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TECHNICAL NOTE

# Transanal total mesorectal excision: a pure NOTES approach for selected patients

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**Abstract**
*Background* The concept of natural orifice transluminal endoscopic surgery (NOTES) has stimulated the development of various "incisionless" procedures. One of the most popular is the transanal approach for rectal lesions. The aims of this study were to report how we standardized NOTES technique for transanal mesorectal excision without abdominal assistance, discuss the difficulties and surgical outcomes of this technique and report its feasibility in a small group of selected patients.
*Methods* Three consecutive female patients underwent transanal NOTES rectal resection without transabdominal laparoscopic assistance for rectal lesions. Functional results were assessed with the Fecal Incontinence Quality of Life scale and the Wexner score.
*Results* The technical steps are described in details and complemented with a video. All procedures were completed without transabdominal laparoscopic help. The mesorectal plane was entirely dissected without any disruption, and distal and circumferential margins were tumor-free. No major complications were observed. Functional results show a significant impairment after surgery with improvement at 6 months to levels near those of the preoperative period.
*Conclusions* The performance and publication of NOTES procedures are subject to much discussion. Despite the small number of patients, this procedure appears feasible and can be accomplished maintaining fecal continence and respecting oncologic principles.

**Keywords** Rectal cancer · Laparoscopic colorectal surgery · Transanal resection · NOTES

## Introduction

The proliferation of new minimally invasive surgery (MIS) techniques and technologies in recent years has been based on achieving one of the primary goals of modern surgery: surgery without visible scars.

Natural orifice transluminal endoscopic surgery (NOTES) could be considered a paradigm of this type of development. It all began with the first clinical reports by Kalloo et al. [1] who performed a transgastric abdominal exploration and liver biopsy; Rao et al. [2] in 2005 performed a transgastric endoscopic appendectomy, and since 2006 the group led by Correia-Pinto [3–5] has described several procedures using a transvesical approach. Significant research efforts have focused on developing safe and reproducible transluminal endoscopic approaches in order to perform intra-abdominal surgical procedures. Despite

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proven feasibility, widespread implementation of NOTES has been limited by a lack of development.

However, the innovations resulting from experimentation with NOTES has allowed for the development of surgical techniques based on the concept of reducing or eliminating the need for incisions. A series of bridge technologies have facilitated this development under high standards of safety and efficacy with single-incision laparoscopic surgery (SILS) being the most attractive of the techniques currently available [6]. SILS has been used for various abdominal procedures including cholecystectomy [7], appendectomy [8], colectomy [9] and bariatric surgery [10]. Finally, the technological development and knowledge obtained from these experiences have contributed to the use of SILS devices for other purposes, such as transanal surgery of rectal lesions, giving rise to what is known as transanal minimally invasive surgery (TAMIS), a type of surgery that uses the anal natural orifices and involves many techniques.

TAMIS was developed in 2010 by the group led by Larach [11] as a hybrid technique between transanal endoscopic microsurgery (TEM) and single-port surgery, with the aim of facilitating transanal access to the middle and upper rectum, without the technical limitations of TEM and with obvious advantages in terms of accessibility and economy. TAMIS surgery has proven to be feasible for the same indications as TEM (resection of benign tumors, selected rectal cancers and palliative resections in patients in poor medical condition) [11–14]. Furthermore, other applications have progressively been developed, with the use of this approach having recently been communicated in the treatment of rectourethral fistulas, proctectomy in inflammatory bowel disease and "down-to-up" total mesorectal excision (TME) [15, 16]. From our point of view, the "down-to-up" transanal approach to the rectum and mesorectum (TAMIS-TME) in neoplastic disease is the most relevant application due to the prevalence and importance of this disease since, in spite of progress in this area, its management still presents difficulties.

The development of the transanal approach as a route for performing TME began in experimental work on human cadavers. Fajardo et al. [17] performed TAMIS-TME for the first time during a low anterior rectal resection in vivo. Subsequently, Bhattacharjee et al. [18] and McLemore et al. [19] performed similar procedures using either modified TEM equipment and instruments or a single-port device. In all cases, the authors concluded that this type of surgery was feasible and in accordance with oncological principles.

The first colorectal resections in humans using a transanal approach were reported by Sylla et al. [20] who used NOTES assisted by conventional laparoscopy and by Tuech et al. [21] who used a transanal single-port device and abdominal single-port assistance.

