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How I Do It

Solo Intracorporeal Esophagojejunostomy Reconstruction Using a Laparoscopic Scope Holder in Single-Port Laparoscopic Total Gastrectomy for Early Gastric Cancer

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Single-incision laparoscopic total gastrectomy for gastric cancer has recently been reported by Seoul National University Bundang Hospital. However, this is not a popular procedure primarily because of the technical difficulties involved in achieving consistent intracorporeal esophagojejunostomy. At Seoul National University Bundang Hospital, we recently introduced a simple, easy-to-use, low-profile laparoscopic manual scope holder that enables the maintenance of a stable field of view, the most demanding condition in single-port gastrectomy. In this technical report, we describe in detail the world's first solo single-incision laparoscopic total gastrectomy with D1+ lymph node dissection and intracorporeal esophagojejunostomy for proximal early gastric cancer.

Key Words: Stomach neoplasms; Solo surgery; Gastrectomy; Single port; Laparoscopy

Introduction

Recently, laparoscopic distal gastrectomy (LDG) became an acceptable treatment option for early-stage gastric cancer in Korea and Japan. Its short-term outcomes including improved cosmetic appearance, reduced postoperative pain, shorter hospital stay, and improved quality of life have been reported in various studies.[1,2] In addition, some retrospective studies reported comparable long-term survival outcomes between LDG and open distal gastrectomy.[3,4] Soon, randomized controlled trials comparing long-term outcomes between laparoscopic and open distal gastrectomy are expected to establish the oncologic feasibility of LDG.[5]

As laparoscopic devices and skills continue to develop, there have been reports of experienced surgeons using single-incision laparoscopic distal gastrectomy (SIDG) to treat early gastric cancer with the aim of reducing the invasiveness of LDG.[6-8] Despite the small number of cases, we previously reported that SIDG is both safe and feasible for treating early gastric cancer, with similar operation times and better short-term outcomes as compared to conventional LDG. A single-incision laparoscopic total gastrectomy (SITG) technique was also reported by Seoul National University Bundang Hospital in 2013.[9]

However, SITG is not as widely performed as SIDG for early gastric cancer, with only two published case reports to date.[10,11] The technical difficulty inherent in maintaining a stable field of view for an intracorporeal esophagojejunostomy is considered the primary reason for the lack of the technique's wider acceptance. Because of the limited field of view, the necessary special equipment, and the need for enhanced cooperation between the surgeon and scopist, single-port gastrectomy is more complex to perform than conventional laparoscopic surgery. At Seoul National University Bundang Hospital, we aimed to overcome these technical difficulties by recently introducing a simple, easy to use, low profile laparoscopic

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manual scope holder for use in single-port gastrectomy. We hypothesized that this scope holder would provide a field of view that was adequately stable for performing secure esophagojejunostomy using barbed sutures.

Here, we report the technical details of the world's first successful solo SITG with D1+ lymph node dissection (LND) and intracorporeal esophagojejunostomy performed using a laparoscopic scope holder and a barbed suture in four patients with proximal early gastric cancer.

Materials and Methods

1. Patients and clinical management

Between October 2013 and July 2013, four patients underwent solo SITG with D1+ LND at Seoul National University Bundang Hospital using a scope holder (Laparostat; CIVCO Medical Solutions, Kalona, IA, USA) without an assistant or scopist. Patient eligibility criteria were as follows: a preoperative diagnosis of stage I gastric cancer according to the American Joint Committee on Cancer staging manual, 7th edition, with no lymph node enlargement; an age between 20 and 80 years; no history of other malignancies; no previous chemotherapy or radiotherapy; and no severe comorbidities. This study was performed according to the ethical standards of the 1975 Declaration of Helsinki (revised in 1983) and approved by an institutional review board.

All procedures from skin incision to skin closure were performed by a single surgeon. Usually, the laparoscopic scope holder was exclusively manipulated and cleaned by the surgeon's right hand while the left hand's instrument was kept within the single port to maintain the surgical field. The surgical technique is described below. Patients were managed according to Seoul National University Bundang Hospital's critical protocols.

