ORIGINAL ARTICLE

Annals of Gastroenterology (2026) **39,** 1-9

Comparative efficacy and safety of endoscopic ultrasound-guided gastrojejunostomy versus surgical gastrojejunostomy for the management of gastric outlet obstruction: a systematic review and meta-analysis

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Abstract

Background Gastric outlet obstruction (GOO) is a common condition leading to impaired gastric emptying and nutritional decline. Surgical gastrojejunostomy (SGJ) has been the traditionally used bypass approach. Endoscopic ultrasound-guided gastrojejunostomy (EUSGJ) has recently emerged as a promising alternative. This systematic review and meta-analysis aimed to compare the efficacy and safety of EUSGJ vs. SGJ for the management of GOO.

Methods PubMed, Embase, MEDLINE and Cochrane were searched to identify studies that specifically compared outcomes of EUSGJ vs. SGJ in GOO patients. Outcomes assessment focused on procedural metrics and immediate postoperative recovery.

Results Nine retrospective studies incorporating 1086 patients were included. SGJ was superior in terms of technical success (odds ratio [OR] 0.16, 95% confidence interval [CI] 0.05-0.45; P<0.001). EUSGJ was superior in terms of length of hospital stay (mean difference [MD] -4.79, 95%CI -6.52 to -3.06; P<0.001), overall complications (OR 0.24, 95%CI 0.17-0.33, P<0.001), ileus (OR 0.07, 95%CI 0.02-0.17; P<0.001), operative time (MD -96.89, 95%CI -146.16 to -47.61; P<0.001) and infection (OR 0.17, 95%CI 0.08-0.37; P<0.001). No significant differences were demonstrated in terms of clinical success, reintervention, hemorrhage, and perforation.

Conclusions EUSGJ is a safe alternative to SGJ for the palliation of GOO in the arsenal of expert endoscopists. Further research is warranted to establish its place in the complex decision-making process around GOO management in the context of individualized patient care.

Keywords Endoscopic, gastrojejunostomy, gastric, obstruction, meta-analysis

Ann Gastroenterol 2026; 39 (XX): 1-9

Conflict of Interest: None

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Received 9 November 2025; accepted 30 March 2026; published online 26 June 2026

DOI: https://doi.org/10.20524/aog.2026.1085

Introduction

Gastric outlet obstruction (GOO) is a common clinical entity caused by mechanical obstruction occurring at the antrum, pylorus or duodenum, and characterized by impaired gastric emptying [1]. It usually presents as a complication of malignant diseases, such as gastric or pancreatic adenocarcinoma or cholangiocarcinoma, but it may also present at the advanced stage of benign diseases, such as peptic ulcer disease or Crohn's disease [2]. Due to the progressive loss of gastrointestinal (GI) continuity, it presents with various clinical manifestations, which may range from non-specific abdominal pain and vomiting to a compromised nutritional status and significant weight loss [3].

Well-researched methods for the restoration of GI continuity and GOO palliation are endoscopic enteral stenting (ES) and surgical gastrojejunostomy (SGJ). The traditional method of SGJ has widely been used to treat the symptoms of GOO in patients with unresectable malignancies, whose life expectancy and preoperative performance status allow them to overcome the short-term morbidity burden of surgery [4]. Laparoscopic SGJ has been distinguished for its high success rates and low requirement for reintervention [5]. It remains, however, an invasive modality that may be associated with a significant risk of postoperative morbidity [6].

Recent advances in GI endoscopy have led to the development of the novel technique of endoscopic ultrasound-guided gastrojejunostomy (EUSGJ), which has emerged as an alternative to already available treatments [7]. EUSGJ involves endoscopically inserting a lumen-apposing metal stent (LAMS) connecting the stomach with a loop of small bowel distal to the obstruction under ultrasound or fluoroscopic guidance, thereby allowing for the endoscopic creation of a complete gastric bypass [8]. Studies have demonstrated the high success and low adverse event rates of this procedure, which render it an attractive option for the management of GOO in poor surgical candidates [9,10].

The aim of this systematic review and meta-analysis was to compare the safety and efficacy of EUSGJ vs. SGJ for the treatment of GOO of any etiology. Primary outcomes of focus were technical and clinical success rates, postoperative length of stay (LOS), operative time and overall complication rates. Secondary outcomes included rates of infection, ileus, hemorrhage, perforation and reintervention. By synthesizing available evidence, we aimed to guide clinicians in the selection of the most appropriate approach for the management of GOO.

Materials and methods

Literature search

The systematic review and meta-analysis were conducted in compliance with a protocol submitted to the International Prospective Register of Systematic Reviews (PROSPERO), with registration number CRD42024614102.

A comprehensive search of the published literature was undertaken in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines for studies that evaluate healthcare interventions [11]. We aimed to identify research publications that specifically compared the efficacy and safety of EUSGJ vs. SGJ for the management of GOO of all causes. The PubMed, Embase, MEDLINE and Cochrane databases were searched for eligible studies until November 2025, as per the PRISMA checklist. The search string was formulated using the following terms: ("gastric outlet obstruction" OR "delayed gastric emptying" OR "palliation" OR "gastroparesis") AND ("endoscopic gastroenterostomy" OR "endoscopic gastrojejunostomy" OR "axios" OR "stent") AND ("surgical gastrojejunostomy" OR "open gastrojejunostomy" OR "laparoscopic gastrojejunostomy" OR "gastric bypass" OR "roux-en-y gastrojejunostomy" OR "gastroenteric anastomosis" OR "gastroenterostomy") AND ("complications" OR "adverse events" OR "morbidity" OR "mortality" OR "adverse events" OR "leak" OR "leakage" OR "anastomotic failure" OR "anastomotic dehiscence" OR "bleeding" OR "hemorrhage" OR "patency" OR "length of hospital stay" OR "hospitalization" OR "inpatient stay" OR "recovery" OR "operative time" OR "surgery duration" OR "procedure time" OR "operative duration" OR "reoperation"). The search string was standardized across all search engines with the appropriate use of Boolean operators.

Two reviewers (IK and VV) were independently involved in conducting the first stage of the literature review, identifying search results from all search engines. After the initial retrieval of yielded studies, duplicates were excluded. During the second stage of the literature review, all retrieved publications were assessed for relevance by screening their titles and abstracts. During the last stage of the screening process, a detailed full-text analysis was undertaken to identify the studies ultimately included in the qualitative and quantitative synthesis. References from the included full-text articles were also screened for relevance and potential inclusion. In cases of disagreement during the decision-making process, a third, independent reviewer (DT) was consulted about study inclusion. The majority opinion was used to arrive at the final decision. Data extraction was conducted on a pre-drafted data extraction sheet recording study parameters, patient demographics and clinical outcomes.

Inclusion and exclusion criteria

In this systematic review and meta-analysis we included studies that specifically assessed the comparative efficacy and safety of EUSGJ vs. SGJ for the management of GOO. The studies ultimately included in the synthesis had to meet the following criteria: (1) to report a direct comparison of the clinical outcomes of EUSGJ vs. SGJ; (2) both techniques had to be used for the treatment of GOO; (3) to include only adult patients; and (4) to be published in the English language. Manuscripts that were not yet published, studies in the gray literature, manuscripts with only abstracts available online, randomized controlled trials (RCTs) with only protocols available online and no published results, conference abstracts and posters were excluded. No restrictions were set on the year of publication.

