Int Surg 2024;**107–108:**49–56
DOI: 10.9738/INTSURG-D-24-00002.1

Comparative Assessment of Laparoscopic and Endoscopic Cooperative Surgery With Laparoscopic Wedge Resection for the Treatment of Gastric Submucosal Tumors

Masaya Enomoto[1], Kenichi Iwasaki[1], Edward Barroga[2], Toru Sakurai[1], Erika Yamada[1], Kenta Miyoshi[1], Yota Shimoda[1], Junichi Mazaki[1], Akihiro Hoshino[1], Yutaka Hayashi[1], Tetsuo Ishizaki[1], Tesshi Yamada[1], Yuichi Nagakawa[1]

[1]*Department of Gastrointestinal and Pediatric Surgery, Tokyo Medical University, Tokyo, Japan*

[2]*Department of Medical Education, Showa University School of Medicine, Tokyo, Japan*

Background: The most commonly performed surgical resection technique for gastric submucosal tumors (gSMTs) is *laparoscopic wedge resection* (LWR). Notably, *laparoscopic and endoscopic cooperative surgery* (LECS) is a surgical procedure that combines laparoscopic gastric resection with an endoscopic submucosal dissection for the local resection of gastric tumors, which provides appropriate and minimal surgical resection margins.

Methods: Seventy-nine patients with gSMT who underwent surgical resection at our department between January 2004 and January 2023 were retrospectively assessed. LWR and LECS were performed in 61 and 18 patients, respectively. Clinicopathological features and short-term surgical outcomes were assessed between the 2 groups. A 2:1 propensity score matching was performed to mitigate the effects of selection biases. Regardless of the surgical procedure, all the patients underwent curative resection with negative margins.

Results: The LWR and LECS groups included 24 and 12 patients, respectively. The mean operative duration was significantly shorter in the LWR group than in the LECS group (LWR, 131.1 minutes; LECS, 195.2 minutes; $P < 0.05$). The mean ratio of tumor diameter to resected specimen diameter was significantly higher in the LECS group than in the LWR group (LWR, 60.3%; LECS, 78.9%; $P < 0.05$). The mean ratio of tumor area to resected specimen area was significantly higher in the LECS group than in the LWR group (LWR, 44.7%; LECS, 66.3%; $P < 0.05$).

Corresponding author: Kenichi Iwasaki, MD, PhD, Department of Gastrointestinal and Pediatric Surgery, Tokyo Medical University, 6–7–1 Nishishinjuku, Shinjuku-ku, Tokyo 160–0023, Japan.
Tel.: +81 3 3342 6111; Fax: +81 3 3340 4575; E-mail: iwa0715@gmail.com; ORCID ID: https://orcid.org/0000–0002–1589–1526

Conclusion: LECS was performed safely with a minimal and optimal safety margin compared with LWR. The findings suggest that LECS can be a feasible option for the treatment of gSMTs.

Key words: Gastric submucosal tumors – Laparoscopic wedge resection – Laparoscopic and endoscopic cooperative surgery – Minimal invasive surgery

Gastric submucosal tumors (gSMTs) are a rarely encountered subtype of gastric tumors. The detection probability of gSMTs is approximately 0.36%.[1] This detection rate is higher in Japan because of routine gastric cancer screening examinations included in annual medical check-ups such as upper gastrointestinal endoscopy.[2,3]

Even in highly malignant gSMTs, such as gastrointestinal stromal tumors (GISTs), the rate of lymph node metastasis is low, and partial resection particularly by laparoscopic surgery without lymph node dissection is widely performed in most cases.[3–6] To avoid the invasive open laparotomy, laparoscopic wedge resection (LWR) has been performed as a surgical option established primarily for tumors <5 cm in diameter.[3]

LWR is commonly performed because of its technical simplicity; however, it is difficult to resect tumors located in the lesser curvature, near the esophagogastric junction (EGJ), and close to the pylorus. Moreover, the ideal resection line is not easy to determine with only a laparoscopic view, particularly for intragastric growth type gSMTs, as a normal-appearing gastric wall covers these tumors. Therefore, postoperative deformity of the stomach may be caused by a large and excessive gastric resection. This condition may lead to reduced oral intake, consequent gastric stasis, and possible local recurrence owing to an inappropriate resection line.[7–10]

