Laparoscopic versus Open Resection of Small Bowel Gastrointestinal Stromal Tumors: Systematic Review and Meta-analysis

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Abstract

Background: Laparoscopic resection (LAP) for small bowel gastrointestinal stromal tumors (GISTs) is not as common as for stomach. This study aimed to evaluate the safety and efficacy of LAP for small bowel GISTs with systematic review and meta-analysis.
Methods: The Web of Science, Cochrane Library, Embase, and PubMed databases before December 2016 were comprehensively searched to retrieve comparative trials of LAP and conventional open resection (OPEN) for GISTs of small bowel with a relevance of review object. These researches reported intraoperative and postoperative clinical course (operation time, blood loss, time to first flatus and oral intake, hospital stay, morbidity, and mortality), oncologic outcomes, and long-term survival status.
Results: Six studies involving 391 patients were identified. Compared to OPEN, LAP had associated with a shorter operation time (weighted mean difference [WMD] = −27.97 min, 95% confidence interval [*CI*]: −49.40–−6.54, $P < 0.01$); less intraoperative blood loss (WMD = −0.72 ml; 95% *CI*: −1.30–−0.13, $P = 0.02$); earlier time to flatus (WMD = −0.83 day; 95% *CI*: −1.44–−0.22, $P < 0.01$); earlier time to restart oral intake (WMD = −1.95 days; 95% *CI*: −3.31–−0.60, $P < 0.01$); shorter hospital stay (WMD = −3.00 days; 95% *CI*: −4.87–−1.13, $P < 0.01$); and a decrease in overall complications (risk ratio = 0.56, 95% *CI*: 0.33–0.97, $P = 0.04$). In addition, the tumor recurrence and long-term survival rate showed that there was no significant difference between the two groups of patients.
Conclusions: LAP for small bowel GISTs is a safe and feasible procedure with shorter operation time, less blood loss, less overall complications, and quicker recovery. Besides, tumor recurrence and the long-term survival rate are similar to open approach. Because of the limitations of this study, methodologically high-quality studies are needed for certain appraisal.

Key words: Complications; Enterectomy; Gastrointestinal Stromal Tumor; Laparoscopy; Meta-analysis

Introduction

Gastrointestinal stromal tumors (GISTs), although rare, are the most common nonepithelial neoplasm of the gastrointestinal tract.[1] Approximately, 95% of GISTs express the KIT receptor tyrosine kinase, and approximately 80% of GISTs have KIT gene mutations. GISTs might arise anywhere along the gut, with the most common sites being stomach (50–70%) and small intestine (35%).[2] Surgery is the only potentially curative therapy for patients with primary, resectable GISTs. Complete resection of the tumor without lymphadenectomy is recommended since lymph node metastases are rare.[3]

Since the development of minimally invasive surgical approaches, laparoscopic surgery (LAP) for GISTs has evolved rapidly over the past decade. Various clinical studies and meta-analysis have demonstrated that LAP for GISTs of the stomach had associated with lesser pain, shorter hospital stay, faster postoperative recovery, lower

Access this article online

Quick Response Code:

Website: www.cmj.org

DOI: 10.4103/0366-6999.208249

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Received: 11-02-2017 **Edited by:** Yi Cui
How to cite this article: Chen K, Zhang B, Liang YL, Ji L, Xia SJ, Pan Y, Zheng XY, Wang XF, Cai XJ. Laparoscopic Versus Open Resection of Small Bowel Gastrointestinal Stromal Tumors: Systematic Review and Meta-Analysis. Chin Med J 2017;130:1595-603.

morbidity, and similar recurrence rates compared to open approach (OPEN).[4-7] However, there is a paucity in the literature on the management and outcomes of laparoscopic small bowel GISTs resection due to relatively low incidence rate.[8] Therefore, the reliable short-term outcomes following LAP for small bowel GISTs are unknown. Besides, whether the oncologic benefits observed in laparoscopic gastric GISTs resection could also apply to intestine need more research to confirm. In recent years, there have been some reports, which compared outcomes between LAP and OPEN for small bowel GISTs, the majority based on small series of patients and retrospective analyses. Therefore, we present a systematic review and meta-analysis of the literature to assess accurately the current status of LAP for small bowel GISTs.

Methods

Search strategy

The systematic searches of Web of Science, Cochrane Library, Embase, and PubMed were conducted in order to find the theses which have been published till the end of 2016 and conducted comparison between LAP and OPEN. The search terms "gastrointestinal stromal tumor," "GIST," "submucosal tumors," "SMT," "laparoscopic," "laparoscopy," "enterectomy," "bowel," "intestine," "jejunum," "ileum," and "gut" were utilized. The linkages of search results and references in the identified original thesis could be reviewed to find the extra literature which has not been indexed. The language of all publications was limited to English only.

