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Clinical Progress in Single-Port and Reduced-Port Laparoscopic Sleeve Gastrectomy

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Abstract

Laparoscopic sleeve gastrectomy (LSG) is one of the most frequently performed procedures in metabolic and bariatric surgery. Single-port sleeve gastrectomy (SPSG/SILSG) and reduced-port LSG (RPLSG) have re-emerged as attempts to refine minimally invasive access rather than to change the metabolic operation itself. Evidence published from 2019 to 2026 suggests that, in experienced centers and carefully selected patients, single-port and reduced-port LSG can be performed safely, with short-term morbidity and weight-loss outcomes broadly comparable to conventional multiport LSG. The main potential advantages are fewer visible incisions, more concealed scars, and higher cosmetic satisfaction. However, transumbilical single-port access concentrates fascial stress in one incision and may worsen instrument triangulation, fundal exposure, specimen extraction, and fascial closure. Long-term risks, especially trocar-site hernia and gastroesophageal reflux disease (GERD), remain insufficiently reported. The value of single-port or reduced-port LSG therefore lies not in port reduction alone, but in delivering a perceptible and reproducible patient benefit without compromising the standardized safety principles of LSG. Future studies should move beyond technical feasibility and focus on patient selection, standardized port-site reporting, long-term abdominal wall and esophageal safety, and patient-reported outcomes.

Keywords

Single-Port Laparoscopy, Reduced-Port Laparoscopy, Sleeve Gastrectomy, Metabolic and Bariatric Surgery, Trocar Layout, Incisional Hernia, Gastroesophageal Reflux Disease

1. Introduction

Obesity and its related metabolic disorders have become a major global health burden. For patients with moderate-to-severe obesity, or obesity complicated by type 2 diabetes, obstructive sleep apnea, fatty liver disease, hypertension, and other comorbidities, metabolic and bariatric surgery remains one of the best supported long-term treatment strategies. The 2022 ASMBS/IFSO guidelines broadened the indications for metabolic and bariatric surgery, increasing the number of patients considered eligible for operative treatment and placing greater emphasis on safety, standardization, and patient experience [1] [2].

LSG has become one of the most widely used bariatric procedures worldwide because it has a relatively straightforward operative pathway, avoids gastrointestinal anastomosis, produces reliable weight loss, and has a well-characterized complication profile. Conventional LSG is usually performed with four or five trocars to mobilize the greater curvature, divide the fundus, create the gastric sleeve with linear staplers, and retrieve the specimen. With the development of single-port platforms, articulating instruments, magnetic retraction, improved fascial closure, and enhanced recovery pathways, surgeons have explored whether fewer abdominal wall access sites can reduce parietal trauma, improve scar appearance, and increase patient satisfaction.

In patients with obesity, however, single-port or reduced-port LSG is not simply a matter of using fewer trocars. A thick abdominal wall, enlarged left hepatic lobe, abundant visceral fat, difficult fundal exposure, and restricted working angles can turn port reduction into a complex problem involving exposure, traction, stapling geometry, specimen extraction, and closure of a larger fascial defect.

Since 2019, the literature has shifted from asking whether single-port LSG is technically possible to asking which patients may benefit, which access routes are safer, how port-site outcomes should be reported, and whether long-term risks have been underestimated. Recent systematic reviews and meta-analyses increasingly treat single-port, reduced-port, magnetic-assisted reduced-port, three-port cosmetic, and other trocar-layout strategies as a continuum of access optimization rather than as a simple binary comparison between single-port and multiport LSG [3]-[5]. This review therefore discusses single-port and reduced-port LSG together, while maintaining a clear distinction between direct single-port evidence, reduced-port or trocar-layout evidence, and broader safety evidence for LSG.

2. Literature Search Strategy and Scope

PubMed was used as the primary database. The search covered publications from January 1, 2019, to June 8, 2026. Core search terms included single-incision, single-port, single port, single-site, single site, reduced-port, reduced port, trocar, port-site, sleeve gastrectomy, and laparoscopic sleeve gastrectomy. The core search string was: (“single-incision” OR “single-port” OR “single port” OR “single-site” OR “single site” OR “reduced-port” OR “reduced port” OR trocar OR port-site) AND (“sleeve gastrectomy” OR “laparoscopic sleeve gastrectomy”). Additional searches used terms related to sleeve gastrectomy leak, GERD, Barrett esophagus, bariatric surgery guidelines, robotic sleeve gastrectomy, and perioperative metabolic and nutritional management.

