Laparoscopic proximal gastrectomy with hinged double flap method using knotless barbed absorbable sutures: A case series

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**A B S T R A C T**

BACKGROUND: Intracorporeal reconstruction following laparoscopic proximal gastrectomy is technically challenging. The aim of this study was to investigate the use of knotless barbed absorbable sutures in esophagogastrostomy closure using the hinged double flap method.

**METHOD:** The subjects comprised patients with gastric cancer who were scheduled to undergo laparoscopic proximal gastrectomy. The V-Loc™ 180 wound closure device (V-Loc; Covidien, Mansfield, MA, USA) was used for all laparoscopic esophagogastrostomy closures. Between January 2015 and November 2016, 13 patients were enrolled.

**RESULTS:** The mean suturing time was 109.6 min. Median hospital stay was 14 days. One anastomotic minor leakage occurred in an esophagogastrostomy and it was managed conservatively. Twelve of 13 patients did not exhibit any symptoms of reflux esophagitis.

**CONCLUSION:** These results suggest the use of the unidirectional barbed absorbable suture is safe and produce reproducible results for esophagogastrostomy closure using the hinged double flap method.

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1. Introduction

Several reconstruction methods to be used following proximal gastrectomy already exist, however, ideal reconstruction techniques have not been established [1–3]. Double-tract reconstruction after proximal gastrectomy results in excellent postoperative outcomes in terms of preventing reflux symptoms, though it is technically complicated because of the formation of three anastomoses and due to the fact that the passage of food is non-physiological [3,4]. In contrast, esophagogastrostomy is simpler because of the need for only one anastomosis and the allowance of easy postoperative endoscopic surveillance. In most cases, this makes esophagogastrostomy the optimal reconstruction method following proximal gastrectomy, except in patients with complications like reflux esophagitis and anastomotic stricture.

To overcome these drawbacks of esophagogastrostomy following proximal gastrectomy, the hinged double flap method (i.e., Kamikawa’s procedure) has been used in patients with an upper early gastric cancer [3,5,6]. However, in most of these instances, the cumbersome multiple anastomoses of intracorporeal hinged double flap method required advanced techniques in laparoscopic surgery. Thus, we modified this method to develop a new laparoscopic procedure that uses the V-Loc™ Absorbable Wound Closure Device (V-Loc; Covidien, Mansfield, MA, USA). This report demonstrates a novel technique of intracorporeal proximal gastrectomy performed with the hinged double flap method using knotless barbed absorbable sutures, and the short-term clinical outcomes of the patients who underwent this procedure at our institution. This work has been reported in line with the PROCESS criteria [7].

2. Patients and methods

Thirteen patients (10 males and three females) underwent proximal gastrectomy at our institution, between January 2015 and November 2016. All patients were preoperatively diagnosed with early gastric cancer using preoperative diagnostic evaluation including gastrointestinal endoscopy, an upper gastrointestinal series, a computed tomography scan, and an endoscopic ultrasound. Tumor stage was classified according to the seventh edition of the International Union against Cancer tumor–node–metastasis staging system for gastric cancer, while the lymph node stations were numbered according to the definitions of the Japanese Gastric Cancer Association [8]. The surgical complications were classified according to the Clavien-Dindo classification [9]. Endoscopic

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assessments of esophagitis were recorded using the Los Angeles classification [10].

3. Surgical procedures

Muraoka et al. [3] previously discussed laparoscopic proximal gastrectomy with hinged double flap method. Here, we present a modified hinged double flap method in laparoscopic proximal gastrectomy. The distal cut end of the stomach was sealed off using a linear stapler and the remnant stomach was brought out of the abdomen through the extended umbilical port for making “double-door” seromuscular flaps. A sideways H-shaped incision (3.5 cm height × 2.5 cm width) was conducted 3 cm to 4 cm below the tip of the remnant stomach under direct vision. Muscular layer was carefully detached from the submucosal layer to create the “double flap”, and the bottom of the muco-submucosal layer was opened.

