Robotic Approach In Rectal Cancer Versus Laparoscopic Approach: Preliminary Results Of A Prospective Comparative Study

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Abstract:
The conventional laparoscopic approach to rectal surgery has several limitations, and therefore many colorectal surgeons have great expectations for the robotic surgical system as an alternative modality in overcoming challenges of laparoscopic surgery and thus enhancing oncologic and functional outcomes. The aim of this study was to evaluate the feasibility and short-term outcomes of robotic surgery for colorectal cancer as initial cases, compared with conventional laparoscopic surgery. From July 2015 to October 2015, fifteen patients with left-sided colon and rectal cancer underwent robotic surgery, and we compare with 20 patients received conventional laparoscopic surgery selected from our database of 153 patients with colorectal cancer operated in the last five years. Both groups were balanced in terms of age, gender, American Society of Anesthesiologists (ASA) score, body mass index (BMI), operative history, TNM staging, and tumor location using the propensity score matching method. The perioperative results included the operative time, amount of estimated blood loss, the need for open conversion or further surgery, complications, flatus passage, the length of postoperative hospital stay, and the number of retrieved lymph nodes. There were no significant differences in the short-term outcomes between the robotic surgery group and the conventional laparoscopic surgery group. However, the operative time was significantly longer in the robotic surgery group than in the conventional laparoscopic surgery group. There were no significant differences between the robotic surgery group and the conventional laparoscopic surgery group with respect to short-term outcomes, with the exception of the operative time. Our early experience indicates that robotic surgery is a promising tool, particularly in patients with rectal cancer.

Keywords: laparoscopic approach, robotic surgery, colorectal cancer

I. INTRODUCTION

The laparoscopic approach for the treatment of colorectal cancer, after initial concerns regarding the oncological safety and the added complexity of the operations, nowadays is widely spread all over the world. Feasibility of laparoscopic colorectal surgery has been proven by several important randomized trials with high level of evidence (1-5) in comparison with open surgery. No one can argue against the fact that minimally invasive surgery scores over conventional open surgery in terms of less post-operative pain, reduced post-operative morbidity, shorter hospital stay while providing similar oncological outcomes. Despite of all these advantages, only 4-6% of all colorectal resections in the USA [6] are performed laparoscopically and up to 29% in France [7]. Various socioeconomic factors, technical limitations and a steep learning curve have been advocated as the causes that hampered the wide spread of laparoscopy. In this perspective, robotics was introduced
to overcome the drawbacks of laparoscopy and change the face of MIS that should not be a luxury for few but a standard of care for many.

Robotic surgery is a new technique with the benefits of a three-dimensional view, the ability to use multi-degree-of-freedom forceps, the elimination of physiological tremors, and a stable camera view. It has been successfully applied in urologic surgery, and the anatomy of the pelvis suggests that performing robotic surgery in this setting is feasible, especially in patients undergoing rectal cancer surgery. To date, several studies have demonstrated the safety and feasibility, as well as acceptable short-term outcomes, of robotic colorectal surgery [8-11]. However, evidence supporting the use of robotic surgery in patients with colorectal cancer is limited, particularly with respect to randomized controlled studies.

The aim of this study was to evaluate the feasibility of robotic surgery compared with conventional laparoscopic surgery for colorectal cancer. We conducted a matched case-control study using the propensity score matching method to assess the short-term outcomes of robotic surgery for colorectal cancer compared with those of conventional laparoscopic surgery.

II. METHODS

We started laparoscopy in our clinic in 1994 and after we get sufficient expertise we performed first laparoscopic rectal resection in 2001. We encountered until now more than 500 laparoscopic procedures for colorectal cancer. From this database we enrolled in this study patients with rectal cancer and left-sided colon cancer.

We gained in 2014 a European grant for minimally invasive treatment of pelvic cancer. So we started in July this year to perform robotic approach for pelvic cancer and until now we perform: 15 rectal resections, two radical prostatectomy, two radical hysterectomy and one right hemicolecction.

This was a matched case-control study using propensity score matching method to compare the outcomes of laparoscopic surgery and robotic surgery for colorectal cancer. The patients were matched with regard to age, gender, body mass index (BMI), tumor location, stages of the disease, history of previous abdominal surgery, American Society of Anesthesiologists (ASA) score.

The immediate results were compare included the operative time, amount of estimated blood loss, conversion to open surgery, time to first bowel movements, complications, reinterventions, hospital stay and the number of retrieved lymph nodes.