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Data extraction, clinical outcome definitions and statistical analysis

Extracted data from each study included: (1) title of publication; (2) name of first author; (3) year of publication; (4) study type; (5) country of origin; (6) patient demographics; (7) numbers of study participants; (8) technical success rates; (9) clinical success rates; (10) operative time; (11) postoperative LOS; (12) number of overall reported complications; (13) number of reinterventions; (14) postoperative ileus rates; (15) postoperative infection rates; (16) postoperative perforation rates; and (17) postoperative hemorrhage rates.

Technical success was defined as the adequate positioning and deployment of a stent during EUSGJ, or the technical feasibility of performing an SGJ. Clinical success was defined as the ability to tolerate diet without vomiting. Pooled data were used for SGJ, regardless of operative technique: open, laparoscopic or robotic. Operative time is presented in min. LOS is presented in days. For studies in which the overall number of complications was not clearly reported, the total number of complications was calculated as the sum of all subsequent reported complications. Nasogastric tube placement, ES placement, percutaneous endoscopic gastrostomy decompression, feeding jejunostomy, endoscopic dilatation or reoperation were all regarded as reinterventions. The postoperative development of hospital-acquired pneumonia, bacteremia or sepsis was considered as a postoperative infection.

In the event of a study not reporting outcomes in any of the predefined categories of extractable data above (1-17), a subgroup meta-analysis was performed after the exclusion of that study. Data in this study are presented as mean ± standard deviation, odds ratio (OR) and 95% confidence interval (CI). Missing means and standard deviations were calculated from extracted data reported either as median (interquartile range) or median (minimum to maximum), as per the guidance provided by the Cochrane Collaboration for the handling of missing statistics in the meta-analysis of continuous outcomes [12]. These meta-calculations were performed using the formulas provided by Wan et al [13].

Statistical analysis

Statistical analysis was performed using the Reviewer Manager 5.4.1 software (Review Manager [RevMan] version 5.4.1 Copenhagen: The Nordic Cochrane Center, Denmark, the Cochrane Collaboration, 2020). The value of $P<0.05$ was used as the cutoff level for statistical significance. An I2 test result of >50% was regarded as the cutoff value indicating high data heterogeneity. Fixed effects (FE) models were used in analyses where data heterogeneity was considered low, and random effects (RE) models where heterogeneity was considered high.

Risk of bias assessment

The risk of bias assessment was conducted independently by 2 separate authors (IK and DT), with a third author (AW) consulted in cases of disagreement.

For each study included in the qualitative synthesis, a risk of bias evaluation was undertaken using the Risk Of Bias in Non-randomized Studies (ROBINS-I) assessment tool provided by the Cochrane Collaboration [14]. During the evaluation, the following domains were examined, investigating for possible risk of bias due to: (1) confounding; (2) participant selection; (3) classification of interventions; (4) deviation from intended interventions; (5) missing data; (6) measurement of outcomes; and (7) selection of reported results. Subsequently, for each study included in the meta-analysis, an overall assessment of low, moderate, serious or critical risk of bias was provided. The traffic light and summary of bias plots were created using the Risk Of Bias VISualization (ROBVIS) tool [15].

For each of our meta-analysis outcomes, we performed a publication bias assessment by providing the respective Begg's funnel plots.

We used the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) approach to appraise the certainty of evidence provided by this meta-analysis [16]. For each outcome, the following domains were examined drawing information from the included studies: (1) risk of bias according to our as above evaluation, (2) inconsistency, (3) indirectness, (4) imprecision, (5) publication bias, (6) size of effect, (7) plausible confounding, (8) dose response gradient. For each of the above domains, an assessment of not serious, serious, very serious or extremely serious risk was provided. The Summary of Findings table was developed using the GRADEpro online tool [17].

Results

Literature search yield and data extraction

The identification phase of the literature search yielded a total of 1428 records from across databases. After the exclusion of 352 duplicate records, the total number of studies was reduced to 1076. After the exclusion of 1048 records during the title and abstract screening phase, 28 full-text articles were sought for retrieval and were assessed for eligibility for inclusion. Of these records, 11 articles constituting either conference abstracts or posters, 1 review article, 1 editorial and 1 RCT protocol with no published results were excluded. Five studies were further excluded, as either the design, protocol or methods investigated a different Population-Intervention-Comparison-Outcome (PICO) question to the one in our study.

A total of 9 retrospective studies were deemed eligible and were ultimately included in the qualitative and quantitative

synthesis (Fig. 1) [18-26]. Collectively, these studies reported data for a total of 1086 patients: 654 patients in the EUSGJ cohort and 432 patients in the SGJ cohort.

All studies in the datasets consisted of retrospective reviews, 6 being multi- and 3 being single-center. Countries of study origin were France, Belgium, Spain, China, Japan and the United States of America. Overviews of extracted study data, summarizing study characteristics, patient demographics and clinical outcomes, are outlined in Supplementary Tables 2, 3.1 and 3.2.

Meta-analysis outcomes

A pooled analysis was conducted using the extracted data presented in Supplementary Tables 3.1 and 3.2 to demonstrate statistically significant differences in the efficacy and safety between EUSGJ and SGJ for the treatment of GOO. More specifically, a series of meta-analyses were performed on the following domains of extracted data: (1) technical and (2) clinical success rates; (3) LOS; (4) overall complication rates; (5) ileus rates; (6) operative time; (7) reintervention rates; (8) infection rates; (9) rates of postoperative hemorrhage; and (10) perforation rates. In domains where data were not universally reported across studies, as demonstrated in Supplementary Tables 3.1 and 3.2, subgroup analyses were performed after the exclusion of studies with missing data.

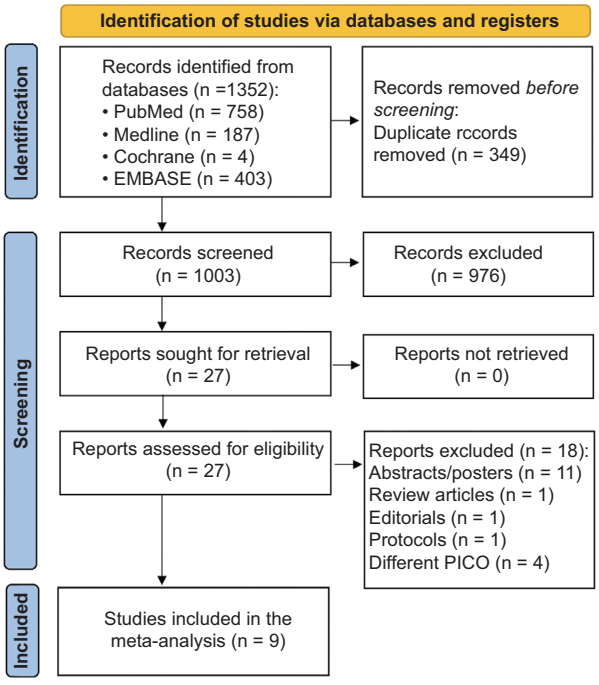

Figure 1 PRISMA flow diagram

Non-statistically significant meta-analysis observations

The pooled analysis did not demonstrate statistically significant differences between EUSGJ and SGJ regarding clinical success, reintervention rates, rates of postoperative hemorrhage and bowel perforation, as demonstrated in Supplementary Table 4.

