

Comparison of the short-term outcomes between totally laparoscopic total gastrectomy and laparoscopic-assisted total gastrectomy for gastric cancer: a meta-analysis

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Abstract

Background: Totally laparoscopic total gastrectomy (TLTG) and laparoscopic-assisted total gastrectomy (LATG) are two common surgical approaches for upper and middle gastric cancer. Which surgical approach offers more advantages is still controversial due to a lack of evidence from randomized controlled trials (RCTs). This meta-analysis was conducted to compare the short-term outcomes between the two surgical approaches.

Methods: A systematic literature search was performed to evaluate short-term outcomes between TLTG and LATG, including overall postoperative complications, anastomosis-related complications, time for anastomosis, operation time, intraoperative blood loss, harvested lymph nodes, proximal margin, distal margin, time to first flatus, time to first diet, and postoperative hospital stay. Short-term outcomes were pooled and compared by meta-analysis using RevMan 5.3. Mean differences (MDs) or risk ratios (RRs) were calculated with 95% confidence intervals (CIs). $P < .05$ was considered statistically significant.

Results: A total of 9 cohort studies fulfilled the selection criteria. The total sample included 1671 cases. The meta-analysis showed no significant difference between the two surgical approaches in overall postoperative complications (RR = 1.02, 95% CI = 0.82 to 1.26, $P = .87$), anastomosis-related complications (RR = 0.64, 95% CI = 0.39 to 1.03, $P = .06$), time for anastomosis (MD = -5.13, 95% CI = -10.54 to 0.27, $P = .06$), operation time (MD = -10.68, 95% CI = -23.62 to 2.26, $P = .11$), intraoperative blood loss (MD = -25.58, 95% CI = -61.71 to 10.54, $P = .17$), harvested lymph nodes (MD = 1.61, 95% CI = -2.09 to 5.31, $P = .39$), proximal margin (MD = -0.37, 95% CI = -0.78 to 0.05, $P = .09$), distal margin (MD = 0.79, 95% CI = -0.57 to 2.14, $P = .25$), time to first flatus (MD = 0.01, 95% CI = -0.13 to 0.15, $P = .87$), time to first diet (MD = -0.22, 95% CI = -0.45 to 0.02, $P = .07$), and postoperative hospital stay (MD = -0.51, 95% CI = -1.10 to 0.07, $P = .09$).

Conclusions: TLTG is a safe and feasible surgical approach for upper and middle gastric cancer, with short-term outcomes that are similar to LATG. Nevertheless, high-quality, large-sample and multicenter RCTs are still required to further verify our conclusions.

Abbreviations: CI = confidence interval, LATG = laparoscopic-assisted total gastrectomy, MD = mean difference, RCT = randomized controlled trials, RR = risk ratio, TLTG = totally laparoscopic total gastrectomy.

Keywords: gastric cancer, laparoscopic-assisted total gastrectomy, meta-analysis, totally laparoscopic total gastrectomy

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1. Introduction

Gastric cancer is the fifth most common cancer and represents the third leading cause of death worldwide, with an estimated 783,000 deaths in 2018.^[1,2] Gastric cancer incidence is highly variable by region and culture. Incidence rates are highest in eastern and central Asia and Latin America.^[3,4] Despite the continuing advancement in chemotherapy, radiotherapy, and biotherapy, radical gastrectomy with regional lymphadenectomy still remains the primary treatment strategy for gastric cancer.^[5-7]

Since the first report of laparoscopic gastrectomy for gastric cancer in 1994 by Kitano et al^[8], the adoption of laparoscopic surgery for the treatment of gastric cancer has become significantly more common. For upper and middle gastric cancer, laparoscopic-assisted total gastrectomy (LATG) is a commonly used methods of laparoscopic gastrectomy due to its well-known advantages over open total gastrectomy, such as decreased blood-loss, faster flatus, earlier feeding, shorter hospital stays, and smaller incision scars.^[9,10,11,12] With LATG, lymph node dissection is performed laparoscopically, but the transection of the stomach and the anastomosis are performed through an epigastric minilaparotomy. Extracorporeal reconstruction has

the advantage that surgeons can perform an anastomosis similarly to that in open surgery.^[13] However, anastomosis via minilaparotomy in LATG is relatively difficult because of the limited angle of the direct view.

