Transanal TME: new standard or fad?

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Abstract:
Transanal total mesorectal excision (taTME) has been developed to overcome the difficulty of laparoscopic dissection and transection in the deep pelvis. TaTME has several clinical benefits over laparoscopic surgery, such as better exposure of the distal rectum and direct determination of distal resection margin. Although evidence demonstrating the true benefits of taTME over laparoscopic TME (LapTME) is still insufficient, accumulating data have revealed that, as compared with LapTME, taTME is associated with shorter operative time and a lower conversion rate without jeopardizing other short-term outcomes. However, taTME is a technically demanding procedure with specific complications such as urethral injury, and so sufficient experience of LapTME and step-by-step acquisition of the skills needed for this procedure are requisite. The role of transanal endoscopic surgery is expected to change, along with the recent progress in the treatment of rectal cancer, such as robotic surgery and the watch-and-wait strategy. Optimization of treatment will be needed in the future in terms not only of oncological but also of functional outcomes.

Keywords:
rectal cancer, laparoscope, transanal TME, surgery

Introduction: Why the Transanal Approach?

The laparoscopic approach has gradually gained acceptance in rectal cancer surgery. However, recent clinical trials from western countries comparing the laparoscopic and open approach for rectal cancer surgery, high rate of conversion to open surgery (around 10%), and some concerns about margin status have been reported. For some difficult cases such as narrow pelvis or bulky tumor, these results might be due to the difficulty of laparoscopic rectal dissection and transection in the deep pelvis.

The transanal approach (under direct vision) was reported to be beneficial in terms of margin status, but the limited visibility under direct vision has hampered the widespread adoption of it. With the recent advances in minimally invasive surgery, such as transanal endoscopic microsurgery and single-port surgery, a combination of the transanal and minimally invasive approaches was introduced and is referred to as transanal TME (taTME). In this paper, we will review the current status and future prospects of taTME.

Operative Procedure

Several operative procedures are performed in the transanal endoscopic approach for treating rectal cancer (Figure 1). In this review study, we will focus on the transanal TME/ISR and transperineal APR.

Typically, the transanal approach is used with the laparoscopic approach, simultaneously (two-team approach) or sequentially (one-team approach). The extent of dissection in each approach usually differs from case to case, however, rectal transection and dissection of the extra-peritoneal part of the rectum is performed transanally. There are several potential benefits of the two-team approach over the one-team
Figure 1. Operations performed using transanal endoscopic approach.
a) Local excision (also referred to as transanal minimally-invasive surgery “TAMIS”).
b) Intersphincteric resection (ISR) / total mesorectal excision (TME).
c) Abdominoperineal resection (APR) (also referred to as “transperineal” APR).

approach, including assistance with exposure of the operative field and/or enhanced comprehension of the surgical anatomy\(^7\). However, the two-team approach requires extra human and device resources that might not always be available with the exception of in specialized centers.

The anastomotic method depends on the height of anastomosis. Conventional hand-sewing is performed for low anastomosis and stapled anastomosis is performed for high anastomosis. Stapled anastomosis is performed in a single staple manner, using a purse-string suture around the distal rectal stump\(^8\). This method is relatively technically demanding, as it is not always easy to make a full-thickness circumferential purse-string suture.

Abdominoperineal resection (APR) is another indication for this approach, and is often referred to as “transperineal APR”\(^9,10\). This approach gives the option, depending on the extent of the tumor, of several perianal dissection lines, including intersphincteric, extralevator, and ischioanal\(^11\). Although this concept of “no-scar surgery” or natural orifice transluminal endoscopic surgery (NOTES) is attractive, transanal mobilization of the splenic flexure/sigmoid colon and division of the inferior mesenteric vessels is still difficult using current operative instruments\(^12\).

Operative Devices (Setup)

Several types of energy devices are used for transanal dissection, which include ultrasonic scissors, vessel sealing devices, and electrocautery (hook or spatula). Many surgeons seem to prefer electrocautery as the energy device of use, with its main benefit being that it facilitates identification of the striated muscles such as the external anal sphincter and levator ani muscle by electrical stimulation, which are crucial surgical landmarks in taTME.

Several types of transanal platforms have been used, including rigid type (i.e., TEO) or single-port devices\(^16\). Currently, the most popular platform is the GelPOINT path transanal access platform (Applied Medical, Rancho Santa Margarita, CA), which allows for better instrumental triangulation in the narrow operative field.