Hiki *et al*[11,12] developed the laparoscopic and endoscopic cooperative surgery (LECS), which decreases the extent of gastric resection compared with LWR. LECS can be carried out regardless of tumor location, and it can potentially overcome the previously mentioned limitations of LWR.[13–15] The advantages of LECS and its feasibility for gSMT resection have been recognized[14,16–18]; however, to our knowledge, current information on LECS and its clinical advantages have not yet been fully established compared with LWR. Moreover, only a few studies have reported on the usefulness of LECS, specifically its quantitative benefits in terms of the surgical resection margin and resected specimen area.

In this study, we assessed and compared LECS with LWR for gSMT treatment. We evaluated the clinicopathological features, clinical outcomes, and quantitative data (*i.e.*, ratio of tumor diameter to resected specimen diameter and ratio of tumor area to resected specimen area) between patients who underwent LWR and patients who underwent LECS for gSMT resection in our hospital.

Patients and Methods

We retrospectively assessed 137 patients who underwent curative surgical resection for gSMTs at Tokyo Medical University Hospital, Japan, between January 2004 and January 2023. Of these 137 patients, patients who underwent the following surgical methods were excluded: open wedge resection (n = 53), hand-assisted laparoscopic wedge resection (n = 1), conversion laparoscopy to open wedge resection (n = 1), proximal gastrectomy (n = 1), simultaneous colorectal resection (n = 1), and inverted LECS[19] (n = 1).

Figure 1 shows the flow diagram of the 79 consecutive patients registered in this study. Patients who underwent curative gSMT resection by LWR or LECS were compared. The areas of comparison were patient characteristics, surgical outcomes, postoperative courses, histopathological examination results, surgical margin, and resected specimen area. The areas were obtained from medical chart reviews, histological slides, and pathological reports. Herein, a 2:1 propensity score matching (PSM) was performed to reduce potential selection bias resulting from the number difference of each group, and to increase the observational evidence level.

Figure 2 shows the surgical algorithm for gSMTs in our hospital. LWR was not performed for tumors located on the lesser curvature, near the EGJ, or close to the pylorus to prevent postoperative stricture resulting from the relatively wide extent of resection. The indications for LWR were tumors showing an extraluminal growth pattern, whereas the indications for LECS were not determined by tumor growth pattern. Tumors located on the lesser curvature were treated by LECS to prevent excessive gastric deformation.

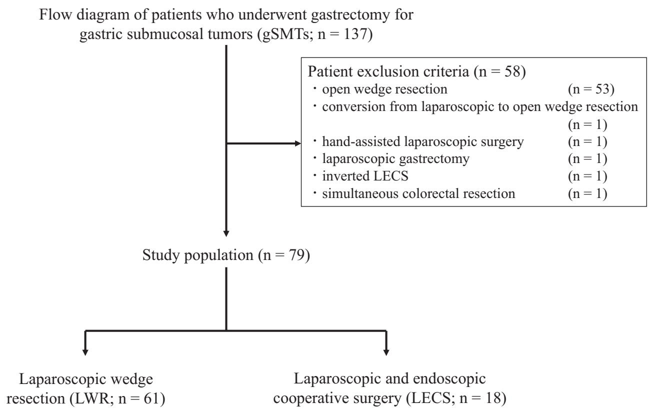

Fig. 1 Flow diagram of patients who underwent gastrectomy for gSMTs (n = 137).

As shown in **Fig. 3**, the tumor and resected specimen areas were determined by approximating an ellipse using the major and minor axes of the tumor and specimen. The tumor and resected specimen areas were calculated using the formula $ab\pi$, where "a" indicates the major axis length and "b" represents the minor axis length of the resected specimen.

Written informed consent for the treatments was provided by all patients. The research protocol was approved by the Ethics Committee for Clinical Research of Tokyo Medical University, Japan (Approval No.: T2022–0122).