With the rapid improvement in techniques and instruments for laparoscopic surgery, totally laparoscopic total gastrectomy (TLTG) has become more commonly used.^[14,15,16] With TLTG, resection of the stomach and intracorporeal anastomosis are performed under pneumoperitoneum. At present, no scientific conclusion can be drawn regarding which surgical approach offers more advantages due to the lack of well-designed randomized controlled trials (RCTs). Hence, we conducted this meta-analysis to compare the short-term outcomes between TLTG and LATG for gastric cancer.

2. Materials and methods

2.1. Literature search

This meta-analysis was approved by the Ethics Committee of the First Affiliated Hospital of Chongqing Medical University. The PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) statement was followed for conducting this meta-analysis.^[17] Published literature was searched using MEDLINE, EMBASE, AMED, CINAHL, Scopus, Biomed Central, and Cochrane Library to June 1, 2019. The language was limited to English. The search strategy was as follows: (“gastric cancer” OR “gastric carcinoma” OR “gastric neoplasms” OR “stomach cancer” OR “stomach carcinoma” OR “stomach neoplasms”) AND (“laparoscopic-assisted total gastrectomy” AND “totally laparoscopic total gastrectomy”) OR (“intracorporeal anastomosis” AND “extracorporeal anastomosis”). Unpublished literature was searched using the WHO International Clinical Trials Registry Platform, Current Controlled Trials, UKCRN Portfolio Database and National Technical Information Service, and OpenSIGLE (System for Information on Gray Literature in Europe) from their inception to June 1, 2019. Finally, reference lists of all full-text articles identified as pertinent to the study were reviewed for unidentified studies.

2.2. Inclusion and exclusion criteria

The inclusion criteria for this meta-analysis included the following: studies comparing TLTG and LATG for gastric cancer; studies reporting clinical characteristics of cases; and studies reporting at least 1 short-term outcome including overall postoperative complications, anastomosis-related complications, time for anastomosis, operation time, intraoperative blood loss, harvested lymph nodes, proximal margin, distal margin, time to first flatus, time to first diet, and postoperative hospital stay. If more than 1 study was reported by the same institute, only the most recent study was included.

The exclusion criteria were as follows: original studies assessing the outcomes of either LATG or TLTG separately, review articles, letters, comments, and case reports.

2.3. Study selection

Two authors (GL and ZW) independently applied the search strategy to select studies from the databases. Titles and abstracts of those articles were reviewed independently. When in doubt, the full text was retrieved for further selection. The two authors independently assessed each study to judge whether it met the

inclusion criteria. When necessary, authors were contacted for more information about their studies. Any disagreement was discussed with the senior author (WZ), and when consensus could not be reached, that study was excluded.

2.4. Data extraction

The same two authors (GL and ZW) independently extracted the data. Disagreements were resolved by consensus or consultation with the senior author. Data extracted included first author, county, study design, sample size, clinical characteristics of patients, and short-term outcomes, including overall postoperative complications, anastomosis-related complications, time for anastomosis, operation time, intraoperative blood loss, harvested lymph nodes, proximal margin, distal margin, time to first flatus, time to first diet, and postoperative hospital stay.

2.5. Quality Assessment

To assess the methodological quality of included cohort studies, the same 2 authors (GL and ZW) used the Newcastle-Ottawa Scale (NOS),^[18] in which a study was judged on three broad perspectives: selection, comparability, and outcome. The methodological quality of each study was scored and ranged from 0 to 9. Any disagreement was resolved by the senior authors. Studies achieving scores of ≥ 6 points were considered to be of high quality and were included in the meta-analysis.

2.6. Statistical analysis

The meta-analysis was performed using RevMan 5.3 (The Cochrane Collaboration, London, United Kingdom). Dichotomous variables were expressed as proportions or risks. Continuous variables were expressed as the mean and standard deviation (SD). For dichotomous and continuous variables, risk ratios (RRs) and mean differences (MDs) were calculated, respectively. A 95% confidence interval (CI) was reported for both measures. Statistical heterogeneity was assessed using the value of I^2 and the result of the Chi-squared test. A P value of less than .1 and an I^2 value of greater than 50% was considered statistically significant for high heterogeneity.^[19,20] The fixed-effect model was used when no high heterogeneity was detected among the studies, while the random-effect model was preferred for the studies with high statistical heterogeneity. $P < .05$ was considered statistically significant.