One of the technical problems specific to taTME is associated with CO\(_2\) insufflation and smoke evacuation. The transanal approach is performed through a very narrow operative field causing unstable perirectal pressure called “bel-
such a costly device. Although the use of a pressure-sensitive insufflator such as the AirSeal system is recommended for prevention of belowering and for smoke evacuation from a surgical field, several effective methods have been reported even without such a costly device⁳⁹.

The arrangement of the operating room with respect to devices is important, especially for the two-team approach, so surgeons in the laparoscopic and transanal teams can see both operative images; an example setup of the operating room is shown in Figure 2.

**Potential Advantages of TaTME**

There are several potential advantages and disadvantages of TaTME as compared with laparoscopic surgery. Compared with the transabdominal approach, secure determination of the distal margin under direct (endoscopic) vision can be performed in the transanal approach. There are two important technical points for the determination of the distal margin. Firstly, circumferential marking with adequate distance from the tumor should be done before closure of the rectum. Secondly, because of the restriction of the direction of the instrument, incision of the rectal wall tends to go obliquely and that might threaten the CRM. Instead, rectal incision should be performed perpendicularly.

Theoretically, the transanal approach offers an in-line vantage point to the distal rectum, which facilitates the dissection of the distal rectum, especially for cases with narrow pelvis or bulky tumor⁴⁸. This good accessibility to the distal rectum will facilitate identification and preservation of the pelvic autonomic splanchnic nerves, better specimen quality, proper CRM, and low conversion rate to open surgery. Reduction of operative time, especially when a two-team approach is used, is another benefit.

**Disadvantages and Specific Complications of TaTME**

In this approach as compared with the abdominal approach, the dissection line tends to move laterally, so there is a possibility of damage to structures, such as the urethra or pelvic autonomic nerves, which are not usually damaged during conventional open and laparoscopic surgery.

Among these, urethral injury is one of the most serious and specific complications of this procedure. The complex surgical anatomy around the anal canal, especially in male patients, is another possible cause of this complication. Anatomically, urethral injury does not occur in cases with relatively high-lying tumor in which dissection starts above the inferior border of the prostate. According to a review by Atallah⁴⁹, the risk factors for urethral injury are as follows: prostatic hypertrophy, history of radiation therapy for prostate cancer, and prior history of surgery for prostate and anal pathology. To avoid this severe complication, other measures, such as intraoperative identification of the prostate or membranous urethra by digital examination, lighted urethral stent placement, ultrasound guidance, and stereotactic navigation are recommended⁵⁰.

Purse-string rupture is another significant complication specific to this procedure and might lead to implantation of tumor cells and bacterial contamination⁵¹. Adequate training for correctly making a secure purse-string suture is necessary before performing this procedure.

Also, transanal specimen extraction is attractive from a cosmetic perspective. However, extracting a bulky tumor through the anus without a protector might implant cancer cells around the anal canal, as in port-site recurrence in the early stages of the development of laparoscopic surgery for colorectal cancer⁵².

There are some concerns about the effect of dilatation of the anal canal on anal function when placing the device²²,²³. As compared with rigid anoscope like TEO/TEM, applying single port device into anus for local excision might be a comparable procedure for anal function²⁴,²⁵. However, its effect in patients who underwent TaTME, in which long-time application of transanal device is needed, has not yet been fully demonstrated and should be carefully evaluated²⁶.

**Clinical Evidence**

As this procedure is relatively new, data evaluating the efficacy of this approach as compared with laparoscopic surgery is scarce.

The largest set of data currently available is the International TaTME Registry reported in 2016 and 2018²⁷,²⁸. The number of registered patients increased from 720 in 2016 to 1,594 in 2018, concurrent with the widespread adoption of this approach (Table 1). Although this registry is interna-
The majority of patients included in this registry are from western countries. The reported positive CRM rate and specimen quality are promising as compared with those of recent clinical trials from western countries comparing laparoscopic and open surgery. Nevertheless, it should be noted with caution that the rates of positive CRM and anastomotic leakage have increased with the widespread use of this procedure in comparison with the previous survey in 2016.

