Comparison of Gastrojejunostomy with Endoscopic Stenting for Gastric Outlet Obstruction: An Updated Systematic Review and Meta-Analysis

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Abstract

Background: Gastrojejunostomy (GJ) and endoscopic stenting (ES) are common palliative treatments for gastric outlet obstruction (GOO). This study aimed to determine the optimal intervention modality for malignant GOO by comparing clinical outcomes after GJ and ES.

Methods: Two authors independently searched Web of Science, PubMed, Embase, and the Cochrane Library for all the relevant articles before February 2021 to compare the clinical outcomes of GOO patients undergoing GJ or ES. The primary outcome was overall survival.

Results: This meta-analysis included 31 articles with 2444 GOO patients. Although the GJ group outperformed the ES group in technical success (OR,3.79; P=0.003), clinical success was not significantly different between the two groups (OR,1.25; P=0.50). The GJ group had a longer hospitalization (WMD,7.34; P=0.001), lower re-obstruction (OR, 0.41; P=0.006) and lower reintervention (OR, 0.30; P<0.001). Moreover, this meta-analysis revealed that GJ had a better overall survival than ES in the gastric cancer group (HR, 0.33; P=0.009). However, no significant statistical difference was observed between GJ and ES in the pancreatic cancer group (HR, 0.55; P=0.159).

Conclusions: Both GJ and ES are safe and effective intervention modalities for malignant GOO. GJ had significantly improved survival in gastric cancer patients with GOO, while no significant difference was observed between the two groups in pancreatic cancer patients with GOO. Therefore, we recommend that life expectancy should be considered when choosing palliative treatment for malignant GOO (ES or GJ).

Introduction

Gastric outlet obstruction (GOO) is a recognized common complication in patients with upper gastrointestinal cancer [1]. The incidence of pancreatic cancer is 7.1 cases per 100000 people, and about 15–20% of these patients develop GOO [2]. In addition, GOO is also one of the typical clinical symptoms of advanced gastric cancer. GOO is typically accompanied by severe nausea, vomiting, bloating, and malnutrition, significantly impacting patients' survival and quality of life [3]. Since most patients suffer from locally advanced or metastatic cancers and have a poor prognosis, the main objectives of palliative treatment are to improve general condition of patients, re-establish an oral intake quickly, with minimal complications, and without compromising survival [4, 5].

Palliative strategies are based primarily on surgical gastrojejunostomy (GJ) and endoscopic stenting (ES) with self-expanding metal stents. For several decades, open GJ has become the standard palliative treatment for GOO patients. Although open GJ is associated with a good functional outcome and adequately relieves symptoms in most patients, many patients experience delayed gastric emptying following surgery, resulting in prolonged hospitalization [6–8]. In addition, the problem of postoperative mortality cannot be ignored [9, 10]. With the development of minimal access surgery, laparoscopic GJ can be used as a substitute for open GJ to relieve the symptoms of malignant GOO due to its less invasiveness and faster resumption [11, 12].

Palliative ES in GOO patients was first reported in 1992 [13]. ES would reduce the surgical burden placed on people and improve their quality of life. Previous studies have demonstrated that ES exhibits shorter procedure time, shorter hospitalization, and faster resumption of oral intake compared with GJ [5, 14–16]. However, ES has been correlated with higher rates of reintervention and re-obstruction, as well as a series of major complications such as migration, bleeding, and stent fracture [17–19]. Furthermore, two randomized controlled trials (RCTs) demonstrated that ES had significant advantages over GJ for GOO patients [20, 21], while another RCT revealed that GJ was associated with better long-term outcomes [22]. It is currently controversial whether GJ or ES is the best treatment option for GOO patients. Therefore, we searched important databases related to the multidisciplinary treatment for GOO and conducted a meta-analysis to compare the effect of GJ or ES on the procedure outcomes, complications, and overall survival in GOO patients.

Methods

Literature search strategy

Following the preferred reporting items for Systematic Review and Meta-Analysis (PRISMA) 2015 [23], two authors independently searched Web of Science, PubMed, Embase, and the Cochrane Library for all the potentially relevant research articles published publicly before February 2021 to compare the clinical outcomes of GOO patients undergoing GJ or ES. The following search terms were used: gastric outlet obstruction, pyloric obstruction, stent, stenting, gastrojejunostomy, and gastroenterostomy. To avoid omitting any possible relevant studies, we manually reviewed the references of included literature.

Inclusion and exclusion criteria

Inclusion criteria: (1) all GOO patients were treated with GJ or ES. (2) The included studies need to include at least clinical outcomes, such as procedure outcomes, complications, mortality, postoperative treatment, overall survival, etc.

Exclusion criteria: (1) the literature was not written in English. (2) Research was published in abstract form, without a full text. (3) The literature was guidelines, case reports, expert consensus, or literature reviews. (4) Effective data could not be extracted.

Outcome measures

The paramount outcome measures of this meta-analysis were overall survival represented as hazard ratio (HR) with 95% confidence interval (95%CI) [24]. Surgery-related procedure outcomes, complications, short-term outcomes were also the outcome measures of meta-analysis. The technical success of ES was defined as satisfactory deployment and adequate positioning at obstruction location. For GJ, technical success was defined as the technical possibility of creating an anastomosis and satisfactory achievement of the scheduled surgery. Although various studies had different definitions of clinical success, general clinical success was defined as improving obstructive symptoms and oral intake after GJ or ES. According to the Clavin-Dindo classification of surgical complications [25], which was currently considered the most authoritative classification of surgical complications, complications were divided into minor and

major complications. Minor complications were defined as any deviation from the normal course of postoperative recovery without requiring surgery, endoscopy, or intervention. Major complications were defined as severe or life-threatening events that require surgery, endoscopic or interventional interventions.

