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ENDOSCOPIC SLEEVE GASTROPLASTY (ESG): OBESITY, METABOLISM, SPECIAL POPULATIONS, COST-EFFECTIVENESS AND COMPARATIVE STRATEGIES. NARRATIVE REVIEW OF MOST RECENT DATA.

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Endoscopic sleeve gastroplasty (ESG) – A semi-systematic review of current evidence, metabolic impact, special populations, and comparative strategies

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Abstract

Obesity is a major global health challenge. Conventional lifestyle interventions or emerging anti-obesity medications often fail to achieve sustained long-term results. Metabolic and bariatric surgery (MBS) remains the gold-standard treatment for moderate-to-severe obesity and its comorbidities. However, concerns regarding operative risk, irreversibility, high cost, and patient refusing surgical option limit broader adoption.

Endoscopic bariatric therapies (EBT) have emerged as a minimally invasive alternative bridging medical and surgical approaches. Endoscopic sleeve gastroplasty (ESG) has become the most widely adopted. First described in 2013, ESG has demonstrated feasibility, safety, and efficacy in obesity management. Large case series and meta-analyses report 15–20% total weight loss up to 24 months, emerging 5-year data, and 50–80% improvement in obesity-related comorbidities. Serious adverse events occur in less than 2.5% of cases. ESG is highly cost-effective compared with lifestyle intervention alone. Relative to laparoscopic sleeve gastrectomy, ESG offers lower procedural risk, faster recovery, and anatomical preservation, making it suitable for patients with mild-to-moderate obesity or elevated surgical risk.

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Emerging innovations in EBT include ESG technical improvements, robotic-assisted ESG, new suturing devices, combination therapy with GLP-1RAs, small-intestine metabolic interventions, and AI-assisted navigation. With ongoing advancements and expanding indications, ESG is poised to become a cornerstone of modern obesity management.

This semi-systematic review summarizes recent global ESG evidence from 2020 to 2025, highlighting mechanisms and technical aspects, indications, efficacy in weight loss and metabolic improvement, special populations, safety, cost-effectiveness, and comparisons with diet alone, pharmacotherapy, and bariatric surgery.

Keywords: Obesity. Bariatric endoscopy. Endoscopic sleeve gastroplasty. Total weight loss. Metabolic therapy. Safety.

Abbreviations list:

ESG: Endoscopic Sleeve Gastroplasty. **LM:** Lifestyle modifications. **AOM:** Anti-obesity medications. **EBT:** Endoscopic Bariatric Therapies. **MBS:** Metabolic Bariatric Surgery. **SAEs:** Serios Adverse Events. **LSG:** Laparoscopic Sleeve Gastrectomy. **BMI:** Body Mass Index. **TBWL:** Total Body Weight Loss. **EWL:** Excess Weight Loss. **T2DM:** Type-2 Diabetes Mellitus. **OSA:** Obstructive Sleep Apnea. **MASLD:** Metabolic dysfunction-Associated Steatotic Liver Disease. **GERD:** GastroEsophageal Reflux Disease. **GLP-1RAs:** Glucagon-like peptide-1 receptor agonists.

1. Introduction

Obesity continues to rise globally and is now recognized as a major driver of metabolic comorbidities. The World Health Organization (WHO) estimates that 1.9 billion people are overweight, with 650 million having obesity [1]. These alarming estimates call for a

strategic treatment plan.

There are currently four accepted recommendations for obesity treatment: lifestyle modifications (LM), anti-obesity medications (AOM), endoscopic bariatric therapies (EBT) and metabolic bariatric surgery (MBS) [2].

Conventional LM is essential but generally proves insufficient for sustained substantial weight loss in the long-term [3]. New AOM appear promising, but their potential for adverse events (AEs), along with the lack of long-term results and cost evaluation are yet to be clearly defined [4]. MBS remains the gold standard and the most sustainable and successful evidence-based therapeutic approach to address moderate to severe obesity and its associated comorbidities [5]. However, MBS carries limitations regarding inclusion criteria, patient acceptance, procedural risk and reversibility, and in many cases, patients refuse surgical options. Nonetheless, only 1–2% of eligible patients undergo surgery [6]. This leaves a significant treatment gap for patients suffering from obesity.

