Original Article

Comparative study on the effects between single-port laparoscopic and open radical gastrectomy on postoperative recovery of patients with gastric cancer

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Abstract: Objective: To investigate and compare the effects of single-port laparoscopy and open radical gastrectomy on postoperative recovery of patients. Methods: One hundred and twelve patients with gastric cancer undergoing gastrointestinal surgery who were admitted to the Department of Gastrointestinal Surgery in our hospital were selected as the subjects of the research. The patients were divided into single-port laparoscopic group (single-port laparoscopic radical gastrectomy) and laparotomy group (open radical gastrectomy) with 56 cases for each group. The effects of different operation modes on postoperative recovery were analyzed. And the observation indexes were: recovery time of aerofluxus, removal time of abdominal drainage tube, recovery time of semi-liquid diet, incision healing time, postoperative length of hospital stay, postoperative complications, postoperative pain, etc. Results: Compared with open radical gastrectomy, the recovery time of aerofluxus (P=0.016), the removal time of abdominal drainage tube (P=0.017) and the recovery time of semi-liquid diet (P<0.001) of single-port laparoscopic group were shorter. There was no difference between these two groups in incision healing time (P=0.21) and postoperative complication rate (P=0.595), but the length of hospital stay of single-port laparoscopic group was shorter (P=0.022). Pain changes of single-port laparoscopic group presented the characteristic of being fast at first and then slow while that of laparotomy group was slow at first and then fast. And Visual Analogue Scale (VAS) scores (P=0.002) and Pain Rating Index (PRI) scores (P=0.003) in laparoscopy group were lower than those of laparotomy group. Conclusion: Compared to open gastrectomy, single-port laparoscopic gastrectomy has more advantages in recovering aerofluxus, removing drainage tube, recovering semi-liquid diet and shortening the length of hospital stay. And it can reduce postoperative pain.

Keywords: Gastric cancer, single-port laparoscopy, laparotomy, postoperative recovery, postoperative pain

Introduction

Gastric cancer is one of the most common malignant tumor in alimentary system and its incidence rate ranks fourth among the most common malignancies in the world with the second highest mortality rate [1, 2]. The early symptoms of gastric cancer are not obvious. With the progression of the disease, patients will have nausea, vomiting, epigastric discomfort, dysphagia and gastrointestinal tract bleeding and other clinical symptoms. In present China, relatively weak national health awareness, eating disorders and other reasons lead to a low early diagnosis rate of gastric cancer. Therefore, most gastric cancer patients who come to the hospital are already in the advanced stage. Surgery is the main method of treatment of gastric cancer, radical resection is still the only treatment which may cure, but the surgery as a noxious stimulation can cause the direct release of various inflammatory mediators and activate the arachidonic acid metabolism pathway, complement system, cytokine system, then cause stress response, thereby cause disorders in the body metabolism and homeostasis, affecting the postoperative survival quality of patients [3].

As an advanced minimally invasive surgical approach, the less trauma, less pain, less bleeding, milder inflammatory reaction, better cosmetic results, faster postoperative recovery and other advantages of laparoscopy have
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been widely applied in the clinical treatment of gastric cancer [4-6]. With the further extension of minimally invasive concept and the development of laparoscopic technology, the laparoscopic surgery progressed from 5 holes to 3 holes and gradually progressed to the concept of single-port surgery. The concept is based on the traditional laparoscopic surgery, which acts as a bridge to develop natural orifice transluminal endoscopic surgery. Laparoscopic surgery for early gastric cancer has been proved to be safe and feasible by high-level clinical studies, and can obtain the same immediate and long-term oncology efficacy as traditional laparotomy [7, 8]. Previous literature analyzed the different clinical efficacy between laparoscopic and open operation mostly through the intraoperative observation indexes, such as incision size, operation time and intraoperative blood loss [5-7]. But we lacked of the analysis and study which focused on postoperative recovery, especially the observation of the postoperative pain indexes. The aim of this study was to compare the quality of laparoscopic surgery with laparotomy.

Materials and methods

Case inclusion

This clinical study was approved by the hospital ethical committee and the patients or their families signed information consent. Patients admitted to the Department of Gastrointestinal Surgery in Binzhou People's hospital and diagnosed with gastric cancer were selected for this study.

Inclusive criteria were as follows. 1) Preoperative electronic endoscopy and pathological biopsy was done for the diagnosis of gastric cancer. 2) There was no serious dysfunction in vital organs of the body and the patients were tolerant of surgery. 3) The gastrointestinal barium meal, chest X-ray, CT examination ruled out liver, lung and other distant metastasis of patients. 4) According to TNM staging from the American Joint Committee on Cancer (AJCC)/International Union Against Cancer (UICC), the patients belonged to preoperative I, II and III.

