Rectal cancer surgery : what's in a name?

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Abstract

The field of rectal cancer treatment is a dynamic and changing field, due to better understanding of the pathology and new medical treatment options, but perhaps mostly due to innovations in the surgical approach.

Surgery is the cornerstone for rectal cancer treatment. Currently, Total Mesorectal Excision is the gold standard. After evolution towards laparoscopic TME, improving technology has led to the development of platforms that allow transanal TME and robotic TME. In addition, local excision can be performed safer and more accurately by means of Transanal Endoscopic Microsurgery (TEM), TransAnal Minimally Invasive Surgery or Endoscopic Submucosal Dissection (ESD), possibly avoiding TME.

The aim of this review is to summarize the different surgical techniques and approaches for rectal cancer in function of tumor stage and describe the specifics of the technique. (Acta gastroenterol. belg., **2019**, 82, **67-74**).

Key Words : rectal cancer, surgery, TME, TAMIS, TEM, ESD, TaTME

Abbreviations : ESD, Endoscopic Submucosal Dis-section ; EMR, Endoscopic Mucosal Resection ; TEM, Transanal Endoscopic Microsurgery ; TAMIS, TransAnal Minimally Invasive Surgery ; TAE, TransAnal Excision ; SILS, Single Incision Laparoscopic Surgery ; TME, Total Mesorectal Excision ; TATA, TransAnal TransAbdominal (proctosigmoidectomy) ; TaTME, TransAnal Total Mesorectal Excision ; LAR, Low anterior Resection ; DRE, Digital Rectal Examination ; NOTES, Natural Orifice Transluminal Endoscopic Surgery ; CRM, Circumferential Resection Margin ; ERUS, EndoRectal UltraSound.

Introduction

Rectal cancer is a frequent cancer with 125.000 new diagnoses per year in the European union and 2400 new diagnoses in Belgium. Rectal cancer comprises approximately 30 % of all colorectal cancers (1, 2).

The field of rectal cancer treatment is a dynamic and changing field, due to better understanding of the pathology and new medical treatment options, but perhaps mostly due to innovations in the surgical approach. These innovations started already in the 1980s when Heald (3) published a new surgical technique in which the complete resection of the mesorectum was introduced, the so-called total mesorectal excision or TME. The adoption of this technique, combined with neoadjuvant chemoradiotherapy in selected patients, has reduced locoregional recurrence rates from 40 % to below 10% and improved cancer-free survival rates from less than 50 % to more than 70% (4-7). Therefore, currently, TME is the gold standard for rectal cancer treatment.

TME can be performed laparoscopically as safe as through laparotomy for rectal cancers not invading adjacent tissues (8). In Belgium, between 2006 and 2014 the majority of TMEs were performed through laparotomy (62%) (2), despite the favorable short term outcomes of laparoscopy (8).

Parallel to the introduction of TME was the introduction of Transanal Endoscopic Microsurgery (TEM) by Buess et al. in 1985 (9). This technique allows endoluminal access for local resection of early rectal cancers without the risks associated with TME, like anastomotic leakage and low anterior resection syndrome (10).

The development of laparoscopy from the typical multiport technique towards the single port or SILS (Single Incision Laparoscopic Surgery) technique has lead to a surgical platform that allows easy access to the rectum transanally. This platform allows endoluminal access to the rectum, as in Transanal Minimally Invasive Surgery (TAMIS), which is suited for resection of early neoplastic lesions. It has allowed the development of the Transanal Total Mesorectal Excision or TaTME as well.

Additionally, in the early 90s, in Japan a technique was developed to endoscopically resect early neoplastic lesions, *en bloc* and without touching the muscularis propria: Endoscopic Submucosal Dissection (ESD). This technique uses an electro-knife, which is advanced through the working channel of the endoscope and allows dissection of the lesion from the muscular layer (11). ESD was initially developed for resection of lesions in the stomach, but the technique was soon adopted for resection of lesions in the colorectum and esophagus. In contrast to Endoscopic Mucosal Resection (EMR), this technique gives the possibility to have the specimen prelevated in one piece, making an exact histopathological analysis possible, without hampering the possibility to do additional surgery (TME)

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Table 1. — **Rectal cancer treatment, adopted from ESMO guidelines on rectal cancer (1)**