To fill this gap, endoscopic bariatric therapies (EBT) have recently emerged, positioning themselves between medical and surgical management [7-9]. Their minimally invasive nature, safety and reversibility have favored their applicability. Endolumenal suturing has gained global acceptance in recent years as the leading EBT and can be performed using various suturing devices. The most studied EBT suturing procedure is the endoscopic sleeve gastroplasty (ESG) using the Apollo OverStitch™ platform (Apollo Endosurgery, Austin, TX, USA, nowadays Boston Scientific, Marlborough, MA, USA). It consist on a minimally invasive, incisionless, endoluminally placed full-thickness running sutures for gastric remodeling, delivering an anatomy-sparing treatment that mimics the restrictive effects of sleeve gastrectomy [7-10]. It is currently the only US FDA-approved endoscopic suturing device for an obesity indication.

The procedure is currently employed clinically on all continents, and more than 40,000 clinical procedures have been performed to date. More than 200 international medical

articles have been published on this topic. This semi-systematic review highlights the evidence and expert consensus regarding ESG. The search strategy is structured but not intended to meet full systematic review criteria. It is focused on: 1) Recent publications from 2020 to 2025, 2) Articles retrieved via PubMed and Embase using "*endoscopic sleeve gastroplasty*" and "*bariatric endoscopy*" search terms, 3) Special attention to systematic reviews and meta-analyses published, 4) ESG performed with the Apollo OverStitch™ device, and 5) No language restriction.

This manuscript reviews ESG mechanisms and technical aspects, clinical indications, efficacy in weight loss and metabolic improvements, special populations, safety profile, learning curve, comparative studies (with diet alone, pharmacology, and laparoscopic surgery), and cost-effectiveness. The report aims to provide a concise yet clinically meaningful update on primary ESG for obesity specialists.

2. Mechanism and Technical Aspects of ESG

The most commonly used device in clinical ESG procedures is the OverStitch™ endoscopic suturing system, first introduced by Abu Dayyeh et al. in 2013 [9]. ESG involves transoral placement of multiple full-thickness sutures along the greater curvature of the stomach, creating a tubular gastric configuration that functionally mimics the restrictive anatomy of the laparoscopic sleeve gastrectomy (LSG). Physiologically, it has been shown that ESG reduces gastric volume and compliance, delays gastric emptying, induces early satiation, trends toward altering gut and metabolic hormones, increases insulin sensitivity, and significantly reduces body weight [11].

There has been a procedural evolution from the first cases to current techniques [12]. Multiple suture patterns and stitching methods have been proposed over time ('C'-shaped, 'U'-shaped, 'Z'-shaped, square-rectangle, single-row, reinforced, interlocking, etc.), all based on anatomical principle of tubularizing the gastric body to alter satiety and satiation, with no apparent differences in results among them [10, 13-15]. The 'U'-shaped pattern used in the MERIT Trial obtained US-FDA approval and has been

predominantly adopted [16].

Anyway, suturing the gastric fundus seems not to confer benefit. In a retrospective analysis [17], ESG without fundal suturing demonstrated greater efficacy, shorter procedure duration, and fewer sutures used compared to ESG with fundal suturing, with no statistically significant difference in the rates of SAEs.

The first-generation OverStitch™ was only compatible with Olympus doble-channel endoscopes. The second-generation OverStitch™-SX achieved adaptation to single-channel endoscopes from different manufacturers, although it was cumbersome and could laboriously limit the examination process. The new generation was launched as the OverStitch™-NXT system. It is compatible with single-channel endoscopes, features enhanced maneuverability, a wider range of articulation, and an upgraded tissue helix which improves operator control and reduces dependence on assistants.

These features have been endorsed by the IFSO Bariatric Endoscopy Committee [18] and supported by FDA market authorization granted in July 2022 after the approval of the MERIT Trial [16]. In 2025, a global expert consensus provided step-by-step guidance for safe and effective performance [10], including 27 statements: 6 on cognitive skills and 21 on technical skills. The latter covered diagnostic endoscopy and pre-suturing steps (97%), fundamental suturing steps (100%), and suture patterns (97%). Key procedural elements with the highest consensus included starting at the incisura, using at least 6 sutures, and avoiding the fundus (Table 1). These guidelines represent a significant step toward global harmonization of ESG techniques and training protocols.