Data extraction

Using the inclusion and exclusion criteria, two authors independently screened the retrieved articles and extracted the data using a pre-designed data extraction table. In the event of disagreements, the final result was obtained through discussion or third-party arbitration [26]. The following information was extracted: author, year of publication, country, study type, study interval, sample size, mean or median age, etiology of malignancy, surgery-related procedure outcomes, complications, short-term outcomes, and overall survival differences between the two surgical modalities (GJ versus ES).

Quality evaluation

We used the Cochrane Collaborative Risk of Bias Assessment Tool to assess the potential risk of bias in RCTs. The risk was divided into three levels: high risk, unclear risk, and low risk. The Newcastle-Ottawa Scale (NOS) was used to evaluate the methodological quality of the observational studies [27]. The evaluation of NOS is divided into three aspects: object selection, intergroup comparability, and outcome measurement. A study scoring over six points is considered to be of high quality [28].

Statistical analysis

Using Revman 5.3 software, we calculated odds ratio (OR) and 95% CI for dichotomous variables and weighted mean difference (WMD) and 95% CI for continuous variables to quantitatively analyze the relevant clinical outcomes between the two surgical methods. The heterogeneity test was performed using the Cochran chi-square test and quantified using the inconsistency test (I^2), and then we chose to use the fixed-effect model or the random-effect model according to heterogeneity. The fixed-effect model was utilized when $I^2 \leq 50\%$, and the random-effect model was utilized when $I^2 > 50\%$.

We used Stata 12.0 software to combine the HR and 95%CI from each study to quantitatively analyze the overall survival between GJ and ES. In addition, the software was also used for publication bias test and sensitivity analysis to assess heterogeneity sources [29]. If less than ten studies were included in the survival analysis, the sensitivity of qualitative and quantitative tests was low, and Egger's publication bias test was not performed.

Result

Study Selection

A total of 2151 related clinical studies were initially searched. Among them, 2052 articles were excluded because of duplication or the title/abstract did not meet the inclusion criteria. After reviewing the full text of the remaining 99 articles, 4 non-original researches were excluded, and 47 were excluded because of lack of comparison between GJ and ES. In addition, 14 articles with invalid data to be extracted were excluded, and three articles were excluded due to duplicate reports. Finally, 31 studies [5, 9, 14-22, 30-49] were included according to inclusion and exclusion criteria, including 3 RCTs and 28 observational studies (Fig. 1). Details regarding the quality assessment of the included studies are presented in Supplementary Table 1.

Study Characteristics

The basic characteristics of the included studies are shown in Table 1. The 31 studies that met the inclusion criteria had 2444 GOO patients in GJ (1076) and ES (1368) groups. Most patients are malignant GOO. All included studies were conducted from 2002 to 2019, with the smallest sample size of 18 and the largest sample size of 347. In the included studies, the main etiology of malignant GOO is gastric cancer (n=1241) and pancreatic cancer (n=753), and others included biliary cancer, ampullary carcinoma, and metastatic cancer. Gastric cancer was the main etiology of malignancy in 13 studies, and pancreatic cancer was the main etiology of malignancy in 12 studies.

Surgery-related procedure outcomes

A total of 14 studies reported technical success. Compared with the ES group, the GJ group has a higher rate of technical success (OR, 3.79, 95%CI, 1.58-9.09, P=0.003) (Fig. 2a). A total of 17 studies reported clinical success, without a significant difference in the clinical success rate between GJ and ES groups (OR, 1.25, 95%CI, 0.65-2.38, P=0.50) (Fig. 2b). Six studies [14, 18, 21, 30, 34, 37] reported the hospital stay, and pooled results demonstrated that the hospitalization of ES group was shorter than that of GJ group (WMD, 7.34, 95%CI, 2.95-11.73, P=0.001) (Fig. 2c).

Complications

A total of 23 out of 31 included studies provided data on overall complications, and no significant difference was found (OR, 1.12, 95%CI, 0.68-1.86, P=0.65) (Fig. 3a). Nine studies reported minor complications, without significant difference between GJ and ES groups (OR, 1.38, 95%CI, 0.82-2.33, P=0.22) (Fig. 3b). Major complications were reported in 10 studies, however, no significant differences in the rates of major complications were observed between the two groups (OR, 0.57, 95%CI, 0.25-1.27, P=0.17) (Fig. 3c).

Short-term outcomes

Eight studies reported 30-day mortality in detail, without significant difference between the two groups (OR, 1.14, 95%CI, 0.43-3.01, P=0.17) (Fig. 4a). Nine studies compared the rate of postoperative chemotherapy between the two groups, and no significant difference was found (OR, 1.04, 95%CI, 0.63-1.70, P=0.89) (Fig. 4b). Six studies compared the re-obstruction rate between the two groups, and the results demonstrated that the GJ group had a significantly

lower re-obstruction rate (OR, 0.41, 95%CI, 0.22-0.78, P=0.006) (Fig. 4c). Furthermore, the rate of reintervention was reported in 12 studies and was found to be significantly higher in the ES group than that in the GJ group (OR, 0.30, 95%CI, 0.22-0.41, P<0.001) (Fig. 4d).