Risk Group	cTN-stage	Therapeutic options
Very Early	cT1 sm1 N0 (on ERUS and MRI)	Local excision. If pT1 and no adverse features, local excision is sufficient. If adverse histo-pathology (Sm≥ 2, G3, V1, L1), requires radical resection (TME) as standard
Early	cT1-cT2; cT3a/b if middle or high, N0 (or also cN1 if high), MRF clear, no EMVI	Surgery (TME) alone is standard. If unexpected poor prognostic signs on histopathology (CRM+, extranodal/N2), consider postoperative CRT/CT
Intermediate	cT3a/b very low, levators clear, MRF clear or cT3a/b in mid- or high rectum, cN1-2 (not extranodal), no EMVI	Surgery (TME) alone is a standard only if good-quality mesorectal resection assured (and local recurrence ≤0.5% or, if not, preoperative SCPRT (5×5 Gy) or CRT followed by TME
Bad	cT3c/d or very low localization levators threatened, MRF clear cT3c/d mid-rectum, cN1–N2 (extranodal), EMVI+, limited cT4aN0	Preoperative SCPRT (5×5cGy) or CRT followed by TME, depending on need for regression
Advanced	cT3 with any MRF involved, any cT4a/b, lateral node+	Preoperative CRT followed by surgery (TME and more extended surgery if needed due to tumor overgrowth), or preoperative SCPRT (5×5 Gy) plus FOLFOX and delay to surgery

ERUS, EndoRectal UltraSound ; CRT, chemoradiotherapy ; EMVI, extramural vascular invasion ; MRF, mesorectal fascia ; MRI, magnetic resonance imaging ; RT, radiotherapy ; SCPRT, short-course preoperative radiotherapy ; TME, total mesorectal excision ; CRM, Circumferential Resection Margin ; CT, ChemoTherapy.

if necessary. Moreover, as the muscular layer is not touched, only a short hospital stay is needed, and daily activities can be quickly resumed.

The aim of this review is to summarize the different surgical techniques and approaches for rectal cancer in function of tumor stage and describe the specifics of the technique.

Patient selection

In the diagnostic work-up, the DRE (digital rectal examination) (12) is important to localize the tumor, evaluate its size and mobility and to assess transanal access. DRE is also essential in evaluating the tumor response after neoadjuvant chemoradiotherapy (13).

A colonoscopy is performed to biopsy and locate the tumor and to exclude the presence of synchronous lesions in the colon. Moreover, with improved endoscopes and endoscopic skills, it allows a good assessment regarding curative endoluminal resection possibilities (14,15).

Rigid endoscopy is often preferred by surgeons due to its better measurements and potential to alter treatment (16, 17).

Locoregional involvement is assessed by MRI and Endo Rectal UltraSound (ERUS). ERUS is indicated for evaluation of early rectal cancers since it allows better evaluation of the extent of submucosal invasion of T1 tumors compared to MRI (18). For more advanced rectal cancers, MRI is superior to ERUS as it allows better evaluation of the circumferential resection margin (CRM), T-stage at T1-T2 or higher, extent of extramural invasion, N- stage and the involvement of anal sphincter and levator ani muscle (19,20).

CT scan of abdomen and thorax is performed to rule out distant metastasis. Once clinical staging has been completed, the therapeutic approach has to be determined in a multidisciplinary setting. Surgical resection is the cornerstone of rectal cancer treatment, however, this can be more or less invasive. According to the guidelines of the European Society of Medical Oncology local excision can suffice for early rectal cancer, defined as cT1 Sm1 N0 (Table 1) (1).

For local excision these guidelines, as well as the NCCN guidelines, refer to Transanal Endoscopic Microsurgery (TEM) because it allows an *en bloc*, full thickness excision rendering similar oncological results as TME for this stage without compromising anorectal function (1,21). Although this is not yet included in the ESMO or NCCN guidelines, current practice proves that this can also be achieved by TransAnal Minimally Invasive Surgery (TAMIS) or Endoscopic Submucosal Dissection (ESD), although the latter inherently does not facilitate a full thickness excision. (22).

Approaches to local excision

Early rectal cancers (Tis/T1a/T1b<1000 μm) are suitable for treatment by local excision since the risk of lymph node metastasis is small (23).)

It is recommended to carefully asses the lesion endoscopically in order to determine the best resection technique, preferably avoiding biopsy since this could lead to fibrosis in the submucosal layer and a positive non-lifting sign, making endoscopic resection more difficult (24). When histological examination of the resected specimen reveals a low grade, papillary or tubular adenocarcinoma, with invasion depth of less than 1000 μm, without vascular invasion and negative resection margins, the resection is deemed sufficient. If one of the criteria is not met, salvage TME surgery should be considered (23).