Exclusion criteria: patients who showed severe heart, lung, and brain dysfunction in preoperative examination; or other parts in preoperative examination; patients had serious coagulant function abnormality and electrolyte balance disorder; patients had narcotic drug allergies, poor cardiopulmonary function and other anesthesia taboo; patients had secondary or multiple operations.

They were randomly divided into single-port laparoscopic group and traditional laparotomy group with 56 cases for each.

Operation methods

All the operations were performed under general anesthesia and endotracheal intubation, and the vital signs were closely monitored. The operation obeyed the following basic principles: 1) principle of non-contact neoplasm operation; 2) en bloc resection principle of neoplasm and peripheral tissue; 3) principle of tumor-free technique in surgical procedures; 4) sufficient surgical source; 5) complete lymph node dissection [9].

The operation methods of laparoscopy were as follows. At first, patients took the supine subleg position, the surgeon stood on the left side of the patient and the assistant stood on the patient’s right side while the camera assistant was located in the end of the legs. Then, a single-port method was used to establish the operation space. Next, the observation hole was placed under the umbilicus, and a specific single-port device was implanted. Through the device, the lens and special laparoscopic instruments were put in simultaneously for surgical operations. Finally, the specimens were removed through this incision and then the digestive tract reconstruction was completed.

The operation methods of laparotomy were as follows. At first, patients took the horizontal supine position, the surgeon stood on the left side of the patient, which was different from the laparoscopic surgery. Next, disinfection and other steps were consistent with that of laparoscopic surgery. Then, the incision was longer than that of the laparoscopic surgery. An incision about 15 cm was made in the middle of the upper abdomen and the specific length was decided by the operation situation. And the general steps were similar to the laparoscopic surgery. After the completion of the free operation, the patency and tension-free of anastomo-
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**Table 1.** Comparison of the clinical data of the two groups

<table>
<thead>
<tr>
<th></th>
<th>Single-port laparoscopic group</th>
<th>Laparotomy group</th>
<th>T/χ²</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (male/female)</td>
<td>27/29</td>
<td>30/26</td>
<td>0.151</td>
<td>0.798</td>
</tr>
<tr>
<td>Age (year)</td>
<td>59.26±10.26</td>
<td>58.57±10.28</td>
<td>1.495</td>
<td>0.811</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>21.9±3.1</td>
<td>22.5±5.3</td>
<td>0.816</td>
<td>0.432</td>
</tr>
<tr>
<td>Preoperative complications (yes/no)</td>
<td>20/36</td>
<td>21/35</td>
<td>2.659</td>
<td>0.551</td>
</tr>
<tr>
<td>Tumor size (mm)</td>
<td>40.35±19.8</td>
<td>41.75±19.3</td>
<td>0.902</td>
<td>0.149</td>
</tr>
<tr>
<td>Histologic type (differentiated/undifferentiated)</td>
<td>45/11</td>
<td>49/7</td>
<td>0.716</td>
<td>0.976</td>
</tr>
<tr>
<td>TNM staging</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
<td>1.000</td>
</tr>
<tr>
<td>I</td>
<td>12</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>33</td>
<td>33</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 2.** Comparison of the postoperative recovery between the two groups

<table>
<thead>
<tr>
<th>Observation indexes</th>
<th>Single-port laparoscopic group</th>
<th>Laparotomy group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recovery time of aerofluxus (d)</td>
<td>3.2±1.1</td>
<td>4.2±1.3</td>
<td>0.016*</td>
</tr>
<tr>
<td>Removal time of abdominal drainage tube (d)</td>
<td>6.8±1.2</td>
<td>9.0±2.1</td>
<td>0.017*</td>
</tr>
<tr>
<td>Recovery time of semi-liquid diet (d)</td>
<td>7.5±2.1</td>
<td>8.7±2.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Incision healing time (d)</td>
<td>10.6±1.4</td>
<td>10.1±1.1</td>
<td>0.21</td>
</tr>
<tr>
<td>Postoperative length of hospital stay (d)</td>
<td>11.5±3.9</td>
<td>13.6±4.1</td>
<td>0.022*</td>
</tr>
</tbody>
</table>

*Note: *P<0.05.

sis were checked; warm saline was used to wash the abdominal cavity where the drainage tube was placed. The abdomen was closed layer by layer, and the experiment was finished.

