World Journal of Gastroenterology

Submit a Manuscript: http://www.wjgnet.com/esps/
Help Desk: http://www.wjgnet.com/esps/helpdesk.aspx
DOI: 10.3748/wjg.v21.i44.12686

World J Gastroenterol 2015 November 28; 21(44): 12686-12695
ISSN 1007-9327 (print) ISSN 2219-2840 (online)

SYSTEMATIC REVIEWS

Transanal total mesorectal excision: Towards standardization of technique

Albert M Wolthuis, Gabriele Bislenghi, Anthony de Buck van Overstraeten, André D'Hoore

Albert M Wolthuis, Gabriele Bislenghi, Anthony de Buck van Overstraeten, André D'Hoore, Department of Abdominal Surgery, University Hospital Leuven, 3000 Leuven, Belgium

Author contributions: Wolthuis AM and D'Hoore A designed the study; Wolthuis AM, Bislenghi G and de Buck van Overstraeten A performed the study; Wolthuis AM and Bislenghi G analysed the data; Wolthuis AM, Bislenghi G, de Buck van Overstraeten A and D'Hoore A wrote the paper.

Conflict-of-interest statement: The authors declare no conflict of interest.

Correspondence to: Albert M Wolthuis, MD, Department of Abdominal Surgery, University Hospital Leuven, Herestraat 49, 3000 Leuven, Belgium. albert.wolthuis@uzleuven.be
Telephone: +32-16-344265
Fax: +32-16-344832

Received: May 16, 2015
Peer-review started: May 20, 2015
First decision: July 14, 2015
Revised: August 1, 2015
Accepted: October 23, 2015
Article in press: October 26, 2015
Published online: November 28, 2015

Abstract

AIM: To describe the role of Transanal total mesorectal excision (TaTME) in minimally invasive rectal cancer surgery, to examine the differences in patient selection and in reported surgical techniques and their impacts on postoperative outcomes and to discuss the future of TaTME.

METHODS: MEDLINE (PubMed), EMBASE, and The Cochrane Library were systematically searched through the 1st of March 2015 using a predefined search strategy.

RESULTS: A total of 20 studies with 323 patients were included. Most studies were single-arm prospective studies with fewer than 100 patients. Multiple transanal access platforms were used, and the laparoscopic approach was either multi- or single port. The procedure was initiated transanally or transabdominally. If a simultaneous approach with 2 operating surgeons was chosen, the operative time was significantly reduced.

CONCLUSION: TaTME was also associated with better TME specimens and a longer distal resection margin. TaTME is thus feasible in expert hands, but the learning curve and safety profile are not well defined. Long-term follow-up regarding anal function and oncological outcomes should be performed in the future.

Key words: Laparoscopy; Colorectal surgery; Rectal cancer; Total mesorectal excision; Transanal total mesorectal excision; Natural orifice specimen extraction; Transanal; Transanal minimally invasive surgery; Reverse total mesorectal excision

Core tip: Transanal total mesorectal excision (TaTME) is a result of recent developments in transanal endoscopic microsurgery, transanal minimally invasive surgery, natural orifice specimen extraction, natural orifice transluminal endoscopic surgery, transanal abdominal transanal proctosigmoidectomy, and laparoscopic total mesorectal excision. TaTME is an exciting convergence

of various existing surgical techniques that represents the future of rectal cancer surgery. A substantial number of patients, and especially obese males with a narrow pelvis, will benefit from this minimally invasive approach. This systematic review addresses all aspects of TaTME and discusses the advantages and disadvantages of this technique. Different surgical approaches are used, but it is clear that experience with TaTME is increasing worldwide. Standardization of the technique and reporting of outcomes is required.

Wolthuis AM, Bislenghi G, de Buck van Overstraeten A, D'Hoore A. Transanal total mesorectal excision: Towards standardization of technique. *World J Gastroenterol* 2015; 21(44): 12686-12695 Available from: URL: http://www.wjgnet.com/1007-9327/full/v21/i44/12686.htm DOI: http://dx.doi.org/10.3748/wjg.v21.i44.12686

INTRODUCTION

Total mesorectal excision (TME) was first described by Heald *et al*[1] in 1982 and is the gold standard for the treatment of rectal cancer. This technique results in larger negative circumferential resection margins, with subsequent reductions in locoregional recurrence and improved oncological outcomes[2]. A minimally invasive approach to TME has additionally been developed to optimize postoperative short-term outcomes. Laparoscopic TME exhibits oncological outcomes similar to those of open TME[3-6] and is also associated with better postoperative recovery, including lower postoperative morbidity and shorter hospital stays[7,8]. However, a steep learning curve is associated with laparoscopic TME, making the implementation of this technique a long process[9]. The technical challenges of laparoscopic TME are linked to operating in a deep and often narrow pelvis, with difficulties in obtaining adequate exposure. Laparoscopic ultra-low TME requires substantial retraction, which hampers visualization of the most distal part of the rectum. This critical step may lead to both breaches in the mesorectal fascia and incorrect identification of the distal resection margin, compromising oncological outcomes. Moreover, distal rectal transection using currently available laparoscopic staplers can be difficult. A suboptimal angle in the deep bony pelvis[10] often requires different staple firings for rectal transection, and the need for more than 2 linear stapling firings is associated with increased postoperative morbidity and anastomotic leakage[11]. The abovementioned technical challenges of operating in a confined space result in considerable rates of conversion from laparoscopic to open TME. Conversion rates as high as 34%[3,4,12-15] have been reported, and these conversions are linked to increased morbidity and worse oncological outcomes[13,16]. The risk of conversion is higher in males and obese patients[17].