The Student t test and χ2 test were used to examine the association between each of the independent factors and outcomes for continuous and categorical variables, respectively. Given the small sample size and varied procedure types, analyses were performed for the aforementioned intraoperative and postoperative outcomes. All statistical analyses were performed by use of SPSS Statistic software program, with a P value of <0.05 being considered to indicate statistical significance (12).

III. ROBOTIC SURGICAL TECHNIQUE

All the patients signed an informed consent regarding the procedure. The patient was placed in the lithotomy position with a proclaim position of 15 grades and with table height as low as possible (Figure 1).

We use Xi da Vinci Surgical System (Intuitive Surgical, Sunnyvale, CA, USA). This is the fourth generation of da Vinci Surgical System that has some important advantages over the Si System. The most important advantage is the redesigned patient cart supporting flexible positioning around patient and efficient with four-quadrant access. So for rectal cancer, when you need to perform splenic flexure mobilization of the colon, you don’t need any more to undock and redocking the platform and you can
establish the position of the patient cart wherever you need for a better access to the patient. Also this new system has a longer instruments by 4.5 cm that it is important for very low rectal resection.

We use four 8-mm trocars (Intuitive Surgical, Sunnyvale, CA, USA) and one 12-mm trocar (AirSeal Access Port). Sometimes we inserted one supplementary 5-mm trocar. The arms of the robot in Xi System should be in line, with a 6-8 cm distance between the arms. The trocar placement is presented in Figure 2.

Both robotic surgery and conventional laparoscopic were performed using a medial-to-lateral approach.

The surgical technique was standardized as follows. First, the inferior mesenteric vein was divided adjacent to the fourth portion of the duodenum. The inferior mesenteric artery was then ligated and the sympathetic paraaortic nerve plexus and superior hypogastric nerve were preserved. Colonic mobilization was performed using medial-to-lateral dissection similar to standard laparoscopic techniques [13, 14]. The splenic flexure was mobilized for tension-free anastomosis as necessary. Rectal mobilization was started at the level of the sacral promontory along the avascular presacral plane. Posterior dissection was performed in this plane down to the pelvic floor and the inferior hypogastric nerve was preserved. A right lateral dissection was performed, followed by a left lateral dissection. Anterior dissection was performed under Denonvilliers’ fascia uretracting the seminal vesicle, prostate,
or vagina. After complete rectal mobilization, a digital rectal examination was performed to evaluate the distal resection margin. To transect the rectum, we used two endoscopic linear staples inserted through 12-mm trocar. The specimen was extracted via a 4- to 6-cm Phanenstiel incision. A double staple colorectal was performed. Finally, a pelvic drain was placed.

IV. RESULTS

A total of 15 patients with robotic surgeries were included in this study. They were comparable with 20 patients with conventional laparoscopy. These patients were comparable in terms of age, gender, ASA score, BMI index, operative history, TNM staging, tumor location. The data for both groups are shown in Table 1.

Table 1. Patients characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Robot (n=15)</th>
<th>Laparoscopy (n=20)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>58.3±11.7</td>
<td>56.7±9.8</td>
<td>0.88</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td>1.00</td>
</tr>
<tr>
<td>Male</td>
<td>9 (60%)</td>
<td>11 (55%)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>6 (40%)</td>
<td>9 (45%)</td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m2)</td>
<td>26.5±4.3</td>
<td>24.7±4.2</td>
<td>0.86</td>
</tr>
<tr>
<td>Comorbidity</td>
<td>8 (53.3%)</td>
<td>12 (60%)</td>
<td>0.92</td>
</tr>
<tr>
<td>Previous abdominal surgery</td>
<td>4 (26.6%)</td>
<td>5 (25%)</td>
<td>0.91</td>
</tr>
<tr>
<td>ASA score</td>
<td></td>
<td></td>
<td>0.66</td>
</tr>
<tr>
<td>1</td>
<td>4 (26.6%)</td>
<td>6 (30%)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>9 (60.1%)</td>
<td>11 (55%)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2 (13.3%)</td>
<td>3 (15%)</td>
<td></td>
</tr>
<tr>
<td>Stage</td>
<td></td>
<td></td>
<td>0.49</td>
</tr>
<tr>
<td>0</td>
<td>1 (6.8%)</td>
<td>2 (10%)</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>2 (13.3%)</td>
<td>5 (25%)</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>8 (53.3%)</td>
<td>10 (50%)</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>4 (26.6%)</td>
<td>3 (15%)</td>
<td></td>
</tr>
<tr>
<td>Operative procedure</td>
<td></td>
<td></td>
<td>0.89</td>
</tr>
<tr>
<td>Low anterior resection</td>
<td>13 (87.7%)</td>
<td>17 (85%)</td>
<td></td>
</tr>
<tr>
<td>Abdominoperineal resection</td>
<td>2 (13.3%)</td>
<td>3 (15%)</td>
<td></td>
</tr>
</tbody>
</table>
The median age of the fifteen patients of the robotic surgery group was 58.3 years (range: 46 to 70), with that of the 20 patients of the conventional laparoscopic surgery group was 56.7 years (range: 45 to 67) ($P = 0.88$). Nine of the fifteen robotic surgery patients were male, compared with 11 of the 20 laparoscopic patients ($P = 1.000$). The median BMI was 26.5 kg/m$^2$ (range: 21 to 31) in the robotic surgery group compared with 24.7 kg/m$^2$ (range: 20 to 29) in the conventional laparoscopic surgery group ($P = 0.86$). Four (26.6%) of the patients on the robotic surgery group and five (25%) of the patients in the conventional laparoscopic surgery group had a previous history of surgery ($P = 0.91$). There were no significant differences between the two groups in terms of the ASA score, tumor location, surgical stage ($P = 0.66, 1.000, 0.49$, respectively).

