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TECHNICAL NOTE

A seven-step dissection technique for robotic total mesorectal excision of rectal cancer

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Introduction

In rectal cancer, surgical quality has a very important role in preventing anastomotic leakage [1], preserving urogenital function [2], and facilitating local control [3].

Robotic surgery has been gaining popularity due to the advanced technology which may improve the quality of rectal cancer surgery. A few studies have reported that the oncological outcomes of robotic total mesorectal excision (Ro-TME) and laparoscopic (Lap)-TME are comparable [4, 5]. A more recent study has shown the advantage of Ro-TME as regards the circumferential resection margin (CRM) [6], suggesting that robotic technology has potential to improve oncological outcomes. However, the quality of robotic surgery generally depends on the console surgeon's skills, and therefore detailed standardization of the procedure is urgently required.

So far, several reports have provided technical tips regarding Ro-TME [7, 8]. However, they mainly focused on docking, port replacements, and the general flow of the operation, and did not provide a detailed technique.

For the best potential performance with robotic surgery, we standardized the Ro-TME procedure. The aim of this technical note is to describe our newly developed 7-step Ro-TME procedure, focusing on how to expose the dissection layer during the TME process.

Materials and methods

Following seven cases as an initial experience, the standardized 7-step Ro-TME was performed for ten consecutive patients between March and October 2018 at our institution using the da Vinci Si surgical system. After 2 years of training at a high-volume center of robotic rectal cancer surgery in Japan, MN performed robotic procedures as a console surgeon in the present institution from June 2017. Ethics committee approval from our institution was obtained prior to conducting the study (IRB Approval No. B170700003). Informed consent was obtained from all patients.

Port placement and docking

Patients were placed in a lithotomy position with 10°–20° Trendenburg and 10° right tilt. In principle, one camera port, three robotic ports, and two laparoscopic 12 mm trocars were placed. The port placement in the abdominal phase is shown in Fig. 1a. Following camera port insertion in the umbilicus, laparoscopic 12-mm trocar was placed on the A1. This port was placed on the line connecting the right anterior superior iliac spine and left nipple and 3 cm away from the anterior superior iliac spine. Then, the robotic port was placed as R1, located at 2 cm caudal of the half point of the camera port and A1. Next, laparoscopic 12-mm port was placed as R3, just lateral of the right inferior epigastric artery and at the lowest point of the abdominal space. R2 was placed on the right mid-clavicular line and at 3 cm caudal of the lowest limb. A2 was placed on the left mid-clavicular line at the umbilical level.

Dual docking was usually chosen. The patient cart was docked next to the left leg on a line from the left upper iliac

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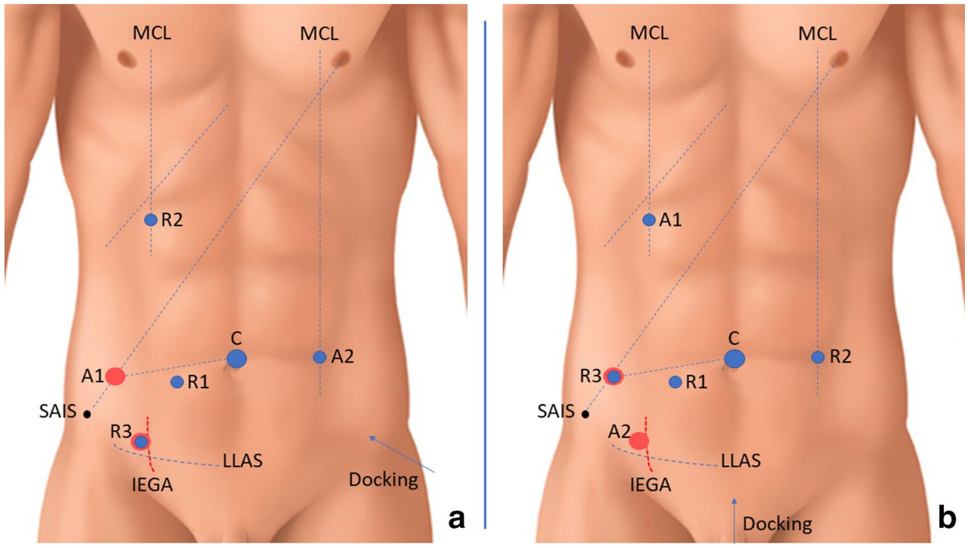

