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Review Article

Transanal Total Mesorectal Excision for Rectal Cancer: Toward Standardization of the Surgical Technique

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Abstract

Laparoscopic surgery is widely used for rectal cancer; however, this technique is challenging due to tapering of the mesorectum in the pelvis, and the forward angle of the distal rectum, which renders this part of the rectum less accessible from the abdominal cavity. Hence, concerns regarding its safety and curability have been raised, particularly for inadequate distal and circumferential resection margins. Recently, transanal total mesorectal excision (TaTME), which involves endoscopic total mesorectal excision (TME) retrogradely from the anal side, has attracted attention worldwide as a solution to these problems. TaTME is superior to the conventional laparoscopic approach for rectal cancer in terms of both oncological and functional preservations. However, a shallow learning curve caused by the unfamiliar anatomical view from the anal side can pose challenges. Therefore, an efficient educational system needs to be established. Randomized controlled trials comparing conventional laparoscopic TME with TaTME are ongoing to demonstrate the usefulness of TaTME. This article reviews changes in the surgical treatment of rectal cancer, with a focus on TaTME, and describes the indications, surgical techniques, and training curricula for TaTME.

Keywords

transanal total mesorectal excision, rectal cancer, single stapling technique, distal margin, circumferential resection margin

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Introduction

Laparoscopic surgery is widely used for rectal cancer. However, tapering of the mesorectum in the pelvis and the forward angle of the distal rectum, which renders this part of the rectum less accessible from the abdominal cavity, pose significant challenges during surgery. As a result, concerns regarding the curability of this surgical approach have been raised. Recently, transanal total mesorectal excision (TaTME), which involves endoscopic total mesorectal excision (TME) performed retrogradely from the anal side, has attracted attention worldwide as a solution to these problems. TaTME offers several advantages: First, it can secure adequate distal margin (DM) and circumferential resection margin (CRM) under a good surgical field of view. Second, it allows better visibility and preservation of the autonomic nerves. Third, a highly reproducible surgical field can be achieved even in difficult cases, such as in male patients with obesity having a narrow pelvis or bulky tumors. TaTME is superior to the conventional laparoscopic approach for rectal cancer treatment in terms of both oncological and functional preservations. In this article, we review changes in the surgical treatment of rectal cancer, with a focus on TaTME. Furthermore, we describe the indications, surgical techniques, and training curricula for TaTME.

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Changes in the Surgical Treatment of Rectal Cancer

Surgical treatment of rectal cancer has significantly evolved over the years. Heald et al.[1] proposed the TME in 1982, and Quirke et al.[2] reported the importance of CRM in 1986. Completing the TME and securing the CRM significantly contribute to the improvement of the local control rate in rectal cancer surgery.

Earlier, Miles' operation, which was first reported in the early 20th century, used to be the mainstream surgery for low rectal cancer. However, the development of surgical devices, such as linear and circular staplers, led to the widespread use of anal preservation surgery. In 1994, Schiessel et al.[3] proposed intersphincteric resection for patients with low rectal cancer to avoid permanent colostomy.

The introduction of laparoscopic surgery was another major advancement in this field. The laparoscopic approach has enabled the recognition of fine anatomy through its magnifying visual effect and the performance of precise dissection, which could not be achieved with open surgery. The ability to share surgical information visually among surgeons in real time has also significantly contributed to surgical education. However, laparoscopic surgery for rectal cancer has not been firmly established. An international randomized controlled trial (RCT), COLOR II, comparing open versus laparoscopic surgery was conducted[4]. The trial showed that the pathological CRM (pCRM)-positive rate was comparable between the open and laparoscopic surgery groups and that the laparoscopic surgery was not inferior in terms of 3-year local recurrence rate and 3-year disease-free survival rate. These results were consistent with those of the COREAN trial[5]. Contrarily, the ALaCaRT[6] and ACOSOG Z6051 trials[7] showed a higher pCRM-positive rate for the laparoscopic surgery group in terms of short-term oncological outcomes, which raised concerns regarding the curability of laparoscopic surgery for rectal cancer.