Statistically significant meta-analysis outcomes

Pooled analysis of data from all 9 studies that compared the technical success rates between EUSGJ and SGJ demonstrated a statistically significant difference in favor of the SGJ group (OR 0.16, 95%CI 0.05-0.45; P<0.001). This calculation was performed using an FE model as data were homogenous (I^2=0%). The outcome of this analysis is demonstrated in Fig. 2. The funnel plot for this meta-analysis is shown in Supplementary Fig. 2.

Regarding postprocedural LOS, the subgroup meta-analysis of 8 studies indicated that EUSGJ was significantly associated with a LOS approximately 5 days shorter when compared to SGJ (mean difference -4.79, 95%CI -6.52 to -3.06; P<0.001). This calculation was conducted using an RE model as data were heterogeneous (I^2=77%). The forest plot of this meta-analysis is shown in Fig. 3, and the respective funnel plot in Supplementary Fig. 3.

When comparing overall complication rates of EUSGJ vs. SGJ, pooled subgroup analysis from 7 studies demonstrated a statistically significant difference in favor of EUSGJ. More specifically, we showed that EUSGJ was associated with 76% lower odds of overall complications when compared to SGJ (OR 0.24, 95%CI 0.17-0.33; P<0.001). For this calculation, an FE model was used, as data heterogeneity was low (I^2=48%). The outcome of this analysis is presented in Fig. 4, and the corresponding funnel plot is shown in Supplementary Fig. 4.

A subgroup analysis of 5 studies indicated a statistically significant difference in favor of EUSGJ concerning the rates of postoperative ileus. The pooled OR was calculated at 0.07 (95%CI 0.02-0.17; P<0.001), suggesting that EUSGJ is associated with approximately 93% lower odds of developing postoperative ileus. For this calculation an FE model was used, as data were homogenous (I^2=0%). The forest plot of this analysis is shown in Fig. 5 and the associated funnel plot in Supplementary Fig. 5.

Pooled analysis from 5 studies demonstrated that there was also a statistically significant difference in terms of operative time between the 2 procedures. The operative time of EUSGJ was shorter by approximately 97 minutes on average (mean difference -96.89, 95%CI -146.16 to -47.61; P<0.001). For this calculation an RE model was used, as data were heterogeneous (I^2=97%). This meta-analysis forest plot is shown in Fig. 6, with its corresponding funnel plot in Supplementary Fig. 6.

Figure 2 EUSGJ vs. SGJ; technical success rates
EUSGJ, ultrasound-guided gastrojejunostomy, SGJ, surgical gastrojejunostomy; CI, confidence interval

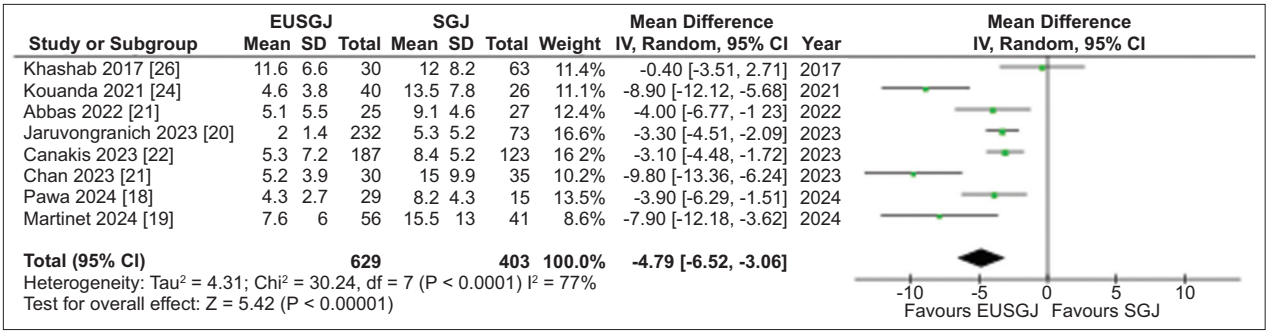

Figure 3 EUSGJ vs. SGJ; postprocedural LOS (days)
EUSGJ, ultrasound-guided gastrojejunostomy, SGJ, surgical gastrojejunostomy; CI, confidence interval; LOS, length of hospital stay

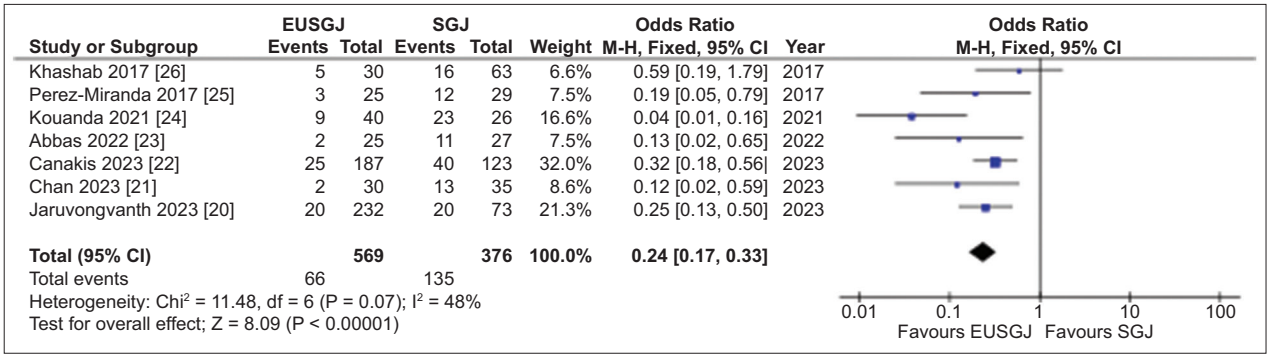

Figure 4 EUSGJ vs. SGJ; overall complications
EUSGJ, ultrasound-guided gastrojejunostomy, SGJ, surgical gastrojejunostomy; CI, confidence interval

Finally, a subgroup meta-analysis of 5 studies indicated a statistically significant difference between EUSGJ and SGJ regarding postoperative infection rates. More specifically, we showed that EUSGJ was associated with lower odds of postoperative infections (OR 0.17, 95%CI 0.08-0.37; P<0.001). For this calculation we used an FE model, given the low heterogeneity of the meta-data (I^2=32%). This analysis outcome is shown in Supplementary Fig. 1, and the associated funnel plot is shown in Supplementary Fig. 7.

Risk of bias assessment

The authors' risk of bias assessment of the individual studies included in the quantitative synthesis is outlined in the traffic light and summary plots in Supplementary Figs. 7 and 8.