Fig. 1 Port placement and settings. **a** Abdominal phase, **b** pelvic phase. A laparoscopic 12-mm trocar is shown in the red circle. A robotic 8-mm trocar is shown in the blue circle. *MCL* mid-clavicular line, *SAIS* superior anterior iliac supine, *IEGA* inferior epigastric artery, *LLAS* the lowest line of the abdominal space, *C* camera port, *R* robot port, *A* assistant port

spine to the umbilicus during the abdominal phase. The 1st, 2nd, and 3rd robotic arms were inserted via R1, R2, and R3 ports, respectively. Regarding R3, an 8-mm robotic port was inserted into the 12-mm laparoscopic port, then docked with a robotic 3rd arm.

During the pelvic phase, the patient cart was re-docked on the mid-line between both legs. The port setting in the pelvic phase is shown in Fig. 1b. The assistant used the A1 port to make a pulling traction using the gauze, as described in the following section. The A2 port was used for gauze or suction tube insertion.

Through the whole process, surgeons usually operated arm 1 (monopolar curved scissors) in the right hand, and operated arm 2 (fenestrated bipolar forceps) in the left hand. Arm 3 (double fenestrated grasper) was also utilized to develop the operative field.

Abdominal phase

In the abdominal phase, dissection of the inferior mesenteric artery (IMA) and mobilization of the left-sided colon and upper rectum are performed. This phase begins with IMA mobilization. Under sufficient traction for IMA pedicle upward by the 3rd arm, IMA is mobilized, then dissected at its root. Following left colic artery and inferior mesenteric vein dissection, left-sided colon and upper rectal mobilization is performed. The 3rd arm gently grasps the mesentery upward, and 2nd arm pulls the retroperitoneum downward for countertraction; the dissection between the retroperitoneum and left-sided colonic mesentery, from medially to laterally, is performed. In the same plane, which equals the TME plane, posterior dissection of the upper rectum is performed. Then, dissection of the lateral adhesion of the left-sided colon and upper rectum is performed. The gauze is inserted between the mesentery and retroperitoneum for three-dimensional (3D) traction, as described in the following section. After changing the port setting and re-docking, rectal mobilization below the mid-rectum is performed as the pelvic phase.

Pelvic phase

3D traction

During TME, clear exposure of the dissection line is important. 3D traction makes it possible to visualize the dissection layer around the rectum. The essential traction is the Z axis traction which pulls the rectum out from the pelvis. Z axis traction is formed by the assistant's subcostal port. The assistant pulls the gauze, which rolls the rectum up. Once sufficient Z axis traction is formed, the 2nd and 3rd arms (X and Y axis traction respectively) will function as counter traction. Then, the 3D traction around the operating field allows clear visualization of the dissection line (Online Resource 1: 3D traction).

First step: Posterior dissection of the mid-rectum

The whole 7-step procedure is shown in an online video (Online Resource 2). The 7-step TME begins with posterior dissection of the mid-rectum. Under sufficient Z axis traction, the assistant moves the rectum ventrally to widen the posterior space. The 3rd arm pushes the rectum ventrally to help the traction. The 2nd arm often grasps the mini-rolled gauze to gently push up the posterior wall of the rectum, and the dissecting line will be clearly visualized (Fig. 2). The dissection line either above or behind the prehypogastric nerve fascia is selected depending on the tumor status. Once the dissection level surpasses the peritoneal reflection level, the second step is performed.

