Technical tips associated with reduction in leak rate after laparoscopic sleeve gastrectomy: lessons to learn from a nested case–control study

Mohamed Bekheit[a,b,c], Khaled Katri[d], Wael Abdel-Salam[d], Tamer Nabil Abdelbaki[a], Bruno Sgromo[e], Jean-Marc Catheline[f], Galal Abou ElNagah[d], El Said El Kayal[d]

[a]Department of Surgery, Alexandria main University Hospital, Faculty of Medicine, University of Alexandria, [b]Minimal Invasive Surgery Unit, Department of Surgery, El Kabbary General Hospital, El Kabbary, Alexandria, Egypt, [c]Centre Hepatobiliare, Paul Brousse Hospital, Villejuif, France, [d]Associate Professor of Surgery, Department of Surgery, Alexandria main University Hospital, Faculty of Medicine, University of Alexandria, Egypt, [e]Consultant Upper GI and Bariatric Surgeon, Oxford University Hospitals, Oxford, United Kingdom, [f]Associate Professor of Surgery, Chief of Gastrointestinal Surgery Unit, Department of Surgery, Delafontaine Hospital, Paris, France

Correspondence to Mohamed Bekheit, MSc, MRCS, MRCPS, Minimal Invasive Surgery Unit, Department of Surgery, El Kabbary General Hospital, El Kabbary, Alexandria 31241, Egypt
Tel: +2(0)3-5570891
e-mail: dr_mohamedbekheit@hotmail.com

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Background
Laparoscopic sleeve gastrectomy (LSG) is one of the common bariatric procedures for the treatment of morbid obesity. One of the most drastic complications of this procedure is leak.

Objective
The aim of the study was to discuss the possible technical factors that might contribute to the occurrence of postoperative leak and how to avoid it through analyzing our series.

Materials and methods
Analysis of the influence of technical adaptations on the outcome of LSG was performed in a nested case–control group of patients. The main modification adapted was performing invaginating sutures over the staple line. The primary outcome was the occurrence of leak. The secondary outcomes were bleeding, operative time, prolonged hospital stay, back pain, and mortality.

Results
The group who had invaginating sutures (group 2) had a significantly lower frequency of leak (0%) than those without invaginating sutures (7.3%; group 1) (P_F = 0.016). There was no significant difference in the occurrence of postoperative bleeding or mortality between the groups (P_F = 0.162 and 0.250, respectively). The frequencies of a hospital stay longer than 48 h and back pain were significantly higher in group 1 (P_F = 0.004, P_F < 0.001, respectively). There were no significant differences between groups in the preoperative BMI (Student's t = −0.763, P = 0.45) or the age (Student's t = −0.5, P = 0.61). The operative time was longer in group 1 (Student's t = 3.56, P < 0.001). There was also a significantly lower intraoperative blood loss in group 2 (Student's t = 1.99, P = 0.048).

Conclusion
From our experience, leak after LSG could be minimized by invaginating sutures of the staple line and by adapting the ergonomic trocar positioning described herein.

Keywords:
bariatric surgery, obesity, sleeve gastrectomy, staple line enforcement, suturing

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Introduction

Obesity is a well-known health risk [1] that is associated with several comorbidities [2]. Bariatric surgery has proven to provide a sustainable weight loss with improvement in the related comorbidities [3,4]. One of the more recently introduced interventions is laparoscopic sleeve gastrectomy (LSG), which is proved to induce a significant excess weight reduction [5]. Despite the successful outcomes reported, LSG, as any other bariatric surgery, is not without complications [6]. Leak is considered one of the most drastic complications after LSG [7]. Several strategies to prevent leak were utilized in many clinical studies. Staple line enforcement is one of the most tried protective methods against the leak [8]. Buttressing, oversewing, and roofing with fibrin glue of the staple line were used to address the prevention of leak [9]. Despite the efforts to minimize leaks after LSG [10], they still occur [11]. The reported leak rate in the literature is up to 3% [10] and is associated with significant morbidity and mortality [12]. The learning curve of the procedure could be an important factor determining the outcome [13]. Mentorship programs could effectively reduce the complications during the learning curve of LSG [14]. Mentorship programs, despite available, might not be achievable for every surgeon who wishes to treat his patients with LSG. The alternative solution is to have a clear description of the technique that explains the subtle differences and their influence on the course of the procedure.