In summary, all original studies included in this meta-analysis demonstrated a critical overall risk of bias. More specifically, in all studies, no concerns were raised during the risk of bias assessment as regards bias due to misclassification of

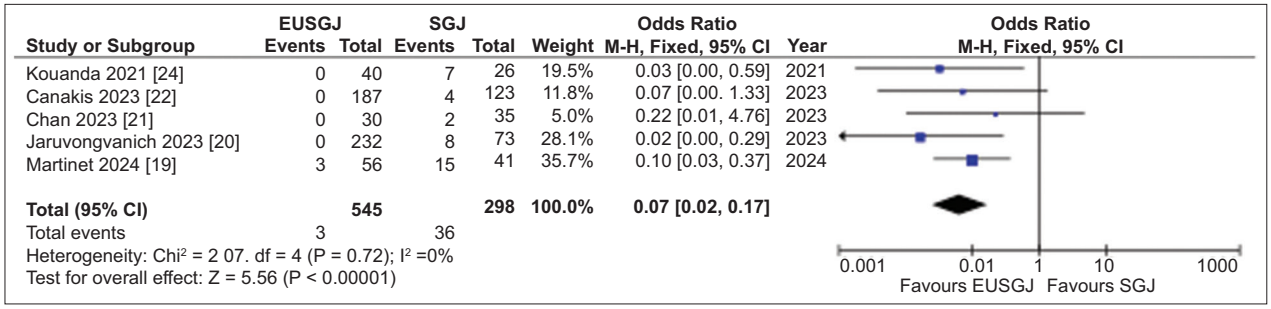

Figure 5 EUSGJ vs. SGJ; rates of postoperative ileus
EUSGJ, ultrasound-guided gastrojejunostomy, SGJ, surgical gastrojejunostomy; CI, confidence interval

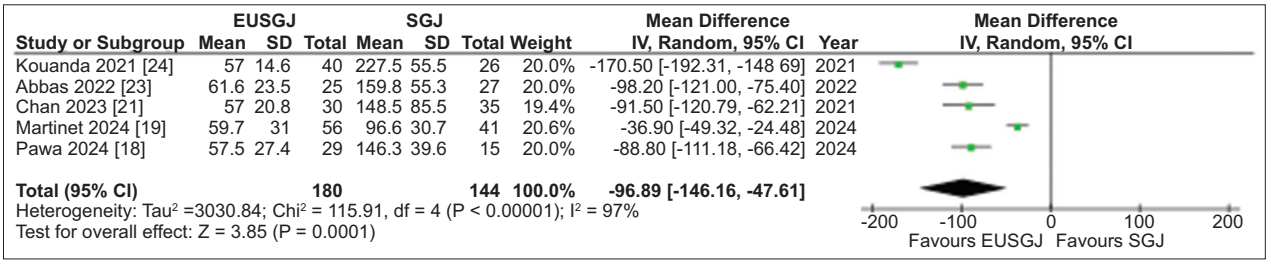

Figure 6 EUSGJ vs. SGJ; operative time (min)
EUSGJ, ultrasound-guided gastrojejunostomy, SGJ, surgical gastrojejunostomy; CI, confidence interval

interventions, deviations from intended interventions, missing data, measurement of outcomes, or selection of reported results. Thus, in domains D3-D7 all studies were deemed to be at low risk of bias.

In all the studies included in the meta-analysis, the selection of the treatment modalities offered to patients was consistently individualized to patients' comorbidities and available clinical expertise. This non-randomized patient allocation to treatment cohorts may introduce risk of bias due to confounding, and thus we judged all studies to be at critical risk in domain D1. Finally, due to the inherent bias found in all studies of a retrospective nature, and therefore lacking prospective selection of participants, all studies in this meta-analysis were further judged to be at critical risk in domain D2: bias due to participant selection.

Our certainty of evidence appraisal on an outcome level is demonstrated in Supplementary Table 5. Pooled analysis on the rates of postoperative infection was deemed to be of high certainty of evidence. Pooled analysis on technical success, postoperative ileus, and operative time was deemed to be of moderate certainty of evidence. The certainty of evidence for LOS and overall complications was deemed to be low and very low, respectively.

Discussion

In our systematic review and meta-analysis we compared the safety and efficacy of EUSGJ vs. SGJ for the management of GOO. We indicated that SGJ was significantly associated with higher odds of technical success compared to EUSGJ (OR 0.16, 95%CI 0.05-0.45; P<0.001). However, EUSGJ was demonstrated to be associated with a shorter operative time of 96.89 min 95%CI -6.52 to -3.06; P<0.001). In addition, we demonstrated that EUSGJ was associated with lower odds of postoperative complications (OR 0.24, 95%CI 0.17-0.33; P<0.001), lower odds of postoperative ileus (OR 0.07, 95%CI 0.02-0.17; P<0.001), lower odds of postoperative infection (OR 0.17, 95%CI 0.08-0.37; P<0.001), and finally a postoperative LOS comparably shorter by approximately 5 days (mean difference -4.79, 95%CI -6.52 to -3.06; P<0.001). No statistically significant differences were demonstrated in terms of clinical success rates, bowel perforation, bleeding or requirement for reintervention.

The endoscopic palliation of malignant GOO in multimorbid patients with a poor life expectancy constitutes an appealing replacement for surgical intervention. ES is an established safe and effective procedure for the management of GOO in this patient population, but it has been demonstrated to be associated with higher rates of GOO recurrence and requirement for reintervention in comparison with SGJ or EUSGJ [27]. EUSGJ has emerged as a promising option in the clinicians' arsenal for the treatment of GOO; by using LAMS, the formation of a complete gastric bypass in combination with the endoscopic, thus minimally invasive, nature of the procedure offers an attractive alternative to the traditional surgical approach. Recently, the European Society of Gastrointestinal Endoscopy guidelines have added the strong recommendation, based on low-quality evidence, that EUSGJ may be performed in the expert setting as an alternative to surgery or stenting [28].

In the available literature, EUSGJ has primarily been

studied with the use of 15 mm-diameter LAMS. More recently, a retrospective study comparing the use of 20 vs. 15 mm LAMS during EUSGJ demonstrated similar technical success, clinical success and adverse events rates for the 2 sizes of LAMS. Notably, a higher proportion of patients in the cohort of larger LAMS tolerated soft or complete diets [29]. Even with the use of the larger LAMS, however, an anastomotic size of 20 mm might still be intuitively considered by surgeons to be an anastomosis of dangerously small caliber. Interestingly, however, it has been previously suggested that the functional diameter of an SGJ might not be greater than 20 mm [30]. This could explain why our subgroup analysis demonstrated no statistically significant difference in the clinical success rates between the 2 methods.

In our study, we demonstrated that EUSGJ was safer than SGJ, by demonstrating lower odds of the development of overall complications, postoperative ileus or infection. The most significant complication of EUSGJ described in the literature is the misdeployment of the LAMS, after the formation of the extraluminal tract when puncturing the stomach wall [31]. During the procedure, there have been accounts of the wire pushing the loop of small bowel away, resulting in the misdeployment of the stent [10,32]. In the studies included in the quantitative synthesis, the specific rates of stent misdeployment were not directly compared against adjusted rates of SGJ failure, and therefore no pooled data were available for a subgroup analysis. However, in a recent international multicenter study of 467 EUSGJ operations, it was found that stent misdeployment occurred in approximately 10% of cases [33]. Of these cases of stent misdeployment, 11% were treated operatively and 89% were managed either conservatively or endoscopically.

