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Abstract

The aim of oncologic surgery is radical cancer treatment with preservation of function and quality of life. Almost 30 years ago, transanal endoscopic microsurgery (TEM) revolutionised the technique and outcomes of transanal surgery, first becoming the standard of treatment for large rectal adenomas, then offering a possibly curative treatment for early rectal cancer, and finally generating discussion on its potential role in combination with neoadjuvant therapies for the treatment of more invasive cancer. TEM afforded the advantage of combining a less invasive transanal approach with low recurrence rates thanks to enhanced visualization of the surgical field, which allows more precise dissection. We describe the current indications, the preoperative work-up, the surgical technique (with the aid of a video), postoperative management and results obtained in an over 20-year-long experience. Designed as an accurate means to allow excision of benign rectal neoplasms with a very low morbidity rate, TEM today is indicated as a curative treatment of malignant neoplasms that are histologically confirmed as pT1 sm1 carcinomas. T1 sm2-3 and T2 lesions should at present be included in prospective trials. Accurate preoperative staging is essential for optimal selection of patients. Patients with clear indication for TEM should be referred to specialized medical centres experienced with the technique.

Keywords

Transanal endoscopic microsurgeryFull thickness excision Rectal adenomaAdenocarcinoma

Introduction

The aim of oncologic surgery is radical cancer treatment with preservation of function and quality of life. In the field of rectal malignant neoplasms, anterior resection with total mesorectal excision, when feasible, and abdominoperineal resection (APR), when mandatory, represent the best curative treatment, with low local recurrence rates reported after neoadjuvant chemoradiotherapy [1–3].

Nevertheless, these procedures are associated with high rates of genitourinary and sexual dysfunction (30–40 %) [4–7], anastomotic leakage (5–17 %) [8] and long-term functional bowel disturbance [9]. Following APR, up to 40 % of patients experience perineal wound complications and long-term discomfort; in addition, stoma- and stoma-appliance-related complications occur in up to 66 % of patients and are associated with change in body image and depression in 30 % of patients [10].

Transanal surgery with retractors, although less invasive, is associated with a consistent incidence of recurrence, especially for tumours of the upper and medium rectum [11–14].

Almost 30 years ago, transanal endoscopic microsurgery (TEM) revolutionised the technique and outcomes of transanal surgery, first becoming the standard of treatment for large rectal adenomas [15–17], then offering a possibly curative treatment for early rectal cancer [18, 19], and finally generating discussion on its potential role in combination with neoadjuvant therapies for the treatment of more invasive cancer [20–23]. TEM afforded the advantage of combining a less invasive transanal approach with low recurrence rates thanks to enhanced visualization of the surgical field, which allows more precise dissection.

Preoperative work-up

The preoperative work-up includes clinical evaluation; total colonoscopy to exclude further colonic polyps; rigid rectoscopy to locate the lesion along the circumference and to measure its distance from the anal verge; endoscopic ultrasound (EUS) to assess wall grade of invasion; liver ultrasound and chest X-rays to exclude metastases; pelvic computed tomography, which was used until 2003, and then pelvic magnetic resonance imaging (MRI) to detect potential lymph node metastases; and tumour markers such as carcinoembryonic antigen and cancer antigen 19–9.

Because of a lack of adequate lymphadenectomy, an accurate preoperative evaluation is key to obtaining satisfactory oncologic results with TEM. In particular, it is crucial to accurately evaluate the depth of tumour invasion and lymph node metastasis in relation to the preoperative biopsy. Thanks to technological innovations in EUS probes, the staging discrepancy rate has progressively decreased from almost 50 % in the early 1990s to less than 15 % in the last 5 years. Due to the risk of EUS overstaging (about 5 %), in case of discrepancy between clinical evaluation (soft and mobile lesions) and EUS staging (uT2) for a large adenoma, we indicate TEM as the means to assess exact diagnosis and staging.

Technique

Patient preparation

All patients undergo a low-fibre diet the week before TEM, and a rectal enema is performed 12 and 2 h preoperatively. Intravenous antibiotics, such as second-generation cephalosporin and metronidazole, are administered before introduction of the rectoscope and continued until hospital discharge. Deep venous thrombosis prophylaxis is not administered. The TEM procedure is generally performed under general anaesthesia.