Quality assessment and data collection

Researches that meet the below standards were comparative, peer-reviewed studies of LAP versus OPEN on intestinal GISTs which were available in the full text of the thesis. All procedures were peer-reviewed by two reviewers independently. The articles including any of the following were excluded: (1) noncomparative studies such as letters, reviews, comments, posters, protocols, and overlap authors or centers; (2) studies including tumors outside small bowel; (3) studies that included emergency operation cases; (4) studies in which <2 of the interesting indices were reported, or it was difficult to calculate these from the outcomes. The Newcastle-Ottawa Quality Assessment Scale (NOS) was utilized to evaluate the quality of the researches included. The scale changes from 0 to 9 stars: researches with a score higher than or equal to 6 could be deemed as good methodological. Any disagreement in quality assessment and data collection was discussed and solved using a third party as the referee. The general information extracted included region, publication year, journal, sample size, operation time, estimated blood loss (EBL), time to flatus, time to oral intake, length of hospital stay (LOS), morbidity, mortality, and long-term outcomes.

Statistical analysis

Continuous variables were assessed using the weighted mean difference (WMD), and dichotomous variables were analyzed using the risk ratio (*RR*). If the study provided medians and ranges instead of means and standard deviations (SDs), we estimated the means and SDs as described by Hozo *et al*.[9] Statistical heterogeneity, which indicated between-study variance, was evaluated according to the Higgins I^2 statistic.[10] To account for clinical heterogeneity, which refers to diversity in a sense that is relevant for clinical situations, we used the random-effects model based on DerSimonian and Laird's method. Potential publication bias was determined by conducting informal visual inspection of funnel plots based on the complications. Data analyses were performed using RevMan 5.1 software (Cochrane Collaboration, Oxford, UK) downloaded from Cochrane Library. A value of $P < 0.05$ was considered statistically significant.

Results

Search and selection

The initial search strategy retrieved 386 publications in English. After the titles and abstracts were reviewed, articles without comparison of LAP and OPEN for intestinal GISTs were excluded, which left nine comparative studies, three of which did not meet the inclusion criteria and were excluded because of including tumors outside small bowel.[11-13] This left six observational studies,[14-19] all of which were accessible in full-text format. Search and selection flowchart is illustrated in Figure 1.

Study characteristics and quality

A total of 391 patients were included in the analysis with 170 undergoing LAP (43.5%) and 221 undergoing OPEN (56.5%). They represented only East Asia experience (one Korea, two Mainland of China, two Chinese Taiwan, and one Chinese Hong Kong). Table 1 presents the characteristics of the included studies, and Table 2 presents the quality assessment based on the NOS, whereas the outcomes reported by the included studies are shown in Table 3. According to the NOS, one article got 8 stars and the remaining five got 9 stars.

Intraoperative effects

The tumor location and laparoscopic technical details and reasons for conversion of included studies are summarized in Table 4. All intraoperative outcomes are summarized in Table 5. The mean operation time of LAP was 27.97 min shorter than for OPEN (WMD = −27.97 min; 95% confidence interval [*CI*]: −49.40–−6.54, $P < 0.01$, Figure 2a). Intraoperative EBL during surgery was decreased

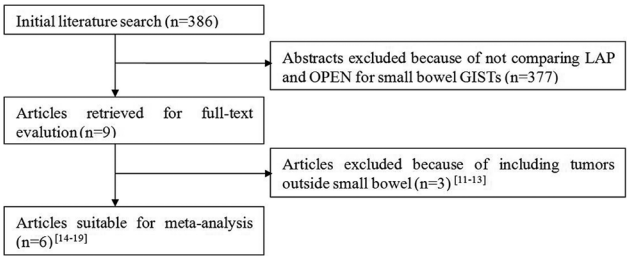

Figure 1: Flowchart of literature search strategies. LAP: Laparoscopic resection.

Table 1: Summary of studies included in the meta-analysis

Author	Region	Journal	Study design	Year	Study period	Sample size		Conversion (%)
						LAP	OPEN	
Tsui	Hong Kong, China	Surg Laparosc Endosc Percutan Tech	OCS (R)	2008	1998–2005	9	11	1
Huang	Taiwan, China	J Laparoendosc Adv Surg Tech A	OCS (R)	2009	2006–2009	13	12	0
Cai	Mainland China	J Dig Dis	OCS (R)	2011	2002–2007	38	47	1
Ihn	Korea	J Gastric Cancer	OCS (R)	2012	1993–2011	41	54	1
Wan	Mainland China	Am Surg	OCS (P)	2012	2004–2010	43	38	E
Liao	Taiwan, China	Anticancer Res	OCS (P)	2015	2005–2013	26	59	2

OCS: Observational clinical study; P: Prospectively collected data; R: Retrospectively collected data; LAP: Laparoscopic resection; OPEN: Conventional open resection; E: Exclude.