3. Results

3.1. Selected Studies and characteristics

A total of 212 studies were identified through database searching. After title and abstract screening, 10 studies remained.^[21–30] After further screening by full text, 1 study was excluded for overlapping data.^[26] A flowchart of study selection is shown in Figure 1. Finally, 9 studies^[21–25,27–30], including 6 retrospective cohort studies and 3 prospective cohort studies, were included for meta-analysis. Clinical characteristics of all included cohort studies eligible for the meta-analysis are presented in Table 1. In total, 4 studies evaluated patients from Korea; 3, from China; and 2, from Japan. Overall, 1671 patients were included in the meta-analysis. All 9 studies were considered to be of adequate quality for the meta-analysis. The quality assessment is displayed in Table 2. Funnel plots were performed to assess publication bias.

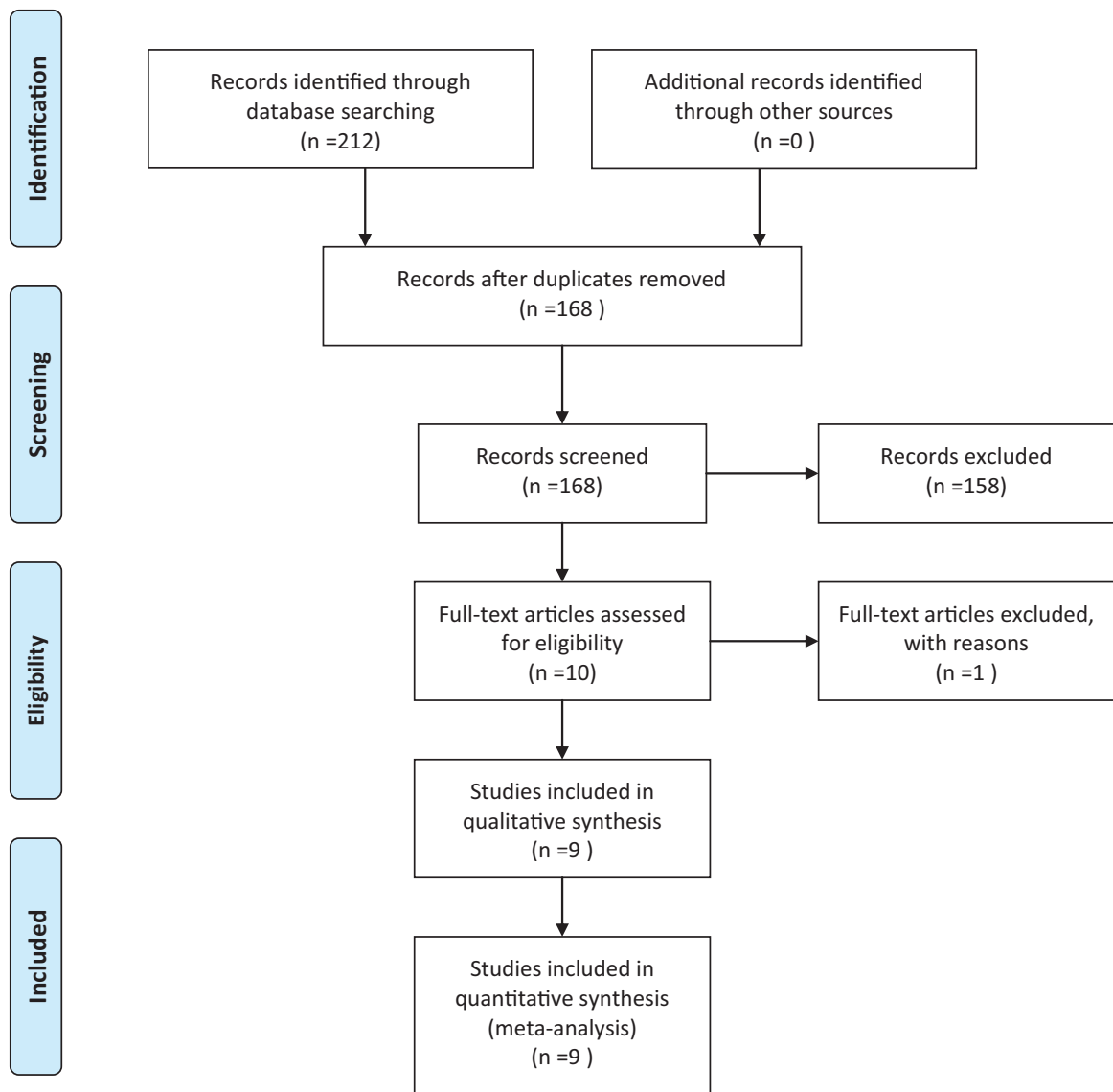


Figure 1. Flowchart of study selection.

Table 1

Clinical characteristics of included cohort studies.

Study	County	Study design	Sample size		Age (years)		Gender (male/female)		BMI (kg/m ²)	
			TLTG	LATG	TLTG	LATG	TLTG	LATG	TLTG	LATG
Jung, 2013 ^[21]	Korea	Retrospective	40	47	63.4±12.1	61.2±12.1	31/9	37/10	24.0±14.8	23.4±4.3
Kim, 2013 ^[22]	Korea	Prospective	90	23	58.0±10.8	56.8±14.2	61/29	19/6	23.2±2.9	22.2±1.8
Ito, 2014 ^[23]	Japan	Prospective	117	46	NA	NA	NA	NA	NA	NA
Kim, 2016 ^[24]	Korea	Prospective	27	29	60.8±9.1	59.3±13.1	22/5	20/9	24.0±2.9	23.3±3.2
Lu, 2016 ^[25]	China	Retrospective	25	25	59.0±8.9	58.4±7.7	22/3	21/4	22.5±2.5	22.9±3.7
Chen, 2016 ^[27]	China	Retrospective	108	145	59.4±11.1	57.3±12.5	73/35	98/47	23.5±3.5	23.1±4.2
