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Comparison of totally laparoscopic total gastrectomy and laparoscopic-assisted total gastrectomy: A systematic review and meta-analysis

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ABSTRACT

Background: Laparoscopic-assisted total gastrectomy (LATG) has been extensively employed for the removal of gastric tumors, although it has several limitations. Totally laparoscopic total gastrectomy (TLTG) is a new technique that has rapidly been gaining popularity, and may help overcome the limitations of LATG; however, its safety and therapeutic effect remain controversial. In the present study, we aimed to assess the safety and efficacy of TLTG, and compare the short-term outcomes of TLTG and LATG.

Methods: We searched for studies comparing TLTG and LATG published up to April 2018 from databases such as PubMed and Embase. The study results, including time of surgery, blood loss, anastomosis time, retrieved lymphatic nodes, proximal and distal resection edges, incision length, time to first fluid and soft diet, hospitalization duration, time to first flatus, and postsurgical and anastomotic complications, were compared between the procedures.

Results: A total of 10 studies were included. TLTG led to reduced intraoperative blood loss ($P < 0.01$), greater number of retrieved lymphatic nodes ($P < 0.01$), decreased hospitalization duration ($P < 0.01$), reduced incision length ($P = 0.05$), and shorter time to first fluid diet ($P < 0.05$), as compared to LATG. The surgery and anastomosis times, time to first soft diet, resection edge, time to first flatus, overall postsurgical complications, and anastomosis-related complications were similar between TLTG and LATG ($P > 0.05$).

Conclusions: TLTG is a safe procedure that yields better cosmesis lower invasiveness, and faster recovery as compared to LATG.

1. Introduction

Gastric cancer is associated with high mortality and morbidity rates worldwide, and East Asian countries such as Korea, Japan, and China in particular exhibit very high morbidity rates related to this disease [1]. Gastrectomy is the optimal treatment for this condition [2], and conventional laparotomy has been the first choice for patients undergoing gastric surgery. Kitano et al. [3] described a novel laparoscopic-assisted distal gastrectomy (LADG) procedure, and indicated the increasing popularity of laparoscopic gastrectomy (LG) over open gastrectomy (OG). The advantages of LG include shorter wound length, decreased blood loss, shorter hospitalization duration, decreased complication rates, and faster recovery [4–7]. Several large-scale studies have confirmed that LG has similar clinical benefits and comparable survival outcomes with OG [8–11].

The 2 versions of LG include totally laparoscopic gastrectomy (TLG) and laparoscopic-assisted gastrectomy (LAG). Extracorporeal anastomosis with LAG is similar to conventional anastomosis with OG. In that procedure, an auxiliary incision is made in the upper abdomen, and digestive reconstruction is performed extracorporeally. In some cases, it is necessary to extend the laparotomy to achieve a better view, particularly in obese patients. Moreover, due to the high tension of extracorporeal anastomosis, the potential risk of surrounding tissue injury is increased. In contrast, intracorporeal anastomosis with LTG does not require an auxiliary incision, and a better operative view can be obtained. However, the reconstruction process associated with this procedure is difficult.

Recently, the number of totally laparoscopic distal gastrectomy (TLDG) procedures have increased. Several meta-analyses have confirmed the feasibility of TLDG by comparing the short-term results of TLDG and LADG [12–14]. However, only few studies have assessed the results of TLTG, and hence, its therapeutic effect remains controversial [15]. Accordingly, in the present study, we aimed to evaluate the safety and feasibility of TLTG, and compare the short-term outcomes of TLTG

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and LATG.

2. Materials and methods

2.1. Search strategy

The study was registered on PROSPERO, and the findings have been reported according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) and AMSTAR (Assessing the methodological quality of systematic reviews) guidelines. The Embase, PubMed, Web of Science, and Cochrane Library databases were searched for primary studies published until April 2018. For a more accurate search, the terms “totally laparoscopic” or “intracorporeal” and “laparoscopic assisted” or “extracorporeal” and “total gastrectomy” were employed. All reference articles of the retrieved studies were reviewed in order to choose studies that better suit our criteria. No language restriction was applied.

2.2. Inclusion and exclusion criteria

Any studies that met the following criteria were considered: (1) all patients were diagnosed with gastric cancer; (2) study compared TLTG and LATG; and (3) the endpoints included postsurgical complications. If there were two or more articles by the same authors or research institutions, the most recent publication was selected.

Articles that met the following criteria were not considered: (1) included hand-assisted LG or robotic gastrectomy; (2) focused on laparoscopic total gastrectomy (LTG) and laparoscopic distal gastrectomy (LDG); (3) sample size < 10; and (4) article type included abstracts presented at meetings, case reports, review articles, or letters.

2.3. Data extraction

Data were collected from each of the selected research papers independently by 2 authors, and disagreements were discussed before a final decision was made. The compiled information included author name, study period, sample size, mean age, gender, geographical region, tumor stage, surgery time, anastomosis time, blood loss, retrieved lymphatic nodes, proximal resection edge, distal resection edge, incision length, postsurgical hospitalization duration, time to first flatus, time to the first fluid diet and soft diet, overall postsurgical complications, and anastomotic complications.

2.4. Statistical analysis

RevMan 5.3 software (Nordic Cochrane Centre; Denmark) was used to analyze data. Risk ratio (RR) was employed to assess the dichotomous variables. If the I^2 value was ≤50%, a fixed effects model was employed, and if the value was > 50%, a random effects model was chosen. To avoid publication bias, we used funnel plots. Statistical significance was acknowledged when P values were < 0.05. In some publications, the mean values and standard deviation values were unavailable. The methods used to determine these values based on the available median and range data have been described previously by Hozo et al. [16].

3. Results

3.1. Selected studies

During the initial search, 159 publications were selected. After reviewing the publications, the full-text of 14 studies were further assessed. Of these, 4 papers [17–20] did not meet the criteria and were excluded. Finally, 10 studies [21–30] were considered for the meta-analysis (Fig. 1).

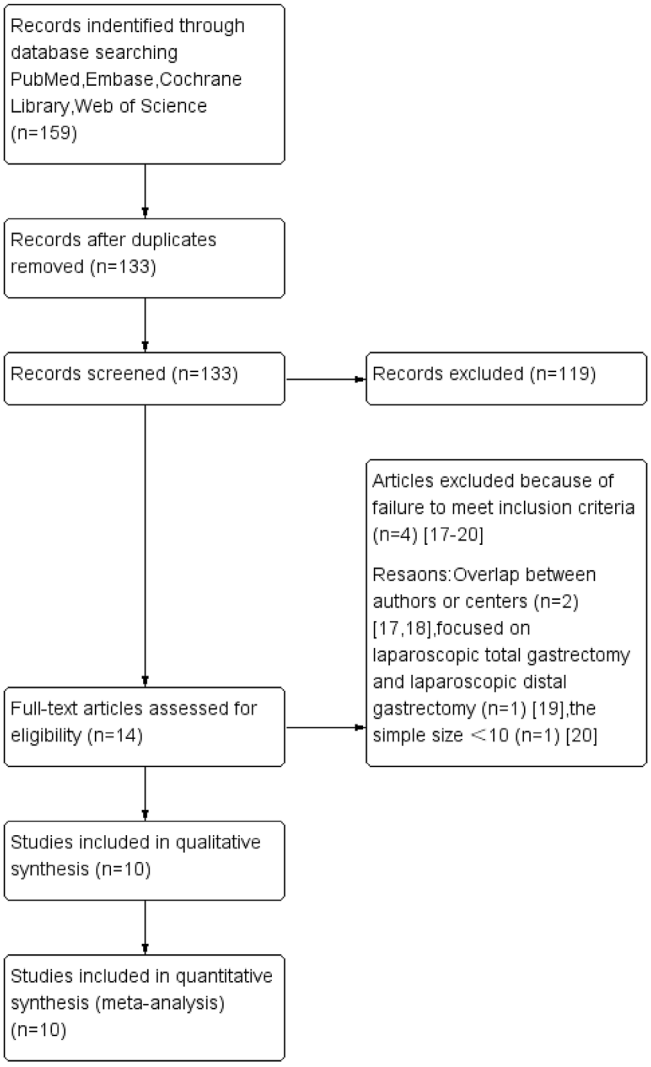

Fig. 1. Flowchart of the search strategy.