Table 2: Quality assessment based on the NOS for observational studies

Author	Selection (out of 4)				Comparability (out of 2)	Outcomes (out of 3)			Total (out of 9)
	①	②	③	④		⑤	⑥	⑦	
Tsui	*	*	*	*	**	*	*	*	9
Huang	*	*	*	*	**	*	*	*	9
Cai	*	*	*	*	**	*	*	*	9
Ihn	*	*	*	*	*	*	*	*	8
Wan	*	*	*	*	**	*	*	*	9
Liao	*	*	*	*	**	*	*	*	9

①: Representativeness of exposed cohort; ②: Selection of nonexposed cohort; ③: Ascertainment of exposure; ④: Outcome not present at the start of the study; ⑤: Assessment of outcomes; ⑥: Length of follow-up; ⑦: Adequacy of follow-up; NOS: Newcastle-Ottawa Quality Assessment Scale.

Table 3: Outcomes of included studies

Author	Operation time	Blood loss	Tumor size	Wound length	Flatus	Oral intake	Hospital stay	Morbidity	Survival
Tsui	Yes	Yes	Yes			Yes	Yes	Yes	Yes
Huang	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cai	Yes		Yes	Yes	Yes		Yes	Yes	Yes
Ihn	Yes		Yes				Yes	Yes	Yes
Wan	Yes		Yes	Yes		Yes	Yes	Yes	Yes
Liao	Yes	Yes	Yes			Yes	Yes	Yes	Yes

Table 4: Systematic review of tumor location, laparoscopic technical details, and reasons for conversion

Author	Tumor location	Laparoscopic technical details	Reasons for conversion
Tsui	Jejunum, ileum	Segmental resection. Intracorporeal side-to-side anastomosis by linear staples	Large tumor measuring 7 cm using hand-assisted method × 1
Huang	Duodenum, jejunum, ileum	Wedge resection or segmental resection. Intracorporeal side-to-side anastomosis by staple or by hand sewn	No case
Cai	Jejunum, ileum	Segmental resection, extracorporeal anastomosis	Suspicious liver mass × 1
Ihn	Duodenum, jejunum, ileum	Wedge resection or segmental resection. Side-to-side anastomosis by staple or end-to-end anastomosis by hand sewn, extracorporeally, or intracorporeally	One case but reason not available
Wan*	Jejunum, ileum	Intestinal segmental resection, anastomotic method not available	Intraabdominal adhesions × 2, close to Treitz' ligament × 1, negative laparoscopic exploration × 1
Liao	Jejunum, ileum	Intracorporeal bowel resection using linear staples. Intracorporeal side-to-side anastomosis with linear staples or extracorporeal end-to-end handsaw anastomosis	Large tumor × 1

*Wan *et al.* reported four conversion cases, which were not assigned in their final analyses.

during the laparoscopic procedure (WMD = −0.72 ml; 95% *CI*: −1.30–−0.13, $P = 0.02$, Figure 2b). The length of abdominal incision was significantly short in LAP patients (WMD = −10.08 cm; 95% *CI*: −10.66–−9.49, $P < 0.01$, Figure 2c). Although individual included studies did not report significant difference in tumor size, the

Table 5: Pooled outcomes of meta-analysis

Outcomes	Number of studies	Sample size (*n*)		Heterogeneity (*P*, I^2)	Overall effect size	95% *CI* of overall effect	*P*
		LAP	OPEN				
Operation time	6	170	221	0.004, 71%	WMD = −27.97	−49.40–−6.54	0.01
Blood loss	3	48	82	0.150, 47%	WMD = −0.72	−1.30–−0.13	0.02
Wound length	3	94	97	0.390, 0	WMD = −10.08	−10.66–−9.49	<0.01
Tumor size	6	170	221	0.005, 7%	WMD = −0.82	−1.52–−0.12	0.02
First flatus	2	51	59	0.820, 0	WMD = −0.83	−1.44–−0.22	<0.01
Oral intake	4	91	120	0.008, 75%	WMD = −1.95	−3.31–−0.60	<0.01
Hospital stay	6	170	221	0.010, 67%	WMD = −3.00	−4.87–−1.13	<0.01
Morbidity	6	170	221	0.710, 0	*RR* = 0.56	0.33–0.97	0.04
Mortality	2	67	113	0.470, 0	*RR* = 1.70	0.18–16.04	0.64
Recurrence	5	132	174	0.100, 48%	RD = −0.06	−0.16–0.05	0.28

WMD: Weighted mean difference; *RR*: Risk ratio; RD: Recurrence diagnosis; *CI*: Confidence interval; LAP: Laparoscopic resection; OPEN: Conventional open resection.

