

# Safety and Outcomes of Laparoscopic Sleeve Gastrectomy in a General Surgery Residency Program

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## ABSTRACT

**Background:** With the escalation of surgical treatment of morbid obesity, there is a growing interest in the training of bariatric surgeons. Laparoscopic sleeve gastrectomy (LSG) gained popularity both as a first-stage approach and as a stand-alone procedure.

**Objectives:** The aim of this study was to assess detectable differences in LSG with intra-operative resident involvement.

**Methods:** We reviewed obese patients, who had undergone LSG between January 1, 2017 and January 31, 2020. Collected data reported demographic factors, operative time, postoperative complications, and outcomes.

**Results:** Among 313 patients who met the inclusion criteria, 94 were men and 219 were women. The procedures were performed either by an expert bariatric surgeon (group 1), or a general surgery resident (group 2), respectively in 228 and 85 cases. Mean operative time of the first group was  $65.3 \pm 18.8$  minutes, while it was  $74.3 \pm 17.2$  among trainees ( $p < 0.001$ ). Perioperative complications were diagnosed in 13 patients (10 in group 1 and 3 in group 2). Mean excess body weight loss after 12 months was  $87.7 \pm 28.2\%$  in the first group and  $81.1 \pm 31.6\%$  in the residents group. Between the two groups, we found no differences in the incidence of perioperative complications and in surgical outcomes.

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Trainee involvement was associated with increased operative time, with no correlation with a worse postoperative course.

**Conclusions:** Residents can safely perform LSG in referral centers under the supervision of an expert bariatric surgeon. Trainee involvement is not related to increased leak rate, nor to suboptimal short-term outcome.

**Key Words:** Resident Training, Fellowship, Bariatric Surgery, Sleeve Gastrectomy.

## INTRODUCTION

The worldwide diffusion of obesity has led to it being deemed a global epidemic.<sup>1</sup> The role of bariatric surgery (BS) in weight reduction compared to intensive medical therapy is undisputed.<sup>2</sup> Surgery in morbidly obese patients is effective in increasing their life expectancy, as well as in resolving or improving the principal obesity related comorbidities, such as diabetes, hypertension, obstructive sleep apnea, and hyperlipidemia.<sup>3</sup> Moreover, the introduction of the minimally invasive approach increased the popularity of bariatric procedures, because of the perceived simplicity, the excellent outcomes, the decrease of postoperative morbidity and of hospitalization time.<sup>4,5</sup> Among bariatric procedures, in the last decade, there has been a shift toward laparoscopic sleeve gastrectomy (LSG). LSG is considered a highly successful surgical technique, both as a first-stage approach in high-risk and super obese patients, and as a standalone bariatric procedure.<sup>6,7</sup> LSG is regarded as less invasive than malabsorptive procedures because of the shortened operative time, the absence of gastrointestinal anastomosis, and the reduced technical challenge.<sup>8,9</sup> Indeed, as well as its excellent postoperative results, LSG has a low incidence of complications. Early adverse events include hemorrhage, leakage from the staple line and sleeve stricture, while reported late complications are gastroesophageal reflux and failure to maintain weight loss.<sup>10</sup> Even if LSG is considered a restrictive operation, the removal of the gastric fundus involves a reduction of the hormone ghrelin,

thus suggesting an, as yet unclear, neurohormonal factor.<sup>11,12</sup> Parallel to the growing popularity of bariatric procedures, there is an increased demand, in our country, for trained metabolic surgeons. Trainees, during their residency in general surgery, are beginning their surgical education in this narrow discipline, but data on resident involvement in safety and outcomes in bariatric procedures reported mixed results.<sup>13-15</sup> In the literature, not a lot of data is present on the capacity of the residency in general surgery to supply adequate training and experience in bariatric surgical practice. In our country, extensive participation of residents in the performance of these laparoscopic procedures is still not a routine.

This study aimed to further examine resident intra-operative involvement in performing LSG and to analyze the effect of the learning process on safety and on surgical outcomes.