The aims of this study are to standardize the NOTES technique for TME without abdominal assistance, discuss the difficulties and surgical outcomes of this technique and report their feasibility on a small group of selected patients.

## Materials and methods

The clinical reports presented here were preceded by extensive laboratory experience with NOTES transanal rectosigmoid resection in porcine models and human cadavers. Furthermore, prior experience was obtained in laparoscopic colorectal surgery, transanal-abdominal-transanal (TATA) surgery, natural orifice specimen extraction (NOSE) surgery, laparo-endoscopic single-site surgery (LESS) and TAMIS. This experience allowed us to move forward to standardize TME using a pure NOTES technique.

### Patient selection

The inclusion criteria were: female patients, American Society of Anesthesiologists (ASA) score 1 or 2, body mass index (BMI) under 30 kg/m$^2$, rectal cancer (adenocarcinoma or high-grade dysplasia) with the lower margin between 5 and 15 cm from the anal verge and no neoadjuvant treatment (Table 1). We also considered the position of the sigmoid colon that had to appear on the right side of the midline in the computed tomography (CT) scan.

Three female patients, without previous abdominal surgery, were selected to undergo pure NOTES. Patient 1 had a rectal mass approximately 8 cm from the anal verge discovered on a screening colonoscopy (biopsy: high-grade dysplasia). Patient 2 presented with rectal bleeding and underwent a total colonoscopy that revealed a rectal mass at 5 cm from the anal verge (biopsy: adenocarcinoma). Patient 3 complains of rectal bleeding and underwent a total colonoscopy which identified a rectal mass at 6 cm from the anal verge (biopsy: adenocarcinoma).

Preoperative staging with magnetic resonance imaging and chest and abdominal CT scans was performed. Patients 2 and 3 were discussed at our multidisciplinary oncologic meetings, and it was decided to propose this new surgical procedure to the patients.

### Preoperative preparation and anesthesia

The procedures were performed at the de Braga Hospital in Braga, Portugal. The day before surgery, the patients were

**Table 1** Clinical characteristics of patients

| Patient | Sex | Age | ASA score | BMI | Localization | Histology | Preoperative TNM stage | CEA |
|---|---|---|---|---|---|---|---|---|
| 1 | F | 32 | 1 | 24.2 | 8 | High-grade dysplasia | – | – |
| 2 | F | 37 | 1 | 23.5 | 5 | Adenocarcinoma | T2N0M0 | 1.6 |
| 3 | F | 58 | 2 | 26.3 | 6 | Adenocarcinoma | T2N0M0 | 1.4 |

*F* female, *ASA* score American Society of Anesthesiologists score, *BMI* body mass index (kg/m$^2$), *Localization* centimeters from anal verge, *CEA* carcinoembryonic antigen (mcg/l)

admitted to the surgical floor and underwent full mechanical bowel preparation with polyethylene glycol electrolyte lavage solution (KLEAN-PREP®, Helsinn Birex Pharmaceuticals Ltd., Dublin, Ireland). Prophylactic thromboembolic medication and prophylactic antibiotic therapy was administered. No epidural catheter was inserted for postoperative pain control. The rectum was irrigated with 1 % diluted iodine solution.

## Operative technique

All procedures were performed exclusively via a transanal approach. The surgical table was positioned at 15 degrees Trendelenburg. A multiport rectal device (GelPOINT Path Transanal®, Applied Medical, Rancho Santa Margarita, CA, USA) was inserted and sealed, and $CO_2$ was insufflated to a pressure of 10 mmHg. We chose this device because of the diameter of the platform (permits better triangulation) and the detachable cover (extraction of swabs and surgical specimens). A two-dimensional (2D) endoscope 5 mm with a 30° angle (KARL STORZ GmbH & Co KG, Tuttlingen, Germany) was introduced through the single-port device. No anal sphincter retractor system was used.