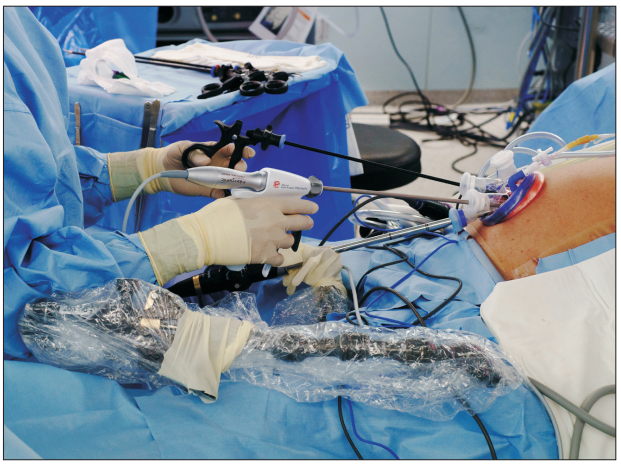

Fig. 1. Position and scope holder placement.

2. Surgical technique

1) Solo single-port laparoscopic total gastrectomy with D1+ lymph node dissection

Since we reported the details of SITG in a previous paper, the SITG with D1+ LND is described briefly here.[10] The only point of difference is that in the present case series, we used a laparoscopic scope holder (Laparostat) instead of a scopist (i.e., solo surgery). The patient was placed in the lithotomy position with reverse Trendelenburg positioning. However, the hip and knee joints were straightened and not bent so as not to limit the instruments' movements. The surgeon sat between the patient's legs. The scope holder was place on the left side rail of the operating table and covered by a sterile plastic bag (Fig. 1). This scope holder has a low profile, providing more working space for the surgeon with no interference between surgeon and scopist and with minimal clashes between the instruments and scope near the single port, which is in contrast to the conditions associated with additional human scope manipulation. A commercial 4-hole single port (Gloveport; Nelis, Bucheon, Korea) was inserted into a longitudinal 2.5-cm long transumbilical incision. The abdominal cavity was insufflated with carbon dioxide

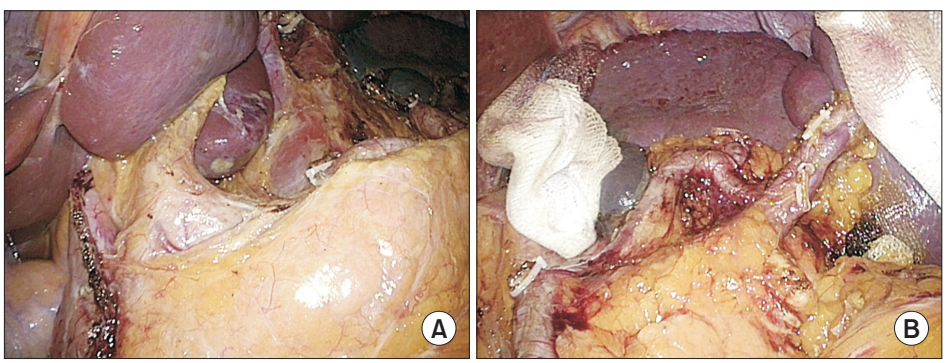

Fig. 2. Lymph node dissection in solo single-incision laparoscopic total gastrectomy. (A) The suprapancreatic area including lymph nodes #7, 8a, 9, 11p, and 12a. (B) The splenic hilum area including lymph nodes #10 and 11d.

at a pressure of 11 to 13 mmHg. No additional assistant port was used. No assistant or scopist was present in any of the surgeries. We used a 10-mm flexible high-definition laparoscopic scope (Endoeye flexible HD camera system; Olympus Medical Systems Corp., Tokyo, Japan) that was manipulated by the surgeon. The conventional laparoscopic grasper was used in nearly all procedures while the curved long grasper was used for single-port surgery (Olympus Medical System Corp.) when operating on the lesser curvature side, including suprapancreatic LND. We used a laparoscopic automatic linear stapler (I-drive 45 Purple and 60 Purple; Covidien, Min-