## METHODS

We performed a retrospective analysis of data from a prospectively collected database. Institutional approval was obtained. The study setting was the Obesity Unit of a university teaching hospital and high-volume tertiary referral center for bariatric surgery. We included for analysis all patients with morbid obesity, defined as body mass index (BMI)  $\geq 35$  kg/m<sup>2</sup> with obesity comorbidities, or BMI  $\geq 40$  kg/m<sup>2</sup>, who underwent LSG at our institution between January 1, 2017 and January 31, 2020. The eligibility for LSG was established according to the criteria of the Italian Society of Bariatric Surgery and Metabolic Disorders (SICOB).<sup>16</sup> Patients who underwent banded sleeve gastrectomy (BSG), LSG for revisional surgery, or LSG with concomitant procedures were included in the analysis, while we excluded patients who underwent other bariatric operations. In advance, all patients gave their informed written consent, were evaluated pre-operatively by a multidisciplinary team,<sup>17-19</sup> and underwent a complete assessment including upper gastrointestinal tract x-rays or upper endoscopy and abdominal ultrasound. Procedures were performed either by an expert bariatric surgeon or by a general surgery resident as the first operator, with an expert surgeon (from the same expert group) as the first assistant. The surgeons in training were allowed to do the entire procedure, but under continuous control of the teacher. Residents involved in the study were all senior residents, post-graduate year-4 (PGY) and PGY-5, and they actively participated in the pre-operative and postoperative management of obese patients, including procedure selection, evaluation of comorbidities, and clinical approach.

All procedures were performed with a laparoscopic approach and the same surgical technique was used by all surgeons. Under general anesthesia and endotracheal intubation, the patient was placed in 30° anti-Trendelenburg position, with the surgeon between abducted legs. Our technique involved establishing pneumoperitoneum to 15 mmHg, with the insertion of 10-mm Hasson trocar in the supraumbilical region. Then, another 4 operative trocars were introduced under direct vision. After the exploration of the abdominal cavity, the procedure continued with the mobilization of the greater curvature, starting 4 – 5 cm proximal to the pylorus, to the angle of His. Under the calibration of a 36-French bougie, a classic vertical gastrectomy was performed by sequential application of linear stapler, paying attention to the total resection of the gastric fundus. After the gastric transection, a methylene blue dye test was performed in all cases, to assay the integrity of the staple line. We do not, routinely, use a drain and we usually remove the nasogastric tube prior to placement of the calibration bougie.

All trainees in our department had a theoretical education, had scrubbed in at least 20 bariatric procedures as first assistant during which they usually performed one part of the intervention, and were ensured access to the laparoscopic training simulator. All patients were managed in the same way in the peri-operative period, in accordance with the principles of the multimodal enhanced recovery after surgery (ERAS) pathway.<sup>20</sup> The mean postoperative follow-up was 12 months after surgery. We collected pre-operative, intra-operative, and postoperative data. Pre-operative data included BMI, weight, gender, and age. Intra-operative variables included associated procedure, possible adverse events, the use of MiniMizer Ring™ (Bariatric Solutions International), and operative time, recorded as time between skin incision and skin suture. Examined outcomes included complications (staple-line leakage and bleeding) and percentage of excess body weight loss in the follow-up period, defined as the ratio of weight loss to the difference between actual pre-operative weight and ideal weight. Result values are presented as mean  $\pm$  standard deviation. Continuous variables were analyzed using the Student's t test, or with ANOVA, when proper. Categorical variables were analyzed using  $\chi^2$  test, with Yates correction. Statistical significance was defined as a  $p < 0.001$ .