In addition, since the leading malignant causes were divided into gastric cancer and pancreatic cancer, we conducted a subgroup analysis of the above indicators according to the malignant cause. The subgroup analysis results were similar to the overall analysis, and the detailed results are presented in Supplementary Table 2.

Survival

In this meta-analysis, seven studies [15, 17, 35, 37, 39, 45, 47] measured the overall survival of 427 patients in the GJ group and 601 patients in the ES group. The overall survival of GJ group was significantly better compared with that of the ES group (HR, 0.41, 95%CI, 0.24-0.72, P<0.001) (Supplementary Fig. 1), however, the heterogeneity of these studies could not be ignored (I^2=82.1%), and the random-effect model was used. To further investigate the overall survival for malignant GOO patients, a subgroup analysis was performed according to etiology of malignancy (gastric cancer or pancreatic cancer). The results indicated that the overall survival of GJ was better than ES in gastric cancer group (HR, 0.33, 95%CI, 0.15-0.76, P=0.009). However, no significant statistical difference between GJ and ES was observed in the pancreatic cancer group (HR, 0.55, 95%CI, 0.24-1.26, P=0.159) (Fig. 5).

Discussion

The present review summarized the published outcomes on GJ and ES treatment modalities for GOO. The main purpose was to determine which of GJ and ES was better treatment modalities. In this meta-analysis, compared with the ES group, the GJ group had a higher technical success rate. Although the technical success rate was different, the success rate of the two surgical methods was very high (99.2% vs. 97.0%, relatively). In addition, no significant difference was observed in the clinical success rate between GJ and ES groups. Our results indicated that both modalities could be considered effective and feasible in terms of improving GOO symptoms.

Consistent with the results of the previous systematic reviews and meta-analysis [50–54], in our study, ES was found to be associated with a shorter hospital stay. The previous review results revealed that the time for ES group to oral intake was significantly shorter than that of GJ group [50, 52]. The main goal of palliative treatment was to improve the patient's general condition and alleviate GOO symptoms, and some people believed that ES showed a shorter time to oral intake and hospital stay; therefore, it should be used as a more effective surgical modality. However, studies have recently demonstrated that laparoscopic GJ and EUS-guided GJ seemed to be able to reduce invasiveness, which significantly shortened the hospital stay and restored oral intake [14, 34]. Several scholars suggested that using a minimally invasive approach could eliminate ES benefits, but further studies are required to solve this issue.

In this study, we conducted a detailed report on the incidence of complications. The results manifested no significant difference in the rates of overall, minor, and major complications between GJ and ES groups. The most common minor complications after GJ were pneumonia, wound infection, and nausea and vomiting in the presence of an open anastomosis. As for the ES, minor complications like nausea, fever of unknown origin, and vomiting without obstruction were the most common ones. The most common major complications within seven days of intervention were bleeding, perforation, and anastomotic leakage in the GJ group. In the ES group, the major complications were insufficient stent expansion and stent migration. After seven days of intervention, the common major complications in the GJ group were anastomotic blockage, and jaundice resulted from obstruction. In the ES group, stent migration and destruction resulted from tumor compression and stent obstruction caused by food bolus. According to the proportion of etiology of malignancy included in the study, we divided the studies with results into two categories. One was malignant GOO secondary to gastric cancer, and the other was secondary to pancreatic cancer. The subgroup analysis results indicated that a higher incidence of major complications was encountered following ES in GOO patients caused by gastric cancer. The reasons may be that the stents of GOO patients secondary to gastric cancer are in direct contact with tumor lesions, leading to complications such as stent migration and destruction. However, GOO secondary to pancreatic cancer is usually due to external pressure from surrounding organs. The mucosa in direct contact with the stent is intact, resulting in a lower incidence of complications.

This study revealed a higher rate of re-obstruction in ES group. Interestingly, the subgroup analysis presented significant differences in the gastric cancer group and no significant difference in the pancreatic cancer group. As known, pancreatic cancer is associated with worse survival than gastric cancer. In the gastric cancer group, the patency duration was shorter than the overall survival time, so re-obstruction was more likely to occur. In contrast, in the pancreatic cancer group, because the overall survival time of patients with advanced pancreatic cancer was shorter than the patency duration of ES, the incidence of re-obstruction is lower. In addition, it may also be due to insufficient sample size. In four reviews [4, 18, 55, 56], recurrence or reintervention was higher in the ES group, consistent with this study results. This result can possibly be explained by the fact that obstruction by hyperplastic or tumor ingrowth/overgrowth after ES, which is one of the major concerns with uncovered stent designs, can result in multiple ES leading to repeated hospitalization [22]. Covered metal stents were recently introduced; however, Hamada et al. reported that compared with uncovered stent, covered stent was associated with a lower occlusion risk but with a higher migration risk [57]. In summary, ES clearly has no advantage in recurrence or reintervention.

The ultimate objective of palliative treatment for GOO is to prolong survival. GJ was significantly associated with enhanced survival. Compared with ES group, the HR of GJ group was 0.41. As reported in our results, the higher re-obstruction and reintervention rates in the ES group might affect patients' survival. Another reason may be that patients undergoing GJ had a longer patency duration than those undergoing ES. These patients may have improved nutritional status and a lower risk of developing GOO-related comorbidities.