**Observation indexes**

The recovery time of aerofluxus (day), removal time of abdominal drainage tube (day), recovery time of semi-liquid diet (day), incision healing time (day), postoperative length of hospital stay (day) were compared between single-port laparoscopic group and laparotomy group. The incidence of postoperative complications and the postoperative pain were compared between the two groups. The definition of operative mortality was the death of any cause which occurred within 30 days after surgery. Postoperative complications were defined as events that required additional treatment or additional extended hospitalization. The major postoperative complications included postoperative bleeding, anastomotic leakage, stenosis, duodenal stump fistula, obstructive complications, gastroparesis, pancreatitis, incision-related complications, cholecystitis, pulmonary-related complications, urinary-tract infection, deep-vein thrombosis, organ dysfunction and so on. The postoperative complications of different operations were described only statistically in this study. The study use the Pain Rating Index (PRI) and Visual Analog Scale (VAS) separately for assessing postoperative pain fully and objectively. To avoid the effects of postoperative complications on pain assessment, the comparative study of pain was performed only on the patients without surgical complications.

**Statistical treatment**

Data were statistically analyzed using the SPSS 19.0 software; the measurement data were shown in the form of mean ± standard deviation; the enumeration data were analyzed by the chi-square test; the t test was used to compare the mean between groups. P<0.05 was considered statistically significant. The comparisons of PRI and VAS scores were performed by using the variance analysis of repeated measurement data combined with the post-hoc Bonferroni test.

**Results**

**Comparison of clinical data of two groups of patients**

There were no statistically significant differences in sex composition, age distribution, body-
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mass indexes, preoperative complications, tumor size, histological type, and preoperative TNM staging between the two groups (see Table 1 for specific clinical data).

Comparison of two groups of patients in recovery time of aerofluxus, removal time of abdominal drainage tube, recovery time of semi-liquid diet, incision healing time, postoperative length of hospital stay

Two groups of patients successfully completed radical operation of gastric cancer and the differences of the postoperative situations are shown in Table 2 and Figure 1. The recovery time of aerofluxus was 3.2±1.1 days in the laparoscopy group and 4.2±1.3 days in the laparotomy group and the former was less than the latter (P=0.016). The removal time of abdominal drainage tube of single-port laparoscopic group was also earlier than that of laparotomy group (P=0.017). The recovery time of semi-liquid diet of single-port laparoscopic group was 7.5±2.1 days and 8.7±2.2 days in laparotomy group, and the difference was statistically significant (P<0.001). There was no statistically significant difference in incision healing time between the single-port laparoscopic group and the laparotomy group (P=0.21). The lengths of hospital stay of patients in the single-port laparoscopic group were shorter than those of the laparotomy group (11.5±3.9 vs. 13.6±4.1 days).

The order of the postoperative recovery time of the two groups was roughly the same: first restore the exhaust, next remove the drainage tube, and then restore the semi-liquid food, heal wounds and finally leave hospital (see Figure 1).

Comparison of postoperative complications of the two groups

There were no deaths in both single-port laparoscopic group and laparotomy group, and there were respectively 5 cases (8.93%) of postoperative complications in single-port laparoscopic group and 4 cases (7.14%) in laparotomy group. And there were no significant differences (t/χ²=0.646, P=0.595). One case of anastomotic fistula, one case of intestinal obstruction, one case of gastroparesis, one case of pulmonary infection and one case of urinary tract infection were found in the single-port laparoscopic group; one case of intestinal obstruction and one case of gastroparesis, one case of intra-abdominal hemorrhage, one case of pulmonary infection were found in laparotomy group. All patients with complications were cured and discharged after treatment.

Comparison of postoperative pain of the two groups

The variance analysis of repeated measurement data showed significant differences in VAS pain scores between the two groups (P=0.002) and interaction with time (P=0.005). The post-hoc Bonferroni test showed that the VAS scores of single-port laparoscopic group on the first (P=0.002), second (P=0.003), third (P=0.001), fifth (P=0.001) postoperative day were less than those of the laparotomy group. On the seventh postoperative day, the pain was significantly reduced to a lower level and the feeling was not obvious. The VAS scores had no statistical difference between the two groups (P=0.265).

Similar to the VAS score, variance analysis of repeated measurement data revealed significant differences in PRI pain scores between the two groups (P=0.003) and interaction with time (P=0.005). The post-hoc Bonferroni test showed that the PRI scores of single-port laparoscopic group on the first (P=0.002), second (P=0.005), third (P=0.001), fifth (P=0.002) postoperative day were less than those of the laparotomy group. On the seventh postopera-
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Postoperative pain was significantly reduced to a lower level and the feeling was not obvious. The PRI scores had no statistical difference between the two groups (P=0.532).

Postoperative pain changed (Figure 2A and 2B). The change of pain in single-port laparoscopic group showed the characteristics of being fast at first and then slow, while that of laparotomy group was slow at first and then fast. On the seventh postoperative day, the pain was significantly reduced to a lower level and the feeling was not obvious.