A recent transanal approach was introduced to facilitate mobilization of the most distal rectum and to overcome the inherent shortcomings of laparoscopic TME[18,19]. In particular, transanal TME (TaTME) is a new minimally invasive procedure that basically merges different concepts of transanal surgery. TaTME was developed as a result of combined experience in transanal endoscopic microsurgery (TEM)[20], transanal abdominal transanal proctosigmoidectomy (TATA)[21], transanal minimally invasive surgery (TAMIS)[22], natural orifice specimen extraction (NOSE)[23], and natural orifice transluminal endoscopic surgery (NOTES)[24,25]. However, although TaTME appears to be an attractive option for improving postoperative outcomes, the technique has not been extensively investigated. The aims of this systematic review were to describe the role of TaTME in minimally invasive rectal cancer surgery, to examine the differences in patient selection and in reported surgical techniques and their impacts on postoperative outcomes and to discuss the future of TaTME.

MATERIALS AND METHODS

MEDLINE (PubMed), EMBASE, and The Cochrane Library were systematically searched through the 1st of March 2015. Boolean AND/OR operators were used to combine keywords and subject headings. The following search criteria were used: (total mesorectal excision or TME) and (transanal or transanal minimally invasive surgery or TAMIS or transanal specimen extraction or natural orifice specimen extraction or NOSE or natural orifice transluminal endoscopic surgery or NOTES). Search results were supplemented with subject headings for Medline. The reference lists of retrieved articles were also hand searched for additional publications. Cross-referencing was continued until no further relevant publications were identified. Randomized controlled clinical trials as well as observational cohort studies (excluding case reports) that described a technique to mobilize the most distal rectum transanally using endoscopic instruments were considered for inclusion. Studies of paediatric surgery were excluded. Studies using cadaveric and animal series were also excluded. First, the titles were screened, and appropriate studies were selected. Second, the full text of these studies was acquired. There was no language restriction. The quality of the included studies was assessed using the Newcastle-Ottawa Scale. This scale assesses the quality of non-randomized clinical trials and evaluates patient selection, the comparability of study groups and outcome assessment. A maximum of 9 stars can be achieved[26,27]. Relevant data from the included studies were extracted using a standard fillable form of predefined parameters and were entered into an Excel database. The following data were extracted: publication year, study type, inclusion and exclusion criteria, sample size, patient