Although there are no randomized controlled studies comparing taTME and laparoscopic TME (LapTME), several comparative retrospective studies have been reported. A meta-analysis combining the available data has revealed that taTME is associated with longer CRM, distant metastasis, and a lower rate of positive CRM, but there was no significant difference in other pathological parameters, such as number of harvested lymph nodes and quality of resected mesorectum. Hu et al. examined short-term clinical outcomes and found that taTME was associated with lower conversion rate and shorter operative time, despite there being no difference in other parameters, including rate of postoperative complications.

Furthermore, data on long-term functional and oncological outcomes are not satisfactory, and these are most important for evaluating the quality of surgery. According to reports in the study by Veltcamp and Koedam, quality of life including anal function after taTME was comparable with that after laparoscopic surgery. There are two ongoing large randomized controlled trials comparing taTME and LapTME, namely the COLOR III and GRECCAR 11 studies. Results of these studies, including long-term outcomes, are awaited for accurately evaluating the efficacy of taTME.

### Table 1. Results of International Registry of taTME.

|                           | 2016   | 2018*  |
|---------------------------|--------|--------|
| Nations                   | 23     | 29     |
| No of patients (cancer)   | 720 (634) | 1594 (1540) |
| Sex (male; %)             | 68     | 68     |
| BMI                       | 26.5   | 26.3   |
| Tumor height (mean; cm)   | 6      | 6      |
| ≥cT3 (%)                  | 67     | 69     |
| cN+ (%)                   | 57     | 56     |
| Operation time (perineal) | 128    | 123    |
| Operation (%)             |        |        |
| HAR                       | 5      | 8      |
| LAR                       | 86     | 92     |
| APR                       | 3.2    |        |
| (inter-sphincteric)       | 26.2   | 20.0   |
| (purse-string)            | 62.5   | 72.5   |
| Anastomosis (Manual / Stapled: %) | 45 /55 | 34 / 66 |
| Two-team approach (%)     | 32.5   | 41.7   |
| Conversion (Abdominal / Perineal: %) | 6 / 2.8 | 4.3 / 1.5 |
| Intraop.adverse events (%)|        |        |
| Wrong dissection plane    | 7.8    | 5.7    |
| Pelvic bleeding           | 6.9    | 4.2    |
| Visceral injury           | 1.5    | 1.8    |
| Urethra                   | 0.7    | 0.8    |
| Rectum                    | 0.3    | 0.4    |
| Postoperative adverse events (%)|        |        |
| Anastomotic leak (early/delay) | 5.4 / 1.3 | 7.8 / 2.0 |
| Pelvic abscess            | 2.4    | 4.7    |
| Clavien Dindo ≥ III       | 11.4   | 13.2   |
| Pathological findings     |        |        |
| Quality of specimen (Intact + minor defect; %) | 96 | 97 |
| DM (median; mm)           | 15     | 16     |
| CRM (median; mm)          | 8      | 10     |
| CRM+ (≤1mm; %)            | 2.4    | 4.1    |

*only cases with anastomosis
Table 2. Comparison of Transanal TME and Robotic TME.

| Characteristic                                      | Transanal (226) | Robo (370) |
|----------------------------------------------------|-----------------|------------|
| Age (mean; year-old)                               | 62.1            | 62.5       |
| Sex (male; %)                                      | 62.8            | 63.5       |
| BMI                                                | 26.1            | 25.8       |
| Clinical T-stage (cT1-2/cT3/cT4)                   | 22/68/10        | 21/68/11   |
| cCRM positive (%)                                  | 30              | 29.2       |
| Distance from a.v. (-5cm / 6-10cm; %)              | 52/48           | 53/47      |
| Tumor size (cm)                                    | 2.8             | 3          |
| Preoperative RT or CRT (yes; %)                    | 70.7            | 69.2       |
| Operative time (mean; min)                         | 190             | 189        |
| Anastomosis (None/Stapled/Hand-sewn; %)            | 3.5/57/39       | 6.5/64/30  |
| Diverting stoma (yes; %)                           | 94              | 81         |
| Conversion (%)                                     | 1.3             | 1.1        |
| 30d-postop. complications (%)                      | 33              | 35         |
| Anastomotic leakage (%)                            | 11              | 9.5        |
| Reoperation (%)                                    | 7.5             | 6.2        |
| Lymph nodes harvests                               | 16.1            | 16.8       |
| Pathological CRM+ (%)                              | 6.3             | 6.2        |
| low rectal tumors                                  | 5.4             | 6.3        |
| mid rectal tumors                                  | 5.7             | 5.5        |
| Distal margin + (%)                                | 1.8             | 0.3        |
| low rectal tumors                                  | 2.7             | 0.9        |
| mid rectal tumors                                  | 0.9             | 0          |
| Distal margin (length; mm)                         | 16.9            | 15.1       |
| low rectal tumors                                  | 12.2            | 9.6        |
| mid rectal tumors                                  | 22              | 21.3       |
| TME grade (Complete/Near complete/Incomplete; %)    | 92.5/6.6/0.9    | 95.4/3.8/0.8 |
| low rectal tumors                                  | 91/8.5/0.9      | 94/4.6/1.5 |
| mid rectal tumors                                  | 94.5/4.6/0.6    | 97.1/2.9/0.0 |
| High quality specimen (complete + near complete/CRM, DM-; %) | 93.1          | 93.2      |
| low rectal tumors                                  | 93.3            | 92.1       |
| mid rectal tumors                                  | 92.8            | 94.5       |

