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ORIGINAL CONTRIBUTIONS

# Comparison of Weight Loss in Sleeve Gastrectomy Patients With and Without Antrectomy: a Prospective Randomized Study

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## Abstract

**Background** Laparoscopic sleeve gastrectomy (LSG) restricts gastric volume to achieve weight loss. We aimed to compare the efficacy of LSG with and without antrectomy for achieving weight loss.

**Methods** The prospective randomized study comprised 127 obese patients that underwent either LSG with antrectomy (2 cm to pylorus) (group 1) or LSG without antrectomy (6 cm to pylorus) (group 2), using 36 Fr and 32 Fr bougies, respectively. Patients were examined at 3-, 6-, 12-, and 24-month intervals for body mass index (BMI) measurements.

**Results** Overall, 66 (51%) and 57 (49%) of patients were assigned to groups 1 and 2, respectively. The mean BMI of group 1 patients were 49.5 ± 8.01, 35.8 ± 5.40, 31.3 ± 4.9, 26.7 ± 4.02, and 22.9 ± 4.01 at the baseline, 3rd, 6th, 12th, and 24th month, respectively. The decreases in BMI were statistically significant. The mean BMI of group 2 patients were 46.7 ± 7.06, 39.3 ± 6.04, 32.4 ± 5.01, 26.6 ± 3.76, and 21.6 ± 3.70 at baseline, 3rd, 6th, 12th, and 24th month, respectively. The differences were also statistically significant. When compared with group 2, group 1 patients showed significantly lower BMI values on the 3rd month. Other differences were not statistically significant.

**Conclusion** LSG with or without antrectomy is safe and effective for weight loss. Larger studies are required to identify patients likely to benefit from LSG with antrectomy.

**Keywords** Bariatric surgery · Sleeve gastrectomy · BMI · Antral resection

## Introduction

Obesity, defined as a body mass index (BMI) ≥ 30, has become a global pandemic [1]. Data show that 15.5% of the US adult population are obese, while the prevalence of severe obesity in the USA, Sweden, and Austria is 6.3%, 1.3%, and 8.1%, respectively [2–4]. Severe obesity (BMI ≥ 35 with comorbidities and BMI ≥ 40 without those clinical conditions) frequently causes chronic health problems (type 2 diabetes, coronary artery disease, osteoarthritis, major depression, etc.), impaired quality of life, and higher premature mortality rates [5–10]. Behavioral alterations and medical treatment of obesity have shown little progress in the last two decades and total number of bariatric surgical procedures in 2014 has increased to 579,517 cases [1, 10, 11]. Laparoscopic sleeve gastrectomy (LSG) is the most commonly performed surgical procedure in the world (53.6%), followed by Roux-en-Y gastric bypass (RYGB) (30.1%), and adjustable gastric banding (AGB) (4.8%) [12].

Although studies show that the incidence/prevalence rates of severe obesity have increased worldwide [13], similar studies have not been conducted in Azerbaijan yet. Moreover, performance of these bariatric surgical procedures in Azerbaijan is relatively new. Several different techniques that potentially affect the residual gastric volume have been described for performing LSG [14, 15]. Smaller bougie use (mostly 36 Fr) increases the restrictive character of LSG and leaves less residual antrum. LSG with antrectomy results in a sleeve remnant with lesser volume [16, 17]. We prospectively randomized the patients to either LSG with antrectomy (Group 1) or LSG without antrectomy (group

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2). We aimed to evaluate the weight loss differences between the groups. We hypothesized ($H_0$) that there were no statistically significant differences between the BMI measurements of the two groups in the follow-up period.

## Methods

The study was designed as a prospective randomized trial and approved by the Azerbaijan Medical University (26th December 2011/C026). The study was conducted from May 2013 to May 2016.

Overall, 127 obese patients were included in the study. Informed consent involved detailed explanation on the outcomes of both surgical operations and also that they would randomly be assigned to one of the two procedures. Approval was received from all patients. All patients complied with the IFSO (International Federation for Surgery of Obesity) 2006 eligibility criteria for bariatric surgery. Before surgery, patients were evaluated by a pulmonologist, gastroenterologist, cardiologist, nutritionist, psychologist, endocrinologist, and an anesthesiologist. BMI, routine blood test results, and comorbidities of patients were recorded and each patient underwent preoperative upper gastrointestinal endoscopy and abdominal ultrasonography.