3. Indications and Contraindications

ESG is primarily indicated for managing patients with class I and II obesity (BMI between 30 and 40 kg/m^2) in accordance with international guidelines, and for those

with class III obesity who do not wish to pursue or qualify for MBS [7-8, 18-19]. In some cases, it can be used for high-risk patients or those contraindicated for abdominal surgery among class III obesity patients, as well as for high BMI (≥50 kg/m²) patients who require preoperative weight reduction [20]. Additionally, ESG has demonstrated clinical benefits in individuals with BMI between 27 and 30 kg/m² who have failed prior weight loss interventions and/or present with obesity-related comorbidities [21]. It is recommended that the intervention be preceded by 6 months of conservative therapy, which must have been unsuccessful as a prerequisite [19].

The IFSO consensus supports ESG as an effective intervention over lifestyle alone in patients with obesity grades I and II and those with grade III who are unwilling or ineligible for conventional MBS (Table 2) [22]. The consensus also endorsed the ESG procedure to treat adolescents with class II obesity who have not responded to conservative therapy. These statements were confirmed by the consensus statements of the UK National Institute for Health and Care Excellence (NICE) guidelines (Table 3) [23].

Main absolute contraindications include active gastroesophageal disease (peptic ulcer, Los Angeles C-D esophagitis, Crohn's disease), vascular lesions that may bleed (varices, angiomas, angiectasias), neoplasms, a history of prior gastric surgery, coagulopathy, severe cardiopulmonary illness, uncontrolled psychiatric or eating disorders, active substance abuse, alcoholism and/or drug addiction, pregnancy and breastfeeding, allergies to any implantable components and those inherent in conventional gastroscopy or sedation/anesthesia. Additionally, centers lacking experience, accreditation, or means to address emergent complications should not perform the procedure [8, 24].

4. Clinical Outcomes

4.1 Weight-Loss Results

In seven systematic reviews and meta-analyses [18, 25-30] evaluating efficacy of ESG, the pooled results for TBWL at 6, 12 and 24 months were 14.4%-15.6%, 16.0%-17.5% and 15.2%-20.0%, respectively. This amounts a pooled EWL of 48.0%-57.9%, 53.9%-68.3% and 46.5%-74.0% (Table 4).

In the most significant consensus on ESG [15], which included 47 Brazilian endoscopists and 1,828 procedures, a mean TBWL of 18.2% at 1-year was reported. Outcomes from the MERIT Trial [16], indicated that patients undergoing ESG achieved a mean 13.6%TBWL (49.2%EWL) at 52 weeks. Additionally, 77% and 68% of participants maintained ≥25%EWL at 52 and 104 weeks, respectively.

With appropiate follow-up, the results appear to be long-lasting. Bhandari et al. [31] reported an average TBWL of 18.19% (17.72%-18.57%) with an EWL of 49.30% (48.91%-49.68%) at a 4-year follow-up. At 5-year follow-up, Sharaiha et al. [32] and Lahooti et al. [33] obtained a maintained mean TBWL of 15.9% and 11.8%TBWL.

4.2 Metabolic Results

ESG can induce the resolution of obesity-associated comorbidities in patients with moderate obesity. In the MERIT Trial [16], 80% of participants experienced an improvement in one or more comorbidities at 52 weeks. In a systematic review and meta-analysis [30], resolution rates were reported as follows: 55.4% for T2DM, 62.8% for hypertension, 56.3% for dyslipidemia, and 51.7% for OSAs. Another meta-analysis [34] associated significant improvements in T2DM, hyperlipidemia, and hypertension, with risk differences of -0.72, -0.65, and -0.60, respectively, at 12 months. Additionally, there were significant reductions in HbA1c, fasting blood glucose, HOMA-IR, low-density lipoprotein, and triglycerides.

A prospective cohort study demonstrated long-term maintained comorbidities improvement: 51.2% of cases of T2DM, 65.8% of cases of hypertension, 73.6% of cases

of dyslipidemia, and 89.9% of cases of OSAs were resolved or improved at a 4-year follow-up [31].

In a prospective cohort study, Lahooti et al. [33], at 5 years after ESG, significant improvement in hypertension systolic blood pressure (reduction of 4.1 mmHg, p=0.0071) and diabetes (HbA1c decreased 0.42%, p=0.0007) were obtained.

4.3 ESG on MASLD

The impact of ESG on metabolic dysfunction-associated steatotic liver disease (MASLD) has been increasingly investigated. In the first systematic review and meta-analysis evaluating MASLD at 12 months post-ESG [35], significant improvements were reported, including a reduction of 4.85 points in the hepatic steatosis index, 0.5 in MASLD fibrosis score, 6.32 U/L in ALT, and 0.51% in HbA1c.

