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ORIGINAL CONTRIBUTIONS

# Laparoscopic Sleeve Gastrectomy After Endoscopic Sleeve Gastroplasty: Technical Aspects and Short-Term Outcomes

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## Abstract

**Background** Endoscopic sleeve gastroplasty (ESG) utilizes full-thickness sutures to plicate the greater curvature of the stomach. As with other weight loss interventions, some patients end up requiring revision to another procedure for insufficient weight loss or weight regain, discomfort, and procedure-related adverse events.

**Objectives** In this paper, we report our technique and short-term outcomes of revisional sleeve gastrectomy (LSG) after ESG.

**Setting** Specialized medical center with standardized multidisciplinary protocols for medical, surgical, and endoscopic management of obesity.

**Methods** A combined laparoscopic-endoscopic technique that identifies plication orientation and the location of anchors and sutures was employed. This prepares the stomach for safe stapling, excluding sutures and anchors from the staple line and the retained sleeve. Hereby, we report this technique with its short-term safety and efficacy outcomes.

**Results** Twenty patients (16 female; mean age 40 ± 6 years) underwent revisional LSG from a total of 1665 (1.2%) who underwent primary ESG. Mean body mass index at the time of primary and revision procedures were 35.0 ± 4.0 and 35.2 ± 3.8 kg/m$^2$, respectively. Nadir % total weight loss (%TWL) after primary ESG was 7.7 ± 3.5%. %TWL at 6 and 12 months after LSG was 21.0 ± 2.7 ($n$ = 11) and 25.6 ± 4.1 ($n$ = 8), respectively. There were no missed follow-up visits. Additionally, there was no mortality, prolonged hospital stay, adverse events, reoperations, or readmissions.

**Conclusions** Based on this combined laparoscopic-endoscopic technique, laparoscopic sleeve gastrectomy is a safe and feasible revision option for patients who fail ESG.

**Keywords** Endosleeve · Endoscopic sleeve gastroplasty · Sleeve gastrectomy · Laparoscopic · Revision · Safety

## Introduction

Endoscopic sleeve gastroplasty (ESG) is a rapidly rising endobariatric technique. In this procedure, a full-thickness transmural endoscopic suturing system is used to plicate the greater curvature of the stomach [1]. Early evidence shows promising results; studies that reported one- to two-year results suggest that the procedure induces significant weight loss that appears to be maintained in the majority of patients [2–4].

As is the case with other bariatric and endobariatric procedures, some patients eventually end up requiring revision to another procedure for reasons including insufficient weight loss or weight regain, discomfort, and procedure-related adverse events. While experience with primary ESG has been encouraging thus far [2], we did encounter patients who required revision. However, there are no prior reports on the safety, efficacy, and technical aspects of revising ESG to laparoscopic sleeve gastrectomy (LSG).

From our experience, we believe that revisional LSG for patients who underwent ESG cannot be performed without special considerations. In this paper, we report our technique for single-stage revisional sleeve gastrectomy in patients who underwent ESG. We explain technical aspects that help avoid

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adverse events and optimize perioperative outcomes. Additionally, we report morbidity and weight loss after revisional LSG for up to the first year after surgery.

## Methods

We started enrolling ESG patients in our prospective bariatric outcomes database beginning December 2016 [2]. Patients who did not lose sufficient weight (defined as < 5% of total weight) after at least three months from ESG, and those who experienced weight regain, were evaluated and considered for revisional options. These included medication-assisted weight loss intervention, redo ESG, and revision LSG. After explaining all options, complete workup including evaluation with upper gastrointestinal contrast study and/or EGD was performed (Fig. 1). Patients were considered for revision LSG if they were eligible for bariatric surgery under The National Institutes of Health (NIH) criteria and The American Society for Metabolic and Bariatric Surgery (ASMBS) and The International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) guidelines [5–7]. Informed consent was obtained from all individual participants included in the study.

### Single-Stage Revision Technique

Our technique utilizes a combined laparoscopic-endoscopic approach that aims to identify the orientation of the previous plication and the location of anchors and sutures. This approach prepares the stomach for safe stapling and excludes sutures and anchors from the gastric sleeve that will be retained.

