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ORIGINAL ARTICLE

Usefulness of Laparoscopic Side-to-Side Duodenojejunostomy for Gastrointestinal Stromal Tumors Located at the Duodenojejunal Junction

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Abstract
Background Surgery for gastrointestinal stromal tumor (GIST) at the duodenojejunal junction is a technically challenging and difficult procedure because of the anatomical complexity. When it comes to laparoscopic surgery, it is more challenging than open surgery. This study aimed to introduce our laparoscopic procedure and to evaluate its clinical implication by comparing with open procedures.
Method Between 2003 and 2013, 19 patients underwent segmental resection for a GIST at the duodenojejunal junction: laparoscopic segmental resection with side-to-side duodenojejunostomy (n=8) and open surgery (n=11). Clinicopathological findings, operation details, and postoperative outcomes were compared.
Results Both groups were comparable in demographics and clinicopathological characteristics. Postoperative hospital stay of the laparoscopic group (6.3 days) was significantly shorter than the open group (15.7 days, P=0.008) while no significant differences were observed regarding estimated blood loss, operation time, and morbidity. All patients in both groups underwent curative resection without operative mortality. Two patients experienced recurrence after open surgery whereas none of the patients after laparoscopic duodenojejunostomy had recurrence with a median follow-up period of 36 months.
Conclusion Laparoscopic segmental resection with side-to-side duodenojejunostomy for a GIST at the duodenojejunal junction is a safe, feasible, and effective alternative to open approach, providing benefits of minimally invasive surgery.

Keywords GIST · Duodenojejunal junction · Laparoscopy · Resection

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Introduction

Gastrointestinal stromal tumors (GISTs) are the most common type of subepithelial tumors of the gastrointestinal tract and account for only 0.1 to 0.3 % of all tumors arising in the gastrointestinal tract.[1] The most common sites for GISTs in the digestive tract are the stomach followed by the small intestine. Surgical resection with a negative margin is the treatment of choice for primary GISTs.[2–4] In recent years, laparoscopic surgery has become widely accepted for resection of gastric and small bowel GISTs, and it has demonstrated similar oncological outcomes compared to open surgery while affording the benefits of minimal invasiveness.[5–7]

Although laparoscopic surgery is gaining popularity for the treatment of GISTs, surgeons sometimes are confronted with a

difficult anastomosis after segmental resection of the duodenojejunal junction for GISTs, even though it is not so frequent. For the treatment of tumors at the duodenojejunal junction, various types of surgery have been performed based on experience with surgery for traumatic transection or obstruction of the duodenojejunal junction. Surgeries involving end-to-end duodenojejunostomy with hand-sewn manner or end-to-side anastomosis with staplers have been practically carried out.[8–10] Although there have been different techniques for restoring bowel continuity during surgery involving the duodenojejunal junction, no standard method has yet been established.

Recently, as a minimally invasive surgery technique for this area, laparoscopic duodenojejunostomy for superior mesenteric artery syndrome was reported to have several advantages, such as less postoperative abdominal pain, a shorter hospital stay, and a better cosmesis compared with open surgery.[11–13] This concept of anastomosis can be applied after segmental resection of tumors at the duodenojejunal junction. We have successfully treated GISTs at the duodenojejunal junction by applying laparoscopic side-to-side duodenojejunostomy. This study aimed to introduce our laparoscopic side-to-side duodenojejunostomy technique and to evaluate it by comparing it to open procedures.

Methods

Patients

Between November 2003 and June 2013, 28 patients with the duodenojejunal junction GIST underwent surgery at the Department of Surgery, Severance Hospital, Yonsei University Health System. We defined a GIST located in the fourth portion of the duodenum, proximal to the jejunum, and within 5 cm from the ligament of Treitz as a duodenojejunal junction GIST. Among those 28 patients, eight patients underwent a wedge resection and one patient underwent emergency debulking surgery due to a rupture of the tumor at the duodenojejunal junction. After exclusion of these nine patients, the remaining 19 patients who underwent segmental resection for duodenojejunal junction GIST were included in the study. Data regarding demographics, operation details, postoperative outcomes, and clinicopathological findings based on the 7th edition of the International Union Against Cancer TNM classification and based on the tumor risk category defined by the tumor size and mitotic index proposed by Fletcher and colleagues [14] were collected retrospectively. Postoperative complications that occurred within 30 days after the operation were classified according to the Clavien-Dindo classification system.[15] Complications that were classified as grade II or greater were considered a postoperative morbidity. Recurrence and the time to recurrence data were collected according to diagnostic imaging and/or histologic confirmation. Types of surgery were selected based on the individual surgeon's preference. All patients gave proper written informed consent before the operation after receiving a detailed explanation of the surgery. This study was approved by the Institutional Review Board of Severance Hospital, Yonsei University Health System (4-2013-0063). Signed patient informed consent for the use of patient data was waived with institutional review board approval because they were retrospectively collected.

