Sleeve Gastrektomide Trokar Yerlerinin Optimizasyonu: 4.450 Vakadan Elde Edilen Deneyim

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Abstract

Background: Obesity is seen in almost one in four adults today and is expected to have an increasing incidence in the coming years. It is predicted that one in every two adults in the USA will be obese by 2030. Laparoscopic sleeve gastrectomy (LSG) is the most frequently preferred surgical method with proven efficacy for the treatment of obesity. In this study, we aimed to describe our experience with the trocar sites we optimized and standardized for use in LSG.
Methods: 4450 patients who had LSG performed by a single surgeon (Senior author) were included in the study. The optimized trocar sites determined according to previous surgical experience were examined in terms of their intended use and advantages.
Results: No trocar site revision or additional trocar use was required during LSG in any of the 4450 cases in which the trocar sites were optimized.
Conclusions: We consider that the technique presented in our study minimizes the risk of insufficient exposure and provides anatomical standardization. The insertion of two additional trocars compared to the three-trocar technique does not increase postoperative herniation risk or esthetic concerns.

Keywords: Laparoscopic sleeve gastrectomy, trocar, obesity surgery

Öz

Amaç: Obezite günümüzde neredeyse dört yetişkinden birinde görülmektedir ve önümüzdeki yıllarda görülme sıklığının artması beklenmektedir. ABD'de her iki yetişkinden birinin 2030 yılına kadar obez olacağı tahmin edilmektedir. Laparoskopik sleeve gastrektomi (LSG), obezite tedavisinde etkinliği kanıtlanmış en sık tercih edilen cerrahi yöntemdir. Bu çalışmada, LSG'de kullanım için optimize ettiğimiz ve standardize ettiğimiz trokar bölgeleri ile ilgili deneyimimizi anlatmayı amaçladık.
Materyal ve Metod: Tek bir cerrah (Kıdemli yazar) tarafından LSG uygulanan 4450 hasta çalışmaya dahil edildi. Önceki cerrahi deneyime göre belirlenen optimize edilmiş trokar bölgeleri, amaçlanan kullanımları ve avantajları açısından incelendi.
Bulgular: Trokar bölgelerinin optimize edildiği 4450 vakanın hiçbirinde LSG sırasında trokar bölgesi revizyonu veya ek trokar kullanımı gerekmedi.
Sonuç: Çalışmamızda sunulan tekniğin yetersiz pozlama riskini en aza indirdiğini ve anatomik standardizasyon sağladığını düşünüyoruz. Üç trokarlı tekniğe kıyasla iki ek trokar yerleştirilmesi, ameliyat sonrası herniasyon riskini veya estetik kaygıları artırmaz.

Anahtar Kelimeler: Laparoskopik sleeve gastrektomi, trokar, obezite cerrahisi

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Received / Geliş tarihi: 12.06.2025

Accepted / Kabul tarihi: 21.08.2025

DOI: 10.35440/hutfd.1718156

Introduction

According to a report published by the World Health Organization in 2022, 23% of adults and 7% of adolescents in the European region have obesity. In the same report, it is predicted that this rate will have reached 37% for adults in 2030 (1). In the USA, it is estimated that obesity, which affects one out of every three adults today, will be seen in more than half of all adults in 2030 (2, 3).

One of the treatment options with proven efficacy for morbid obesity is bariatric surgery (4). In recent years, with the increase in the prevalence of obesity, the demand for bariatric surgery has also increased. Considering the history of bariatric surgery, the most frequently performed operation was Roux-n-Y gastric bypass (RNYGB), which has now been replaced by laparoscopic sleeve gastrectomy (LSG). According to a study conducted in 2015, LSG constituted 71% of all bariatric procedures performed in the USA, and RNYGB only 23% (5). In addition to these two operations, many surgical techniques, such as single anastomosis gastric bypass, bipartition, and duodenal switch, have been described.

In laparoscopic and open surgery, exposure is critical for the success of the operation and technical convenience. Trocar sites and patient position are the two most important parameters of exposure in laparoscopic surgery. Unlike open surgery, retractors are less important for laparoscopic surgery (6). Traditionally, five trocars are used in bariatric operations performed with the laparoscopic technique as the gold standard. However, today, there are also surgeons who perform these operations with the three- or single-trocar technique (7, 8).

In this study, we aimed to describe trocar sites and their uses, which were identified to apply the LSG technique under optimum conditions in a standardized manner based on our experience with a total of 4,450 cases.

Materials and Methods

This study was carried out in accordance with the principles of the Declaration of Helsinki. This study received approval from the Non-Interventional Clinical Research Ethics Committee of Ankara Medipol University (date:12/02/2025; decision number 23).