Surgical procedures

Laparoscopic wedge resection

During the LWR, the patient was under general anesthesia and in a supine position. A split leg position was used to allow the scope assistant to stand between the patient's legs. A camera port was inserted into the umbilical lesion using an open method. This port was used for inflation with a pneumoperitoneum pressure of 10 mmHg using carbon dioxide. Three or 4 additional ports were added in the upper abdomen according to tumor location. An extra port was added to lift the left liver lobe using a liver retractor if needed. After confirming the tumor location, the gastric marginal vessels around the tumor were dissected using an ultrasonic dissection device to control bleeding and for better tissue mobility. Local resection was performed to extract the tumor with a safe surgical margin using a laparoscopic linear stapling device inserted through a 12-mm port (**Fig. 4a**). A video of the LWR surgical technique is shown in **Supplemental Digital Content 1a**.

Laparoscopic and endoscopic cooperative surgery

The surgical setting and anesthesia for LECS were similar to those for LWR. After vessel preparation of the excision areas, tumor peripheries were marked endoscopically. Specimens were removed by endoscopic submucosal incision and subsequent laparoscopic seromuscular dissection around the tumor periphery markings. After the complete tumor resection, the gastric

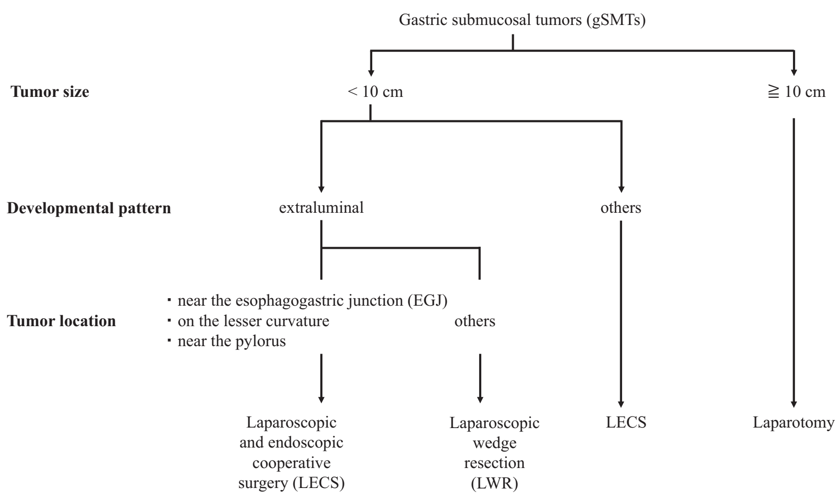

Fig. 2 Surgical algorithm for gSMTs at our institute.

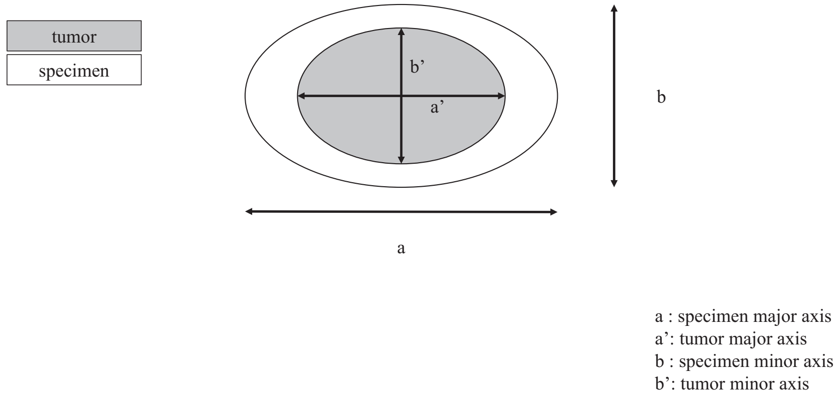

Fig. 3 Measurement method of the diameter and area of the resected specimen and tumor. Areas of the tumor and resected specimens were calculated using the formula abπ, where "a" represents the length of the major axis and "b" represents the length of the minor axis of the resected specimen.

wall defect was closed by laparoscopic hand suturing in all cases, with the minimum gastric transformation. Finally, LECS was completed after confirming the absence of bleeding and leakage (**Fig. 4b**). A video of the LECS surgical technique is shown in **Supplemental Digital Content 1b**.