Laparoscopic surgery for rectal cancer is challenging, in part due to the limited surgical maneuverability caused by the deep and narrow pelvic space. Robotic surgery can address some of the limitations of laparoscopic rectal cancer surgery by providing an immersive three-dimensional depth of field, articulating instruments, and a stable camera platform. However, the ROLARR trial[8] failed to demonstrate the superiority of robotic surgery for rectal cancer to conventional laparoscopic surgery. Nonetheless, the REAL trial[9] successfully showed that robotic surgery for middle and low rectal cancer enabled better resection than conventional laparoscopic surgery, with less surgical trauma and better postoperative recovery. Later on, TaTME, the focus of this study, was developed to overcome the challenges associated with laparoscopic surgery for rectal cancer.

Changes in Transanal Endoscopic Surgery

Transanal endoscopic resection of rectal tumors has evolved over time, starting with transanal local excision under direct vision, followed by transanal endoscopic microsurgery (TEMS) and transanal minimally invasive surgery (TAMIS), and now to TaTME.

Transanal local excision was not only limited to lower rectal tumors but also carried the risk of incomplete tumor resection. To address these issues, Buess et al.[10] proposed TEMS in 1983, which allowed *en bloc* resection of rectal tumors with a stable endoscopic view. However, TEMS has limitations, including the requirement for complex specialized instruments, high equipment costs, and a steep learning curve.

An access platform developed for single-incision laparoscopic surgery (SILS) has been recently applied to transanal endoscopic surgery. Atallah et al.[11] named this technique TAMIS and reported its outcomes in 2010. TAMIS is cost-effective and easy to perform as it uses the same instruments as laparoscopic surgery. This technique has since been applied to a range of procedures and has evolved into TaTME[12].

Indications for TaTME

In 2012, our institution adopted TaTME for the treatment of early-stage lower rectal cancer, and we have since expanded its indications to include advanced rectal cancer located within 10 cm from the anal verge, recurrent rectal cancer, and multivisceral resection, including total pelvic exenteration. When introducing TaTME, it is advisable to begin with early-stage middle rectal cancer to ensure safe implementation. One of the potential advantages of TaTME is its ability to control the dissection plane in the deep and narrow pelvis, which has traditionally been challenging with the conventional transabdominal approach. Thus, we believe that the benefits of TaTME will be most evident in cases with difficult conditions for deep pelvic manipulation, such as male sex, narrow pelvis, obesity, large tumors, enlarged prostate, large uterine myoma, and a history of pelvic surgery.

Surgical Technique for TaTME

A two-team surgery that combines the transabdominal and transanal approaches can maximize the benefits of TaTME. However, because TaTME requires a unique anatomical understanding that differs from that for laparoscopic TME, there is a risk of dissection plane misidentification, which can lead to injuries to the autonomic nerves and urethra. A report on the postoperative outcomes of 720 TaTME cases by the TaTME registry collaborative[13] indicated that dis-

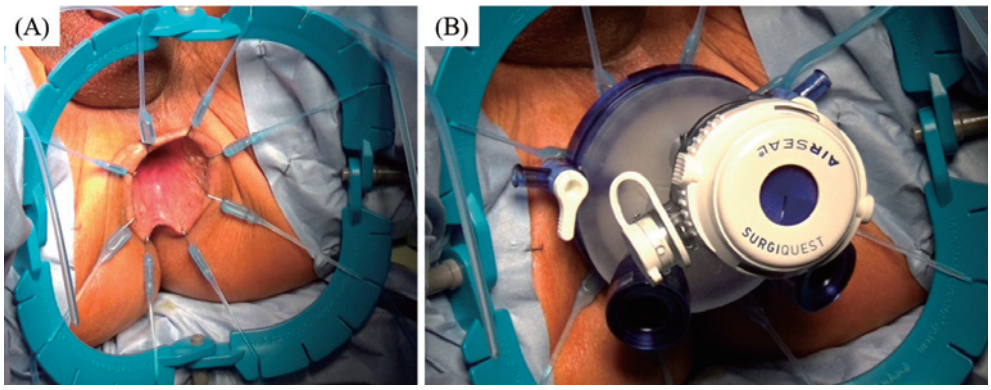

Figure 1. Installation with (A) Lone Star Self-Retaining Retractor (CooperSurgical, Inc., Trumbull, CT, USA) and (B) GelPOINT Path Transanal Access Platform (Applied Medical Resources Corp., Rancho Santa Margarita, CA, USA).