Optimized trocar sites were used in 4,450 LSG surgeries performed for morbid obesity in a single center between 2006 and 2022. All patients were included in the study. All the operations were performed by the senior author.

Technique

All the operations were performed in the French position under general anesthesia. After proper preparation, insufflation was started by entering the abdomen using a 10-mm optical trocar (ENDOPATH XCEL Dilating Tip Trocars, Ethicon Endo-Surgery) (trocar C) and a 0-degree camera immediately inferior to the intersection of the left midclavicular line and costal arch. During the insufflation process, the transition to a 30-degree camera view was achieved, and then a 10-mm trocar (trocar B), which was to be used as the camera trocar during the operation, was placed 2-4 cm inferior to the lower edge of the antrum at the level of the esophageal hiatus to the left of the midline. A 12-mm trocar to be used for firing the stapler device and extracting the stomach, was placed at a distance that was long as articulating part of the stapler device (ECHELON FLEX60 Articulating Endoscopic Linear Cutter, Ethicon Endo-Surgery) (approximately 10cm) on the right side of the point where transection was to be started at the lower edge of the antrum. Then, the camera was inserted through trocar B. A 5-mm assistant trocar (trocar D) was inserted immediately inferior to the point where the left anterior axillary line cuts the costal margin. To insert the liver retractor from the left inferolateral of the xiphoid process, a 5-mm trocar (trocar E) was inserted, and the Nathanson retractor (Cook Medical Inc., Bloomington, IN) was placed to visualize the esophageal hiatus. Figures 1 to 3 present the localizations of the trocars on the abdominal wall and the view of the antrum through trocars A and B.