Instrumentarium

Until 2008, we routinely used the original Richard Wolf (Knittlingen, Germany) TEM equipment. Afterwards, we introduced TEO (Transanal Endoscopic Operation) instrumentation by Karl Storz GmbH (Tuttlingen, Germany), always according to the standard technique described by Buess [15]. TEO instrumentarium includes a 7- or 15-cm rectal tube, 4 cm in diameter (Fig. 1), with 3 working channels (12, 5 and 5 mm) for dedicated or conventional laparoscopic instruments, plus a 5-mm channel dedicated to a 30° optic (Fig. 2). The rectoscope is connected to the operating table via a holding arm consisting of 3 joints and a single screw (Fig. 3). The system is used in combination with standard laparoscopic units. Camera imaging is projected on a screen, and insufflation is obtained by a conventional CO_2 thermal insufflator which is connected to the rectoscope via a luer lock connector. In most cases, the particular shape of the tip of this rectoscope allows the patient to remain in a supine position, no matter the location of the neoplasm; this method minimizes time for patient positioning on the OR table.

Fig. 1

Short (*above*) and long (*below*) rectoscope

Fig. 2

Rectoscope with 3 working channels and a 5-mm channel for a 30° optic

Fig. 3
TEO instrumentation

Surgical technique

After introduction of the rectoscope, the lesion is identified and the rectoscope is fixed in the correct position. High-flow CO_2 insufflation is required, and endoluminal pressure is kept at 8 mmHg, although it might need to be increased. Dissection usually is started at the right lower border of the tumour. The macroscopic distance from the neoplasm needs to be at least 5 mm in case of both benign and malignant lesions. Tumour excision is performed by monopolar hook, ultrasonic shears or the electrothermal bipolar vessel sealing system (Valleylab, Covidien, Boulder, CO). Dissection is continued all around the lesion until the perirectal fat is reached. Due to the uncertainty of the preoperative diagnosis and staging, full-thickness resection with adequate margins of clearance is the technique routinely performed, thus respecting the sphincter muscles. The specimen is retrieved transanally. After the parietal defect is disinfected with iodopovidone solution, the wall defect is closed with 1 or more Maxon 3/0 (Codisan® S.p.A.) running sutures secured with dedicated silver clips (Richard Wolf, Knittlingen, Germany). At this stage, the endoluminal pressure might be reduced to allow better compliance of the rectal wall. Suturing is performed with particular attention to respect the integrity of the rectal lumen, so that when suturing large defects, the surgeon places a midline stitch to approximate proximal and distal margins.

Postoperative management

Patients are mobilized the same day of surgery. The urinary catheter placed at the time of surgery is removed 24 h later or 48 h later in all cases of involvement of the anterior wall. Postoperative analgesia is ensured by intravenous paracetamol for 24 h. Oral intake is allowed the day after the first flatus occurs.

Results

Morbidity

Opening of the peritoneal cavity is no longer considered an intraoperative complication. In fact, perforation into the peritoneum during TEM excision does not oblige the conversion to laparoscopy or laparotomy but may be safely repaired by TEM without any postoperative consequences [24]. In more than 500 cases, we needed to convert only 1 patient to laparoscopic anterior resection.

In line with the previous studies that reported complication rates between 2 and 15 % [25–29], we reported an early postoperative complications rate of 7.7 % (23 cases) in our initial series of 300 patients [30]; the rate decreased to 4 % (8 cases) in the last 200 patients, although indications to TEM widely extended to more complicated cases. No deaths occurred. The most common local complications, bleeding and dehiscence, can be managed conservatively in the majority of cases. Also noteworthy was the occurrence of rectovaginal fistulas in 4 patients; therefore, special care should be taken when performing an anterior full-thickness resection in female patients.

Oncologic outcomes

Large adenoma

TEM was initially proposed almost 30 years ago by Buess as a technique for excision of benign extraperitoneal rectal neoplasms. Even today, most TEM procedures are performed for benign rectal neoplasms which involve the maximum half of circumference (Video 1). However, although technically challenging, circumferential full-thickness excision for benign lesions with an end-to-end anastomosis can also be achieved by TEM (Video 2).