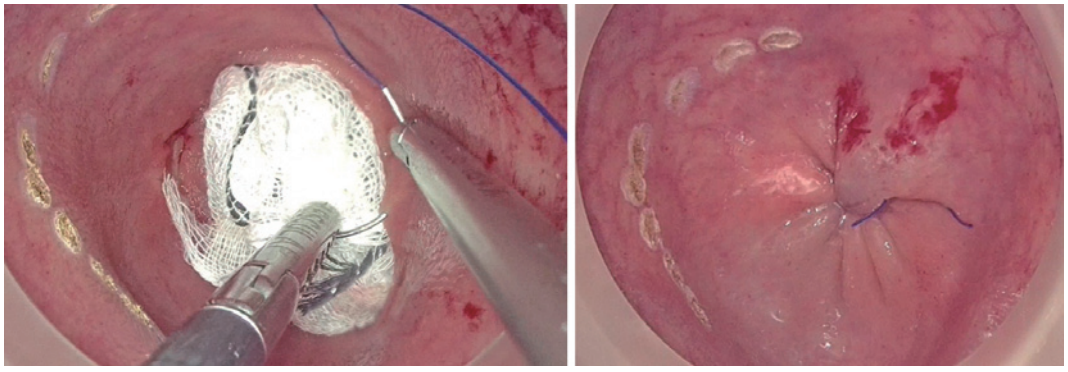

Figure 2. Marking and purse-string closure for the distal rectal stump.

section plane misidentification occurred in 7.8% of cases, organ injury in 1.5%, and urethral injury in 0.7%. The two-team surgery reduces the risk of misidentifying the dissection plane by allowing the transabdominal and transanal teams to share information regarding the dissection plane. This approach also shortens the operative time and reduces surgical invasiveness.

1. Purse-string closure for the rectum

In our approach, a Lone Star Self-Retaining Retractor (CooperSurgical, Inc., Trumbull, CT, USA) was applied to the anal verge to expose the transanal surgical field (Figure 1A). Next, the GelPOINT Path Transanal Access Platform (Applied Medical Resources Corp., Rancho Santa Margarita, CA, USA) was used (Figure 1B). These procedures should be carefully performed to avoid injury to the rectal mucosa. Fogging due to mist and bellowing due to suction are other issues related to standard insufflation devices used in TaTME; therefore, AirSeal iFS (CONMED Corp., Largo, FL, USA), a CO_2 circulatory insufflation device with a pressure sensor, should be used. In our approach, the tumor location was confirmed endoscopically, markings were made at a sufficient DM from the lower edge of the tumor, and the rectum on the anal side of the tumor was closed with a purse-string suture at the submucosal depth (Figure 2). A double-purse-string closure is always performed as intraoperative closure failure can cause local recurrence due to tumor cell dissemination[14]. In 2019, Norway reported multifocal local recurrence during the early postoperative period after TaTME[15], which may be attributed to incomplete purse-string closure. Thus, mastering the technique of purse-string closure is essential before performing TaTME. After the purse-string closure is complete, the transanal surgical field should be thoroughly irrigated to prevent tumor cell implantation.

2. Rectotomy

To perform rectotomy, the previously placed markings are used as landmarks. The angle of entry of the electrocautery device tends to be oblique; thus, it is crucial to make a perpendicular full-thickness incision into the rectal wall to secure the CRM. The incision was made from the luminal side in the order of the rectal mucosa, submucosa, internal circular muscle, and external longitudinal muscle from the medial side, as presented in Figure 3. It is important to perform incision equally and circumferentially while being aware of

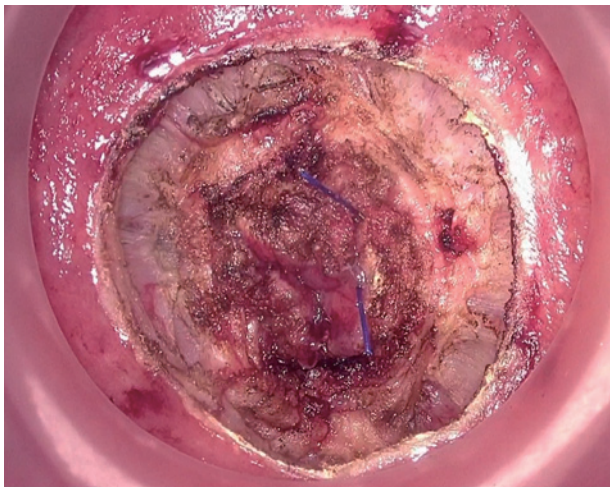

Figure 3. The external longitudinal muscles are circumferentially exposed, and the radial direction of smooth muscle fibers can be observed.