Indications for taTME

The selection of surgical approach depends on patient body habitus (obese, narrow pelvis), tumor status (location and extent), and surgeon preference and experience. As mentioned previously, this technique has been developed because of the limitations in the deep pelvis of laparoscopic surgery, especially in western countries. Therefore, surgeons tend to use this approach for cases in which they expect to be presented with difficulty in dissection and transection of the rectum in the deep pelvis. There are also some differences in indications for taTME between Japan and western countries.

Tumor location is one of the most important factors. According to recent results of the International taTME Registry, where the majority of patients were from western countries, the proportion of high-lying tumor has increased over the past two years. On the contrary, in eastern countries like Japan and Korea, as compared with western countries, patient body habitus and anatomical restriction are not so severe, and the benefit of taTME over laparoscopic surgery is not as prominent. Indeed, the reported outcomes of laparoscopic rectal cancer surgery seem fairly satisfactory, having low conversion rate and equivalent oncologic outcomes as compared with open surgery in Japan and Korea. Therefore, many Japanese surgeons prefer the laparoscopic approach, which is technically familiar.

With regard to the extent of the tumor, theoretically advanced tumor might be a good indication for taTME because of its greater tendency to gain a more radial margin than laparoscopic surgery. For example, a bulky tumor located in the mid rectum hampers exposure and dissection of the rectum distal to the tumor via the transabdominal approach alone. In such cases, bi-directional dissection from above and below might be a reasonable option to obtain better exposure and subsequent good pathological or oncologi-
cal outcomes.

**Education and Training**

taTME is a technically demanding procedure, and so appropriate education and training for performing this procedure is vital for safe adoption of this technique\(^{36}\). The International TaTME Education Collaborative has published training guidelines\(^{40}\). The guidelines recommend step-by-step acquisition of the technique skills as follows: self-learning; training; proctorship; and then independent practice. Adequate knowledge of the surgical anatomy of the anal canal and lower rectum, especially from below, is also mandatory. The development of taTME has been accompanied with further accumulation of knowledge of the surgical anatomy of the anal canal\(^{41-44}\).

Currently, cadaver training is the most effective method available for mastery of this procedure\(^{45-47}\). Trainees can learn some key steps of this procedure, including purse-string suture for rectal closure, full thickness rectal incision, bottom-to-up dissection, and purse-string suture for stapled anastomosis. The use of human cadaver models reportedly facilitates the acquisition of vital skills for rectal cancer surgery because the detailed anatomy of the complex human pelvis can only be represented by a cadaveric model\(^{48}\). However, the major problem is their limited availability.

Although the learning curve of taTME has not been fully clarified\(^{49}\), the skills are believed to be difficult to acquire and should be taken to avoid serious complications, especially in the early learning stages\(^{50}\). Deijen et al. in their study performed pooled-analysis and compared clinical outcomes between low-volume (< 30 cases) and high-volume (≥ 30 cases) centers. They stated there might be trends for better outcomes in high-volume centers with regard to conversion rate (4.3% vs. 2.7%), major complications (12.2 vs. 10.5%), complete TME specimens (80.5% vs. 89.7%), and CRM involvement (4.8% vs. 4.5%)\(^{51}\).