3.2. Study characteristics

The characteristics of the individual trials are shown in Table 1. A total of 1003 patients were included in the TLTG group, whereas 921 patients were included in the LATG group. The studies were from Korea (3 studies), Japan (1 study), and China (6 studies).

3.3. Study quality

The Newcastle-Ottawa Scale (NOS) was used to assess the quality of the studies. The total NOS score was 9, and papers with a score ≥6 were classified as methodologically sound studies. All articles included in this study rated between 6 and 9, indicating that the study quality was sufficient (Table 2).

3.4. Intraoperative outcomes

With regard to intraoperative outcomes, the surgery time, anastomosis time, blood loss, retrieved lymphatic nodes, proximal resection edge, distal resection edge, and incision length were evaluated. In the 9 studies reporting surgery time [21–29], we found that there was no difference between the 2 groups (WMD, 3.33 min; 95% confidence interval [CI], −11.72 to 18.37; P = 0.66; Fig. 2). Among the 4 studies reporting anastomosis time [21,24,27,29], we found that the TLTG group had similar anastomosis time (WMD, 3.77 min; 95% CI, −2.97 to

Table 1
Characteristics of the included studies.

Author	Nation	Year	Study period	Surgical type	Sample size	Mean age (years)	Gender (male/female)	Tumor stage (I/II/III/IV/pCR)
Chen [21]	China	2016	2006–2015	TLTG	108	59.4	73/35	53/27/28/0/0
				LATG	145	57.3	98/47	8227/36/0/0
Cui [22]	China	2015	2013–2014	TLTG	16	61.3	10/6	NA
				LATG	50	67.6	34/16	NA
Gong [23]	Korea	2017	2008–2014	TLTG	421	57.78	173/148	337/62/22/0/0
				LATG	266	55.69	167/99	228/27/11/0/0
Hong [24]	China	2017	2015–2016	TLTG	183	58	122/61	NA
				LATG	190	60	135/55	NA
Huang [25]	China	2017	2014–2016	TLTG	51	55.5	34/17	13/17/21/0/0
				LATG	102	55.9	68/34	18/40/44/0/0
Ito [26]	Japan	2014	2001–2012	TLTG	117	NA	NA	79/24/12/2/0
				LATG	46	NA	NA	35/5/5/1/0
Kim EY [27]	Korea	2016	2009–2014	TLTG	27	60.8	22/5	25/1/1/0/0
				LATG	29	59.3	27/9	12/6/10/0/0
Kim HB [28]	Korea	2016	2013–2015	TLTG	30	51	16/14	NA
				LATG	24	53	14/10	NA
Lu [29]	China	2015	2011–2014	TLTG	25	59	22/3	0/5/17/3/0
				LATG	25	58.4	21/4	4/5/15/1/0
Miao [30]	China	2016	2012–2016	TLTG	25	56	11/14	14/5/5/1/0
				LATG	47	59.1	25/22	15/19/11/1/1

10.51; P = 0.27; Fig. 3), as compared to the LATG group. In the 8 studies that reported intraoperative blood loss [21,22,24–29], the value was found to be lower in the TLTG group, as compared to that in the LATG group (WMD, 2.40 ml; 95% CI, −54.47 to 59.27; P < 0.01; Fig. 4). Among the 8 studies that reported on the number of retrieved lymphatic nodes [21–25,27,28,30], the TLTG group was found to have a greater number as compared to the LATG group (WMD, 2.62; 95% CI, 1.47 to 3.78; P < 0.01; Fig. 5). Six studies reported on the proximal resection edge [21,22,24,27–29] and 4 studies reported on the distal resection edge [22,23,27,28]. The proximal resection edge (WMD, −0.35 cm; 95% CI, −0.96 to 0.25; P = 0.25; Fig. 6) or distal resection edge (WMD, 0.27 cm; 95% CI, −0.35 to 0.89; P = 0.40; Fig. 7) did not differ between the groups. Only 2 studies reported the incision length [22,29], and the value was lower in the TLTG group than in the LATG group (WMD, −3.25 cm; 95% CI, −6.48 to −0.02; P = 0.05; Fig. 8).

3.5. Postsurgical outcomes

We also assessed the postsurgical hospitalization duration, time to first flatus, and time to first fluid and soft diet to evaluate the postoperative recovery in the patients. The TLTG group had a shorter hospital duration as compared to the LATG group (WMD, −0.57 days; 95% CI, −1.00 to −0.14; P < 0.01; Fig. 9). The time to first flatus did not significantly differ between the 2 groups (WMD, −0.17 days; 95% CI, −0.37 to 0.02; P = 0.09; Fig. 10). The patients in the TLTG group had a shorter time to first fluid diet than those in the LATG group (WMD, −0.23 days; 95% CI, −0.41 to −0.04; P < 0.05; Fig. 11), whereas the time to first soft diet was comparable between the 2 groups (WMD, −0.46 days; 95% CI, −1.44 to 0.52; P = 0.35; Fig. 12).

The overall postsurgical complications were evaluated in 10 studies [21–30]. There was no significant difference in the risk of overall postsurgical complications (RR, 1.00; 95% CI, 0.83–1.21; P = 0.97; Fig. 13). The risk of all anastomosis-related complications, including anastomotic leakage (RR, 0.93; 95% CI, 0.57–1.51; P = 0.78; Fig. 14), anastomotic stenosis (RR, 0.85; 95% CI, 0.46–1.57; P = 0.59; Fig. 15), and anastomotic hemorrhage (RR, 0.78; 95% CI, 0.28–2.18; P = 0.64; Fig. 16), was similar between the TLTG and LATG groups.

3.6. Publication bias

A funnel plot of the overall postoperative complications was used to evaluate the for presence of publication bias. The funnel plot was not asymmetric, indicating that there was no evidence of publication bias in the study (Fig. 17).

4. Discussion

LATG is a widely used treatment for gastric cancer. The therapeutic

Table 2
Quality of the included studies.

Author	Selection (out of 4)				Comparability (out of 2)	Outcomes (out of 3)			Total (out of 9)
	Representativeness of exposed cohort	Selection of non-exposed cohort	Ascertainment of exposure	Outcome not present at the start of the study		Assessment of outcomes	Length of follow-up	Adequacy of follow-up	
Chen	1	1	1	1	2	1		1	8
Cui	1	1	1	1	1	1		1	7
Gong	1	1	1	1	1	1		1	7
Hong	1	1	1	1	2	1	1	1	9
Huang	1	1	1	1	2	1		1	8
Ito	1	1	1	1	1	1			6
Kim EY	1	1	1	1	1	1		1	7
Kim HB	1	1	1	1	1	1		1	7
Lu	1	1	1	1	2	1		1	8
Miao	1	1	1	1	1	1		1	7