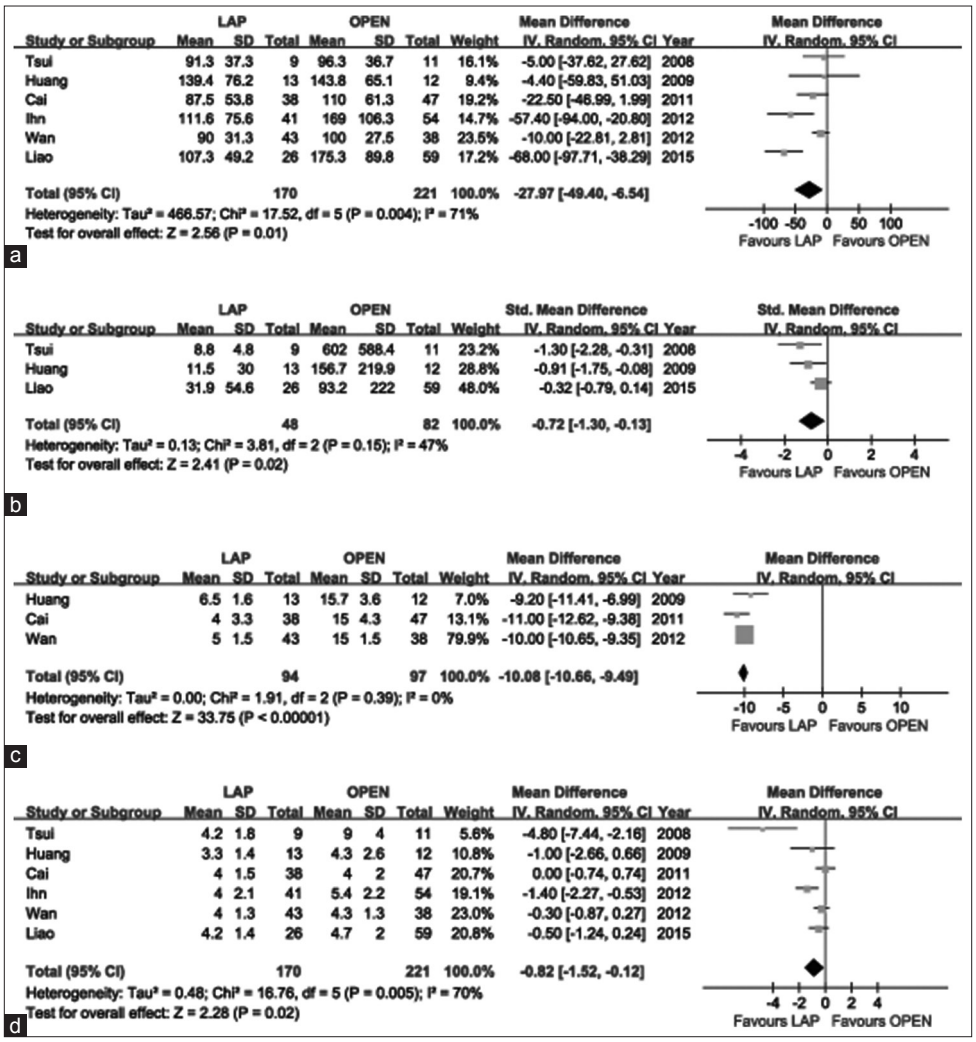

Figure 2: Forest plot of the meta-analysis for intraoperative effects. (a) Operation time. (b) Estimated blood loss. (c) Length of abdominal incision. (d) Tumor size. LAP: Laparoscopic resection; OPEN: Conventional open resection.

pooled data showed that the tumor size in LAP group was significantly smaller than that in OPEN from the analysis of 391 resections (WMD = −0.82 cm; 95% *CI*: −1.52–−0.12, *P* = 0.02, Figure 2d).

Postoperative clinical course

All postoperative outcomes are summarized in Table 5. Postoperative pain was evaluated by the number of days of analgesic use or the dosage of analgesic. Tsui *et al.*[14]