Statistical analysis

Comparisons of the baseline characteristics and surgery-associated outcomes of the patients who underwent LWR or LECS were made by Fisher's exact test or Pearson's chi-square test for categorical variables, and by Mann-Whitney *U* test for continuous variables. PSM was applied to minimize the effects of confounding factors. In the logistic regression model, the covariates included were age, sex, body mass index (BMI), American Society of Anesthesiologists physical status (ASA-PS), tumor size, and tumor location. The surgical outcomes were compared using a 2:1 nearest neighbor PSM algorithm without replacement in a 2 (LWR) to 1 (LECS) ratio with a caliper value of 0.2 of the standard deviation. P values of < 0.05 were considered to indicate a statistically significant difference. Statistical analysis was conducted using R software for Windows (version 3.3.3; http://www.r-project.org/).

Results

A comparative summary of the background and clinicopathological features of the LWR and LECS patients is shown in **Table 1**. Among the 79 patients, 61 underwent LWR and 18 underwent LECS. There were no significant differences in gender, age, BMI, ASA-PS, tumor location, and diagnosis between the LWR and LECS groups. GIST was the most frequent pathological diagnosis in both groups. Because of the difference in the number of patients between the 2 groups, a 2:1 PSM was conducted to reduce the influence of patient selection bias. Each group was well matched in terms of gender, age at surgery, BMI, ASA-PS, and tumor location.

Table 2 shows the clinicopathological characteristics of the patients after PSM. After PSM, 24 LWR patients and 12 LECS patients were matched. There were no differences in gender, age, BMI, ASA-PS, tumor location, and diagnosis between the LWR and LECS groups.

As shown in **Table 3**, surgical outcomes were also stratified to the 2 groups. There was no significant difference in the intraoperative blood loss, postoperative hospital stay, or resected tumor size. The mean

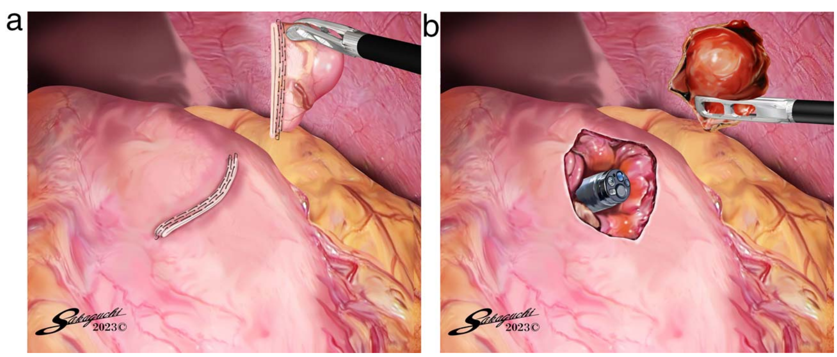

Fig. 4 (a) Image of the surgical procedures for LWR. (b) Image of the surgical procedures for LECS.

Table 1 Clinicopathological characteristics of the patients

	LWR (n = 61)	LECS (n = 18)	*P*-value
Gender			
Male/female	31/30	7/11	0.43
Age (years)			
Mean (range)	63.7 (39–85)	63.6 (38–84)	0.98
BMI (kg/m^2)			
Mean (range)	23.4 (18.0–35.5)	23.6 (15.8–34.1)	0.90
ASA-PS			
1/2/3	29/31/1	13/5/0	0.18
Tumor location			
Upper/Middle/Lower	34/17/9	12/4/2	0.80
Ant/Post/Gre/Less[a]	12/8/22/18	7/2/4/5	0.41
Diagnosis			
GIST/Others	56/5[b]	15/3[c]	0.37
Modified Fletcher classification			
Very low/low/intermediate/high	4/38/8/3	4/8/1/2	0.10

ASA-PS, American Society of Anesthesiologists physical status; BMI, body mass index; GIST, gastrointestinal stromal tumor; LECS, laparoscopic and endoscopic cooperative surgery; LWR, laparoscopic wedge resection.
[a]Anterior/Posterior/Greater curvature/Lesser curvature.
[b]Ectopic pancreas, 1; Schwannoma, 3; Leiomyosarcoma, 1.
[c]Schwannoma, 1; Leiomyoma, 1; Erosive inflammatory lesion, 1.