This article is framed as a scoping review rather than a systematic review. Thirty-one PubMed-indexed studies were included. Eighteen addressed single-port surgery, reduced-port surgery, magnetic-assisted reduced-port surgery, trocar layout, or cosmetic incision strategies; thirteen were used to define the broader safety context of LSG, including indications, leak, GERD, Barrett esophagus, long-term outcomes, robotic platforms, and perioperative management. Studies that were remote from LSG, could not be verified through PubMed bibliographic information, or were isolated case reports unable to support a review-level argument, were excluded.

The search and reporting process was guided by the logic of the PRISMA extension for scoping reviews (PRISMA-ScR), although this article was not registered as a systematic review protocol. Titles and abstracts identified through the search strategy were screened first for relevance to laparoscopic sleeve gastrectomy and access reduction. Full texts were then assessed for whether they provided direct evidence on single-port, single-incision, reduced-port, magnetic-assisted, or trocar-layout strategies in LSG, or whether they supplied essential background evidence on LSG safety outcomes. Study selection was performed by the author; uncertain records were retained only when the bibliographic information and relevance to the review question could be verified through PubMed. This process yielded the final set of 31 studies cited in the review.

3. Evolution from Single-Port Procedure to Access-Optimization Spectrum

Terminology in this field remains inconsistent. Single-port LSG may be described as single-port sleeve gastrectomy, single-incision laparoscopic sleeve gastrectomy, single-site sleeve gastrectomy, or transumbilical single-incision sleeve gastrectomy. In broad terms, these approaches attempt to complete LSG through one main incision. Reduced-port LSG generally refers to procedures using fewer than the conventional four or five trocars, including three-port, two-port, magnetic-assisted, or specially retracted approaches. Because definitions differ across studies, heterogeneity in meta-analyses is unavoidable [3]-[5].

From a clinical standpoint, fewer ports do not automatically mean less trauma. A larger transumbilical fascial defect may concentrate local tension and place greater demands on secure closure. Conversely, a three-port or bikini-line strategy may not be a strict single-port operation, but it can offer a pragmatic balance among scar concealment, operative triangulation, and abdominal wall safety. The more useful framework is therefore not single-port versus multiport, but a spectrum that includes conventional multiport LSG, reduced-port LSG, magnetic-assisted reduced-port LSG, left hypochondrial single-port LSG, and transumbilical single-port LSG. These approaches should be compared by exposure quality, operative safety, incision-related outcomes, and patient-reported benefit.

4. Current Evidence: Feasibility Established, Clinical Advantages Remain Uncertain

Studies published after 2019 support a cautious conclusion: in experienced centers and selected patients, single-port or reduced-port LSG can be completed safely and can achieve short-term outcomes close to those of conventional multiport LSG. Tranchart *et al.* found broadly comparable short-term safety and early recovery between single-port and conventional LSG after propensity-score matching, although single-port surgery generally required longer operative time [6]. Khidir *et al.* extended the comparison to 5-year weight loss, comorbidity resolution, and cost, suggesting that single-port LSG can become a stable clinical pathway rather than only a cosmetic variant [7].

Technical series further show that the success of single-port LSG depends less on the incision itself than on exposure and retraction. Wang *et al.* described transumbilical single-incision LSG assisted by a stomach retractor in superobese patients, emphasizing the need to reconstruct effective traction under single-port conditions [8]. Borjas *et al.* compared magnetic-assisted reduced-port LSG with conventional LSG and suggested that magnetic retraction may help reduce port number while preserving exposure quality [9]. Together, these studies point to a central principle: port reduction can become a real clinical advantage only when it does not weaken fundal exposure, His-angle dissection, or staple-line quality.

Systematic reviews and meta-analyses provide a higher level of evidence but also reveal important limitations. Ataya *et al.* found limited differences in several perioperative outcomes between single-incision and conventional multiport LSG, but the included studies varied in sample size, port definitions, surgeon experience, and endpoints [5]. Jiang *et al.* showed that trocar number and placement may influence operative efficiency, exposure, and incision-related outcomes [4]. Gutiérrez-Ramírez *et al.* reported that reduced-port techniques are generally feasible, but whether they consistently reduce pain, improve cosmesis, or lower complications remains uncertain [3]. Current evidence therefore supports feasibility, but not universal superiority.