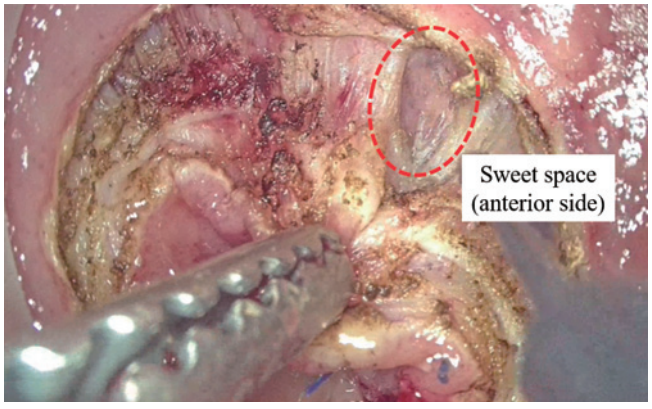

Figure 4. The longitudinal muscle is incised at the 1 o'clock position to enter the "sweet space," a space with only sparse areolar tissue on the dorsal side of the prostate.

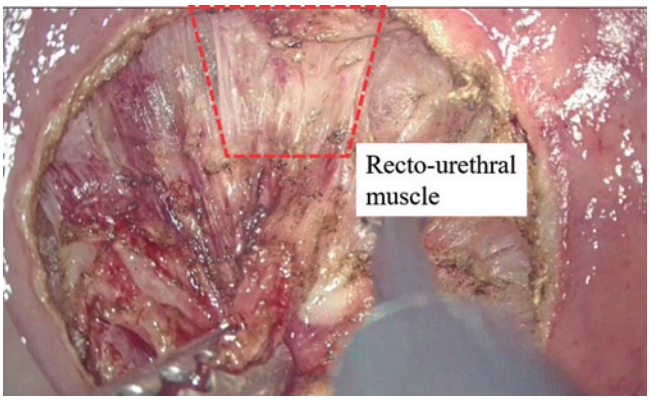

Figure 5. The relatively thick smooth muscle tissue at the 12 o'clock position connecting the rectal wall and urethra is the recto-urethral muscle.

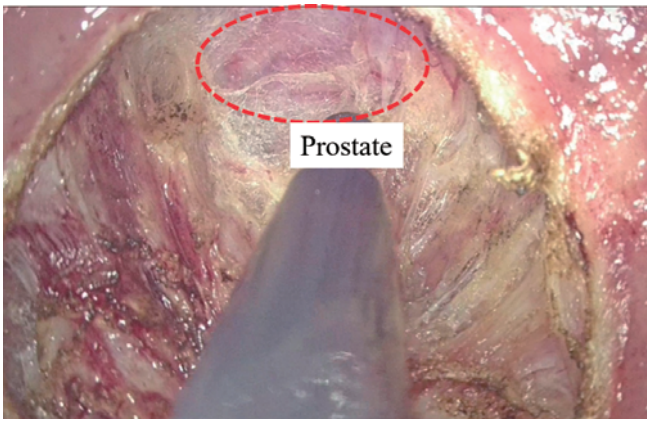

Figure 6. The dorsal side of the prostate is widely exposed after dissecting the recto-urethral muscle.

the plane being incised at that moment.

3. Anterior dissection

The landmarks for anterior dissection in male patients are the recto-urethral muscle, Denonvilliers' fascia, and prostate. Contrarily, the rectovaginal muscle, rectovaginal septum, and posterior wall of the vagina are used as landmarks in female patients. In laparoscopic TME, the visibility of the anterior side is often poor, whereas a uniform and reproducible surgical field can be easily obtained in TaTME. This article describes the surgical procedures for male patients.