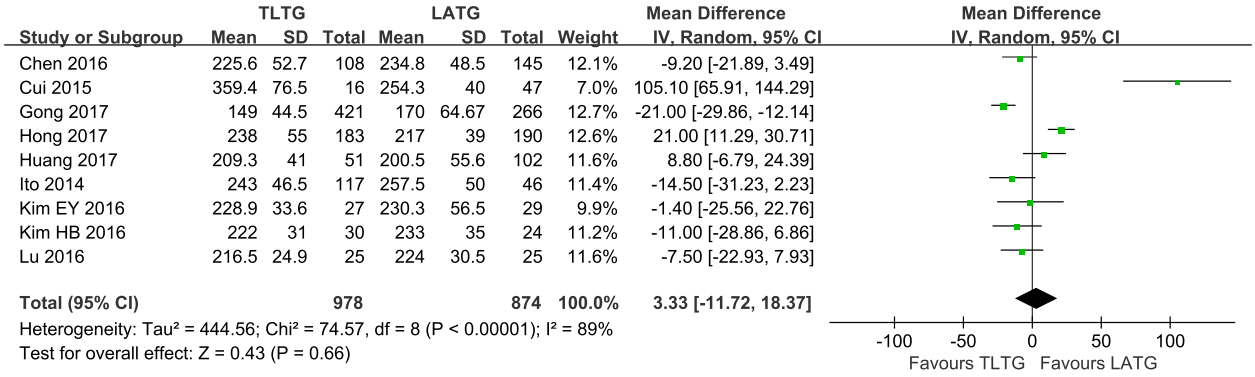

Fig. 2. Meta-analysis of pooled data on surgery time. TLTG: totally laparoscopic total gastrectomy; LATG: laparoscopic-assisted total gastrectomy; CI: confidence interval; SD: standard deviation.

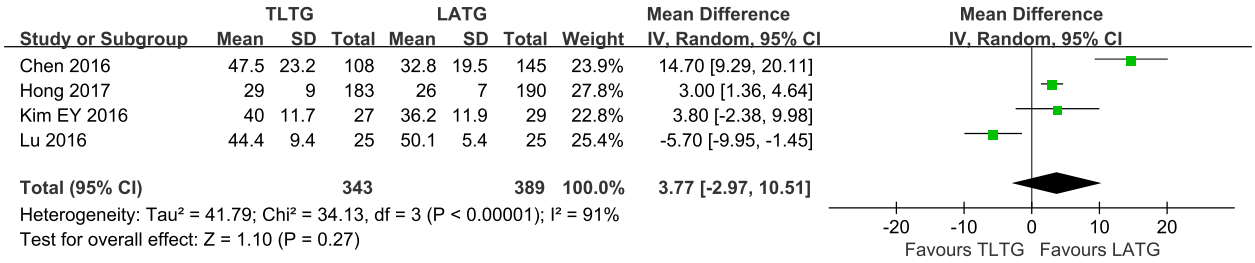

Fig. 3. Meta-analysis of pooled data on anastomosis time. TLTG: totally laparoscopic total gastrectomy; LATG: laparoscopic-assisted total gastrectomy; CI: confidence interval; SD: standard deviation.

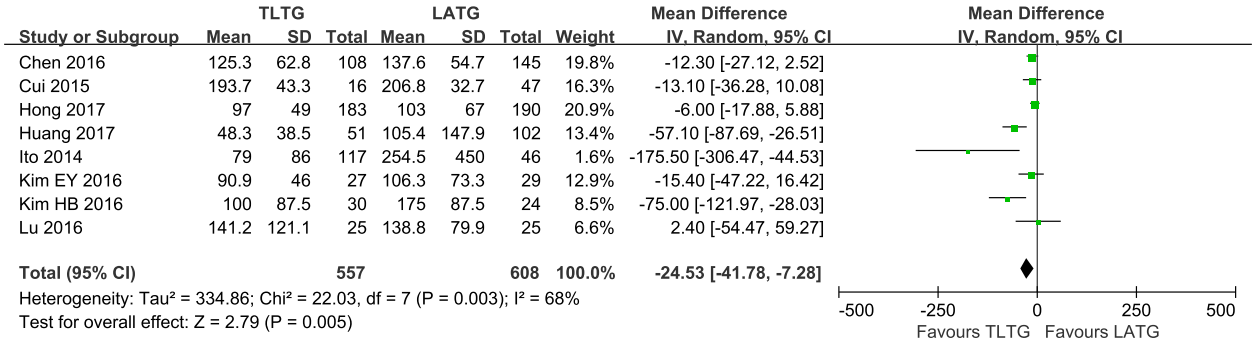

Fig. 4. Meta-analysis of pooled data on intraoperative blood loss. TLTG: totally laparoscopic total gastrectomy; LATG: laparoscopic-assisted total gastrectomy; CI: confidence interval; SD: standard deviation.

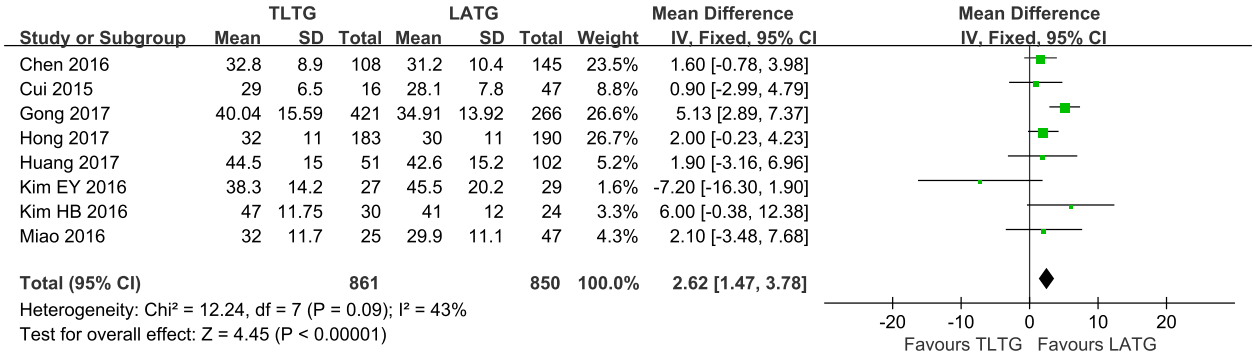

Fig. 5. Meta-analysis of pooled data on the number of retrieved lymphatic nodes. TLTG: totally laparoscopic total gastrectomy; LATG: laparoscopic-assisted total gastrectomy; CI: confidence interval; SD: standard deviation.

effect of LATG has been confirmed in previous studies [31], although the procedure is associated with several limitations. Extracorporeal anastomosis with LATG requires an auxiliary incision, in order to reconstruct the digestive tract extracorporeally. In some cases, such as in obese patients, the laparotomy needs to be extended to obtain a better operative view. In addition, LATG results in high tension in the extracorporeal anastomosis, which could damage the surrounding tissue in certain cases. Extracorporeal anastomosis with increased tension will

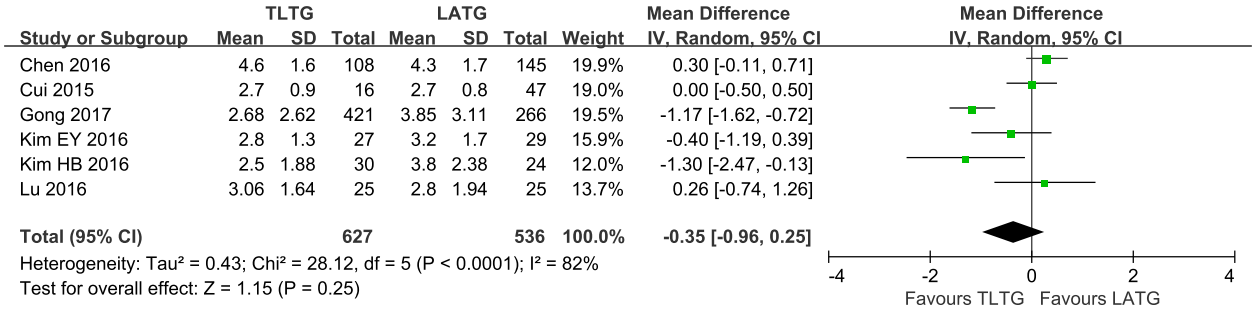

Fig. 6. Meta-analysis of pooled data on the proximal resection edge. TLTG: totally laparoscopic total gastrectomy; LATG: laparoscopic-assisted total gastrectomy; CI: confidence interval; SD: standard deviation.

