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SURGERY AND SURGICAL INNOVATIONS IN COLORECTAL CANCER (S HUERTA, SECTION EDITOR)

Current Trends in the Management of Low Rectal Tumors: Transanal Total Mesorectal Excision

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Abstract

Purpose of Review The access of the low rectum is a surgical challenge and, in case of cancer, the outcome of the patient depends on the quality of the surgery. The transanal total mesorectal excision (taTME) is a surgical technique with a combined abdominal and perineal approach. We review the literature for technical aspect of taTME as well as comparisons with other techniques.
Recent Findings Comparison with laparoscopic total mesorectal excision and taTME was summarized in a meta-analysis which showed better oncological results with lower circumferential margin involvement and better completeness of the mesorectum.
Summary TaTME is a safe approach. All steps of the intervention are well described and should be followed as numerous pitfalls exist. When compared with laparoscopic or robotic TME, the taTME showed to be safe with similar oncological results. Patients known to be difficult, male, obese, with a narrow pelvis, should be considered for the taTME approach.

Keywords taTME · Minimally invasive surgery · Rectal cancer · Robotic surgery · Da Vinci

Introduction

Colorectal cancer is recognized as an important burden with a worldwide annual incidence of 1.7 million colon and rectum cancers and 832,000 related deaths in 2015. Colorectal cancer stands third for cancer incidence and second for cancer-related deaths [1] in high-sociodemographic countries.

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Low rectal cancers can locally invade the mesorectum and metastasize to the perirectal lymph nodes contained within the mesorectum and along the iliac arteries. Noteworthy, Bill Heald showed in 1986 that the excision of the meso surrounding the rectum improved overall survival and recurrence-free survival [2•].

History of rectal cancer management has shown improvement not only with the introduction of neoadjuvant radiochemotherapy treatment but also with the development of new surgical techniques allowing excising mesorectal tissue. By using the total mesorectal excision (TME), the local recurrence rate was reduced from 20% using traditional surgical technique to less than 5% [3] in combination with the use of preoperative radiotherapy.

To be accurately performed, TME should produce a rectal specimen with intact mesorectum with only minor irregularities of a smooth mesorectal surface. No defect is deeper than 5 mm, and there is no coning toward the distal margin of the specimen, as stated by Nagtegaal and Quircke [4].

TME has been since recognized as the gold standard for middle and low rectal cancers. However, the application of this surgical principle has encountered limitations due to either the morphology of the patient or the tumor. These characteristics were associated with poor outcomes, as the surgical quality is directly connected to the recurrence rate: an incomplete mesorectum has a higher recurrence rate compared with complete resection (28.6 vs.14.9%) [5••] or involvement of the circumferential margin (CRM) has a local recurrence risk of 16% compared with 5.8% in patients with clear CRM [6]. Further, whereas the upper part of the rectum is easily accessible by an abdominal approach, its distal end has limited surgical access due to the narrowing of the pelvis.

Surgical techniques have been developed to achieve the quality criteria stated by Nagtegaal and Quircke [4] to offer optimal recurrence-free and overall survival for rectal cancer patients.

In the present review, we summarize the recent literature regarding a surgical technique allowing to overcome anatomical limitations usually associated with middle and low rectal cancer surgery by combining abdominal and transanal approaches, the transanal total mesorectal excision (taTME).

History of taTME

The necessity of operating within a bony compartment without viewing the tumor distal margin is a well-known limitation to a total abdominal approach for medium and low rectal cancers. A minimally invasive low anterior resection (LAR) is a technically challenging operation, with reduced working space, retraction capabilities, and visibility. In these settings, conversion rates to open procedures remain high and unsatisfactory.

