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**Current status of endoscopic sleeve gastroplasty: An opinion review**

Wang JW *et al*. Current status of ESG

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**Abstract**

Bariatric surgeries have been demonstrated to be safe and effective treatment options for morbid obesity patients, but operative risks and high health care costs limit their clinical application. Endoscopic bariatric therapies are emerging as valuable alternatives for patients with doubts about bariatric surgery or ineligible for it. Endoscopic sleeve gastroplasty (ESG), a relatively novel technique of endoscopic bariatric therapies, has gained standing in the past few years. The safety, feasibility, repeatability, and potential for reversibility of ESG have been proven by multicenter studies. Compared to other weight loss strategies, current evidence demonstrates that ESG offers satisfactory efficacy in weight loss. Even though it is inferior to laparoscopic sleeve gastrectomy, it has lower risks of adverse events than surgical interventions and intragastric balloon within one-year follow-up. Furthermore, ESG may be the ideal weight control strategy for patients who have poor adherence to behavioral interventions. Even so, trends in decreased weight loss effect over time, post-procedure weight regain, post-procedure gut hormone alteration, and possible effects of race and ethnicity on ESG still remain undetermined due to very limited reports and very short follow-ups. Further clinical trials are required to validate and answer these questions.

**Key words:** Obesity; Endoscopic bariatric therapy; Endoscopic sleeve gastroplasty; Laparoscopic sleeve gastrectomy; Intragastric balloon; Behavioral weight loss intervention

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**Core tip:** Endoscopic sleeve gastroplasty offers satisfactory efficacy in weight loss, even though it is inferior to laparoscopic sleeve gastrectomy and has lower risks of adverse events than surgical interventions and intragastric balloon within one-year follow-up. Furthermore, it may be the ideal weight control strategy for patients who have poor adherence to behavioral interventions.

**INTRODUCTION**

Growing prevalence of obesity has become a current worldwide public health epidemic in adults, children, and adolescents. The increasing trend in obesity is also of concern owing to the high comorbidity and mortality in obesity patients and the expanding economic burden for society[1,2]. Bariatric surgeries have been demonstrated to be safe and effective treatment options for morbid obesity patients, but low patient acceptance due to fear of operative risks and high health care costs limit its clinical application[3]. In this situation, endoscopic bariatric therapies (EBTs), with their characteristics of minimally invasive nature, reversibility, and high applicability, are emerging as valuable alternatives for patients with doubts about bariatric surgery or ineligible for it[4]. Endoscopic sleeve gastroplasty (ESG), a relatively novel technique of EBTs, was first published by the Mayo Clinic in the USA in 2013 and has gained standing in the past few years[5]. ESG is an incisionless transoral endoscopic procedure that uses a full-thickness endoscopic suturing system to reduce stomach volume into a tubular gastric cavity[6]. The safety, feasibility, repeatability, and potential for reversibility of ESG have been shown by several multicenter studies[7,8]. Furthermore, there are many studies making a direct comparison between ESG and other weight loss strategies[9-12], which are separately discussed in the following sections.

**ESG *vS* laparoscopic sleeve gastrectomy**

Laparoscopic sleeve gastrectomy (LSG) is the most popular restrictive bariatric surgical procedure because of its high efficiency in weight loss, reduction in obesity-related morbidities, and simple surgical technique[13]. Novikov *et al*[9] conducted an unmatched cohort study to compare the outcomes of ESG with surgical interventions. The study showed that LSG achieved greater body mass index (BMI) decrease and percent total body weight loss (%TBWL) than ESG at 12-mo follow-up (29.28% *vs* 17.57%, *P* < 0.001). Furthermore, and there were no significant differences (*P* = 0.21) in %TBWL between the two procedures in the subgroup of patients with BMI *<* 40 kg/m2 after multivariable adjustment. Significantly lower post-procedure length of stay (0.34 d ± 0.73 d *vs* 3.09 d ± 1.47 d, *P* < 0.01) and adverse event rate (2.20% *vs* 9.17%, *P* < 0.05) were both observed in ESG compared with those in LSG. The other case-match study by Fayad *et al*[10] enrolled 54 ESG and 83 LSG patients. ESG initially presented more %TBWL and BMI decrease than LSG at 30 d (9.8% *vs* 6.6%, *P* < 0.001; 9.4% *vs* 6.7%, *P* < 0.001, respectively), but reverse outcomes in both %TBWL and BMI decrease for ESG and LSG (17.1% *vs* 23.6%, *P* < 0.001; 17.2% *vs* 23.7%, *P* < 0.001, respectively) were shown at 6-mo follow-up. Moreover, a significantly lower rate of adverse events was observed in ESG than in LSG (5.2 *vs* 16.9%, *P* < 0.05), especially in new onset gastroesophageal reflux disease (1.9% *vs* 14.5%, *P* < 0.05). Both comparison studies both demonstrated the superior weight loss effects of LSG and increased safety of ESG at 6-mo and 12-mo follow-up. In addition, the recent case-match retrospective study evaluated 6-mo quality of life after operation between 23 pairs of ESG and LSG patients with questionnaire[14]. ESG cohort reported significantly better results in gastrointestinal symptoms subdomain than LSG cohort (*P* = 0.001). No ESG patients but 7 LSG patients developed postoperative gastroesophageal reflux disease and required daily proton-pump inhibitors use (*P* = 0.004). Nevertheless, the current results are limited due to the retrospective nature of the studies and short-term follow-up, and they should be validated in future randomized controlled trials with longer follow-up.

