Endoscopic sleeve gastroplasty: a narrative review on historical evolution, physiology, outcomes, and future standpoints

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Abstract

Since its first description in 2013, robust evidence supporting the efficacy and safety of the endoscopic sleeve gastroplasty (ESG) has been on the rise. A large case series and meta-analysis report supported results up to 24 months, while some other studies already described 5-year data. If associated with pharmacotherapy, the ESG may help one to achieve weight loss similar to that of surgical sleeve gastrectomy. Though the results of the ongoing randomized trials on ESG are awaited, currently available data support the clinical use of the ESG, especially for patients who are refusing or unfit for bariatric surgery.

Keywords: Endoscopy; Bariatric; Obesity; Overweight; Sleeve; Suturing

Introduction

As obesity rates escalate worldwide, bariatric surgery falls short in addressing all suitable patients.[1,2] Consequently, a huge proportion of individuals with obesity keeps suffering from the burden of the disease without an actual prospects of getting treated. In this context, alternative procedures to bariatric surgery are appreciated. At the same time, less invasive ones could also address patients with overweight and mild obesity who currently do not fulfill eligibility criteria for the operative treatment.[3]

The endoscopic sleeve gastroplasty (ESG) has been identified as one of such alternatives to bariatric surgery. In its current technique, it was first described in 2013.[4] Since then, sound evidence has accumulated in support of the procedure, which made it an important procedure in the minimally invasive armamentarium against obesity. This article summarizes and appraises both traditional and novel data regarding ESG as a treatment for obesity and overweight.

History and Development of the Technique

The ESG is also called "the Apollo method." It employs a full-thickness endoscopic suturing device (Apollo Over-Stitch, Apollo company, Austin, TX, USA) to create apposition of the anterior, greater curvature, and posterior wall of the gastric body. The endoscopist alters the shape of the stomach from a beanlike fashion into a tubular one.[5]

The development of Apollo OverStitch dates back to the 1990s when a summit was organized by Olympus Corporation at Kiawah Island (SC, USA). It summoned several experts committed to developing novel devices to treat reflux disease, large neoplastic lesions, and to refine transluminal suturing. As a result of this summit, the first set of animal studies was published in 2005 describing the Eagle Claw device. The Eagle-Claw was an endoscopic suturing device initially used for major arterial bleedings.[6,7] After further refinements, the first set of human studies initiated in 2010 with the renewed Apollo Over-Stitch, resulting in publications mainly related to the treatment of post-Roux-en-Y gastric bypass (RYGB) weight regain.[8]

In parallel, other studies were testing endoscopic plication devices for a similar purpose.[9] That was particularly important as it accumulated evidences which suggest that endoscopic gastric tubularization was a tangible weight loss promoter.

Using the second-generation Apollo OverStitch device [Figure 1], Dayyeh *et al*[4] first described the ESG in 2013. However, the technique underwent several refinements as the clinical use expanded worldwide. While the first description reported numerous interrupted stitches, the

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Quick Response Code:

Website: www.cmj.org

DOI: 10.1097/CM9.0000000000002098

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Chinese Medical Journal 2022;135(7)

Received: 15-11-2021 **Online:** 02-03-2022 **Edited by:** Yuanyuan Ji

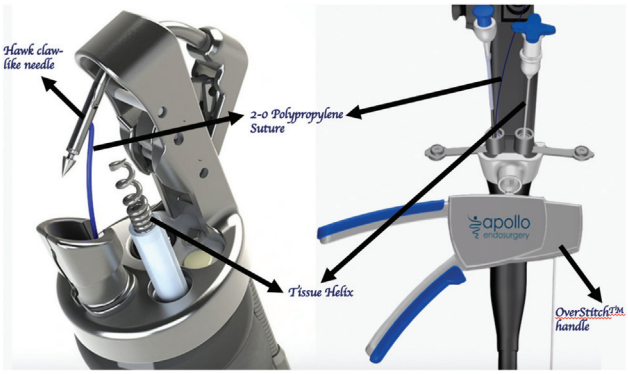

Figure 1: The Apollo OverStitch™ device.

