ABSTRACT

Purpose: Robotic total mesorectal excision (R-TME) has been advocated to improve the quality of surgery for rectal cancer. The objective of this study was to analyze the short-term outcomes for R-TME.

Materials and Methods: Twenty-four consecutive patients with rectal cancer who underwent R-TME between 2019 January and 2019 September were analyzed retrospectively. One surgeon with experience in performing more than 1,000 laparoscopic colorectal surgeries performed the robotic surgery. A six-port system, including a camera port, was designed to perform rectal cancer surgery from the splenic flexure to the pelvic reflection in one step. To check the feasibility and safety of the procedure, perioperative outcomes including conversion rate, morbidity, and mortality were analyzed.

Results: Mean distance from the anal verge was 5.6 cm. Mean body mass index was 24.4 kg/m². Mean robotic docking time and robotic procedure time were 13 and 108 minutes, respectively. No patient needed conversion to an open approach. One patient involved circumferential resection margin. Median lymph node yield was 19.6 (25.0%) postoperative surgical complications were recorded.

Conclusions: Early perioperative outcomes and quality of surgical resection of robotic rectal surgery were feasible and safe. This result could facilitate the spread of robotic surgery for rectal cancer and maximize the advantage of robotic surgery.

Keywords: Robotic; Proctectomy; Rectal cancer

INTRODUCTION

Total mesorectal excision (TME) is considered the standard procedure for treating rectal cancers. This surgical approach entails complete removal of the mesorectum circumferentially, all blood vessels, lymphatic vessels, and lymph nodes through which the tumor may disseminate [1,2]. There have been significant advances in the treatment of rectal cancer, particularly with minimally invasive surgery, laparoscopic, and robotic approaches. Robotic surgery has increasingly been applied to the treatment of rectal cancer with expectation of overcoming the limitations of conventional laparoscopic surgery through its technical advantages such as an operator-controlled stable visual field, three-dimensional imaging, and articulated tips of instruments. Thus, the boundaries of minimally invasive
surgery are being expanded even further with the introduction of robotic surgery over a decade ago, bringing new concepts and benefits for surgical patients.

However, for beginner, application of the robotic system for the treatment of rectal cancer is a challenge especially in performing multi-quadrant operation such as rectal cancer surgery with current da Vinci Xi systems due to the limited range of motion of the robotic arms and difficulty in moving the surgical cart during operations. In this study, the short-term outcomes of one surgeon's robotic surgery for rectal cancer during learning period of a new practical surgical technique were analyzed.

**MATERIALS AND METHODS**

Twenty-four patients with a primary rectal adenocarcinoma who underwent robotic total mesorectal excision (R-TME) by one colorectal surgeon between January 2019 and September 2019 were analyzed. The surgeon (J.W.H.) who performed these operations had experience in conventional laparoscopic and single-port laparoscopic surgery for treating colorectal disease. Informed consents were obtained from all patients. Inclusion criteria was if the patient had biopsy-proven adenocarcinoma of the rectum ≤10 cm from the anal verge and underwent TME with sphincter preservation by robotic method. The 24 cases of R-TME were considered as the learning curve period.

In this study, the decision of R-TME was made based on patient’s decision after going through all the aspects such as procedure, cost, insurance coverage, and complications and a surgeon’s preference to surgical approach.

All patients underwent preoperative staging with rectum magnetic resonance imaging and computed tomography scans of the abdominopelvic and thorax. Neoadjuvant chemoradiotherapy was offered to patients with clinical T3 and higher or with clinical nodal involvement. The chemoradiation regimen consisted of long course radiation with 4,500–5,400 cGy in 5–6 weeks with synchronous 5-fluorouracil based chemotherapy. Surgery was performed 6–8 weeks after completion of chemoradiation.

The main outcomes measures of this study were perioperative outcomes and composite of quality of mesorectal excision, circumferential resection margin (CRM), and distal resection margin (DRM). The macroscopic quality of TME specimens was assessed by a pathologist specialized in colorectal disease according to the grading system used by the American College of Surgeons Oncology Group Z6051 [3]. A positive CRM was defined as <1 mm between deepest tumor invasions to the mesorectal fascia while a positive DRM was defined as <1 mm between the lower aspect of tumor and distal cut edge of specimen.