A purse-string suture with 0 silk suture (MERSILK®, Ethicon, USA) is placed through the rectal mucosa to tightly occlude the rectum 1–2 cm below the tumor. Pneumopelvis starts with low insufflation (pressure 3 mmHg) so that the rectum does not collapse. Circumferential dissection of the rectum is initiated at the level of the anorectal ring starting in a posterior plane (Fig. 1). Once within the presacral plane, the pneumopelvis is increased to 10 mmHg in order to help the dissection. The mesorectum is mobilized with a 36 cm × 5 mm Ultracision® device (Ethicon, USA) that is used for the entire procedure, and the posterior dissection proceeds cephalad in the avascular presacral plane in accordance with TME principles. This plane of dissection is extended right and left, with a careful maneuvering of the vagina (with a uterus manipulator) from the anterior rectal wall to achieve circumferential rectal mobilization. The dissection progresses on the right side (the patient's left side) in order to

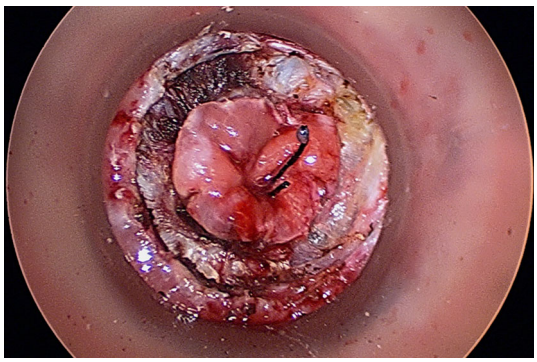

**Fig. 1** Down-to-up mesorectal dissection: circumferential dissection of the rectum

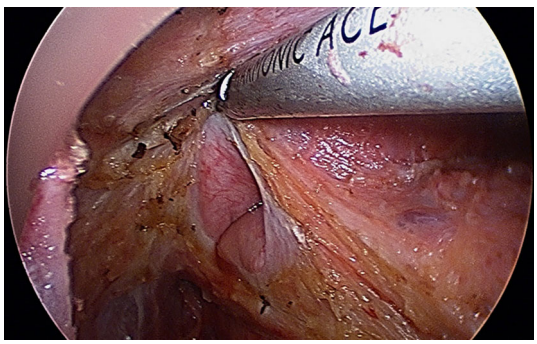

**Fig. 2** Down-to-up mesorectal dissection: extension of mesorectal dissection and entrance into the abdominal cavity

avoid the mesosigmoid. This dissection continues until the reflection of pelvic peritoneum appears as a transparent layer. Before penetrating this layer, the patient is placed in Trendelenburg position in order to diminish the risk of a visceral lesion (Fig. 2). If, the pelvic space collapses after entrance into the abdominal cavity, a Verress needle is placed in the superior left quadrant to reduce intra-abdominal pressure.

The left paracolic gutter is dissected with the Ultracision® device and, if necessary, the splenic flexure is mobilized. No flexible instruments are used. With lateral-to-medial dissection, the inferior mesenteric artery (IMA) is isolated and transected at its base with vascular clips

(Fig. 3). The remaining mesentery is dissected with special attention not to injure the ureters.

After confirming that sufficient length of colon had been freed, the device cap is removed and the specimen is extracted transanally. In the first patient described, we mobilized the splenic flexure (see video). The sigmoid colon is transected with a minimum margin of 10 cm proximal to the tumor. A circular anastomosis stapler with a long anvil is used—EEA™ Hemorrhoid and Prolapse Stapler 33 mm (Covidien, Minneapolis, MN, USA). The anvil is introduced and the tip pushed to perforate the anti-mesenteric border of the colon. The sectioned border of the sigmoid colon is closed with a linear stapler (Echelon Flex™ Ethicon 60 4.1 mm, Ethicon, USA) (Fig. 4). A purse-string suture is applied and tied around the tip of the anvil. The sigmoid is reintroduced into the abdominal cavity with care taken to keep the tip of the anvil visible. With the help of the access port and anoscope of the stapler set, a second purse-string suture is applied to the distal stump and tied around the tip of the anvil. The stapler is attached to the anvil, and a lateral-to-end anastomosis was performed. The anastomosis is carefully inspected to confirm circumferential closure of the staple line, and four stitches of 2-0 polyglactin 910 suture (VICRYL®, Ethicon, USA) are applied to reinforce the suture. No defunctioning stoma is fashioned, and no drains are placed.

The extracted specimen shows the integrity of the mesorectum. All the images in this article are from patient 2.

## Results

All procedures were performed as a pure NOTES procedure without transabdominal laparoscopic assistance. The mesorectal plane was entirely dissected via a transanal approach, without any disruption, up to the level of peritoneal reflection (Supplementary video). The operating time ranged from 190 to 330 min and the estimated blood loss between 30 and 80 ml (Table 2).