Another meta-analysis [36], with an average TBWL of 14.5% at 6 months, demonstrated a significant reduction in liver fibrosis (standardized mean difference of 0.7) and notable improvements in other MASLD surrogates, including ALT, hepatic steatosis, and histologic MASLD activity score.

Furthermore, a multicenter randomized trial [37] in patients with MASLD (NAS≥3, fibrosis stage F0–F3) compared ESG+LM versus sham endoscopy + LM. Patients achieving TBWL>10% in the ESG group showed significant improvements in liver stiffness, hepatic steatosis, and MASLD scores compared with the control group.

At long-term follow-up, Lahooti et al. [33] obtained 5-years after ESG a significant improvement in MASLD (ALT decrease of 7.4 U/L, p=0.002).

4.4 Special Populations

4.4.1 ESG in Class III Obesity. While ESG may not fully replace bariatric surgery in this population, it represents a valuable non-surgical alternative for patients unwilling, ineligible, or at high operative risk.

In a comparative study of classes I, II, and III obesity [38], adjusted mean TBWL at 1 year was 16.5%, 18.2%, and 20.5%, respectively, with class III patients achieving significantly greater weight loss. Overall complication rates and hospital stay were similar across the groups.

In a cohort of 404 patients with BMI≥40kg/m², ESG achieved 100% technical success, inducing effective and durable weight loss (mean TBWL of 20.9% at 1-y and 20.3% at 3-y) and significant improvement in comorbidities (66% for hypertension, 45% for hyperlipidemia and 61% for T2DM), with an acceptable safety profile (0.2% SAEs) [39].

In a safety review among ESG patients, no difference in AEs, readmission, or reinterventions were observed in patients with BMI>40kg/m² vs those with BMI 30-40kg/m². Additionally, ESG in class III obesity patients appeared at least as safe as LSG, and safer than RYGB [40].

Both the IFSO consensus and NICE guidelines recognize ESG as an effective intervention over LM alone for patients with grade III obesity who are unwilling or ineligible for conventional MBS (Tables 2 and 3) [22, 23].

4.4.2 ESG in Superobesity Patients. ESG is a feasible, safe, and effective option for patients with superobesity, particularly those at high surgical risk or with contraindications to abdominal surgery. In the study by Li et al. [20], all ESG procedures were completed successfully without intraoperative complications. At 12

months post-procedure, patients achieved 12.2%TBWL and 29.1%EWL. Only one (4.2%) moderate post-procedure AE (gastric mucosal bleeding) was reported.

4.4.3 ESG in Overweight Patients. ESG appears safe, well-tolerated, and effective in BMI 27-30kg/m² patients. In the first large study including 656 patients [41], mean TBWL at 6, 12, 24, and 36 months after ESG was 11.0%, 15.5%, 15.1%, and 13.3%, respectively. Notably, 36% of patients with diabetes and 18% with hypertension experienced complete remission.

4.4.4 ESG in Transplant Candidates. ESG has been proposed as a safe, well-tolerated, minimally invasive approach to manage obesity in transplant candidates (liver, lung, etc.), improving eligibility and overall health outcomes [42-43].

4.4.5 ESG in Children and Adolescents. The first study in pediatric obese patients [44], ESG demonstrated to be a safe and effective procedure, achieving sustained weight loss (TBWL 14.4% at 6-m and 13.7% at 24-m), without mortality or significant morbidity.

A narrative review in individuals under 21-years [45] further supported its safety and moderate efficacy, positioning ESG as a valuable bridge between conservative therapy and bariatric surgery for adolescents with moderate-to-severe obesity.
The IFSO consensus supports ESG as an effective intervention over LM alone for adolescents with class II obesity who have not responded to conservative measures (Table 2) [22]. Despite promising results, ESG remains supported by Level IV evidence and is recognized in only a few pediatric guidelines.

4.4.6 ESG in Older Patients. In a case series evaluating ESG in patients aged 65-years and older, median TBWL at 6, 12, and 24 months was 15.1%, 15.5%, and 15.5% (EWL of 39%, 37% and 41%), with median BAROS scores of 3.0, 3.4, and 2.5, respectively. Most

patients with comorbidities -including hypertension, diabetes and OSAs- either reduced or discontinued their medications. No AEs were reported [46].