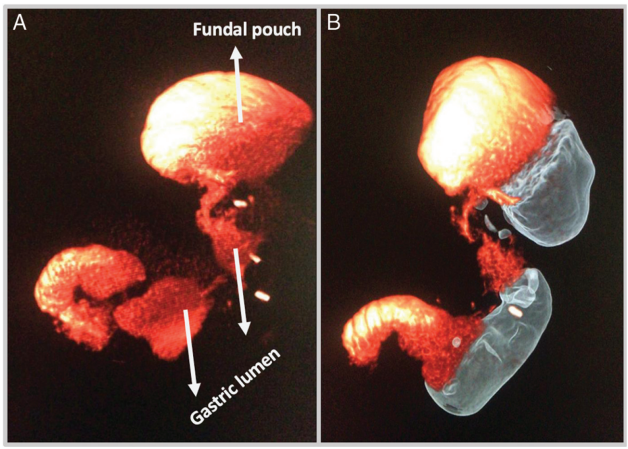

Figure 2: A three-dimensional reconstruction of a post-ESG stomach showing the narrowed lumen and the fundal pouch: (A) novel gastric configuration; (B) details of the gastric imbrication (gray colored). Courtesy of Dr. Mauro Jacome. ESG: Endoscopic sleeve gastroplasty.

current technique employs several running stitches along the gastric body. For each running stitch, the endoscopist performs 6 to 12 bites in a square-shaped fashion. Some experts add reinforcement sutures in-between the first suturing line. In time, suturing the gastric fundus was found laborious and time-consuming.

Moreover, most of the serious complications of ESG were collections arising adjacent to the gastric fundus. Eventually, the endoscopist abandoned suturing this part of the stomach, resulting in a remaining fundal pouch [Figure 2]. Later evidence revealed that this pouch plays an important role in the physiology of the weight loss as it delays gastric emptying.[5] Other refinements from the initial to the modern ESG technique include using the helix — and not just moving the scope toward the gastric wall — to grasp tissue, and per-protocol CO_2 insufflation.[10]

Figure 3 illustrates the current method of stitching which is extensively applied worldwide in academic as well as community health centers.[11-13]

Physiology of Weight Loss

The physiology behind the weight loss following the ESG is unclear yet. Nonetheless, the few available shreds of evidences suggest that delayed gastric emptying is pivotal. Four individuals from a series of 25 patients underwent assessment of metabolic and physiological alterations occurring due to the ESG. The authors performed satiation assessment through a nutrient drink test, gastric emptying with gastric scintigraphy, and assessment of glycemic and hormonal changes 2 weeks before and 3 months after the procedure.

Interestingly, there was a significant delay in gastric emptying of solids at 3 months. The authors reported an increase by 90 min in time for 50% (T50) ($P = 0.03$). Accordingly, 32% of the meal was still retained in the fundus 4 h after ingestion compared to 5% in the preprocedural assessment. These findings validate the role of the fundal pouch in favoring weight loss and improving satiation.

As to satiation, patients terminated the meal 24 min earlier at 3 months than at pre-procedural ($P = 0.01$). Additionally, there was a 59% decrease in caloric intake at maximum fullness in the nutrient drink test ($P = 0.003$). This information suggests that restriction is also an active weight loss promoter in parallel to delayed gastric emptying. Finally, the authors found no significant changes in leptin, glucagon-like peptide-1, and peptide YY levels.[5]

In another study, Sharaiha *et al*[14] reported a decrease by 14 cm in the stomach length from the pylorus to the gastroesophageal junction after ESG. Such data support Abu Dayyeh finding, suggesting that restriction is central to induce weight loss in this context.

Practical Guidelines

An exciting topic of discussion concerns the suture pattern. Galvao Neto *et al*[15] reported the U-shaped one, which has been recently refined to the square pattern with reinforcement stitches.[10,16] Also, some other experts employ a Z-shaped suturing design with good outcomes.[17] Nonetheless, data suggest weight loss is unrelated to the suture pattern.[18]

Initially, argon plasma coagulation (APC) was used to mark the stitching points. Differently, Itani *et al*[19] employed the APC as an ablation method to expose deeper gastric wall layers and enhance fibrosis in the plication line. Hypothetically, it would result in a more hermetic sleeve-like lumen. Clinical data are still needed to prove such a rationale, although other studies have already demonstrated that adequate endoscopic anatomy correlates with better long-term outcomes.[20]

Recently, a Brazilian consensus pooled experiences from a panel of 47 endoscopists and provided good clinical practice guidelines at performing the ESG.[21] This consensus includes recommendations for indications/contraindications, workup, technique, and post-procedural care. Currently, it is the most updated clinical guidance to execute an ESG adequately.