Since 2025, research questions have become more refined. Abdallah *et al.* compared transumbilical and left hypochondrial single-port LSG, showing that the access route may influence cosmetic results, efficiency, and incision risk [10]. Widjaja *et al.* examined transumbilical single-port LSG according to height and BMI, underscoring the impact of body habitus on technical suitability [11]. Zidan *et al.* proposed the PSPOSO checklist to standardize reporting of port-site placement and outcomes in metabolic and bariatric surgery [12]. These studies indicate that the field is moving from technical demonstration toward standardized reporting and individualized selection.

5. Safety Considerations: Port Reduction Should Not Compromise LSG Quality

The clinical value of single-port or reduced-port LSG must rest on uncompromised safety. Perioperative safety includes operative time, bleeding, leak, stenosis, reoperation, readmission, and mortality. Comparative studies and meta-analyses generally suggest that severe complications are not clearly higher than with conventional multiport LSG in experienced centers [3]-[7]. This conclusion should be interpreted carefully, however, because many studies are retrospective, single-center, and subject to selection bias. Outcomes from expert teams may not be generalizable to patients with very high BMI, a thick abdominal wall, marked hepatomegaly, or complex previous upper abdominal surgery.

Staple-line leak remains one of the most serious complications of LSG. Port number does not directly determine healing of the staple line, but instrument angle, traction direction, completeness of fundal mobilization, and staple-line tension can all be affected by trocar layout. Iossa *et al.* emphasized that leak is associated with patient factors, technical factors, and perioperative management [13]. Ma *et al.* showed that the value of intraoperative leak testing must be interpreted within specific workflows and risk stratification [14]. Single-port or reduced-port LSG should therefore never compromise bougie calibration, fundal dissection, hemostasis, staple-line assessment, or closure quality.

6. Incision Outcomes, Cosmesis, and Patient-Reported Outcomes

Cosmesis is the most visible appeal of single-port and reduced-port LSG. Fewer incisions, or scars hidden in the umbilicus or bikini line, can improve patients' acceptance of postoperative appearance. Recent studies of three-port bikini-line LSG and aesthetic-focused bikini-line LSG suggest that incision-position optimization can improve satisfaction with appearance [15] [16]. These findings are clinically relevant because patients care not only about complication rates, but also about body image, scar visibility, and recovery experience.

Cosmetic benefit is also the outcome most easily overinterpreted. Transumbilical single-port access usually requires a larger single fascial incision, and patients with obesity often have thicker abdominal walls, higher local tension, and less favorable wound-healing conditions. Short follow-up may underestimate trocar-site hernia. Muñoz-Leija *et al.* highlighted the importance of standardized fascial closure in reducing port-site complications after LSG [17]. Cosmetic outcomes should therefore be reported together with trocar-site hernia, chronic incision pain, infection, seroma, and need for repair. A study that reports only 30-day morbidity or length of stay cannot fully evaluate the benefit-risk profile of a transumbilical single-port approach.

Pain and enhanced recovery also require cautious interpretation. Fewer trocars may reduce abdominal wall injury in theory, but traction through one larger incision, specimen extraction, and fascial closure may offset some of this advantage. Future studies should include visual analogue pain scores, analgesic consumption, time to ambulation, length of stay, time to return to work, scar satisfaction, and validated body-image measures instead of using port number as a proxy for what patients actually experience.

7. Weight Loss, Metabolic Outcomes, and Long-Term Safety

From the perspective of weight loss and metabolic improvement, single-port or reduced-port LSG remains LSG. If sleeve geometry, fundal resection, antral management, bougie size, and staple-line quality are equivalent, port number alone should not substantially alter long-term mechanisms of weight loss or metabolic remission. Available mid-term data suggest that single-port LSG can achieve weight loss and comorbidity improvement close to conventional LSG [7]. However, if reduced access compromises exposure, leaves residual fundus, twists the sleeve, or changes staple-line trajectory, long-term weight control and reflux risk may be affected.

Recent studies of modified three-port LSG, antrum preservation versus resection, omentopexy, and banded versus non-banded LSG show that long-term outcomes after LSG are influenced by multiple technical details [18]-[21]. Single-port and reduced-port studies should therefore report more than port number. Important operative details include distance from the pylorus at the first staple firing, bougie size, fundal management, staple-line reinforcement, sleeve shape, postoperative reflux, and need for reintervention (**Table 1**).

Table 1. Selected evidence on single-port, reduced-port, and access-optimization strategies in LSG.