The transanal approach laid its basis on the Natural Orifice Translumenal Endoscopic Surgery (NOTES) experience with endoluminal removal of rectal pathology. Feasibility and safety of transanal proctectomy and transrectal rectosigmoid resection have been demonstrated in human cadavers and porcine models using a rigid transanal endoscopic platform. With progress, rigid endoscopic platforms, notably used for transanal endoscopic microsurgery (TEM), were replaced by more versatile platforms such as the glove port [7] or the GelPOINT® Path (Applied Medical, Rancho Santa Margarita, CA, USA)) and the creation of a new approach: the transanal minimally invasive surgery (TAMIS) [8].

The main concern with NOTES for transcolonic or transrectal surgery was the contamination of the abdominal cavity. A small series [9] on animal model showed that, in peritoneoscopies using NOTES (with 10 transrectal approaches), positive peritoneal culture was noted but did not lead to clinical signs of gross infection. The authors concluded that peritoneal contamination occurs but does not lead to septic complications.

The technique of transanal total mesorectal excision (taTME) was developed with the concept that full-thickness endoscopic rectal dissection can be extended beyond the rectal wall to incorporate the mesorectum and the perirectal fat and achieve a complete circumferential rectal mobilization including perirectal lymph nodes. Sylla et al. presented in 2010 their first experience on a patient with a rectal tumor at 8 cm from the anal margin [10]. The potential advantages of transanal access for rectal cancer compared to the transabdominal surgical approach are potential sphincter-saving surgery in low tumor, no traction on the rectum, respecting the no-touch principle, direct sight of the tumor, improving the control of the distal resection margin and guarantee an oncologically adequate distal margin. All these advantages could facilitate a high-quality dissection and enable nerve-sparing surgery. This “down-to-up” procedure could be a “a new solution to an old problem” as recognized by Heald [11].

The Technique of taTME

taTME is recognized as a difficult and demanding surgical technique. A preoperative planning with recent imaging is of valuable assistance. For instance, magnetic resonance imaging (MRI) can assess tumoral response after neoadjuvant radiochemotherapy and evaluate the CRM integrity, as well as the possibility to preserve the sphincter. In addition, the length of the horizontal rectum can be appreciated: the longer the horizontal segment, the more the operation can benefit from the transanal phase [12].

In discussing the technical aspects of the taTME, an international consensus [13••] of 40 experts have advocated to operate with two teams simultaneously, one abdominal and one transanal. If not available, they proposed to start the TaTME abdominally in order to exclude peritoneal carcinomatosis, mobilize the splenic flexure, and identify the left ureter at the promontory level.

Briefly, laparoscopic division of the inferior mesenteric artery and vein are performed. After full mobilization of the left colon and the splenic flexure, mesorectal dissection is initiated from above. The anterior dissection is usually limited to incision of the peritoneal fold, but the posterior dissection continues posteriorly down to Waldeyer’s fascia and this should mark the end of the abdominal phase. The transanal time begins with a purse string to occlude the rectum below at a recommended distance of 1 cm distal from cancer with a monofilament 2/0 purse string suture. A single port platform is inserted and a pneumopelvis is created at a pressure of 10–12 mmHg. The purse string should be airtight in order not to loose the pneumatic pressure and to avoid seeding from bacteria and tumor cells. After a full-thickness circumferential division of the rectal wall, the mesorectal plane should be identified posteriorly [14••]. As the posterior dissection begins, the muscle fibers of the levator ani are often visible. This slightly too deep plane is quite easily corrected and there is no risk of nerve or presacral vessel injury as this “zone” contains no significant structures.

Once the posterior plane is established, the right and left lateral planes are dissected. Lateral pillars of adipose tissue (approximately 2–3 cm in diameter) are avascular. The natural, pneumatic dissection that occurs tends to create a false plane lateral to these pillars. This can be misleading and a continued dissection lateral to the pillars can result in pelvic bleeding. The anterior midline is last to be dissected. The communication with the abdominal team through the peritoneal cavity should be done as late as possible to diminish the loss of the pneumopelvis [15].