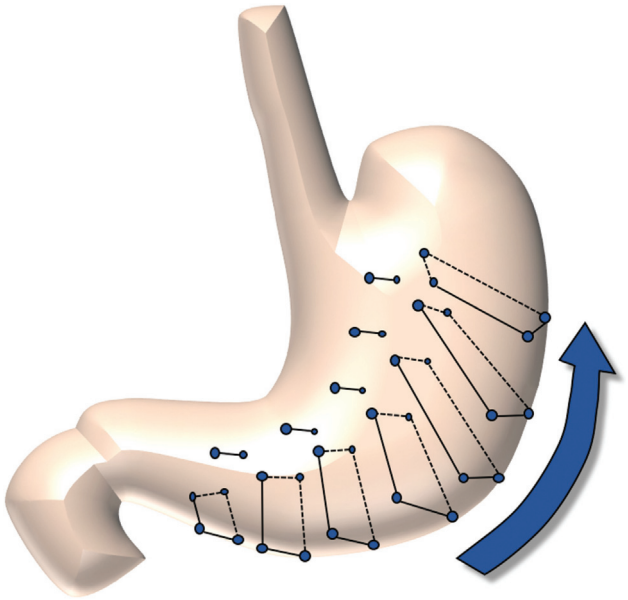

Figure 3: Schematics for the current "U" stitching pattern with reinforcement stitches.

Efficacy

Numerous articles reported the outcomes of ESG in the short term. Alqahtani *et al*[22] published the largest series to date, including 1000 patients. Most individuals were mildly obese females, Accordingly, the mean baseline BMI was 33.3 ± 4.5 kg/m^2. At 12 and 18 months, the mean % total weight loss (%TWL) was $15.0\% \pm 7.7\%$ ($n = 216$), and $14.8\% \pm 8.5\%$ ($n = 54$), respectively. The same group reported similar outcomes for children and adolescents undergoing the ESG.[23]

As the procedure spread worldwide, most published studies reported %TWL around 18% to 20% at 18 to 24 months.[11,13,24] Moreover, consistent systematic reviews corroborated this same result.[25-28] Concerning long-term data Sharaiha *et al*[29] recently reported 5-year outcomes of the ESG. Thirty-one out of 38 eligible individuals were successfully followed up to 60 months and had a mean %TWL of 15.9% (11.7–20.5%). Sixty-one percent of patients sustained at least 10% TWL at 5 years. Despite its small sample this article suggests that outcomes arising from the ESG are durable in the long term. Also, an interesting study demonstrated the beneficial effect of the ESG at improving non-alcoholic fatty liver disease.[30]

Another interesting aspect of the ESG is the possibility of combining pharmacotherapy. Badurdeen *et al*[31] recently published a case-matched study comparing ESG alone to ESG plus liraglutide, an anorexigenic drug. Twenty-six patients receiving liraglutide 5 months after ESG were compared to 26 individuals declining it. At 1 year, patients with adjunct pharmacotherapy experienced $24.72 \pm 2.12\%$ TWL, significantly greater than the ESG-only group ($20.51\% \pm 1.68\%$, $P < 0.001$). Of note, the amount of weight loss is surprisingly high as it may reach surgical levels.[32]

Finally, another study investigated whether the ESG could cause any nutritional deficiency. In the short term, Svagera *et al*[33] found no deficiencies in micro- or macronutrients after the ESG. Nonetheless, patients experienced significant weight loss, decreased body composition, and reduced blood glucose levels.

As to the comparative data, a recent case-matched cohort compared the ESG to high-intensity diet plus lifestyle therapy and demonstrated that the former induces a more pronounced weight loss at 12 months.[34] Another case-matched study compared surgical SG to the ESG. With a sample of 137 patients, the authors concluded that the SG promotes better weight loss at 6 months ($23.6\% \pm 7.6\%$ *vs.* $17.1\% \pm 6.5\%$, $P < 0.01$) at a cost of more adverse events (AEs) (16.9% *vs.* 5.2%, $P < 0.05$).[35] Although no head-to-head study is available, a subsequent meta-analysis confirmed such results.[36,37]

Concerning obesity-related comorbidities, several studies have already demonstrated the effectiveness of ESG at ameliorating or resolving the conditions. In a study with 24 super-obese individuals, the improvement rates for hypertension, T2D, dyslipidemia, and GERD were 69.2%, 87.5%, 25%, and 100%, respectively.[38] Another series with 1000 individuals showed complete T2D remission rate of 76.5%. Hypertension and dyslipidemia remission rates were 100% and 56.3%, respectively.[22]

