Original Article

A new contrivance of single port and reduced port gastrectomy for gastric cancer

Takashi Urushihara[1,2], Noriaki Tokumoto[1], Yuji Takakura[1], Akihiko Oshita[1,2], Satoshi Ikeda[1], Yasuhiro Matsugu[1], Hideki Nakahara[1], Toshiyuki Itamoto[1,2]

[1]Department of Gastroenterological, Breast and Transplant Surgery, Hiroshima Prefectural Hospital, Hiroshima, Japan; [2]Department of Gastroenterological and Transplant Surgery, Applied Life Science, Institute of Biomedical and Health Science, Hiroshima University of Medicine, Hiroshima, Japan

Contributions: (I) Conception and design: T Urushihara; (II) Administrative support: None; (III) Provision of study materials or patients: None; (IV) Collection and assembly of data: N Tokumoto, Y Takakura, A Oshita, S Ikeda, Y Matsugu, H Nakahara, T Itamoto; (V) Data analysis and interpretation: All authors; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Takashi Urushihara. Department of Gastroenterological, Breast and Transplant Surgery, Hiroshima Prefectural Hospital, 5-54, 1-chome, Ujinakanda, Minami-ku, Hiroshima 734-8530, Japan. Email: t-urushiha@hph.pref.hiroshima.jp.

Background: Single-port laparoscopic gastrectomy (SPG) and reduced-port laparoscopic gastrectomy (RPG) are favorably accepted by patients with early gastric cancer because of less pain, early recovery time, and improving quality of life. However, performing SPG or RPG has some technical difficulties. This article focuses on the contrivance of SPG and RPG with operation technique and on the advantages of the combination of pneumoperitoneum and abdominal wall-lift method.

Methods: Ninety-five patients with preoperative stage IA gastric cancer underwent SPG and RPG with D1+ lymphadenectomy between April 2005 and May 2016 at Hiroshima Prefectural Hospital. Thirty patients underwent SPG, and 65 underwent RPG.

Results: No significant differences in amount of blood loss [10–357 (mean: 67) *vs.* 4–470 (mean: 63) mg, P=0.591] and operation time [218–471 (mean: 323) *vs.* 238–467 (mean: 320) min, P=0.595] were found between the SPG and RPG groups. No significant differences were also between the two groups in terms of post-operative complication and cosmetic results.

Conclusions: SPG was safety performed with our special surgical technique, and RPG was safety and easily performed with the wide working space provided by the combination of pneumoperitoneum and abdominal wall lifting method.

Keywords: Reduced port; single port; abdominal wall-lift method; laparoscopic gastrectomy; X-technique

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Introduction

The recent development of laparoscopic surgery includes the introduction of single-port laparoscopic surgery. However, various single-port operations are difficult for laparoscopic surgeons to perform because of conflict of some instruments and the laparoscope. Moreover, single-port laparoscopic surgery reduces postoperative pain and has advantages of cosmetic merit (1-3).

To overcome the difficulty from the conflict of some instruments and camera in single-port laparoscopic gastrectomy (SPG), we used special access platform and created the surgical techniques. Moreover, additional ports were inserted for optimal surgical manipulation in reduced-port laparoscopic gastrectomy (RPG). We had used the combination method of pneumoperitoneum and abdominal wall lifting (4,5) to secure the visual field and obtain the proper angle for manipulation in RPG. RPG is favorably accepted by patients with early gastric cancer because the