intraoperative duration was significantly shorter in the LWR group than in the LECS group (LWR, 131.1 minutes; LECS, 195.2 minutes; $P < 0.05$). There were no Clavien-Dindo grade II or above complications in the 2 groups. There was no record of mortality during hospitalization, no patient reoperation within 30 days, and no rehospitalization in either group. Histopathological examinations revealed that every patient underwent curative resection with negative margins, irrespective of the surgical procedure.

In **Fig. 5a**, quantitative analysis of the resected specimen showed that the mean ratio of tumor diameter to resected specimen diameter (tumor diameter: specimen diameter) was significantly higher in the LECS group than in the LWR group (LWR, 60.3% ± 20.9; LECS, 78.9% ± 15.7; $P < 0.05$).

Similar to the tumor diameter:specimen diameter ratio, **Fig. 5b** shows that the mean ratio of tumor area to resected specimen area (tumor area:specimen area) was significantly higher in the LECS

Table 2 Clinicopathological characteristics of the patients after propensity score matching

	LWR (n = 24)	LECS (n = 12)	*P*-value
Gender			
Male/female	11/13	5/7	1.00
Age (years)			
Mean (range)	63.0 (39-84)	65.5 (38-84)	0.42
BMI (kg/m^2)			
Mean (range)	22.8 (18.0-33.5)	22.1 (15.8-29.2)	0.71
ASA-PS			
1/2	14/10	7/5	1.00
Tumor location			
Upper/Middle/Lower	14/7/3	7/3/2	1.00
Ant/Post/Gre/Less[a]	7/3/10/4	5/2/2/3	0.53
Diagnosis			
GIST/Others	20/4	10/2	1.00
Modified Fletcher classification			
Very low/low/intermediate/high	3/12/3/2	3/6/0/1	0.64

ASA-PS, American Society of Anesthesiologists physical status; BMI, body mass index; GIST, gastrointestinal stromal tumor; LECS, laparoscopic and endoscopic cooperative surgery; LWR, laparoscopic wedge resection.
[a]Anterior/Posterior/Greater curvature/Lesser curvature.

Table 3 Surgical and short-term postoperative outcomes

	LWR (n = 24)	LECS (n = 12)	*P*-value
Operative duration (min)			
Mean (range)	131.1 [51–379]	195.2 [111–369]	<0.05
Intraoperative blood loss (mL)			
Mean (range)	6.1 [0–144]	11.3 [0–52]	0.24
Postoperative hospital stay (days)			
Mean (range)	7.7 [6–44]	7.8 [6–10]	0.85
Tumor size (mm)			
Mean (range)	25.7 [7.0–80.0]	28.5 [14.0–55.0]	0.39
Tumor major axis/specimen major axis (%)	60.3	78.9	<0.05
Tumor area/specimen area (%)	44.7	66.3	<0.05
Surgical margin			
Positive/negative	0/24	0/24	1.00
Number of complications (CD[a] ≧2)	0	0	1.00
Reoperation (within 30 days)	0	0	1.00
Readmission (within 30 days)	0	0	1.00

LECS, laparoscopic and endoscopic cooperative surgery; LWR, laparoscopic wedge resection.
[a]Clavien Dindo Classification.

group than in the LWR group (LWR, 44.7% ± 24.8; LECS, 66.3% ± 22.9; $P < 0.05$).

Discussion

Most gSMTs, including GISTs, show expansive growth in the gastric wall. They rarely metastasize to regional lymph nodes or other organs. Thus, treatment of gSMTs requires neither lymphadenectomy nor wide surgical resection margins.[3–5,20,21] The basic treatment choice for gSMTs (including nonmetastatic GISTs) is complete tumor excision[22]; however, there is still no consensus regarding the resection methods.