## RESULTS

We reviewed 313 patients who met the inclusion criteria. Among them, 94 were men (30%) and 219 were women (70%). Mean age was  $44.6 \pm 11.1$  (range 17 – 70) years. Mean preoperative BMI was  $43.9 \pm 7.1$  (range 29 – 73) kg/m<sup>2</sup>. An expert bariatric surgeon (group 1) performed 228

**Table 1.**  
Perioperative Factors

	Total	Surgeon		P Value	
		Expert	Trainee		
	N = 313 (100%)	N = 228 (72.8%)	N = 85 (27.2%)		
Years (mean ± SD)	44.6 ± 11.1	44.9 ± 11.4	43.6 ± 10.4	0.331	
Males	94 (30.0%)	74 (32.5%)	20 (23.5%)	0.125	
Females	219 (70.0%)	154 (67.5%)	65 (76.5%)		
BMI (kg/m <sup>2</sup> , mean ± SD)	43.9 ± 7.1	44.3 ± 7.1	43.1 ± 7.0	0.176	
Surgical Procedure	LSG	207 (66.1%)	152 (66.7%)	55 (64.7%)	0.192
	BSG	93 (29.7%)	67 (29.4%)	26 (30.6%)	
	LSG + Lapchol	6 (1.9%)	2 (0.9%)	4 (4.7%)	
	BSG + Lapchol	1 (0.3%)	1 (0.4%)	0	
	(ReSG)	3 (1.0%)	3 (1.3%)	0	
	(RedoSG)	3 (1.0%)	3 (1.3%)	0	
Operative time (min., mean ± SD)	67.8 ± 18.8	65.3 ± 18.8	74.3 ± 17.2	<b>&lt; 0.001*</b>	

\*Statistically significant value.

BMI, body mass index; SG, sleeve gastrectomy; BSG, banded sleeve gastrectomy; Lapchol, laparoscopic cholecystectomy; ReSG, revisional sleeve gastrectomy; RedoSG, sleeve gastrectomy after failed adjustable gastric banding; SD, standard deviation.

(72.8%) surgical procedures, while 85 (27.2%) patients underwent LSG performed by a general surgery resident (group 2). Mean operative time of the first group was 65.3 ± 18.8 (range 30–139) minutes, while mean operative time among trainees was 74.3 ± 17.2 (range 45–153) minutes. A laparoscopic BSG, defined as LSG with the positioning of MiniMizer Ring™ (Bariatric Solutions International), was performed in 94 cases (29.7%), 68 in group 1 (29.8% of the total) and 26 in group 2 (30.6% of the total). At our institution, we deem all patients as suitable candidates for BSG who, after evaluation of multidisciplinary board, and after being informed in detail about risks and benefits of the procedure, give their written informed consent.

Concomitant procedures were performed in 7 (2.2%) out of the overall 313 LSGs, while 6 patients (1.9%) underwent revisional surgery, defined as revisional sleeve gastrectomy for failure of primary LSG, or redo-sleeve after failed adjustable gastric banding.

Peri-operative adverse events were diagnosed in 13 (4.2%) patients (10 in group 1, 3 in group 2); among them, staple line leakage occurred in 10 (3.2%) patients (7 in group 1, 3 in group 2). The staple line leaks were diagnosed in the first two weeks postoperatively and were treated by endoscopic prosthesis.<sup>21</sup>

Complications that required operative reintervention occurred in three patients, one for staple line bleeding (0.3%), one for bowel obstruction (0.3%), and one (0.3%) for slippage of MiniMizer Ring™ (Bariatric Solutions International). Mean follow-up among patients was one year after surgery. Mean EBWL after 12 months was of 87.7 ± 28.2% (range 0 – 164) among patients operated by expert bariatric surgeons and of 81.1 ± 31.6% (range 18 – 129) among patients whose procedure was performed by general surgery residents. We found no statistically significant differences in the demographic factors, as age (P = .331), gender (P = .125) and pre-operative BMI (P = .176), between the two groups (**Table 1**). Neither were there any significant differences between expert surgeons and trainees in postoperative complications (P = .736), particularly staple line leak rate (P = .837), and EBWL one year after surgery (P = .194, **Table 2**). Trainee involvement was associated with increased operative time (P < .001, **Figure 1**), but this was not associated with morbidity or a worse postoperative course.