Transanal endoscopic microsurgery (TEM)

The TEM platform consists of a specially developed rectoscope with a 4.5 cm diameter and a length of 20 cm (Figure 1). This scope is placed in the anal canal and allows insufflation, rendering a good and clear view of the rectum in the patient under general anesthesia. With dedicated instruments a full thickness resection with a

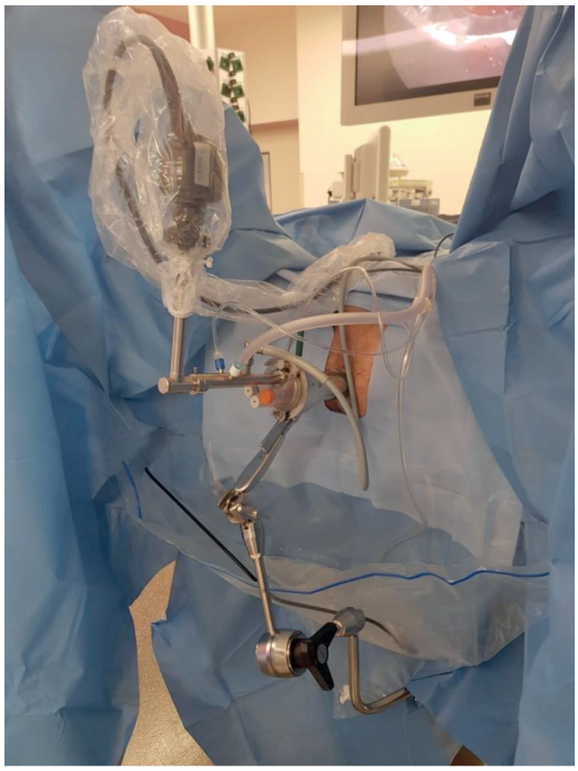

Fig. 1. — TEM technique: Under general anesthesia a 4.5 cm diameter scope is inserted into the anal canal and rectum. Through this scope carbon dioxide is pumped into the rectum to allow a clear view of the bowel lining. Instruments are inserted to allow the surgeon to work with both hands to achieve precise dissection of the bowel wall and tissues beyond. Bleeding can be controlled, the specimen removed and the defect in the bowel wall closed with stitches.

one cm margin should be obtained. After extraction, the specimen should be pinned for orientation before it is sent to pathology. The defect in the rectal wall is closed subsequently (25).

TEM was introduced in the 1980s years by Buess (26, 27) and has been the mainstay transanal treatment for rectal lesions since then (28). It is superior to standard transanal excision (TAE) for local excision of rectal masses, most notably because of its ability to perform high-quality resections (29, 30). This superiority is most likely due to the use of quality optics, specialized instruments, and a specialized insufflation system.

Despite the size of the rectoscope that has to be inserted for the procedure, anal sphincter pressure, rectoanal reflexes, rectal sensation and compliance and continence are not affected (31).

Despite its minimally invasive character, TEM has a few disadvantages. Its steep learning curve and the expensive equipment (32, 33) have prevented widespread adoption of this technique and, as such, patients with mid and upper rectum tumors were often subjected to more radical surgery, such as a low anterior resection (LAR). In addition, tumors located very close to the anal verge cannot be resected with this technique.

It can be debated, however, that cost of TEM is not exceptional in the long term due to its reusability, decreasing cost with every procedure that is performed. In addition, in expert hands very low lesions may be resectable by TEM as well.

Endoscopic Submucosal Dissection (ESD)

ESD is a technique practiced by gastroenterologists as opposed to the strictly surgical techniques the bulk of this paper describes.

With the endoscope positioned in front of the lesion, a fluid is injected in the submucosa, resulting in a cushion between the mucosa and the muscular layer. Subsequently, the healthy mucosa around the lesion is incised with an electric knife and then, the lesion is progressively dissected from the muscular layer, leaving the muscular layer untouched. This allows endoscopic "en bloc" resections of colorectal lesions.

ESD can be performed under conscious sedation, which is an advantage over TEM and TAMIS. Moreover, lesions located close to the anal canal are amenable for ESD, while resection with TEM or TAMIS can be more challenging in this context.

Unfortunately, appropriately powered randomized controlled trials comparing TEM/TAMIS and ESD are lacking to date. The few retrospective series published so far were not able to show major differences in R0 resection rate, recurrence rate and complications between surgical and endoscopic treatment (22). ESD does may provide a shorter hospital stay (34).