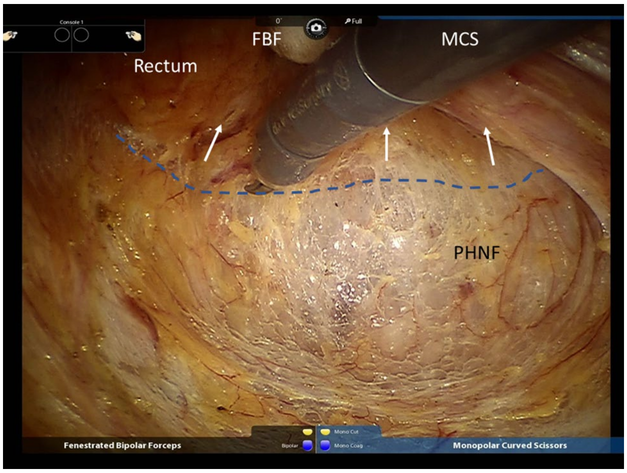

Fig. 2 First step: Posterior dissection of the mid-rectum. *MCS* monopolar curved scissors, *FBF* fenestrated bipolar forceps, *PHNF* prehypogastric nerve fascia. Arrows: traction vectors in the surgical field. Dotted line: dissection line

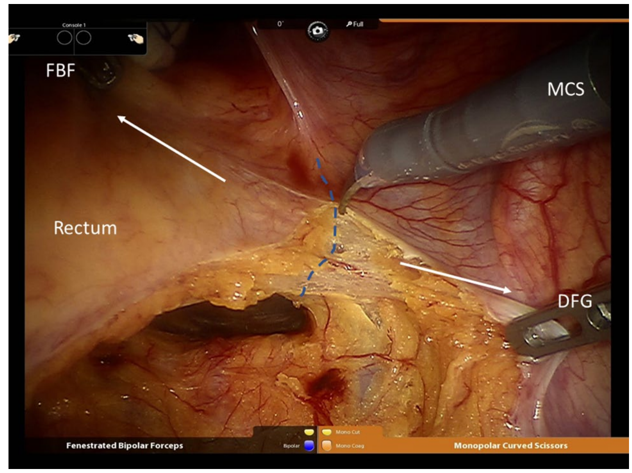

Fig. 3 Second step: Lateral dissection of the mid-rectum. *MCS* monopolar curved scissors, *FBF* fenestrated bipolar forceps, *DFG* double fenestrated grasper. Arrows: traction vectors in the surgical field. Dotted line: dissection line

This 7-step procedure clearly describes the specific region to dissect and final task in each step to ensure sufficient 3D traction in every phase of dissection. For example, in the 1st step, it is technically possible to dissect the whole posterior space down to the levator space as the 1st step; however, in some cases, we experienced difficulty in maintaining sufficient 3D traction in the deep pelvis owing to the undissected lateral ligament or anterior attachment, which resist rectal traction. Thus, we think that dividing the procedure into seven steps contributes to maintaining good traction throughout the whole TME process, with reproducibility regardless of patient factors or surgeons' skills.

Second step: Lateral dissection of the mid-rectum

In the second step, lateral dissection of the mid-rectum is performed. The right side is usually dissected first, followed by the left. When exposing the field in the right side, the assistant makes Z axis traction tilted 15° to the left to widen the space on the right. Counter traction, formed by the 2nd arm grasping the anterior wall of the rectum and the 3rd arm grasping the peritoneum of the pelvic wall, will enable linear dissection line visualization (Fig. 3). Once the dissecting level reaches the peritoneal reflection level, the third step is performed.

Third step: Antero-lateral dissection behind the seminal vesicle

In the 3rd step, anterolateral dissection below the peritoneal reflection is performed. Under the appropriate Z axis traction, the 3rd arm grasps the anterior side of the peritoneal reflection, then lifts it ventrally. The 2nd arm, grasping the mini-rolled gauze, pushes the anterior rectal wall to make counter traction. After cutting the peritoneum at the bottom of the peritoneal reflection, a loose dissecting layer will appear (Fig. 4). The dissection layer either above or behind the Denonvillier's fascia can be selected depending on the tumor status [2]. Once the dissection level surpasses the seminal vesicle, the fourth step is performed.

