—Case Reports—

Useful Preoperative Simulation of Laparoscopic Surgery for Rectal Cancer in Patients with Kyphosis

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Kyphosis complicates abdominal surgery. Here, we report a case of rectal cancer in a patient with kyphosis who underwent successful laparoscopic surgery after a preoperative simulation. An 81-year-old woman with rectal cancer was admitted to our department, and laparoscopic surgery was planned. Physical examination revealed severe kyphosis. To ensure successful laparoscopic surgery, we conducted a detailed preoperative simulation, including three-dimensional CT simulations of port arrangement and anatomy, simulation of body position, selection of surgical instruments, and preoperative discussion with the anesthesiologist. We planned to insert the first port in the umbilical region for pneumoperitoneum and the camera port in the ventral region under pneumoperitoneum. We planned to insert the ports on the right side of the patient's body from the caudal regions, after considering the location of the inferior mesenteric artery and the limitations in degrees and space attributable to the costal arch and promontorium. Beach chair position was planned. We used a fan-shaped retractor and sponge retractor to remove the small intestine from the surgical view. In preoperative discussions with the anesthesiologist, we decided to maintain pneumoperitoneum pressure at less than 8 mm Hg during the operation, to safeguard respiratory function. Lower anterior resection with D2 lymph node dissection was performed, without intraoperative complications. At 2 years postoperatively, the patient was healthy with no signs of recurrence. Laparoscopic surgery appears to be a suitable choice for patients with kyphosis. We believe that preoperative simulation will result in successful outcomes.

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Key words: kyphosis, laparoscopic surgery, rectal cancer, preoperative simulation

Introduction

Kyphosis tends to increase with age; prevalence was 20-40% in a geriatric population[1]. In patients with kyphosis, abdominal surgery is difficult because of the lack of working space, during both laparotomy and laparoscopic surgery[2].

Here, we report a case of rectal cancer in a patient with kyphosis. The cancer was satisfactorily treated by laparoscopic surgery after preoperative simulation. We also discuss management of colorectal cancer in patients with kyphosis and review the literature.

Case Report

An 81-year-old woman was admitted to our department for assessment of breathlessness and palpitations. Blood tests revealed anemia, and a colonoscopy revealed a type 1 tumor in the upper rectum (**Fig. 1**), which was classified pathologically as tubular adenocarcinoma. CT scanning revealed no signs of lymph node metastasis or distant metastasis. On the basis of these findings, we preoperatively diagnosed rectal cancer, clinical T3N0M0 Stage IIa (according to the Japanese Classification of Colorectal, Appendiceal, and Anal Carcinoma)[3].

On physical examination, the patient had severe

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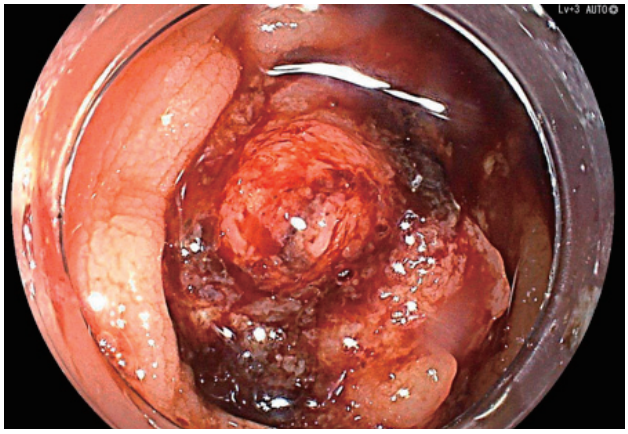

Fig. 1 Colonoscopy revealed a type 1 tumor in the upper rectum.

Fig. 2 Physical examination revealed severe kyphosis.

kyphosis (**Fig. 2**). Her height was 140 cm and body weight was 39 kg. On CT, the angle between the abdominal cavity and thorax was acute because of severe kyphosis, and the intra-abdominal organs were located above the rib cage (**Fig. 3**). To ensure satisfactory laparoscopic surgery, a detailed preoperative simulation was conducted.

Preoperative Simulation

The preoperative simulation comprised 3-D CT simulations of port arrangement and anatomy, simulation of body position, selection of surgical instruments, and preoperative planning with the anesthesiologist.