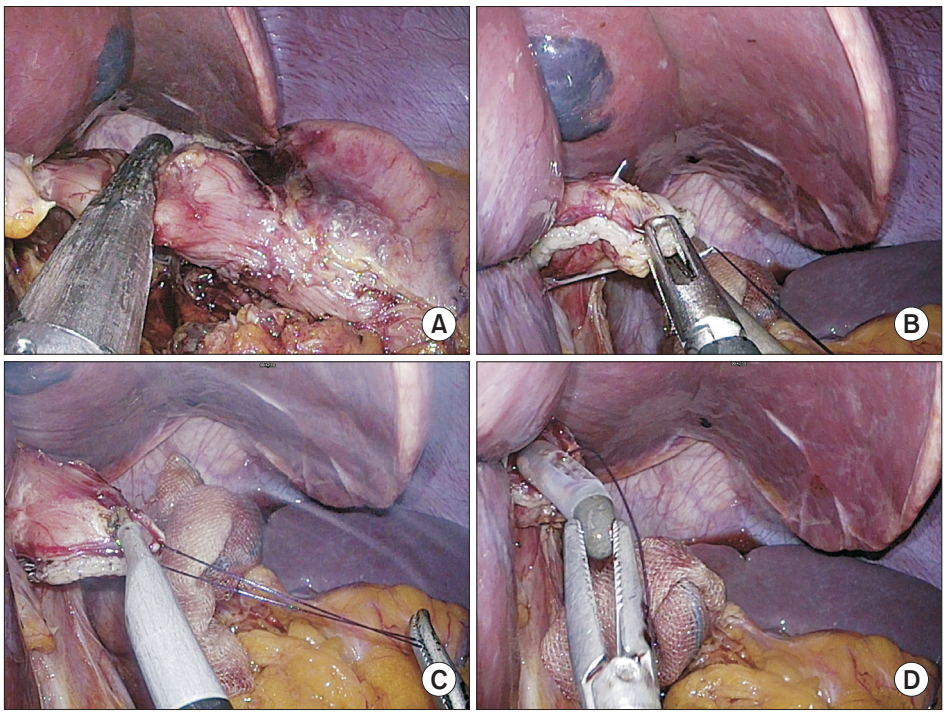

Fig. 3. Esophagus preparation. (A) Transection of the distal esophagus. (B) The stay suture at the mid-portion of the staple line. (C) The opening of the jejunum made using the hook in cutting mode. (D) Confirmation of the exact opening of the esophagus guided by a nasogastric tube.