Study	Design and sample	Comparison/intervention	Main interpretation
Abdallah *et al.* [10]	Retrospective comparison, 449 SPSG cases	Transumbilical versus left hypochondrial SPSG	Access route may affect efficiency, cosmesis, and incision-related risk; findings remain center-dependent.
Widjaja *et al.* [11]	Retrospective cohort, 753 transumbilical SPSG cases	Stratified by height and BMI	Height ≥ 1.8 m or BMI ≥ 50 kg/m² was associated with longer operative time; long-term comparative data remain limited.
Gutiérrez-Ramírez *et al.* [3]	Systematic review and meta-analysis, 18 studies, 2945 patients	Reduced-port versus conventional LSG	Reduced-port LSG was feasible; differences in complications, pain, weight loss, and comorbidity improvement were generally limited.
Jiang *et al.* [4]	Systematic review and meta-analysis, 61 studies, 20,180 patients	Trocar number/location; single-incision versus conventional LSG	Single-incision LSG tended to have longer operative time and lower day-1 pain scores; other outcomes were less clearly different.
Ataya *et al.* [5]	Systematic review and meta-analysis, 14 studies	Single-incision versus multiport LSG	Most perioperative outcomes were similar; cosmetic satisfaction favored single-incision approaches, but study quality varied.
Borjas *et al.* [9]	Comparative study, 150 magnetic-assisted RPLSG versus 135 conventional LSG	Magnetic-assisted reduced-port LSG	Operative time was similar and length of stay was shorter; minor device-related liver injuries were reported.
Lainas *et al.* [26]	High-volume single-center experience, 1800 SILSG cases	Left hypochondrial or transumbilical SILSG	Low additional trocar use and acceptable morbidity were reported, but generalizability to lower-volume centers is uncertain.
Tranchart *et al.* [6]	Propensity-score matched retrospective study; 314 matched pairs	SPSG versus conventional LSG	SPSG increased operative time by about 15 minutes, with broadly similar complications, hernia, 12-month %TWL, and comorbidity outcomes.

GERD is one of the most important long-term issues after LSG. Single-port or reduced-port access is not itself the main determinant of GERD, but insufficient exposure may indirectly increase reflux risk by affecting His-angle dissection, fundal resection, or sleeve geometry. Reviews of GERD after LSG and studies on de novo Barrett esophagus emphasize the need for long-term symptom and endoscopic surveillance [22] [23]. Magnetic sphincter augmentation has also been explored for refractory GERD after LSG [24]. These data show that evaluation of single-port and reduced-port LSG must extend beyond early incisions and pain to include reflux symptoms, endoscopic findings, proton-pump inhibitor use, and revisional surgery.

8. Patient Selection and Surgical Learning Curve

Current evidence supports selective use rather than broad routine adoption. Patients who may be better candidates for single-port or reduced-port LSG include those with relatively lower BMI, moderate abdominal wall thickness, no marked enlargement of the left hepatic lobe, no complex upper abdominal surgical history, a clear preference for better cosmetic outcomes, and willingness to undergo long-term follow-up. Reduced-port experience in Asian patients suggests that body habitus and abdominal wall characteristics influence feasibility [25]. Large single-port series using left hypochondrial or transumbilical access also indicate that access selection is closely tied to center experience [26] [27]. In patients with very high BMI, central obesity, abundant male-pattern visceral fat, severe hepatomegaly, dense adhesions, or complex GERD, conventional multiport LSG remains the more prudent option.

These selection factors should be interpreted as expert-derived practical considerations and proposed reporting domains rather than validated contraindications. They are intended to guide shared decision-making, study design, and transparent reporting until prospective evidence defines more reliable selection thresholds.

The learning curve also limits generalizability. Single-port LSG requires familiarity with coaxial manipulation, instrument crossing, restricted traction, and closure of a single larger incision. Many favorable reports come from high-volume or expert centers. Future studies should report surgeon experience, case-sequence position, additional trocar use, conversion rate, and learning-curve subgroup outcomes. In clinical practice, adding a trocar when exposure is inadequate should be considered a safety strategy, not a technical failure.

9. Limitations of Current Evidence

The evidence base remains limited in several ways. Recent strict single-port LSG studies are still mainly retrospective and single-center, often with modest sample sizes. Terminology is heterogeneous, with single-port, single-incision, reduced-port, three-port, and magnetic-assisted approaches used inconsistently. Outcomes are unevenly reported across operative time, complications, pain, cosmesis, and cost, while long-term trocar-site hernia, GERD, Barrett esophagus, and revisional surgery are underreported. Selection bias is substantial because single-port or reduced-port surgery is often offered to patients who are already more suitable for access optimization. Economic evidence is also sparse, although device cost, availability, and training requirements strongly affect scalability.