4.4.7 ESG in HIV Patients. In the first study evaluating ESG in HIV patients [47], mean TBWL was 21.3% at 6-months. No SAEs were reported. Viral loads remained undetectable, and there were no significant changes in mean CD4+ cell counts.

5. Redo-ESG

The need for redo-ESG after primary-ESG seems to be low. When required, redo-ESG appears to be safe and effective in inducing weight loss in patients experiencing weight regain. Ali et al. [48] developed and validated an ESG reintervention score to aid clinicians in preoperative risk stratification while clarifying factors contributing to a higher risk of reintervention. These findings highlight an important advantage of ESG as a repeatable minimally invasive procedure.

López-Nava et al. [49], in a technically successful with a median of 3 (range 2-6) sutures, obtained redo-ESG maximum benefit in weight plateau compared to weight loss failure and weight regain patients (overall TBWL of 26%, 11.2% and 12% respectively). No SAEs were reported.

Hajifathalian et al. [50] obtained significantly greater additional weight loss when compared redo-ESG vs AOM for managing weight recidivism after primary-ESG (mean TBWL of 9.5% vs 2.1%), with final TBWL clearly favored redo-ESG (19.9% vs 13.6%, p=0.028).

6. Safety of ESG

The safety profile of ESG is consistently supported in the literature. Pooled serious adverse event (SAEs) rates below 2.5% are reported. Across seven systematic reviews and meta-analyses [18, 25-30], the estimated rate of SAEs ranged from 1.0% to 2.2% (Table 4). The most common post-procedural symptoms included transient abdominal pain, nausea, and vomiting, which typically resolve within a few days. Rare

complications -such as gastric wall perforation, perigastric leak or fluid collection, and GI bleeding- occur in <1% of cases and are generally manageable with conservative treatment. The incidence of new-onset gastroesophageal reflux disease (GERD) is deemed negligible [19]. Isolated cases of surgical requirements, but no procedure-related mortality has been reported.

7. ESG Learning Curve

ESG requires specialized training and procedural expertise. Published studies report a learning curve ranging from 9 to 38 cases to achieve technical proficiency [51-54]. Physicians with prior experience in therapeutic endoscopy, such as gastroenterologists, generally reach competence more efficiently. Machine learning models to predict ESG success [55] and teleproctoring programs [56] have also been favorably evaluated.

8. Comparative studies

8.1 Comparation between ESG and diet alone

Several studies comparing ESG -alone or combined with diet- with diet and lifestyle modifications alone (LM) consistently demonstrate superior weight loss outcomes in the ESG intervention group [18-21, 24-32].

In a case-matched study [57], 12-month post-ESG combined with low-intensity diet and lifestyle therapy achieved a mean TBWL of 20.6%, compared with 14.3% in the high-intensity LM group, showing a mean difference of 6.3% (95% CI 3.12–9.48).

The multicenter randomized MERIT trial [16] also confirmed ESG superiority: after 12 months, patients undergoing ESG+LM achieved 49.2%EWL and 13.6%TBWL versus 3.2%EWL and 0.5%TBWL with LM alone.

8.2 ESG combined with pharmacology

ESG and AOM both promote significant weight loss and metabolic improvement in patients with class I–II obesity. Comparative evidence suggests ESG induces more rapid weight loss, whereas pharmacotherapy provides a slower but more continued weight loss beyond six months [58].

Recent studies confirm additive benefits with combination therapy (ESG+AOM). In a retrospective study [59], patients receiving liraglutide 5 months after ESG exhibited greater mean TBWL at 7 months after initiation of liraglutide compared with ESG alone (24.7% vs 20.5%). Another retrospective comparison of ESG alone vs ESG+AOM (oral semaglutide) [60], demonstrated greater efficacy at 6-month in the combination group (20.3% vs 15.3%TBWL, p=0.015) and superior metabolic dysfunction improvement, particularly diabetes control (HbA1c reduction of 1.4 vs 1.2, p=0.02). Similarly, a randomized trial [61] demonstrated superior 12-month TBWL (25.2% vs 18.7%) and improved comorbidity control when semaglutide was initiated one month after ESG.