**ESG *VS* intragastric balloon insertion**

EBTs have several promising applications in metabolic obesity disease, and one of them is intragastric balloon (IGB), whose efficacy in body weight loss and safety were demonstrated by a systematic review and meta-analysis[15]. IGB was introduced 30 years ago and underwent several upgraded product developments but, so far, weight regain remains the major limitation because of necessary removal of the balloon at 6 mo[16]. Likewise, ESG, a new emerging EBT, presented satisfactory effects against obesity disease. One recent retrospective study reported by Fayad and his colleague compared the two EBTs (ESG and IGB)[11]. All 58 ESG and 47 IGB patients achieved meaningful body weight loss. The ESG group showed significant higher mean %TBWL than the IGB group over 12 mo post-procedure (at 12-mo follow-up, 21.3% *vs* 13.9%, *P* = 0.005, respectively). Notably, a decreasing trend in %TBWL was seen in the ESG group and decreasing %TBWL presented after 6 mo for the IGB group, which can be explained by balloon removal at 6 mo. There was a significantly lower rate of adverse events in the ESG group than in the IGB group (5.2% *vs* 17.0%, *P* = 0.048, respectively). Up to 17% of IGB patients had adverse events requiring balloon removal, and these events completely subsided after balloon removal. In contrast, ESG-associated adverse events are more likely to require medical treatment. This study provided evidence that ESG may be a more appropriate EBT than IGB in clinical practice even with limitation of selection bias.

**ESG *VS* behavioral interventions**

The United States Department of Health and Human Services has proposed lifestyle interventions, such as dietary therapy and physical activity, as first-line treatment for weight loss and maintenance since 1998[17]. One systemic review and meta-analysis revealed that behavioral interventions bring about small but significant benefits for weight loss and maintenance[18]. Certain obese patients prefer these non-surgical interventions over invasive therapies. Cheskin *et al*[12] conducted a case-matched study of 105 patients who underwent ESG and 281 patients who underwent high-intensity diet and lifestyle therapy (HIDLT) to compare weight loss between the two groups. The ESG group had a significantly greater mean %TBWL than the HIDLT group throughout the 12-mo follow-up (20.6% *vs* 14.3%, respectively). It is worth noting that ESG had no superiority in weight loss over 6 mo post-procedure compared with HIDLT in BMI > 40 kg/m2 patients. In addition, a low proportion of patients (4.8%) experienced moderate-to-severe adverse events in the ESG group, and no subjects suffered from any adverse event in the HIDLT group. Consequently, ESG is likely a valuable alternative for patients who do not comply with HIDLT.

**Conclusion**

Current evidence, summarized in Table 1, indicates that ESG offers satisfactory efficacy in weight loss even if inferior to LSG, and has lower risks of adverse events compared to surgical interventions and IGB within one-year follow-up. Moreover, ESG may be the ideal weight control strategy for patients who have poor adherence to behavioral interventions. Even so, the reasons for the trends in decreased weight loss effect with time and post-procedure weight regain in ESG still remain undetermined. As gut hormones[19,20], cytokines[21], adipokines[22], hepatokines[23], and bile acids[24] play important roles in promoting weight loss, ameliorating type 2 diabetes mellitus and improving fatty liver disease, basic mechanistic insights into EBT, including ESG, are required. Since the Y-Y paradox exists between Caucasians and Asians[25], direct extrapolation of the results obtained from Western countries may not be proper in Eastern countries. Thus, analyses of the possible effects of race, ethnicity, and comorbidities on weight loss outcomes in each cohort become more and more imperative. With very limited reports and very short follow-ups, this novel endoscopic technique for obesity treatment, ESG, will require more large-scale randomized controlled trials in order to validate its clinical efficacy and safety in long-term follow-up.