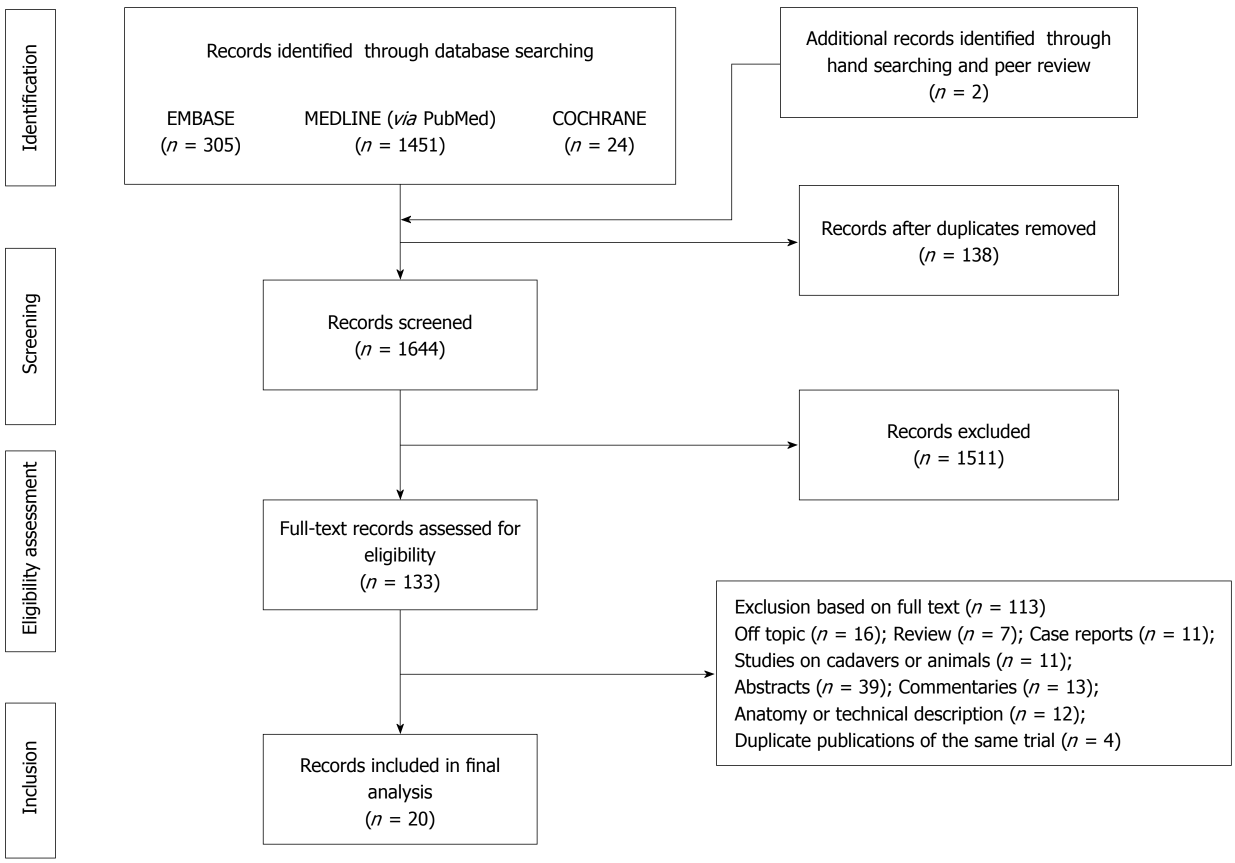

Figure 1 PRISMA flow diagram of the systematic literature review.

characteristics (age, gender, and body mass index (BMI)), neoadjuvant treatment, tumour characteristics (clinical stage and distance from anal verge or dentate line), surgical technique (approach, transanal platform used, specimen extraction, anastomotic technique, and defunctioning stoma), and operative outcomes (duration of surgery, estimated blood loss, postoperative complications, length of hospital stay, and follow-up). This systematic review was conducted in compliance with the PRISMA guidelines[28].

RESULTS

The predefined search strategy returned 1644 non-duplicated references (Figure 1). Publication titles and abstracts were screened, and 133 publications were retrieved for full-text review. Subsequently, 113 articles were excluded for the following reasons after a detailed review of the studies: 16 studies were off topic, 11 studies were case reports, 7 studies were reviews, 11 studies reported on cadaveric or animal series, 39 studies were abstracts, 14 studies were expert commentaries, 11 studies described the surgical technique or the anatomy involved in TaTME, and 4 studies were duplicate publications of the same clinical series. The article with the most comprehensive data was used in the last case. In total, 20 publications with a total of 323 patients were included[29-48]. Seventeen studies were prospective studies, 1 study was a case-control study, 1 study was a comparative study, and 1 study was a retrospective cohort study.

Patient selection

Only small studies, with fewer than 100 patients, were found (Table 1). Patients were predominantly male (male:female = 2:1), with a reported median age of approximately 65 years. The median BMI ranged from 22-31 kg/m^2. Eighteen of the 20 studies reported the tumour distance from either the anal verge or the dentate line. This distance ranged from 0-15 cm, with reported median distances of between 1.7 and 9.7 cm. Most patients in studies reporting on neoadjuvant therapy received induction chemoradiotherapy (231 of 296 patients). Patient and/or tumour characteristics played a role in patient selection. Specifically, patients were selected according to age (> 18 years old)[31,43], BMI (BMI > 30 kg/m^2, BMI < 40 kg/m^2)[31,33,42], or pelvic anatomy (pubococcygeal diameter < 10 cm)[29,33,42]; in 15 studies, tumour characteristics determined patient selection. Here, patients were selected if they were diagnosed with tumours located anteriorly in 1 study[42], with low (< 5 cm) rectal cancer in 8 studies[29,30,34,36,39,40,44,45], or with tumours within 12 cm from the anal verge in 3 studies[31,41,42]. Only T1-T3 tumours, as staged by magnetic resonance imaging, were included in 1 study[43], and tumours that

Table 1 Types of studies and patient selection for transanal total mesorectal excision