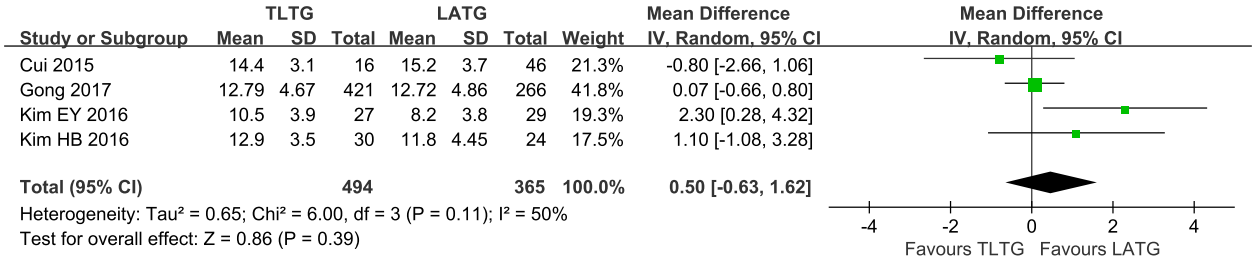

Fig. 7. Meta-analysis of pooled data on the distal resection edge. TLTG: totally laparoscopic total gastrectomy; LATG: laparoscopic-assisted total gastrectomy; CI: confidence interval; SD: standard deviation.

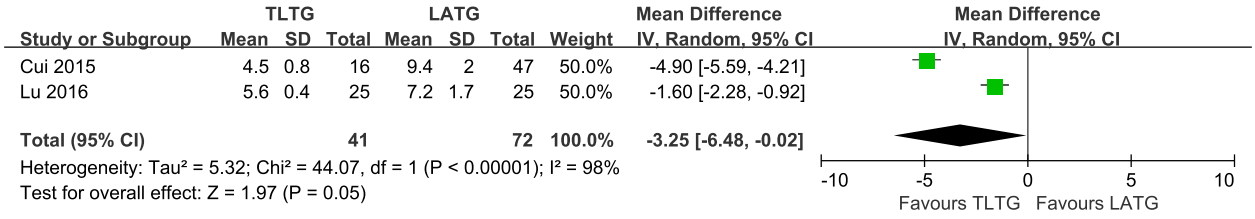

Fig. 8. Meta-analysis of pooled data on incision length. TLTG: totally laparoscopic total gastrectomy; LATG: laparoscopic-assisted total gastrectomy; CI: confidence interval; SD: standard deviation.

increase the risk of anastomosis-related complications, particularly anastomotic leakage and hemorrhage. TLTG can overcome these deficiencies. Intracorporeal anastomosis with TLTG is usually performed in a narrow surgical space, and the anastomosis is more tension-free. This technique avoids direct contact with the tumor, and is associated with reduced incision length and decreased exposure of the surgical area. The technique is also less invasive and traumatic than LATG. TLTG is not widely used as intracorporeal esophagojejunostomy is difficult to perform. Therefore, LATG remains the most commonly used technique for LTG. In recent years, however, several anastomotic techniques for TLTG have been described, including hand-sewn esophagojejunostomy [32], the single stapling technique with a circular stapler [33], double stapling technique with a circular stapler [34], functional end-to-end anastomosis with a linear stapler (FETEA) [35], and side-to-side anastomosis with a linear stapler (overlap) [36]. Due to the complicated surgery involved, hand-sewn esophagojejunostomy is not widely used. Instead, a circular stapler is most commonly used for digestive reconstruction, and surgeons are familiar with the technical essentials and operation methods involved. The single and double stapling techniques with a circular stapler are 2 methods of for esophagojejunostomy in TLTG. The main difficulty associated with esophagojejunostomy using a circular stapler involves the insertion of the anvil head and

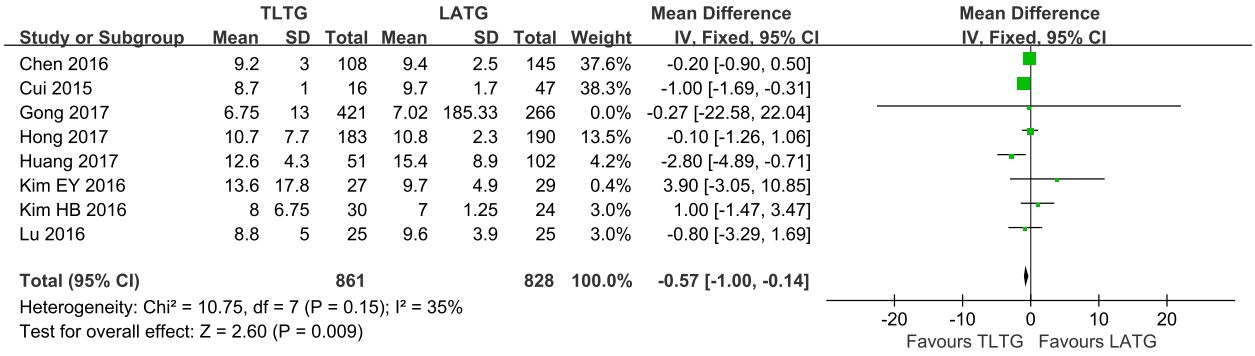

Fig. 9. Meta-analysis of pooled data on postoperative hospitalization duration. TLTG: totally laparoscopic total gastrectomy; LATG: laparoscopic-assisted total gastrectomy; CI: confidence interval; SD: standard deviation.

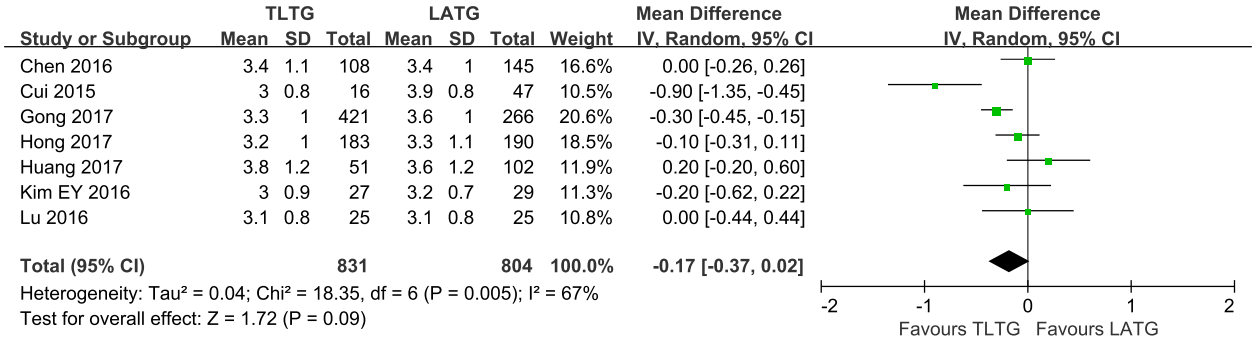

Fig. 10. Meta-analysis of pooled data on the time to first flatus. TLTG: totally laparoscopic total gastrectomy; LATG: laparoscopic-assisted total gastrectomy; CI: confidence interval; SD: standard deviation.