For tumors <5 cm in diameter, LWR has been performed as one of the most appropriate laparoscopic surgical techniques.[3] Other than LWR, several retrospective studies have reported the feasibility and safety of laparoscopic resection for gSMTs.[13–15] Among these surgical methods, since the first report of Hiki *et al* in 2008,[11] LECS as a treatment for gSMTs has gradually increased in usage over the years. LECS has been developed to minimize the invasiveness of surgical interventions for gSMTs. Compared with LWR, LECS makes it possible to resect tumors located in the EGJ, lesser curvature, and even near the pylorus, locations that are difficult to be treated by LWR because of the wide extent of resection by a straight linear stapling device, potentially leading to postoperative

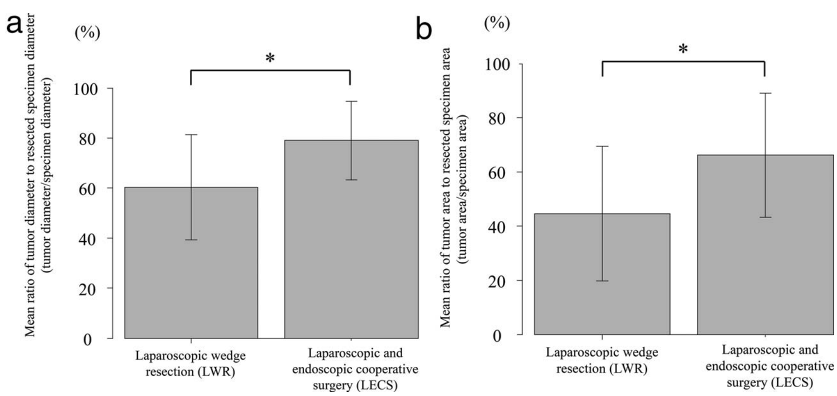

Fig. 5 (a) Quantitative analysis of the mean ratio of tumor diameter to resected specimen diameter (tumor diameter:specimen diameter). The mean ratio was significantly higher in the LECS group than in the LWR group (LWR, 60.3% ± 20.9%; LECS, 78.9% ± 15.7%; $P < 0.05$). The data are expressed as mean ± standard deviation (SD). *$P < 0.05$. (b) Quantitative analysis of the mean ratio of tumor area to resected specimen area (tumor area:specimen area). The mean ratio of tumor area to resected specimen area was significantly higher in the LECS group than in the LWR group (LWR, 44.7% ± 24.8%; LECS, 66.3% ± 22.9%; $P < 0.05$). The data are expressed as mean ± SD. *$P < 0.05$.

gastric deformation or structuring. In the present study, after LECS introduction for gSMT treatment in 2018, gastrectomy was required in only 1 case, which was a circumferential SMT of the EGJ.

Consistent with previous reports,[13,23,24] we found that the operative duration was significantly shorter in the LWR group than in the LECS group. This was because of the simplicity of the surgical procedures in the LWR group. LWR only requires the use of a laparoscopic linear stapling device without circumferential incisions under laparoscopy or endoscopy. Although the use of linear stapling devices shortens the operative duration, their application has restrictions in specific tumor locations (*i.e.*, lesser curvature, EGJ, or pylorus). This may lead to postoperative deformation or structuring and has disadvantages in creating an optimal minimum required surgical margin.

Interestingly, our results showed that the LECS group had a predominantly larger proportion of tumor specimens, and that we were able to show quantitative differences in the surgical margins between the LECS and LWR groups. Even though every patient underwent curative resection with negative margins, the mean ratio of tumor diameter to resected specimen diameter (*i.e.*, tumor diameter:specimen diameter) and the mean ratio of tumor area to resected specimen area (*i.e.*, tumor area:specimen area) were both significantly higher in the LECS group than in the LWR group. These findings suggest the high efficiency of LECS.

Several reasons may underlie these results. First, as LWR requires the use of a straight linear stapling device (multiple in cases), expansion of the normal stomach resection area around the tumor is more often experienced. Excessive gastric resection will lead to gastric deformation causing postoperative complications in the worst case. Second, specimens were extirpated after endoscopic peripheral dissection around the tumor, which avoided the unnecessary resection of the normal stomach wall in the LECS group. Closure of the gastric wall defect was performed using the laparoscopic hand-suturing technique in LECS. Hand-suturing closure and minimum incision around the tumor theoretically show a synergetic effect in preventing deformation of the remnant stomach.