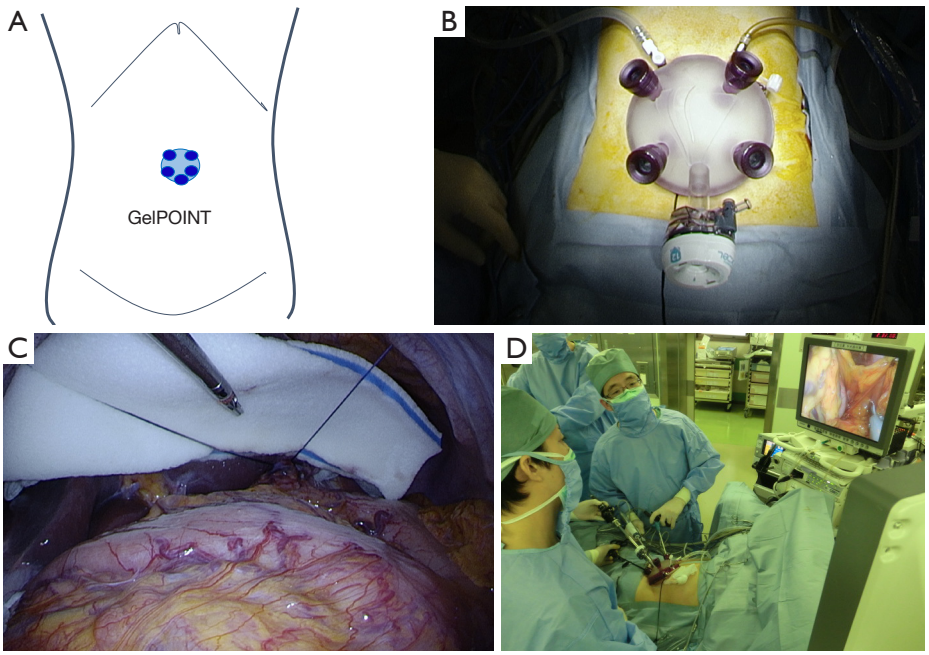

Figure 1 Setting of platform and liver retractor in SPG. (A) Set up with an operation theater for SPG, 3.5 cm umbilical vertical skin incision and fasciotomy were made into the peritoneal cavity; (B) a multi-channel platform was set up through the umbilical incision; (C) a water expanding sponge was retracted left lobe of the liver; (D) a surgeon stands on the right side of patient and perform the operation using straight instrument through a multi-channel platform. SPG, single-port gastrectomy.

postoperative pain and recovery time are similar with those in conventional laparoscopic gastrectomy (6,7). In this study, we assessed that safety of SPG and RPG performed with our special surgical technique and estimated with benefits of combination of pneumoperitoneum and abdominal wall-lift method.

Methods

Ninety-five patients with preoperative stage IA gastric cancer underwent SPG and RPG with D1+ lymphadenectomy between April 2005 and May 2016 at Hiroshima Prefectural Hospital. All the patients were classified in accordance with the TNM criteria for gastric cancer (8). Thirty patients underwent SPG, and 65 patients underwent RPG.

The surgical procedure

In the operation theater, the patients received general anesthesia and placed in the supine position. The surgeon stood on the right side; the assistant, on the left side; and the camera operator, between the patient's legs. In SPG, a 3.5 cm umbilical vertical skin incision and fasciotomy were performed on the peritoneal cavity. A multi-channel access platform (GelPOINT; Applied Medical, Rancho Santa Margarita, CA, USA) was set up through the umbilical incision (*Figure 1A*). A multi-channel access platform was created by attaching four 10-mm trocars and a 12-mm trocar. A flexible laparoscope was introduced through the 12-mm trocar (*Figure 1B*). Thereafter, pneumoperitoneum of 8-mmHg pressure was established. A water expanding sponge (Endoractor; Kawamoto, Osaka, Japan) was introduced into the abdominal cavity from the umbilical incision and placed under the left lobe of the liver. A straight needle with 2-0 nylon thread was introduced via a percutaneous puncture through the right tendon of the diaphragm and withdrawn percutaneously and by extracorporeal ligation (*Figure 1C*).

The surgeon dissected the left side of the greater omentum, and the left gastroepiploic artery and vein were isolated and divided (*Figure 1D*).