Once the circular communication is completed, the extraction of the specimen can be done transanally or via an abdominal incision. Transanal extraction avoids an abdominal wound (and its potential complications of incisional hernia and infection) but could result in vascular shearing especially if the tumor is bulky. Alternative options include a Pfannenstiel incision or via the site of a planned diverting ileostomy. Transection of the proximal colon and mesocolon are completed. Four anastomotic techniques have been described [16]: one handsewn and three circular stapled anastomoses. One of the techniques described by Bracey et al. [17] consisted of guiding the passage of the shaft of a circular stapler through the purse string by putting a drain on the shaft, which is advanced into the pelvis. The drain is then removed laparoscopically and the anastomosis performed under laparoscopic visualization. A diverting stoma is routinely performed as a low anastomosis is at risk of leak. Most of the teams used a routine pelvic drain as well.

Potential Perioperative Complications

With this new approach, erroneous planes can be followed, especially laterally, anteriorly, and posteriorly. This could lead to dangerous complications such as nerve injuries or bleeding. In addition, urethral injury, which is an unknown complication during abdominal LAR, is the most significant procedure-specific morbidity of the taTME. This complication typically occurs at the level of the membranous urethra during distal anterior dissection and is probably more likely to occur with locally advanced distal lesions after neoadjuvant radiation [14••].

Bleeding that can be difficult to control at this level suggests injury to the branches of the neurovascular bundle of Walsh. Continuing the plane of dissection "through" those vascular branches will then deflect the posterior lobe of the prostate downward, putting the posterior aspect of the membranous urethra at risk. In women, the posterior wall of the vagina can be inadvertently injured during anterior dissection, particularly when the rectovaginal septum is fused.

Correct operative planes are critical to the success of this surgery. With no real anatomical landmark, erroneous planes can readily be developed, especially in an irradiated pelvis. Stereotactic navigation, which [18] has been widely used in neurosurgery and orthopedic surgery, could help during this complex surgery. Surgeons can, in real time, determine arbitrary points on a patient's body and precisely correlate them with points on an imaging scan. This new technology has been applied for taTME by Atallah et al. [19]. They presented a series of three patients for which they used stereotactic navigation to guide during the transanal approach. In the approach, a computed tomography scan was obtained intraoperatively with 3-D reconstructions. For navigation, two trackers are required, one fixed at the patient and one on the instrument. The relationship between the two trackers is displayed on a screen. Histological results and operative outcomes were encouraging with intact mesorectal envelope and no intraoperative complication.

Another tool to assist the surgeon is the assurance of satisfying blood supply to the anastomosis with fluorescence angiography. This could change the proximal level of resection margin and help diminish the rate of anastomotic leakage [20].

An additional complication previously reported by Racliffe et al. [21] is CO_2 embolus. The authors presented a case of a patient who suffered desaturation with fall of blood pressure during the perineal phase of taTME, after the insufflation in the endoscopic air-seal device. They ceased the CO_2 insufflation and the patient improved quickly. Intervention continued normally and postoperative course went uneventful. A similar clinical situation occurring during the perineal phase should evoke this complication and require stopping immediately the insufflation.

Anastomotic leakage (AL) is the most feared complication after colorectal surgery with high morbidity and poor oncological outcomes [22]. It has been reported to range from 2 to 24% after colorectal surgery [23]. Using the international taTME registry (that includes 107 surgical centers in 29 different countries) and analyzing 1594 patients who benefited from an anastomosis after taTME, Penna et al. [24] described an incidence of anastomotic failure rate of 15.7%. Within 30 days, AL occurred in 7.8% of patients. The authors identified the following risk factors for early AL: male gender, obesity, smoker, diabetes, larger tumors (> 25 mm diameter), and tumor height (> 4 cm from anorectal junction based on MRI). The technical risk factor was an excessive intraoperative blood loss of > 500 mL. For overall anastomotic failure rate, an additional technical factor of long perineal phase > 1.5 h was identified.