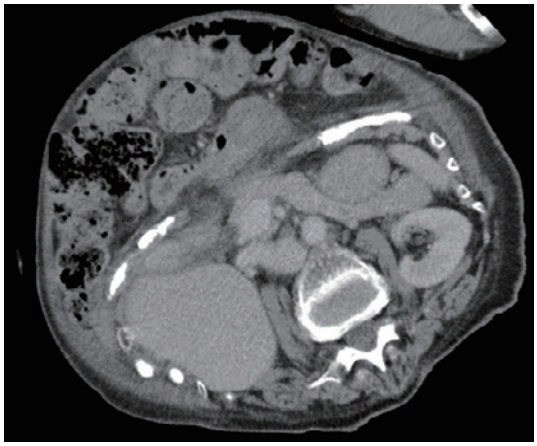

Fig. 3 CT showed that the angle of the abdominal cavity and thorax was acute because of severe kyphosis. Therefore, intra-abdominal organs were located above the rib cage.

3-D CT Simulations of Port Arrangement and Anatomy

We planned to insert the first port from the umbilical region for pneumoperitoneum, and the second port from the ventral region under pneumoperitoneum for the laparoscopic camera port (**Fig. 4A**). The root of the inferior mesenteric artery was located below the rib cage (**Fig. 4B**). Because the costal arch and promontorium limited degrees and space, we planned to insert the ports on the right side of the patient's body at regions that were more caudal than those used for typical cases (**Fig. 4**).

Simulation of Body Position

Because lying down in the supine position was difficult, we used the MagicBed (vacuum posture fixing device), which allows for free adjustment of angle and pressure. Before the operation, the patient positioned herself on the MagicBed, and we simulated the position and degree during surgery and checked the stability. We planned to use beach chair position, with the operating table in 20° reverse Trendelenburg and the legs flexed 45° upward at the hips. To maintain this position throughout the surgery, the patient was secured to the operating table with operating table fixation strips, a body fixture device, acrylic plate, and cushions (**Fig. 5A and B**).

Selection of Surgical Instruments

The abdominal area was small, and there was some concern that the small intestine would disturb the surgical field. Surgical instruments that could gently reposition the small intestine over a wide range were required. We preoperatively prepared a fan-shaped retractor and sponge retractor, which we do not use for patients without kyphosis.

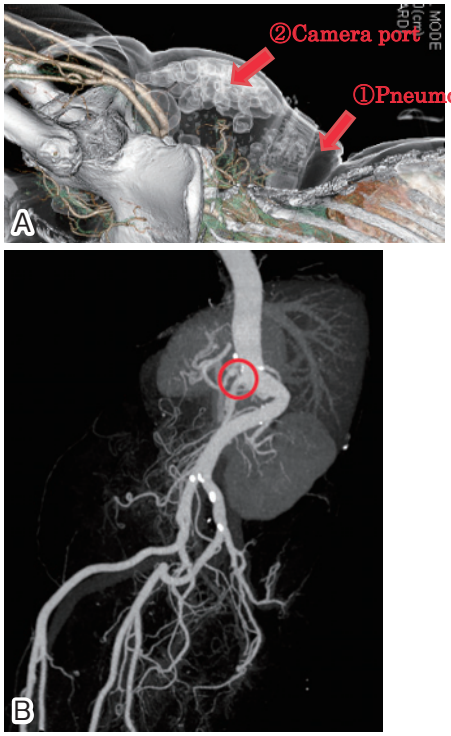

Fig. 4 A: We planned to insert the first port at the umbilical region, for pneumoperitoneum (Arrow ①). We planned to insert the second port at the most ventral region under pneumoperitoneum, for the laparoscopic camera port (Arrow ②). B: The root of the inferior mesenteric artery was located below the rib cage (red circle).

Preoperative Planning with the Anesthesiologist

Forced expiratory volume in 1 s (FEV1) was 1.02 L and forced expiratory volume in 1 s as a percentage of forced vital capacity (FEV1.0%) was 70.5%, indicating that the patient had restrictive ventilatory impairment. In light of this, we decided to maintain pneumoperitoneum pressure at less than 8 mm Hg during the operation. We also confirmed that we would be able to maintain circulatory and respiratory dynamics during surgery.