One meta-analysis was published comparing ESD and TEM. However, the data set constituted of cases series where all patients were subjected to either ESD or TEM, making a good comparison between the 2 techniques even more difficult. In general, significantly better en bloc resection rates (98,7 % vs. 87,8 %) and R0 resection (88,5% vs. 74,6%) rates were demonstrated in case of TEM compared to ESD with similar complication rates. Yet, recurrence rate was significantly higher in the TEM group (5,2% vs. 2,6) but the need for additional abdominal surgery for treatment of complications or oncologic reasons was significantly higher in ESD group (8,4 % vs. 1,8 %) (28).

Although experience with ESD is growing, the technique is performed in a limited number of centers in Europe, this is largely due to its steep learning curve and the fact that the procedure is rather time consuming compared to EMR or simple polypectomy (35, 36). As a result, in contrast to the emphasized role of ESD in treatment of early rectal cancer by the Japan Gastroenterological Endoscopy Society, ESD is not mentioned in the European or American guidelines on rectal cancer treatment so far (1, 21, 23).

Trans Anal Minimally Invasive Surgery (TAMIS)

The good results of local excision with TEM combined with the drawbacks of the technique have

Fig. 2. — GelPOINT Path platform (Applied Medical, RanchoSanta Margarita, CA, USA). The flexible access channel (image A) has a diameter of 4 cm and is inserted transanally. The trocars are placed through the GelSeal Cap , which is than clicked on the access channel (image B). Image C shows how the platform is situated in a patient for TAMIS and TaTME.

lead to a more practical and affordable alternative, TransAnal Minimally Invasive Surgery (TAMIS). This technique was developed as a hybrid between TEM and Single Incision Laparoscopic Surgery (SILS) for resection of rectal lesions. It was originally described in 2010 by Atallah et al. (37) who used a SILS platform that was readily available. The platform allows access to more distal rectal lesions to any advanced laparoscopist with rectal surgery familiarity. In addition, classical laparoscopic instruments can be used which makes this technique, in combination with the low cost of the platform, an affordable alternative for TEM.

Several platforms are commercially available. As an example, a commonly used platform in Belgium is depicted in Figure 2.

Unlike TEM, for TAMIS the patient can always be positioned in lithotomy position independent of the tumor since it allows a 360 ° working field. Positioning for TEM should always be in a way that the tumor is posterior in view. Other differences are summarized in Table 2.

Purpose of a local resection with TAMIS is similar as for TEM, to obtain a full thickness resection with a one cm margin. The specimen should be pinned for orientation before it is sent to pathology. The defect in the rectal wall is closed subsequently (25).

TransAnal Excision (TAE)

Transanal excision used to be considered for low rectal lesions and is performed while retracting the anus, for example by means of a lone star® retractor (figure 3). This does, however, not yield a proper visibility, which makes it difficult to obtain a proper full thickness resection with a one cm margin.

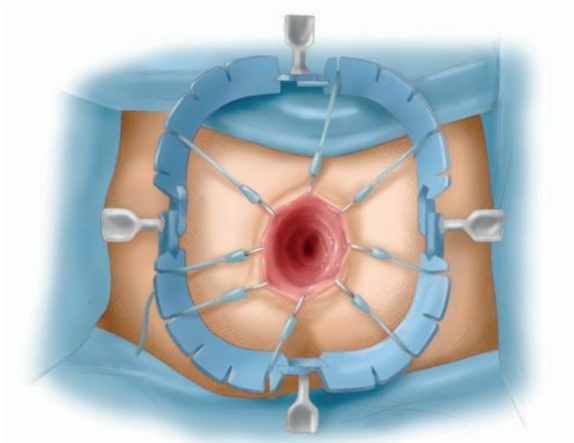

Fig. 3. — Lone star® anal retractor

Table 2. — **Comparison of techniques for LE, adopted from Althumairi et al. (39)**

Variables	TEM	TAMIS	TAE	ESD
Tumor distance in the rectum (from dentate line)	>4 cm-up to 15 cm	Up to 15 cm	Up to 8 cm	no limitation
Bowel preparation	Required	Required	Required	Required
Patients position	Tumor dependent	Lithotomy	Tumor dependent	No limitation
Anesthesia	General	General	Spinal or general	Conscious sedation or general
Instrument	Rigid	Flexible	Rigid	Flexible
Cost	Expensive	Low cost	Low cost	Low cost
Learning curve	Steep learning curve	Shallow learning curve	Moderate learning curve	Steep learning curve
View	220 degree	360 degree	180 degree	360 degree

LE, local excision ; TAE, transanal excision ; TEM, transanal endoscopic microsurgery ; TAMIS, TransAnal Minimally Invasive Surgery ; ESD, Endoscopic Submucosal Dissection.