In SPG, manipulation of the tissue is sometimes difficult because of lack of appropriate triangulation (*Figure 2A*). Therefore, we developed the X-technique by using two straight laparoscopic instruments across through the multi-channel access platform. *Figure 2B* shows the X-technique,

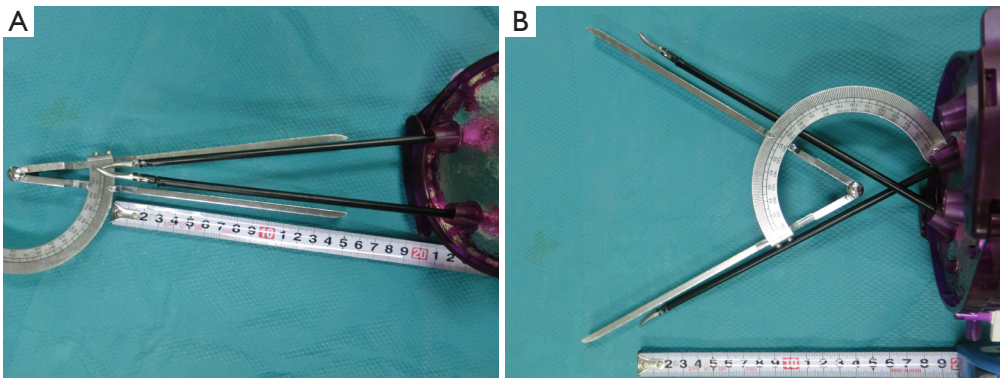

Figure 2 Formation of triangulation. (A) In SPG, it is sometimes difficult to manipulate the tissue, because of lack of appropriate triangulation; (B) X-technique, using two straight laparoscopic instruments across through the multi-channel access platform. SPG, single-port gastrectomy.

Figure 3 X-technique, in which two straight forceps are crossed over through the platform to make a reverse triangulation (9). Excursion of the operation spreads out, when I knot the thread with two forceps in the access platform and operate right and left to the opposite direction in box trainer. The X-technique provides an optimal countertraction of the target and a moving wide angle. Available online: http://www.asvide.com/articles/1464

which involves reverse triangulation by using two straight instruments (*Figure 3*).

In RPG, an abdominal wall-lifting retractor is set up on the left side of the operation table. A 1.2-mm-long Kirschner wire was inserted in the subcutaneous tissue of the upper umbilicus lesion. An additional 3-mm trocar for the surgeon and 3- and 5-mm (or 12-mm) trocars for the assistant were inserted for optimal surgical manipulation.

Abdominal wall lifting can provide a wider intra-abdominal operative field with 8 mmHg of pressure in the pneumoperitoneum (*Figure 4A*). Passage of several instruments and a flexible scope was possible through three trocars via the multi-access platform with the combination of 8-mmHg pneumoperitoneum and the abdominal wall-lift method, which could provide a 30° proper angle and a wide visual field (*Figures 4B,5*).

The greater omentum was dissected by using combined laparoscopic ultrasonic coagulating and bipolar sealing shears (Thunderbeat; Olympus Optical, Tokyo, Japan) or laparoscopic ultrasonic coagulating sears (Harmonic A+; Ethicon Endosurgery, Cincinnati, USA) from the left to the right side. For one of the station of lymphadenectomy, the right gastroepiploic vein was isolated and divided (*Figure 6*). The right gastroepiploic artery was ligated with an endoclip applicator (5-mm Liga Clip; Ethicon Endosurgery, Cincinnati, USA) and divided with No. 6 lymphadenectomy. The right gastric artery was clipped and divided with No. 5 lymphadenectomy. Next, lymph node dissection of the suprapancreatic area was performed with the medial approach (*Figures 7,8*).

Gastrectomy was performed by using an endolinear stapler (60-mm Powered Echelon Flex; Ethicon Endosurgery Co., Ltd., USA). Reconstruction was performed with functional end-to-end anastomosis; gastroduodenostomy, with the Billroth-I method (*Figure 9*); gastrojejunostomy with Roux-Y after distal gastrectomy (DG); gastrogastrostomy with pylorus-preserving gastrectomy (PPG) and esophagojejunostomy, with total gastrectomy (TG).