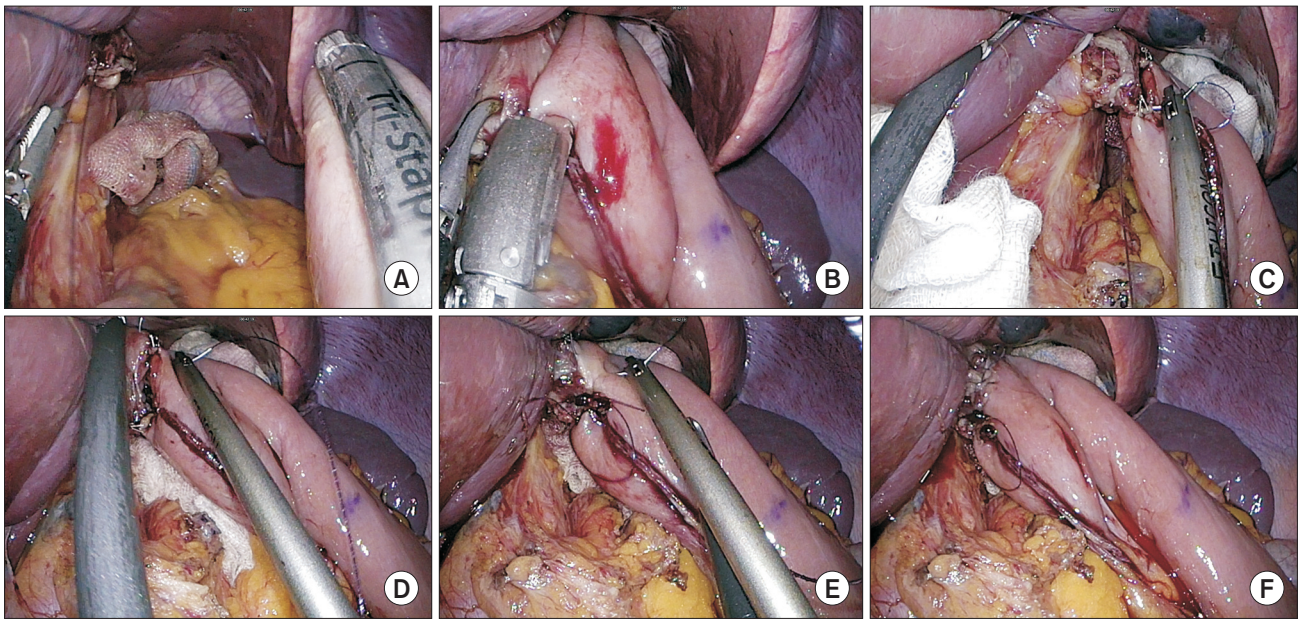

Fig. 4. Semi-loop esophagojejunostomy in solo single-incision laparoscopic total gastrectomy. (A) Inserting the stapler by pulling the jejunum. (B) Inserting the anvil side by pulling the stay suture or the esophagus. (C) A corner stay suture at the near side of the stapling site that can be used during suturing. (D) A barbed suture closure at the far side of the stapling site. (E) A seromuscular suture made using the same barbed thread. (F) Complete view of the solo semi-loop esophagojejunostomy.

neapolis, MN, USA). We performed routine total gastrectomy with D1+ LND (1; 2; 3; 4sa, sb, d; 5; 6; 7; 8a; 9; 11p, 11d; and 12a), including partial omentectomy (Fig. 2). After complete exposure of the esophagus by division of the anterior and posterior vagus nerves, the esophagus was transected using a linear stapler (Fig. 3A). The specimen was delivered through the single umbilical incision without any extension.

2) Solo modified semi-loop esophagojejunostomy (barbed suture closure)

After the specimen's proximal resection margin was examined histopathologically, we used semi-loop reconstruction to create an intracorporeal anastomosis after SITG. After a jejunal loop located approximately 20 cm distal to the Treitz ligament was transected by a linear stapler (I-drive 60 Tan; Covidien), a side-to-side jejunojejunostomy was created using the I-drive 45 Tan (Covidien) to construct a 40 to 45 cm Roux-en-Y limb. The common entry opening was then closed in double layers by barbed sutures (V-loc; Covidien). Next, the Roux-en-Y limb was brought up via the antecolic route to form an esophagojejunostomy. A stay suture made using 3-0 monofilament thread was passed from the anterior part of the mid-portion of the staple line and retracted through the single port. This traction suture is important for manipulating the esophagus (Fig. 3B). An esophageal opening was created at the mid-portion of the esophagus using the hook in cutting mode (Fig. 3C), which allowed for easy access to the esophageal lumen with nasogastric tube guidance (Fig. 3D). The opening of the jejunum was created in a similar manner using the hook in cutting mode.

First, the stapler side of a linear stapler was inserted into the jejunal opening with a motion similar to that of pulling up socks; the stapler side could then easily enter the jejunum without separate human assistance. The jaw of the linear stapler was partially closed to prevent the jejunum slipping from the stapler (Fig. 4A). The anvil side of the linear stapler was finally inserted into the opening in the esophagus while the traction suture was controlled with the grasper. By maintaining friction between the two serosal surfaces, it is possible to pull either the esophagus or jejunum using the grasper to adjust the length as needed. In general, a first stapling with a 3-cm length is adequate for preventing stenosis (Fig. 4B).