TAE has been shown to have poor surgical outcomes compared to TEM/TAMIS and ESD. It has been demonstrated that TEM, compared to TAE, more often results in clear margins (90 % vs. 71%) and a nonfragmented specimen (94% vs. 65 %) (30). A study comparing ESD with TAE, showed similar results regarding R0-resection (67 % vs. 42 %), with lower recurrence rate. Moreover, a significant shorter hospital stay was recorded after ESD (7 days vs. 4,2 days) (38). For these reasons, TAE cannot be recommended any more. Early neoplastic lesions in the distal rectum should preferably be resected by TEM, TAMIS or ESD. More advanced lesions should be resected by means of Total Mesorectal Resection.

Approaches to total mesorectal excision

When clinical staging shows that a tumor is not suited for local excision, more invasive procedures are warranted. Total Mesorectal Excision is the gold standard for rectal resection and can be achieved in several ways. Typically, TME is performed through laparotomy or laparoscopy. Several new approaches to TME have gained popularity in recent years. Transanal Transabdominal proctosigmoidectomy has evolved into transanal TME. In addition, robot assisted TME also has several advantages over conventional TME as described in the following paragraphs.

TransAnal Total Mesorectal Excision (TaTME)

The introduction of TME has greatly benefited rectal cancer patients in terms of recurrence and survival rates. Initially this procedure was performed mainly through laparotomy. Striving towards minimally invasive surgery, the approach for TME has shifted from the open approach to a laparoscopic technique. Randomized clinical trials (RCTs), such as COLOR II and COREAN have shown favorable results for laparoscopic total mesorectal excision compared to open TME, such as earlier recovery of bowel function, shorter hospital stay and less postoperative morbidity (6,8,40-42).

Bonjer et al. showed that after laparoscopic TME a negative circumferential resection margin (CRM) is found more often compared to open TME. However, 9 % positive CRM after laparoscopic TME for distal rectal tumors is far from perfect (8). In addition, Fleshman et al. showed that laparoscopic TME does not yield histological results, defined as a composite of distal resection margin, CRM and TME quality, equivalent to open TME (10).

Moreover, narrow pelvic anatomy, male sex and high body mass index (BMI) are also unfavorable patient characteristics for a laparoscopic approach (43). Furthermore, because of the limited view of the distal margin of the tumor, conversion rates to open procedures remain unsatisfactory (42).

Finally, in open and laparoscopic TME the rectum is transected through cross stapling with an endoscopic stapler. Major disadvantage of this technique is that the stapler has to be placed without direct vision on the tumor, risking a positive distal resection margin. In addition, due to the anatomy of the pelvis and the limited angulation of the stapler multiple cartridges are often required to divide the rectum. This increases the risk of anastomotic leakage (44, 45).

These challenges have lead to the development of the transanal TME (TaTME). This "bottom up" approach has been proposed to facilitate operative treatment of low rectal tumors and it originates from fusion of previous techniques such as transabdominal-transanal (TATA) operations, TEM, TAMIS and natural orifice transluminal endoscopic surgery (NOTES) (12,37,46,47).

TaTME starts like a laparoscopic TME, laparoscopically mobilizing the splenic flexure, ligation of the inferior mesenteric artery followed by mobilization of the descending colon, sigmoid and mesorectum. Simultaneously, the transanal portion of the procedure starts with installation of an anal retractor (figure 3) and a transanal acces channel (figure 2) into the anal canal as for TAMIS. A watertight purse-string suture is placed endoluminally to seal the lumen distaly to the tumor, with direct vision on the tumor. Pneumorectum is then created using an Airseal™ insufflation system. This system allows a stable pneumorectum and facilitates continuous smoke evacuation ensuring visibility even under difficult surgical conditions (48), as opposed to the standard laparoscopic insufflation devices.

After installation and placing the purse string suture with vision on the tumor, the rectal wall is transected and the dissection is performed upwards along the mesorectal fascia using standard laparoscopic instruments. After connection with the abdominal dissection plane has been made, the specimen is extracted through a Pfannenstiehl incision or transanally. An anastomosis is created using either a hand-sewn technique or a stapled technique using a circular stapler and a double purse string. For the stapled technique, the anvil is tied into the proximal colon using a purse-string suture. A second purse-string suture is placed on the rectal cuff transanally and tied as the anvil and circular stapler are joined (double purse string) (49).