Despite the promising data in favor of EUSGJ presented in this study, it is not a universally implemented modality for the management of GOO. Its technically challenging nature, coupled with the lack of standardization of the technique, are factors that are likely to impede clinical training [34]. In a study using cumulative sum curve analysis to evaluate the learning curve of EUSGJ for a single expert endoscopist, it was shown that 25 cases would be necessary for the clinician to become proficient, and 40 cases would be required to achieve mastery of the procedure [35]. In our included studies, EUSGJ was performed in tertiary medical centers by specialized endoscopists, which may explain the statistically significant differences in the technical success rates between the 2 methods. Therefore, the conventional approach of an SGJ remains relevant, as it may be performed in hospitals without available EUSGJ-trained endoscopists [36].

In our patient pool, the leading cause of GOO was pancreatic cancer, followed by gastric cancer. At present, the various international community guidelines have not yet adapted to the most recent advances in interventional gastrointestinal endoscopy, with no recommendations made for the use of EUSGJ. Additionally, no consensus exists among the National Comprehensive Cancer Network (NCCN), the European Society for Medical Oncology (ESMO), the National Institute for Health and Care Excellence (NICE) of the United Kingdom, or the Japanese and Korean Treatment guidelines for the management of malignant GOO. More specifically, NICE and NCCN guidelines recommend open or laparoscopic SGJ, with or without feeding jejunostomy over ES, for patients with malignant GOO and an expected overall survival of more than 3 months [37-39]. The corresponding ESMO and Korean guidelines advocate for ES over SGJ, as this has been associated with a lower complication rate and shorter postoperative LOS [40,41]. Finally, the Japanese Gastric Cancer Association recommends either palliative gastrectomy or SGJ, depending on the resectability of the tumor and other risk–benefit considerations [42]. In other available guidelines, it is recommended that a multidisciplinary approach would be most appropriate to help patients decide between available treatments [37,38,43,44].

Several limitations should be considered when interpreting the findings of this meta-analysis. The retrospective nature of the studies included may introduce a certain degree of bias, as demonstrated in our risk of bias assessment. Additionally, all EUSGJ procedures were performed in selected patients by specialized endoscopists in tertiary medical centers, which may introduce a degree of confounding and potential publication bias. It should be noted that statistical evaluation of potential publication bias is limited by the small number of included studies, suggesting that publication bias cannot be entirely excluded. In addition, meta-calculations were performed to estimate missing means and standard deviations from the reported data of included studies, which may also imply bias that is not possible to quantify and was not taken into consideration in the bias assessment. Despite these calculations, one of the strengths of our meta-analysis was that inter-study data heterogeneity was predominantly low (I^2=48% for overall complications, I^2=32% for infection), or zero (I^2=0% for technical success, ileus), which ultimately suggests the robustness of this study's results.

In conclusion, in this systematic review and meta-analysis we compared the safety and efficacy of EUSGJ vs. SGJ for the treatment of GOO. SGJ was demonstrated to have higher technical success rates compared to EUSGJ. However, we demonstrated significant differences in favor of EUSGJ in terms of postoperative LOS, overall complication rates, operative time, postoperative ileus and infection rates. EUSGJ has emerged as a promising approach for the management of GOO in the arsenal of expert endoscopists. Standardization of the technique and further research in the form of RCTs are warranted to establish its role in the complex decision-making process of GOO management, accounting for the distinct underlying pathology, altered anatomy and individual performance status of each patient.

Summary Box

What is already known:

- Endoscopic ultrasound-guided gastrojejunostomy (EUSGJ) endoscopically connects the stomach with a loop of small bowel to facilitate a minimally invasive, endoscopic gastric bypass, utilizing a lumen-apposing metal stent
- It has emerged as a promising new alternative to surgical gastrojejunostomy (SGJ) for the treatment of gastric outlet obstruction

What the new findings are:

- SGJ was superior to EUSGJ in terms of technical success
- EUSGJ was superior to SGJ in terms of postoperative length of stay, overall complications, postoperative ileus, operative time, and infection
- There were no significant differences between the 2 methods in the rates of clinical success, reintervention, hemorrhage, or perforation

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Author Queries???

AQ1: Kindly cite the supplementary figure 9 in text part

Supplementary material

Supplementary Table 1 PRISMA 2020 checklist

Section and Topic	Item #	Checklist item	Location where item is reported
		TITLE	
Title	1	Identify the report as a systematic review.	Title page
		ABSTRACT	
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	
		INTRODUCTION	
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Main text section 1
Objectives	4	Provide an explicit statement of the objective (s) or question (s) the review addresses.	Main text section 1
		METHODS	
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Main text section 2.1, 2.2
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Main text section 2.1
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Main text section 2.1
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Main text section 2.2
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Main text section 2.3
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g., for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Main text section 2.3
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Main text section 2.3
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool (s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Main text section 2.4
Effect measures	12	Specify for each outcome the effect measure (s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Main text section 2.3
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Main text section 2.3
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Main text section 2.3
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Main text section 2.3
	13d	Describe any methods used to synthesize results and provide a rationale for the choice (s). If meta-analysis was performed, describe the model (s), method (s) to identify the presence and extent of statistical heterogeneity, and software package (s) used.	Main text section 2.3
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g., subgroup analysis, meta-regression).	Main text section 2.3
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Main text section 2.3
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Main text section 2.4
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Main text section 2.4

(*Contd...*)

Supplementary Table 1 *(Continued)*

Section and Topic	Item #	Checklist item	Location where item is reported
		RESULTS	
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Main text section 3.1
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Main text section 3.1
Study characteristics	17	Cite each included study and present its characteristics.	Supplementary Table 2
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Supplementary Figures 7.8
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g., confidence/credible interval), ideally using structured tables or plots.	Supplementary Tables 3.1, 3.2
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Main text sections 3.2.1, 3.2.2, 3.3
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g., confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Main text sections 3.2.1, 3.2.2
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Main text section 3.2.2
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	Main text section 3.2.2
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Main text section 3.3
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Main text section 3.3
		DISCUSSION	
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Main text section 4
	23b	Discuss any limitations of the evidence included in the review.	Main text section 4
	23c	Discuss any limitations of the review processes used.	Main text section 4
	23d	Discuss implications of the results for practice, policy, and future research.	Main text section 4
		OTHER INFORMATION	
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	PROSPERO No. CRD42024614102
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	PROSPERO No. CRD42024614102
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	Title page
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Title page
Competing interests	26	Declare any competing interests of review authors.	Title page
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Main text section 2

Supplementary Table 2 Characteristics of included studies and patient demographics