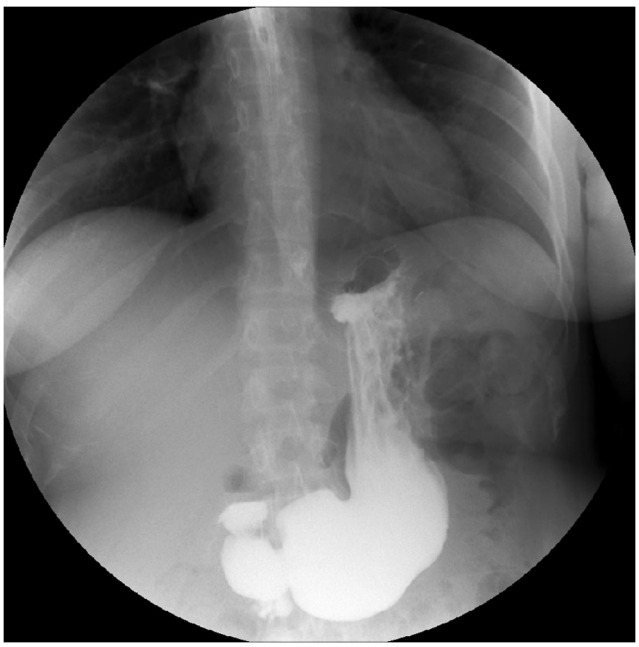

**Fig. 1** Barium contrast radiography of the esophagus and stomach of a patient who underwent ESG 10 months before the present investigation

### Laparoscopy

Patients were positioned in the reverse Trendelenburg French position, and a 4-trocar approach was employed. The surgeon carefully released adhesions between the anterior surface of the stomach and the surrounding structures including the parietal peritoneum and the liver (Fig. 2). Anchors and needles placed during ESG may become buried in the gastric wall and/or exteriorize (Fig. 3). These anchors and needles must be thoroughly identified and carefully released laparoscopically, since they may not be visible in endoscopy. The greater omentum was then taken down from its attachment to the stomach close to the gastric wall, beginning at approximately 2 cm from the pylorus using an energy dissection/sealing device. Dissection continued up to the angle of His exposing the left crus. The posterior side of the stomach was evaluated next. Adhesions created on this side by ESG sutures were carefully released, taking care not to injure the pancreas and other close structures which might have been pulled by adhesions.

### Endoscopy

The duodenum was occluded using an atraumatic grasper to prevent bowel insufflation, which would interfere with laparoscopic visualization. An esophagogastroduodenoscopy (EGD) using a dual-channel endoscope (Olympus, Tokyo, Japan) was performed. The esophagus and the stomach were evaluated. Any suture or anchor that was judged to come in the staple line was released using an endoscopic scissor (Fig. 4), while those that were judged to be safely outside the staple line were left in place. The stomach was then deflated. For calibrating the sleeve, the surgeon may use the endoscope itself or replace it with a 36-Fr orogastric calibration tube that is carefully advanced to the pylorus.

### Continuation of Laparoscopic Sleeve Gastrectomy

Beginning at 2–3 cm from the pylorus, the stomach is transected vertically using a linear stapler (Echelon 60™). We use two black reloads (4.4 mm), followed by two green reloads (4.1 mm), followed by blue (3.5 mm) or gold (3.8 mm) reloads according to our judgment of the thickness of the stomach. Alternatively, the stomach can be transected using an Endo GIA Tristapler (Covidien, Medtronic, USA). When used, we employed black (4–4.5–5 mm) and purple (3–3.5–4 mm) reloads. Hemostatic clips were placed on the staple line as necessary. We do not perform routine staple line reinforcement, routine testing for leak, or routine drain placement. The excised remnant was then extracted through the 12 mm port, which was enlarged using a Kelly forceps.