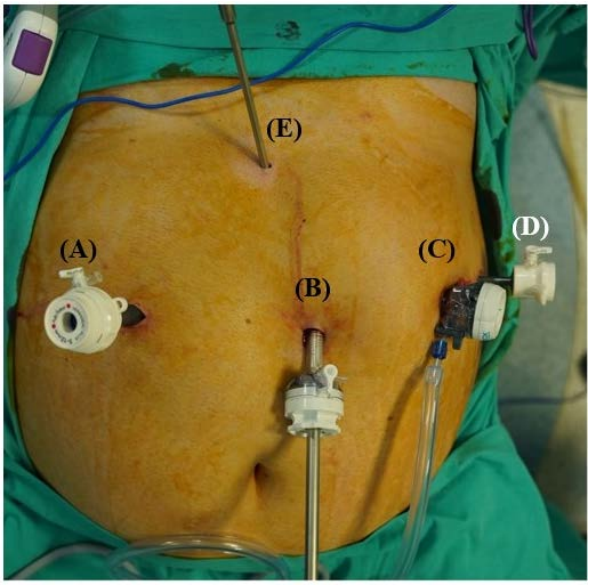

Figure 1. Localization of each trocar on the abdominal wall

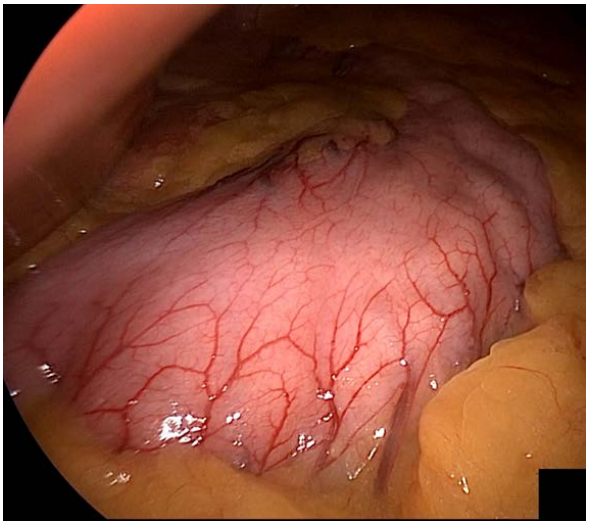

Figure 2. View of the antrum through trocar A

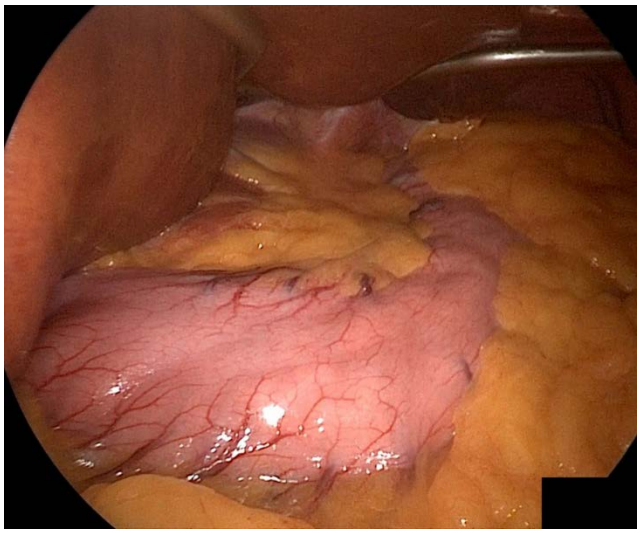

Figure 3. View of the antrum through trocar B

The use of each trocar at various stages of the operation is described below.
Dissection
Trocar A: Grasper (operator)
Trocar B: Camera
Trocar C: Energy device (operator)
Trocar D: Grasper (assistant)
Trocar E: Nathanson retractor
Transection
A: Stapler shooter
B: Camera
C: Grasper (assistant)
D: Grasper (assistant)
E: Nathanson retractor
Hemostasis
A: Grasper (operator) or metal clip shooter (operator)
B: Camera
C: Grasper (assistant) or metal clip shooter (operator)
D: Grasper (assistant)
E: Nathanson retractor
Omentopexy
A: Grasper (operator)
B: Camera
C: Needle holder (operator)
D: Grasper (assistant)
E: Nathanson retractor
Stomach extraction
A: Extractor
B: Grasper (assistant)
C: Camera
D: Grasper (assistant)
E: Nathanson retractor
Fascial suturing
A: Suture passer
B: Grasper (falciform ligament retraction if needed)
C: Camera
D: Grasper (assistant)
E: Nathanson retractor
Drain placement
B: Camera
C: Grasper (pushing the drain into the subdiaphragmatic space)
D: Grasper (pulling the outer part of the drain out of the abdomen)
E: Nathanson retractor
After the drain was placed, the Nathanson retractor was removed. Then trocar B was pulled and hemostasis of the trocar site was checked with the camera (through the trocar C). Finally the optical trocar C was withdrawn while simultaneously checking for bleeding through the camera. The drain was fixed. The operation was terminated following the closure of the incisions of trocars A, B, and C with subcuticular sutures and the incision of trocar E with primary sutures.

Postoperative follow up

All patients followed a standardized postoperative dietary protocol. During the first 3 days, liquid nutrition was provided. From days 4-15, patients consumed low-fat dairy products, protein shakes, and strained vegetable soups. From days 16-30, fiber-free pureed fruits, lean ground meat, egg whites, and pureed soups were permitted. After one month, patients followed a low-calorie, high-protein diet (minimum 60g/day). Physical activity consisted of mobilization at 6 hours postoperatively, walking exercises only for the first month, followed by additional activities including pilates, yoga, and swimming.
Postoperative patients are scheduled for in-person follow-up appointments every three months during the first year and every six months during the second year, completing a two-year surveillance period.

Results

A total of 4,450 patients underwent LSG at our clinic from 2006 to 2022. All of these patients, the trocar sites were optimized as described. Patients' characteristics, operative parameters, and early complications are presented in Tables 1 and 2. During the postoperative follow-up period, none of the patients had any esthetic complaints associated with the trocar incisions

Table 1. Patients' preoperative characteristics.

Mean Age, years (min-max)	36.4 (14-73) years
Sex, n (%)	
Female	3196 (71.8%)
Male	1254 (28.2%)
BMI, kg/m^2 (min-max)	42.3 (30-76.2)
Comorbidities, n (%)	
Type 2 diabetes mellitus	718 (16.1%)
Hypertension	984 (22.1%)
Obstructive sleep apnea syndrome	313 (7.0%)
Hyperlipidemia	811 (18.2%)

BMI: Body Mass Index, Min: Minimum, Max: Maximum

Table 2. Operative parameters and early complications

Mean operative time, minutes (min-max)	47.4 (23-72)
Need for trocar site revision	0
Need for extra trocar (6th or more)	0
Early complications, n (%)	
Wound infection	36 (0.8%)
Bleeding	
Conservative treatment	7 (0.15%)
Reoperation	2 (0.04%)
Leakage	4 (0.09%)
Pulmonary embolism	3 (0.06%)
Mesenteric venous thrombosis	2 (0.04%)
Mortality	0