Moreover, Shoji *et al*[2] reported the economic benefits of the use of the laparoscopic hand-suturing technique over the use of a linear stapling device. Regarding surgical indications, our surgical algorithm for gSMTs was found to be suitable, showing no complications in any case. As the algorithm shows, LWR is a reasonable and time-saving surgical method for cases that are unlikely to show postoperative complications, severe deformation of the remnant stomach, or stricture.

This study has several limitations. First, this was a retrospective single-center analysis. Further accumulation of clinical cases and prospective randomized trials are needed to fully establish the most appropriate treatment options for gSMTs. Second, other treatment options for gSMTs such as CLEAN-NET[25] and NEWS[26] were not included in this study as there was no case requiring such treatment options, and this may have led to bias in the results. Third, postoperative upper gastrointestinal radiographic examinations using contrast media to show objective deformation of the remnant stomach were not performed in any case.

Conclusion

Operative procedures for gSMTs must be carefully selected according to the tumor location and characteristics. LECS is a less invasive surgical technique that avoids postsurgical complications. Moreover, LECS is potentially beneficial in minimizing ontologically acceptable surgical margins, which account for the functional and anatomic preservation of gSMTs.

References

1. Hedenbro JL, Ekelund M, Wetterberg P. Endoscopic diagnosis of submucosal gastric lesions. The results after routine endoscopy. *Surg Endosc* 1991;**5**:20–23
2. Shoji Y, Takeuchi H, Goto O, Tokizawa K, Nakamura R, Takahashi T *et al*. Optimal minimally invasive surgical procedure for gastric submucosal tumors. *Gastric Cancer* 2018;**21**:508–515
3. Nishida T, Hirota S, Yanagisawa A, Sugino Y, Minami M, Yamamura Y *et al*. Clinical practice guidelines for gastrointestinal stromal tumor (GIST) in Japan: English version. *Int J Clin Oncol* 2008;**13**:416–430
4. Shiratori W, Matsumura T, Okimoto K, Akizue N, Matsusaka K, Ohyama Y *et al*. Long-term course of gastric submucosal tumors: growth speed and size-increasing factors. *Gastrointest Endosc* 2023;**97**(6):1052–1058
5. Demetri GD, von Mehren M, Antonescu CR, DeMatteo RP, Ganjoo KN, Maki RG *et al*. NCCN Task Force report: update on the management of patients with gastrointestinal stromal tumors. *J Natl Compr Canc Netw* 2010;**8**:S1–41 (quiz S2–S4)
6. ESMO/European Sarcoma Network Working Group. Gastrointestinal stromal tumors: ESMO Clinical Practice Guidelines for diagnosis, treatment, and follow-up. *Ann Oncol* 2014;**25**:iii 21–6
7. Matsuda T, Hiki N, Nunobe S, Aikou S, Hirasawa T, Yamamoto Y *et al*. Feasibility of laparoscopic and endoscopic cooperative surgery for gastric submucosal tumors (with video). *Gastrointest Endosc* 2016;**84**:47–52