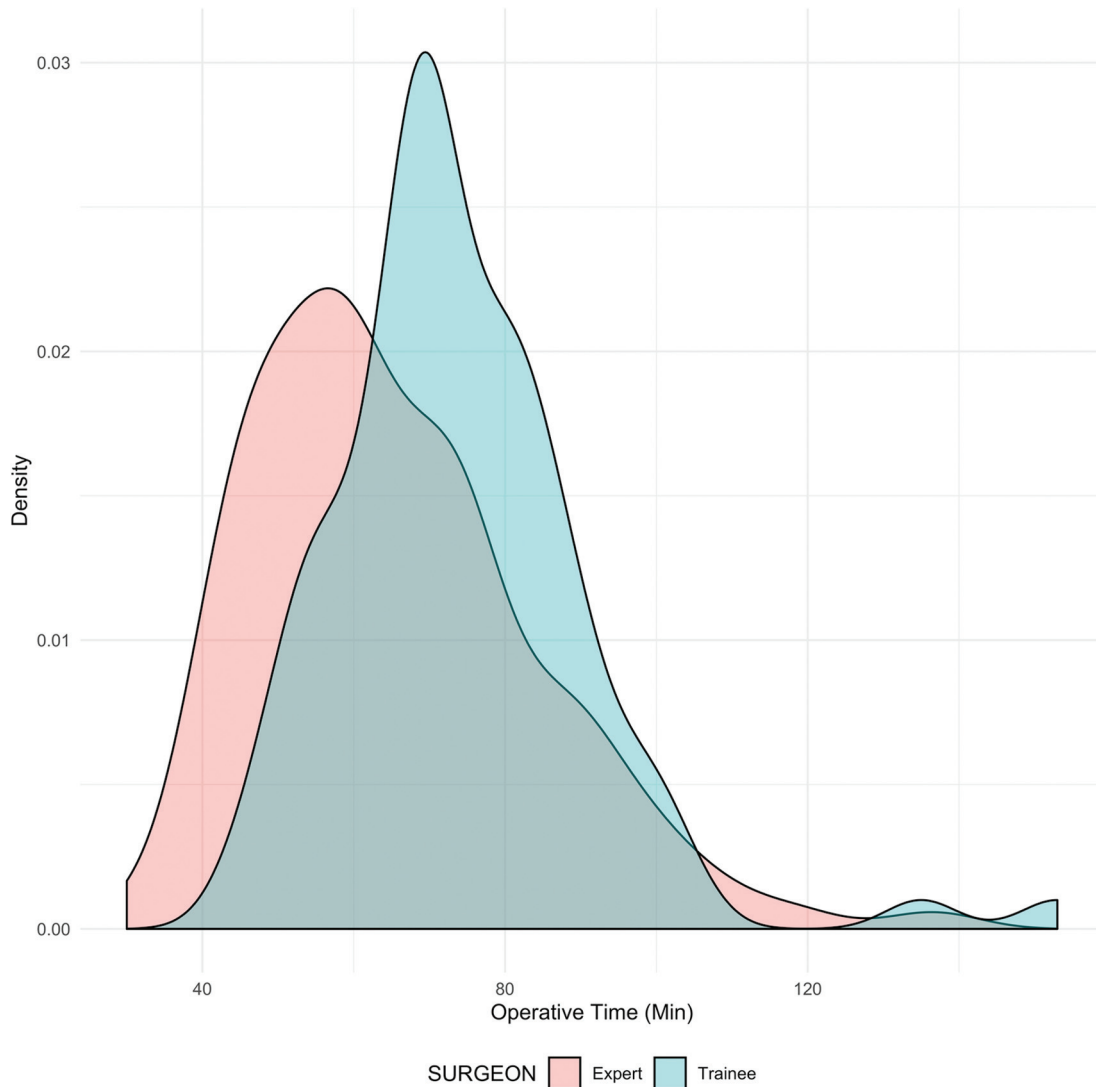
## DISCUSSION

In parallel with the increasing demand for trained bariatric and metabolic surgeons, BS is becoming an ever-growing part of general surgery resident training and surgical

**Table 2.**  
Surgical Outcome

Total	Surgeon		P Value	
	Expert	Trainee		
EBWL (%)	N = 165 (52.7%)	87.7 ± 28.2	81.2 ± 31.6	0.194
Adverse events	N = 13 (4.2%)	N = 10 (4.4%)	N = 3 (3.5%)	0.736
Leak Rate	10 (3.2%)	7 (3.1%)	N = 3 (3.5%)	0.837
Bleeding	1 (0.3%)	1 (0.4%)	-	-
Bowel Obstruction	1 (0.3%)	1 (0.4%)	-	-
Slippage Ring	1 (0.3%)	1 (0.4%)	-	-

EBWL, excess body weight loss.