Notably, this is the first meta-analysis to analyze survival for GOO patients with various malignant causes. The results implied that GJ had significantly better survival in GOO patients secondary to gastric cancer, while no significant difference between the two groups was observed in patients secondary to pancreatic cancer. Generally, the survival in patients with pancreatic cancer is shorter than other malignant diseases, including gastric cancer [45]. The poorer prognosis correlated with pancreatic cancer might contribute to the lack of a significant difference in survival between the groups in this study. Palliative chemotherapy

is an independent predictor of survival in malignant GOO patients [45]. Interestingly, this meta-analysis results revealed that although the survival of ES group was shorter than that of GJ group in GOO secondary to gastric cancer, no significant difference in the rate of chemotherapy was observed between the two groups. These results could possibly be explained by the fact that the invasive nature of GJ decreases the probability of receiving chemotherapy and increases the chance of delayed treatment [47].

Although we did not conduct a quantitative analysis of cost comparison, we analyzed data from nine studies [14, 22, 33, 36, 37, 40, 43, 49, 58] comparing the costs of the two surgical modalities and identified that in eight studies, the costs of the ES group were significantly lower than those of the GJ group. However, some studies only considered the initial surgical costs and postoperative hospitalization costs but did not consider reintervention and additional care costs [50]. Jeurnink and his colleagues reported a detailed cost analysis of GJ and ES, including all costs [59], indicating that total GJ costs were higher, mainly due to longer hospital stay after surgery. Nevertheless, since long-term outcomes were also significantly improved following GJ, the daily costs associated with patients being able to eat soft solids were comparable between GJ and ES.

The present study has certain limitations: (1) except for three RCTs, most of the papers included in this study are retrospective observational studies, which are less than optimal because of their potential for bias, such as performance bias and selection bias. (2) Individual data could not be obtained. A mixture of patients with different primary diseases was included in this review. Although we classified the studies according to the primary tumor type, the classification was crude and simple. (3) Due to a lack of sufficient data, it is impossible to compare laparoscopic GJ with ES and open GJ.

Conclusion

In conclusion, this meta-analysis demonstrates that both GJ and ES are safe and effective surgical modalities for GOO. While ES has a shorter hospital stay, GJ is substantially superior to ES in terms of survival, re-obstruction, and reintervention. The findings indicated that GJ had a significantly higher survival rate in patients with GOO secondary to gastric cancer, while no significant difference was observed between the two groups in patients with GOO secondary to pancreatic cancer. As a result, we suggest that if the expected survival time is longer, GJ might be the preferable procedure; however, for patients with a shorter expected survival time, the less invasive ES is recommended. Further well-designed RCTs with a larger sample size are required to validate the conclusion of this review.

Abbreviations

CI: Confidence interval, ES: Endoscopic stenting, GJ: Gastrojejunostomy, GOO: Gastric outlet obstruction, HR: Hazard ratio, NOS: Newcastle-Ottawa Scale, OR: Odds ratio, RCTs: Randomized controlled trials, WMD: Weighted mean difference.

Declarations

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None

Ethics approval and consent to participate

Not applicable (this paper was provided based on researching in global databases).

Consent to publish

Not applicable.

Availability of data and materials

The datasets supporting the conclusions of this article are included within the article. If you want detailed data about this article, please contact the corresponding author (Jingjie Chen: alexhappy2121@126.com).

Competing interests

The authors declare that they have no conflict of interest.

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Authors' contributions

Jingjie Chen designed the research process. Jiaze Hong and Lihu Gu searched the database for corresponding articles. Ping Chen and Nannan Du extracted useful information from the articles above. Jiayu Li and Peidong Hu used statistical software for analysis. Jiaze Hong and Lihu Gu drafted the meta-analysis. Tongmin Huang polished this article. All authors had read and approved the manuscript and ensured that this was the case.

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Tables

Table 1. Characteristics of all the studies included in the meta-analysis.

Author	Year	Country	Study type	Study interval	Patient number		Age (years)		Etiology of malignancy		
					GJ	ES	GJ	ES	Tumor type	GJ	ES
Chandrasegaram	2012	Australia	ROBS	1998.12 -2008.11	OGJ: 19	26	65 ± 10	67 ± 12	Pancreatic	8 (42%)	12 (46
									Gastroduodenal	9 (47%)	10 (38
									Metastatic	2 (11%)	4 (
Del Piano	2005	Italy	ROBS	1997.04 -2002.12	OGJ: 23	24	76 (48-92)	74 (51-90)	Pancreatic	15 (65.2%)	18 (75
									Gastric	4 (17.4%)	3 (12
									Nodal metastases	1 (4.3%)	1 (
									Ampullary	2 (8.7%)	1 (
									Biliary	1 (4.3%)	1 (
El-Shabrawi	2006	Austria	ROBS	2001.10 -2004.12	OGJ: 17	22	71 (38-88)	75 (50-93)	Pancreatic	9 (53%)	7 (
									Gastric	3 (17%)	8 (
									Biliary	2 (12%)	3 (
									Duodenal	2 (12%)	1 (
									Metastatic	1 (6%)	3 (13
Espinel	2006	Spain	ROBS	1999.07 -2004.09	OGJ: 17	24	75.29	79.04	Pancreatic	10 (58.8%)	13 (54
									Gastric	5 (29.4%)	4 (16
									Duodenal	1 (5.9%)	2 (
									Ampullary	0 (0%)	2 (
									Biliary	1 (5.9%)	3 (12
Fiori	2004	Italy	RCT	2001.01 -2002.12	OGJ: 9	9	70	72	Peritoneal	—	—
Fiori	2013	Italy	RCT	1999.12 -2011.12	OGJ: 9	9	70	72	Gastric	—	—
Fiori	2016	Italy	ROBS	2000-2014	OGJ: 30	70	70	71	Gastric	—	—
Ge	2019	USA	ROBS	2014.01 -2017.11	EUS-guided GJ: 22	78	66.4 ± 9.2	65.7 ± 12.6	Gastric	1 (4.6%)	8 (10
									Pancreatic	7 (31.8%)	40 (51
									Duodenal	1 (4.6%)	1 (
									Ampullary	0 (0%)	2 (
									Biliary	4 (18.2%)	8 (10
									Metastatic	9 (40.9%)	19 (24
Jang	2017	Korea	ROBS	2009.01 -2013.11	OGJ/LGJ: 45	99	58.9 ± 11.4	58.8 ± 13.2	Gastric	—	—
Jeurnink	2007	The Netherlands	ROBS	1994–2006	OGJ: 32 LGJ: 10	53	63.4 ± 11.0	63.8 ± 11.9	Pancreatic	40 (96%)	31 (55
									Biliary	1 (2%)	1 (
									Duodenal	0 (0%)	2 (
									Gastric	0 (0%)	5 (
									Metastatic	1 (2%)	13 (24