The objective of this study was to describe the technical factors that might reduce the leak during the learning curve of LSG.

Materials and methods

We started LSG in 2009. Because of the high initial leak rate in our series, we considered some technical modifications to minimize the leak rate. We retrospectively reviewed the clinical data of the whole cohort of patients who underwent LSG in our prospectively maintained bariatric registry. The leak rate was the primary outcome of evaluation in both the initial (the control group; group 1) and the current series (the intervention group; group 2). The secondary outcomes compared were the occurrence of bleeding, the operative time, the frequencies of prolonged hospital stay and back pain, and the mortality rate. Informed consent was taken from all patients included in this study. The ethical committee of human research (IRB), Faculty of Medicine, Alexandria University, Alexandria, Egypt, approval was obtained before adapting the LSG.

Statistical analysis

The independent *t*-test was used to estimate the significance of difference of the quantitative data of both groups and the χ^2-test was used for the qualitative data using portable SPSS V20. The significance level was set for a P value less than 0.05.

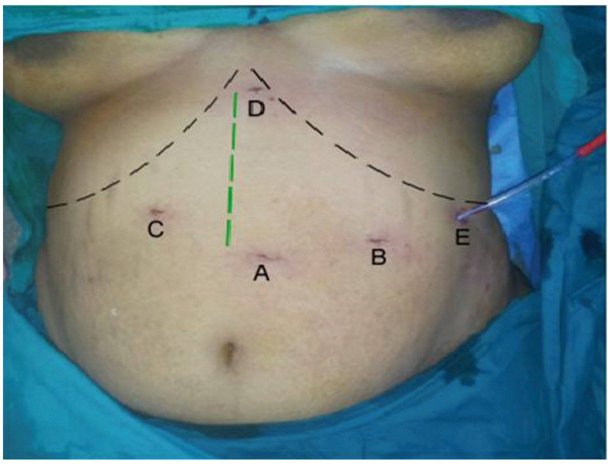
The surgical technique (group 2)

Patients were positioned in a steep anti-Trendelenburg position with the pneumoperitoneum established through a 12-mm trocar, inserted a hand breadth (13–14 cm) beneath the xiphoid process and minimally deviated to the left of the midline. A second 12-mm optical trocar is inserted two fingers breadth beneath the costal margin just at the left midclavicular line. Three 5-mm trocars are inserted: One subxiphoid for liver retraction and manipulation of the gastric fundus when needed, another one at the left midaxillary line for the assistant, and the third one in the right pararectal line, two fingers breadth below the costal margin (Fig. 1). The last one may transfix the falciform ligament if found broad and long.

Dissection was pursued using ultrasonic dissector (Harmonic Ace; Ethicon Endo-Surgery, USA) through accessing the lesser sac, then the whole greater curvature of the stomach is dissected. Afterwards, complete liberation of the posterior gastric attachments except for the unique left gastric vessel bundle is performed. All the remaining fat, peritoneal bands, and posterior fundic vessels are freed from their gastric attachment (Fig. 2a and b). Complete exposure of the left crus is gained and mobilization of the angle of His is completed through dissection of the phrenogastric membrane from the left side until the gastroesophageal junction is mobilized (Fig. 3).

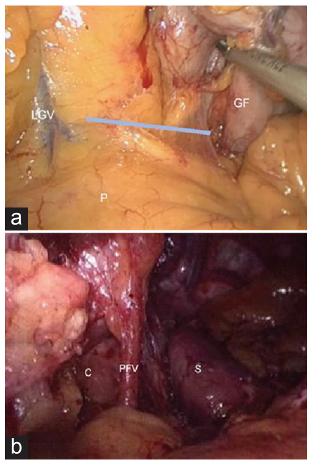
The resection is started 2–3 cm from the pylorus through the paramedian trocar with gold loads (closed staples height is 1.8 mm) mounted on a 60-mm stapler (Echelon Endopath; Ethicon Endo-Surgery) and is performed with a 38-Fr calibrating tube inside the pouch. The resection is continued until the angle of His through the same port. During resection, traction

Figure 1



(a) 12 mm port site (paramedian trocar) is inserted at 13–15 cm (green interrupted line) from the xiphoid process and is used initially for scope until the dissection is complete then used for stapling. (b) 12 mm port site is used initially for right working hand of the surgeon then for the scope. (c) 5 mm port site for the left working hand. (d) 5 mm port site for liver retraction and assisting in fundus manipulation for dissection. (e) 5 mm port site for assistant and is the site for drain left after completion of intervention.