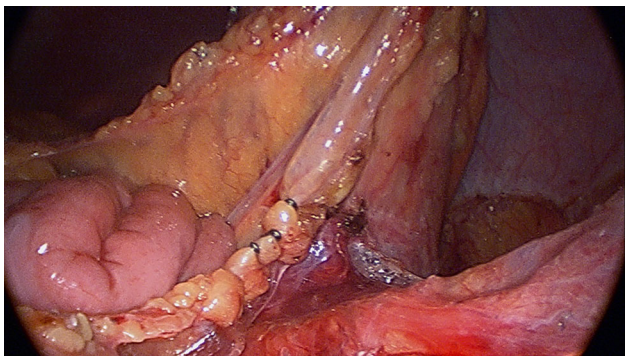

**Fig. 3** Peritoneal cavity accessed via a transanal approach: the inferior mesenteric artery transected at its base

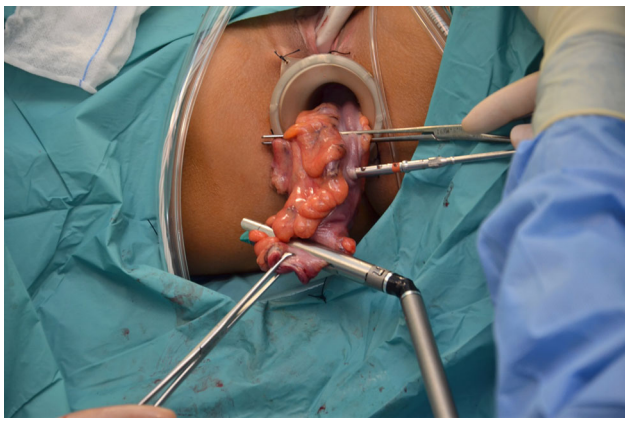

**Fig. 4** Removal of surgical specimen transanally and anastomosis confection: anvil introduction and closure of sectioned border of the sigmoid colon

Patients 1 and 3 had an uneventful postoperative course and were discharged home on the third postoperative day. Patient 2 had postoperative diarrhea that resolved and was discharged home on the fourth postoperative day. Follow-up of 6 months demonstrated no additional complications.

Histopathological assessment confirmed that distal and circumferential margins were tumor-free in all cases and that the quality of the mesorectum excision was reported as intact (Table 3). At least 12 lymph nodes were harvested, with a maximum of 44 lymph nodes (collected from patient 2). Patient 2 had 4 metastatic lymph node and was treated with adjuvant therapy.

The functional impairment of the patients was evaluated preoperatively, and at 1, 3 and 6 months postoperatively with two functional scales: the Fecal Incontinence Quality of Life Scale (FIQoLS) and the Wexner score. The results show that after surgery patients reported poor outcomes that improved at 6 months after surgery to levels near those in the preoperative period (Table 4).

## Discussion

The basis of minimally invasive surgery is the reduction in access size and trauma in order to shorten recovery time, improve postoperative well-being and provide better

**Table 2** Surgery outcomes

| Patient | Access | OT (min) | EBL (ml) | Complications |
|---|---|---|---|---|
| 1 | GPP | 330 | 30 | None |
| 2 | GPP | 190 | 50 | None |
| 3 | GPP | 262 | 80 | None |

*GPP* GelPOINT Path Transanal®, *OT* operative time, *EBL* estimated blood loss

**Table 3** Histopathology results

| Patient | Postoperative TNM | LN+ | LN harvest | TME quality | Tumor size (cm) | Distal margin (cm) | CRM (cm) | Adjuvant treatment |
|---|---|---|---|---|---|---|---|---|
| 1 | High-grade dysplasia | 0 | 12 | Complete | 5.5 | 2.5 | – | No |
| 2 | pT2N1M0R0 | 4 | 44 | Complete | 2.7 | 0.8 | 0.1 | Yes |
| 3 | pT2N0M0R0 | 0 | 16 | Complete | 4.5 | 0.6 | 2.3 | No |

*LN* lymph nodes, *LN+* metastatic lymph nodes, *TME* total mesorectal excision, *CRM* circumferential radial margin