									Unknown	0 (0%)	1 (
Jeurnink	2010	The Netherlands	RCT	2006.01 -2008.05	OGJ/LGJ: 18	21	66 ± 11	66 ± 13	Pancreatic	13 (72.2%)	15 (71
									Biliary	1 (5.6%)	0 (
									Duodenal	1 (5.6%)	3 (14
									Gastric	1 (5.6%)	2 (
									Ampullary	1 (5.6%)	0 (
									Metastatic	1 (5.6%)	1 (
Johnsson	2004	Sweden	POBS	1999-2004	OGJ: 15	21	69 (55-88)	80 (57-92)	Gastric	7 (46.7%)	12 (57
									Duodenal	1 (6.7%)	2 (
									Pancreatic	4 (27.0%)	3 (14
									Biliary	1 (6.7%)	2 (
									Peritoneal	2 (13.0%)	2 (
Keränen	2013	Finland	ROBS	1999-2010	OGJ/LGJ: 21	50	69 (31-88)	73 (40-94)	Gastric	—	—
Khashab	2013	USA	ROBS	2001.01 -2010.12	OGJ: 227	120	65.61	63.94	Pancreatic	169 (74.5%)	64 (53
									Ampullary	50 (22.0%)	5 (
									Peritoneal	41 (18.1%)	46 (38
Kubota	2007	Japan	ROBS	1998.01 -2004.08	stomach-partitioning GJ: 16	9	71 (50-87)	73 (46-92)	Gastric	12 (75.0%)	5 (55
									Pancreatic	0 (0%)	3 (33
									Metastatic	3 (18.8%)	1 (11
									Malignant lymphoma	1 (6.3%)	0 (
López-Sánchez	2019	Spain	ROBS	2007-2018	stomach-partitioning OGJ: 30	28	69 ± 14.6	78.1 ± 11.7	Gastric	20 (66.7%)	15 (53
									Pancreatic	4 (13.3%)	6 (21
									Duodenal	5 (16.7%)	2 (
									Ampullary	0 (0%)	3 (10
									Metastatic	0 (0%)	2 (
									Retroperitoneal	1 (3.3%)	0 (
Maetani	2004	Japan	ROBS	1993.02 -2002.08	OGJ: 19	20	68.7 ± 2.4	71.8 ± 1.7	Pancreatic	14(73.7%)	12
									Biliary	5(26.3%)	7(3
									Ampullary	0(0%)	1(5
Maetani	2005	Japan	ROBS	1994.09 -2004.09	OGJ: 22	22	66.1 ± 2.3	72.3 ± 2.5	Gastric	—	—
Mehta	2006	United Kingdom	RCT	—	LGJ: 14	13	67.6 ± 2.9	70.4 ± 4.9	Pancreatic	15(55.6%)	
									Gastric	4(14.8%)	
									Cholangiocarcinoma	2(7.4%)	
									Biliary	1(3.7%)	
									Metastasis	4(14.8%)	
									Benign gastric ulcer	1(3.7%)	