These factors helped identify high-risk patients, which require a defunctioning ileostomy with a shift from routine diversion of low anastomosis to highly selective. Selective diversion has been shown to have similar results in term of anastomosis leakage rate with a substantial decrease in 1-year readmission and reintervention rate compared to routine diversion [25].

Indications for taTME

TaTME for Cancer

Several local anatomical and pathological factors favor the use of TaTME. These include male gender, locally advanced rectal cancer, tumors in the distal third of rectum, narrow and/or deep pelvis, visceral obesity, large tumor diameter, and distorted tissue planes due to neoadjuvant radiotherapy [13••]. TaTME can be performed for rectal tumor of the upper third but placement of endoscopic purse string on the long rectal stump technically demanding. The minimum distal margin of 1 cm applies to lower third cancers. For cancers of the middle third, a 2-cm distal margin is required. Even in non-sphincter sparing surgery, such as abdominoperineal excision, transperineal TaTME approach may be undertaken [26].

TaTME is also an alternative surgical strategy after incomplete resection following TEM or TAMIS for rectal adenocarcinoma. In this context, taTME has shown higher rates of sphincter preservation than laparoscopy alone [27].

Table 1 summarizes the initial experience of seven case series [28–33] of patient treated with taTME for rectal cancer. These case series include 26 to 720 patients. Despite being a new technique with numerous pitfalls, the results of these experience showed promising results in term of pathological outcomes with a positive CRM found in 1.7 to 8.1% of the cases, a positive DRM from 0 to 3.2%, complete mesorectal excision from 72 to 97.1% and median number of harvested lymph node ranging from 10 to 20.

Postoperative outcomes were also encouraging with a morbidity rate reported from 26.9 to 39%. This compares favorably to other techniques. For instance, in the laparoscopic arm of the COLOR II trial [35], a randomized controlled trial comparing open to laparoscopic surgery for rectal cancer, the mesorectum was complete in 84% of the cases, with a median number of harvested lymph node of 13 and an involvement of the CRM was in 10% of the cases.

Concerning the long-term results, Marks et al. [36] published the results of 373 patients treated with a transanal approach (TATA approach) for rectal cancer. The overall survival rate was 90% with local recurrence in 7.4% of cases and distant metastasis in 19.5% of cases. The mean follow-up was 65.7 months. These long-term outcomes showed that excellent overall survival can be achieved and probably that these results can be extrapolated to taTME.

Laparoscopic TME Versus taTME

As previously mentioned, laparoscopic TME encounters several technical limitations due to the narrow anatomy of the pelvis and the limited range of motion of conventional laparoscopic instruments. Zhang et al. [37] performed a systematic review and meta-analysis pooling all studies comparing taTME to laparoscopic TME (LaTME). They included 11 studies (one randomized controlled trial and 10 non-randomized) totalizing 757 patients (361 patients with taTME and 396 with laparoscopic TME). They found no difference in operative time and length of hospital stay but reported lesser postoperative complications and inferior conversion rates in the taTME group. Regarding the pathological results, the authors reported no difference in the number of harvested lymph nodes or distal resection margin, but better completeness of the mesorectum and lower CRM involvement in the taTME group. They could not, however, conclude on long-term prognosis as only two studies reported a 2-year survival. The results of this meta-analysis tend to favor the taTME approach, but there was a high heterogenecity of studies. Further, the quality of the included publications was low (insufficient follow-up) and the heterogeneity of the pooled results was high.

Further, a Dutch retrospective trial [38] using a national database proposed a propensity-matched cohort comparing taTME and laparoscopic TME for rectal cancer located within 10 cm from the anal verge. In this analysis, 396 patients were included in each group. Despite having more complicated cases in the taTME group (more males, threatened resection margin on preoperative MRI, and larger proportion of lower tumor), the authors found a similar proportion of CRM involvement (4.3% in the taTME group vs. 4.0% in the laparoscopic group). There was no difference in morbidity such anastomotic leak rate. There was an increased conversion rate in the laparoscopic group compared to taTME (1.4 vs. 8.7%).