The longitudinal muscle was incised at the 1 and 11 o'clock positions to access the so-called sweet space, as this space contains sparse areolar tissue on the dorsal side of the prostate (Figure 4). The 12 o'clock position, which has a relatively thick smooth muscle tissue, should be avoided. After identifying the "sweet space" on both sides, the recto-urethral muscle, a relatively thick smooth muscle tissue that connects the rectal wall and urethra at 12 o'clock (Figure 5), was dissected to widely expose the dorsal side of the prostate (Figure 6). The dorsal prostate area is difficult to visualize using the conventional laparoscopic approach. The recto-urethral muscle, with a thickness of approximately 5-10 mm, is an important anatomical structure that secures the CRM on the anterior side. One of the advantages of TaTME is its ability to control the dissection line or plane according to the tumor localization and depth.

The plane between the rectum and the prostate was dissected to identify the Denonvilliers' fascia; then, the prostate was dissected to identify seminal vesicles (Figure 7). Subsequently, the dissection was extended to the peritoneal reflection. However, it is important to note that once the peritoneal reflection is incised and meets the abdominal cavity, a stable insufflation pressure cannot be maintained. Therefore, the peritoneal reflection should not be incised at an early-stage.

4. Posterior dissection

The landmarks for posterior dissection are the levator ani muscle, rectococcygeal muscle, and endopelvic fascia.

The longitudinal muscle was incised at the 5 and 7 o'clock positions, where the connective tissue is sparse, to enter the "sweet space." The relatively thick smooth muscle tissue at the 6 o'clock position (Figure 8) that connects the rectum and coccyx is the rectococcygeal muscle. Dissection of the rectococcygeal muscle, followed by the identification of the "sweet space" on both sides, helps avoid misidentification of the dissection plane.

The endopelvic fascia is defined differently in different specialties. However, for rectal surgery, it is often referred to as the fascia of the levator ani muscle. In TaTME, it is possible to select either above or below the dissection plane of the endopelvic fascia depending on the localization and depth of the tumor. In cases of early-stage cancer or cancer on the anterior wall, the plane preserving the endopelvic fascia, i.e., above the endopelvic fascia, should be selected. However, in cases of advanced cancer on the posterior or lateral wall, the plane exposing the surface of the levator ani muscle, i.e., below the endopelvic fascia, should be selected (Figure 9). Dissection below the endopelvic fascia can help secure the CRM. However, after passing the tumor, changing the dissection plane from below to above the endopelvic fascia is important as proceeding with dissection on this plane can be a risk factor for injury to the autonomic nerve, particularly the fourth pelvic splanchnic nerve.

After posterior dissection, the rectosacral fascia connecting the mesorectal fascia and the anterior surface of the sacrum was identified at the S4 level (Figure 10). After incision of this fascia, the dissection direction should be changed ventrally along the sacral fold; otherwise, the median sacral vein would be at risk of injury. Subsequently, posterior dissection is performed along the mesorectal fascia.

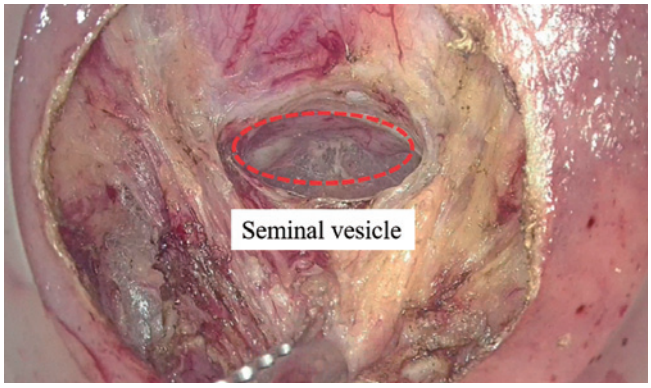

Figure 7. The incisional hole on Denonvilliers' fascia incised on the dorsal side of the prostate and the seminal vesicle is observed on the far side of the fascia.