The safest interpretation at present is that single-port and reduced-port LSG are feasible refinements of conventional multiport LSG, not fully proven replacements for it. Clinical adoption should depend on patient selection, technical training, standardized port reporting, meticulous fascial closure, and long-term follow-up (Table 2).

Table 2. Practical selection and reporting framework for single-port or reduced-port LSG.

Domain	Favors single-/reduced-port LSG	Favors conventional multiport LSG	Minimum reporting focus
Body habitus and exposure	Relatively lower BMI, moderate abdominal wall thickness, no marked left-lobe enlargement	Very high BMI, thick abdominal wall, central obesity, severe hepatomegaly	Report BMI, height, sex distribution, abdominal wall or liver-related difficulty when available.
Previous surgery and adhesions	No complex upper abdominal surgical history	Prior upper abdominal surgery or high adhesion risk	Report adhesions, additional trocar use, and conversion or bailout strategies.
Reflux and esophageal safety	No severe GERD, esophagitis, large hiatal hernia, or Barrett risk	Severe GERD, hiatal hernia, esophagitis, Barrett esophagus, or need to reconsider LSG itself	Report GERD symptoms, PPI use, endoscopy, Barrett esophagus, and revisional surgery.
Cosmetic priority	Clear patient preference for scar concealment after shared decision-making	Low cosmetic priority or unwillingness for long-term follow-up	Use validated scar satisfaction, body-image, pain, analgesic, and return-to-work measures.
Technical safety threshold	Experienced team, standardized retraction and fascial closure, readiness to add trocars	Learning-curve setting or inadequate exposure with insistence on minimal access	Report surgeon experience, case-sequence position, operative time, bleeding, leak, stenosis, readmission, and reoperation.
Long-term effectiveness	Equivalent sleeve construction can be maintained	Reduced access compromises fundal resection, sleeve geometry, or staple-line trajectory	Report pyloric distance, bougie size, fundal handling, staple-line reinforcement, %TWL, %EWL, comorbidity remission, and weight regain.

10. Future Directions and Research Priorities

Future work should advance in three directions. First, technical reporting should be standardized and should include incision location, number of ports, single-port platform, liver-retraction method, additional trocar use, bougie calibration, distance from the pylorus, staple-line reinforcement, and fascial closure. Second, endpoints should extend from early operative measures to patient-reported outcomes and long-term safety, including pain, scar satisfaction, body image, trocar-site hernia, GERD, Barrett esophagus, weight regain, nutritional risk, and revisional surgery. Third, study design should improve through multicenter prospective studies or high-quality real-world cohorts comparing single-port, reduced-port, and conventional multiport LSG under standardized pathways with prespecified subgroup analyses.

Robotic platforms, magnetic retraction, articulating instruments, and more mature single-port access systems may further improve the working conditions of single-port LSG [28]. Studies of left-sided LSG and long-term comparisons between LSG and Roux-en-Y gastric bypass provide additional context for technical choices beyond port optimization [29] [30]. Perioperative nutritional, metabolic, and nonsurgical support guidelines also remind us that access refinement cannot be separated from comprehensive bariatric care [31]. Valuable technical progress should be safe, effective, reproducible, teachable, and perceptible to patients; reducing ports is only one part of that standard.

11. Conclusion

Evidence from 2019 to 2026 suggests that single-port and reduced-port LSG can serve as minimally invasive refinements of conventional multiport LSG in experienced centers and selected patients. The current literature supports feasibility and acceptable short-term safety, but does not yet prove stable, universal, or long-term clinical superiority. Recent work has shifted from feasibility toward access-route selection, trocar layout, incision-related complications, patient-habitus matching, and long-term safety. For clinical practice, the key question is not whether fewer incisions can be used, but whether patients gain a real, durable, and reproducible benefit without increased risk of leak, trocar-site hernia, GERD, or revisional surgery. Future evaluation should prioritize trocar-site hernia, GERD, patient-reported outcomes, and long-term weight loss rather than port number alone.

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Ethics Approval

This manuscript is a narrative/scoping review and did not involve human participants, animal experiments, or identifiable personal data.

Data Availability

No new datasets were generated or analyzed during the preparation of this review.

Author Contributions

Zheng Zuo drafted and revised the manuscript. Jinjian Xiang supervised the work, reviewed the manuscript critically, and served as corresponding author. Both authors approved the final manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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