Author; year [ref.]	Countries of origin	Total patients (n)	EUSGJ (n)	SGJ (n) EUSGJ	Age (years, mean±SD		Female sex (n, %)	
					SGJ	EUSGJ	SGJ	
Khashab; 2017 [26]	Multicenter; US, Japan	93	30	63	70±13.3	68±9.6	13 (43%)	31 (49%)
Perez-Miranda; 2017 [25]	Multicenter; Spain, France, US	54	25	29	-	-	14 (56%)	7 (24.1%)
Kouanda; 2021 [24]	Single-center; US	66	40	26	70.5±11.5	69.7±15.4	17 (42.5%)	11 (42.3%)
Abbas; 2022 [23]	Single-center US	52	25	27	65.3±10.2	61.3±14.8	14 (56%)	14 (52%)
Canakis; 2023 [22]	Multicenter; US	310	187	123	67.50±12.60	61.60±13.50	76 (40.6%)	68 (55.3%)
Chan; 2023 [21]	Multicenter; Japan, China	65	30	35	62±13.7	67.5±9.9	8 (26.6%)	1 (2.8%)
Jaruvongvanich; 2023 [20]	Multicenter; US, Belgium	305	232	73	64.5±12.3	62.1±14.4	97 (41.8%)	37 (50.6%)
Martinet; 2024 [19]	Multicenter; France	97	56	41	70.1±14.4	67±16.9	24 (42.8%)	16 (39%)
Pawa; 2024 [18]	Single-center; US	44	29	15	66.3±12.6	64.1±13.7	10 (34%)	7 (47%)

EUSGJ, endoscopic ultrasound-guided gastrojejunostomy; SGJ, surgical gastrojejunostomy; SD, standard deviation

Supplementary Table 3.1 Outline of clinical outcomes reported in included studies

Author; year [ref.]	Technical success (n, %)		Clinical success (n, %)		LOS (days, mean±SD)		Complications (n, %)		Ileus (n, %)	
	EUSGJ	SGJ	EUSGJ	SGJ	EUSGJ	SGJ	EUSGJ	SGJ	EUSGJ	SGJ
Khashab; 2017 [26]	26 (87%)	63 (100%)	26 (87%)	57 (90%)	11.6±6.6	12±8.2	5 (16%)	16 (25%)	-	-
Perez-Miranda; 2017 [25]	23 (88%)	29 (100%)	21 (84%)	28 (90%)	-	-	3 (12%)	12 (41%)	-	-
Kouanda; 2021 [24]	37 (92.5%)	26 (100%)	34 (85%)	22 (84%)	4.6±3.8	13.5±7.8	9 (22.5%)	23 (88.4%)	0 (0%)	7 (26.9%)
Abbas; 2022 [23]	25 (100%)	27 (100%)	22 (88%)	23 (85%)	5.1±5.5	9.1±4.6	2 (8%)	11 (41%)	-	-
Canakis; 2023 [22]	183 (97.9%)	123 (100%)	176 (94.1%)	116 (94.3%)	5.31±7.28	8.45±5.25	25 (13.4%)	40 (33.3%)	0 (0%)	4 (3.25%)
Chan; 2023 [21]	28 (93.3%)	35 (100%)	28 (93.3%)	28 (80%)	5.25±3.9	15±9.9	2 (6.6%)	13 (37.1%)	0 (0%)	2 (5.7%)
Jaruvongvanich; 2023 [20]	228 (98.3%)	73 (100%)	228 (98.3%)	66 (90.4%)	2±1.4	5.3±5.2	20 (8.6%)	20 (27.4%)	0 (0%)	8 (10.9%)
Martinet; 2024 [19]	49 (87.5%)	40 (97.6%)	51 (91.1%)	35 (85.4%)	7.6±6	15.5±13	-	-	3 (5.4%)	15 (36.6%)
Pawa; 2024 [18]	29 (100%)	15 (100%)	29 (100%)	15 (100%)	4.3±2.7	8.2±4.3	-	-	-	-

EUSGJ, endoscopic ultrasound-guided gastrojejunostomy; SGJ, surgical gastrojejunostomy; SD, standard deviation; LOS, length of hospital stay

Supplementary Table 3.2 Outline of clinical outcomes reported in included studies (continued)

Author; year [ref.]	Operative time (minutes, mean±SD)		Reintervention (n, %)		Infection (n, %)		Hemorrhage (n, %)		Perforation (n, %)	
	EUSGJ	SGJ	EUSGJ	SGJ	EUSGJ	SGJ	EUSGJ	SGJ	EUSGJ	SGJ
Khashab; 2017 [26]	-	-	-	-	-	-	-	-	-	-
Perez-Miranda; 2017 [25]	-	-	-	-	-	-	-	-	-	-
Kouanda; 2021 [24]	57.0±14.6	227.5±55.5	-	-	2 (5.0%)	9 (34.6%)	1 (2.5%)	2 (7.7%)	1 (2.5%)	0 (0%)
Abbas; 2022 [23]	61.6±23.5	159.8±55.3	8 (32%)	11 (40.7%)	0 (0%)	8 (30%)	0 (0%)	2 (7%)	1 (4%)	-
Canakis; 2023 [22]	-	-	29 (15.5%)	2 (1.63%)	0 (0%)	5 (4%)	3 (1.6%)	5 (4.07%)	4 (2.14%)	0 (0%)
Chan; 2023 [21]	57±20.8	148.5±85.5	1 (3.3%)	6 (17.1%)	0 (0%)	3 (8.5%)	-	-	-	-
Jaruvongvanich; 2023 [20]	-	-	2 (0.9%)	10 (13.7%)	8 (3.4%)	4 (5.5%)	4 (1.7%)	2 (2.7%)	0 (0%)	1 (1.4%)
Martinet; 2024 [19]	59.7±31.7	96.6±30.7	7 (12.5%)	1 (2.4%)	-	-	-	-	-	-
Pawa; 2024 [18]	57.5±27.4	146.3±39.6	-	-	-	-	-	-	-	-

EUSGJ, endoscopic ultrasound-guided gastrojejunostomy; SGJ, surgical gastrojejunostomy; SD, standard deviation

Supplementary Table 4 EUSGJ vs. SGJ: non-statistically significant meta-analysis outcomes

Domain	Type	Meta-result: EUSGJ vs. SGJ	P-value	Method
Clinical success	All studies	OR 1.37 (95%CI 0.86-2.16)	0.18	FE model, I^2=38%
Reintervention	Subgroup (5 studies)	OR 0.83 (95%CI 0.11-6.02)	0.86	RE model, I^2=87%
Hemorrhage	Subgroup (4 studies)	OR 0.7 (95%CI 0.25-1.97)	0.5	FE model, I^2=0%
Perforation	Subgroup (4 studies)	OR 1.67 (95%CI 0.46-6.08)	0.44	FE model, I^2=21%

EUSGJ; endoscopic ultrasound-guided gastrojejunostomy, SGJ; surgical gastrojejunostomy, OR; odds ratio, CI; confidence interval, FE; fixed effects, RE; random effects