Min: Minimum, Max: Maximum

Discussion

The measurement points based on centimeters on the abdominal surface and landmarks such as the umbilicus and xiphoid, which are conventionally used in laparoscopic surgery, can be misleading in patients with morbid obesity due to retroperitoneal fat and abdominal distension. Therefore, the trocar sites determined with reference to these points can result in insufficient exposure. There are many studies in the literature on the techniques and trocar insertion sites used during bariatric surgery. Chung et al. (9) recommended that the trocar, which was used as a camera trocar during dissection, be inserted from the midline, 20 cm inferior to the xiphoid process. Dunford et al. (10) suggested that it would be better to place the camera port in the left upper quadrant, the right hand trocar in the midline supraumbilical region, and the left hand trocar in the right upper quadrant. Consalvo et al. (11) compared cases in which sleeve gastrectomy operations were performed with three trocars and five trocars. Based on the measurements they performed on the abdominal wall, they recommended that the camera trocar be placed 11 cm inferior to the xiphoid and the remaining trocars be positioned according to this trocar. According to the results of the same study, there was no significant difference in terms of the technique or postoperative pain, except that the operative time was shorter in the five-trocar group. In a study comparing the conventional five-trocar method to other techniques involving the use of fewer trocars, Amiki et al. (12) suggested that the camera trocar should be placed in the midline in both techniques. In the comparison between the groups, no significant difference was found in terms of blood loss, complication rates, and length of hospital stay, and it was observed that the operative time was significantly shorter in the five-trocar technique.

Since the xiphoid-umbilicus distance is variable in each patient, there is a possibility that the trocar placed at a fixed distance from these points may be too far from or too close to the stomach. A camera trocar placed far from the stomach or into the midline may cause difficulties in dissection of the gastrosplenic ligament and fundus region. Therefore, we consider that the position of the camera trocar should be adjusted according to the antrum and placed to the left of the midline. Placing trocar A (for stapler firing) close to the midline can reduce its angulation capability, whereas placing it too lateral may cause difficulty in reaching the fundus area, and placing it superiorly or inferiorly can make it difficult to properly perform transection, especially the first one. We consider that when the angle of trocar A is not suitable, trocar C placed in the left upper quadrant provides a significant advantage for fundus level transection or for the hemostasis of the staple line at the same level. Placing trocar D (assistant) lateral to the anterior axillary line can complicate lateral traction during omental dissection and gastric transection, while placing it more medially can cause overlap with trocar C during dissection.

LSG is the most preferred surgical method in the treatment of morbid obesity and can be performed with different numbers of trocars and modified techniques. We used the optimized technique described in this paper in 4450 cases in a standardized manner. It is considered that in this technique, the insertion of the first trocar in the point whose position is the same in every patient (subcostal area) and the placement of the remaining trocars with reference to the position of the target organ, i.e., the stomach, minimize the risk of insufficient exposure and contribute to the application of the technique under optimum conditions. Since working with fewer trocars does not result in any surgical difference and even prolongs the operative time, LSG can be performed optimally with the five-trocar technique we presented. In the optimized technique, the two additional trocars compared to the three-trocar technique are both 5 mm, the 10- and 12-mm incisions are sutured with subcuticular sutures, and three incision scars are excised with abdominoplasty, which not only reduces negative esthetic outcomes but also does not increase the risk of herniation.

Our findings regarding patient characteristics, operative time, and early complication rates are consistent with those reported in the literature [10-12]. But still there are some strengths and limitations of this study. A key strength of this study is the consistent methodology, as all surgeries were performed by a single surgeon using a standard technique. This approach minimizes inter-surgeon variability and increases the reliability of our results. Furthermore, the number of cases is substantial, providing a robust cohort for comparison with similar studies in the literature. Despite these strengths, we acknowledge several limitations. A primary limitation is the retrospective design of the study. Another significant limitation is the lack of a control group, which prevents a direct comparative analysis. Lastly, the absence of objective aesthetic measurements means that cosmetic outcomes were assessed subjectively, which may affect the generalizability of these findings.

However, prospective and controlled studies are needed to confirm our findings.

Strengths and Limitations

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Ethical Approval: *This study received approval from the Non-Interventional Clinical Research Ethics Committee of Ankara Medipol University (date: 12.02.2025; decision number 23).*

Author Contributions:
Concept: S.O., F.C.
Literature Review: Y.U., Ö.S.
Design : A.A., O.B.
Data acquisition: S.O., F.C.
Analysis and interpretation: A.A., O.B.
Writing manuscript: S.O., F.C.
Critical revision of manuscript: Ö.S., O.B., Y.U.
Conflict of Interest: *The authors have no conflicts of interest to declare.*
Financial Disclosure: *Authors declared no financial support.*

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