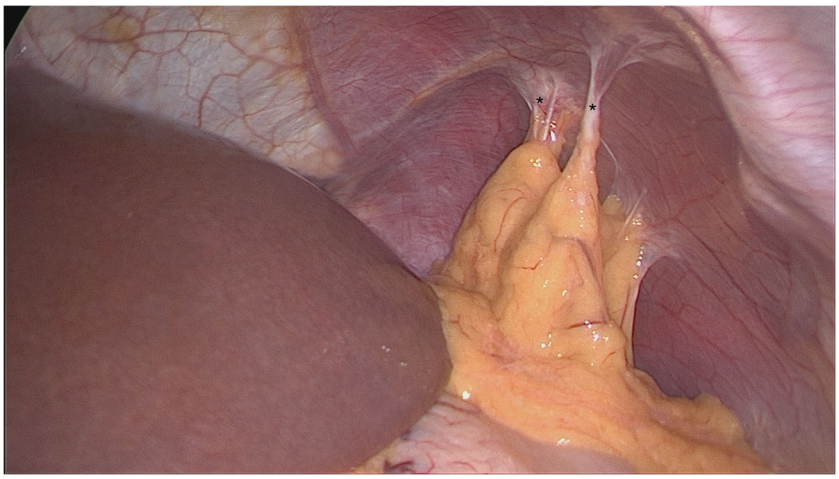

**Fig. 2** Laparoscopic view of omental adhesions with the anterior abdominal wall. Asterisk: reaction to the transgastric sutures

## Post-procedural Protocol

From this stage, patients received similar management to those who underwent primary sleeve gastrectomy. Briefly, patients were encouraged to ambulate once they were fully awake and vitally stable. Sips of water were introduced in the evening of surgery. The treating team visited patients on the next morning of surgery for commencing the standardized postoperative protocol. Patients were evaluated at the end of this day for potential discharge.

## Statistical Analysis

Data concerning adult patients who underwent revision from ESG to laparoscopic sleeve gastrectomy (LSG) were abstracted from our database. These included demographics, procedure technique, anthropometric variables, past bariatric history, and adverse events. Additionally, we abstracted post-revision hospital stay, adverse events, and anthropometric changes. Weight-related variables reported were absolute weight, absolute body mass index (BMI), BMI change, %TWL, and % excess weight loss (%EWL). We reported results from patients up to one year after primary ESG, nadir weight after ESG, and results from the first year after LSG. This study received approval from our Institutional Review Board.

## Results

Up to date, 20 patients (16 female) under our care underwent revision of ESG to LSG from a total of 1665 (1.2%) who underwent primary ESG. The mean age and body mass index at the time of primary ESG were 39.9 ± 5.8 years and 35.0 ± 4.0 kg/m$^2$, respectively. Patients spent 10.8 ± 3.5 months on average (range 5.3–18.1 months) between the ESG and the LSG.

Nadir %TWL after ESG was 7.7 ± 3.5% (range 1.5–15.4%), attained after an average of 2.6 ± 1.6 (range 1.1–5.7) months from ESG. At the time of revision, mean BMI was 35.2 ± 3.8, and 11 patients (55%) gained more weight than they lost after ESG. Weight loss before and after revision is reported in Fig. 5. All patients had disrupted sutures, and in seven (35%), the disruption was complete.

After primary ESG, one patient developed a mild right-sided pleural effusion that was managed conservatively. There was no mortality, prolonged hospital stay, reoperations, or readmissions in any of the 20 patients after revision LSG.