A review of 1,682 large rectal adenomas treated by TEM, including 18 studies with a minimum follow-up of 12 months, has been recently reported by Casadesus [31]. The local recurrence rate was reported as high as 6.3 %. These cases are generally suitable for further treatment by TEM. Five series have reported the use of TEM in the treatment of recurrent adenoma or residual disease without further recurrence [32–36]. The recurrence rate in our series is 4.9 %, and at successive follow-up, all cases further treated by TEM did not have a new recurrence.

Other authors have compared TEM with transanal local excision according to Parks. Local excision was associated with a higher recurrence rate, ranging between 10 and 27 % [29, 37–39]. The higher recurrence risk of conventional transanal surgery is most likely due to the lower rate of complete excision with tumour-free margins in conventionally treated patients.

Besides conventional transanal local excision and TEM, endoscopic submucosal dissection (ESD) currently represents a therapeutic option for the treatment of large adenomas. For extended ESD, an en-bloc specimen is resected including the mucosa and a consistent portion of the submucosal layers. This combines the advantages of an en-bloc resection with the potential benefit of fewer complications. Extended ESD has progressively gained more support in the last few years, mainly due to good clinical results after ESD for neoplasia in the oesophagus and stomach, as reported in Japanese centres [40, 41]. ESD has also been described for the treatment of large colorectal adenomas, revealing recurrence rates slightly higher than those observed for TEM (18.0 vs. 6 %), mainly due to a higher risk of positive margins, reported as high as 40 % in some series [42, 43]. To the best of our knowledge, TEM and ESD have never been formally compared; therefore, further and eventually randomized clinical trials are needed to evaluate short-term and long-term results of TEM and ESD for the resection of large rectal adenomas.

Adenocarcinoma

For more than 20 years, TEM has also been proposed for curative treatment of early rectal cancer when located within 12 cm of the anal verge on the anterior and lateral walls and within 15 cm on the posterior wall. Well-known negative prognostic factors are the diameter of the lesion >3 cm, pT staging, depth of submucosal invasion for pT1 cancers, poorly differentiated tumour grading, positive resection margins and the presence of

lymphovascular infiltration. As a consequence, it appears evident that an adequate preoperative evaluation of these parameters would certainly help in defining correct indications for TEM [44–47]. In particular, a precise evaluation of the depth of tumour invasion and lymph node metastasis is crucial for the appropriate selection of patients. Even if EUS appears to be the most accurate preoperative diagnostic tool for investigating tumour invasion of the rectal wall [45], we could ascertain, as indicated by others, a consistent discrepancy between preoperative EUS and histology staging of the tumours [48], consisting of a 19 % understaging and a 3 % overstaging rate, respectively, in the last 5 years.

Thus, it is difficult today to objectively define preoperatively which lesions would better be removed by TEM instead of transabdominal surgery, or even whether neoadjuvant therapy would be beneficial. In association with TEM in uT2 lesions, neoadjuvant therapy was reported to be as effective as abdominal radical surgery [20–23]. A further step towards a more accurate preoperative staging would probably allow TEM to progress from the present situation, in which it is often used as a macrobiopsy with curative potentials if submucosal infiltration and tumour grading are not unfavourable. A better selection of patients who could be considered cured by the precise local excision that TEM can offer would avoid the need to resort to further abdominal surgery, which occasionally leads to disappointing results.

One of the key factors in avoiding local recurrence after the removal of rectal adenocarcinomas is complete excision with sufficient tumour-free margins. Even if TEM allows better exposure, maintaining a constant view of the margin and reducing the risk of piecemeal tumour excision, the risk of invaded margins increases with a more advanced tumour stage, as demonstrated in our series. A precise preoperative T staging is therefore crucial also from the technical point of view, as margin invasion in pT1 cancers is occasional (2 %). Furthermore, an effort to increase the rate of free margins is essential to allow a radical local excision in cases of more advanced rectal cancers.