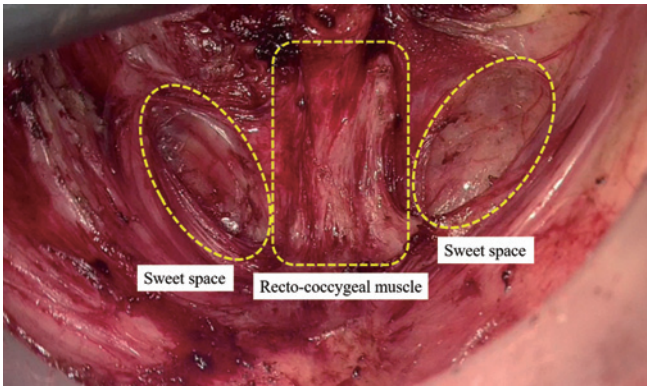

Figure 8. The longitudinal muscle is incised at the 5 and 7 o'clock positions to enter the "sweet space." The relatively thick smooth muscle tissue remaining at the 6 o'clock position connecting the rectum and coccyx is the recto-coccygeal muscle.

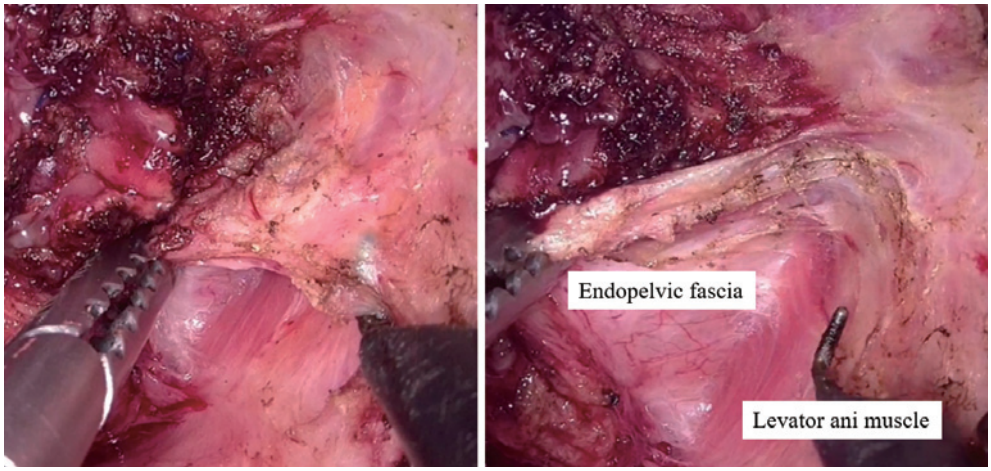

Figure 9. The plane that exposes the surface of the levator ani muscle, i.e., below the endopelvic fascia, is dissected.

5. Lateral dissection

The anatomy of the lateral dissection becomes clear after the anterior and posterior dissections are completed. The landmarks for the lateral dissection are the neurovascular bundle (NVB) and pelvic splanchnic nerves.

In TaTME, the rectal branch of the NVB (Figure 11A) and the fourth pelvic splanchnic nerve (Figure 11B) are highly visible. Autonomic nerves can be preserved by proceeding with the lateral dissection, which contributes to the preservation of postoperative sexual and urinary functions.

Dissection around the NVB and pelvic splanchnic nerves is one of the most challenging steps in TaTME, and selection of the dissection plane can be difficult. In such situations, the transanal team should cooperate with the transabdominal team for better outcomes.

6. Anastomosis

In our approach, the distance between the rectal stump and the edge of the GelPOINT Path Transanal Access Platform was adjusted to 1-2 cm, and a full-thickness purse-string suture was performed circumferentially. It is crucial to ensure reliable anastomosis, and gaps in the purse-string suture must be avoided as they can lead to defects in the anastomosis[16]. Anastomosis was performed using a single stapling technique with a circular stapler and a double purse-string suture[16]. However, a potential drawback of this technique is that it requires good visualization of the pelvic floor and the rectal stump from the abdominal side to dock the anvil. In a narrow pelvis with a short rectal stump, such an exposure is sometimes limited. To overcome this challenge, the pull-through method, which relies on a transanal view rather than an abdominal view, should be adopted[16]. After performing circular stapled anastomosis, a reinforcement suture was performed circumferentially.