Min	2017	Korea	ROBS	2005.07 -2015.09	LGJ: 43	58	70 ± 14	70 ± 13	Gastric	—	—
Mittal	2004	New Zealand	ROBS	1989-2002	OGJ/LGJ: 30	16	OGJ: 67.5(44-83) LGJ: 68.0(60-90)	63.5(39-82)	Gastric	5 (16.7%)	5 (31
									Ampullary	2 (6.7%)	1 (
									Duodenal	5 (16.7%)	1 (
									Pancreatic	8 (26.7%)	5 (31
									Cholangiocarcinoma	0 (0%)	1 (
									Metastasis	6 (20.0%)	2 (12
									Lymphoma	0 (0%)	1 (
									Benign	4 (13.3%)	0 (
No	2013	Korea	ROBS	2001.01 -2010.12	OGJ/LGJ: 41	72	64.5 ± 12.1	66.4 ± 11.6	Gastric	—	—
Park	2015	Korea	ROBS	2005.11 -2012.11	OGJ/LGJ: 39	217	61.7 ± 13.3	60.7 ±13.3	Gastric	—	—
Park	2016	Korea	ROBS	2001.01 -2014.12	OGJ/LGJ: 74	74	61.1 ± 12.1	62.1 ± 13.8	Gastric	—	—
Roy	2012	USA	ROBS	2006–2008	OGJ: 75	29	62.9	59.6	—	—	—
Schmidt	2009	USA	POBS	—	OGJ: 16	24	—	—	Pancreatic	9 (56.3%)	12 (50
									Biliary	3 (18.6%)	6 (
									Gastroduodenal	2 (12.5%)	2 (
									Metastasis	2 (12.6%)	4 (16
Shuai	2018	China	ROBS	2008.01 -2014.12	LGJ: 34	29	59.8 ± 15.5	64.6 ± 14.2	Gastric	29 (85.3%)	25 (86
									Intestinal	4 (11.8%)	2 (
									Metastatic	1 (2.9%)	2 (
Uemura	2018	Japan	ROBS	2008.12 -2017.10	OGJ: 35	64	68 (47-87)	72 (43-90)	Pancreatic	—	—
Wong	2002	USA	ROBS	1988.10 -1998.09	OGJ: 17	6	—	—	Pancreatic	—	—
Yoshida	2017	Japan	ROBS	2010.04 -2016.03	OGJ/LGJ: 30	23	63.5 (46-72)	70 (48-87)	Pancreatic	—	—
Yukimoto	2018	Japan	ROBS	2010.01 -2016.12	OGJ: 27	38	75 (66.0-81.5)	73 (65.0-79.0)	Gastroduodenal	21 (77.8%)	19 (50
									Pancreatobiliary	6 (22.2%)	19 (50

—,Unknown; GJ, Gastrojejunostomy; OGJ, Open Gastrojejunostomy; LGJ, Laparoscopic Gastrojejunostomy; ES, Endoscopic Stenting; RCT, Randomized Clinical Trial; ROBS, Retrospective Observational Study; POBS, Prospective observational study;

Figures

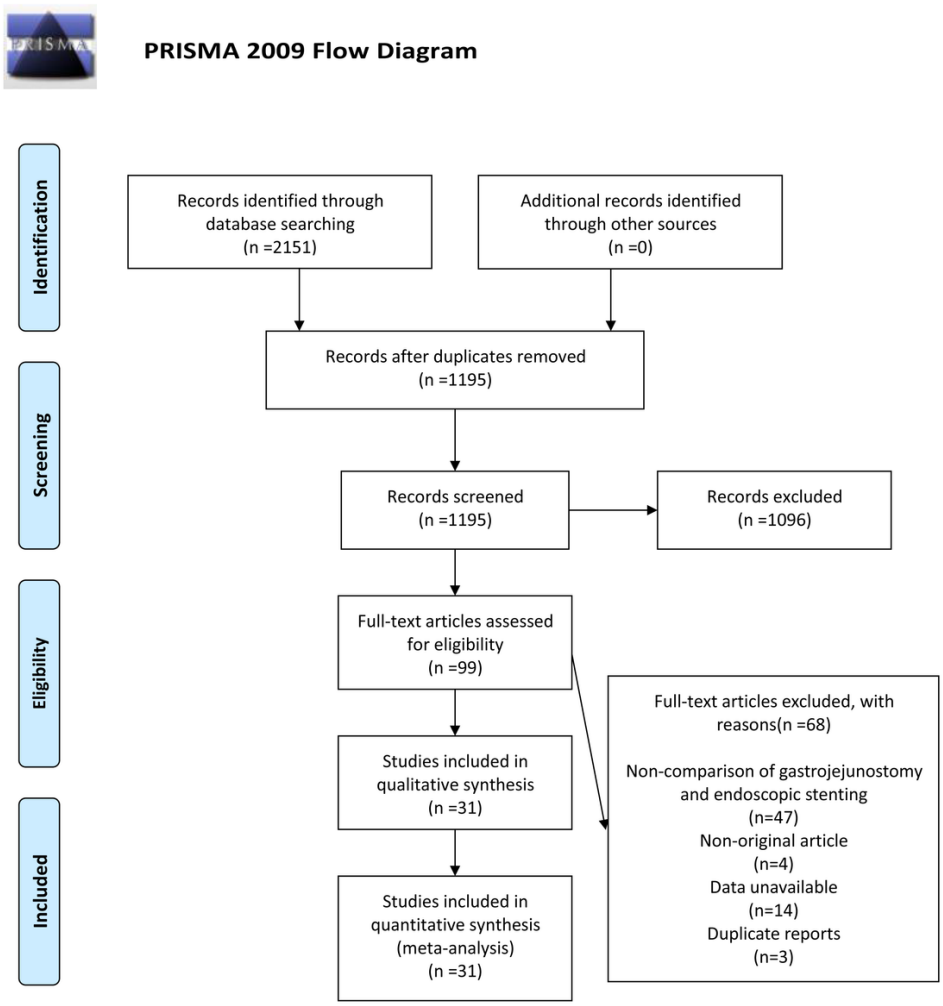

Figure 1

Flow diagram of selection.