Statistical analysis

Continuous data were expressed as mean ± SD. The

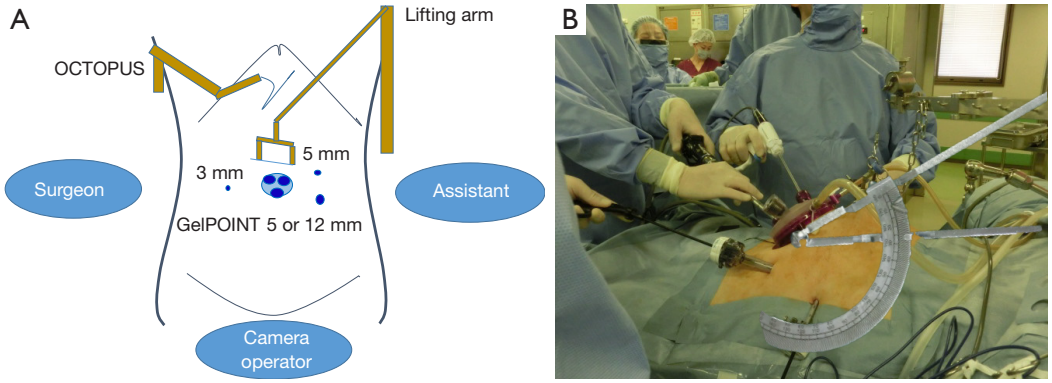

Figure 4 Setting of platform, trocars and liver retractor in RPG. (A) Set up with operation theater for RPG. An abdominal wall lifting retractor is set up on the left side of the operation table. A 1.2-mm long Kirschner wire is inserted into subcutaneous of the upper umbilicus lesion. A 3-mm puncture was made at the right lateral side of abdomen and two additional trocars were used; (B) abdominal wall lifting could provide a cephalad elevation of 30° of a multi-channel platform. RPG, reduced-port gastrectomy.

Figure 5 Set up of a multi-channel platform and abdominal wall lifting, and lymphadenectomy of No. 4sb, No. 6 and No. 5 in RPG (10). A 3.5 cm umbilical vertical skin incision and fasciotomy were performed on the peritoneal cavity. A multi-channel access platform was set up through the umbilical incision. A 1.2-mm-long Kirschner wire was inserted in the subcutaneous tissue of the upper umbilicus lesion. The greater omentum was dissected by using combined laparoscopic ultrasonic coagulating and bipolar sealing shears. The left gastroepiploic vein and artery were isolated and divided with No. 4sb lymphadenectomy. Thereafter, the right gastroepiploic vein was isolated and divided. The right gastroepiploic artery was ligated with an endoclip applicator and divided with No. 6 lymphadenectomy. The right gastric artery was clipped and divided with No. 5 lymphadenectomy. RPG, reduced-port gastrectomy.
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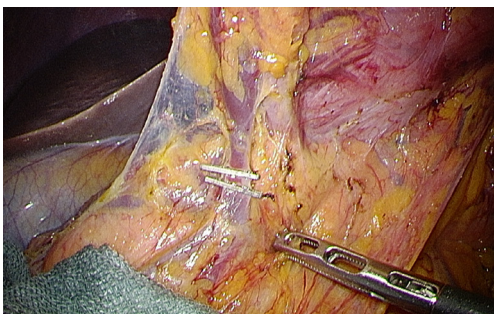

Figure 6 Lymphadenectomy of No. 6 station. Right gastroepiploic vein was clipped.

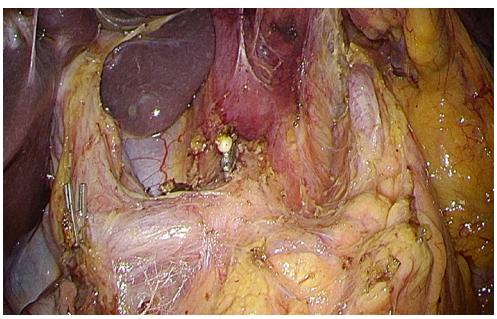

Figure 7 After supra pancreatic lymphadenectomy.