Surgical Technique of Laparoscopic Segmental Resection with Side-to-Side Duodenojejunostomy

Under general anesthesia, with the patient in a supine position, four ports were inserted: first port (10 mm) at the infraumbilical area for the camera, second port (5 mm) below the right subcostal margin on the right midclavicular line, third port (12 mm) two to three fingers above the umbilical level lateral to the left midclavicular line, and fourth port (5 mm) below the left subcostal margin on the left midclavicular line (Fig. 1). After laparoscopic exploration and traction of the omentum and the transverse colon toward the diaphragm, mobilization of the duodenojejunal junction by dissection of the ligament of Treitz and careful division of the branches from the first jejunal vessels were performed. The duodenojejunal junction area proximal to the tumor was transected with a linear stapler and then segmental resection of the jejunum including the tumor was completed by transecting the jejunum distal to the tumor with a linear stapler (Fig. 2). Details of these resection procedures are demonstrated in Video 1. To restore the bowel continuity, the second to third portion of the duodenum was exposed by dissecting the

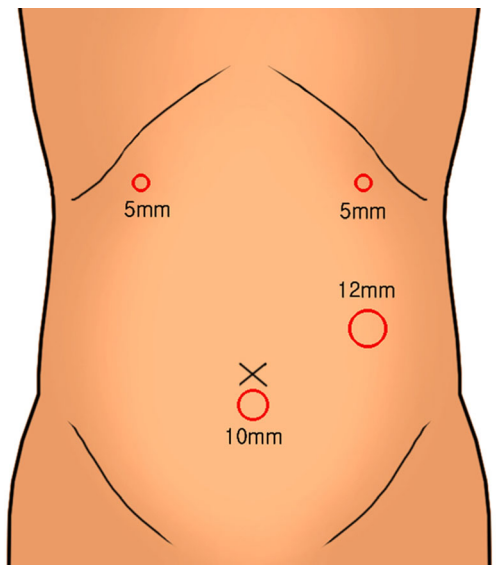

Fig. 1 Schematic illustration of the port placement

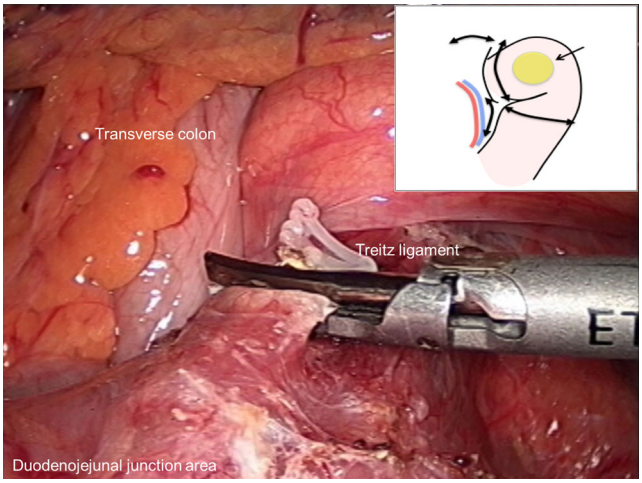

Fig. 2 Mobilization of the duodenojejunal junction and segmental resection of the duodenojejunal junction area (**a**) with schematic illustration (**b**). Ligament of Treitz and feeding vessels from the first jejunal branches were dissected to mobilize the duodenojejunal junction and a segmental resection was performed

posterior leaflet of the transverse mesocolon right to the midcolic vessels, and after adequate mobilization, the distal loop of the jejunum was anastomosed with the third portion of the duodenum using a linear stapler in a side-to-side manner (Fig. 3). The entry hole for the stapler was closed with laparoscopic suturing. Details of anastomosis procedures are presented in Video 2. After completing the anastomosis, the specimen was delivered through an extension of the infraumbilical port. A representative preoperative computed tomography image and postoperative barium study image are shown in Fig. 4.