**Figure 1.** Operative Time. The density plot indicates the number of procedures carried out by an expert (pink) or a trainee surgeon (green).

fellowship programs.<sup>22</sup> This narrow field requires advanced laparoscopic skills and experience, so the effect of the trainees' involvement on patients' safety has come into question.<sup>23–25</sup> In our results, pre-operative characteristics were similar between patients operated on by expert bariatric surgeons and by residents. Our surgical outcomes are comparable to national and international results. Despite the conversion rate that for LSG ranges from 10.0 to 10.8%,<sup>9</sup> in our series no procedure required conversion to the laparotomic approach. As far as concerns postoperative complications that required operative reinterventions, our rates were comparable to those reported in the literature,<sup>26</sup> and there were no statistical differences between the two groups. No 30-day mortality was reported. Even regarding the staple line leakage, the most feared of bariatric complications, our results are comparable to those reported in the literature,<sup>27</sup> and the rate was not affected by the performance of a resident in the surgical procedure.

As previously reported by Aminian et al.,<sup>28</sup> our results suggest that trainee involvement is related to an increase in mean operative time of LSG. Surgical education requires time-consuming training moments during the procedure that could, eventually, affect a patient's outcome. Even if the literature reports a relationship between duration of surgery and rate of postoperative complications,<sup>29</sup> and the shortened operative time is a key point of ERAS protocol, in our program this was not related to increased morbidity nor to a worsening of the postoperative course. Our study supported the thesis that general surgery resident involvement in performing BS, in a high-volume tertiary referral center, under the watchful eye of an expert bariatric surgeon, does not lead to increased risk of complications, and does not affect short-term surgical outcomes. In an era where there is a growing need for high-quality bariatric centers, one of the concerns should be to enable general surgery residency and fellowship programs to adequately prepare the next generation of bariatric and metabolic surgeons, without impairing patient safety, and providing optimal outcomes. Surgical education should be enhanced in all referral academic bariatric centers of our country, and a greater effort must be made to manage validated fellowship programs in order to ensure additional training in malabsorptive procedures, and to give a more comprehensive education in BS for those trainees who want to dedicate to this field.

As highlighted in general surgery practice<sup>30</sup> and in BS as well,<sup>31</sup> training in surgical simulators can be helpful in

improving technical skills outside the operating room and can increase surgical efficiency. Limitations of our study include the retrospective nature of the analysis, the small sample size, and the single center experience. Patients were not randomized, thus leading to a significant selection bias. Although the two groups of patients were similar for pre-operative characteristics, cases considered usually more difficult (male patients, higher BMI, revisional surgery, or concomitant procedures) could have been performed on a larger scale by an expert bariatric surgeon.

Our Department is a high-volume referral center for BS and is a teaching hospital with surgical simulation laboratories, so our results would not be valid for other minor centers.

Despite these limitations, our series suggest how in adequate settings, LSG could be safely performed by general surgery residents, even in countries where their participation is still not routinely ensured. Further studies and randomized controlled trials could confirm our data on larger scale, and with a longer follow up.

## CONCLUSIONS

Resident involvement in BS is safe and effective. General surgery residents can safely perform LSG in high volume referral centers under supervision of an expert bariatric surgeon. Trainee involvement is not related to an increased rate of adverse events, nor to suboptimal short-term outcomes. Surgical education in BS will ensure high quality care for obese patients. In an era of increasing need for competent bariatric surgeons, education should be considered a priority for all general surgery residents, providing structured programs in referral centers, thus avoiding any added risk to morbidly obese patients.

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