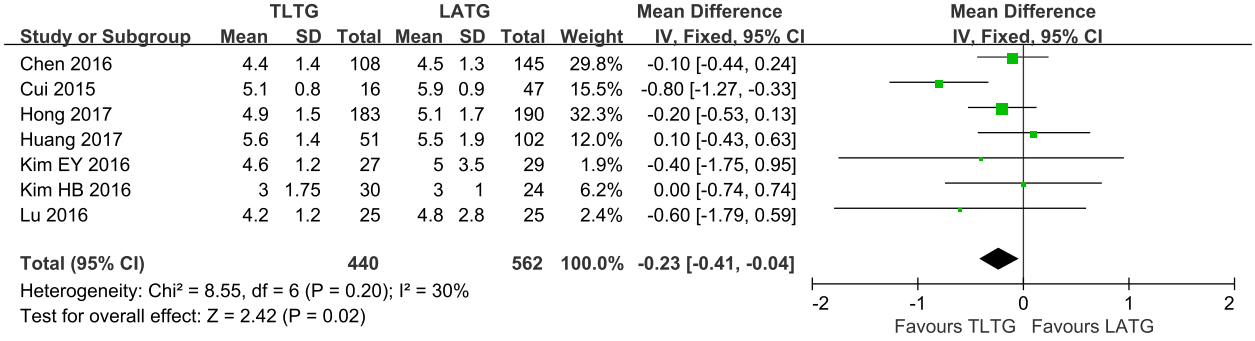

Fig. 11. Meta-analysis of pooled data on the time to the first fluid diet. TLTG: totally laparoscopic total gastrectomy; LATG: laparoscopic-assisted total gastrectomy; CI: confidence interval; SD: standard deviation.

purse-string under laparoscopy. Compared with circular staplers, linear staplers can be inserted into the abdominal cavity via a trocar, and can complete digestive reconstruction without the need for an auxiliary incision. Furthermore, the anastomosis width is sufficient with this method, which reduces the risk of anastomotic stenosis. The FETEA method was initially proposed for esophagojejunostomy using a linear stapler, but the overlap technique was subsequently used in most cases. Compared with the FETEA method, the overlap method does not restrict the peri-hiatal space, which reduces the overall anastomotic tension. However, there is no standard method for determining the optimal intracorporeal anastomotic technique. The popularity of TLTG has been gradually increasing. Nevertheless, due to the lack of randomized clinical trials (RCTs), the therapeutic effect and safety of TLTG remain controversial. In the present meta-analysis, we aimed to offer an objective evaluation between TLTG and LATG.

Due to the technical difficulty associated with the procedure, and because most surgeons are more experienced in performing LATG than TLTG, TLTG is usually considered to be time-consuming. However, we found that the operation time and anastomosis time between TLTG and LATG were comparable. In fact, several studies have shown that the operation time and anastomosis time were lower with TLTG than with LATG [23,29]. There are several possible reasons for this. First, TLTG has become more simple to perform with modified intracorporeal anastomosis techniques. Second, the surgical space in TLTG is wider than that in LATG. Third, no additional incision is needed with TLTG, which could avoid the prolongation of the operation time. Surgeons need to be more skillful to perform TLTG, and sufficient practice helps in overcoming the initial learning-curve and leads to decreases in the operation time. In addition, the amount of blood loss with TLTG is lower than that with LATG, which could be attributed to the following reasons. First, the incision is shorter in TLTG, which may lead to reduced bleeding. Second, TLTG yields a clearer operative field, which could prevent unnecessary damage and reduce bleeding. Third, TLTG effectively reduces tissue retraction, which might decrease the risk of bleeding due to excessive traction. Finally, the difference in the operating skill and technique could lead to differences in the amount of bleeding. Furthermore, cosmesis is better in the TLTG group due to the shorter incision length needed.

In the present analysis, we found that TLTG was associated with a shorter hospitalization duration and time to first diet, both of which are major parameters of postsurgical recovery. Huang et al. [25] reported that patients in the TLTG group had less pain than those in the LATG group. Thus, we infer that TLTG yields faster recovery and lower invasiveness.

The occurrence of postsurgical complications is an important issue in surgery. Severe postsurgical complications could increase the

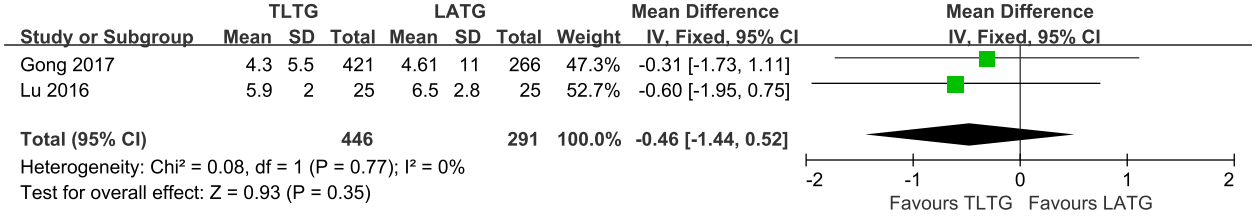

Fig. 12. Meta-analysis of pooled data on the time to the first soft diet. TLTG: totally laparoscopic total gastrectomy; LATG: laparoscopic-assisted total gastrectomy; CI: confidence interval; SD: standard deviation.

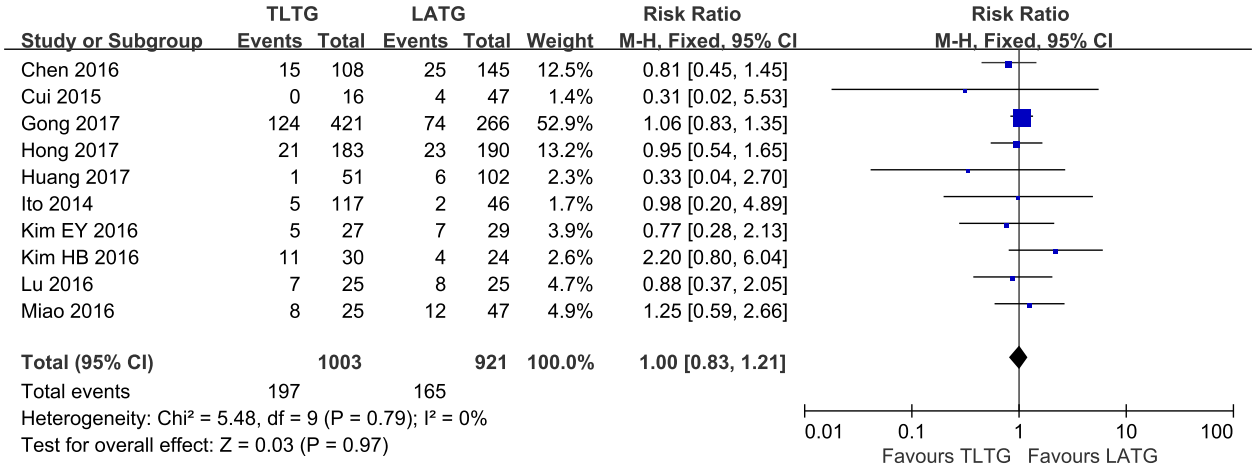

Fig. 13. Meta-analysis of pooled data on overall postsurgical complications. TLTG: totally laparoscopic total gastrectomy; LATG: laparoscopic-assisted total gastrectomy; CI: confidence interval.

duration of hospital stay and treatment cost, and could affect the prognosis. Nevertheless, we did not find any difference between the 2 groups. Anastomosis-related safety was an important issue in patients who underwent TLTG, which was closely associated with the use of intracorporeal esophagojejunostomy. The risk of anastomotic leakage, anastomotic stenosis, and anastomotic hemorrhage in the TLTG and LATG groups was comparable. TLTG did not lead to an increase in the risk of anastomotic complications, and can hence be considered as a safe technique.