Figure 8 Lymph node dissection of the suprapancreatic area was performed with the medial approach (11). After the lesser omentum was dissected, the surgeon identified the crus of diaphragm from the right side to the left side at the lateral side of the esophagus. After the assistant's right hand grasped the pedicle of the left gastric artery and vein and the assistant's left hand grasped the nerve around the common hepatic artery, the surgeon isolated, clipped and divided the left gastric vein. The left gastric artery was isolated surround the tissue, clipped and divided in the same manner as in conventional laparoscopic gastrectomy. Thereafter, the lymph nodes along the common hepatic artery and the celiac artery were dissected by using combined laparoscopic ultrasonic coagulating and bipolar sealing shears. In this video, the lymph nodes along the proper artery and the splenic artery were also dissected over surface of the neural layer.
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Figure 9 Reconstruction was performed with functional end-to-end anastomosis; gastroduodenostomy, with the Billroth-I method by using an endolinear stapler (12). A 60-mm endolinear stapler was inserted into the gastric and duodenal stumps via the 12-mm port within access platform. After the posterior walls of the remnant stomach and the duodenum were put together, the endolinear stapler was closed over 50-mm and fired. The stapler entry hole was temporarily sutured with three stiches and closed with 2 times of 60-mm endolinear stapler.
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statistical analyses were performed with the JMP 13.0 software (SAS Institute Inc., Cary, USA). Data comparison was performed by using Fisher and Student's *t*-tests. Statistical significance was established at $P<0.05$.

Results

The characteristics of the 95 patients are summarized in *Table 1*. The surgical results of the 95 patients are summarized in *Table 2*.

No significant differences in amount of blood loss [10–357 (mean: 67) *vs.* 4–470 (mean: 63) mg, P=0.591] and operation time [218–471 (mean: 323) and 238–467 (mean: 320) min, P=0.595] were found between the SPG and RPG groups. Intra-abdominal abscess occurred in one patient (3.3%) in the SPG group.

Anastomotic bleeding and leakage of duodenal stump occurred in 2 patients (3.1%) in the RPG group. Conversion to open surgery was not necessary in all the cases. All the patients who underwent SPG and RPG successfully were satisfied because of the less pain and cosmetic operation scar (*Figure 10A*: after SPG, *Figure 10B*: after RPG).

Discussion

Laparoscopic-assisted distal gastrectomy (LADG) was first performed by Kitano *et al.* in 1994 with the abdominal wall-lift method by using U-shaped retractor elevation (13). The usefulness of LADG for patients with early gastric cancer was investigated because it was associated with less surgical trauma, less pain and rapid return to normal activity without decrease in surgical curability (14). Patients who underwent LADG had better quality of life than those who underwent open DG (15). As we previously reported (16), laparoscopic-assisted PPG was indicated for patients with cancer in the middle third of the stomach. Single-incision laparoscopic gastrectomy was first reported by Omori *et al.* in 2011 (17). SPG is difficult for many laparoscopic surgeons to perform because of conflict of some instrument and the laparoscope. Therefore, surgical techniques should be considered for performing SPG when conflict of the endoscopic forceps, energy device, and flexible endoscopy is expected. In many procedures in single-port surgery, handling the forceps and the camera without clashing is difficult. Owing to the loss of

Table 1 Characteristics of SPG and RPG

Characteristics	SPG group (n=30) (%)	RPG group (n=65) (%)	P value
Age (years)			0.887
Range	49–90	42–93	
Mean	69.4	66.3	
Gender, n (%)			
Male	11 (36.7)	45 (69.2)	
Female	19 (63.3)	20 (30.8)	0.0036
Platform	GelPOINT	GelPOINT: +3 mm, +5 mm (+12 mm)	
Type of operation	B-I: 11; DG-RY: 6; PPG: 13	B-I: 26; DG-RY: 15; PPG: 15; PG: 1; TGRY: 9	

SPG, single port laparoscopic gastrectomy; RPG, reduced port laparoscopic gastrectomy.

Table 2 Result of SPG and RPG

Variables	SPG (n=30)	RPG (n=65)	P value
Operation time [mean], min	218–471 [323]	238–467 [320]	0.595
Blood loss [mean], g	10–357 [67]	4–470 [63]	0.591
Complication, Clavien Dindo < III	Intra-abdominal abscess: 1	Anastomotic bleeding: 1; leakage of duodenal stump: 1	

SPG, single port laparoscopic gastrectomy; RPG, reduced port laparoscopic gastrectomy.