Fourth step: Lateral dissection of the lower rectum

The main purpose of this step is to enable lateral ligament dissection. The lateral ligament is a bundle, comprising the middle rectal artery and rectal branch from the pelvic nerve

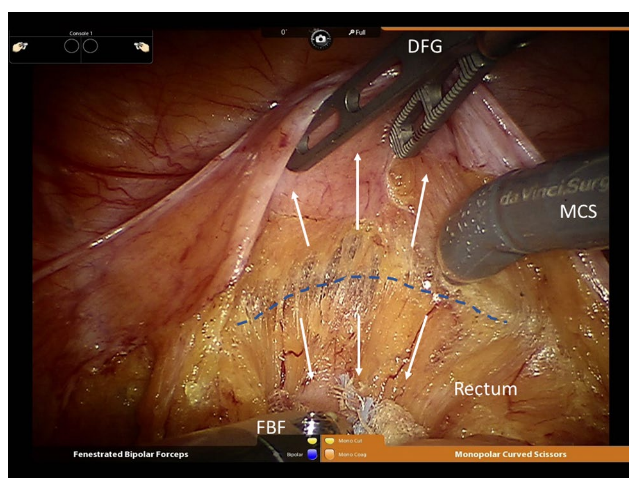

Fig. 4 Third step: Anterolateral dissection behind the seminal vesicle. *MCS* monopolar curved scissors, *FBF* fenestrated bipolar forceps, *DFG* double fenestrated grasper. Arrows: traction vectors in the surgical field. Dotted line: dissection line

plexus, bridging the rectum and pelvic side wall. Given that the lateral ligament is dense, the appropriate dissection line may be unclear. With our 7-step method, the posterior and anterior spaces around the lateral ligament are already freed; thus, the dissection line is visualized. Similar to the 2nd step, sufficient Z axis traction, medial traction of the rectum by the 2nd arm, and lateral traction by the 3rd arm allow for a clearer visualization of the shape of the lateral ligament (Fig. 5). Dissection is performed with a monopolar on the medial line of the lateral ligament to avoid damaging the autonomic nerve plexus.

Fifth step: Posterior dissection of the lower rectum

In this step, pelvic floor dissection starts. Prior to this step, positioning of the wide gauze is recommended to move the anal side of the rectum to maintain sufficient Z axis traction. Similar to the 1st step, the assistant moves the gauze ventrally to dilate the posterior space. The 3rd arm pushes the rectum ventrally to help the assistant's traction. The 2nd arm, grasping the mini-rolled gauze, pushes up the posterior wall of the rectum to allow visualization of the dissecting line (Fig. 6). Posterior wall dissection ends when it reaches the levator muscle.

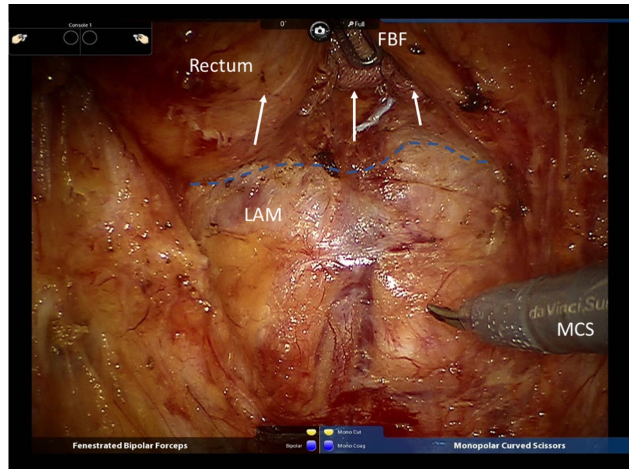

Fig. 6 Fifth step: Posterior dissection of the lower rectum. *MCS* monopolar curved scissors, *FBF* fenestrated bipolar forceps, *LAM* levator ani muscle. Arrows: traction vectors in the surgical field. Dotted line: dissection line