Safety

Most AEs arising from the ESG are mild or moderate in severity, and serious AEs are extremely rare. Therefore, their management usually entails non-operative treatment. Alqhatani *et al*[22] reported a 2.4% readmission rate in the largest series to date but no emergency interventions or related mortalities. In a meta-analysis, Hedjoudje *et al*[28] pooled data from eight studies ($n = 1772$) and found a similar serious adverse events rate (2.2%). Pain and nausea requiring hospital admission was the most frequent one (1.08%), followed by upper gastrointestinal bleeding (0.56%) and perigastric fluid collection (0.48%). Typically, intravenous medications control nausea and pain, epinephrine injection or clipping successfully addresses bleeding, and perigastric collections can be managed through antibiotics and percutaneous drainage. One anecdotal report described a gallbladder perforation during ESG, leading to acute abdominal pain and emergency surgery.[39] Instead of the standard left lateral decubitus, adopting a semi-supine position could eventually mitigate the risk of inadvertently suturing the liver or the gallbladder.[16]

Finally, when the ESG began spreading worldwide, surgeons advocated that peritoneal adhesions and gastric imbrication could hamper future surgical interventions. Indeed, there are peritoneal adherences, but it poses few technical issues to surgical revision [Figure 4]. Recent studies demonstrated that the surgical conversion is safe for RYGB or SG.[40,41]

Future Perspectives

The indications have revealed that ESG have grown exponentially. Currently, it has also been proposed for extremely high-risk patients as bridge for bariatric

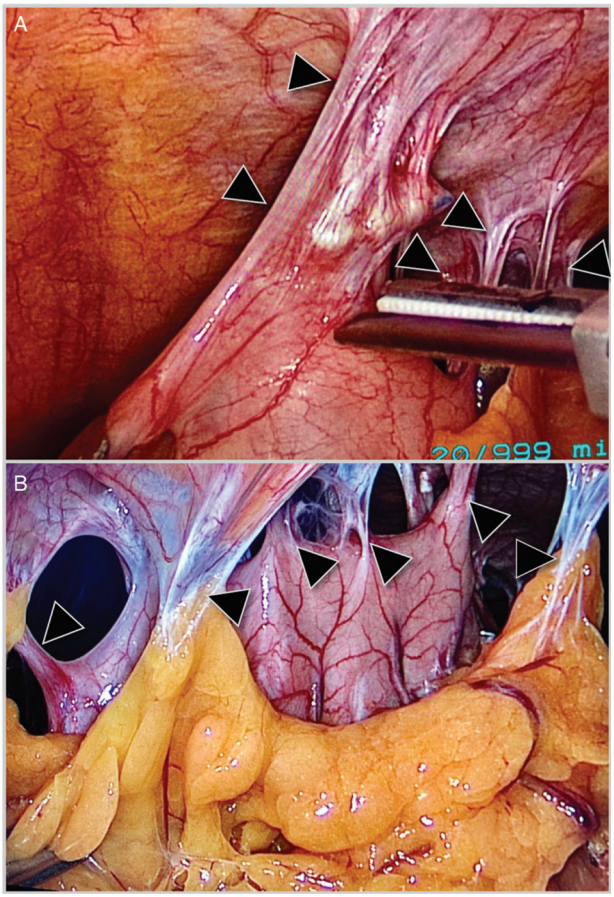

Figure 4: Laparoscopic view of post-ESG peritoneal adherences (arrowheads) (A and B). Courtesy of Dr. Luciano Antozzi. ESG: Endoscopic sleeve gastroplasty.

surgery.[42] Also, the clinical success encouraged similar rationales to address dilated gastric sleeves and gastric pouches for weight regain after SG and RYGB, respectively.[43,44] Another experimental animal study has combined the ESG with natural orifice transluminal endoscopic surgery (NOTES) to mimic a surgical RYGB.[45] While we wait for the results of the ongoing randomized trials on ESG, current data already support its use on a routine basis.

Conflicts of interest

Dr. Brunaldi reports receiving personal fees for lectures from Erbe Elektromedizin GmbH; Dr. Galvao Neto also received personal fees for lectures from Erbe Elektromedizin GmbH; is consultant for GI Dynamics, Apollo EndoSurgery, USGI, Colubris Mx, Scitech, and MITech, outside the submitted work; is Scientific Advisor for Apollo EndoSurgery and Keyron; is speaker for Olympus LA, Erbe, and Meditronics LA, outside the submitted work. All authors read and approved the final version of this manuscript.

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How to cite this article: Brunaldi VO, Galvao Neto M. Endoscopic sleeve gastroplasty: a narrative review on historical evolution, physiology, outcomes, and future standpoints. Chin Med J 2022;135:774–778. doi: 10.1097/CM9.0000000000002098