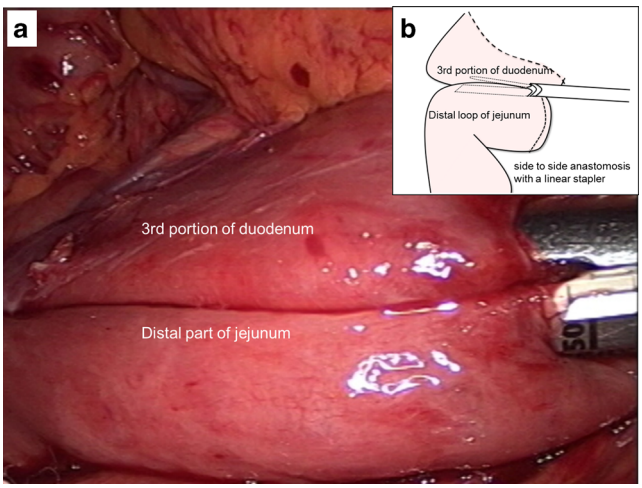

Fig. 3 Laparoscopic side-to-side anastomosis (**a**) with schematic illustration (**b**). Mobilization of the third portion of the duodenum was performed and a side-to-side anastomosis made using a linear stapler. Linear stapler was inserted from the 12-mm trocar at the left flank of the patient

Statistical Analysis

All statistical analyses were performed using the Statistical Package for Social Sciences statistical software version 19.0 (IBM, Armonk, NY, USA). Categorical data were compared with the chi-square test, and continuous variables were compared using the Student's *t* test. A *p* value of <0.05 was considered to be statistically significant.

Results

Of the 19 patients who underwent segmental resection of the duodenojejunal junction, eight patients underwent laparoscopic segmental resection with side-to-side duodenojejunostomy (LAP group), and 11 patients underwent segmental resection through open laparotomy (OPEN group). Within the open surgery group, four patients underwent a hand-sewn end-to-end anastomosis, two patients underwent a hand-sewn end-to-side anastomosis, two patients underwent an end-to-side anastomosis using a circular stapler, and three patients underwent a side-to-side anastomosis using a linear stapler.

The patients' characteristics in the two groups are summarized in Table 1. There were no significant differences between the groups in terms of age, gender, body mass index, American Society of Anesthesiologists Physical Status, and previous abdominal operation history. There were no significant differences in all pathological findings between the two groups (Table 2).

Surgical outcomes are summarized in Table 3. There were no significant differences observed in estimated blood loss (LAP 90.4 ml, OPEN 161.1 ml, P=0.491) and operation time (LAP 141.3 min, OPEN 170.9 min, P=0.491). However, the hospital stay was shorter in the laparoscopic group [(mean; LAP 6.3 days, OPEN 15.7 days, P=0.008), (median; LAP 5 days, OPEN 14 days, P=0.020)]. There was no conversion in the laparoscopic group. Regarding morbidity, one patient in the laparoscopic group presented with a small bowel obstruction and required laparoscopic bandlysis. Two patients in the open group who presented with small bowel obstruction were managed conservatively. One patient in the open group had an intra-abdominal abscess and was treated with intravenous antibiotics alone. Overall, no significant difference was observed in the postoperative morbidity rate (LAP 1 (12.5 %), OPEN 3 (27.3 %), P=0.435) and no mortality was observed in either group.

All patients in both groups underwent curative resection without violating oncologic principles such as tumor rupture or spillage. With a median follow-up period of 36 months (range 1–107 months) of all cohorts [(LAP 37 months (range 1–100 months), OPEN 36 months (range 1–107 months)],