Regarding quality of life after rectal cancer surgery, a retrospective study [39] comparing 54 patients (27 with taTME and 27 with laparoscopic resection) showed no difference in term of quality of life, sexual function, and urinary function with a mean follow-up of 6 months. Another study by Bjoern et al. [40] compared 49 taTME patients with 36 LaTME. The overall global health status was similar between the groups with comparable sexual results and urinary function. Anorectal symptoms were significantly in disfavor of taTME with buttock pain, diarrhea, clustering of stools, and urgency. However, there was a major difference of mean follow-up (taTME 22 months vs. LaTME 75 months) that could interfer with these results. Quality of life after taTME tend to have similar results as laparoscopic approach.

Two ongoing randomized controlled trials could help answer the short-term and long-term differences between the two techniques. The first is COLOR III [41], an international, multicenter trial, which compares conventional laparoscopic TME with taTME for the treatment of mid- and low rectal cancer with the primary endpoint being the CRM involvement.

The second is GRECCAR 11 [42], a multicentric study comparing taTME with standard transabdominal laparoscopic proctectomy for patients with low rectal cancer requiring

Table 1 Histological results of the TaTME series

Author	Year	Number of patients	Design	Mesorectum	CRM	DRM	Lymph node (median)
De Lacy [28]	2018	186	Retrospective	Complete 95.7% Almost complete 1.6% Incomplete 1.1%	Negative 91.9% Positive 8.1%	Negative 96.8% Positive 3.2%	14
Penna [29]	2017	720	Retrospective	Complete 85% Almost complete 11% Incomplete 4%	Negative 98.3% Positive 1.7%	Negative 99.7% Positive 0.3%	16.5
Hüscher [30]	2016	102	Retrospective	Complete 97.1% Almost Complete 2.9% Incomplete 0%	Negative 94.6% Positive 5.4%		20
Burke [31]	2016	50	Retrospective	Complete 72% Almost complete 26% Incomplete 2%	Negative 96% Positive 4%	Negative 98% Positive 2%	18
Buchs [32]	2016	40	Retrospective	Complete 92.5% Almost complete 5% Incomplete 2.5%	Negative 95% Positive 5%	Negative 100%	20
Lacy [33]	2015	140	Retrospective	Complete 97.1% Almost complete 2.1% Incomplete 0.7%	Negative 95.6% Positive 6.4%		15
Veltcamp [34]	2015	80	Retrospective	Complete 88% Almost complete 9% Incomplete 3%	Negative 97.5% Positive 2.5%	Negative 100%	14

CRM circumferential resection margin, *DRM* distal resection margin)

manual colo-anal anastomosis. The primary endpoint is R1 resection rate and secondary endpoints are conversion rate and disease-free survival at 3 years. The authors intend to include 226 patients with a completion date estimated for 2021.

Robotic TME Versus taTME

Recently, TME has also been performed by an abdominal approach using robotic assistance. The robotic assistance allows a three-dimensional vision of the operative field, tactile feedback, and ease of dissection with 6° of freedom.

Law et al. [43] compared the outcomes of 40 patients operated with TaTME with those of 40 patients operated with TME performed with robotic assistance for rectal cancer.

They found the operative time and the blood loss to be improved in the taTME group. However, the incidence of postoperative complications, the length of hospital stay, and the reoperation rate were similar. Pathological findings were also similar in terms of harvested lymph nodes and CRM involvement. The authors concluded that robotic and taTME could achieve a safe rectal resection following the surgical principles of TME.

Perez et al. [44] compared 60 robotic LAR with 55 taTME performed for rectal cancer. They described median operative time, morbidity, and conversion rate to be similar between the two groups. Pathological results were similar with 15 harvested lymph nodes in both groups, R1 resection in two patients for the robotic group and zero for taTME. Mesorectum was complete in 90.9% of taTME cases and 88.3% for the robotic group. The authors concluded that results between robotic and taTME for rectal cancer regarding oncological parameters were similar.