Intraoperative Findings and Postoperative Course

During the preoperative simulation, we inserted six ports, and lowered the head side at an angle of 20°. Pneumoperitoneum pressure was maintained at 8 mm Hg. We used a fan-shaped retractor and sponge retractor to remove the small intestine from the surgical view (**Fig. 6A and B**). The movement of the forceps was restricted to some extent, but we were able to resect the rectum as planned (**Fig. 6C**). We extended the incision of the second port to remove the excised rectum from the abdominal cavity (**Fig. 6D**). Lower anterior resection with D2 lymph node dissection was performed, without intraoperative complications. The operation time was 4 hours 14 minutes and blood loss was minimal.

The patient was discharged from our department at 13 days postoperatively, with no postoperative complications. The rectal cancer was diagnosed pathologically as T3N0M0 Stage IIa. The patient was healthy at 2 years postoperatively, with no signs of recurrence.

Discussion

Kyphosis tends to increase with age. The cause is multifactorial and involves interaction between degenerative changes, vertebral compression fractures, muscular weakness, and altered biomechanics[1]. Japanese males and females have the longest life expectancy worldwide (United Nations Population Division. World Population Prospects: The 2019 Revision; https://population.un.org/wpp/). Therefore, the number of elderly adults with kyphosis, as well as those requiring medical treatment for unrelated conditions, is increasing.

In patients with kyphosis, abdominal surgery, including laparotomy and laparoscopic surgery, is difficult, and the superiority of these procedures for this subpopulation

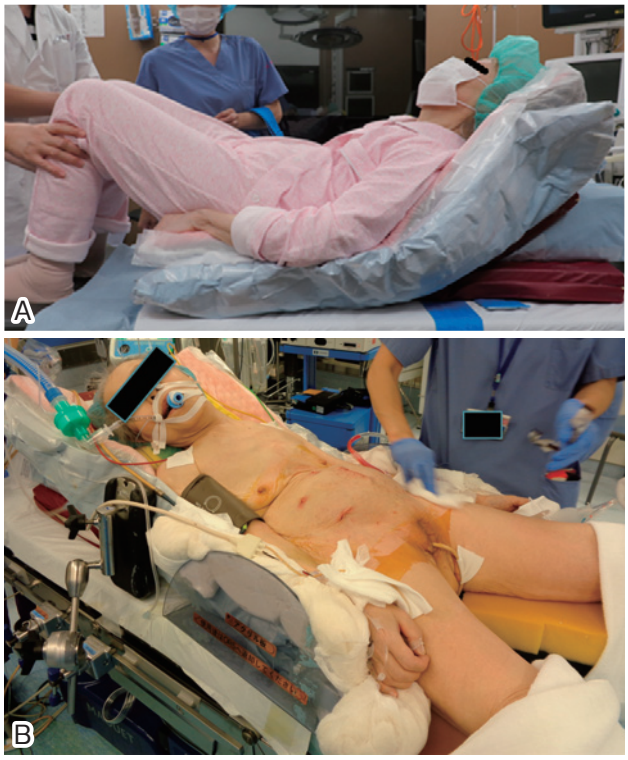

Fig. 5 A, B: Because the supine position was difficult, we used the MagicBed, which allows for free adjustment of angle and pressure. Before the operation, the patient positioned herself on the MagicBed, and we simulated the position and angles during the operation and checked the stability. The beach chair position was planned. To maintain her body position throughout the surgery, the patient was fixed to the operating table with operating table fixation strips, a body fixture device, acrylic plate, and cushions.

remains unclear[2]. Laparotomy limits bleeding and secondary handling damage to other organs during surgery, because of the wide visual field[4]. However, it has been reported that patients with kyphosis often have respiratory and cardiac dysfunction due to compression and deformation of the thorax[5], and laparoscopic surgery has a lower risk than laparotomy of postoperative respiratory complications, because there is less postoperative pain and fewer effects on respiratory muscles[6]. Therefore, laparoscopic surgery may be a good choice for patients with kyphosis who are at low risk. In the present case, FEV1 was 1.02 L, FEV1.0% was 70.5%, and the patient showed restrictive ventilatory impairment. Therefore, laparoscopic surgery was selected.