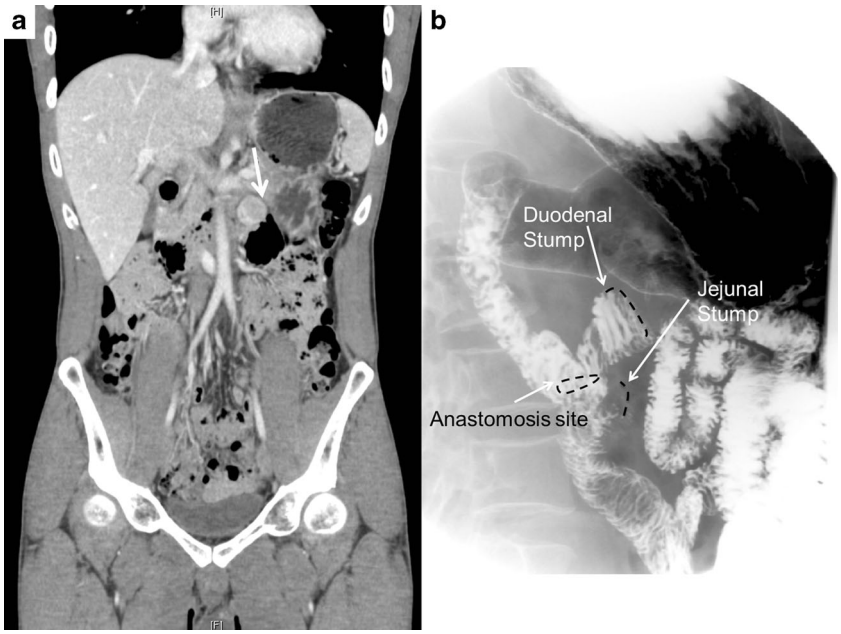

Fig. 4 Preoperative computed tomography showing a 3-cm enhancing mass (*arrow*) at the duodenojejunal junction (**a**) and postoperative barium study image showing the anastomosis site, duodenal stump, anastomosis site, and jejunal stump (**b**)

recurrences were observed in two patients only in the open group whereas none were observed in the laparoscopic group. Two patients in the open group developed multiple liver metastases at 13 and 30 months after surgery.

Discussion

Treatment of a GIST at the duodenojejunal junction has been considered to be a difficult procedure even by open surgery. In our study, we demonstrated a successful laparoscopic segmental resection followed by side-to-side anastomosis for GISTs located at the duodenojejunal junction. Moreover, we confirmed its safety and efficacy with a resultant shorter hospital stay, comparable morbidity, and comparable oncological outcome compared with open surgery.

The main reasons for the difficulties in resection and reconstruction around the duodenojejunal junction area come

Table 1 Comparison of patients' characteristics

Characteristics	Laparoscopy (N=8)	Open (N=11)	P
Age[a]	51.3±11.7	56.6±13.0	0.367[b]
Sex (male/female)	5/3	7/4	0.960[c]
Body mass index[a]	21.7±3.5	24.2±2.4	0.128[c]
ASA-PS			
I	4	5	0.845[c]
II, III	4	6	
Previous abdominal operation history	1	1	0.811[c]

ASA-PS American Society of Anesthesiologists Physical Status classification

[a] Values are mean±SD

[b] Student's *t* test

[c] $\chi 2$ test

Table 2 Comparison of pathological characteristics

Characteristics	Laparoscopy (N=8)	Open (N=11)	P
Tumor size (cm)	51.3±11.7	46.1±21.2	0.835[a]
T1 (tumor size ≤2)	1	0	0.316[b]
T2 (2<tumor size ≤5)	2	9	
T3 (5<tumor size ≤10)	2	2	
T4 (10<tumor size)	1	0	
Histologic grade			
G1 (≤5/50 HPF)	7	10	0.811[b]
G2 (>5/50 HPF)	1	1	
Prognostic groups			
I	4	9	0.415[b]
II	2	1	
IIIa	1	0	
IIIb	1	1	
IV	0	0	
Risk category			
Very low	1	0	0.200[b]
Low	3	9	
Intermediate	3	1	
High	1	1	

Values are mean±SD

HPF mitoses per 50 high-power fields

[a] Student's *t* test

[b] $\chi 2$ test

Table 3 Comparison of operative outcomes

Characteristics	Laparoscopy (N=8)	Open (N=11)	P
Operation time[a]	141.3±54.2	170.9±65.6	0.297[b]
Estimated blood loss[a]	90.4±206.7	161.1±205.8	0.491[b]
Curability			
R0	8	11	>0.999[c]
R1/2	0	0	
Hospital stay			
Median	5	14	0.020[d]
Mean[a]	6.3±3.9	15.7±9.2	0.008[b]
Postoperative morbidity	1 (12.5 %)	3 (27.3 %)	0.435[c]
Mortality	0	0	
Recurrence	0	2	0.202[c]