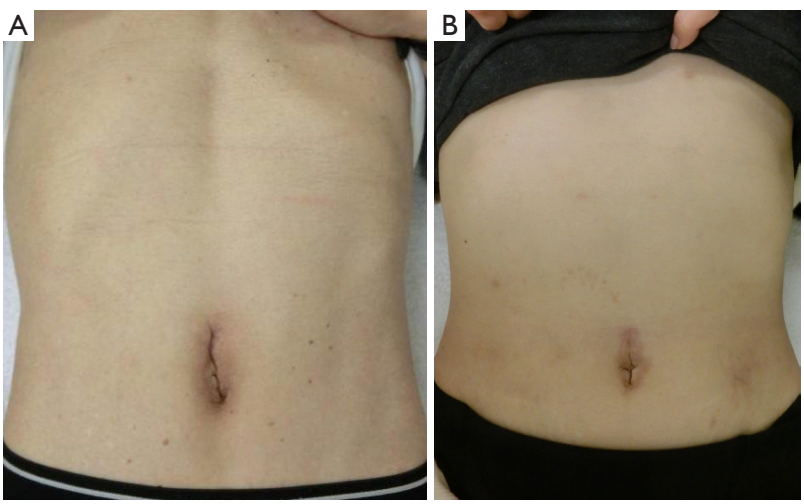

Figure 10 A postoperative scar after SPG (A) and RPG (B). Operative incisions are almost hidden within the natural umbilical scar. Both approaches have equal cosmetic result. SPG, single port laparoscopic gastrectomy; RPG, reduced port laparoscopic gastrectomy.

triangulation by parallel entry of the two instruments used by the surgeon, the operation becomes more difficult to perform than conventional laparoscopic surgery. Articulated or curved instruments were developed for single-port surgery, but a crossover setting is still necessary (18). While surgical outcomes depend on the surgeon's skill in single-port laparoscopic surgery, the surgeon's effort is needed to improve the technique. Parallel movement in the same direction limit the movement range and is more difficult to manipulate. On the other hand, fulcrum movement allows

instruments to diverge from the target point. Without switching hands, we used the chopstick effect to switch between the right and left sides.

Therefore, we developed a technique called the X-technique, in which two endoscopic conventional straight forceps or energy device was crossed over through the platform to make a reverse triangulation. The X-technique provides an optimal countertraction of the target tissue and a moving wide angle without using articulated or curved instruments. We performed SPG safety by using the X-technique.

By contrast, the choice of RPG is reasonable from the standpoint of patient safety.

An additional 3-mm trocar by the surgeon and 3- and 5-mm (or 12-mm) trocars by the assistant were inserted for optimal surgical manipulation without hesitation. In addition, we acquired a wide workspace and elevated the cranial side by additional abdominal wall lifting. Cranial elevation of the platform enabled us to manipulate the tissue owing to the smooth manipulation of the instruments with proper manipulation angle.

In this study, we assessed the safety of performing RPG with additional trocars and workspace provided by the combination of pneumoperitoneum and abdominal wall-lift method. Based on our retrospective study, no significant difference was found between SPG and RPG. The choice between SPG and RPG by the patient should be made with consideration of patient safety. RPG offers less invasiveness and cosmetic advantage for patients with early gastric cancer.

Conclusions

SPG was safely and feasibly performed with our special surgical technique, and RPG was safely and easily performed in the wide working space provided by the combination of pneumoperitoneum and abdominal wall-lift method in the patients with early gastric cancer.

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Footnote

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/ales.2017.02.20). The series "Advancement of Single-port, Reduced-port Laparoscopic Gastrectomy for Gastric Cancer" was commissioned by the editorial office without any funding or sponsorship. The authors have no other conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Written informed consent was obtained from the patient for publication of this manuscript and any accompanying images. Institutional ethical approval was waived due to the retrospective nature of the study.

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