With regard to tumor resection, the number of retrieved lymph nodes and surgical resection edge are major indicators of oncology outcomes. The amount of retrieved lymphatic nodes in the TLTG group was significantly greater than that in the LATG group, which differed from the result of Zheng et al. [37]. Although the cause of this difference is unclear, a possible reason might be the close association with surgeon experience in lymphadenectomy and the difference in tumor size or classification. We also found that the proximal resection edge and distal resection edge did not differ between the 2 groups, and hence, the oncology outcomes of TLTG were not inferior to those of LATG.

LTG which is believed to be difficult, can be more efficient via systematic learning. Hence, it is important to recognize the learning curve involved. Yasukawa et al. [38] collected the clinical data of 81 patients who underwent LTG, and defined 3 periods based on the esophagojejunostomy procedure: (1) various conventional processes based on surgeon choice (n = 14); (2) use of the transoral method (n = 51); and (3) use of intracorporeal esophagojejunostomy (n = 18). Compared with patients in period 1, those in period 2 had a higher lymph node yield and lower blood loss. Moreover, the lymph node yield was higher in period 3 than in period 2. Patients will achieve greater benefits once the esophagojejunostomy procedure has been well established. Kunisaki et al. [39] reported that after completing 30 cases, the learning curve of lymph node dissection (assessed based on time) flattens. In addition, after completing 40 cases, the learning curve of digestive reconstruction (assessed based on time) flattens. Compared with LDG, studies on the learning curve of LTG are scarce, and hence, we cannot offer any definitive conclusions. Nevertheless, a certain amount of training is required to complete LTG, particularly TLTG, and hence, we recommend that surgeons require repeated practice to perfect the technique.

We did not evaluate the long-term outcomes in the present study. Only 1 study reported an exact follow-up time and survival values. In that study, the follow-up duration ranged from 4 to 26 months, and the mean follow-up was 13 months. The researchers compared overall survival, tumor recurrence, and metastasis during the follow-up period, and did not observe any significant differences in these parameters between the TLTG and LATG groups [24]. Hence, further studies are needed to evaluate the long-term survival of TLTG.

Nevertheless, the present study had certain limitations. First, all the included studies were conducted in Asian countries, which made the results more applicable to the population in East Asian countries than to the population in Western countries. Second, all the studies were retrospective in nature, and no RCTs or blinded studies were included in this meta-analysis. Due to the retrospective nature of the studies, there

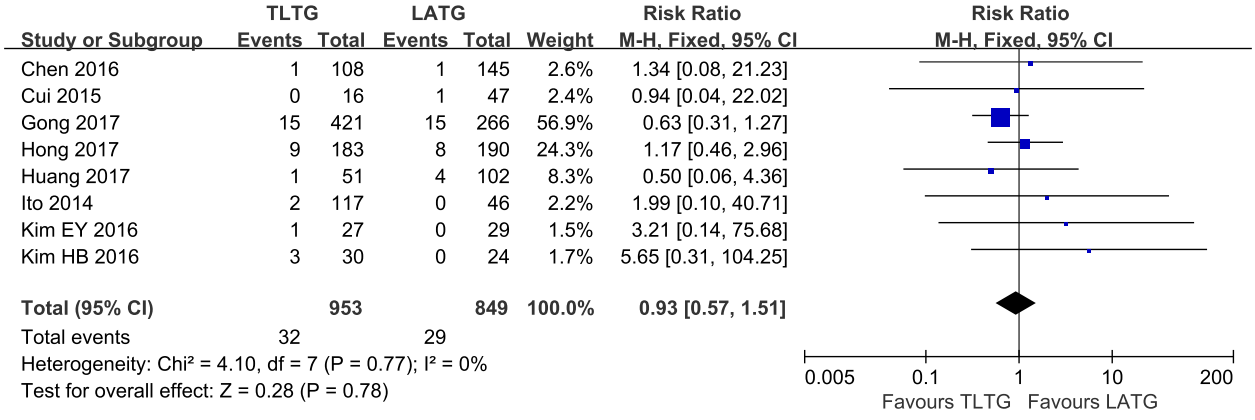

Fig. 14. Meta-analysis of pooled data on anastomotic leakage. TLTG: totally laparoscopic total gastrectomy; LATG: laparoscopic-assisted total gastrectomy; CI: confidence interval.

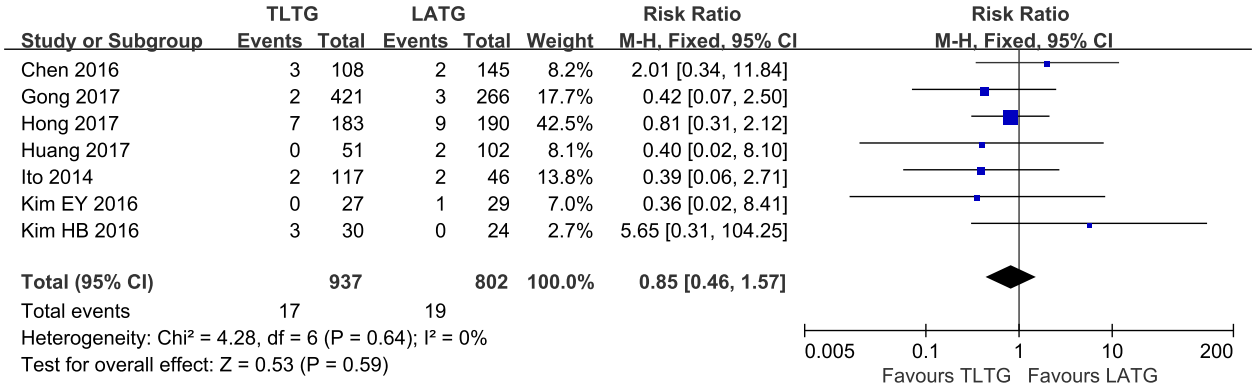

Fig. 15. Meta-analysis of pooled data on anastomotic stenosis. TLTG: totally laparoscopic total gastrectomy; LATG: laparoscopic-assisted total gastrectomy; CI: confidence interval.

is also a risk of bias. Third, although we included all the relevant publications from our search, the sample size may not be sufficient. Hence, additional RCTs and large-scale studies need to be included. Fourth, several intracorporeal techniques were included in our meta-analysis, and the difference between these techniques was ignored; however, this could lead to high heterogeneity. Finally, the surgery was conducted in different medical institutions, and no uniform criteria were used, which could affect the results.

In conclusion, compared to LATG, TLTG is an easy technique that may yield better cosmesis, lower invasiveness, and faster recovery. Nevertheless, additional large-scale studies are needed from different countries.

Ethical Approval

Our study is a systematic review and meta-analysis. So there was no Ethical Approval.

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Author contribution

Substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data: Shuai Zhao, Kai Zheng, Jian-Chun Zheng, Tao-Tao Hou, Zhen-Ning Wang, Hui-Mian Xu, Cheng-Gang Jiang; drafting the article or revising it critically for important intellectual content: Shuai Zhao, Jian-Chun Zheng, Tao-Tao Hou; final approval of the version to be published: Shuai Zhao, Kai Zheng, Cheng-Gang Jiang.

Conflicts of interest

No benefits in any from have been or will be received from a commercial party related directly or indirectly to the subject of this manuscript.

Research registration number

The name of the registry:RROSPERO; Research Registration Unique Identifying Number.

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Data statement

All data generated or analysed during this study are included in this published article. No additional unpublished data are available.