[a] Values are mean±SD

[b] Student's t test

[c] $\chi 2$ test

[d] Fisher's exact test

from the associated anatomical complexity. The fourth part of the duodenum is directed obliquely upward from the retroperitoneum and ends at the duodenojejunal junction at the level of the second lumbar vertebra (i.e., around the root of the transverse mesocolon). Its end is very close to the draining point of the inferior mesenteric vein to the splenic vein, and the upper end of the root of the mesentery also attaches around the duodenojejunal junction. The duodenojejunal junction is suspended by the ligament of Treitz, a remnant of the dorsal mesentery, which extends from the duodenojejunal flexure to the right crus of the diaphragm, which has considerable anatomical variation in each patient.[16] These anatomical complexities make it difficult to expose the operation field by visualizing the intestine circumferentially. Thus, anastomosis is technically difficult. More importantly, the short stump of bowel after resection of the tumor at the duodenojejunal junction makes it difficult to handle during the anastomosis.

Recently, several different procedures for duodenojejunal junction GISTs through the open approach have been reported such as end-to-end duodenojejunostomy using hand-sewn technique and end-to-side duodenojejunostomy technique.[9,10] However, even in those open procedures, the technical difficulties of the duodenojejunostomy are evident because of the anatomical complexity of the duodenojejunal junction, and all of these technical obstacles have not been sorted out yet. Thus, no standard procedure for duodenojejunostomy for GISTs is established, even for the open approach. As for our laparoscopic side-to-side duodenojejunostomy, the concept of the procedure was inspired by reports of laparoscopic duodenojejunostomies for duodenum obstruction due to superior mesenteric artery syndrome.[11–13] Using this concept for reconstruction after resection of a duodenojejunal junction GIST, a surgeon can easily perform the resection and reconstruction in this anatomically difficult area using a minimally invasive approach. Moreover, laparoscopic side-to-side duodenojejunostomy showed advantages of minimally invasive surgery such as shorter hospital stay, although it was not statistically significant.

At the same time, the most important matter concerning the resection of GISTs is the oncological safety. There is uniform agreement that the surgical treatment of choice for GISTs is resection of the tumor with negative surgical margins and without tumor spillage during the operation.[17] The optimal surgical procedure for duodenal GISTs of the fourth portion of the duodenum is guided by the size and exact location of the tumor.[10] The oncological feasibility of the limited resection with a safe margin is regarded as an alternative to the wide resection represented by pancreaticoduodenectomy. A wedge resection can be adequate for small lesions provided that the lumen is not compromised after resection. Otherwise, a segmental resection is adequate for larger tumors located around the duodenojejunal junction. We have previously described oncological outcomes after laparoscopic resection of the small bowel including of duodenum GISTs of size less than 10 cm.[5] In fact, in our study, there was no tumor spillage during the operation, and all patients underwent curative resection. Further, no recurrence was observed after laparoscopic segmental resection with duodenojejunostomy with a follow-up period of 36 months. Thus, this procedure could be a treatment option for GISTs located at the duodenojejunal junction. Although resection of tumor without regional lymphadenectomy is accepted as standard treatment for GIST unlike to surgery for small bowel or duodenal adenocarcinomas, laparoscopic side-to-side duodenojejunostomy after primary tumor resection with regional lymphadenectomy can be applied for the treatment of duodenojejunal junction adenocarcinomas.

However, our study is limited by its retrospective nature and possible selection bias based on surgeons' preference for open or laparoscopic approach and anastomotic technique. Some surgeons had little experience of advanced laparoscopic procedure while some surgeons were experts; thus, the operative approaches were decided based on different skills of each surgeon. As mentioned above, since there is no standard procedure for the reconstruction of this area even with open laparotomy, the anastomosis procedure in the open group includes several methods. Patients included in this study were having mostly normal BMI, thus there would be more technical difficulties when laparoscopic side-to-side duodenojejunostomy is applied to obese patients. The number of patients included in our study was rather small with which to make conclusions, due to the infrequent incidence of GISTs located at the duodenojejunal junction. However, to our knowledge, this is the first study to introduce the laparoscopic approach for this technically difficult resection and

anastomosis of GISTs located at the duodenojejunal junction. Furthermore, our study also confirms the procedure's safety, short term benefits, and intermediate oncological outcomes.