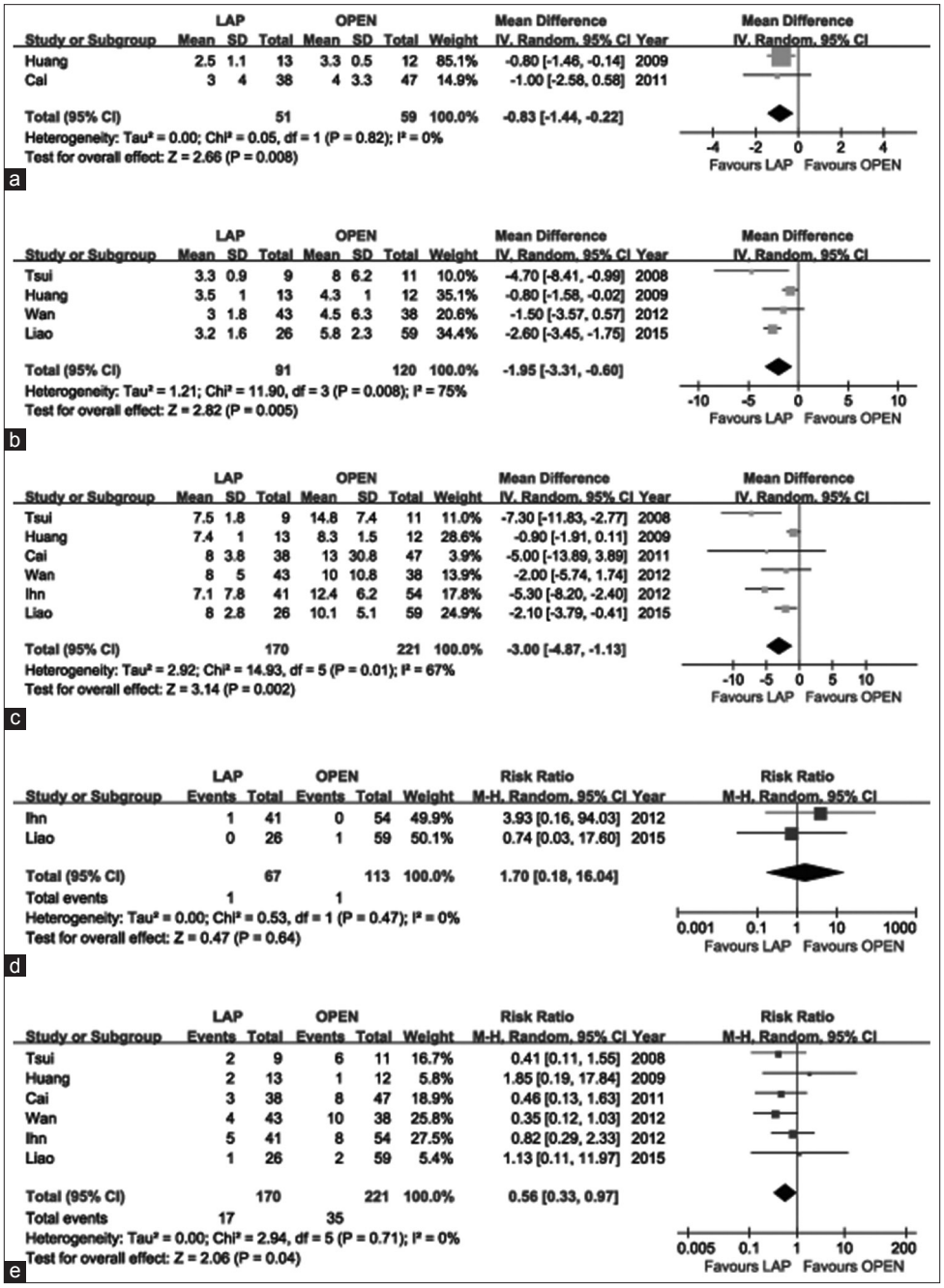

Figure 3: Forest plot of the meta-analysis for postoperative clinical course. (a) Time to first flatus. (b) Time to restart oral intake. (c) Postoperative hospital stay. (d) Mortality. (e) Overall postoperative complications. LAP: Laparoscopic resection; OPEN: Conventional open resection.

reported less morphine consumption, whereas Liao *et al*.[19] reported shorter duration of analgesia in LAP group. The mean time of first flatus was shorter in LAP than that in OPEN (WMD = −0.83 day; 95% *CI*: −1.44–−0.22, $P < 0.01$, Figure 3a) as was the time to restart oral intake after surgery (WMD = −1.95 days; 95% *CI*: −3.31–−0.60, $P < 0.01$, Figure 3b). Moreover, LOS was 3 days shorter for LAP patients (WMD = −3.00 days; 95% *CI*: −4.87–−1.13, $P < 0.01$, Figure 3c). Besides, Cai *et al.*[16] documented a reduced hospital costs in LAP group regardless of surgical or medical charges.

Mortality was described only in two studies. Ihn *et al*.[17] reported a dead case in LAP group due to bleeding secondary to recurrent anastomosis leakages, while Liao *et al*.[19] reported another dead case in OPEN group because of profound sepsis. The pooled data showed that there was no significant difference in postoperative mortality (*RR* = 1.70, 95% *CI*: 0.18–16.04, $P = 0.64$, Figure 3d). Besides, Tsui *et al*. reported two reoperation cases in LAP group due to intestinal obstruction.[14] The specific postoperative complications included in the studies are summarized in Table 6. The rate of overall postoperative complications was lower for LAP with a significant difference (*RR* = 0.56, 95% *CI*: 0.33–0.97, $P = 0.04$, Figure 3e).