Figure 2



(a) Posterior attachment of the gastric fundus before dissection. The blue line shows the division line for the posterior fundic attachments. (b) Dissection of the posterior fundic vessel cuff if encountered. C, crus; GF, gastric fundus; LGV, left gastric vessels; P, pancreas; PFV, posterior fundic vessel; S, spleen.

Figure 3

Complete dissection of the angle of His. C, crus; PEM, phrenoesophageal membrane.

is applied at the greater gastric curvature that is slightly pulled toward the anterior abdominal wall to remove the relatively larger surface of the posterior wall of the gastric fundus. Care was always taken during the stapling not to crumble the stomach inside the stapler by avoiding caudal traction of the stomach. This was particularly important at the region of the fundus of the stomach.

It is also of importance to avoid the crossing over of the staples, which could cause the stapler's knife disturbing the junction between the consecutive firings. This could be achieved by applying the stapler to the middle of preceding end of the staple line.

Invaginating sutures were adapted in December 2010. Sutures were taken into the superficial seromuscular layer, 2–3 mm lateral to the staple line, in a continuous manner. The sutures covered the staple line from the gastroesophageal junction until approximately the level of the gastric incisura, using polypropylene 3/0, 26–30-mm round needle (Ethicon Sutures, Cincinnati, Ohaio, USA) in a continuous manner.

A leak test with diluted methylene blue is performed and a tube drain is left with respect to the gastric pouch. We routinely keep the nasogastric tube (NGT) until the first postoperative night, and the tube drain is removed before discharge at 48 h unless otherwise indicated.

The differences from our initial technique

This group of patients was operated from November 2009 to December 2010. The port sites, in this group of patients, were generally the same except for the paramedian trocar, which was inserted about 18 cm below the xiphoid process. The dissection of the greater curve of the stomach at the region of the antrum was limited to 4–6 from the pylorus. The resection phase started with the first firing from the paramedian trocar, then the rest of the firings are continued through the left midclavicular trocar. Sutures were not taken except for control of bleeding points from the staple line in the form of figure-of-eight absorbable stitches.

Results

A total of 119 consecutive patients were operated following our modifications (group 2). Their mean preoperative BMI was 48.4 ± 10.2 kg/m^2 and their mean age was 39 ± 5 years. In this group, 80 patients (67.2%) were women and 39 (32.8%) were men. The mean operative time was 116 ± 13 min. The mean operative blood loss as measured from the suction cup was 50 ± 10 ml.

All patients of this group except one remained in hospital for 48 h after surgery with a standard postoperative care, and all contrast studies were negative for leakage. The NGT was removed on the first postoperative day in all patients. The tube drain was removed before discharge in all patients except one in whom there was a continuous blood efflux of 500 ml/day during the first and the second day. Laparoscopic exploration was performed on the second postoperative day, but no active source of bleeding could be found. Nonetheless, a large intraperitoneal hematoma was irrigated and a large caliber drain was reinserted. Despite that, the patient continued to have a bloody effluent of about 150 to 50 ml per day for 7 consecutive days without manifestations of systemic decompensation. After discharge, all patients were attended at 1 week and at 4 weeks' follow-up visits, where no clinical signs of leakage was demonstrated.

Five patients in this group (4.2%) had significant low back pain during the early postoperative period, which significantly decreased before discharge in four patients. One patient required facet joint injection for pain relief, which was partially successful.

Forty-one patients, 10 (24.4%) men and 31 (76.6%) women, were operated before these adaptations (group 1). Their mean preoperative BMI was 47.2 ± 8.1 kg/m^2 and their mean age was 38.2 ± 9.7 years. The mean operative time of this group was 130 ± 24 min. The estimated mean operative blood loss was 150 ± 45 ml. Five patients (12.1%) remained in hospital for more than 48 h; this included two readmissions. Two patients remained in hospital under conservative management of a drain effluent of 250 and 300 ml of fresh blood per 24 h. The effluent amount decreased to less than 50 ml before discharge on the fourth and fifth postoperative day. The drain was removed on the seventh postoperative day in one patient and on the 10th postoperative day in the other. None of them required blood transfusion.