A prospective study comparing monotherapy (ESG alone) and combination therapy (ESG+GLP-1RAs) found significantly higher TBWL (18.2% vs 9.6%) and greater improvements in MASLD fibrosis score, HbA1c, and insulin resistance in the combination group [62]. Sequential approaches also suggest optimal outcomes when AOM is started within six months of ESG, while delayed initiation or prolonged pharmacotherapy before ESG is associated with less favorable results [63]. Overall, evidence supports early combination therapy as a strategy to enhance and sustain weight reduction and metabolic improvement.

8.3 Comparison between ESG and laparoscopic sleeve gastrectomy (LSG)

When compared to LSG, ESG provides meaningful but generally lower short-mid-term weight loss, with a plateau observed after 12 months. Both procedures are safe, but ESG demonstrates significantly fewer complications rate [19].

A comparative study evaluating ESG, LSG, and laparoscopic greater curvature plication (LGCP) at 2-years [64], found all effective for weight loss, but TBWL was lower for ESG (18.5%) versus LSG (28.3%) and LGCP (26.9%). ESG, however, had a shorter inpatient

stay (1 vs 3 days, p<0.001) and lower complication rate (0.5% vs 4.9% vs 8.3%, p=0.006).

Meta-analyses confirm these findings. One analysis including patients with BMI 30-40 kg/m² and a minimum of 12-months of follow-up [65] reported mean EWL of 62.2% for ESG versus 80.3% for LSG, with a lower complication rate for ESG (0.19% difference). Another meta-analysis [66] showed LSG yielded higher TBWL at 6, 12, and 24 months (MD -7.48, -9.90 and –7.63), but ESG was associated with a significantly lower complication rate and had a markedly lower incidence of postoperative gastroesophageal reflux disease (1.3% vs 17.9%). Both techniques offered comparable improvements in metabolic markers and quality of life, but ESG provided advantages in reduced hospitalization time, faster recovery, and procedural reversibility.

A systematic review and meta-analysis [67] reinforced that, while 6-month LSG yields higher TBWL (23.5–23.6% vs 13.7–15.2% for ESG), ESG is associated with lower complication rates (2.0–2.7% vs 9.2–16.9%), with no grade IV–V Clavien-Dindo scale complications in either group.

In summary, although LSG achieves greater absolute weight loss, ESG provides comparable obesity-related comorbidities improvements with fewer complications and shorter hospitalization, making it an appealing minimally invasive alternative for selected patients.

9. Cost-effectiveness of ESG

ESG incurs higher initial costs than LM alone but has been shown to be more cost-effective for adults with class I–II obesity over a 5-year horizon [68–71].

Comparative analyses indicate ESG to be more economically favorable than GLP-1RAs therapy in class I and II obesity, achieving greater and more sustained weight loss at a lower total cost over five years [72–74]. Unlike chronic pharmacotherapy, which leads to rapid weight regain after discontinuation, ESG is a one-time, repeatable procedure.

Although MBS remains the most cost-effective treatment for moderate-to-severe obesity, ESG is considerably less expensive in class I–II obesity, owing to shorter

procedural time, lack of hospitalization, and fewer complications [72-73].

In conclusion, best cost-effective strategies seem to be ESG for class I obesity and MBS for class II/III obesity. Pharmacotherapy may be cost-effective with substantial cost reduction or as an adjunctive measure.

10. Future Directions

ESG is increasingly incorporated into clinical guidelines as an established, evidence-based intervention for obesity. Emerging innovations include ESG improvements [75], robotic-ESG platforms [76], and combination or sequential strategies with pharmacotherapies, which have demonstrated synergistic effects, particularly in improving the durability response, and in enhancing weight loss and metabolic outcomes [59].

New endoscopic gastric remodeling systems -such as the Primary Obesity Surgery Endoluminal 2.0™, Endomina™ Gastric Plication system and Endozip™ automated suturing device- are under active clinical evaluation [77]. Furthermore, artificial intelligence (AI)-assisted endoscopic navigation [78], automated tissue approximation, and gut hormone modulation are under active investigation and may significantly expand ESG's clinical indications and long-term efficacy.

Conclusion

Endoscopic Sleeve Gastroplasty (ESG) is a minimally invasive therapy with demonstrated safety and mid-term durable weight loss efficacy. It is particularly beneficial for patients with class I and II obesity, as well as for those with class III obesity who are not suitable candidates for MBS.

Recent data report 15–20%TBWL at 2-years -emerging 5-year data- and significant improvement in metabolic parameters, including HbA1c and liver function in patients with MASLD. ESG is more effective than lifestyle modifications alone but achieves slightly lower weight loss than LSG, although with similar comorbidities resolution.