Author, year	Type of study	No. of patients	Median age (yr)	Gender ratio (M:F)	Median BMI (kg/m²)	Neoadjuvant therapy	Median distance from AV/DL (cm)
Zorron, 2010	Prospective	9	63 (range, 52-81)	5:4	NR	4/9	AV 7.5 (range, 4-12)
Dumont, 2012	Prospective	4	67 (range, 70-66)	4:0	23 (range, 22-25)	NR	AV 5.3 (range, 4-7)
de Lacy, 2013	Prospective	20	65 ± 10.2[1] (range, 44-77)	11:9	25 ± 3.8 (range, 19-33)	14/20	DL 6.5 ± 3.3[1] (range, 2-15)
Lacy, 2013	Prospective	3	73 (range, 71-75)	1:2	22 (range, 16-25)	2/3	9.7 (range, 9-10)
Rouanet, 2013	Prospective	30	65 (range, 43-82)	30:0	26 (range, 21-32)	29/30	AV Low rectum (0-5 cm) 20/30; Middle rectum (5-10 cm) 10/30; Upper rectum (10-15 cm) 0/30
Sylla, 2013	Prospective	5	49 ± 9.8[1]	3:2	26 ± 2.3	2/5	AV 5.7 (range, 4-10)
Atallah, 2014	Prospective	20	57 (range, 36-73)	14:6	24 (range 18-41)	17/20	AV 5 (range 1-9)
Chen, 2014	Prospective	20	58 ± 10.1[1]	11:9	25 ± 3	11/20	AV 5.9 ± 1.7 (range, 2-8)
Chouillard, 2014	Prospective	16	58 (range, 34-81)	6:10	28 (range, 21-38)	Yes	NR
Fernandez-Hevia, 2014	Prospective Comparative	37	65 ± 11.8[1]	24:13	24 ± 3.6 (range, 18-31)	27/37	AV Middle rectum 8.1 ± 1.7[1]; Low rectum 3.5 cm ± 1.2[1]
Kneist, 2014	Prospective	6	56 (range, 45-65)	5:1	25 (range, 23-28)	4/6	DL 1.7 (range, 0-3)
Meng, 2014	Prospective	3	80 (range, 76-82)	2:1	NR	1/3	AV 4.3 (range, 4-5)
Tuech, 2014	Prospective	56	65 (range, 39-83)	41:15	27 (range, 20-42)	47/56	AV 4 (range, 0-5)
Velthuis, 2014	Prospective Case-Matched	25	64 (range, 49-86)	18:7	25 (range, 20-36)	25/25	AV 8 (range, 0-16)
Wolthuis, 2014	Prospective	7	65 (range, 38-87)	6:1	25 (range, 17-32)	NR	NR
Atallah, 2015	Retrospective	4	45 (range, 26-59)	3:1	31 (range, 21-38)	3/4	AV 3.3 (range, 1-4)
Gomez Ruiz, 2015	Prospective	5	53 (range, 38-67)	4:1	26 (range, 22-31)	4/5	AV 5 (range, 4-6)
Knol, 2015	Prospective	10	61 (range 36-70)	8:2	27 (range 22-34)	10/10	DL 2.9 ± 1.21
Muratore, 2015	Prospective	26	66 (range, 38-84)	16:10	26 (range, 17-38)	19/26	4.4 (range, 3-6)
Prochazka, 2015	Prospective	17	68 (range, 49-81)	11:6	28 (range, 22-32)	12/17	AV 6 (range, 3-8)

[1]Values reported as the mean ± SD. AV: Anal verge; DL: Dentate line; NR: Not reported; M: Male; F: Female; BMI: Body mass index.

responded well to neoadjuvant therapy were included in another study[36]. cT4 tumours were excluded in 4 studies[33,37,40,45], and Rullier type Ⅱ/Ⅲ[49] tumours were excluded in 1 study[40].

Operative technique

TaTME was initiated transanally in 7 studies[31,33,40,41,44,46,47], and the abdominal phase was performed first in 7 other studies (Table 2)[29,30,35-37,42,45]. TaTME was performed simultaneously with the presence of laparoscopic and perineal operative teams[32,34,38,39,43,48]. This simultaneous approach was taken to reduce the operative time. Seven different transanal access platforms were used: the GelPOINT Path Transanal Access Platform (Applied Medical, Inc., Rancho Santa Margarita, CA, United States), SILS Port (Covidien, Mansfield, MA, United States), TriPort (Olympus Medical Europe Holding GmbH, Germany), TEO proctoscope (Karl Storz, Tuttlingen, Germany), TEM proctoscope (Richard-Wolf, Knittlingen, Germany), Endorec Trocar (Aspide Medical, La Talaudiere, France), and PAT transanal access port (Developia-humV, Santander, Spain). The tumour distance, as measured from the anorectal junction, determined the type of anastomosis (stapled or hand-sewn) before insertion of the transanal access platform. Therefore, the tumour height dictated the type of dissection. Intersphincteric dissection was required using an open approach under direct vision if the tumour was located at the anorectal junction. A Lone Star Retractor (Lone Star Medical Products Inc., Houston, TX, United States) was first inserted. Circumferential sleeve mucosectomy was then performed at the dentate line to safeguard the internal sphincter, and the rectum was closed using a purse-string suture. In particular, the rectal lumen was occluded with a purse string if the distal tumour margin (at least 1 cm below the tumour) allowed for a stapled coloanal anastomosis. Subsequently, the transanal access platform was placed into the anal muscular cuff, and insufflation was initiated with CO_2 to a pressure of 8-15 mmHg using a conventional CO_2 insufflator. The TME plane was identified in a reverse manner, beginning at the top of the puborectal muscle. The posterior TME plane was developed under direct vision using conventional laparoscopic instruments *via* incision of the endopelvic fascia and dissection in front of the presacral fascia to preserve the mesorectal envelope. Anterior dissection was performed in the rectovaginal septum or Denonvilliers' fascia (rectoprostatic plane) as cephalad as possible until the pouch of Douglas could be opened. Lateral dissection involved division of the middle rectal artery and connection of the anterior and posterior planes bilaterally. Only one study reported pure NOTES TaTME[31], whereas TaTME was performed with laparoscopic assistance (Hybrid TaTME) in most studies. Laparoscopy was performed using multiport laparoscopy (3-5 ports)[32,34-40,43,44,46,47] or single-port access[31,33,44,45,48]. The single port was placed in the future ileostomy site. High ligation