After firing the stapler, we checked for bleeding along the stapling line and lumen. The common entry opening was closed with a 23-cm barbed suture (3-0 V-Loc suture on a V-20 needle; Covidien). Before starting the V-Loc suture, one stay suture was placed on the corner of the near side of the staple site; this stay suture was used to visualize the blind corner while the common entry opening was sutured (Fig. 4C). Using 23-cm 3-0 V-Loc sutures for both layers, a full-thickness inner layer closure was made proceeding from the corner of the far side of the staple site to the near side using a continuous technique (Fig. 4D). Once the full-thickness layer was completed, the second seromuscular layer was closed by returning to the far side corner using the same barbed suture (Fig. 4E). After the last stitch was made, the suture was simply cut without any knots or additional sutures (Fig. 4F). At this point, a flexible scope with a laparoscopic scope holder provided a stable field of view for carrying out intracorporeal suturing. This is normally a difficult task because even a scopist's minute tremors are maximized due to the leverage effect along with trembling caused by the movements of the heart and diaphragm. In this case, the suturing of the common entry opening could be accomplished without much difficulty in the stable field of view provided by the laparoscopic scope holder. The intracorporeal esophagojejunostomy was then complete.

Results

At Seoul National University Bundang Hospital, solo SITG with D1+ LND using a laparoscopic scope holder has thus far been performed for four patients with clinical stage I gastric cancer. The patients' demographic characteristics and operative data are described in Table 1. No intraoperative events occurred (conversion to conventional laparoscopy or open gastrectomy, uncontrolled bleeding, unexpected injury to the adjacent organ, or surgery-related complications). The mean operation time was 206.3±11.1 minites

Table 1. Patient demographics and clinical characteristics

Variable	Solo SITG with D1+ LND (n=4)
Age (yr)	56.5±9.0 (51~70)
Sex (male:female)	4:0
Body mass index (kg/m^2)	26.2±2.6 (24.1~29.9)
Comorbidity	3 (75.0)
Previous abdominal operation	0 (0)
ASA grade	
1	1
2	3

Values are presented as mean±standard deviation (range), number only, or number (%). SITG = single-incision laparoscopic total gastrectomy; LND = lymph node dissection; ASA = American Society of Anaesthiologist grade.

Table 2. Operative data and postoperative outcomes

Variable	Solo SITG with D1+ LND (n=4)
Operation time (min)	206.3±11.1 (190~215)
Laparoscopy or open conversion	0 (0)
Estimated blood loss (ml)	53.8±57.8 (5~100)
Postoperative hospital stay (d)	9.0±3.2 (6~13)
No. of retrieved lymph nodes	55.5±13.2 (38~68)
Early complications	1 (25.0)
Late complications	0 (0)
Re-operation	0 (0)
Postoperative mortality	0 (0)

Values are presented as mean±standard deviation (range) or number (%). SITG = single-incision laparoscopic total gastrectomy; LND = lymph node dissection.

(range, 190~215 minutes). The mean estimated blood loss was 53.8 ±57.8 ml (range, 5~100 ml). The total number of retrieved lymph nodes was 55.5±13.2 (range, 38~68).

Postoperatively, all patients recovered rapidly. They tolerated the consumption of a semi-fluid diet on the third postoperative day and a soft blended diet on the fourth postoperative day. Postoperative cholangitis was the only early postoperative complication, occurring in a 51-year-old man who had common bile duct stones; his condition improved following percutaneous transhepatic biliary drainage. The mean postoperative hospital stay duration was 9.0±3.2 days (range, 6~13 days) (Table 2).

Discussion

Here, we described the world's first solo semi-loop intracorporeal esophagojejunostomy performed using a manual scope holder without any assistance. Our findings demonstrate that with the use of a scope holder, intracorporeal semi-loop esophagojejunostomy after SITG is technically feasible as a solo surgery that offers a more stable field of view than a procedure performed with human scope assistance. In addition, barbed suture closure of the common entry opening after linear stapling can also be performed for other types of bowel anastomosis without separate assistance.