Fig. 1. Intraoperative view during the esophagogastrostomy.

a) The esophagogastrostomy of the posterior wall. b) Continuous sutures were used for layer-layer suturing on the closure of anterior wall. c) Anastomosis was covered by seromuscular flaps. d) The view of completed anastomosis with the hinged double flaps.

E: esophagus, Fl; flap, St; the remnant stomach.
Table 1

| Case | Age (years) | Gender | ECOG-PS | BMI (kg/m²) | Operation method | Operation time (min) | Anastomosis time (min) | Blood loss (mL) | Anatomostomy Grade | Curability | Operation morbidity | Symptom of reflux | Reflux esophagitis | Discharge time (POD) | Postoperative morbidity |
|------|-------------|--------|---------|------------|-----------------|---------------------|----------------------|----------------|-------------------|------------|-------------------|-----------------|------------------|-------------------|----------------------|
| 1    | 60          | M      | 0       | 22.3       | LPC             | 357                 | 20                   | 12              | none              | R0         | none              | none             | none             | 10                | 0                    |
| 2    | 76          | M      | 0       | 22.9       | LPC             | 370                 | 43                   | 13              | none              | R0         | none              | none             | none             | 15                | 12                   |
| 3    | 76          | F      | 0       | 21.8       | LPC             | 370                 | 60                   | 12              | none              | R0         | none              | none             | none             | 11                | 12                   |
| 4    | 60          | M      | 0       | 21.3       | LPC             | 338                 | 121                  | 12              | none              | R0         | none              | none             | none             | 14                | 13                   |
| 5    | 60          | M      | 0       | 22.2       | LPC             | 339                 | 114                  | 13              | none              | R0         | none              | none             | none             | 13                | 13                   |
| 6    | 60          | F      | 0       | 28.1       | LPC             | 405                 | 56                   | 36              | none              | R0         | none              | none             | none             | 5                 | 12                   |
| 7    | 77          | M      | 0       | 25.7       | LPC             | 403                 | 57                   | 57              | none              | R0         | none              | none             | none             | 4                 | 12                   |
| 8    | 77          | F      | 0       | 22.3       | LPC             | 403                 | 57                   | 57              | none              | R0         | none              | none             | none             | 4                 | 12                   |
| 9    | 68          | M      | 0       | 20.7       | LPC             | 10                  | 89                   | 89              | none              | R0         | none              | none             | none             | 14                | 13                   |
| 10   | 68          | M      | 0       | 20.7       | LPC             | 10                  | 89                   | 89              | none              | R0         | none              | none             | none             | 14                | 13                   |
| 11   | 69          | M      | 0       | 18.2       | LPC             | 378                 | 142                  | 13              | none              | R0         | none              | none             | none             | 13                | 13                   |
| 12   | 72          | M      | 0       | 26.1       | LPC             | 427                 | 151                  | 85              | none              | R0         | none              | none             | none             | 14                | 12                   |
| 13   | 73          | M      | 0       | 28         | LPC             | 525                 | 143                  | 77              | none              | R0         | none              | none             | none             | 14                | 12                   |

*: Staging was performed according to the 7th edition of the International Union against Cancer tumor–node–metastasis staging system for gastric cancer.

Results

The patients' backgrounds and surgical outcomes are listed in Table 1. These individuals had a median age of 70 years (range 55–89) and body mass index of 22.3 kg/m² (range 18.2–28.1). The mean operation time was 389 min (range 338–525) and blood loss was 110 ml (range 10–433). When considering only the time for anastomosis, the mean suturing time was 109.6 min (range 72.6–128.7). The mean anastomosis time of gastrectomy with two-dimensional visualization was 114.4 min (range 89.9–128.7), while the time with three-dimensional (3D) visualization was 81.0 min (range 77.5–85.4). The learning curve was not steep and there was no conversion to other procedures (Fig. 2). Surgical complications included one grade II anastomotic minor leakage. The median length of hospital stay was 14 days (range 11–36).