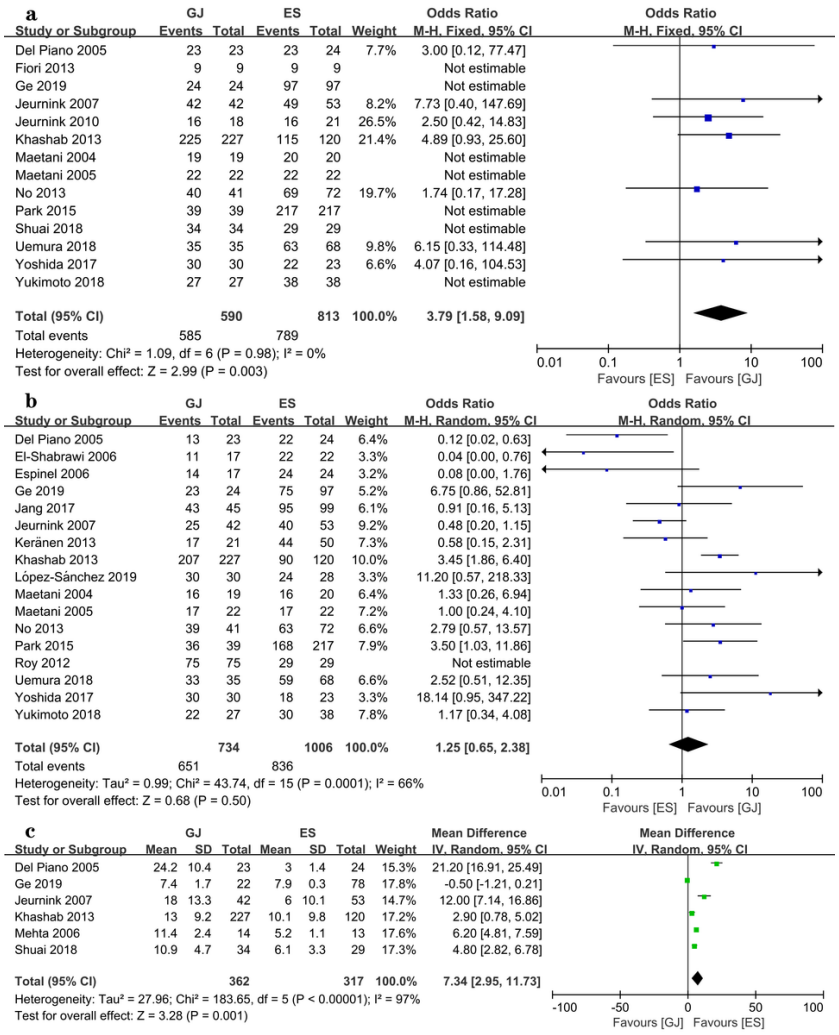

Figure 2

Forest plot of meta-analysis of surgery-related procedure outcomes. (a) Technical success, (b) Clinical success, (c) Hospital stay.

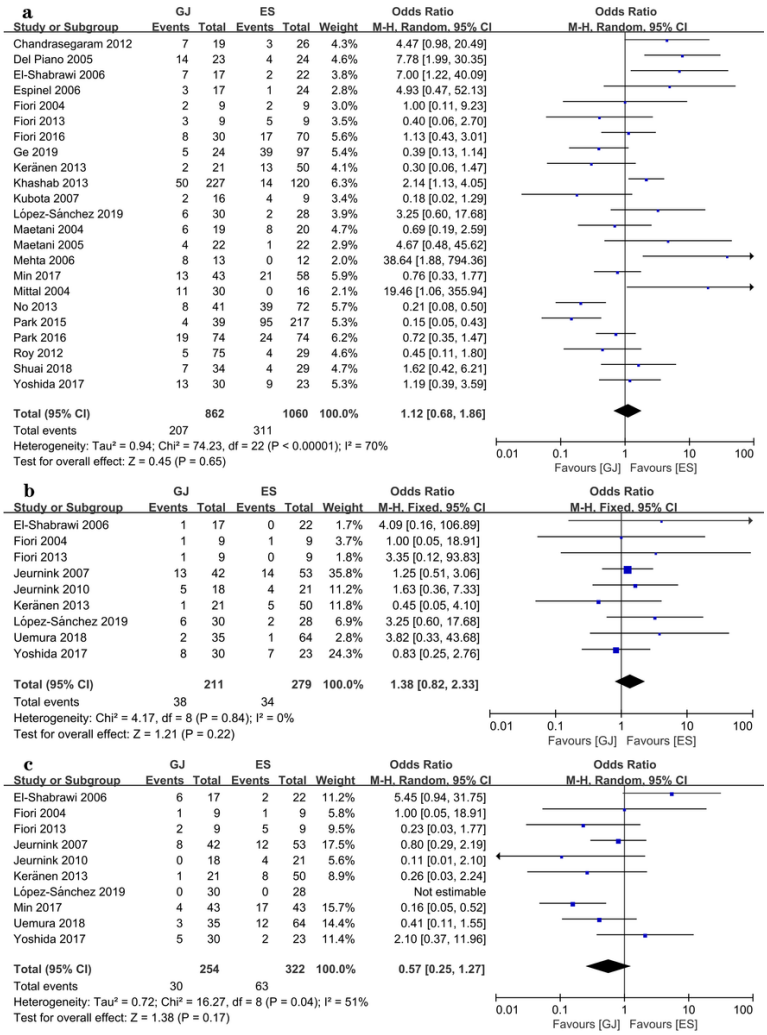

Figure 3

Forest plot of meta-analysis of complications. (a) Overall complications, (b) Minor complications, (c) Major complications.