In single-incision laparoscopic gastrectomy, team cooperation is crucial since the surgeon's laparoscopic field of view is highly limited and is manipulated by an assistant. Any mismatch or miscommunication between the surgeon and the assistant(s) causes stress with consequent operative risk.[12]

The concept of solo surgery-frequently discussed over the past 30 years-is a potential solution to this problem that offers various advantages including enhanced precision, enhanced ergonomics, and reduced health costs via reduction in the required human resources. Over the past 30 years, many trials, including randomized controlled trials, evaluated the feasibilities of different camera-holding systems.[13] However, such solo systems have yet to be implemented into general clinical practice, and most of these camera-holding systems have already disappeared from the market. Moreover according to some authors, such solo surgery is associated with loss of comfort and limitations in practice and application, with only marginal resource benefits.

Various camera and instrument holders have been described in the literature. It is recognized that compared with human assistance, using a camera holder in laparoscopic surgery provides an optimal and stable image of the operation field. Control of the laparoscope by the surgeon is also generally considered superior to control accomplished with a scopist's assistance. Aiono et al.[14] concluded that there was no difference in these respects between passive and active (robotic) camera holders; however, the benefits of active holders are questionable in relation to the performance of the much simpler passive designs, which can be repositioned with one hand.

Even with five ports, laparoscopic total gastrectomy is a technically demanding procedure because of the difficulty of performing esophagojejunostomy solely via laparoscopy.[15-17] Among the various types of laparoscopic total gastrectomy techniques described thus far, SITG is considered the most technically demanding procedure. In 2013, we published the first technical report describing SITG .[10] However, we recognize that it is not a comfortable procedure, mainly due to the difficulty inherent in performing continuous intracorporeal esophagojejunostomy via a single port. This difficulty results from an unstable field of view, which can occur when the scope is manipulated by a scopist. Typically, the instruments around the single port tend to clash, and narrow areas of movement lead to physical bumping between the surgeon and scopist.

At Seoul National University Bundang Hospital, we aimed to overcome these technical difficulties by recently introducing a simple, easy to use, low profile laparoscopic manual scope holder for use in single-port gastrectomy. This can provide the surgeon with a greater degree of freedom of movement in the narrow workspace (between the patient's legs) along with a more stable field of view, which allows for precise dissection and suturing. When the scope holder (Laparostat) is used as described in this report, the surgeon must manually reposition the camera or instrument. Consequently,

the surgeon has to release one or more laparoscopic instruments in order to reposition the camera or instrument. At first glance, this may appear inconvenient; however, using one hand (the dominant one) to reposition the camera and release an instrument is not an important limitation because the surgeon never dissects when the camera requires repositioning. Thus, a passive scope holder is expected to be more efficient and economical in such situations.

Based on our experience, we found that the Laparostat could be used in clinical practice for single-port surgery; furthermore, its usage could also be extended to conventional laparoscopic surgery. The handling of the scope holder by the surgeon proved to be a skill that was easy to acquire and did not prolong the operation time. In addition, with solo surgery, manpower resources can be reduced significantly. The per-operation cost of a scope holder is estimated to be United States dollar (USD) 10 to 20 after the initial purchase (USD 8,000 for the Laparostat). Finally, solo surgery performed using a laparoscopic holder would allow an experienced surgeon to operate at any time, independent of the scheduling requirements of other staff such as assistants and scopists. However, it would not be easy to react quickly in the event of bleeding, and there is a possibility of greater surgeon fatigue consequent to the solo execution of all procedures from skin incision to closure.

This technical report demonstrates the feasibility of solo intracorporeal esophagojejunostomy and solo SITG. However, further experience from other surgeons and planned, well-designed studies are required to confirm the safety and feasibility of this technique.