Huang, 2017 ^[28]	China	Retrospective	51	102	55.5±12.1	55.9±11.0	34/17	68/34	22.5±13.1	22.6±12.8
Gong, 2017 ^[29]	Korea	Retrospective	421	266	57.78±11.2	55.69±11.96	273/148	167/99	NA	NA
Yamamoto 2017 ^[30]	Japan	Retrospective	100	9	64.6±11.7	68.3±12.0	59/41	4/5	22.3±3.0	23±2.3

Age and BMI are presented in terms of mean±SD (standard deviation).

BMI=body mass index, TLTG=totally laparoscopic total gastrectomy, LATG=laparoscopic-assisted total gastrectomy, NA=not available.

Table 2
Quality assessment of included studies by the Newcastle-Ottawa Scale.

Study	Selection (stars)	Comparability (stars)	Outcome (stars)	Total (stars)
Jung, 2013	4	2	2	8
Kim, 2013	4	2	1	7
Ito, 2014	4	2	2	8
Kim, 2016	4	2	1	7
Lu, 2016	4	2	2	8
Chen, 2016	4	2	2	8
Huang, 2017	4	1	1	7
Gong, 2017	4	1	2	7
Yamamoto, 2017	4	1	1	6

A funnel plot based on the most frequently cited outcome was broadly symmetrical, indicating minimal publication bias (Fig. 2).

3.2. Postoperative complication outcomes

3.2.1. Overall postoperative complications. Overall postoperative complications mainly included anastomosis-related complications, pulmonary complications, wound infection, pancreatic fistula, and intestinal obstruction. Seven^[21,22,24,25,28-30] of the included studies reported results regarding overall postoperative complications in both groups. No significant difference was observed (RR=1.02, 95% CI=0.82 to 1.26, $P=.87$) (Fig. 3).

3.2.2. Anastomosis-related complications. Eight studies^[21-25,28-30] provided data on anastomosis-related complications. The meta-analysis showed no significant difference in anastomosis-related complications between Group TLTG and Group LATG (RR=0.64, 95% CI=0.39 to 1.03, $P=.06$) (Table 3).