The postoperative complications were defined as any adverse event within 30 days after surgery. Anastomosis leakage was defined as clinically suspected and radiologically proven, and in which therapeutic intervention was performed.

Urinary dysfunction was defined as the inability of spontaneous voiding after foley catheter removal. All patients underwent foley catheter removal at post-operative day 4 followed by bladder ultrasound. If the patients had more than 200 cc post-void residual, intermittent catheterization and re-insertion of foley catheter were performed.
Operative techniques
A totally robotic approach with a six-port system (daVinci Xi system) was adopted [4]. The surgical cart approached the left lower quadrant of the patient’s abdomen in an oblique manner and remained in the same location during the whole procedure. Port configuration was changed in the middle of the procedure to allow colon mobilization, splenic flexure take down and pelvic dissection, respectively (Fig. 1). For the case with stapled anastomosis, the specimen was extracted through an incision that extended from the supraumbilical camera port whereas in the case of a hand-sewn coloanal anastomosis, it was retrieved through the anal canal.

Statistical analyses
All statistical analyses were performed using SPSS for Windows, version 23.0 (SPSS, Chicago, IL, USA). Differences between the two groups were analyzed using Chi-square test, Fisher’s exact test, or the Mann-Whitney U test as appropriate. Results were considered statistically significant at $P<0.05$.

RESULTS

Patient characteristics
Twenty-four patients’ demographics were as summarized in Table 1. The mean age of the patients was 55±11 years. The mean body mass index of the patients was 24.4 kg/m$^2$. The American Society of Anesthesiology class distribution found 10 patients in class I, 11 patients in class II, and 3 patients in class III. The mean height from anal verge was 5.6±1.4 cm, and 6 patients underwent neoadjuvant chemoradiotherapy.

Operative procedure
The mean operative outcomes were as shown in Table 2. Among the 24 patients, 13 patients underwent low anterior resection, 10 underwent ultra-low anterior resection, and 1 underwent interspinsteric resection. The surgical procedure had an operation time of 210±53 minutes, a robot time of 108±24 minutes, and a robot docking time of 13±5 minutes. The details of docking and robotic procure time were as shown in Fig. 1. Five patients underwent prophylactic diverting ileostomy. There was not open or laparoscopic conversion.
Postoperative morbidity in 30 days
Six patients experienced postoperative surgical complications (Table 3) including anastomosis leakage, intraabdominal bleeding, and urinary dysfunction. Anastomosis leakages were encountered in 3 patients (12.5%) on postoperative 4–14 days and all patients managed by diverting ileostomy. The intraabdominal bleeding was recovered by transfusion and no operation-related mortality was recorded. Urinary retention was detected in 2 patients (8.3%) and all patients were successfully treated. They failed self voiding after foley catheter removal at postoperative day 4, re-insertion of foley catheter and removed after 2 days. They were all discharged after recovering voiding problem.

Histopathologic outcomes
The histopathologic outcomes were as demonstrated in Table 4. The mean tumor size was 4.0±2.1 cm. One patient had CRM while some of the patients had DRMs. The mean total numbers of harvested lymph nodes were 19±7. All patients achieved high quality of TME.
Laparoscopic procedures are generally thought to have better short-term outcomes than open procedures [5,6]. However, two recent RCTs, ALacART [7] and ACOSOG Z6051 [8] trial, confirmed that laparoscopic resection failed to meet the criterion for non-inferiority of oncologic outcomes when compared with open resection for rectal cancer patients. These results indicate that modification of instruments or a different platform such as robotics can improve results of minimally invasive surgery for rectal cancer patients. R-TME approaches are developed to overcome some limitations of conventional laparoscopic TME. R-TME has been adopted for a quality oncologic resection [9].