The other three patients with prolonged hospital stay had staple line leaks. Leak was diagnosed clinically in one patient on the first postoperative day, who was brought back to the operating theater for laparoscopic exploration. The leak site was located by a diluted methylene blue administration through the NGT. It was at the most proximal part of the pouch for which a single figure-of-eight stitch was taken. Peritoneal lavage was performed and a drain was left nearby the pouch. The patient's drain continued to have leakage efflux for 45 days during which the patient was on regular enteral feeding, with nearly normal daily activity. In a second patient with a BMI 64 kg/m^2, leak was diagnosed on the third postoperative day. Computed tomography (CT)-guided drainage of intraperitoneal collection was attempted and an endoscopic stent was placed, which failed to contain the leak. The patient developed pulmonary embolism during the course of treatment, despite the antithrombotic measures, on the 16th postoperative day, which led to consumption of the patient reserve, and the patient died on the 34th postoperative day. The leak in the third patient was diagnosed on the seventh postoperative day. The patient had CT-guided drainage and was successfully managed conservatively for 3 weeks. The diagnosis of leak in the last two patients was achieved by CT scan, which was requested upon clinical suspicion.

The postoperative back pain was significant in three patients in this group. All of them showed considerable improvement at discharge.

Statistical analysis showed that group 2 had a significantly lower incidence of leaks than group 1 (P_F = 0.016) (Fig. 1). There were no significant differences in the occurrence of postoperative bleeding or mortality between the groups (P_F = 0.162 and 0.250, respectively). The frequencies of a hospital stay longer than 48 h and back pain were significantly higher in group 1 (P_F = 0.004, P_F < 0.001, respectively).

There were no significant differences between groups in the preoperative BMI (Student's t = –0.763, P = 0.45) or the age (Student's t = –0.5, P = 0.61). The operative time was longer in group 1 (Student's t = 3.56, P < 0.001). There was also a significantly lower intraoperative blood loss in group 2 (Student's t = 1.99, P = 0.048). Table 1 summarizes the main findings of this study.

Discussion

Leak after LSG is ubiquitously reported in the literature and its incidence varies from 0 to 5% [15,16]. Devascularization and increased intraluminal pressure were widely accepted predisposing factors for leaks [17]. We believe that preservation of the left gastric bundle adequately supplies the pouch by its branches along the lesser curvature – that is, the extensive posterior dissection and the dissection of the whole greater curve is less likely to jeopardize the pouch vascularity.

Leak is most common at the proximal part of the stomach [10]. This could be attributed to the difficulty to manipulate the proximal gastric area from the earlier trocar sites, and the temptation to reduce the pouch volume lead to stapling over the relatively more vulnerable bare area of the stomach or even the stretched lower esophageal end, if excessive traction is posed during stapling. We had one patient in the first group with stapling over a small part of the lower esophagus, which passed without complications. The stapling in this patient was conducted through the left midclavicular trocar.

Table 1 Summary of the outcome data and the comparison of both groups

Complication	No suture group (n = 41)	With suture group (n = 119)	Estimated significance of the difference
	Frequency	Frequency	Significance
Leakage	3	0	p_F = .016
Post operative bleeding	2	1	p_F = .162
Mortality	1	0	p_F = .250
Back pain	3	5	p_F < .001
Prolonged hospital stay	5	1	p_F = .004
	Mean ± SD	Mean ± SD	Significance
Age	38.2 ± 9.7 year-old	39 ± 5 year-old	Student t = –.5, p = 0.61
Operative time	130 ± 24 minutes	116 ± 13 minutes	Student t = 3.56, p < .001
Pre-operative BMI	47.2 ± 8.1 kg/m^2	48.4 ± 10.2 kg/m^2	Student t = –.763, p = 0.45
Intra-operative bleeding	150 ± 45 ml	50 ± 10 ml	Student t = 1.99, p = 0.048

p_F, Fisher exact significance.

Oversewing and buttressing of the staple line have received great attention as prophylactic measures against leaks. Buttressing of the staple line was found to be effective in reducing the incidence of leak in some studies [18], which, nevertheless, has a higher cost than sutures [15].