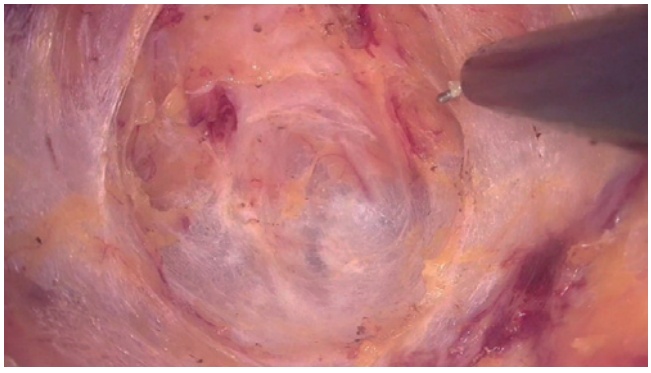

Figure 10. The rectosacral fascia connecting the mesorectal fascia and the anterior surface of the sacrum is incised, and the mesorectal fascia can be observed (through the prehypogastric nerve fascia).

Training Curriculum for TaTME

Understanding transanal anatomy and training in surgical techniques are essential for the safe implementation of TaTME. In addition to basic laparoscopic techniques, SILS-specific techniques as well as suture and ligation techniques for transanal endoscopic surgery are required.

The international TaTME educational collaborative group[17] recommends that trainees meet the following prerequisites when implementing TaTME: completion of training and accreditation in laparoscopic colorectal surgery, ≥30 cases of laparoscopic TME, >5 cases of TEMS or TAMIS, ≥2 TaTME-trained surgeons per unit, and case volume to allow for at least 20 TaTME cases per year per unit[17].

Conclusions

TaTME offers several advantages over conventional laparoscopic approaches for rectal cancer, including superior oncological and functional preservations. However, the unfamiliar anatomical view from the anal side creates a steep learning curve, particularly for novice surgeons. Thus, it is important to establish an efficient educational system. RCTs,

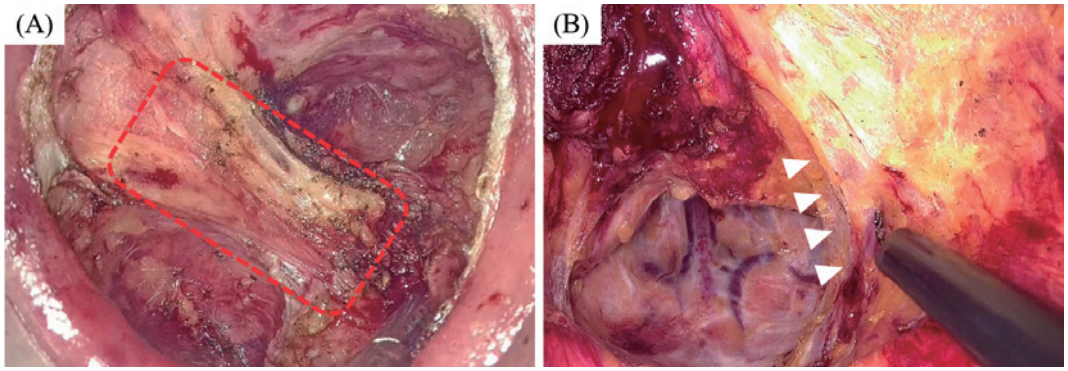

Figure 11. Surgical view of the lateral dissection. (A) Rectal branch of the neurovascular bundle on the right side. (B) Fourth pelvic splanchnic nerve on the left side.

such as the ongoing COLOR III trial[18] and the ETAP-GRECCAR 11 trial[19], are comparing conventional laparoscopic TME with TaTME and are expected to demonstrate the usefulness of TaTME.

Conflicts of Interest

There are no conflicts of interest.

Author Contributions

All authors made substantial contributions to the study. They were involved in the study concept, data analysis, and interpretation. They also contributed to the drafting or critical revision of the manuscript for important intellectual content. Additionally, all the authors approved the final version of the manuscript for publication and agreed to be accountable for all aspects of the work.

Approval by Institutional Review Board(IRB)

Not applicable.

Disclaimer

Masaaki Ito is one of the Associate Editors of Journal of the Anus, Rectum and Colon and on the journal's Editorial Board. He was not involved in the editorial evaluation or decision to accept this article for publication at all.

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