Sixth step: Anterior dissection behind the prostate

In the 3rd step, the anterior dissection stops at the seminal vesicle level, because sufficient counter traction cannot be performed at the prostate level. In the 6th step, mobility of the rectum is better than in the 3rd step; thus, anterior exposure at the prostate level can easily be achieved. The 3rd arm pushes the prostate up ventrally, while the 2nd arm pushes the anterior wall of the rectum dorsally with the mini-rolled gauze to visualize the dissecting line (Fig. 7). The extent of anterior dissection depends on the rectal transection level.

Seventh step: Lateral dissection from the neurovascular bundle (NVB)

In the last step, the remaining lateral dissection is performed. The anal edge of the anterolateral mesorectum firmly attaches to the NVB. Without appropriate tension, the dissection easily injures the NVB. Hence, sufficient Z axis traction should be confirmed first; then, the medial traction of the rectum by the 2nd arm and the lateral traction by

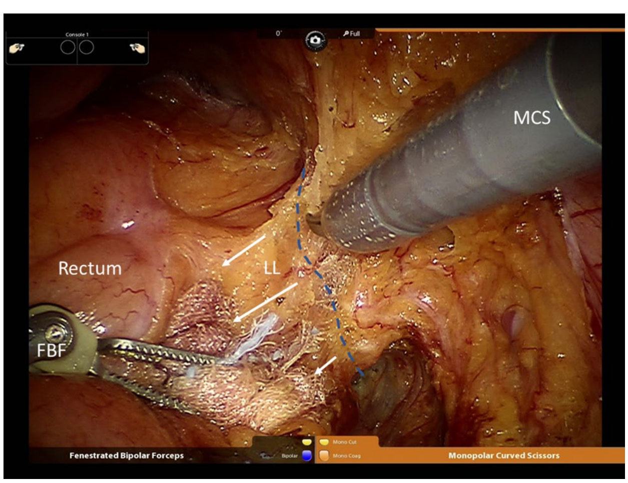

Fig. 5 Fourth step: Lateral dissection of the lower rectum. *MCS* monopolar curved scissors. *FBF* fenestrated bipolar forceps, *LL* lateral ligament. Arrows: traction vectors in the surgical field. Dotted line: dissection line

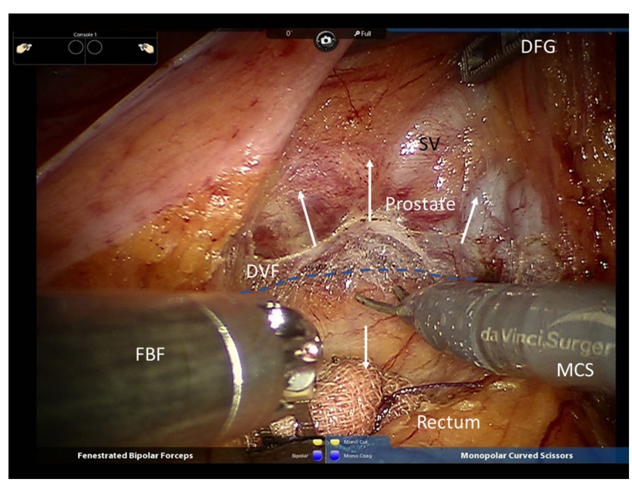

Fig. 7 Sixth step: Anterior dissection behind the prostate. *MCS* monopolar curved scissors, *FBF* fenestrated bipolar forceps, *DFG* double fenestrated grasper, *DVF* Denonvillier's fascia. Arrows: traction vectors in the surgical field. Dotted line: dissection line