The ESG safety profile is consistently supported in the literature, with major complication rates below 2.5% and typically managed endoscopically. The incidence of AEs and new-onset GERD is deemed negligible and occurs less frequently than LSG.

There are ongoing innovative techniques, pharmacotherapy combination, AI-assisted navigation, and expanded indications. With increasing long-term data and real-word validation, ESG could be poised to become an essential component of comprehensive obesity management.

Author contributions:

1. **EEC:** Substantial contributions to the conception or design of the work; to the acquisition, analysis, and interpretation of data for the work; and drafting of the work or critical revision of the work to determine its important intellectual content. Final approval of the version to be published. Agreement to take responsibility for all aspects of the work to ensure that the related issues or integrity of any part of the work are adequately investigated and resolved.

2. **JND, CBA, SP and MGN**: Substantial contributions to drafting of the work and critical revision of the work to determine its important intellectual content. Final approval of the version to be published. Agreement to take responsibility for all aspects of the work to ensure that the related issues or integrity of any part of the work are adequately investigated and resolved.

Statement of Interests:

Dr. Espinet-Coll is consultant of Apollo Endosurgery, Boston scientific and SwanMedical.

Dr. Galvao-Neto is consultant of Apollo Endosurgery, Boston scientific, GIDynamics, USGI Medical, ERBE and Keyron.

Dra. Perretta is consultant and educational engagements with Boston Scientific.

They have no conflict of interest for this review. All authors read and approved the final version of this manuscript.

Inclusion and Diversity Declaration:

We support inclusive, diverse, and equitable research.

Statement of Generative AI and AI-assisted technologies in the writing process:

During the preparation of this paper, no AI or AI-assisted have been used.

Data availability statement:

The data supporting the findings of the study are available in a public repository.

Ethical Approval: This article does not contain any studies with human participants or animals performed by any of the authors.

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Table 1. Standarized expert consensus providing step-by-step guidance for safe and effective performance of ESG [10]. STEPS.

ESG cognitive skills	1. Describe primary endoscopic bariatric and metabolic therapies and available treatment options for patients with obesity. 2. Understand ESG indications, contraindications, and patient selection criteria. 3. Ensure patients are appropriately consented for possible risks and adverse events. 4. Understand pre- and postprocedural management, including antiemetics, pain control, antibiotics, and diet plan. 5. Be competent in diagnosing and managing adverse events. 6. Communicate well with team members.
ESG technical skills	**DIAGNOSTIC ENDOSCOPY AND PRESUTURING STEPS** 1. Perform a diagnostic endoscopy and identify key landmarks, including the antrum, incisura, anterior wall, greater curvature, posterior wall, fundus, and gastroesophageal junction. 2. Evaluate for any contraindications to the ESG procedure. 3. Measure the gastric length. 4. Perform argon plasma coagulation of the anterior and posterior walls of the gastric body to define gastric boundaries (optional). 5. Pass an endoscope with mounted suturing device into the stomach with or without an overtube. **FUNDAMENTAL SUTURING STEPS** 6. Advance the helix to capture the gastric wall and apply 3-4 clockwise turns with initial forward pressure and early retraction as needed to avoid capturing tissue outside the stomach.

	7. Pull the helix with the gastric wall, maneuver the endoscope, and place a full-thickness stitch. 8. Create suture slack and work from a distance from the gastric wall. 9. Load the needle driver without crossing the suture. 10. Drop the tissue anchor at completion of the suture pattern. 11. Cinch the suture with adequate tension to compress the stomach while avoiding overtensioning. Suture should not be visible after cinching. 12. Ability to troubleshoot if needed during the procedure. 13. Identify and manage intraprocedural adverse events such as bleeding, if any. 14. Remove the device with the handle closed. 15. Examine the final appearance of the sleeve. Ensure that the endoscope is able to traverse the entirety of the sleeve into the gastric antrum and identify landmarks post-ESG (fundus, body, and antrum). Ensure there is no active bleeding or esophageal tear. **SUTURE PATTERNS** 16. For suture 1, start at the incisura and place the first stitch at the anterior wall. 17. For suture 1, perform 6-12 full-thickness bites per suture. 18. For suture 1, perform a continuous suture pattern, which could be a single-row running or U-pattern. 19. For suture 2, place an interrupted reinforcement suture immediately adjacent to the running or U-suture (optional). 20. A total of 6-10 sutures is recommended 21. Identify the fundus and avoid suturing the fundus.