Comparison of perioperative clinical outcomes is shown in Table 2. The estimated blood loss did not differ significantly between groups. Two patients in the laparoscopic group required conversion to open surgery compared to one patient in the robotic group. The mean operation time was significantly longer in the robotic group. Postoperatively, the mean time to first flatus passage was 1.9 days in the robotic group and 1.7 days in the laparoscopic group ($p=0.92$). The mean hospital stay was 9 days in the robotic group and 10.5 days in the laparoscopic group ($p=0.24$).

Table 2 Perioperative clinical outcomes

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Robot (n=15)</th>
<th>Laparoscopy (n=20)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated blood loss (ml)</td>
<td>50 (10 to 250)</td>
<td>70 (20 to 300)</td>
<td>0.66</td>
</tr>
<tr>
<td>Conversion to open surgery (%)</td>
<td>1 (6.8%)</td>
<td>2 (10%)</td>
<td>0.86</td>
</tr>
<tr>
<td>Operation time (min)</td>
<td>227 (195 to 312)</td>
<td>164 (148 to 259)</td>
<td>0.001</td>
</tr>
<tr>
<td>Flatus passage (days)</td>
<td>1.9 (1 to 4)</td>
<td>1.7 (1 to 3)</td>
<td>0.92</td>
</tr>
<tr>
<td>Hospital stay (days)</td>
<td>9 (7 to 17)</td>
<td>10.5 (7 to 39)</td>
<td>0.24</td>
</tr>
<tr>
<td>Postoperative morbidity (%)</td>
<td>1 (6.8 %)</td>
<td>2 (10%)</td>
<td>0.64</td>
</tr>
<tr>
<td>Reoperation (%)</td>
<td>0</td>
<td>1 (5%)</td>
<td>0.89</td>
</tr>
<tr>
<td>No. of harvested limph nodes</td>
<td>14 (2 to 18)</td>
<td>13 (5 to 30)</td>
<td>0.24</td>
</tr>
</tbody>
</table>

No postoperative mortality occurred in either group. The overall perioperative complication rates were similar between groups (Table 2). The one patient who underwent reoperation in the laparoscopic group was a 67-year-old man who had undergone a previous Miles’ operation and the reoperation was performed for ileus on postoperative day 8. Bowel congestion was observed and an adherence between the loop of the sigmoid and small bowel and was removed also laparoscopic. The patient was discharged on postoperative day 13.

In terms of the median number of harvested lymph nodes, there were no significant differences between the robotic surgery group (median: 14.0, range: 2 to 18) and the conventional laparoscopic surgery group (median: 13.0, range: 5 to 30; $P = 0.243$). No patients had a positive distal resection margin or positive circumferential resection margin in either group.
V. DISCUSSION

There are obvious some limitations of current laparoscopic rectal surgery. There is some concern about the higher rate of circumferential resection margin (CRM) involvement among rectal cancer patients undergoing low anterior resection with laparoscopic surgery (12.4%) compared to that of open surgery (6.3%) in the CLASICC trial (4). In addition, the rectal laparoscopic subgroup had a higher conversion rate than the colon laparoscopic subgroup (34% vs. 25%). Furthermore, in the CLASICC trial, mortality and morbidity rates were highest in colon and rectal cancer patients who were converted from laparoscopic to open surgery. Patients who underwent conversion had a higher mortality rate than open or laparoscopic patients (9% vs. 5% and 1%, respectively, \( P = 0.34 \)). The complication rate was also higher in converted patients compared to non-converted patients and patients who underwent open surgery (\( P = 0.002 \)). This suggests that there are still technical issues that need to be addressed for the use of the laparoscopic approach for rectal cancer (4, 15). In addition, the COLOR II trial reported noninferior oncological outcomes but a high conversion rate (17%) in patients undergoing laparoscopic rectal surgery, although the conversion rate was decreased compared with previous studies. The study was a large multicentric randomized trial, but it was performed in selected patients treated by skilled surgeons (5).