**References**

1 **Flegal KM**, Kit BK, Orpana H, Graubard BI. Association of all-cause mortality with overweight and obesity using standard body mass index categories: a systematic review and meta-analysis. *JAMA* 2013; **309**: 71-82 [PMID: 23280227 DOI: 10.1001/jama.2012.113905]

2 **Wu WC,** Lee WJ, Yeh C, Chen SC, Chen CY. Impacts of Different Modes of Bariatric Surgery on Plasma Levels of Hepassocin in Patients with Diabetes Mellitus. *Reports* 2019; **2**: 24 [DOI: 10.3390/reports2040024]

3 **Welbourn R**, Pournaras DJ, Dixon J, Higa K, Kinsman R, Ottosson J, Ramos A, van Wagensveld B, Walton P, Weiner R, Zundel N. Bariatric Surgery Worldwide: Baseline Demographic Description and One-Year Outcomes from the Second IFSO Global Registry Report 2013-2015. *Obes Surg* 2018; **28**: 313-322 [PMID: 28822052 DOI: 10.1007/s11695-017-2845-9]

4 **Hill C**, Khashab MA, Kalloo AN, Kumbhari V. Endoluminal weight loss and metabolic therapies: current and future techniques. *Ann N Y Acad Sci* 2018; **1411**: 36-52 [PMID: 28884820 DOI: 10.1111/nyas.13441]

5 **Abu Dayyeh BK**, Rajan E, Gostout CJ. Endoscopic sleeve gastroplasty: a potential endoscopic alternative to surgical sleeve gastrectomy for treatment of obesity. *Gastrointest Endosc* 2013; **78**: 530-535 [PMID: 23711556 DOI: 10.1016/j.gie.2013.04.197]

6 **Lopez-Nava G**, Galvão MP, da Bautista-Castaño I, Jimenez A, De Grado T, Fernandez-Corbelle JP. Endoscopic sleeve gastroplasty for the treatment of obesity. *Endoscopy* 2015; **47**: 449-452 [PMID: 25380508 DOI: 10.1055/s-0034-1390766]

7 **Lopez-Nava G**, Sharaiha RZ, Vargas EJ, Bazerbachi F, Manoel GN, Bautista-Castaño I, Acosta A, Topazian MD, Mundi MS, Kumta N, Kahaleh M, Herr AM, Shukla A, Aronne L, Gostout CJ, Abu Dayyeh BK. Endoscopic Sleeve Gastroplasty for Obesity: a Multicenter Study of 248 Patients with 24 Months Follow-Up. *Obes Surg* 2017; **27**: 2649-2655 [PMID: 28451929 DOI: 10.1007/s11695-017-2693-7]

8 **Sartoretto A**, Sui Z, Hill C, Dunlap M, Rivera AR, Khashab MA, Kalloo AN, Fayad L, Cheskin LJ, Marinos G, Wilson E, Kumbhari V. Endoscopic Sleeve Gastroplasty (ESG) Is a Reproducible and Effective Endoscopic Bariatric Therapy Suitable for Widespread Clinical Adoption: a Large, International Multicenter Study. *Obes Surg* 2018; **28**: 1812-1821 [PMID: 29450845 DOI: 10.1007/s11695-018-3135-x]

9 **Novikov AA**, Afaneh C, Saumoy M, Parra V, Shukla A, Dakin GF, Pomp A, Dawod E, Shah S, Aronne LJ, Sharaiha RZ. Endoscopic Sleeve Gastroplasty, Laparoscopic Sleeve Gastrectomy, and Laparoscopic Band for Weight Loss: How Do They Compare? *J Gastrointest Surg* 2018; **22**: 267-273 [PMID: 29110192 DOI: 10.1007/s11605-017-3615-7]