All patients received a postoperative one-year follow-up endoscopy after the operation. Follow-up endoscopic findings in a representative case are shown in Fig. 3. In this instance, a small pseudo-fornix was created, resulting in a similar appearance to the natural gastric cardia. Only one patient, who suffered from grade II anastomotic minor leakage after operation, was troubled with reflux esophagitis at the postoperative one-year follow-up endoscopy. One patient (7.7%) suffered a recurrence during the 36-
month median follow-up period (range 21–41 months). There were no fatalities.

5. Discussion

A multi-institutional phase II trial was conducted by the Gastric Cancer Surgical Study Group of the Japan Clinical Oncology Group [JCOG 0703], and Katai et al. [11] demonstrated the safety of laparoscopy-assisted distal gastrectomy for clinical stage I gastric cancer in terms of surgical complications and short-term clinical outcome. Other studies have also shown possible clinical benefits of laparoscopy-assisted distal gastrectomy [12–14].

However, these accumulating evidences were based on the experience of laparoscopy-assisted distal gastrectomy, with the safety and feasibility of other laparoscopic procedures for gastric cancer remaining relatively unknown. Further advancements in laparoscopic techniques and instrumentation are necessary for the development of the laparoscopic gastrectomy procedure. Among these developments, the clinical efficacy and suitability of knotless barbed absorbable suture has been reported to facilitate intestinal anastomosis in the past [15–17]. One of these novel sutures, the V-Loc is a self-anchoring unidirectional barbed suture that obviates the need for tying knots. One end of the V-Loc is a surgical needle while the other end is loop to enable avoidance of the need to tie a surgical knot. Although several reports of this device’s use for laparoscopic gastrectomy have recently been proposed [15–19], there have been no reports for its incorporation during esophagogastrostomy closure, especially with hinged double flap method.

In the present study, only one case (7.7%) of anastomotic leakage, which resulted in postoperative reflux esophagitis, was observed. This patient underwent additional gastric resection because of cancer cells at the edge of the resected tissue. It was suggested that a small remnant stomach might have been one cause of the anastomotic leakage of esophagogastrostomy with hinged double flap method.

In contrast, the other patients who participated in the study did not suffer from postoperative complications, including anastomotic stenosis, anastomotic leakage or reflux esophagitis. Furthermore, running-suture techniques using V-Loc helped to relatively shorten anastomosis time, although this study was not controlled. A running suture technique is usually faster than an interrupted suture technique, though the former generally cannot maintain tension on the suture line properly. With regards to this problem, the V-Loc distributes tension evenly across the suture line so that during the running suture, the tension is self-maintained. In addition, the learning curve of this procedure was not steep, implying that this procedure is relatively easy to acquire. Considering the anastomosis time, there is a possibility that 3D monitoring during laparoscopic gastrectomy may help facilitate easy suturing, although the number of cases present in this study was too limited to run analyses. Further investigation is necessary to prove the impact of the use of 3D vision during laparoscopy on surgical performance.

Our study is the first to report on the use of knotless unidirectional barbed suture for intracorporeal esophagogastrostomy closure with the hinged double flap method during laparoscopic proximal gastrectomy. In this article, we noted several advantages of this procedure, finding that it was effective and feasible. However, further clinical study and lengthier follow-up patient data is necessary.

Conflicts of interest

The authors declare no conflicts of interest associated with this manuscript.

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None of the authors has any conflicts of interest or any financial ties to disclose.

Ethical approval

Ethical approval was obtained from the ethical committee of Hiroshima University Hospital (E-687).

Consent

Written informed consent was obtained from all of the patients for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.
Author contributions

YS and KT collected and analysed the data, and wrote the manuscript. HO designed the study. YY, HO, RS collected the data. All authors read and approved the final manuscript.

Registration of research studies

We have registered our research. (UIN:researchregistry4334).

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