**Table 4** Functional evaluation of fecal incontinence

| Patient | Scale | PreOP | 1M | 3M | 6M |
|---|---|---|---|---|---|
| 1 | Wexner score | 0 | 2 | 0 | 0 |
| | FIQoLS | | | | |
| | (1) Lifestyle | 4 | 3.7 | 4 | 4 |
| | (2) Coping/behavior | 4 | 2.888 | 4 | 4 |
| | (3) Depression/self-perception | 3.857 | 4 | 4.429 | 4.429 |
| | (4) Embarrassment | 4 | 2 | 4 | 4 |
| 2 | Wexner score | 0 | 11 | 6 | 1 |
| | FIQoLS | | | | |
| | (1) Lifestyle | 4 | 3 | 4 | 4 |
| | (2) Coping/behavior | 4 | 2.666 | 3 | 4 |
| | (3) Depression/self-perception | 4.143 | 2.286 | 4 | 4 |
| | (4) Embarrassment | 4 | 2 | 4 | 4 |
| 3 | Wexner score | 0 | 16 | 6 | 1 |
| | FIQoLS | | | | |
| | (1) Lifestyle | 4 | 1 | 1.2 | 4 |
| | (2) Coping/behavior | 4 | 1.333 | 2 | 4 |
| | (3) Depression/self-perception | 3.571 | 1.429 | 2.143 | 2.666 |
| | (4) Embarrassment | 4 | 1 | 2.666 | 3.857 |

*PreOP* preoperatively, *1M* one month after surgery, *3M* three months after surgery, *6M* six months after surgery, *FIQoLS* Fecal Incontinence Quality of Life Scale

cosmesis and less postoperative restrictions [22]. NOTES represent the evolution of minimally invasive surgery toward even less invasive procedures. One particularly attractive target for NOTES is transanal surgery. With a transanal approach, some laparoscopic limitations are resolved: the transection of the rectum distal to the tumor is under direct vision, and there is no need worry about tumor penetration with the stapler, especially in low tumors; obese patients, males or patients with large tumors are no longer a problem because the surgeon's vision of the pelvis is not compromised, thus making it possible to maintain the oncologic principles of TME [23].

One of the major advantages of transanal NOTES is the convenience of transanal endoscopic surgery (TES) as a stable endoscopic platform. TES is an attractive minimally invasive alternative to more radical resections of benign and selected malignant rectal lesions [20]. There are several cases of resection above the peritoneal reflection that result in peritoneal entry, but with adequate closure of the defect, no significant increases in infectious complications were noted [24, 25]. This supports the belief that intentional entry into the peritoneal cavity via the anus, rectum, and colon using NOTES procedures might be safe.

Pure NOTES has the potential for complications related to technical limitations as do the other laparoscopic surgery techniques [26, 27]. With experience and optimization, it is possible to use pure NOTES to perform many types of procedures with minimum risk. There are critical steps in a pure NOTES for TME: luminal suture occlusion, transrectal bowel division, entry through the mesorectum into the presacral space, passage from pneumopelvis to pneumoperitoneum, transanal delivery of the specimen and creation of a stapled lateral-to-end colorectal anastomosis. One of the difficulties encountered when using this technique is finding the correct dissection plane. We usually make the rectal opening posteriorly at 4 o'clock. The opening of the rectum in the posterior region should be made downwards and not in the same direction as the

rectum can be opened iatrogenically. This angle of dissection has been recently highlighted in the report by Knol et al. [28]. The dissection should be performed concentrically. If in the correct plane, the ureters should be clearly seen. After dissecting the mesorectum concentrically, a transparency on the right side (as seen in the video) should be encountered. It is a sign that the peritoneal cavity is approaching. At this point, the patient is placed in steep Trendelenburg position to decrease the risk of damaging any intestinal loops. After opening the Douglas pouch, a uterine manipulator is introduced in order to facilitate the work in the abdominal cavity. Regarding the IMA, this was approached in a lateral-to-medial fashion moving up the aorta until it was found (as can be seen in the video). By following these steps, we have been able to safely carry out this procedure.

Other common challenges facing many NOTES procedures include suturing, triangulation of instruments and stable tissue retraction. These limitations can be overcome with experience gained in single-port TAMIS and NOSE procedures.

However, the advantages of NOTES include reduced incisional pain (with no trocar placement), decreased wound complications such as infections and hernias, improved cosmesis and faster recovery and return to work [27, 29]. It is our belief that this approach allows to perform a more complete mesorectal excision.