Anastomotic leakage, bleeding, and stricture were 3 main types of anastomosis-related complications. Eight studies^[21-25,28-30] provided data on anastomotic leakage. Pooling the data showed that there was no significant difference between the two groups (RR=0.62, 95% CI=0.36 to 1.06, $P=.08$) (Table 3). Four studies^[24,25,28,30] provided information on anastomotic bleeding. The overall rate of anastomotic bleeding was comparable between the two groups and showed no significant difference (RR=0.56, 95% CI=0.07 to 4.48, $P=.59$) (Table 3). Seven studies^[21-25,28,29] provided information on anastomotic stricture. The meta-analysis showed no significant difference between the two groups (RR=0.69, 95% CI=0.27 to 1.72, $P=.42$) (Table 3).

3.3. Intraoperative outcomes

3.3.1. Time for anastomosis. Four^[21,24,25,27] of the 9 included articles reported data regarding time for anastomosis, and no significant difference was observed between Group TLTG and Group LATG (MD=-5.13, 95% CI=-10.54 to 0.27, $P=.06$) (Table 3).

3.3.2. Operation time. Eight^[21-25,27,28,30] of the 9 articles included in the meta-analysis reported data regarding operation time, and no statistically significant difference was observed between Group TLTG and Group LATG (MD=-10.68, 95% CI=-23.62 to 2.26, $P=.11$) (Table 3).

3.3.3. Intraoperative blood loss. Six studies^[23-25,27,28,30] reported intraoperative blood loss. Compared with the LATG group, the TLTG group had similar intraoperative blood loss (MD=-25.58, 95% CI=-61.71 to 10.54, $P=.17$) (Table 3).

3.4. Oncologic outcomes

3.4.1. Harvested lymph nodes. Six studies^[21,22,24,27-29] provided harvested lymph nodes. After pooling all the data, there

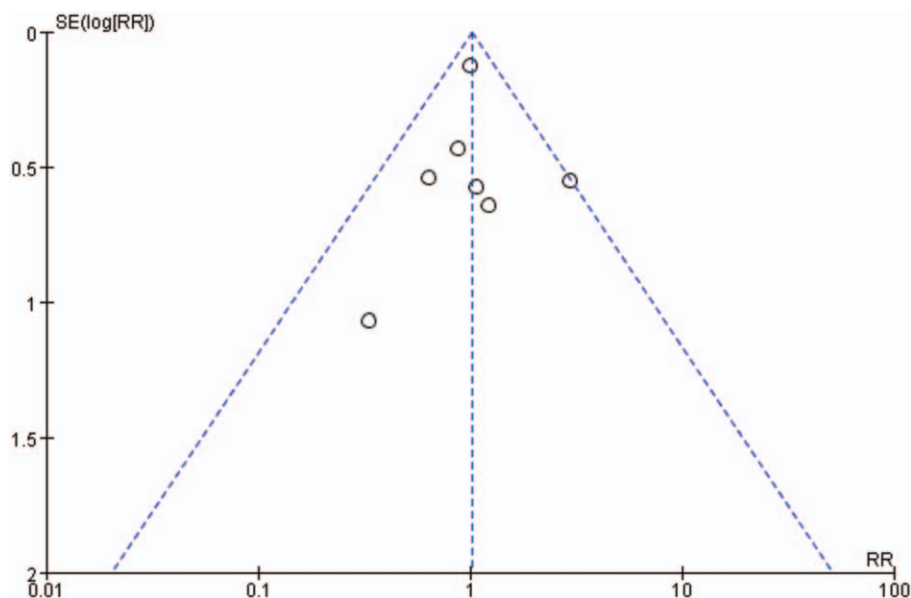


Figure 2. Funnel plot of anastomosis-related complications. SE=standard error, RR=risk ratio.