Oncologic outcomes and long-term survival

Liao *et al*.[19] reported 2 (8.7%) cases of microscopic rupture in LAP group and 6 (13.6%) cases in OPEN group. They also found 2 (3.4%) cases of tumor spillage in OPEN group. Other studies reported no case of spillage or rupture with negative surgical margin involved.[15-18] Besides, Cai *et al*.[16] reported no differences in distances from the upper or lower margin between two groups.

During the follow-up, tumor recurrence was observed in all six studies. Cai *et al*.[16] only reported a total of ten recurrence cases in two groups but failed to indicate respective ones between groups. The difference between LAP and OPEN about recurrence was not statistically significant (recurrence diagnosis = −0.06, 95% *CI*: −0.16–0.05, *P* = 0.28, Figure 4a). Four studies reported postoperative survival rates, all of which did not find significant differences in survival rates between groups.[14-16,18,19] Although Ihn *et al*.[17] did not report specific survival rate, they also found no significant difference in the survival rates between the two groups during their follow-up time. Meta-analysis of these available data demonstrated that the 3-year disease-free survival (DFS) rate was not significantly different in participants who received LAP compared with OPEN (*RR* = 1.13, 95% *CI*: 0.91–1.39, *P* = 0.27, Figure 4b). However, the meta-analysis of another survival rate cannot be done due to limited data. The available data about recurrence patterns, specific recurrent sites, and survival outcomes are summarized in Table 7.

Publication bias

A funnel plot analysis of total postoperative complications was performed. It was shown that none of the studies were outside the limits of 95% *CI*, and there was no evidence of publication bias [Figure 5].

Discussion

The main reason why most minimally invasive abdominal surgeries such as laparoscopic gastrectomy, colorectectomy, and pancreaticoduodenectomy need longer operation time compared to open ones is the necessity of complicated lymphadenectomy under laparoscopy.[20-22] However, LAP for small bowel GISTs need no lymph node dissection, while avoids cutting and suturing of the long abdominal incision, thus leading to a shorter operation time. The intraoperative bleeding in the LAP group was less than that in the OPEN group, similar to most reports comparing laparoscopic and open surgery. The reduced length of incision wound and

Table 6: Systematic review of postoperative complications

Author	Group	*n*	Event	Specifed complications
Tsui	LAP	9	2	Adhesive intestinal obstruction × 1, anastomosis stricture × 1
	OPEN	11	1	Adhesive intestinal obstruction × 1
Huang	LAP	13	2	Glaucoma × 1, reactivation tuberculosis × 1
	OPEN	12	1	Wound bleeding × 1
Wan	LAP	43	5	Intestinal obstruction × 1, anastomosis site bleeding × 2, cerebral infarction × 1, cardiac failure × 1
	OPEN	38	11	Pyrexia × 3, intestinal obstruction × 4, hypertension × 2, incisional hernia × 1, cardiac failure × 1
Liao	LAP	26	1	Intra-abdominal abscess × 1
	OPEN	59	2	Pneumonia × 1, intra-abdominal abscess × 1

LAP: Laparoscopic resection; OPEN: Conventional open resection.

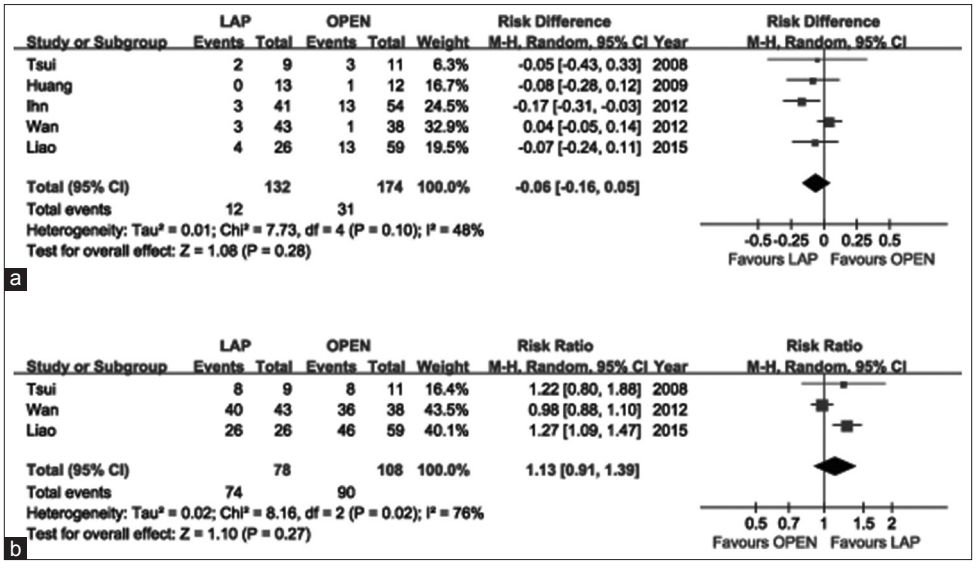

Figure 4: Forest plot of the meta-analysis for oncologic outcomes and long-term survival. (a) Recurrence. (b) 3-year DFS. LAP: Laparoscopic resection; OPEN: Conventional open resection; DFS: Disease-free survival.