Table of random numbers between 1 and 99 was used for the randomization process [18]. All numbers on the table were randomly assigned to either surgery groups. After the patient was intubated in the operating room, one of the available medical personnel in the operating room created a random number between 1 and 99 by using research randomizer website (www.randomizer.org) and that number's group was located from the above-mentioned table and the surgeon was informed. Thus, patients were randomly assigned to either group 1 (LSG with antrectomy 2 cm to pylorus, using a 32 Fr bougie) or group 2 (LSG without antrectomy 6 cm to pylorus, using a 36 Fr bougie).

All eligible patients were admitted to the clinic the night before the operation and we used low molecular weight heparin and elastic stockings for deep vein prophylaxis. None of the patients had gastroesophageal reflux disease (GERD) symptoms and findings. All patients received 2 g iv cefazolin after anesthesia induction.

The patients were placed in modified lithotomy/reverse Trendelenburg position and a four Trocar technique was used. The greater gastric curvature was dissected with an ultrasonic scalpel (Ace® Ethicon Endo-Surgery). In group 1, we used a 32 Fr sleeve-calibrating bougie; the stomach resection started approximately 2 cm proximal to pyloric sphincter with partial resection of the antrum of the stomach and continued along the lesser curvature using linear GIA (Ethicon Echelon Flex™ GST) staplers. The selected cartridge colors for the antrum, midbody, and fundus in both groups were green-blue-blue. In group 2, LSGs were performed in a standard fashion; using a 36-Fr calibrating bougie, resection started approximately 6 cm to pyloric sphincter. Leak test on the gastric stapler line was performed using methylene blue and suture line was reinforced using interrupted polyglactin sutures. Suture omentoplasty was invariably performed to enforce the stapler line. Authors of the study also advocate the use of omentoplasty to prevent sleeve rotation. Patients underwent simultaneous cholecystectomy if the preoperative abdominal ultrasound revealed gallstones. A single-drainage tube was used in all patients to detect stapler line leaks. The same surgical team performed all surgical operations. Liquid diet was routinely started on the 2nd postoperative day and patients were discharged between the 3rd and 5th postoperative days.

Postoperative follow-up was conducted at 3, 6, 12, and 24 month after the procedure. They were scheduled for examination by the bariatric surgery team members. BMI and blood pressure measurements and routine blood test analyses were performed and recorded on every follow-up visit.

In order to determine the number of patients in both groups, we conducted ad hoc power analysis. Groups 1 and 2 patients' preoperative and postoperative 3rd month mean (± SD) BMI values were analyzed using Guc Analizi (Power Analysis) application (Savante Mobile Apps, Google Play). Sample size power was set at 80%. Analyses showed that group s1 and 2 required at least 66 and 57 patients, respectively. All data were analyzed using SPSS v.22 (IBM Corp; Armonk, NY, USA). In order to analyze the group differences (within subjects design), Friedman test was used. Upon finding a statistically significant difference, analyses between comparison groups were performed using Bonferroni-corrected Wilcoxon Signed-Rank test. Mann-Whitney *U* test was performed for analyzing the preoperative and postoperative BMI differences between groups 1 and 2 patients. We used mean (± SD) for descriptive purposes. Independent samples *t* test and chi square test were performed for the analyses of patient demographics and the study groups. Level of statistical significance was set at 0.05.

## Results

Overall, 123 patients were operated. Demographic data of patients in both groups is showed in Table 1.

Using simple randomization technique, 66 (51%) and 57 (49%) of patients were assigned to groups 1 and 2, respectively. The mean BMI values of group 1 patients were $49.5 \pm 8.01$, $35.8 \pm 5.40$, $31.3 \pm 4.9$, $26.7 \pm 4.02$, and $22.9 \pm 4.01$ at the preoperative period, 3rd, 6th, 12th, and 24th month, respectively. The differences were statistically significant ($p = 0.001$, $p = 0.003$, $p = 0.003$, $p = 0.006$, respectively). The mean BMI values of group 2 patients were $46.7 \pm 7.06$, $39.3 \pm 6.04$, $32.4 \pm 5.01$, $26.6 \pm 3.76$,