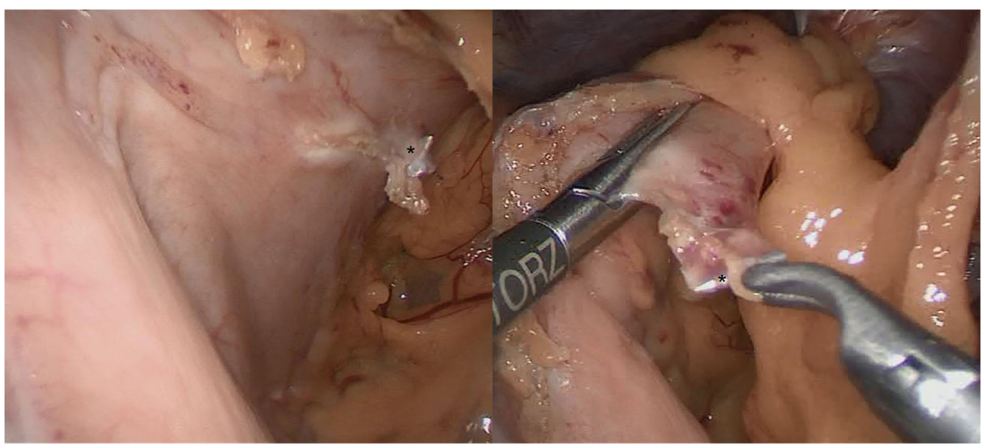

**Fig. 3** Laparoscopic view of the stomach after ESG. Asterisk: needle that exteriorized from the gastric lumen

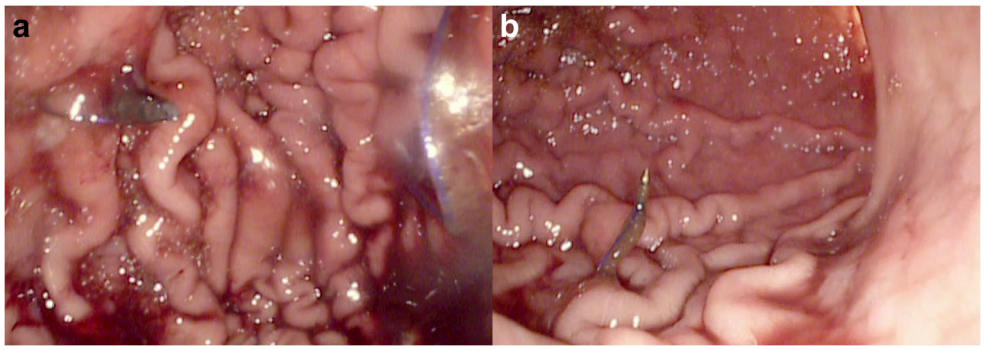


**Fig. 4** **a** Cinch with thread, suspected to be in the path of the staple line and therefore removed endoscopically. **b** Endoscopic needle with thread, not in path of staple line

## Discussion

This is the first paper that reports on the technical aspects of revising failed ESG to LSG. The study demonstrates that through the technique described in this report, revision is safe, technically feasible, and effective.

The field of endobariatrics, which has undergone a rapid revolution over the past few years, consists of constantly developing techniques. Intragastric plication has shown promising results, and procedures have been refined [8]. Several endoscopic suturing techniques were assessed in the past with varying safety and efficacy.[9, 10] Early studies on superficial thickness suturing, such as the TRIM trial, reported variable, modest weight loss, and a failure rate of approximately 50% [11]. Endoscopic sleeve gastroplasty was born out of the necessity to have a safe and effective solution for obese patients who do not want a surgical intervention, and those who are not eligible for bariatric surgery. This procedure utilizes a full-thickness suturing system that is aimed at overcoming the disadvantages associated with superficial thickness suture techniques [8]. With primary ESG, patients lost an average of 70% of their excess weight at 9 months and 65% after 18 months from primary ESG independent of baseline BMI [2]. Factors that were previously suggested to be associated with weight loss include baseline BMI, frequency of follow-up, early post-ESG weight loss, and age [3, 12–15].

Although the Overstitch Endoscopic Suturing system promises to create full-thickness sutures across the gastric wall, concerns over suture durability and sleeve shape longevity have not been addressed yet. Our experience suggests that suture effectiveness might be technique-related; sutures placed under tension could break, and gastric peristalsis may break others. Lax sutures on the other hand may not help maintain the sleeve configuration. In our experience, no patient had completely intact sutures at the time of revision.

Studies suggest that 1% of patients who had primary ESG were revised with sleeve gastrectomy [2]. Those who did not achieve satisfactory weight loss results after at least three months from ESG and were eligible for bariatric surgery according to the NIH criteria and ASMBS and IFSO guidelines