Table 7: Systematic review of recurrence and long-term survivals

Author	Group	Follow-up (month)	Recurrence	Survival (%)
Tsui	LAP	30 (18.3–113.3)	2	3 year-DFS: 85.7*
	OPEN	44 (4.5–99.9)	3	3 year-DFS: 75.0*
Huang	LAP	11.5 ± 9.8	0	NR
	OPEN	9.4 ± 9.6	1†	NR
Cai	LAP	26 (0–63)	10‡	2 year-OS: 86.9
	OPEN			2 year-OS: 89.4
Ihn	LAP	24.7	3§	NSD
	OPEN	51.6	13§	
Wan	LAP	40 (4–79)	3‖	3 year-DFS: 91.1
	OPEN	36 (11–88)	1‖	3 year-DFS: 93.8
Liao	LAP	24.3	4	3 year-DFS: 100, 5 year-DFS: 88.5, 3 year-OS: 100, 5 year-OS: 100
	OPEN	44.9	13	3 year-DFS: 78.2, 5 year-DFS: 71.4, 3 year-OS: 92.9, 5 year-OS: 87.5

Follow-up time was shown as means ± SDs, median (range) or median only. *Limited to cases of GIST; †Pleomorphic carcinoma (n = 1); ‡Hepatic metastases (n = 9), diffuse peritoneal seeding (n = 1); §LAP, mesentery (n = 1), duodenum (n = 1), liver (n = 1); OPEN, liver (n = 8), jejunum or ileum (n = 1), stomach and retroperitoneum (n = 1), peritoneum (n = 1), rectum (n = 1), sacrum (n = 1); ‖Liver (n = 2), other cases not specialized. DFS: Disease-free survival; OS: Overall survival; NR: Not report; NSD: Only reported no significant difference between two groups without specific survival rate; SDs: Standard deviations; GIST: Gastrointestinal stromal tumors. LAP: Laparoscopic resection; OPEN: Conventional open resection.

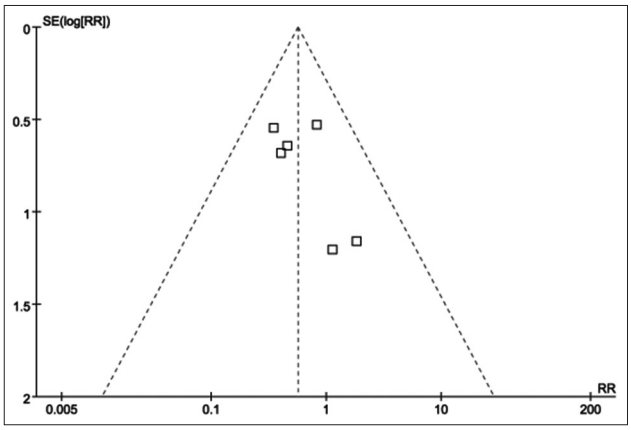

Figure 5: Funnel plot of the overall postoperative complications. *RR*: Risk ratio.

the application of energy-dividing devices contribute to the reduction in blood loss. However, this result should be interpreted prudently due to the high heterogeneity between studies as a result of different methods of estimating blood loss. It was conceivable that complications were similar between groups because LAP results in the same organ as OPEN [Table 6]. Nevertheless, it is should be noted that two included studies reported cases of occurring intestinal obstruction after LAP.[14,18] Wan *et al*.[18] presumed that postoperative anastomotic swelling and intra-abdominal adhesion were probably the main causes of postoperative intestinal obstructions. Patients received LAP was associated with less pain, as well as shorter surgical duration and lower dosage of analgesic application than OPEN.[14,19] The time to first flatus was also earlier in LAP group, indicating a rapid recovery of gastrointestinal function after LAP. Smaller incisions of abdominal cavity, lower usage of paregoric, and earlier postoperative activities are thought to be the main reasons for faster recovery from LAP.[16]