**Future Prospects**

There is another solution for difficult cases in conventional laparoscopic surgery. Robotic surgery has several advantages over conventional laparoscopic surgery, such as high-dexterity EndoWrist instruments, tremor filtering, and 3 D high-definition imaging. Several reports have also demonstrated the clinical benefits of robotic surgery over laparoscopic surgery, especially for male patients, obesity, or low-lying tumors\(^{52,53}\). Thus, transanal and robotic approaches aim at almost the same targets in rectal cancer surgery and there is an argument over which approach is better, robotic TME or taTME for patients with rectal cancer having challenging features\(^{54,55}\). Robotic surgery also has several drawbacks such as high cost, longer operative time, and lack of tactile sensa-

**Conclusions**

taTME might have several benefits over laparoscopic surgery, especially for cases in which dissection and transection of the rectum is expected to be difficult. Data demonstrating the true safety and efficacy of this approach is limited. Furthermore, the operative procedure is difficult and is associated with several complications specific to this procedure. There are now multiple surgical approaches available as treatment options for rectal cancer, each with specific benefits and drawbacks. Nonetheless, it is most important to do good surgery, based on the principles of surgical oncology, regardless of surgical approach.
Conflicts of Interest
There are no conflicts of interest.

References
1. Fleshman J, Branda M, Sargent DJ, et al. Effect of Laparoscopic-Assisted Resection vs Open Resection of Stage II or III Rectal Cancer on Pathologic Outcomes: The ACOSOG Z6051 Randomized Clinical Trial. Jama. 2015 Oct; 314(13): 1346-55.
2. Stevenson AR, Solomon MJ, Lumley JW, et al. Effect of Laparoscopic-Assisted Resection vs Open Resection on Pathological Outcomes in Rectal Cancer: The AlaCaRT randomized Clinical Trial. Jama. 2015 Oct; 314(13): 1356-63.
3. Marks JH, Frenkel JL, D’Andrea AP, Greenleaf CE. Maximizing rectal cancer results: TEM and TATA techniques to expand sphincter preservation. Surg Oncol Clin North Am. 2011 Jul; 20(3): 501-20, viii-ix.
4. Denost Q, Adam JP, Rullier A, Buscai E, Laurent C, Rullier E. Perineal transanal approach: a new standard for laparoscopic sphincter-saving resection in low rectal cancer, a randomized trial. Ann Surg. 2014 Dec; 260(6): 993-9.
5. Bues G, Theiss R, Gunther M, Hutterer F, Pichlmairer H. Endoscopic surgery in the rectum. Endoscopy. 1985 Jan; 17(1): 31-5.
6. Sylla P, Rattner DW, Delgado S, Lacy AM. NOTES transanal rectal cancer resection using transanal endoscopic microsurgery and laparoscopic assistance. Surg Endosc. 2010 May; 24(5): 1205-10.
7. Koedam TWA, Veltcamp Helbach M, van de Ven PM, et al. Transanal total mesorectal excision for rectal cancer: evaluation of the learning curve. Tech Coloproctol. 2018 Apr; 22(4): 279-87.
8. Penna M, Knoll JH, Tuynman JB, Tekkis PP, Mortensen NJ, Hompes R. Four anastomotic techniques following transanal total mesorectal excision (TaTME). Tech Coloproctol. 2016 Jan; 20(3): 185-91.
9. Hasegawa S, Okada T, Hida K, Kawada K, Sakai Y. Transperineal minimally invasive approach for extralevator abdominopерineal excision. Surg Endosc. 2016 Oct; 30(10): 4620-1.
10. Yasukawa D, Hori T, Kadokawa Y, Kato S, Aisu Y, Hasegawa S. Trans-perineal minimally invasive surgery during laparoscopic abdominopерineal resection for low rectal cancer. Surg Endosc. 2018 Jul.
11. Holm T. Controversies in abdominopерineal excision. Surg Oncol Clin North Am. 2014 Jan; 23(1): 93-111.
12. Simillis C, Baird DL, Kontovounios C, et al. A systematic review to assess resection margin status after abdominopерineal excision and pelvic exenteration for rectal cancer. Ann Surg. 2017 Feb; 265(2): 291-9.
13. Stelzner S, Holm T, Moran BJ, et al. Deep pelvic anatomy revisited for a description of crucial steps in extralevator abdominopерineal excision for rectal cancer. Dis Colon Rectum. 2011 Aug; 54(8): 947-57.