To adequately perform laparoscopic surgery in patients with kyphosis, a detailed preoperative simulation is required. In patients with kyphosis, the abdominal area is small, and insertion of laparoscopic ports is difficult. In our patient, we inserted the first port from the umbilical region for pneumoperitoneum, because this region is the site of the thinnest abdominal wall and has no important blood vessels, thus resulting in easy and safe access[7,8]. However, as preoperatively simulated, by inserting the laparoscopic camera from this port, we were unable to achieve a good surgical view because of the acute angle to the pelvic region. Therefore, under pneumoperitoneum, we inserted the second port from the most ventral region for the camera port, which we believe provides the best visual field. Ultimately, we inserted six ports, which is one port more than is usually required for laparoscopic lower anterior resection. However, we believe that increasing the number of ports in order to reduce the risk of the operation is acceptable. Some reports mention the possibility of inserting the first port along the midline around the umbilicus by using the open method without the risk of bleeding[9], and if we were able to simulate the most ventral region under pneumoperitoneum preoperatively, the first, umbilical region port was not needed. When we next experience a similar case, we want to attempt this operation with fewer ports.

To remove the small intestine from the intra-abdominal working space, the patient's body position and selection of surgical instruments is important. It has been reported that the Trendelenburg position is ideal for lower abdominal laparoscopic surgery[10]. However, this position is difficult for patients with kyphosis. When supine position and beach chair position were compared, the intra-abdominal pressure was equivalent but intra-abdominal volume was greater in the beach chair position[10]. Therefore, we preoperatively planned the beach chair position using the MagicBed, in which the angle and pressure can be freely adjusted. We achieved a good surgical view by using the beach chair position; however, the sacral region protrudes in patients with kyphosis, and development of pressure ulcers must be avoided. To prevent pressure ulcers, changing the body position frequently during surgery and decompressing the sacral region using cushions and dressing materials is important. In addition, shortening the operation time is effective. Detailed preoperative simulation helps shorten operation time, thus contributing to prevention of pressure ulcers.

To create an intra-abdominal working space, lifting the rib from outside of the body using surgical sutures, a procedure called the "rib-lifting method" was described[11]; however, there is a risk of organ damage in this procedure. In our case, we used a fan-shaped retractor and sponge retractor, which could gently reposition the small