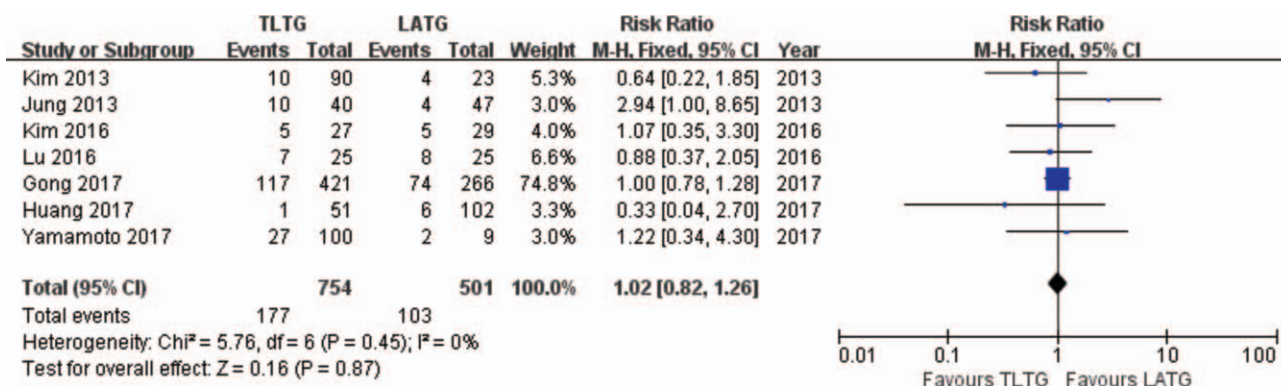


Figure 3. Forest plot of overall postoperative complications. TLTG=totally laparoscopic total gastrectomy, LATG=laparoscopic-assisted total gastrectomy, CI=confidence interval.

was no statistically significant difference between the two groups (MD=1.61, 95% CI=-2.09 to 5.31, P=.39) (Table 3).

3.4.2. Proximal margin. Proximal margin data were provided in 6 studies.^[21,22,24,25,27,29] After pooling all the data, there was no significant difference between the two groups (MD=-0.37, 95% CI=-0.78 to 0.05, P=.09) (Table 3).

3.4.3. Distal margin. Distal margin data were provided by 3 studies.^[22,24,29] After pooling all the data, there was no statistically significant difference between the two groups (MD=0.79, 95% CI=-0.57 to 2.14, P=.25) (Table 3).

3.5. Postoperative recovery outcomes

3.5.1. Time to first flatus. Six^[21,22,24,25,27,28] of the 9 articles reported data on the time to first flatus. The meta-analysis showed no significant difference in time to first flatus between the two groups (MD=0.01, 95% CI=-0.13 to 0.15, P=.87) (Table 3).

3.5.2. Time to first diet. Six^[21,22,24,25,27,28] of the 9 articles provided data on the time to first diet. Meta-analysis showed no statistically significant difference in the time to first diet between the two groups (MD=-0.22, 95% CI=-0.45 to 0.02, P=.07) (Table 3).

3.5.3. Postoperative hospital stay. Six^[21,22,24,25,27,28] of the 9 articles included in the meta-analysis reported data regarding

postoperative hospital stay. There was no statistically significant difference between the two groups (MD=-0.51, 95% CI=-1.10 to 0.07, P=.09) (Table 3).

4. Discussion

TLTG and LATG are two commonly used methods of laparoscopic gastrectomy for upper and middle gastric cancer.^[31-37] The surgical procedure of total gastrectomy mainly includes 3 aspects: lymph node dissection, resection of the stomach and anastomosis. For the two surgical approaches, lymph node dissection is performed laparoscopically. However, for LATG and TLTG, resection of the stomach and anastomosis are performed with direct view through an epigastric mini-laparotomy and with laparoscopy under pneumoperitoneum, respectively. Compared with TLTG, LATG is a relatively more mature surgical approach. Upper gastrointestinal surgeons preferred LATG because of the difficulties of intracorporeal anastomosis. They can perform extracorporeal anastomosis easily through an epigastric minilaparotomy similarly to open surgery. However, sometimes extracorporeal anastomosis via minilaparotomy in LATG is relatively difficult because of the limited angle of direct view, especially in obese patients.^[38,39,40] Compared with LATG, TLTG has a wider operation field during intracorporeal anastomosis. Moreover, TLTG appears to be less

Table 3

Summary of the meta-analysis of other short-term outcomes between TLTG and LATG.