14. Leroy J, Barry BD, Melani A, Mutter D, Marescaux J. No-scar transanal total mesorectal excision: the last step to pure NOTES for colorectal surgery. JAMA Surg. 2013 Mar; 148(3): 226-30; discussion 31.
15. Marks JH, Lopez-Acevedo N, Krishnan B, Johnson MN, Montenegro GA, Marks GJ. True NOTES TME resection with splenic flexure release, high ligation of IMA, and side-to-end hand-sewn coloanal anastomosis. Surg Endosc. 2016 Oct; 30(10): 4626-31.
16. Hasegawa S, Takahashi R, Hida K, Kawada K, Sakai Y. Transanal total mesorectal excision for rectal cancer. Surg Today. 2016 Jun; 46(6): 641-53.
17. Loong TH, Liu HM, Fong SS. Stable pneumorectum using an in-line glove - a cost-effective technique to facilitate transanal total mesorectal excision. Colorectal Dis. 2018 May; 20(5): O119-22.
18. Atallah S, Martin-Perez B, Albert M, et al. Transanal minimally invasive surgery for total mesorectal excision (TAMIS-TME): results and experience with the first 20 patients undergoing curative-intent rectal cancer surgery at a single institution. Tech Coloproctol. 2014 May; 18(5): 473-80.
19. Atallah S, Mabardy A, Volpato AP, Chin T, Sneider J, Monson JRT. Surgery beyond the visible light spectrum: theoretical and applied methods for localization of the male urethra during transanal total mesorectal excision. Tech Coloproctol. 2017 Jun; 21(6): 413-24.
20. Martin-Perez B, Otero-Pineiro A, Lacy AM. Purse-string rupture: pitfalls of transanal total mesorectal excision (Cecil approach). Tech Coloproctol. 2018 May; 22(5): 393-4.
21. Perdawood SK. A case of local recurrence following transanal total mesorectal excision: a new form of port-site metastasis? Tech Coloproctol. 2018 Apr; 22(5): 319-20.
22. Mendes CRS, Araujo SEA, Perez R, Cecconello I, D’Albuquerque LAC. Controversies in colorectal surgery result from the impact on rectal capacity: clinical and functional evaluation before and after surgical treatment. J Coloproctol. 2018 Jul/Sept; 38(3): 227-32.
23. Mora Lopez L, Serra Aracil X, Hermoso Bosch J, Rebasa P, Navarro Soto S. Study of anorectal function after transanal endoscopic surgery. Int J Surg (London, England). 2015 Jan; 13: 142-7.
24. Clermonts S, van Loon YT, Schiphorst AHW, Wasowicz DK, Zimmerman DDE. Transanal minimally invasive surgery for rectal polyps and selected malignant tumors: caution concerning intermediate-term functional results. Int J Colorectal Dis. 2017 Dec; 32(12): 1677-85.
25. Garcia-Flores LJ, Otero-Diez JL, Encinas-Muniz AI, Sanchez-Dominguez L. Indications and outcomes from 32 consecutive patients for the treatment of rectal lesions by transanal minimally invasive surgery. Surg Innov. 2017 Aug; 24(4): 336-42.
26. Jakubauskas M, Jotautas V, Poskus E, et al. Fecal incontinence after transanal endoscopic microsurgery. Int J Colorectal Dis. 2018 Dec; 33(4): 467-72.
27. Penna M, Hompes R, Arnold S, et al. Transanal total mesorectal excision: International registry results of the first 720 cases. Ann Surg. 2017 Jul; 266(1): 111-7.
28. Penna M, Hompes R, Arnold S, et al. Incidence and risk factors for anastomotic failure in 1594 patients treated by transanal total mesorectal excision: results from the International TaTME Registry. Ann Surg. 2018 Jan.
29. Jiang HP, Li YS, Wang B, et al. Pathological outcomes of transanal total mesorectal excision. Int J Surg (London, England). 2018 Jul; 54(8): 947-57.
30. Hu D, Jin P, Hu L, et al. The application of transanal total mesorectal excision for patients with middle and low rectal cancer: a systematic review and meta-analysis. Surgery. 2018 Jan; 35(1): 2632-42.
31. Koedam TWA, van Ramshorst GH, Deijen CL, et al. Transanal total mesorectal excision (TaTME) for rectal cancer: effects on patient-reported quality of life and functional outcome. Tech Coloproctol.
33. Deijen CL, Velthuis S, Tsai A, et al. COLOR III: a multicentre randomised clinical trial comparing transanal TME versus laparoscopic TME for mid and low rectal cancer. Surg Endosc. 2016 Aug; 30(8): 3210-5.