This study demonstrates that invaginating the staple line could help in reducing the leak rate after LSG. This finding is supported by a recent meta-analysis [19] that has, nevertheless, included only two randomized studies with over 1000 patients.

We previously reported our leak rates after various bariatric procedures [20]. In that series, there were three cases of leak (7.3%) after LSG. Our initial experience involved only reinforcement of the crossing points of the consecutive firings of the staple line in some patients or hemostatic sutures for bleeding points, but it neither involved the adapted higher trocar positioning nor the invagination of the upper two-third of the staple line. Besides, in our earlier experience, we used to perform only the first firing through the paramedian port and the rest of the firings were performed through the left midclavicular port. The recently adapted firing direction facilitated easier gastric manipulation and more consistent pouch calibration.

The above described extensive gastric mobilization is not only valuable for reducing the gastric pouch volume, but also necessary for safe stapling. This was assisted with the adapted more ergonomic positions of the ports, which facilitated the manipulation at the proximal gastric area, particularly when only regular length staplers are available.

Recent recommendations support the use of a relatively large calibrating tube (≥40 Fr), as it is thought to be associated with a lower incidence of leak [10]. The use of a calibrating tube of 38 Fr seems to be safe in our experience as long as there is no much traction applied to the stomach during stapling. Excessive traction would lead to overstretch of the pouch wall, which could lead to stricture or narrowing of the gastric pouch.

Caudal traction is equally unfavorable as this would crumple the stomach inside the stapler, leading to higher tension on the fired staples. Besides, the struggle with the abdominal wall to overcome the shortage in instrument length would also render the stapling process difficult, subsequently contributing to its failure. Indeed, one of our known bariatric surgeons had gastric slippage from the stapler during firing as a consequence of this struggle; this led to staple misfire that he had to sew.

Noteworthy, the current evidence has controversial statements regarding the value of staple line enforcement in reducing either leak or bleeding from staple line [8,15,19]. We emphasize that bleeding detected during the postoperative period could be from sources other than the staple line. Therefore, unless a definitive source of bleeding is identified during laparoscopic exploration, no bleeding in the postoperative stage could be linked to the staple line. Perhaps, this is one reason why it is difficult to link staple line enforcement to postoperative bleeding [9]. One other value of staple line invagination, in our opinion, is to decrease the postoperative adhesions between the pouch and the liver, thus reducing the difficulty of a second intervention if needed.

The mean operative time was shorter in the second group, despite the additional time incurred because of sutures. This could be ascribed to the learning curve of the procedure. Besides, in the first group, we had to take multiple figure-of-eight sutures for the purpose of hemostasis or at the crossings of consecutive firings, which could have consumed a significant time. We could not estimate the suturing time in group 1 as there was no dedicated step for sutures and many of them were taken before completion of stapling. The mean suturing time in group 2 was 23 ± 4 min. It might not be possible, in this study, to demonstrate that sutures will not significantly increase the operative time. It is yet unimpeachable that, if the reduction in the leak rate is true, invagination of the staple line could save much more time than it would take.

The lower frequency of back pain in the second group could be due to the modification of the patient positioning. We used to support the arch of the lordosis early in our experience. This was modified to support also the thoracic region rather than the lumbar alone. The philosophy of this modification comes from the hypothesis that pain originates from the overstretch of the spinal ligaments as a result of the exaggerated lordosis, particularly in patients with full buttocks. This is also accentuated by the leg abduction that could lead to more strain on the ligaments as a result of the internal rotation of the hips that is reflected on the sacroiliac joints with more stretch. With thoracic support, the lordosis angle is reduced; hence, the tension over the ligaments could also be reduced.

The beforehand study results should be cautiously interpreted as the study was conducted retrospectively and without a priori power analysis. Moreover, the control group (first or historical) contained a relatively small number of patients, which could have inflated the type II error in this study; this was also the reason why the percentage of leaks in this group was 7%. It is, nonetheless, evident that the leak rate after LSG has been minimized to zero, in the subsequent consecutive patients, after the technical modifications described herein.

Conclusion

The essence of performing good sleeve gastrectomy is to have good dissection that would ensure gentle tissue handling and safe stapling. Invagination of the staple line could be useful in minimizing the leak rate after LSG.

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Conflicts of interest

There are no conflicts of interest.

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