A recent systematic review identifies 16 clinical studies that included 150 patients who underwent TAMIS-TME [16]. Transabdominal assistance was used in all patients except in 12 patients reported in 4 publications [30–33] (Table 5). The first of these studies, published by Zhang et al. [31] in 2013, describes the case of a 48-year-old woman with an adenocarcinoma at 8 cm from the anal verge. Preoperative staging was T3N1M0. The access to the rectum was achieved through a three-channel cannula adapted inside a PPH® anal dilator (Ethicon, USA). The first purse-string suture was performed 1 cm below the distal margin of the tumor. The mesenteric vessels were ligated by Hem-O-Lok® Clips (Teleflex, Morrisville, NC, USA). An end-to-end coloanal anastomosis was performed with a number 33 circular stapler (Ethicon, USA). A drain was left in the ischiorectal fossa. No defunctioning ileostomy was described. In the same year, Leroy and colleagues [33] described a NOTES for TME performed on a 56-year-old woman with a tubulovillous adenoma of the mid-third of the rectum. The surgical platform used was a transanal endoscopic operation (TEO®) device (KARL STORZ GmbH & Co KG, Tuttlingen, Germany). The superior rectal artery was ligated and divided distal to the left colic artery. The Lone Star® retractor (Cooper Surgical, Trumbull, CT, USA) was then inserted, and a hand-sewn, side-to-end, coloanal anastomosis was constructed. No defunctioning ileostomy or drain was described. In 2014, Wolthuis et al. [30] published a series of 14 patients with benign disease or American Society of Anesthesiologists (ASA) 3 rectal carcinoma selected for transanal rectal excision. Only 3 patients were operated entirely via a transanal approach. The purse-string suture and circumferential sleeve mucosectomy were performed before placement of GelPOINT Path Transanal® (Applied Medical, Rancho Santa Margarita, CA, USA). A hand-sewn straight coloanal was fashioned. In the same year, Chouillard [32] publish a series of 16 patients selected for TME by NOTES approach. Totally, transanal approach without abdominal assistance was accomplished in 10 patients (8 women and 2 men). A Lone Star® retractor (Cooper Surgical, Trumbull CT, USA) was used, and the rectal wall was opened circumferentially at the level of the dentate line. The dissection continued until reaching the puborectalis muscle, and at this point the SILS® Port (Covidien, Minneapolis, MN, USA) was inserted. The inferior mesenteric vessels ligated, and an end-to-end hand-sewn coloanal anastomosis was performed. On the contrary, we had no cases of hybrid NOTES, probably due to a meticulous selection of patients.

Our aim was to standardize the NOTES technique for TME without abdominal assistance. We selected female patients because of the advantage of controlling the uterus with a uterine manipulator in the anterior rectal dissection. However, Lacy et al. [34] and Tuech et al. [35] report the feasibility of a rectal dissection from down to up in male patients.

The procedures were accomplished with non-flexible cameras and straight laparoscopic instruments. There are several reports of the use of articulate instruments, but, as we demonstrate, the procedure can be done with standard laparoscopic instruments which reduces the cost of performing pure NOTES. Despite being performed with non-flexible standard laparoscopic instruments and without transabdominal laparoscopic assistance, the operating time of all the procedures (190–330 min) was similar to that in previously published papers on pure NOTES for TME [30–33].

It is our opinion that one of the critical steps is the entrance into the abdominal cavity. In order to avoid bowel lesions, we place the patient in Trendelenburg which allows the small intestine to move to the superior part of the abdomen. Another issue that we observe at the transition from the pneumopelvis to pneumoperitoneum is contraction movements of the pelvic peritoneal reflection that we resolved placing a Verress needle to reduce intra-abdominal pressure. We did not find any reference to this problem in other publications, which leads us to wonder whether this is a technical issue that only occurred in our study or a problem that other studies do not report.