**Table 1** Patient demographics according to the surgery groups

| | | Groups | | *p* value |
|---|---|---|---|---|
| | | Group 1 ($n = 66$) (Laparoscopic sleeve + subtotal antrectomy) | Group 2 ($n = 57$) (LSG) | |
| Age (mean ± SD) | | 40.7 ± 9.8 years | 41 ± 10.7 years | 0.8** |
| Sex | Male | 11 (37%) | 21 (63%) | 0.01* |
| | Female | 55 (60%) | 36 (40%) | |
| Length of stay (mean ± SD) | | 3.9 ± 0.8 days | 3.6 ± 0.6 days | 0.4** |
| Operative time (mean ± SD) | | 58.3 ± 6.8 min | 57.9 ± 5.4 min | 0.8** |
| Postoperative leak *n* (%) | | 1 (1.5%) | 1 (1.8%) | 1** |

*Statistically significant

**Statistically not significant

and 21.6 ± 3.70 at the preoperative period, 3rd, 6th, 12th, and 24th month, respectively. The differences were also statistically significant ($p = 0.007$, $p = 0.007$, $p = 0.006$, $p = 0.011$, respectively).

We also compared the changes in BMI values between the two groups. In the preoperative period, the BMI values of group 1 patients were higher than the group 2 patients (49.5 ± 8.01 vs. 46.7 ± 7.06), which was marginally significant ($p = 0.04$). When compared with group 2, group 1 patients showed significantly lower BMI values on the 3rd month ($p = 0.03$). The rest of the comparisons were not statistically significant ($p > 0.05$) (Table 2) (Fig. 1).

In the postoperative period, 1 (1.5%) patient in group 1 and 1 (1.8%) patient in group 2 presented with stapler line leaks in the proximal third of the gastric sleeve. Both patients were successfully treated by endoscopic stent placement.

**Table 2** Surgery groups and changes in mean BMI measurements on follow-up visits and statistical comparisons between groups

| BMI (mean ± SD) | Groups | | *p* value |
|---|---|---|---|
| | Group 1 (Laparoscopic sleeve + subtotal antrectomy) (mean ± SD) | Group 2 (LSG) (mean ± SD) | |
| Preoperative | 49.5 ± 8.01 | 46.7 ± 7.06 | 0.04* |
| Postop. 3rd month | 35.8 ± 5.40 | 39.3 ± 6.04 | 0.03* |
| Postop. 6th month | 31.3 ± 4.9 | 32.4 ± 5.01 | 0.24** |
| Postop. 12th month | 26.7 ± 4.02 | 26.6 ± 3.76 | 0.80** |
| Postop. 24th month | 22.9 ± 4.01 | 21.6 ± 3.70 | 0.07** |

*Statistically significant

**Statistically not significant

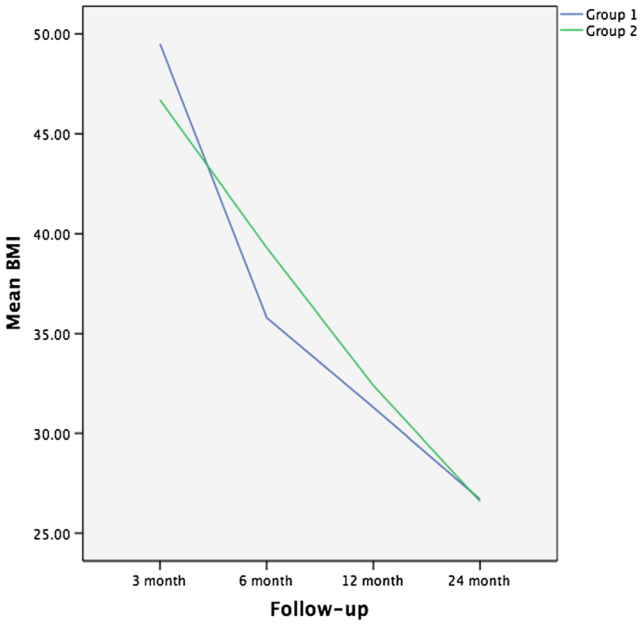


**Fig. 1** BMI changes in groups1 and 2 patients during follow-up

Additionally, another patient in group 2 presented with stapler line bleeding to peritoneal cavity in the early postoperative period. The patient was re-operated and additional sutures successfully treated the visible bleeding point.

## Discussion

Severe obesity inflicts cardiovascular, metabolic, pulmonary, and psychosocial hazards, which may be improved or reversed by surgical weight loss. Thus, the principal goal of bariatric surgery is accomplishing weight loss. Although an oversimplification for explaining the mechanism of weight loss, bariatric surgeries may be classified as restrictive (to decrease the gastric volume), malabsorptive, or a combination of both [19]. LSG is the most frequently performed restrictive procedure and its outcomes have been associated with residual gastric volume. However, by resecting the fundus, the majority of the ghrelin-producing cells are removed, which may also contribute to the weight loss caused by LSG [10].