Table 2 Operative techniques reported for transanal total mesorectal excision

Author, year	Transanal first	Transanal platform	Pure NOTES	Number of laparoscopic ports	Splenic flexure mobilization	Specimen extraction	Anastomosis	Defunctioning stoma (loop ileostomy)
Zorron, 2010	Yes	TriPort	No	3	Yes	Transanal 7; transabdominal 2	Hand-sewn 1/9, hand-sewn J-pouch 3/9, stapled 5/9	Yes
Dumont, 2012	Yes	GelPOINT Path	No	GelPOINT	Yes	Transabdominal	Hand-sewn	Yes
de Lacy, 2013	Simultaneous	GelPOINT Path	No	3.2 ± 0.8[1] (range, 3-4)	NR	Transanal	Hand-sewn 13/20, stapled 7/20	16/20
Lacy, 2013	Simultaneous	GelPOINT Path	No	4	2/3	Transanal	Stapled	2/3
Rouanet, 2013	Not systematically	TEO proctoscope	No	NR	Yes	Transanal or transabdominal	Hand-sewn straight 12/30, hand-sewn J-pouch 18/30	Yes
Sylla, 2013	Simultaneous	TEO proctoscope	No	4 or 5	Yes	Transanal	Hand-sewn	Yes
Atallah, 2014	No	SILS™ Port or GelPOINT path	No	NR	Yes	NR	Hand-sewn straight 11/20, stapled 4/20	14/20
Chen, 2014	No or simultaneous	GelPOINT Path	No	GelPOINT + 1	4/20	Transanal or transabdominal	Hand-sewn 6/20, stapled 14/20	Loop colostomy 12/20, loop ileostomy 5/20
Chouillard, 2014	Yes	SILS™ Port or GelPOINT path	Yes (10/16)	GelPOINT	NR	NR	Hand-sewn	Loop ileostomy 4/16, permanent ileostomy 1/16, permanent colostomy 1/16
Fernandez-Hevia, 2014	Simultaneous	GelPOINT Path	No	4 or 5	14/37	Transanal 36; transabdominal 1	Hand-sewn 16/37, stapled 21/37	32/37
Kneist, 2014	No	SILS™ Port or GelPOINT path	No	3-5	Yes	Transanal	Hand-sewn J-pouch 2/6, hand-sewn E-E 2/6, hand-sewn S-E 1/6, stapled J-pouch 1/6	Yes
Meng, 2014	Simultaneous	TEM platform	No	5	Yes	Transabdominal	Stapled	NR
Tuech, 2014	Yes	SILS™ Port or GelPOINT path or Endorec®	No	4 or single port in future ileostomy site	NR	Transanal	Hand-sewn J-pouch 4/56, hand-sewn S-E 29/56, hand-sewn straight 13/56	Permanent colostomy 4/56, loop ileostomy 44/56
Velthuis, 2014	5/25	SILS™ Port or GelPOINT path	No	SILS™ Port	Yes	Transanal	Hand-sewn or stapled	Loop ileostomy 19/25, permanent colostomy 6/25
Wolthuis, 2014	Yes	GelPOINT Path	No	3	Yes	Transanal	Hand-sewn	Yes
Atallah, 2015	No	GelPOINT Path	No	NR	Yes	Transabdominal	Hand-sewn 3/4	Loop ileostomy 3/4, permanent ileostomy 1/4
Gomez Ruiz, 2015	No	Transanal access port proctoscope	No	4	Yes	Transanal	Hand-sewn straight 2/5, stapled 3/5	Yes
Knol, 2015	No	GelPOINT Path	No	4 or 5	8/10	Transanal 1; transabdominal 9	Hand-sewn 3/10, stapled 7/10	Yes
Muratore, 2015	Yes	SILS™ Port	No	3	Yes	Transanal	Hand-sewn straight 17/26, hand-sewn J-pouch 8/26	Yes
Prochazka, 2015	Yes	SILS™ Port or GelPOINT path or Endorec®	No	NR	Yes	Transanal	Hand-sewn	Yes

[1]Values reported as the mean ± SD. E-E: End-to-end; NR: Not reported; S-E: Side-to-end.