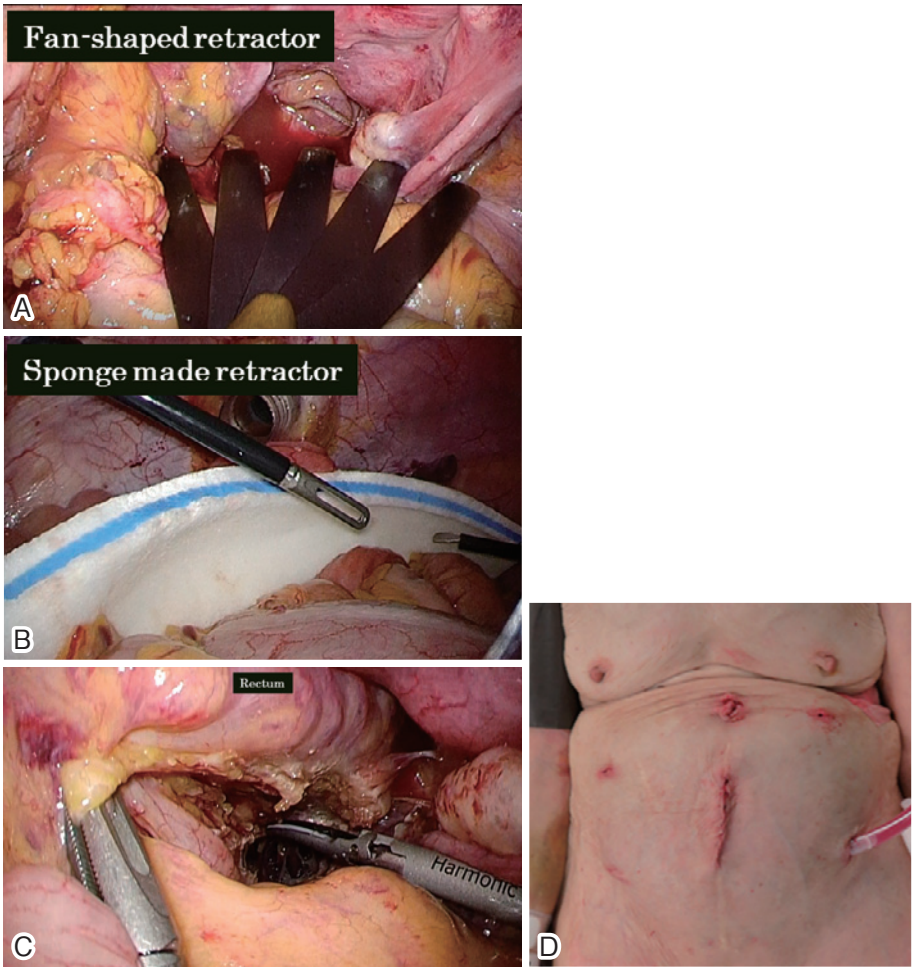

Fig. 6 A, B: To remove the small intestine from the surgical view, we used a fan-shaped retractor and sponge retractor. C: Forceps movement was restricted to some extent, but we were able to resect the rectum as planned. The rectum was mobilized with a medial to lateral approach. D: We inserted six ports in total. We extended the incision of the second port to remove the excised rectum from the abdominal cavity.

intestine over a wide area and achieved a good surgical view. Similar instruments are used in gasless laparoscopic surgery and were reported to be safe and easy to handle[12].

Because of the detailed preoperative simulation, laparoscopic surgery was adequately performed. The No. 252 lymph node was dissected, and vascularization of the inferior mesenteric artery was performed. However, movement of the forceps was restricted to some extent, and the operation time was slightly longer than in typical cases. As compared with laparotomy, laparoscopic surgery is disadvantageous for stopping bleeding and secondary handling damage to other organs during surgery[4]. Therefore, in kyphosis patients with a high risk of bleeding and damage to other organs during surgery, such as obese patients and those with a history of laparotomy, laparoscopic surgery may not be indicated.

In addition, this case was clinical stage IIa, and according to the 2019 Japanese Society for Cancer of the Colon and Rectum (JSCCR) guidelines for treatment of colorectal cancer[13] D3 lymph node dissection is recommended. However, in our patient, the root of the inferior mesenteric artery was located below the rib cage, and dissection of the No. 253 lymph node was expected to be technically high risk, both for laparotomy and laparoscopic surgery. According to the 2019 JSCCR guidelines for treatment of colorectal cancer[13], the probability of No. 253 lymph node metastasis in T3 upper rectum cancer is 2.7%. The patient was elderly, and epidural anesthesia was difficult because of kyphosis. Thus, postoperative pain was expected, which could lead to postoperative respiratory complications. Preoperative discussions with anesthesiologists and surgical nurses confirmed that we could maintain body position and circulatory and respi-

ratory dynamics during surgery. Thus, we decided to perform laparoscopic lower anterior resection with D2 lymph node dissection. In conclusion, laparoscopic surgery may not be indicated for all kyphosis patients: patient age, background, and clinical stage of cancer, among other criteria, should be evaluated when selecting the operative method.

Reports of laparoscopic surgery for patients with colorectal cancer with kyphosis are rare. We searched for articles in the PubMed database, using the keywords "kyphosis" and "colorectal cancer," "colon cancer," or "rectal cancer." We found only four cases of laparoscopic colectomy for patients with kyphosis. Three cases were right hemicolectomy and one case was sigmoidectomy[14,15]. To our knowledge, the present study is the first to report lower anterior resection. We satisfactorily completed this laparoscopic surgery; however, the procedure in the pelvic region was difficult because of the lack of working space and the acute angle of the forceps. In cases in which the tumor is located more toward the anal side than in our case, laparoscopic surgery in the pelvic region will be more difficult, and a procedure from the perineal side—transanal total mesorectal excision (TaTME)[16]—may be indicated.

We encountered a rare case of rectal cancer with kyphosis, in which laparoscopic surgery was satisfactorily performed. With the growing older population, the number of colorectal cancer patients with kyphosis is increasing, and we believe that laparoscopic surgery is effective because of the low risk of postoperative complications. Preoperative simulation is important when attempting to reduce the risk of laparoscopic surgery for patients with kyphosis.

Conflict of Interest: None declared.

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