Discussion

In recent years, the incidence of gastric cancer has continued to rise in China and most cases have entered the advanced stage when they are in the initial diagnosis. Gastric cancer is still a serious threat to life and a major issue of health and the surgical operation is still the only therapeutic measure which can potentially cure gastric cancer currently [10, 11]. With the improvement of the curative effects of comprehensive treatment, as for those patients who have gastric cancer and expect to obtain long-term survival, they are paying more attention to postoperative recovery and postoperative quality of life and their requirements for postoperative recovery and postoperative quality of life are becoming more and more urgent. Most scholars believed that laparoscopic radical gastrectomy had some other advantages besides the same clinical efficacy as the laparotomy [12-14].

Through this study we found these conclusions. 1) The postoperative recovery time of patients in single-port laparoscopic group was earlier than that of laparotomy group, which indicated that the recovery of gastrointestinal motility of the single-port laparoscopic group was faster than that of laparotomy group. Surgical treatment for the removal of lesions played a role in the treatment, but it was a trauma for other normal tissues, and it could also cause the stress response of the body. The recovery of gastrointestinal motility of the single-port laparoscopic group was faster than that of laparotomy, indicating that single-port laparoscopic surgery could reduce the trauma of other tissues, and it was a better choice when compared with open operation. Bang YJ, Hamabe A and other scholars believed that the recovery time of aerofluxus of patients could be shortened through single-port laparoscopic surgery. This was because that single-port laparoscopic surgery was much more sophisticated in the operation, and the incision was much smaller than that of the open surgery. And thus the single-port laparoscopic surgery had less irritation of the gastrointestinal tract [15, 16]. 2) The postoperative removal time of abdominal drainage tube of single-port laparoscopic group was earlier than that of the laparotomy.

Figure 2. The trends of postoperative pain between two groups. A: The trends of PRI scores of postoperative pain between two groups. B: The trends of VAS scores of postoperative pain between two groups. *P<0.05.
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group, which reduced stimulation of the abdominal organs caused by the drainage tube and the intraperitoneal inflammatory response caused by foreign bodies, and it was also helpful for less laparoscopic adhesion. This was more conducive to recover the gastrointestinal blood supply, while a small intestine serosal surface damage was also effective in reducing postoperative adhesive small bowel obstruction, so that the postoperative recovery of patients became more smoothly, thereby shortening the drainage tube removal time. 3) Patients in the single-port laparoscopic group had an earlier recovery time of semi-liquid diet than those of the laparotomy group, indicating that the accelerated recovery of intestinal peristalsis in patients with single-port laparoscopic surgery was helpful to advance the semi-liquid food eating time and thus quickened the postoperative recovery of patients. So, the postoperative recovery of patients became more smoothly. 4) Patients in the single-port laparoscopic group had a shorter hospital stay than those of the laparotomy group. Because of the features of minimally invasive of single-port laparoscopic surgery, intestinal tract disturbance during operation was significantly reduced. Earlier and more successful recovery of gastrointestinal function made gastrointestinal peristalsis more regularly, reducing the patients' postoperative nausea, vomiting, reflux and other abdominal discomfort, and the enteral nutrition could be applied earlier, which was related to the quality of life of patients after surgery, while earlier discharge could also reduce the pressure on the spirit of patients, and it also had better effects on the prognosis of patients. 5) There was no significant difference between the two groups of patients in the incision healing time. The comparison of the results of this study showed that laparoscopic surgery accelerated the recovery of patients after surgery without increasing the healing time, which was consistent with the reported study results [17]. The recovery time of the two groups of patients was consistent with the normal recovery function of the human body. 6) There were no significant differences in the postoperative complications between the two groups (P>0.05), which was similar to those reported study results, indicating that laparoscopic surgery was a viable and safe technique [18-20]. 7) The postoperative pain in the single-port laparoscopic group was significantly lighter than that of the laparotomy group. A major advantage of laparoscopic radical gastrectomy was less pain and could be significantly alleviated early, which significantly improved the close cooperation of patients during the postoperative recovery period and the subjective experience.

In summary, single-port laparoscopic radical gastrectomy had better effects than laparotomy on the treatment of gastric cancer, with many advantages such as smaller trauma, faster postoperative recovery and improved quality of treatment, which deserved clinical application and development. This study only focused on the short-term results after surgery. The deficiencies were as follows. There was no comparative analysis in the operation time of surgery, bleeding volume, number of lymph node dissection, etc. There was no follow-up study for the postoperative survival rate and other long-term results, which were necessary to study further.

Disclosure of conflict of interest

None.

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