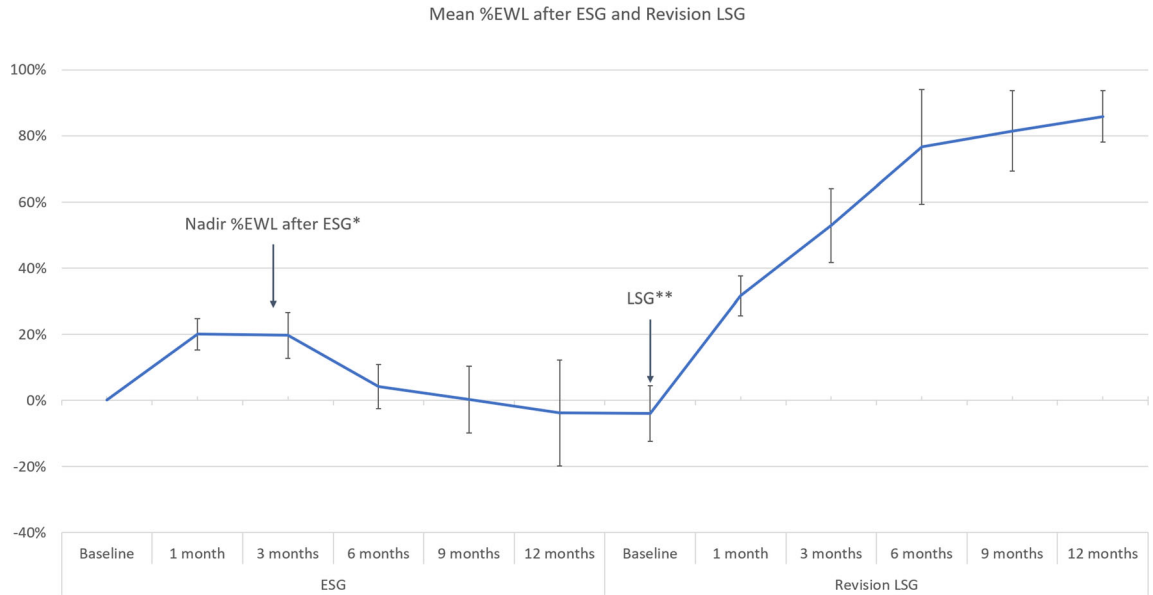


**Fig. 5** Mean %EWL after ESG and Revision LSG. Single asterisk: Nadir %EWL after ESG: 28.2 ± 11.4% attained at 2.6 ± 1.6 months after ESG. Double asterisk: %EWL at time of revision LSG, calculated based on measurements at the time of ESG

[5–7] were considered for revision. More than half of those who had revision to LSG had more weight at the time of LSG than at the time of ESG. Additionally, none of the patients who had revisional LSG experienced weight loss beyond the first three months after ESG. For this reason, the minimum acceptable duration between ESG and revision is three months. However, we prefer to wait longer and view one year as the optimum duration before considering revision options.

LSG is the most commonly performed bariatric procedure worldwide [16, 17]. Numerous studies have confirmed the safety and efficacy of sleeve gastrectomy in a revisional role after other bariatric procedures, including gastric banding and surgical gastric plication [18, 19]. However, there is limited evidence on the safety and efficacy of LSG in patients who underwent endoscopic intraluminal plication. The isolated laparoscopic view may miss sutures, anchors, and cinches that would obstruct the staple line, risking a misfire, or be retained within the gastric sleeve, risking a stricture.

In the case report published by Ferrer-Márquez et al. [20] researchers reported subjecting two patients who had failed ESG to LSG. The authors observed adhesions to surrounding structures and at least one endoscopic suture during dissection of the greater curvature. However, they did not perform EGD to study the location and orientation of the sutures and anchors. While preoperative radiologic study of these two patients suggested normal gastric anatomy, this does not rule out the presence of one or more anchor or stitch in the staple line or the gastric sleeve. Stapler misfire is a serious event that could result in major morbidity [21]. For this reason, we strongly recommend intraoperative EGD using a double-channel endoscope before stapling the stomach. Sutures and anchors that may come in the way of the staple line or be retained within the gastric sleeve must be carefully removed. A single-channel endoscope may be used with caution if a double-channel version is not available. As an option of last resort, a "blind" sleeve gastrectomy may be attempted, but surgeons should strive to leave a wide lumen that is amenable for revision should the stapler get jammed by material from the previous ESG.

While this study proves that sleeve gastrectomy after ESG is safe and effective, studies with a larger sample size are required to draw definitive conclusions on relatively rare events, including staple line leak. Additionally, the follow-up period of one year precludes us from drawing any conclusions on long-term outcomes. Nevertheless, this technical paper provides a safe and effective option for patients with poor weight loss after ESG.

## Conclusions

Based on the combined endoscopic-laparoscopic approach we reported in this paper, laparoscopic sleeve gastrectomy is a safe revision option for patients who fail endoscopic sleeve gastroplasty. Future studies may refine the technique of ESG to reduce procedure failure.

## Compliance with Ethical Standards

Informed consent was obtained from all individual participants included in the study. All procedures performed were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments. This study received approval from our Institutional Review Board.

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

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