On the technical side, bougies are frequently used as a guide to determine a selected and uniform gastric sleeve volume. Studies have addressed the issue of different bougie sizes and the related weight loss outcomes. Parikh et al. [20] aimed to analyze the percent excessive weight loss (% EWL) caused by bougie size (40 Fr vs. 60 Fr) and they found no statistically significant difference during a 12-month follow-up. Shao et al. [21] retrospectively compared 38–40 Fr and 50 Fr group patients that underwent LSG and they found no association with bougie size and % EWL up to 1 year. Helmy [22] also compared LSG patients prospectively. He classified the patients as 32 F–40 Fr groups and found no statistically significant %

EWL difference between the groups. Strikingly, the 2016 sleeve gastrectomy consensus conference showed that experts tended to use larger bougies (median 36 Fr) as they believed smaller bougies were associated with leaks and strictures [23].

It has been postulated that gastric volume is not associated with obesity [24] Sista et al. [15] addressed the remaining gastric volume-weight loss equation from a different perspective. They prospectively studied 105 patients that underwent LSG using a standard 36 Fr bougie and measured the resected gastric volume. They showed that higher resected gastric volumes significantly increased the % EWL during 6-, 12-, and 36-month follow-up. Likewise, despite the added advantage of less antrum volume due to smaller 32 Fr bougie use, our results suggest smaller bougie sizes may not be beneficial for weight loss.

Few studies have compared LSG with antral resection and LSG prospectively. Obeidat et al. [25] prospectively assigned 54 patients to 6 cm proximal to pylorus (LSG) and 56 patients to 2 cm proximal to pylorus (LSG + partial antrectomy) groups. Antrectomy patients had significantly higher weight loss on the 12th and 24th month. They concluded that besides greater weight loss, LSG + antrectomy safely potentiated the restrictive effect of LSG. Additionally, ElGeidie et al. [26] created the same groups as above and followed the patients at 6- and 12-month intervals. Similarly, weight loss was significantly higher in the antrectomy group at 6 months, while the difference between the two groups lost significance at 12 months. On the other hand, our study showed that weight loss was significantly higher in the antrectomy group only at the 3rd month, while the difference was not significant at 6, 12, and 24 months. Despite the common sense that lower gastric volume would yield higher degrees of weight loss, our study suggests that this may not be true. The significant difference on the 3rd month needs to be substantiated by larger studies. Also, variable data presented by similar studies [25, 26] suggests the presence of other complex mechanisms associated with weight loss and presence of different confounding factors are inherent to each patient and their nutrition behaviors in the postoperative period.

Stapler line bleeding and leakage are among major complications of LSG and may occur in 5% of cases [27]. Leaks generally occur in the upper third portion of the stapler line, its incidence range between 1. [1–]5.3% and it is the second most common cause of mortality (0.4%) after LSG [28]. In our LSG study, the overall leak rate was 1.6% and these cases were successfully treated using endoscopic stents. As the possible association between the bougie size and leak rates has been emphasized by Gagner et al. [23] in their sleeve gastrectomy consensus paper, a future study that compares both the leak rates and BMI changes with higher bougie sizes may be appropriate.

One (0.8%) patient presented with intra-peritoneal bleeding from the stapler line in the early postoperative period. The patient was re-operated and the bleeding was evident between the inverting re-enforcement sutures and treated by an over suture. The bleeding may be due to the failure to check hemostasis with low intra-abdominal pressure [29].

Our study is not without limitations. Primary focus of the authors of the present study focused mainly on the BMI changes in two bariatric surgery groups. Although we tried to create a reliable randomization system for assigning patients, the preoperative BMI values between the groups were significantly different. Randomly assigning BMI-matched individuals could yield more easily interpretable results. Likewise, including ghrelin measurements to the study could also significantly increase our understanding of BMI changes between the groups.

## Conclusion

We found that both techniques resulted in significant weight loss and also both surgical techniques are safe in terms of postoperative complications. Larger studies are required to identify the patients likely to benefit from these two different techniques.

### Compliance with Ethical Standards

**Conflict of Interest** The authors declare that they have no conflict of interest.

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