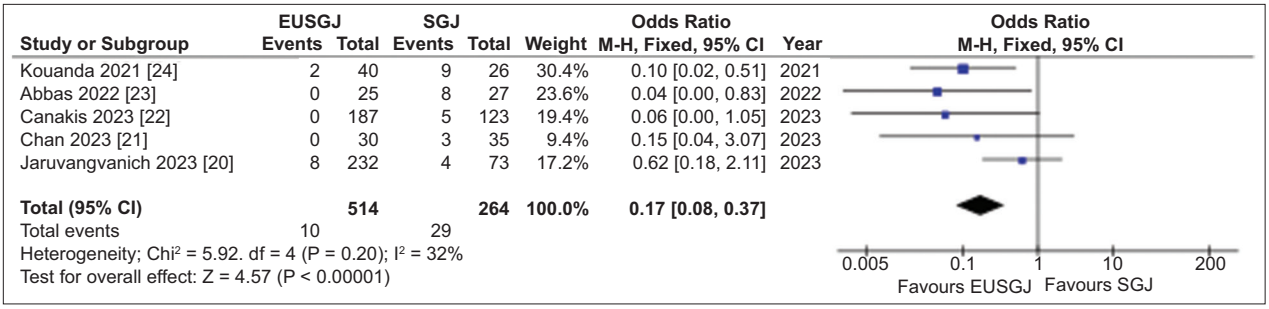
Supplementary Table 5 GRADE Summary of Findings

EUSGJ compared to SGJ for GOO

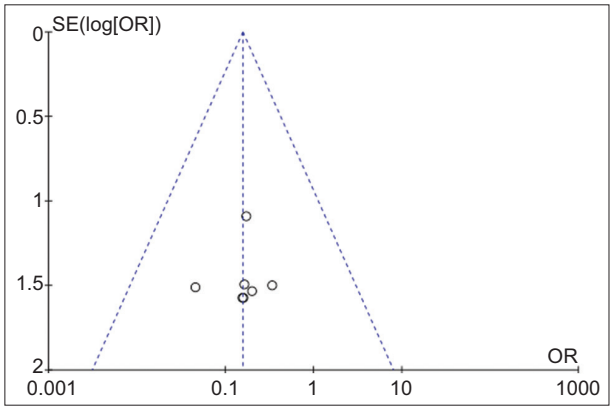
Patient or population: Gastric Outlet Obstruction
Intervention: EUSGJ
Comparison: SGJ

Outcomes	No of participants (studies)	Certainty of the evidence (GRADE)	Relative effect (95% CI)	Risk with SGJ	Risk difference with EUSGJ
Technical success	1086 (9 non-randomised studies)	Moderate	OR 0.16 (0.05 to 0.45)	998 per 1,000	12 fewer per 1,000 (42 fewer to 3 fewer)
Length of stay (LOS)	1032 (8 non-randomised studies)	Low	MD 4.79 days lower (6.52 lower to 3.06 lower)	Mean LOS 7.64 days	4.79 days lower (6.52 lower to 3.06 lower)
Overall complications	945 (7 non-randomised studies)	Very low	OR 0.24 (0.17 to 0.33)	359 per 1,000	241 fewer per 1,000 (272 fewer to 203 fewer)
Postoperative ileus	843 (5 non-randomised studies)	Moderate	OR 0.07 (0.02 to 0.17)	121 per 1,000	111 fewer per 1,000 (118 fewer to 98 fewer)
Operative time	324 (5 non-randomised studies)	Moderate	MD 96.89 min lower (146.16 lower to 47.61 lower)	Mean operative time 178.3 min	96.89 min lower (146.16 lower to 47.61 lower)
Postoperative infection	798 (5 non-randomised studies)	High	OR 0.17 (0.08 to 0.37)	35 per 1,000	29 fewer per 1,000 (32 fewer to 22 fewer)

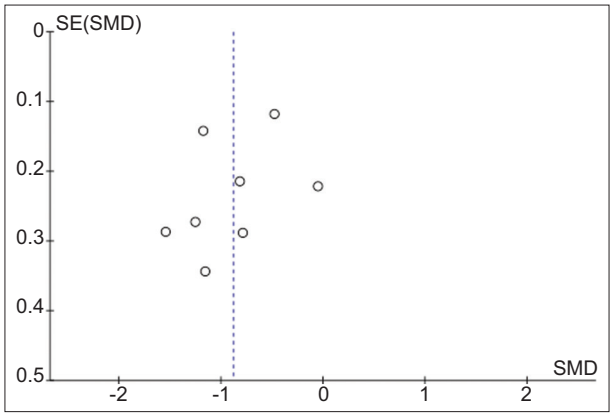
*The risk in the intervention group (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).
CI, confidence interval; MD, mean difference; OR, odds ratio
GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect



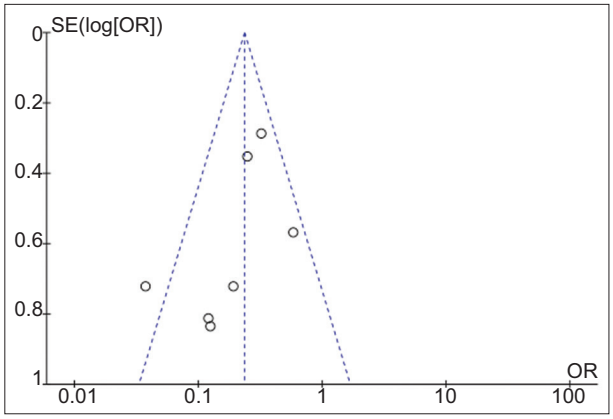
Supplementary Figure 1 EUSGJ vs. SGJ; postoperative infection rates
EUSGJ, ultrasound-guided gastrojejunostomy, SGJ, surgical gastrojejunostomy; CI, confidence interval



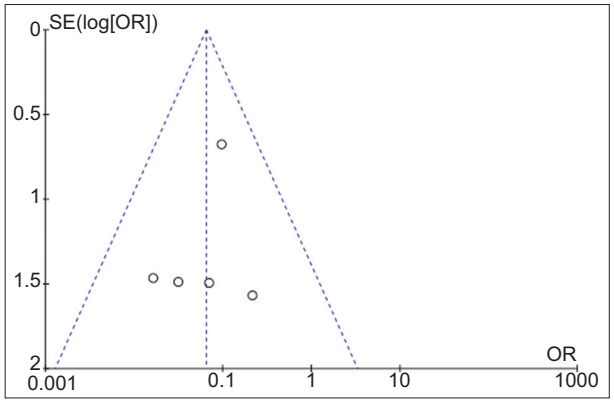
S**upplementary Figure 2** Funnel plot: postprocedural length of hospital stay
SE, standard error; SMD, standard mean difference



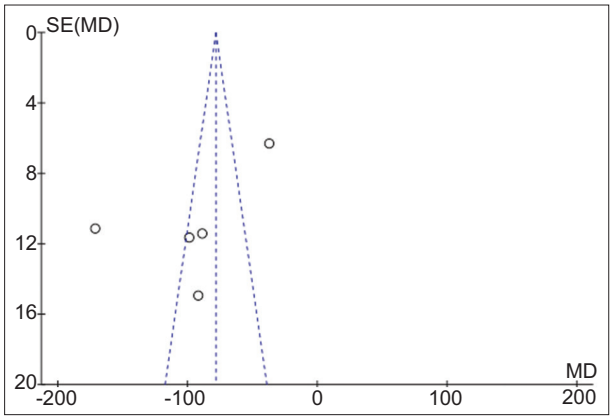
Supplementary Figure 3 Funnel plot: postprocedural length of hospital stay
SE, standard error; SMD, standard mean difference