When a surgeon starts practicing a new procedure, his/her performance will improve with continuous repetition of that procedure. This period of training is referred to as the “learning curve.” As a new surgical procedure, R-TME is adopted increasingly by surgeons. Thus,

### Table 3. Postoperative outcomes

| Variables                        | R-TME (n=24) |   |
|----------------------------------|--------------|---|
| Length of stay (days)            | 10±5         |   |
| Soft diet (days)                 | 3±1          |   |
| First bowel movement (days)      | 4±7          |   |
| Postoperative complications      |              |   |
| Anastomotic leakage              | 3 (12.5)     |   |
| Rectovaginal fistula              | 0 (0.0)      |   |
| Postoperative ileus              | 0 (0.0)      |   |
| Urinary retention                | 2 (8.3)      |   |
| Superficial surgical site infection | 0 (0.0)  |   |
| Intraabdominal bleeding          | 1 (4.2)      |   |

Values are presented as number of patients (%) or mean±standard deviation. R-TME = robotic total mesorectal excision.

### Table 4. Pathologic outcomes

| Variables                        | R-TME (n=24) |   |
|----------------------------------|--------------|---|
| Pathologic T stage               |              |   |
| pT0                              | 2 (8.3)      |   |
| pT1                              | 5 (20.8)     |   |
| pT2                              | 3 (12.5)     |   |
| pT3                              | 11 (45.9)    |   |
| pT4                              | 3 (12.5)     |   |
| Pathologic N stage               |              |   |
| pN0                              | 14 (58.3)    |   |
| pN1                              | 6 (25.0)     |   |
| pN2                              | 4 (16.7)     |   |
| Harvested lymph nodes (No.)      | 19±7         |   |
| Cell differentiation             |              |   |
| Well differentiation             | 7 (29.2)     |   |
| Moderately differentiation       | 17 (70.8)    |   |
| Poorly differentiation           | 0 (0.0)      |   |
| Mean tumor size (cm)             | 4.0±2.1      |   |
| CRM involvement                  | 1 (4.2)      |   |
| Distal resection involvement     | 0 (0.0)      |   |
| Mean distance to distal margin (cm) | 2.7±1.4   |   |
| CRM (mm)                         | 9.0±2.6      |   |
| TME grade                        | Complete     | 24 (100.0) |

Values are presented as number of patients (%) or mean±standard deviation. R-TME = robotic total mesorectal excision; CRM = circumferential resection margin; TME = total mesorectal excision.
patient selection is crucial. In the present study, during the initial period after embarking on
a new procedure, the surgeon selected the less complex cases until the more experience and
confidence was gained.

Nevertheless, in the early period or robotic surgery, 3 patients experienced postoperative
anastomosis leakage. In those cases, the surgeon could not complete take down the splenic
flexure colon due to technical difficulties. One problem of robotic rectal surgery is that the da
Vinci system is not regarded as an adequate device for performing multiquadrant operations.
The large surgical cart and huge robotic arms working in a relatively small belly could collide,
especially during multiquadrant surgeries such as rectal surgery.

With time, none of robot-assisted operations were converted to laparotomy which may be
related to the experience the surgeon had in conventional laparoscopy. The experience in
laparoscopic TME can be advantageous as the surgeon is more familiar with the laparoscopic
view of the surgical anatomy and is more comfortable with endoscopic dissection and tissue
handling. It is also desirable to have the option of conversion to conventional laparoscopy
in the event of complications or robotic system failures rather than do a direct conversion to
open surgery.

With respect to quality of surgical resection, the most important parameters used to assess
the quality of rectal cancer surgery are TME quality and circumferential margin. Results of
this study suggest that the incidence of high-quality TME, CRM involvement for rectal is
comparable for robotic approaches. Although it was an early experience in robotic surgery,
the quality of specimen was comparable.

This study had various limitations such as: its retrospective nature, small number of patients,
and lack of data such as sexual functional outcomes.

In conclusion, early perioperative and pathologic outcomes of robotic rectal surgery are
feasible and safe. The proposed technique will improve further as more experience is
gathered in this field. Future studies are required to determine long-term oncologic and
functional outcomes and perform cost analyses.

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