Short-term outcomes	Studies (n)	Participants (TLTG/LATG)	Mean Difference (95% CI)	Heterogeneity
Anastomosis-related complications	8	871/547	0.64 [0.39, 1.03]; P=.06	I ² =0%; P=.94
Anastomotic leakage	8	871/547	0.62 [0.36, 1.06]; P=.08	I ² =0%; P=.47
Anastomotic bleeding	4	203/165	0.56 [0.07, 4.48]; P=.59	I ² =0%; P=.67
Anastomotic stricture	7	771/538	0.69 [0.27, 1.72]; P=.42	I ² =0%; P=.92
Time for anastomosis	4	200/246	-5.13 [-10.54, 0.27]; P=.06	I ² =87%; P<.0001
Operation time	8	558/426	-10.68 [-23.62, 2.26]; P=.11	I ² =70%; P=.001
Intraoperative blood loss	6	428/356	-25.58 [-61.71, 10.54]; P=.17	I ² =79%; P=.0002
Harvested lymph nodes	6	737/612	1.61 [-2.09, 5.31]; P=.39	I ² =76%; P=.0009
Proximal margin	6	771/535	-0.37 [-0.78, 0.05]; P=.09	I ² =70%; P=.005
Distal margin	3	538/318	0.79 [-0.57, 2.14]; P=.25	I ² =53%; P=.12
Time to first flatus	6	341/371	0.01 [-0.13, 0.15]; P=.87	I ² =0%; P=.63
Time to first diet	6	341/371	-0.22 [-0.45, 0.02]; P=.07	I ² =20%; P=.28
Postoperative hospital stay	6	341/371	-0.51 [-1.10, 0.07]; P=.09	I ² =33%; P=.19

TLTG=totally laparoscopic total gastrectomy, LATG=laparoscopic-assisted total gastrectomy, CI=confidence interval.

invasive because it does not require minilaparotomy. With regard to LATG and TLTG, which surgical approach is better is still controversial due to the lack of support from RCTs. Therefore, this meta-analysis was conducted to compare the short-term outcomes between the 2 surgical approaches. It is well known that RCTs are ideal for a meta-analysis. However, it is very difficult to carry out RCT due to special circumstances of surgical clinical trials. For these reasons, the inclusion of high-quality non-RCTs is an appropriate strategy to extend the source of evidence. Since no RCT was retrieved through the literature search, we included high-quality cohort studies for meta-analysis in our study.

In terms of surgical approaches, one of the greatest concerns for upper gastrointestinal surgeons is their postoperative complication outcomes. With regard to overall postoperative complications, this meta-analysis showed no significant difference between the 2 surgical approaches. Anastomosis-related complications mainly include anastomotic leakage, bleeding and stricture, which are important types of postoperative complications. With the gradual accumulation of surgical experience and the rapid improvement in laparoscopic instruments, functional end-to-end anastomosis, the OrVilTM method and the overlap method have been commonly used as main types of intracorporeal anastomosis in TLTG.^[41,42,43] Some surgeons think the technical complexity of intracorporeal anastomosis may lead to increased anastomosis-related complications of TLTG.^[44] On the other hand, extracorporeal anastomosis through the narrow field of minilaparotomy is sometimes very difficult; pulling the stomach causes forceful tension and injuries to the structures around the anastomosis, which may increase the anastomosis-related complications of LATG. In contrast to the extracorporeal anastomosis procedure, intracorporeal anastomosis offers a wider operation field than minilaparotomy. Therefore, surgeons still take a different view with regard to anastomosis-related complications of the two surgical approaches. This meta-analysis showed no significant difference in anastomosis-related complications between the two surgical approaches. However, we could not perform a subgroup analysis based on the types of intracorporeal anastomosis of TLTG due to the lack of detailed relevant data and the limited number of included studies.