Table 3 Operative outcomes after transanal total mesorectal excision

Author, year	Median duration of surgery (min)	Median blood loss (mL)	Postoperative morbidity	Median length of stay (d)	Median follow-up (mo)	NOS
Zorron, 2010	311 (range, 200-420)	96 (range, 20-250)	Anastomotic leakage 1/9	7 (range, 4-27)	NR	3
Dumont, 2012	360 (range, 270-460)	175 (range, 50-300)	Anastomotic leakage 1/4	13 (range, 10-21)	4.3 (range, 3-9)	4
de Lacy, 2013	234.7 ± 56[1] (range, 150-325)	45 ± 151 (range, 10-110)	Urinary retention 2/20, POI 1/20, high-output ileostomy 1/20	6.5 ± 3.1[1]	NR	6
Lacy, 2013	143 (range, 125-155)	65 (range, 15-30)	High-output ileostomy 1/3	5 (range, 4-5)	NR	4
Rouanet, 2013	304 (range, 120-432)	NR	POI 2/30, transient urinary dysfunction 2/30	14 (range, 9-25)	21 (range, 10-41)	6
Sylla, 2013	274.6 ± 85.4[1]	166 (range, 80-300)	POI 1/5, transient urinary dysfunction 2/5	5.2 ± 2.6[1]	5.4 ± 2.3[1]	5
Atallah, 2014	243 (range, 140-495)	153 (range 30-500)	SSI 2/20, Pelvic abscess 4/20, POI 4/20, Anastomotic leakage 1/20	4.5 (range, 3-24)	6 (range, 1-24)	6
Chen, 2014	200.8 ± 47.7[1]	68 ± 106[1]	Urinary retention 3/20, pelvic abscess 2/20	8.85 ± 2.5[1]	NR	6
Chouillard, 2014	265 (range, 155-440)	225 (range, 50-600)	SBO 2/14, pelvic abscess 1/16	10 (range, 4-29)	9 (range, 3-29)	6
Fernandez-Hevia, 2014	215 ± 60[1] (range, 120-360)	NR	Anastomotic leakage 2/37, haemorrhage 1/37, urinary retention 1/37, POI 4/37	6 (range, 3-17)	NR	8
Kneist, 2014	NR	NR	NR	NR	NR	3
Meng, 2014	NR	NR	No	NR	NR	2
Tuech, 2014	270 (range, 150-495)	NR	Anastomotic leakage 3/56, pelvic sepsis 3/56, transient urinary dysfunction 5/56	10 (range, 6-21)	29 (range, 18-52)	6
Velthuis, 2014	NR	NR	NR	NR	NR	8
Wolthuis, 2014	148 (range, 85-250)	49 (range, 0-150)	Pelvic haematoma 1/7	9 (range, 3-14)	6 (range, 2-14)	6
Atallah, 2015	376 (range, 40-409)	200 (range, 50-300)	High-output ileostomy 1/20, SSI 1/20	4 (range, 4-5)	9 (range, 6-12)	4
Gomez Ruiz, 2015	375 (range, 270-450)	76 (range, 25-120)	Anastomotic leakage 1/5	6 (range, 5-7)	NR	4
Knol, 2015	235 (range, 150-290)	220 (range, 65-480)	POI 1/10	6 (range, 5-9)	NR	4
Muratore, 2015	241 (range, 150-360)	NR	Urinary retention 1/26	7 (range 3-25)	18 (range, 16-30)	6
Prochazka, 2015	280 (range, 212-375)	200 (range, 40-900)	Anastomotic leakage 2/17, POI 2/17, UTI 1/17, SSI 1/17	9 (range, 6-30)	NR	4

[1]Values reported as the mean ± SD. NR: Not reported; POI: Postoperative ileus; SBO: Small-bowel obstruction; SSI: Surgical site infection; UTI: Urinary tract infection.

of the inferior mesenteric artery and vein was performed. In 12 studies, after full mobilization of the left and sigmoid colon and connection to the TME plane were performed, the specimen was extracted transanally[32,34-36,38,40,41,43-47]. This extraction was only performed if the specimen was not too bulky. Adequate length was obtained *via* mobilization of the splenic flexure. Nine studies described hand-sewn coloanal anastomoses[30,31,33,40-44,46], and only stapled anastomoses were performed in 2 studies[38,39]. Both hand-sewn and stapled coloanal anastomoses were created in another 9 studies[29,32,34-37,45,47,48]. Additionally, a diverting-loop stoma (loop ileostomy or loop colostomy) was created in nearly every case.

Outcomes

The median total surgery duration ranged from 143-375 min (Table 3). This time included the transabdominal and transanal operative times. The operative times were significantly reduced when TaTME was performed using a 2-team approach compared with laparoscopic TME[34]. The reported median blood loss ranged from 45-225 mL. Overall, rendezvous was not possible using laparoscopy in 9 patients, so conversion to laparotomy was performed. The reasons for conversion included small-bowel adhesions (3 patients)[44,46], obesity (2 patients: 1 male and 1 female)[44], a posteriorly fixed tumour (2 patients)[42], a bulky tumour (1 patient)[47], and uncontrolled bleeding from the presacral plane (1 patient)[48]. Seventeen studies also reported postoperative morbidity. The anastomotic leak rate in the included studies was calculated to be 3.8%. There were also 3.4% pelvic abscesses. Other postoperative complications noted in the studies were (prolonged) postoperative ileus (15 patients)[29,32,34,37,41-43], transient urinary dysfunction (9 patients)[42-44], urinary retention (7 patients)[32,34,40,48], surgical site infection (4 patients)[29,30,41], high-output ileostomy (3 patients)[30,32,38], adhesive small-bowel obstruction (2 patients)[31], haemorrhage/pelvic haematoma (2 patients)[34,46], and urinary tract infection (1 patient)[41]. The median length of hospital stay ranged from 4-14 d, and there was no 30-day mortality.