**Table 5** Summary of the current clinical experience with a pure natural orifice transanal endoscopic microsurgery–transanal endoscopic microsurgery approach

| | Leão | Zhang [23] | Leroy [25] | Chouillard [24] |
|---|---|---|---|---|
| Number of patients | 3 | 1 | 1 | 10 |
| Age (mean, years) | 44.3 | 48 | 56 | 58.2 |
| F/M | 3:0 | 1:0 | 1:0 | 8:2 |
| BMI (mean, kg/m$^2$) | 24.6 | 20 | ND | ND |
| Benign/malignant | 1:2 | 0:1 | 1:0 | 0:10 |
| Distance to anal verge (mean, cm) | 6.3 | 8 | Mild-rectum | ND |
| Anal platform | GPP | Adapted PPH anal dilator | TEO | SILS |
| Instruments described | Ultracision, Metallic clips | Ultracision, LigaSure, Hem-O-Lok | LigaSure | LigaSure |
| Anastomosis | S–E stapler no. 33 | E–E stapler no. 33 | S–E hand-sewn | E–E hand-sewn |
| Defunctioning ileostomy | No | ND | ND | ND |
| Drain | No | Yes | ND | ND |
| Operating time (mean, min) | 260.7 | 300 | 190 | 272.5 |
| LN harvest (mean) | 24 | 12 | 16 | 15.2 |
| Complications | Self-limited diarrhea | No | Hematoma (percutaneous drainage) | Pelvic abscess; bowel obstruction |
| Length of stay (mean, days) | 3.3 | ND | ND | ND |

The study published by Wolthuis et al. [29] is not included in this table because it is not possible to separate the cases presented in the paper between pure and hybrid NOTES

*F* female, *M* male, *BMI* body mass index, *LN* lymph node, *GP* GelPOINT Path Transanal®, *PPH* procedure for prolapse and hemorrhoids, *TEO* transanal endoscopic operation; *SILS* single-incision laparoscopic surgery, *S–E* side-to-end anastomosis, *E–E* end-to-end anastomosis; *min* minutes, *cm* centimeters, *ND* not described

For ligation of the mesenteric vessels, we preferred metallic clips because they fit in the 5-mm port and it is not necessary to extract in order to refill.

Finally, we selected a circular stapler with a long anvil because it facilitates the second purse-string suture and the construction of the anastomosis [28]. One problem with this stapler is the diameter of the anvil that may not fit every colon. One alternative can be to use a circular stapler with a smaller diameter and prolong the tip of the anvil with a small silicone tube.

There are several concerns regarding to this procedure. One of them is the functional impairment of the patients, and other is related to the maintenance of oncologic principles as regards functional results; there are studies that analyze anorectal function after TEM. The studies report contradictory results. Some demonstrated a temporary effect on anorectal function [36, 37], but others reported preserved function after TEM [38–40]. In order to evaluate the functional outcomes, we used two scales (FIQoLS and Wexner score). All of our patients reported some degree of fecal continence impairment immediately after surgery. This dysfunction could result from mechanical stretching of the anal sphincter. Lower hypogastric nerve damage could lead to urinary disorders and sexual dysfunction, but this was not observed in our patients. A progressive recovery was observed, and at 6 months after surgery, all patients described their fecal continence as similar to what it was in the preoperative period.

Despite the contradictory studies of anorectal function in the literature, our study shows good outcomes of anorectal function 6 months after surgery.

The performance and publication of NOTES procedures are likely to cause debate. Although no major complication was observed, we cannot assume that the procedure is safe because the number of patients was so small. In our small series, an intact mesorectum was reported by the pathologist in all cases, surgical margins were negative, and a minimum of 12 lymph nodes were retrieved.

This approach can introduce new technical challenges for the surgeon, such as a new anatomic points of view, transition from a narrow space (pelvic-time) to an open cavity (abdominal-time) and performance of a totally extracorporeal colorectal ultra-low anastomosis. With the standardization of the procedure, surgeons should be able to overcome some of the difficulties that are imposed by this new technique (pure NOTES-TME).

Pure NOTES procedure for TME may not be suitable for all patients with rectal tumors, but may have benefits in younger patients and probably in obese patients. However, this can only be hypothesized at this stage since we

operated on highly selected group: All patients were female and with a lower BMI in order to facilitate the mesorectal dissection.

## Conclusions

More studies are needed to validate the efficacy, reproducibility and safety of this approach to TME. However, a pure NOTES-TME can be an alternative for selected patients to fulfill the "ideal goals" of minimally invasive contemporary surgery.

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** No ethical approval was required by our institution.

**Informed consent** The procedure and consequences were explained to all of the patients, and written informed consent was obtained. Patients also gave permission for publication of technique and results.

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