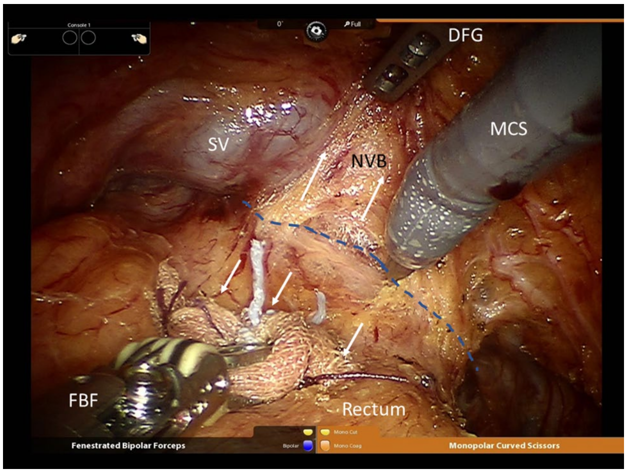

Fig. 8 Seventh step: Lateral dissection from the neurovascular bundle. MCS monopolar curved scissors, FBF fenestrated bipolar forceps, DFG double fenestrated grasper, NVB neurovascular bundle. Arrows: traction vectors in the surgical field. Dotted line: dissection line

the 3rd arm will allow visualization of the border between the mesorectum and the NVB (Fig. 8). Even a minor NVB injury may lead to massive bleeding; thus, dissection has to be performed carefully. Once the anterolateral attachment is dissected, the postero–lateral area becomes very loose, allowing for easier dissection.

Table 1 Patient characteristics and short-term results ($n = 10$)

Parameters	
Age (years)	59 (34–65)
Sex	
Male	9
Female	1
Body mass index (kg/m^2)	25.3 (18.0–34.0)
The distance from the anal verge to the tumor (cm)	5.0 (2.0–13.0)
Type of operation	
Low anterior resection	6
Intersphincteric resection	2
Abdominoperineal resection	2
Diverting stoma construction	8
Tumor size (cm)	4.0 (1.8–5.5)
TNM Stage T 1/2/3/4	5/0/4/1
Operative time (min)	
Total operative time	313 (233–419)
Console operative time	152 (121–239)
Estimated blood loss (ml)	14 (2–240)
Postoperative complication[a]	1
Ileus	1
Postoperative hospital stay (days)	13 (9–19)
Lymph nodes harvested	22 (8–31)
Positive resection margin	0 (0.0%)

Continuous variables are presented as median with range

[a]More than Grade 3 postoperative complication according to the Clavien–Dindo classification was evaluated

Results

Patient characteristics and short-term results are presented in Table 1. The median length of follow-up was 123 days (range 35–246 days). The cohort included nine males and one female with a median age of 59 years (range 34–65 years). The median distance from the anal verge to the tumor was 5 cm. Postoperative complications were evaluated according to the Clavien–Dindo classification system. There were no cases of anastomotic leakage or urinary retention. One case of ileus occurred due to outlet obstruction of the diverting stoma. A diverting stoma was constructed in all patients with anastomosis. The pathology report confirmed negative resection margins in all patients.

Discussion

Our 7-step procedure is based on two principles. First, always keep the Z axis traction to visualize the dissection plane. In our procedure, a wide gauze with sufficient friction contributes to maintaining the Z axis traction. Second, lateral dissection is followed by anterior and posterior dissections. Given that the dissecting line around the pelvic nerve plexus and NVB may be unclear, autonomic nerve injury may easily occur. Our procedure allows dissection of the anterior and posterior antecedent to the lateral demanding field, which visualizes the sandwiched lateral dissection line.

Our standardized 7-step Ro-TME procedure appears to be safe and effective. We hope that this method will improve the surgical outcome following Ro-TME.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval The approval from the ethics committee of our institution was obtained prior to conducting the study.

Informed consent Informed consent was obtained from all individual participants included in the study.

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