The recent introduction of high-definition, 20-Mhz through-the-channel mini-probes seems to be a step forward in the possibility of preoperatively identifying not only the T staging but also the depth of submucosal invasion [49]. Our series of 48 pT1 patients showed a significant difference in recurrence rate between pT1 sm1 (0 %) and sm2-3 (22.7 %) cases. Therefore, in future, we need to preoperatively discriminate between these 2 groups of patients.

The role of TEM in the treatment of more invasive rectal cancer is controversial. One of the main disadvantages of transanal excision concerns an adequate lymphadenectomy [50]. The incidence of lymph node metastasis is very low for T1 sm1, but for T1 sm2-3 and for T2, it increases up to 25 % [37]. In these cases, especially T2 cases, TEM alone does not represent an adequate therapy, being burdened by a significantly higher recurrence rate compared with that observed for abdominal surgery. In our series of 43 T2 N0 cancer patients, neoadjuvant radiotherapy followed by TEM in responders to therapy was associated with a lower recurrence rate, although not statistically significant ($p = 0.219$), compared with the rate for patients treated by TEM uniquely or with other adjuvant therapies. During a median follow-up of 36 months, no recurrence occurred in this group of patients, which had a disease-free survival rate of 100 %.

Therefore, based on our results and data available in the literature [51], we recently considered other treatment strategies associated with TEM in the treatment of invasive rectal cancer with no evident lymph node metastases. In particular, a large prospective study is ongoing at our institution to evaluate the role of short-term neoadjuvant radiotherapy followed by TEM in cases of tumour downstaging or downsizing. At the same time, the role of laparoscopic sentinel node biopsy and PET at 2 months after TEM in detecting lymph node metastasis is currently under evaluation, in order to discriminate which patients would be candidates for major radical surgery for risk of local nodal recurrence.

Functional results

As TEM requires the transanal introduction of a 40-mm diameter rigid rectoscope with continuous intrarectal CO_2 insufflation, both gas and faecal continence represent a concern [52, 53]. In a series of approximately 200 patients studied by preoperative and postoperative manometry, we observed that post-procedure anal resting pressure decreased markedly before returning to preoperative values at a mean of 4 months after surgery [54–57]. No differences in maximum squeeze pressure or duration of voluntary contraction were noted.

Despite the manometrical findings, very few patients reported limited defecation problems, as shown by both the EORTC QLQ-CR38 and the Cleveland Clinic Incontinence scores. We could observe at 3 months after surgery less compliance to intrarectal balloon distension ($p = 0.034$) and maximum tolerable volume ($p = 0.007$), and a trend towards

increased urgency to defecate ($p = 0.043$) [58]. This can probably be related to the significantly reduced rectal sensitivity threshold and the partial reduction of the rectal reservoir.

Two factors that may affect sphincter function in terms of anal resting pressure are duration of the procedure and rectal lesion size. It has been suggested that a TEM procedure lasting more than 2 h may confer a significantly increased risk of lowering anal resting pressure [54, 55], without severe clinical consequences for continence. Similarly, full-thickness excision of lesions greater than 50 % of rectum circumference could be associated with serious impairment of postoperative anorectal function [56]. In our series, no statistically differences in anal resting pressure emerged between shorter versus longer operative time (< or $\geq$60 min), proximal versus distant tumours (< or $\geq$7 cm) or smaller versus larger tumours (< or $\geq$4 cm).

Transient worsening of faecal continence and a higher rate of urgency are the reasons for a temporary reduction of quality of life, which is completely recovered at 1 year. In contrast, the urological and sexual dysfunction that frequently occurs after abdominal surgery for rectal cancer is rare after TEM.

Conclusions

After almost 30 years after its introduction, TEM is living a second youth. Designed as an accurate means to allow excision of benign rectal neoplasms with a very low morbidity rate, TEM today is indicated as a curative treatment of malignant neoplasms that are histologically confirmed as pT1 sm1 carcinomas. T1 sm2-3 and T2 lesions should at present be included in prospective trials. In line with these observations, accurate preoperative staging is essential for optimal selection of patients. Furthermore, TEM does not have long-term effects on anorectal function or quality of life. We hold that patients with clear indication for TEM should be referred to specialized medical centres in which surgeons, endoscopists, gastroenterologists and pathologists are experienced with the technique.

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