The intraoperative safety is a long-standing concern for upper gastrointestinal surgeons. The main differences between LATG and TLTG lie in their different anastomosis types. Extracorporeal anastomosis and intracorporeal anastomosis are applied to LATG and TLTG, respectively.^[31–37] On the one hand, the technical complexity of intracorporeal anastomosis may increase the time for anastomosis and operation time.^[45] Compared with intracorporeal anastomosis, extracorporeal anastomosis can be performed more easily. On the other hand, for intracorporeal anastomosis, it is sometimes very difficult to expose the operation field through the narrow field of minilaparotomy,^[46] which may extend the time for anastomosis and operation time. Compared with extracorporeal anastomosis, intracorporeal anastomosis offers a wider operation field. This meta-analysis showed no significant difference in the time for anastomosis and operation time between the two surgical approaches. The underlying cause of the result is unclear; perhaps it is because the adverse effects of their own shortcomings offset each other. However, we could not perform a subgroup analysis based on the types of intracorporeal anastomosis of TLTG due to the lack of detailed relevant data and the limited number of included studies.

Intraoperative blood loss mainly takes place in the process of lymph node dissection and digestive tract reconstruction. The two surgical approaches share the same process in lymph node dissection. Therefore, they should have the same intraoperative blood loss in the process of lymph node dissection. During digestive tract reconstruction, forceful traction of the stomach and minilaparotomy bleeding may increase intraoperative blood loss.^[47] However, this meta-analysis showed no significant difference in intraoperative blood loss between the two surgical approaches. Perhaps it is because the influential factors in digestive tract reconstruction are not enough to make a difference in intraoperative blood loss.

Oncological outcomes are critical measures of success in laparoscopic surgery for gastric cancer. With short-term follow-up, the number of harvested lymph nodes and proximal and distal margins of resection are the major indicators of oncological safety.^[48] The 2 surgical approaches share the same process of lymph node dissection. Therefore, they should have a similar number of harvested lymph nodes. This meta-analysis showed no significant difference in harvested lymph nodes between the two surgical approaches, which is consistent with speculation. In terms of proximal and distal margins, surgeons still take an opposing view. First, for LATG, resection of the stomach is performed with direct view through an epigastric minilaparotomy. Pulling the stomach through an epigastric minilaparotomy causes forceful tension, which may influence the resection margin.^[48] For TLTG, resection of the stomach is performed without tension, which avoids influencing the resection margin. Second, precise intraoperative detection of the tumor is very important to the exact assessment of the resection margin. In LATG, surgeons can easily locate the tumor through an epigastric minilaparotomy; however, it is relatively difficult in TLTG. To solve this problem, various methods, such as intraoperative endoscopy and laparoscopic ultrasonographic detection, should be introduced to locate the tumor.^[49,50] However, the included studies lacked the information on the method for intraoperative detection of the tumor in TLTG. After pooling all the data, there was no statistically significant difference in proximal and distal margins between the two surgical approaches. For lack of long-term follow-up data in included studies, we could not perform a meta-analysis of long-term oncological outcomes. For the two surgical approaches, long-term follow-up is required in the future.

LATG requires epigastric minilaparotomy resection of the stomach and anastomosis. Compared with LATG, TLTG only requires a smaller periumbilical incision for en bloc extraction of the specimen.^[34,36] The periumbilical incision is the extension of a trocar wound. In terms of length of the incision, TLTG appears to be less invasive than that of LATG and should have a faster postoperative recovery than LATG in theory. However, with regard to postoperative recovery, our pooled analysis demonstrated that there was no statistically significant difference in the time to first flatus, time to first diet and postoperative hospital stay. The cause of the result is unclear. It is possible that the advantage of TLTG resulting from the incision was not enough to give rise to a reduction in the duration of postoperative recovery.

There are several limitations in our study. First, without RCTs, this meta-analysis was based only on the cohort studies. In spite of the adequate quality of included cohort studies, RCTs are still needed to further confirm these results in the future. Second, the included studies are all from countries in eastern Asian, without western countries, which will limit the applicability of these

results to a certain extent. Third, due to the lack of long-term follow-up data in the included cohort studies, we could not assess long-term outcomes of LATG and TLTG. Therefore, long-term follow-up of the two surgical approaches is required in the future.

In conclusion, this meta-analysis demonstrates that TLTG is a safe and feasible surgical approach for upper and middle gastric cancer, with similar short-term outcomes to LATG. Nevertheless, high-quality, large-sample and multicenter RCTs are still required to further verify our conclusions in the future.

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