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Table 2. IFSO statements from the 2024 Consensus Conference on ESG indications [22]**.**

• ESG combined with lifestyle intervention in preferable to lifestyle intervention alone, for the management of adults with class I obesity
• ESG combined with lifestyle intervention in preferable to lifestyle intervention alone, for the management of adults with class II obesity • ESG combined with lifestyle is an acceptable management option for adults with class III obesity who either do not qualify (given medical or psychological comorbidities) or do not wish to pursue MBS • ESG combined with lifestyle intervention in preferable to lifestyle intervention alone, for the management of adolescents with class II obesity

(*) ***ESG:*** *Endoscopic Sleeve Gastroplasty.* (†) ***MBS:*** *Metabolic Bariatric Surgery*

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Table 3. NICE guidelines statements from 2024 on ESG indications [23].

The committee considered that this procedure may particulary benefit people:
• With class III obesity for whom invasive bariatric surgery would be considered high risk • Who decline bariatric surgery because of the associated risks and complications • Who have class I or class II obesity, for whom the procedure may prevent progression of obesity and associated comorbidities

(*) ***NICE:*** *National Intitute for Health and Care Excellence.* (†) ***ESG:*** *Endoscopic Sleeve Gastroplasty*

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Table 4. Systematic reviews and meta-analyses evaluating efficacy and safety of ESG.

Author/year	Studies Patients	%TBWL %EWL (6-m)	%TBWL %EWL (12-m)	%TBWL %EWL (24-m)	AEs	Conclusions
Gys, 2019 *[25]*	22 2475	14.47% 57.9%	16.09% 68.3%		1.01%	ESG and POSE are both safe and feasible procedures with good short-term weight loss. ESG seems to be superior in terms of weight loss at this point. Few major AEs are reported and long-term results are awaited.
Hedjoudje, 2020 *[26]*	8 1772	15.1% 57.7%	16.5% 60.4%	17.2% 61.8%	2.2%	ESG produces clinically significant weight loss that is reproducible among independent centers and has a low rate of SAEs. ESG appears to be an effective intervention for patients with obesity, although comparative studies and randomized controlled trials are necessary.
Li, 2020 *[27]*	9 1542	14.47% 53.14%	16.09% 59.08%		72% mild 1% SAEs	Although conventional surgical LSG is the gold standard, ESG could be a promising minimally invasive alternative for treating obesity with

						satisfactory efficacy and low risk.
De Miranda Neto, 2020 *[28]*	11 2170	15.3% 55.8%	16.1% 60.0%	16.8% 73% *(18-m)*	No mortality	ESG is a safe and effective procedure for primary obesity therapy with promising short- and mid-term results.
Singh, 2020 *[29]*	8 1859	14.86% 55.75%	16.43% 61.84%	20.01% 60.40%	SAEs: 2.26% No mortality	ESG, a minimally invasive bariatric therapy, is reproducible among centers worldwide with effective weight loss and favorable safety profile outcomes. Controlled studies would be valuable to further corroborate these findings.
Fehervari, 2023 *[30]*	35 7525		16.2% 51.7%	15.4% 51.8% *(medium-term, 2-5y)* <u>Remission</u> T2DM: 55.4% HTA: 62.8% DLP: 56.3% OSAS: 51.7%		This pooled analysis demonstrates that ESG can induce durable weight loss and resolution of obesity-associated comorbidities in patients with moderate obesity.

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Abu Dayyeh (IFSO), 2024 *[18]*	44 15.714	15.66% 48.64%	17.56% 53.09%	15.2% 46.57% <u>60-m:</u> 15.9%TBWL 45.3%EWL	SAEs: 1.25%	ESG is an effective and valuable treatment for obesity. ESG provides significant weight loss outcomes and demonstrates a favorable safety profile with a low rate of SAEs.

(*) **TBWL:** Total Boby Weight Loss. (†) **EWL:** Excess Weight Loss. (‡) **T2DM:** Type-2 Diabetes Mellitus. (§) **HTA:** Hypertension. (‖) **DLP:** Dyslipidemia. (fi) **OSAS:** Obstructive Sleep Apnea Syndrome. (**) **SAEs:** Serious Adverse Events.