8. Hu J, Or BH, Hu K, Wang ML. Comparison of the post-operative outcomes and survival of laparoscopic versus open resections for gastric gastrointestinal stromal tumors: a multi-center prospective cohort study. *Int J Surg* 2016;**33 Pt A**:65–71
9. DeMatteo RP, Lewis JJ, Leung D, Mudsan SS, Woodruff JM, Brennan MF. Two hundred gastrointestinal stromal tumors: recurrence patterns and prognostic factors for survival. *Ann Surg*. 2000;**231**:51–58
10. Thomas Z, Farhan I, Amelia F, Kon V. Lap-Endo cooperative surgery (LECS) in gastric GIST: updates and future advances. *Surg Endosc* 2022;**37**:1672–1682
11. Hiki N, Yamamoto Y, Fukunaga T, Aikou S, Kodashima S, Yamashita H *et al*. Laparoscopic and endoscopic cooperative surgery for gastrointestinal stromal tumor dissection. *Surg Endosc*. 2008;**22**:1729–1735
12. Hiki N, Nunobe S. Laparoscopic endoscopic cooperative surgery (LECS) for the gastrointestinal tract: updated indications. *Ann Gastroenterol Surg* 2019;**3**(3):239–246
13. Komatsu S, Ichikawa D, Kosuga T, Okamoto K, Konishi H, Shiozaki A *et al*. Clinical impact of laparoscopy and endoscopy cooperative surgery (LECS) on gastric submucosal tumor after its standardization. *Anticancer Res* 2016;**36**(6):3041–3047
14. Matsuda T, Nunobe S, Kosuga T, Kawahira H, Inaki N, Kitashiro S *et al*. Laparoscopic and luminal endoscopic cooperative surgery can be a standard treatment for submucosal tumors of the stomach: a retrospective multicenter study. *Endoscopy* 2017;**49**:476–483
15. Aisu Y, Yasukawa D, Kimura Y, Hori T. Laparoscopic and endoscopic cooperative surgery for gastric tumors: perspective for actual practice and oncological benefits. *World J Gastrointest Oncol* 2018;**10**(11):381–397
16. Kawahira H, Hayashi H, Natsume T, Akai T, Uesato M, Horibe D *et al*. Surgical advantages of gastric SMTs by laparoscopy and endoscopy cooperative surgery. *Hepatogastroenterology* 2012;**59**(114):415–417
17. Hanayama H, Katagata M, Sato T, Nakano H, Matsumoto T, Tada T *et al*. Clinical outcomes of laparoscopic and endoscopic cooperative surgery for gastric gastrointestinal stromal tumor. *Fukushima J Med Sci* 2022;**68**:3:169–173
18. Aoyama J, Kawakubo H, Matsuda S, Mayanagi S, Fukuda K, Irino T *et al*. Clinical outcomes of laparoscopic and endoscopic cooperative surgery for submucosal tumors on the esophagogastric junction: a retrospective single-center analysis. *Gastric Cancer* 2020;**23**:1084–1090
19. Nunobe S, Hiki N, Gotoda T, Murao T, Haruma K, Matsumoto H *et al*. Successful application of laparoscopic and endoscopic cooperative surgery (LECS) for lateral spreading mucosal gastric cancer. *Gastric Cancer* 2012;**15**:338–342
20. Nguyen SQ, Divino CM, Wang JL, Dikman SH. Laparoscopic management of gastrointestinal stromal tumors. *Surg Endosc* 2006;**20**:713–716
21. Novitsky YW, Kercher KW, Sing RF, Heniford BT. Long-term outcomes of laparoscopic resection of gastric gastrointestinal stromal tumors. *Ann Surg* 2006;**243**:738–745.
22. Otani Y, Ohgami M, Igarashi N, M Kimata, T Kubota, K Kumai *et al*. Laparoscopic wedge resection of gastric submucosal tumors. Surg Laparosc Endosc Percutan Tech 2000;**10**(1): 19–23
23. Nunobe S, Hiki N, Gotoda T, Murao T, Haruma K, Matsumoto H *et al*. Successful application of laparoscopic and endoscopic cooperative surgery (LECS) for a lateral-spreading mucosal gastric cancer. *Gastric Cancer* 2012;**15**:338–342
24. Namikawa T, Hanazaki K. Laparoscopic endoscopic cooperative surgery as a minimally invasive treatment for gastric submucosal tumor. *World J Gastrointest Endosc* 2015;**7**(14):1150–1156
25. Inoue H, Ikeda H, Hosoya T, Yoshida A, Onimaru M, Suzuki M *et al*. Endoscopic mucosal resection, endoscopic submucosal dissection, and beyond: full-layer resection for gastric cancer with nonexposure technique (CLEAN-NET). *Surg Oncol Clin N Am* 2012;**21**(1):129–140
26. Mitsui T, Niimi K, Yamashita H, Goto O, Aikou S, Hatao F *et al*. Non-exposed endoscopic wall-inversion surgery as a novel partial gastrectomy technique. *Gastric Cancer* 2014;**17**: 594–599