DISCUSSION

This systematic review of TaTME for rectal cancer demonstrated that TaTME is feasible in select patients. The abdominoperineal rectum amputation rate is approximately 21% for low rectal cancer, but most patients are candidates for reconstruction after TME to avoid permanent colostomy[49]. Acceptance of a shorter distal resection margin (1 cm)[50], an increased interval after neoadjuvant chemoradiotherapy[51] and (partial) intersphincteric dissection increase the rates of sphincter-saving surgery in patients with distal rectal cancer[49]. The recent introduction of TaTME suggests that every patient who is selected for sphincter-saving surgery would undergo a minimally invasive approach, without conversion to laparotomy. This review clearly demonstrated that TaTME is currently performed in a non-standardized manner, which reflects surgeons exploring the technical boundaries of ultra-low rectal cancer surgery. Heterogeneity in patient selection and operative techniques leads to differences in surgical, oncological, and functional outcomes, which in turn hinder inter-study comparisons. Operative techniques specifically differed among studies in the present analysis, with use of different numbers of ports, different transanal platforms and different methods of performing TaTME. The procedure can be initiated either transabdominally or transanally, and the extent of dissection from either side can be tailored to each individual patient. The additional use of Airseal technology leads to a stable workspace (pneumopelvis), which avoids any "flapping" of the specimen and facilitates pneumodissection[52].

TaTME has certain advantages over laparoscopic TME, but there are still issues that must be addressed. TaTME is advocated in the case of a narrow male pelvis, so most studies have selected male patients. Only a few studies considered BMI or pelvic anatomy for patient selection. Less than half of the studies included here exclusively selected low (*i.e.*, < 5 cm from the anal verge) rectal tumours for TaTME. TaTME is an attractive alternative to laparoscopic TME because of several benefits, including determination of the distal resection margin, creation of a single stapled anastomosis, and avoidance of abdominal wall incision for specimen retrieval. If TaTME is first initiated in the transanal phase, then the distal resection margin and the level of the future anastomosis can be chosen under direct vision. A significantly longer distal resection margin has been reported using TaTME compared with conventional laparoscopic TME[34]. TaTME also results in better TME specimens[45]. Furthermore, this review demonstrated that a hand-sewn anastomosis was performed in approximately half of the studies, which may reflect the selection of patients with ultra-low rectal cancers. A stapled coloanal anastomosis using the double purse-string technique results in a single stapled anastomosis. This technique may eventually lead to a decreased anastomotic leak rate, but whether this technique improves functional outcomes is not clear. Moreover, TaTME will ultimately be performed as a pure NOTES procedure, which may be its greatest advantage. In this way, the diseased target organ can be reached transanally, so future developments should focus on pure NOTES TaTME. If laparoscopy can be omitted in this setting, then true NOTES may become possible in a consecutive series of patients. Mobilization and extraction of the specimen can presently be performed *via* the anus if the splenic flexure is mobilized using laparoscopic assistance. Therefore, TaTME is a NOSE technique that shares all of the advantages of NOSE. The avoidance of abdominal wall incision that is tailored to specimen and tumour sizes is important because the extraction site carries a morbidity risk. A wound infection rate of 9% has been documented, albeit generally, with only local septic complications in particular[53]. This review demonstrated that specimens were extracted transanally in 12 studies. Differences between transanal NOSE techniques involving laparoscopic TME using the anus as the extraction site and techniques involving transanal TME in the literature must be highlighted. Both procedures are transanal NOSE techniques, but transanal TME is performed in a reverse manner. TaTME may offer several advantages over laparoscopic and open TME, but it also has limitations. One major perioperative complication that is specific to TaTME is urethral injury. For example, Rouanet *et al*[42] described two urethral injuries that were sutured transanally. Moreover, the impact of TaTME on the anal sphincter is not known, and therefore, functional outcomes after TaTME are of interest. Additionally, this technique is in its infancy, so the learning curve is ill defined. Further prospective studies will therefore be required to describe the safety profile of and learning curve for TaTME. However, it is clear that a reverse approach to the mesorectum forces surgeons to recognize new anatomical landmarks and to perform the fundamental steps of TaTME[54,55]. Most studies have only reported short-term outcomes, which reflects the novelty of TaTME. Whether this new approach exhibits similar oncological outcomes in terms of local recurrence, disease-free survival and cancer-specific survival will require further study in prospective trials that compare TaTME with conventional laparoscopic or robotic TME over substantial follow-up periods.

In conclusion, this state-of-the-art narrative review presents recent developments in the TaTME technique. The technical possibilities and shortcomings of TaTME are also described. A new era of further optimization of distal rectal cancer surgery has dawned: standardization of surgical technique and implementation in daily practice are the steps required to take TaTME to the next level. In addition, large prospective studies should focus on safety and functional and oncological outcomes, and the presumed benefits of TaTME must be studied in controlled trials.

COMMENTS

Background

Laparoscopic ultra-low total mesorectal excision remains cumbersome because it is technically difficult to mobilize the most distal part of the rectum, especially in obese male patients with a narrow pelvis. Transanal total mesorectal excision (TaTME) may resolve all issues related to pelvic exposure, cross-stapling, and specimen quality. TaTME seems to be an attractive new methodology in rectal cancer surgery, but this approach has not been extensively investigated.

Research frontiers

The aims of this systematic review were to describe the role of TaTME in minimally invasive rectal cancer surgery, to examine the differences in patient selection and in reported surgical techniques and their impacts on postoperative outcomes and to discuss the future of TaTME.

Innovations and breakthroughs

A total of 20 studies with 323 patients were included. Most studies were single-arm prospective studies with fewer than 100 patients. Multiple transanal access platforms were used, and the laparoscopic approach was either multi- or single port. The procedure was initiated transanally or transabdominally. If a simultaneous approach with 2 operating surgeons was chosen, the operative time was significantly reduced.