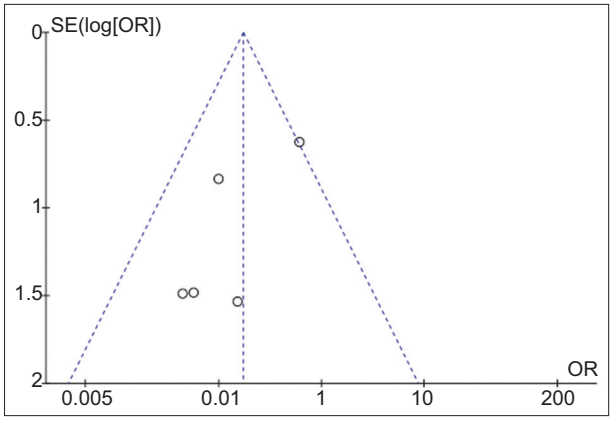
Supplementary Figure 4 Funnel plot: overall complications (Clavien-Dindo grade ≥ IIIa)
SE, standard error; OR, odds ratio



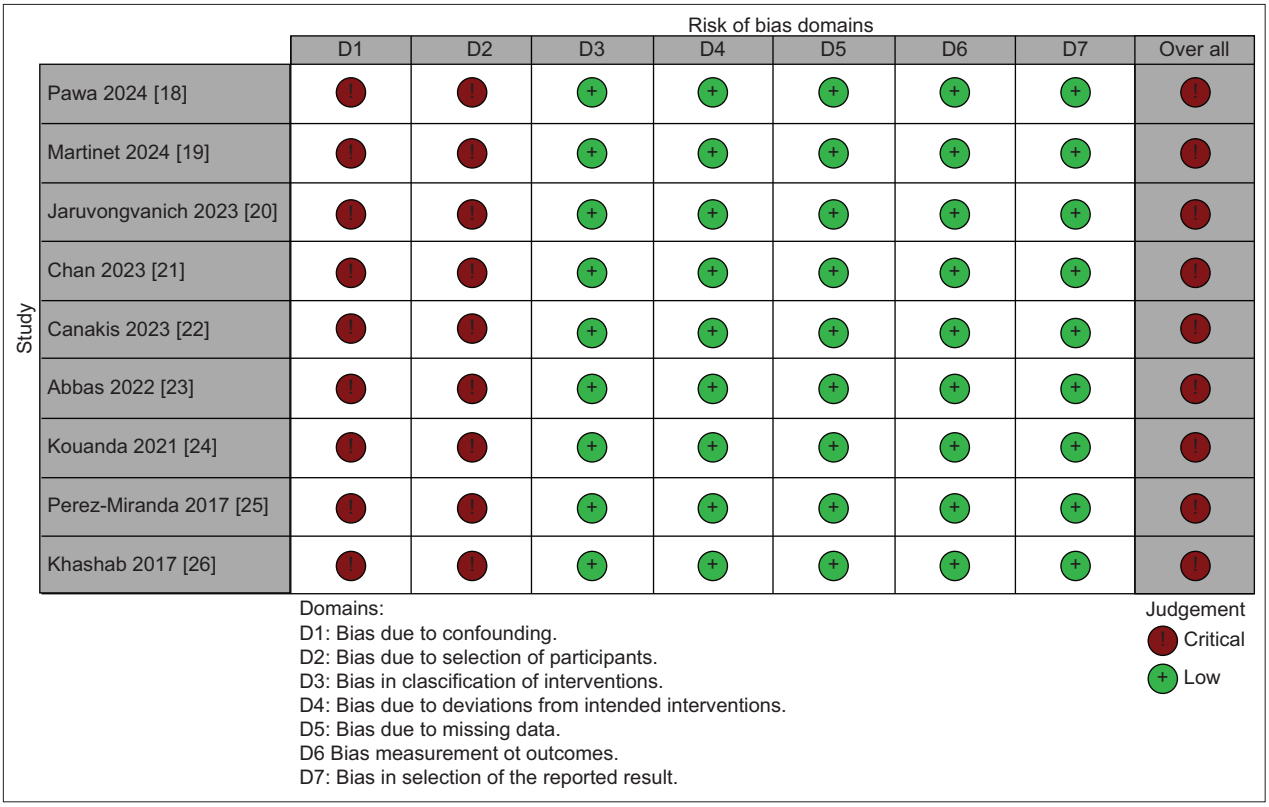
Supplementary Figure 5 Funnel plot: postoperative ileus
SE, standard error; OR, odds ratio



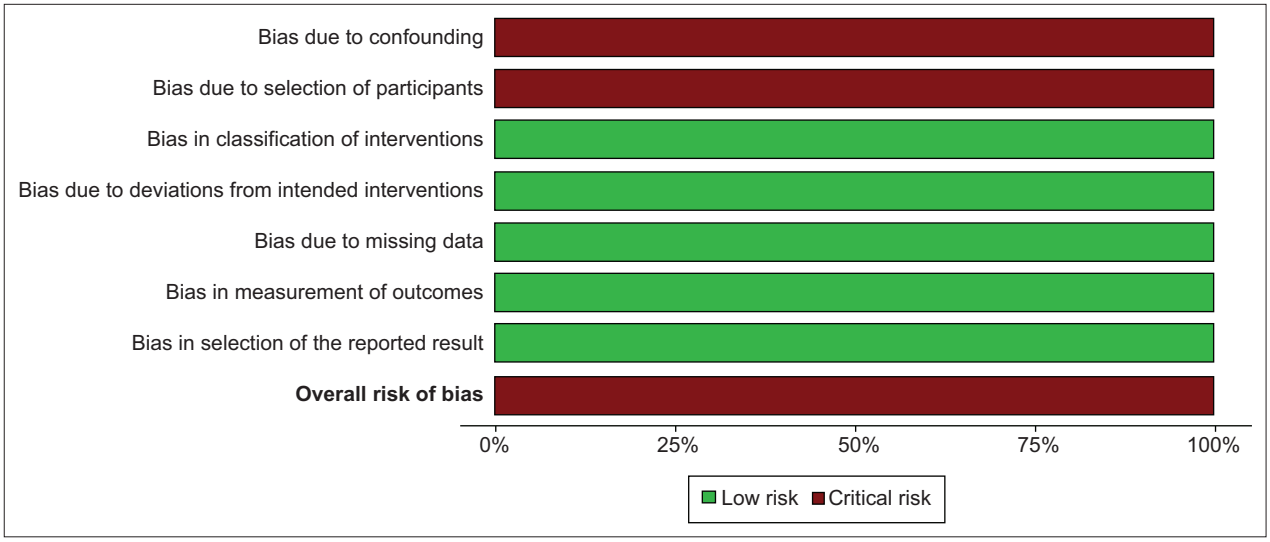
Supplementary Figure 6 Funnel plot: operative time
SE, standard error; MD, mean difference



Supplementary Figure 7 Funnel plot: postoperative infections
SE, standard error; OR, odds ratio



Supplementary Figure 8 Risk of bias assessment of included studies: traffic light plot



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Supplementary Figure 9 Risk of bias assessment of included studies: summary plot