The adequacy of the radical resection should be evaluated not only by margin status but also by complete resection without tumor spillage or rupture. In addition to the included studies with a lower rate of tumor rupture,[15-19] Tabrizian *et al*.[23] reported no evidence of tumor spillage or rupture and achieved an R0 resection in 97.4% of cases based on their 26 cases of intestinal GISTs. In our view, LAP is in accordance with the "no touch tumor" principle as open surgery and even might be better. Tumor can be resected *in situ*, thus avoiding stressing on the tumor. Even for tumor failed to be resected totally laparoscopically, the operation can be accomplished in mini-laparotomy after fully mobilization of tumor. Compared with gastric GISTs, small bowel tumors with similar size and mitotic index had a markedly worse prognosis in a large series with decreased recurrence-free survival rate.[24] Based on the available data, postoperative recurrence and the long-term survival rate in LAP were similar to those in OPEN. Tabrizian *et al*.[23] analyzed the results of 26 cases of small bowel GISTs treated with LAP with a median follow-up of 56.4 months (range 0.1–162.4 months). The 10-year overall survival rate and DFS rate were 91.3% and 71.6%, respectively. It seems that laparoscopy as a minimally invasive intervention provides a similar long-term outcome for GIST tumors compared to open surgery. Therefore, we believed that the pathological presentation of the tumor, particularly tumor size and mitotic rate, was a more critical factor that influenced recurrence, rather than the operative technique. In recent years, the development of imatinib has led to modifications in the standard care for GISTs in many places around the world.[25,26]

Small bowel GISTs had a more acute presentation requiring emergent resections secondary to hemorrhage, obstruction, or perforation.[23] Zang *et al*.[27] reported 77 cases small intestinal bleeding treatment by laparoscopic surgery, in which neoplasm is the most frequent cause of small intestinal bleeding (48 GISTs cases, 62.3%). Thinks to the ability of inspecting the whole intestinal serosa and mesentery thoroughly, it is logical to assume that laparoscopic

exploration can avoid the omission of multiple synchronous lesions. They recommended that laparoscopic wedge resection was performed when the tumor size is smaller than 1 cm, whereas segmental resection was used for the bigger lesions.[27] Therefore, laparoscopic technique could achieve good therapeutic outcomes and improve diagnostic chance in small intestinal diseases. Obstruction was less common than bleeding. Morrison and Hodgdon[28] reported two cases of small bowel GISTs presented with obstructive symptoms and were treated laparoscopically. They summed up the elements to the success of such operation, these were early intervention, accurate entry to the abdominal cavity, higher pressure for insufflation, appropriate position of patients and location of trocars, dissection from the distal ileum back to the lesion, and grasp the mesentery instead of the bowel.[28] Besides, it is accepted that the leakage rate will increase if the anastomosis done with a stapler when the bowel wall is thickened. Therefore, hand-sewn extracorporeal anastomosis is recommended in these instances.

Combined with literature and our practice,[4,7,29] we have summarized some surgical experience. First of all, to avoid tumor rupture or spillage, the oncological principles are same as open surgery, including no tumor touch, adequate margins, and en bloc resection without lymphadenectomy. Tabrizian *et al*.[23] summarized that the factors associated with failure of LAP were extensive adhesions, preoperative tumor perforation, proximity to the duodenum, extent of disease, or concomitant resection of other malignant lesions, which were similar to the conversion reasons in our included studies [Table 4]. GISTs are often in oval shape and hypogastrium wall has more ductility, making specimen being delivered through a bit smaller incision size than shortest diameter of the mass. Because of the mobility of the small intestine, the bowel could be able to pull out from the umbilical incision. Therefore, we recommend extracorporeal anastomosis under direct vision instead of intracorporeal one to reduce the operation time and lower the learning curve of this procedure, making it accessible to novice laparoscopic surgeons. Extracorporeal anastomoses also save the charge of anastomotic staplers.[16] We should not ignore the fact that small bowel GISTs were incidentally found during the workup of other diseases or other operations. Therefore, one point should be deeply rooted in mind that careful abdominal exploration is essential when performing other abdominal operations.[23]

The results of this meta-analysis should be interpreted with caution for several limitations. First, none of the included studies are randomized, and the overall level of clinical evidence is low. Hence, these results are only an estimate of the true benefit of LAP for small bowel GISTs. Significant heterogeneity existed among the studies, so we applied a random-effects model to take between-study variation into consideration. Second, there was inevitably a selection bias in the published literature. Although individual included studies did not report significant difference in tumor size, the pooled data showed that the tumor size for LAP was significantly smaller than that for OPEN, which will tend to favor laparoscopic technique. Third, there were a relatively small number of studies and sample size, as well as regional differences. Therefore, we included studies which a small proportion of other type gastric submucosal tumors (SMTs).[14,15] It is critical that getting sample size large enough to detect a possible treatment effect, especially for some issues with few studies. Considering the surgical strategies of SMTs are similar, we did not exclude the studies including a small proportion of other SMTs. Even through such a few cases does not result in a significant bias, it still can lead to clinical heterogeneity.

In conclusion, the results of this meta-analysis favor the safety and efficacy of LAP compared with OPEN for small bowel GISTs. However, given the aforementioned limitations, more evidence of multicenter RCTs is needed to further address the real role of laparoscopic technique.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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