34. Lelong B, de Chaisemartin C, Meillat H, et al. A multicentre randomised controlled trial to evaluate the efficacy, morbidity and functional outcome of endoscopic transanal proctectomy versus laparoscopic proctectomy for low-lying rectal cancer (ETAP-GRECCAR 11 TRIAL); rationale and design. BMC Cancer. 2017 Apr; 17(1): 253.

35. Fuji S, Yamamoto S, Ito M, et al. Short-term outcomes of laparoscopic intersphincteric resection from a phase II trial to evaluate laparoscopic surgery for stage 0/I rectal cancer: Japan Society of Laparoscopic Colorectal Surgery Lap RC. Surg Endosc. 2012 Nov; 26(11): 3607-16.

36. Jeong SY, Park JW, Nam BH, et al. Open versus laparoscopic surgery for mid-rectal or low-rectal cancer after neoadjuvant chemoradiotherapy (COREAN trial): survival outcomes of an open-label, non-inferiority, randomised controlled trial. Lancet Oncol. 2014 Jun; 15(7): 767-74.

37. Kang SB, Park JW, Jeong SY, et al. Open versus laparoscopic surgery for mid or low rectal cancer after neoadjuvant chemoradiotherapy (COREAN trial): short-term outcomes of an open-label randomised controlled trial. Lancet Oncol. 2010 Jul; 11(7): 637-45.

38. Hida K, Okamura R, Sakai Y, et al. Open versus laparoscopic surgery for advanced low rectal cancer: a large, multicenter, propensity score matched cohort study in Japan. Ann Surg. 2018 Aug; 268(2): 318-24.

39. Atallah SB, DuBose AC, Burke JP, et al. Uptake of transanal total mesorectal excision in north america: initial assessment of a structured training program and the experience of delegate surgeons. Dis Colon Rectum. 2017 Oct; 60(10): 1023-31.

40. Francis N, Penna M, Mackenzie H, Carter F, Hompes R. Consensus on structured training curriculum for transanal total mesorectal excision (TaTME). Surg Endosc. 2017 Jul; 31(7): 2711-9.

41. Watanabe J, Ishibe A, Suwa Y, et al. Surgical techniques for identification of the prostate gland using the autonomic nerve as a landmark during transanal total mesorectal excision: secure dissection of the male rectourethral muscle. Dis Colon Rectum. 2018 Aug; 61(8): 999-1000.

42. Muro S, Tsukada Y, Harada M, Ito M, Akita K. Spatial distribution of smooth muscle tissue in the male pelvic floor with special reference to the lateral extent of the rectourethralis muscle: application to prostatectomy. Clin Anat (New York, NY). 2018 Aug.

43. Tsukada Y, Ito M, Watanabe K, et al. Topographic anatomy of the anal sphincter complex and levator ani muscle as it relates to intersphincteric resection for very low rectal disease. Dis Colon Rectum. 2016; 59: 426-33.

44. Atallah S, Gonzalez P, Chadi S, Hompes R, Knol J. Operative vectors, anatomic distortion, fluid dynamics and the inherent effects of pneumatic insufflation encountered during transanal total mesorectal excision. Tech Coloproctol. 2017 May; 21(5): 783-94.

45. Wynn GR, Austin RCT, Motson RW. Using cadaveric simulation to introduce the concept and skills required to start performing transanal total mesorectal excision. Colorectal Dis. 2018 Jun; 20: 496-501.

46. Penna M, Whiteford M, Hompes R, Sylla P. Developing and assessing a cadaveric training model for transanal total mesorectal excision: initial experience in the UK and USA. Colorectal Dis. 2017 May; 19(5): 476-84.

47. Telem DA, Han KS, Kim MC, et al. Transanal rectosigmoid resection via natural orifice transluminal endoscopic surgery (NOTES) with total mesorectal excision in a large human cadaver series. Surg Endosc. 2013 Jan; 27(1): 74-80.

48. Foster JD, Gash JK, Carter FJ, et al. Development and evaluation of a cadaveric training curriculum for low rectal cancer surgery in the English LOREC National Development Programme. Colorectal Dis. 2014 Sep; 16(9): O308-19.

49. Lee L, Kelly J, Nassif GJ, deBeche-Adams TC, Albert MR, Monson JRT. Defining the learning curve for transanal total mesorectal excision for rectal adenocarcinoma. Surg Endosc. 2018 Jul.