The apparent advantages of robotic surgery include a three-dimensional view, the ability to use 7-degree-of-freedom forceps, the elimination of physiological tremors, and stable camera control.

The available literature also shows that robotic surgery provides all advantages of the MIS approach and it may allow performing complex procedures, such as rectal resections, with greater ease, lower conversion rate, less pelvic autonomic nerve damage and a reduced learning curve.[16,17] Notwithstanding these promising results, the conclusion of many studies is that robotics is too expensive and probably not as cost-effective as laparoscopy.

The real benefits of robotics, however, are difficult to quantify by means of preliminary cost-effectiveness analyses performed on the early experience of a few specialised centres.[16]

In this study, we compared various parameters between the robotic surgery group and the conventional laparoscopic surgery group. In order to evaluate the invasiveness of the procedures, we compared the operative length, amount of estimated blood loss, timing of flatus passage, and length of postoperative hospital stay. In our series, there were no significant differences in the amount of estimated blood loss, timing of flatus passage, or length of postoperative hospital stay between the robotic surgery group and the conventional laparoscopic surgery group. In terms of the operative length, the median 227 min observed in the robotic surgery group (range: 195 to 312 min) was significantly longer than the 164 min noted in the conventional laparoscopic surgery group (range: 148 to 259 min; \( P = 0.001 \)). A longer operative time is one disadvantage of robotic surgery, in addition to the high cost, lack of tactile sensation, and narrow visual field, as compared with conventional laparoscopic surgery. However, we believe that the technique of robotic surgery will improve with experience after a learning curve. Indeed, previous studies have reported comparable operative times between robotic surgery and conventional laparoscopic surgery for rectal cancer [18,19].

In terms of the median number of harvested lymph nodes, there were no significant differences between the robotic surgery group (median: 14.0, range: 2 to 18) and the conventional laparoscopic surgery group (median: 13.0, range: 5 to 30; \( P = 0.243 \)), as shown in Table 2. No patients had a positive distal resection margin or positive circumferential resection margin in either group.

In accordance with the results of our study, several studies reported that the operating time was significantly longer in robotic rectal surgery than in laparoscopic rectal surgery [20-22]. In recent studies [23,24] analyzing the learning curves of robot-assisted rectal surgery, the initial learning was achieved after 21-35 cases. After sufficient cases to overcome the learning curve for robotic surgery, the
operative time in the robotic surgery, except for the docking time, would be shortened and comparable with those in the laparoscopic surgery.

In the current study, the numbers of harvested lymph nodes fulfilled the oncological principles in both groups. A recent meta-analysis found no difference in the mean number of lymph nodes collected during both surgical approaches [25]. Other pathological factors, including proximal resection margin and distal resection margin, were negative in all patients after robot-assisted or laparoscopic surgery.

This study has several limitations. First, it was retrospective in nature. To overcome this limitation, we matched the cases using several clinical variables. Accordingly, the groups were well balanced and selection bias was reduced. Second, the sample size was small. However, the current study describes our initial experience with performing robot-assisted surgery, thus the number of cases is still quite low.

VI. CONCLUSION

In conclusion, short-term outcomes of robot-assisted surgery for mid or low rectal cancer after CRT were similar to those of laparoscopic surgery. The postoperative clinical outcomes such as recovery of bowel function, postoperative hospital stay and morbidity were similar to those of laparoscopic surgery. Moreover, in the oncologic respect, we achieved the complete TME qualities in 97% of patients and harvested a similar number of lymph nodes in robot surgery.

Our early experience indicates that robotic surgery is a feasible and safe procedure in patients with colorectal cancer. Although there were no significant benefits regarding the perioperative and oncological results, robotic surgery provides better outcomes, especially in patients undergoing rectal surgery. However, before extending the indications for this procedure, it is necessary to evaluate the perioperative and long-term oncological safety in large randomized controlled trials.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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