As for open and laparoscopic TME, a defunctioning loop ileostomy is usually created to reduce the rate of clinically relevant anastomotic leakages (50, 51). The first TaTME resection assisted by laparoscopy was reported in 2010 (52) and thus far results are promising with regard to pathological quality, and short- and mid- term outcomes (53-55). The main goal of TaTME is to improve the distal mesorectal dissection, which is technically the most challenging part of a transabdominal TME. Whether the oncological and perioperative outcomes of TaTME are better than those of laparoscopic TME remains to be proven (56).

Transabdominal Transanal proctosigmoidectomy (TATA)

As mentioned before, one of the procedures leading up to TaTME was the TransAbdominal TransAnal proctosigmoidectomy with colo-anal anastomosis or TATA technique. This operation was introduced in 1984 by Marks and was indicated for patients with low rectal cancer (57). The purpose of this approach is to ensure a known tumor-free distal resection margin by starting the dissection transanally, as for TaTME. After exploring the exact location of the tumor, a full thickness circumferential incision is performed at the level of the dentate line with eyes on the tumor. Afterwards dissection continues in the intersphincteric plane and along the mesorectal fascia in the pelvis.

The difference with TaTME lies in the level of rectal transection. In TATA the transection is performed "open" at the dentate line giving way to the intersphincteric space. Dissection is continued intersphincterically until an acces channel (figure 2) can be placed. Then, further dissection can be performed with laparoscopic instruments and the purse string can be placed after which the procedure continues similarly to the earlier described TaTME. In case of doubt, frozen section analysis of the margin can be performed (58). Alternatively, laparoscopic dissection following the mesorectal fascia can be performed until the pelvic floor is reached and the transanal approach is used solely to transect the rectum under direct vision of the tumor (59).

Extraction of the specimen can be performed transanally or transabdominally. Since incision is made at the dentate line, continuity is restored by means of a hand sewn colo-anal anastomosis. Using TATA, a positive distal resection margin was found in 1 % of patients and a positive CRM (defined as CRM les than 0,2 cm), was found in 6 % of patients. Major complications requiring surgical treatment occurred in 11 % of patients and consisted of full thickness rectal prolapse, anastomotic leakage and bowel obstruction.

Robot assisted TME

Robotic surgery has several technical advantages over open and laparoscopic surgery. The system provides a stable operating platform, three-dimensional imaging, articulating instruments and a stable surgeon controlled camera which is mainly beneficial in areas where space and maneuverability is limited such as the pelvis (60).

The robot assisted TME is similar to the laparoscopic TME with, besides the technical differences, only a different port placement. Therefore, with robot assisted TME, as with laparoscopic TME, the rectum is transected by cross stapling. Thus the surgeon divides the rectum without direct vision on the tumor and potentially increases the risk of anastomotic leakage in case of multi-cartridge stapling.

The recently published results of the ROLARR trial, comparing robot-assisted TME to laparoscopic TME, show no advantages of robot assistance in terms of intraoperative complications, postoperative complications, plane of surgery, 30-day mortality, bladder dysfunction, and sexual dysfunction (61). A drawback of the study is the variability in experience of the participating surgeons in robotic surgery. After correction of this confounder, an advantage for robotic assistance was suggested in terms of risk of conversion to open surgery (62).

Conclusions

In summary, when a rectal lesion allows local excision, TEM, TAMIS and ESD can be considered. Currently TEM and TAMIS both aim for a full thickness excision of the lesion. TAMIS may be favorable in terms of cost and availability. ESD aims for a submucosal dissection and is a promising technique with the advantage that it is feasible with conscious sedation. To date, randomized controlled comparison of these techniques is lacking.

The outcome of salvage TME after TEM seems to be similar compared to primary TME, suggesting that TEM in selected patients may be considered as primary treatment (63). This is probably due to the envelop of mesorectal fat surrounding the rectum that is resected with TME. It remains unclear, however, if salvage TME after TEM/TAMIS or ESD for distal or anterior rectal lesions has a good outcome as well. In this part of the rectum, there is no or limited mesorectal fat and salvage TME can be challenging due to the fibrosis caused by the previous local excision.

When a rectal resection is indicated, TME remains the gold standard. Transanal TME seems promising, however data showing superiority of this approach over the transabdominal TME are lacking.

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