50. Mege D, Hain E, Lakkis Z, Maggiori L, Prost AIDJ, Panis Y. Is trans-anal total mesorectal excision really safe and better than laparoscopic total mesorectal excision with a perineal approach first in patients with low rectal cancer? A learning curve with case-matched study in 68 patients. Colorectal Dis. 2018 Jun; 20(6): O143-51.

51. Deijen CL, Tsai A, Koedam TW, et al. Clinical outcomes and case volume effect of transanal total mesorectal excision for rectal cancer: a systematic review. Tech Coloproctol. 2016 Nov; 20(12): 811-24.

52. Jayne D, Pigazzi A, Marshall H, et al. Effect of robotic-assisted vs conventional laparoscopic surgery on risk of conversion to open laparotomy among patients undergoing resection for rectal cancer: The ROLARR Randomized Clinical Trial. Jama. 2017 Oct; 318 (16): 1569-80.

53. Essani R, Bergamasci R. Robotic colorectal surgery: advance or expense? Adv Surg. 2016 Sep; 50(1): 157-71.

54. Kuo LJ, Ngu JC, Chen CC. Transanal total mesorectal excision: is it necessary in the era of robots? Int J Colorectal Dis. 2018 Mar; 33(3): 341-3.

55. Wexner SD, Berho M. Transanal total mesorectal excision of rectal carcinoma: evidence to learn and adopt the technique. Ann Surg. 2015 Feb; 261(2): 234-6.

56. Cheng CL, Rezac C. The role of robotics in colorectal surgery. BMJ. 2018 Feb; 360: j5304.

57. Park EJ, Baik SH. Robotic surgery for colon and rectal cancer. Curr Oncol Rep. 2016 Jan; 18(1): S5.

58. Paull JO, Pudalov N, Obias V. Medrobotics FLEX transanal excision of a rectal GIST: First video of Transanal Flex robot used in a human - video vignette. Colorectal Dis. 2018 Aug.

59. Pellino G, Warusavitarne J. Medium-term adoption trends for laparoscopic and transanal total mesorectal excision (TaTME) techniques. Tech Coloproctol. 2017 Dec; 21(12): 911-3.

60. Law WL, Foo DCC. Comparison of early experience of robotic and transanal total mesorectal excision using propensity score matching. Surg Endosc. 2018 Jul.

61. Paull JO, Pudalov N, Obias V. Medrobotics FLEX transanal excision of a rectal GIST: First video of Transanal Flex robot used in a human - video vignette. Colorectal Dis. 2018 Aug.

62. Atallah S, Hodges A, Larach SW. Direct target NOTES: prospective applications for next generation robotic platforms. Tech Coloproctol. 2018 May; 22(5): 363-71.
63. Liu S, Suzuki T, Murray BW, et al. Robotic transanal minimally invasive surgery (TAMIS) with the newest robotic surgical platform: a multi-institutional North American experience. Surg Endosc. 2018 Jul; 1-6.

64. Atallah S. Assessment of a flexible robotic system for endoluminal applications and transanal total mesorectal excision (taTME): Could this be the solution we have been searching for? Tech Coloproctol. 2017 Oct; 21(10):809-14.

65. van der Valk MJM, Hilling DE, Bastiaannet E, et al. Long-term outcomes of clinical complete responders after neoadjuvant treatment for rectal cancer in the International Watch & Wait Database (IWWD): an international multicentre registry study. Lancet. 2018 Jun; 391(10139): 2537-45.

66. Dattani M, Heald RJ, Goussous G, et al. Oncological and survival outcomes in watch and wait patients with a clinical complete response after neoadjuvant chemoradiotherapy for rectal cancer: a systematic review and pooled analysis. Ann Surg 2018 May.

67. Rombouts AJM, Al-Najami I, Abbott NL, et al. Can we Save the rectum by watchful waiting or TransAnal microsurgery following (chemo) Radiotherapy versus Total mesorectal excision for early REctal Cancer (STAR-TREC study)?: protocol for a multicentre, randomised feasibility study. BMJ open. 2017 Dec; 7(1): e019474.

68. Verseveld M, de Graaf EJ, Verhoef C, et al. Chemoradiation therapy for rectal cancer in the distal rectum followed by organ-sparing transanal endoscopic microsurgery (CARTS study). Br J Surg. 2015 Jun; 102(7): 853-60.