More recently, the robotic system has been applied for the transanal phase using a single port [45]. The transanal phase was performed using a gelpoint path (Applied Medical Inc., Rancho Santa Margarita, CA). The authors reported 15 procedures with a median number of collected lymph nodes of 12, a median blood loss of 33 mL, and two conversions to conventional five ports elaparoscopic abdominal surgery. All patients had a complete TME specimen with no CRM involvement.

TaTME for Benign Pathology

The TaTME approach can also be applied to complicated non-cancer cases. An international consensus [13] of 40 experts concluded that surgical indications beyond rectal cancer exist and that taTME can be performed in the context of inflammatory bowel disease. Pouch advancement procedures, dissection/removal of a neorectum in case of chronic anastomotic leak, and proctectomy for rectovaginal fistula can also be performed transanally.

Of note, Coffey et al. [46] reported a case of proctectomy, ileal pouch-anal anastomosis and loop ileostomy for ulcerative colitis. The transanal component was performed by taTME. The stoma was mobilized and an ileal pouch constructed (through the ileostomy site) externally and a handsewn, ileal pouch-anal anastomosis was created. Further, the taTME approach allowed to remove a diffuse cavernous hemangioma of the rectum and to perform a coloanal anastomosis at 2 cm of the anorectal junction [47]. Moreover, TaTME was used in association with single-port laparoscopy to perform restorative proctocolectomy for ulcerative colitis in 16 patients with good results [48]. The authors concluded that the technique allowed a stapled ileoanal anastomosis to be performed with the added advantage of an easier dissection for the distal 5 cm of the rectum and to avoid multiple stapler firing.

Training and Learning Curve

The introduction and adoption of a new procedure should be carefully planned and surgeons need to be trained and confident to optimize patient outcomes. In order to obtain all the benefits from a complex surgical technique, standardization of the training through a dedicated learning process is mandatory to avoid adverse events resulting from surgeon inexperience.

Due to the complex anatomy of the human pelvis, training on human cadavers should be an essential prerequisite to clinical training. The first cadaveric training model for taTME was reported by Penna et al. [49]. Of note, a better purse string occlusion of the rectum was noted in the surgeons who attend the preliminary courses. A complete TME specimen was achieved by 81% of surgeons with improvements between the first and second procedures. The authors concluded that cadavers provide excellent teaching models for complex pelvic surgery with already TME grading improvement between the first and the second cases.

The learning curve for the taTME technique was studied Keodam et al. [50] The authors showed improvement of postoperative outcomes (decrease in major postoperative complications and leakage rate) after the 40th case. The mean operative time and conversion rate were not influenced by the caseload but by the implementation of a dual team approach. A teaching and supervisory program is also recommended to shorten the learning curve and to improve the clinical outcomes of the first patients.

A consensus [51] on the content of an ideal training curriculum for taTME determined that only certified colorectal surgeons with experience of a minimum of 30 laparoscopic LAR cases, five TAMIS cases and an estimated annual case volume of 20 taTME should be eligible to learn the TaTME technique. Mentors should have performed at least 30 cases independently. The training curriculum should be subdivided as first self-learning, then cadaver workshop, practice on live patients under the supervision of a mentor, and finally independent practice.

Conclusion

TaTME is a step forward in the surgical management of patients with low rectal tumors. This approach is safe and feasible with acceptable short-term postoperative outcomes. Based on the current data, it allows for adequate oncological resections even when the tumor appears difficult to remove. TaTME includes complications specific to the technique and should be learned in experienced structures before its use in an independent fashion. Apart from oncological cases, the taTME approach can be proposed for benign pathology as well with satisfactory results as the distal dissection of the rectum is facilitated. The potential superiority of taTME over minimally invasive techniques requires additional studies and the results of the ongoing randomized trials will help elucidate the unresolved questions of long-term outcomes.

Compliance with Ethical Standards

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

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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