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References

1. Kim HH, Hyung WJ, Cho GS, Kim MC, Han SU, Kim W, et al. Morbidity and mortality of laparoscopic gastrectomy versus open gastrectomy for gastric cancer: an interim report: a phase III multicenter, prospective, randomized Trial (KLASS Trial). Ann Surg 2010;251:417-420.
2. Kim YW, Baik YH, Yun YH, Nam BH, Kim DH, Choi IJ, et al. Improved quality of life outcomes after laparoscopy-assisted distal gastrectomy for early gastric cancer: results of a prospective randomized clinical trial. Ann Surg 2008;248:721-727.
3. Kim HH, Han SU, Kim MC, Hyung WJ, Kim W, Lee HJ, et al. Long-term results of laparoscopic gastrectomy for gastric cancer: a large-scale case-control and case-matched Korean multicenter study. J Clin Oncol 2014;32:627-633.
4. Hwang SH, Park do J, Jee YS, Kim MC, Kim HH, Lee HJ, et al. Actual 3-year survival after laparoscopy-assisted gastrectomy for gastric cancer. Arch Surg 2009;144:559-564.
5. Kim HH, Han SU, Kim MC, Hyung WJ, Kim W, Lee HJ, et al. Prospective randomized controlled trial (phase III) to comparing laparoscopic distal gastrectomy with open distal gastrectomy for gastric adenocarcinoma (KLASS 01). J Korean Surg Soc 2013;84:123-130.
6. Ahn SH, Son SY, Lee CM, Jung do H, Park do J, Kim HH. Intracorporeal uncut Roux-en-Y gastrojejunostomy reconstruction in pure single-incision laparoscopic distal gastrectomy for early gastric cancer: unaided stapling closure. J Am Coll Surg 2014;218:e17-e21.
7. Park do J, Lee JH, Ahn SH, Eng AK, Kim HH. Single-port laparoscopic distal gastrectomy with D1+β lymph node dissection for gastric cancers: report of 2 cases. Surg Laparosc Endosc Percutan Tech 2012;22:e214-e216.
8. Omori T, Oyama T, Akamatsu H, Tori M, Ueshima S, Nishida T. Transumbilical single-incision laparoscopic distal gastrectomy for early gastric cancer. Surg Endosc 2011;25:2400-2404.
9. Ahn SH, Son SY, Jung do H, Park do J, Kim HH. Pure single-port laparoscopic distal gastrectomy for early gastric cancer: comparative study with multi-port laparoscopic distal gastrectomy. J Am Coll Surg 2014;219:933-943.
10. Ahn SH, Park do J, Son SY, Lee CM, Kim HH. Single-incision laparoscopic total gastrectomy with D1+beta lymph node dissection for proximal early gastric cancer. Gastric Cancer 2014;17:392-396.
11. Ertem M, Ozveri E, Gok H, Ozben V. Single incision laparoscopic total gastrectomy and d2 lymph node dissection for gastric cancer using a four-access single port: the first experience. Case Rep Surg 2013;2013:504549.
12. Yoshino I, Yasunaga T, Hashizume M, Maehara Y. A novel endoscope manipulator, Naviot, enables solo-surgery to be performed during video-assisted thoracic surgery. Interact Cardiovasc Thorac Surg 2005;4:404-405.

13. Stolzenburg JU, Franz T, Kallidonis P, Minh D, Dietel A, Hicks J, et al. Comparison of the FreeHand® robotic camera holder with human assistants during endoscopic extraperitoneal radical prostatectomy. BJU Int 2011;107:970-974.
14. Aiono S, Gilbert JM, Soin B, Finlay PA, Gordan A. Controlled trial of the introduction of a robotic camera assistant (EndoAssist) for laparoscopic cholecystectomy. Surg Endosc 2002;16:1267-1270.
15. Kawamura Y, Satoh S, Suda K, Ishida Y, Kanaya S, Uyama I. Critical factors that influence the early outcome of laparoscopic total gastrectomy. Gastric Cancer 2014; doi: 10.1007/s10120/014/0392/9 [epub].
16. Okabe H, Tsunoda S, Tanaka E, Hisamori S, Kawada H, Sakai Y. Is laparoscopic total gastrectomy a safe operation? A review of various anastomotic techniques and their outcomes. Surg Today 2015;45:549-558.
17. Kim HH, Ahn SH. The current status and future perspectives of laparoscopic surgery for gastric cancer. J Korean Surg Soc 2011;81:151-162.