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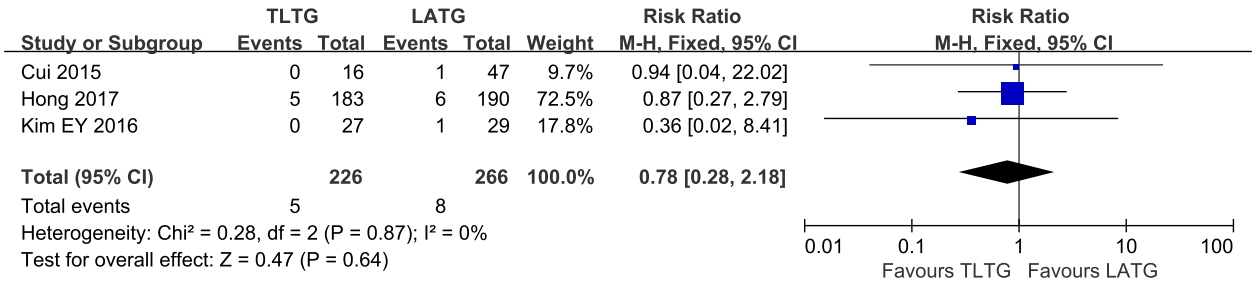

Fig. 16. Meta-analysis of pooled data on anastomotic hemorrhage. TLTG: totally laparoscopic total gastrectomy; LATG: laparoscopic-assisted total gastrectomy; CI: confidence interval.

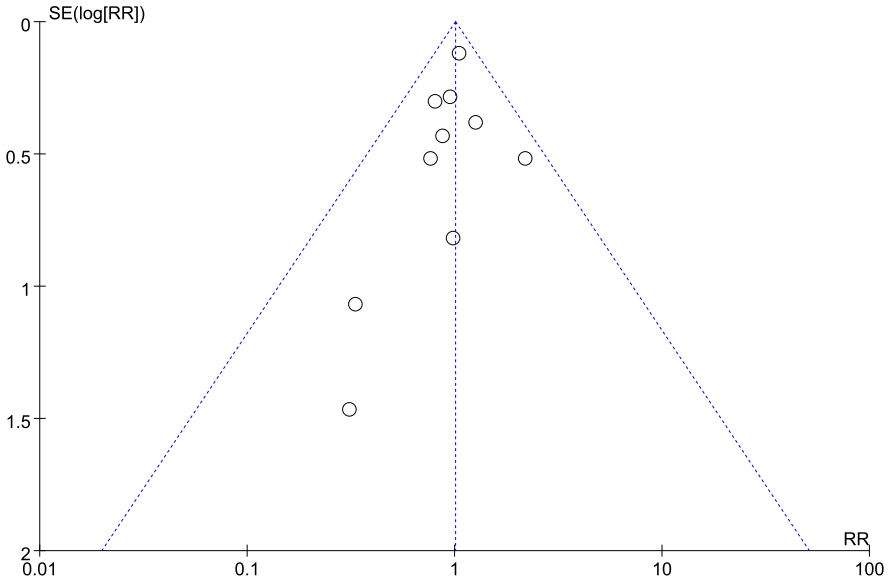

Fig. 17. Funnel plot of the overall postsurgical complications. RR: risk ratio; SE: standard error.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijsu.2019.05.020.

References

[1] L.A. Torre, F. Bray, R.L. Siegel, J. Ferlay, J. Lortet-Tieulent, A. Jemal, Global cancer statistics, CA A Cancer J. Clin. 65 (2) (2012) 87–108 2015.

[2] M. Saka, S. Morita, T. Fukagawa, H. Katai, Present and future status of gastric cancer surgery, Jpn. J. Clin. Oncol. 41 (3) (2011) 307–313.

[3] S. Kitano, Y. Iso, M. Moriyama, K. Sugimachi, Laparoscopy-assisted billroth I gastrectomy, Surg. Laparosc. Endosc. 4 (2) (1994) 146–148.

[4] J. Sun, J. Li, J. Wang, T. Pan, J. Zhou, X. Fu, S. Zhang, Meta-analysis of randomized controlled trials on laparoscopic gastrectomy vs. open gastrectomy for distal gastric cancer, Hepato-gastroenterol 59 (118) (2012) 1699–1705.

[5] D. Martinez-Ramos, J.M. Miralles-Tena, M.A. Cuesta, J. Escrig-Sos, D. Van der Peet, J.S. Hoashi, J.L. Salvador-Sanchis, Laparoscopy versus open surgery for advanced and resectable gastric cancer: a meta-analysis, Rev. Esp. Enferm. Dig. 103 (3) (2011) 133–141.

[6] H.B. Wei, B. Wei, C.L. Qi, T.F. Chen, Y. Huang, Z.H. Zheng, J.L. Huang, J.F. Fang, Laparoscopic versus open gastrectomy with D2 lymph node dissection for gastric cancer: a meta-analysis, Surg. Laparosc. Endosc. Percutaneous Tech. 21 (6) (2011) 383–390.

[7] K. Chen, Y. Pan, J.Q. Cai, X.W. Xu, D. Wu, Y.P. Mou, Totally laparoscopic gastrectomy for gastric cancer: a systematic review and meta-analysis of outcomes compared with open surgery, World J. Gastroenterol. 20 (42) (2014) 15867–15878.

[8] Y. Quan, A. Huang, M. Ye, M. Xu, B. Zhuang, P. Zhang, B. Yu, Z. Min, Comparison of laparoscopic versus open gastrectomy for advanced gastric cancer: an updated meta-analysis, Gastric Cancer 19 (3) (2016) 939–950.

[9] X.Z. Chen, L. Wen, Y.Y. Rui, C.X. Liu, Q.C. Zhao, Z.G. Zhou, J.K. Hu, Long-term survival outcomes of laparoscopic versus open gastrectomy for gastric cancer: a systematic review and meta-analysis, Medicine 94 (4) (2015) e454.

[10] Y.Y. Choi, J.M. Bae, J.Y. An, W.J. Hyung, S.H. Noh, Laparoscopic gastrectomy for advanced gastric cancer: are the long-term results comparable with conventional open gastrectomy? A systematic review and meta-analysis, J. Surg. Oncol. 108 (8) (2013) 550–556.

[11] K. Chen, X.W. Xu, Y.P. Mou, Y. Pan, Y.C. Zhou, R.C. Zhang, D. Wu, Systematic review and meta-analysis of laparoscopic and open gastrectomy for advanced gastric cancer, World J. Surg. Oncol. 11 (2013) 182.

[12] Y.-X. Zhang, Y.-J. Wu, G.-W. Lu, M.-M. Xia, Systematic review and meta-analysis of totally laparoscopic versus laparoscopic assisted distal gastrectomy for gastric cancer, World J. Surg. Oncol. 13 (2015).

[13] D.G. Kim, Y.Y. Choi, J.Y. An, I.G. Kwon, I. Cho, Y.M. Kim, J.M. Bae, M.G. Song, S.H. Noh, Comparing the short-term outcomes of totally intracorporeal gastroduodenostomy with extracorporeal gastroduodenostomy after laparoscopic distal gastrectomy for gastric cancer: a single surgeon's experience and a rapid systematic review with meta-analysis, Surg. Endosc. 27 (9) (2013) 3153–3161.

[14] J. Wang, Y. Xie, L. Hu, Totally laparoscopic distal gastrectomy and laparoscopic-assisted distal gastrectomy:A Meta-analysis of efficacy comparation, Chin J Pract Surg 34 (4) (2014) 351–355.

[15] A. Umemura, K. Koeda, A. Sasaki, H. Fujiwara, Y. Kimura, T. Iwaya, Y. Akiyama, G. Wakabayashi, Totally laparoscopic total gastrectomy for gastric cancer: literature review and comparison of the procedure of esophagojejunostomy, Asian J. Surg. 38 (2) (2015) 102–112.

[16] S.P. Hozo, B. Djulbegovic, I. Hozo, Estimating the mean and variance from the median, range, and the size of a sample, BMC Med. Res. Methodol. 5 (2005) 13.