10 **Fayad L**, Adam A, Schweitzer M, Cheskin LJ, Ajayi T, Dunlap M, Badurdeen DS, Hill C, Paranji N, Lalezari S, Kalloo AN, Khashab MA, Kumbhari V. Endoscopic sleeve gastroplasty versus laparoscopic sleeve gastrectomy: a case-matched study. *Gastrointest Endosc* 2019; **89**: 782-788 [PMID: 30148991 DOI: 10.1016/j.gie.2018.08.030]

11 **Fayad L**, Cheskin LJ, Adam A, Badurdeen DS, Hill C, Agnihotri A, Dunlap M, Simsek C, Khashab MA, Kalloo AN, Kumbhari V. Endoscopic sleeve gastroplasty versus intragastric balloon insertion: efficacy, durability, and safety. *Endoscopy* 2019; **51**: 532-539 [PMID: 30841009 DOI: 10.1055/a-0852-3441]

12 **Cheskin LJ**, Hill C, Adam A, Fayad L, Dunlap M, Badurdeen D, Koller K, Bunyard L, Frutchey R, Al-Grain H, Kahan S, Hedjoudje A, Khashab MA, Kalloo AN, Kumbhari V. Endoscopic sleeve gastroplasty versus high-intensity diet and lifestyle therapy: a case-matched study. *Gastrointest Endosc* 2020; **91**: 342-349.e1 [PMID: 31568769 DOI: 10.1016/j.gie.2019.09.029]

13 **Benaiges D**, Más-Lorenzo A, Goday A, Ramon JM, Chillarón JJ, Pedro-Botet J, Flores-Le Roux JA. Laparoscopic sleeve gastrectomy: More than a restrictive bariatric surgery procedure? *World J Gastroenterol* 2015; **21**: 11804-11814 [PMID: 26557004 DOI: 10.3748/wjg.v21.i41.11804]

14 **Fiorillo C**, Quero G, Vix M, Guerriero L, Pizzicannella M, Lapergola A, D'Urso A, Swanstrom L, Mutter D, Dallemagne B, Perretta S. 6-Month Gastrointestinal Quality of Life (QoL) Results after Endoscopic Sleeve Gastroplasty and Laparoscopic Sleeve Gastrectomy: A Propensity Score Analysis. *Obes Surg* 2020 [PMID: 31965488 DOI: 10.1007/s11695-020-04419-1]

15 **ASGE Bariatric Endoscopy Task Force and ASGE Technology Committee.**, Abu Dayyeh BK, Kumar N, Edmundowicz SA, Jonnalagadda S, Larsen M, Sullivan S, Thompson CC, Banerjee S. ASGE Bariatric Endoscopy Task Force systematic review and meta-analysis assessing the ASGE PIVI thresholds for adopting endoscopic bariatric therapies. *Gastrointest Endosc* 2015; **82**: 425-38.e5 [PMID: 26232362 DOI: 10.1016/j.gie.2015.03.1964]

16 **Genco A**, López-Nava G, Wahlen C, Maselli R, Cipriano M, Sanchez MM, Jacobs C, Lorenzo M. Multi-centre European experience with intragastric balloon in overweight populations: 13 years of experience. *Obes Surg* 2013; **23**: 515-521 [PMID: 23224509 DOI: 10.1007/s11695-012-0829-3]

17 Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults--The Evidence Report. National Institutes of Health. *Obes Res* 1998; **6 Suppl 2**: 51S-209S [PMID: 9813653]

18 **Dombrowski SU**, Knittle K, Avenell A, Araújo-Soares V, Sniehotta FF. Long term maintenance of weight loss with non-surgical interventions in obese adults: systematic review and meta-analyses of randomised controlled trials. *BMJ* 2014; **348**: g2646 [PMID: 25134100 DOI: 10.1136/bmj.g2646]

19 **Lee WJ**, Chen CY, Chong K, Lee YC, Chen SC, Lee SD. Changes in postprandial gut hormones after metabolic surgery: a comparison of gastric bypass and sleeve gastrectomy. *Surg Obes Relat Dis* 2011; **7**: 683-690 [PMID: 21996600 DOI: 10.1016/j.soard.2011.07.009]