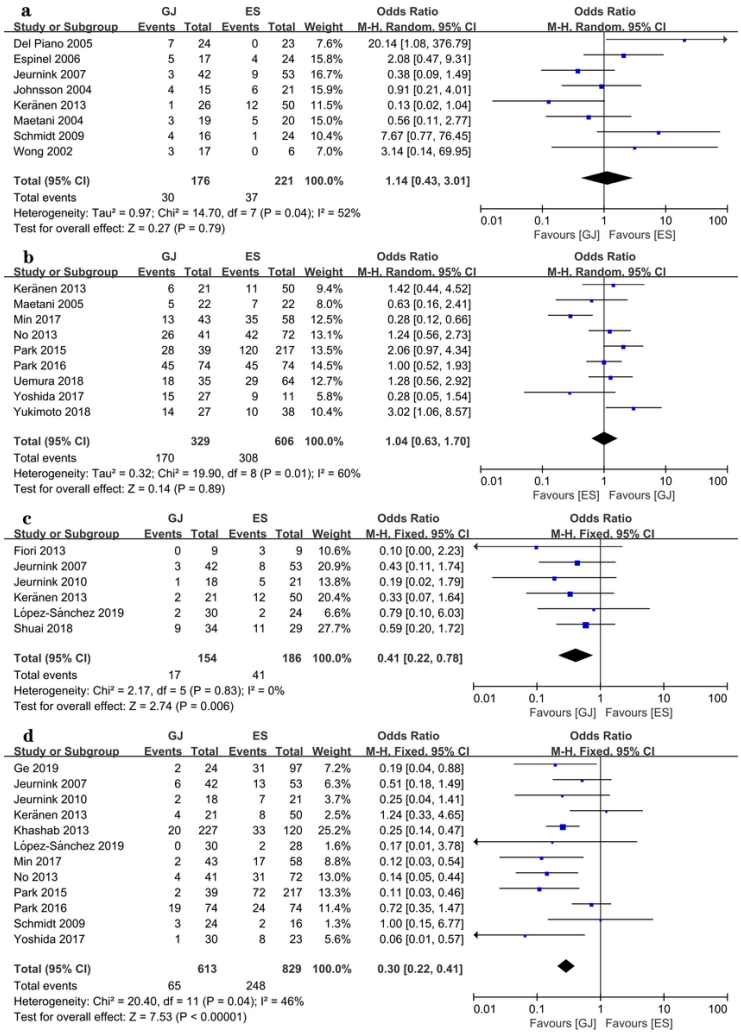

Figure 4

Forest plot of meta-analysis of short-term outcomes. (a) 30-day mortality, (b) Postoperative chemotherapy, (c) Re-obstruction, (d) Reintervention.

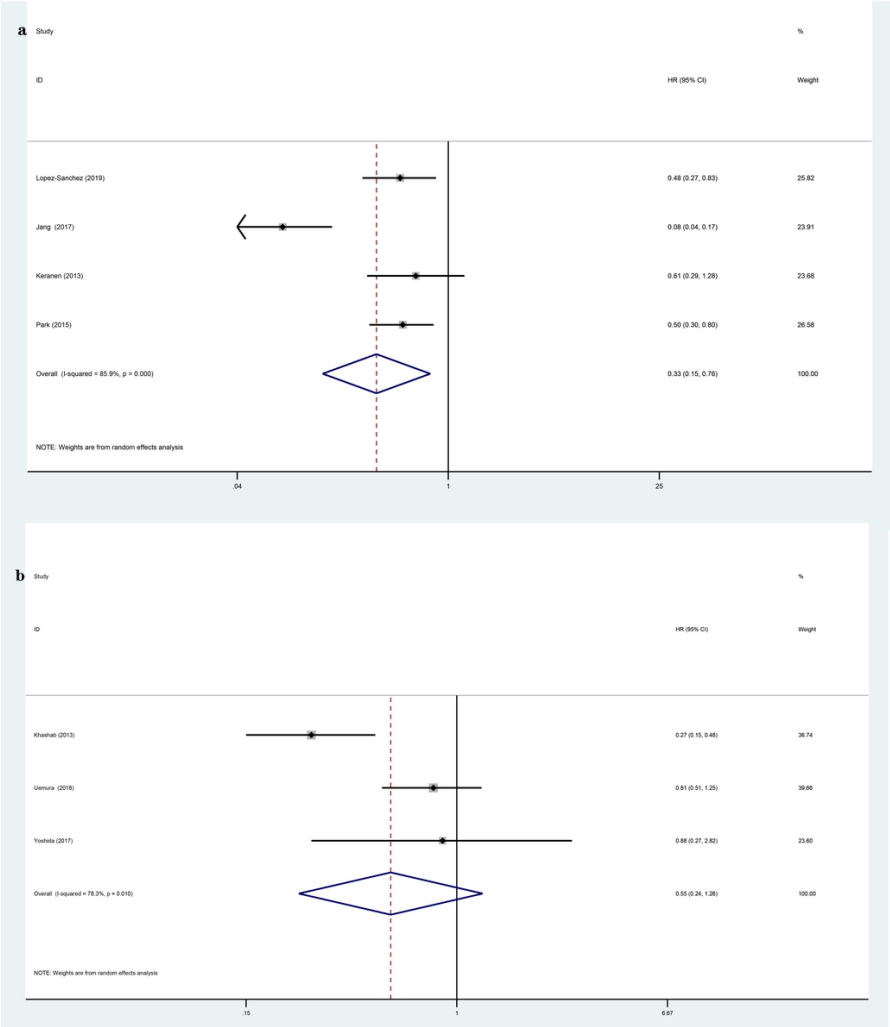

Figure 5

Forest plot of meta-analysis of overall survival in the subgroup. (a) Survival of gastric cancer with GOO, (b) Survival of pancreatic cancer with GOO.

Supplementary Files

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