[17] K. Chen, Y. He, J.Q. Cai, Y. Pan, D. Wu, D.W. Chen, J.F. Yan, H. Maher, Y.P. Mou, Comparing the short-term outcomes of intracorporeal esophagojejunostomy with extracorporeal esophagojejunostomy after laparoscopic total gastrectomy for gastric cancer, BMC Surg. 16 (2016) 13.

[18] H.S. Kim, M.G. Kim, B.S. Kim, I.S. Lee, S. Lee, J.H. Yook, B.S. Kim, Comparison of totally laparoscopic total gastrectomy and laparoscopic-assisted total gastrectomy methods for the surgical treatment of early gastric cancer near the gastroesophageal junction, J Laparoendosc Adv A 23 (3) (2013) 204–210.

[19] Y.J. Jung, D.J. Kim, J.H. Lee, W. Kim, Safety of intracorporeal circular stapling esophagojejunostomy using trans-orally inserted anvil (OrVil (TM)) following laparoscopic total or proximal gastrectomy - comparison with extracorporeal anastomosis, World J. Surg. Oncol. (2013) 11.

[20] M. Yamamoto, H. Kawano, S. Yamaguchi, A. Egashira, K. Minami, M. Morita, Y. Sakaguchi, Y. Toh, Technical and survival risks associated with esophagojejunostomy by laparoscopic total gastrectomy for gastric carcinoma, Surg. Laparosc. Endosc. 27 (3) (2017) 197–202.

[21] K. Chen, Y. Pan, J.Q. Cai, D. Wu, J.F. Yan, D.W. Chen, H.M. Yu, X.F. Wang, Totally laparoscopic versus laparoscopic-assisted total gastrectomy for upper and middle gastric cancer: a single-unit experience of 253 cases with meta-analysis, World J. Surg. Oncol. 14 (2016) 96.

[22] C. Cui, W. Liang, Z. Zhu, H. Yao, Y. Wu, L. Liu, J. Guan, Feasibility, safety and short-term efficacy of totally laparoscopic total gastrectomy for upper stomach cancer, Chin. J. Gen. Surg. 24 (10) (2015) 1377–1382.

[23] C.S. Gong, B.S. Kim, H.S. Kim, Comparison of totally laparoscopic total gastrectomy using an endoscopic linear stapler with laparoscopic-assisted total gastrectomy using a circular stapler in patients with gastric cancer: a single-center experience, World J. Gastroenterol. 23 (48) (2017) 8553–8561.

[24] Q. Hong, W. Wang, J. Zhang, L. Fan, J. Zhu, G. Ji, S. Yan, J. You, Clinical efficacies of totally laparoscopic and laparoscopy-assisted radical total gastrectomies in 373 patients: a multicentre retrospective study, Chin J Dig Surg 16 (8) (2017) 822–827.

[25] Z.N. Huang, C.M. Huang, C.H. Zheng, P. Li, J.W. Xie, J.B. Wang, J.X. Lin, J. Lu, Q.Y. Chen, L.L. Cao, M. Lin, R.H. Tu, J.L. Lin, Digestive tract reconstruction using isoperistaltic jejunum-later-cut overlap method after totally laparoscopic total gastrectomy for gastric cancer: short-term outcomes and impact on quality of life, World J. Gastroenterol. 23 (39) (2017) 7129–7138.

[26] H. Ito, H. Inoue, N. Odaka, H. Satodate, M. Onimaru, H. Ikeda, D. Takayanagi, K. Nakahara, S-e Kudo, Evaluation of the safety and efficacy of esophagojejunostomy after totally laparoscopic total gastrectomy using a trans-orally inserted anvil: a single-center comparative study, Surg. Endosc. 28 (6) (2014) 1929–1935.

[27] E.Y. Kim, H.J. Choi, J.B. Cho, J. Lee, Totally laparoscopic total gastrectomy versus laparoscopically assisted total gastrectomy for gastric cancer, Anticancer Res. 36 (4) (2016) 1999–2003.

[28] H.B. Kim, S.M. Kim, M.H. Ha, J.E. Seo, M.-G. Choi, T.S. Sohn, J.M. Bae, S. Kim, J.H. Lee, Comparison of reduced port totally laparoscopic-assisted total gastrectomy (duet TLTG) and conventional laparoscopic-assisted total gastrectomy, Surg. Laparosc. Endosc. 26 (6) (2016) E132–E136.

[29] X. Lu, Y. Hu, H. Liu, T. Mou, Z. Deng, D. Wang, J. Yu, G. Li, Short-term outcomes of intracorporeal esophagojejunostomy using the transorally inserted anvil versus extracorporeal circular anastomosis during laparoscopic total gastrectomy for gastric cancer: a propensity score matching analysis, J. Surg. Res. 200 (2) (2016) 435–443.

[30] R. Miao, Z. Li, Y. Wang, Usage of mechanical stapler in digestive tract reconstruction of laparoscopic total gastrectomy, Chin J Pract Surg 36 (9) (2016) 968–972.
[31] L. Haverkamp, T.J. Weijs, P.C. van der Sluis, I. van der Tweel, J.P. Ruurda, R. van Hillegersberg, Laparoscopic total gastrectomy versus open total gastrectomy for cancer: a systematic review and meta-analysis, Surg. Endosc. 27 (5) (2013) 1509–1520.
[32] K.O. So, J.M. Park, Totally laparoscopic total gastrectomy using intracorporeally hand-sewn esophagojejunostomy, J Gas Cancer 11 (4) (2011) 206–211.
[33] H.I. Kim, I. Cho, D.S. Jang, W.J. Hyung, Intracorporeal esophagojejunostomy using a circular stapler with a new purse-string suture technique during laparoscopic total gastrectomy, J. Am. Coll. Surg. 216 (2) (2013) e11–16.
[34] G. Marangoni, F. Villa, E. Shamil, A.J. Botha, OrVil-assisted anastomosis in laparoscopic upper gastrointestinal surgery: friend of the laparoscopic surgeon, Surg. Endosc. 26 (3) (2012) 811–817.
[35] Y. Ebihara, S. Okushiba, Y. Kawarada, S. Kitashiro, H. Katoh, Outcome of functional end-to-end esophagojejunostomy in totally laparoscopic total gastrectomy, Langenbeck's Arch. Surg. 398 (3) (2013) 475–479.
[36] K. Inaba, S. Satoh, Y. Ishida, K. Taniguchi, J. Isogaki, S. Kanaya, I. Uyama, Overlap method: novel intracorporeal esophagojejunostomy after laparoscopic total gastrectomy, J. Am. Coll. Surg. 211 (6) (2010) e25–29.
[37] X.Y. Zheng, Y. Pan, K. Chen, J.Q. Gao, X.J. Cai, Comparison of intracorporeal and extracorporeal esophagojejunostomy after laparoscopic total gastrectomy for gastric cancer: a meta-analysis based on short-term outcomes, Chin. Med. J. (Taipei) 131 (6) (2018) 713–720.
[38] D. Yasukawa, T. Hori, Y. Kadokawa, S. Kato, T. Machimoto, T. Hata, Y. Aisu, M. Sasaki, Y. Kimura, Y. Takamatsu, T. Ito, T. Yoshimura, Impact of stepwise introduction of esophagojejunostomy during laparoscopic total gastrectomy: a single-center experience in Japan, Ann. Gastroenterol. 30 (5) (2017) 564–570.
[39] C. Kunisaki, H. Makino, N. Yamaguchi, Y. Izumisawa, H. Miyamato, K. Sato, T. Hayashi, N. Sugano, Y. Suzuki, M. Ota, A. Tsuburaya, J. Kimura, R. Takagawa, T. Kosaka, H.A. Ono, H. Akiyama, I. Endo, Surgical advantages of reduced-port laparoscopic gastrectomy in gastric cancer, Surg. Endosc. 30 (12) (2016) 5520–5528.