Conclusion

Laparoscopic segmental resection of GIST at the duodenojejunal junction with side-to-side duodenojejunostomy is a safe and feasible alternative to the traditional open approach. Although a larger cohort of patients is needed for conclusions to be drawn, a laparoscopic segmental resection with side-to-side duodenojejunostomy might have the potential to be one of the options for the treatment of GISTs located at this anatomically complex area and provides the benefits of minimally invasive surgery.

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Conflicts of Interest None.

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References

1. Lewis JJ, Brennan MF. Soft tissue sarcomas. Curr Probl Surg 1996;33:817–872.
2. Pandey R, Kochar R. Management of gastrointestinal stromal tumors: looking beyond the knife. An update on the role of adjuvant and neoadjuvant imatinib therapy. J Gastrointest Cancer 2012;43: 547–552.
3. Wu TJ, Lee LY, Yeh CN, Wu PY, Chao TC, Hwang TL, Jan YY, Chen MF. Surgical treatment and prognostic analysis for gastrointestinal stromal tumors (GISTs) of the small intestine: before the era of imatinib mesylate. BMC Gastroenterol 2006;6:29.
4. Kim YM, Lim JS, Kim JH, Hyung WJ, Noh SH. Image-based approach for surgical resection of gastric submucosal tumors. J Gastric Cancer 2010;10:188–195.
5. Ihn K, Hyung WJ, Kim HI, An JY, Kim JW, Cheong JH, Yoon DS, Choi SH, Noh SH. Treatment results of small intestinal gastrointestinal stromal tumors less than 10 cm in diameter: A comparison between laparoscopy and open surgery. J Gastric Cancer 2012;12: 243–248.
6. Sexton JA, Pierce RA, Halpin VJ, Eagon JC, Hawkins WG, Linehan DC, Brunt LM, Frisella MM, Matthews BD. Laparoscopic gastric resection for gastrointestinal stromal tumors. Surg Endosc 2008;22: 2583–2587.
7. 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.
8. Chung JC, Kim HC, Chu CW. Segmental duodenectomy with duodenojejunostomy of gastrointestinal stromal tumor involving the duodenum. J Korean Surg Soc 2011;80 (Suppl 1):S12-16.
9. Sakamoto Y, Yamamoto J, Takahashi H, Kokudo N, Yamaguchi T, Muto T, Makuuchi M. Segmental resection of the third portion of the duodenum for a gastrointestinal stromal tumor: a case report. Jpn J Clin Oncol 2003;33:364–366.
10. Goh BK, Chow PK, Kesavan S, Yap WM, Wong WK. Outcome after surgical treatment of suspected gastrointestinal stromal tumors involving the duodenum: is limited resection appropriate? J Surg Oncol 2008;97:388–391.
11. Jo JB, Song KY, Park CH. Laparoscopic duodenojejunostomy for superior mesenteric artery syndrome: report of a case. Surg Laparosc Endosc Percutan Tech 2008;18:213–215.
12. Kim IY, Cho NC, Kim DS, Rhoe BS. Laparoscopic duodenojejunostomy for management of superior mesenteric artery syndrome: two cases report and a review of the literature. Yonsei Med J 2003;44:526–529.
13. Munene G, Knab M, Parag B. Laparoscopic duodenojejunostomy for superior mesenteric artery syndrome. Am Surg 2010;76:321–324.
14. Fletcher CD, Berman JJ, Corless C, Gorstein F, Lasota J, Longley BJ, Miettinen M, O'Leary TJ, Remotti H, Rubin BP, Shmookler B, Sobin LH, Weiss SW. Diagnosis of gastrointestinal stromal tumors: A consensus approach. Hum Pathol 2002;33:459–465.
15. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: A new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 2004;240: 205–213.
16. Kim SK, Cho CD, Wojtowycz AR. The ligament of Treitz (the suspensory ligament of the duodenum): anatomic and radiographic correlation. Abdom Imaging 2008;33:395–397.
17. Connolly EM, Gaffney E, Reynolds JV. Gastrointestinal stromal tumours. Br J Surg 2003;90:1178–1186.