20 **Lee WJ**, Chen CY, Ser KH, Chong K, Chen SC, Lee PC, Liao YD, Lee SD. Differential influences of gastric bypass and sleeve gastrectomy on plasma nesfatin-1 and obestatin levels in patients with type 2 diabetes mellitus. *Curr Pharm Des* 2013; **19**: 5830-5835 [PMID: 23768444 DOI: 10.2174/13816128113198880010]

21 **Chen CY**, Lee WJ, Asakawa A, Fujitsuka N, Chong K, Chen SC, Lee SD, Inui A. Insulin secretion and interleukin-1β dependent mechanisms in human diabetes remission after metabolic surgery. *Curr Med Chem* 2013; **20**: 2374-2388 [PMID: 23531221 DOI: 10.2174/0929867311320180008]

22 **Chen YC**, Inui A, Chang ES, Chen SC, Lee WJ, Chen CY. Comparison of gut hormones and adipokines stimulated by glucagon test among patients with type II diabetes mellitus after metabolic surgery. *Neuropeptides* 2016; **55**: 39-45 [PMID: 26621498 DOI: 10.1016/j.npep.2015.11.002]

23 **Huang HH**, Yeh C, Chen JC, Lee TH, Chen SC, Lee WJ, Chen CY. Does bariatric surgery influence plasma levels of fetuin-A and leukocyte cell-derived chemotaxin-2 in patients with type 2 diabetes mellitus? *PeerJ* 2018; **6**: e4884 [PMID: 29910974 DOI: 10.7717/peerj.4884]

24 **Huang HH**, Lee WJ, Chen SC, Chen TF, Lee SD, Chen CY. Bile Acid and Fibroblast Growth Factor 19 Regulation in Obese Diabetics, and Non-Alcoholic Fatty Liver Disease after Sleeve Gastrectomy. *J Clin Med* 2019; **8** [PMID: 31181641 DOI: 10.3390/jcm8060815]

25 **Chen CY**, Tsai CY. From endocrine to rheumatism: do gut hormones play roles in rheumatoid arthritis? *Rheumatology (Oxford)* 2014; **53**: 205-212 [PMID: 23882111 DOI: 10.1093/rheumatology/ket255]

**Footnotes**

**Conflicts of interest statement:** Jiunn-Wei Wang and Chih-Yen Chen have no potential conflicts of interest to declare.

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**Table 1 Summary of comparison studies for weight control strategies**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Ref.** | **Type of study** | **Comparison** | **Subject numbers** | **Length of follow-up (mo)** | **Weight loss efficacy (%TBWL)** | **Adverse event rate** |
| Novikov *et al*[9] 2018 | Retrospective cohort study, case-unmatched | ESG *vs* LSG *vs* LABG | 91 ESG/120 LSG/67 LAGB | 12 | LSG (29.28%) > ESG (17.57%) > LAGB (13.30%), *P* < 0.001 | LSG (9.17%) > LAGB (8.96%) > ESG (2.20%), *P* < 0.05 |
| Fayad *et al*[10] 2019 | Retrospective cohort study, case-matched | ESG *vs* LSG | 54 ESG/83 LSG | 6 | LSG (23.6%) > ESG (17.1%), *P* < 0.001 | LSG (16.9%) > ESG (5.2%), *P* < 0.05 |
| Fiorillo *et al*[14] 2020  | Retrospective cohort study, case-matched | ESG *vs* LSG | 23 ESG/23 LSG | 6 | LSG (18.8%) > ESG (13.4%), *P* = 0.03 | GERD symptoms LSG (30.7%) > ESG (0%), *P* = 0.004 |
| Fayad *et al*[11] 2019  | Retrospective cohort study, case-matched | ESG *vs* IGB | 58 ESG/47 IGB | 12 | ESG (21.3%) > IGB (13.9%), *P* = 0.005 | IGB (17.0%) > ESG (5.2%), *P* = 0.048 |
| Cheskin *et al*[12] 2019  | Retrospective cohort study, case-unmatched | ESG *vs* HIDLT | 105 ESG/281 HIDLT | 12 | ESG (20.6%) > HIDLT (14.3%), *P* < 0.001 | ESG (4.8%) > HIDLT (0.0%) |

ESG: Endoscopic sleeve gastroplasty; GERD: Gastroesophageal reflux disease; HIDLT: High-intensity diet and lifestyle therapy; IGB: Intragastric balloon; LAGB: Laparoscopic adjustable gastric banding; LSG: Laparoscopic sleeve gastrectomy; %TBWL: Percent total body weight loss.