Applications

TaTME was also associated with better TME specimens and a longer distal resection margin. TaTME is thus feasible in expert hands, but the learning curve and safety profile are not well defined.

Peer-review

Well written paper, well conducted review.

REFERENCES

1 **Heald RJ**, Husband EM, Ryall RD. The mesorectum in rectal cancer surgery--the clue to pelvic recurrence? *Br J Surg* 1982; **69**: 613-616 [PMID: 6751457]

2 **Heald RJ**, Moran BJ, Ryall RD, Sexton R, MacFarlane JK. Rectal cancer: the Basingstoke experience of total mesorectal excision, 1978-1997. *Arch Surg* 1998; **133**: 894-899 [PMID: 9711965]

3 **Lujan J**, Valero G, Hernandez Q, Sanchez A, Frutos MD, Parrilla P. Randomized clinical trial comparing laparoscopic and open surgery in patients with rectal cancer. *Br J Surg* 2009; **96**: 982-989 [PMID: 19644973 DOI: 10.1002/bjs.6662]

4 **van der Pas MH**, Haglind E, Cuesta MA, Fürst A, Lacy AM, Hop WC, Bonjer HJ. Laparoscopic versus open surgery for rectal cancer (COLOR II): short-term outcomes of a randomised, phase 3 trial. *Lancet Oncol* 2013; **14**: 210-218 [PMID: 23395398 DOI: 10.1016/S1470-2045(13)70016-0]

5 **Vennix S**, Pelzers L, Bouvy N, Beets GL, Pierie JP, Wiggers T, Breukink S. Laparoscopic versus open total mesorectal excision for rectal cancer. *Cochrane Database Syst Rev* 2014; **4**: CD005200 [PMID: 24737031 DOI: 10.1002/14651858.CD005200.pub3]

6 **Bonjer HJ**, Deijen CL, Abis GA, Cuesta MA, van der Pas MH, de Lange-de Klerk ES, Lacy AM, Bemelman WA, Andersson J, Angenete E, Rosenberg J, Fuerst A, Haglind E. A randomized trial of laparoscopic versus open surgery for rectal cancer. *N Engl J Med* 2015; **372**: 1324-1332 [PMID: 25830422 DOI: 10.1056/NEJMoa1414882]

7 **Breukink S**, Pierie J, Wiggers T. Laparoscopic versus open total mesorectal excision for rectal cancer. *Cochrane Database Syst Rev* 2006; (**4**): CD005200 [PMID: 17054246 DOI: 10.1002/14651858.CD005200.pub2]

8 **Xiong B**, Ma L, Zhang C. Laparoscopic versus open total mesorectal excision for middle and low rectal cancer: a meta-analysis of results of randomized controlled trials. *J Laparoendosc Adv Surg Tech A* 2012; **22**: 674-684 [PMID: 22881123 DOI: 10.1089/lap.2012.0143]

9 **Ito M**, Sugito M, Kobayashi A, Nishizawa Y, Tsunoda Y, Saito N. Influence of learning curve on short-term results after laparoscopic resection for rectal cancer. *Surg Endosc* 2009; **23**: 403-408 [PMID: 18401643 DOI: 10.1007/s00464-008-9912-1]

10 **Brannigan AE**, De Buck S, Suetens P, Penninckx F, D'Hoore A. Intracorporeal rectal stapling following laparoscopic total mesorectal excision: overcoming a challenge. *Surg Endosc* 2006; **20**: 952-955 [PMID: 16738989 DOI: 10.1007/s00464-005-0536-4]

11 **Ito M**, Sugito M, Kobayashi A, Nishizawa Y, Tsunoda Y, Saito N. Relationship between multiple numbers of stapler firings during rectal division and anastomotic leakage after laparoscopic rectal resection. *Int J Colorectal Dis* 2008; **23**: 703-707 [PMID: 18379795 DOI: 10.1007/s00384-008-0470-8]

12 **Braga M**, Frasson M, Vignali A, Zuliani W, Capretti G, Di Carlo V. Laparoscopic resection in rectal cancer patients: outcome and cost-benefit analysis. *Dis Colon Rectum* 2007; **50**: 464-471 [PMID: 17195085 DOI: 10.1007/s10350-006-0798-5]

13 **Guillou PJ**, Quirke P, Thorpe H, Walker J, Jayne DG, Smith AM, Heath RM, Brown JM; MRC CLASICC trial group. Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASICC trial): multicentre, randomised controlled trial. *Lancet* 2005; **365**: 1718-1726 [PMID: 15894098 DOI: 10.1016/S0140-6736(05)66545-2]

14 **Ng KH**, Ng DC, Cheung HY, Wong JC, Yau KK, Chung CC, Li MK. Laparoscopic resection for rectal cancers: lessons learned from 579 cases. *Ann Surg* 2009; **249**: 82-86 [PMID: 19106680 DOI: 10.1097/SLA.0b013e31818e418a]

15 **Penninckx F**, Kartheuser A, Van de Stadt J, Pattyn P, Mansvelt B, Bertrand C, Van Eycken E, Jegou D, Fieuws S. Outcome following laparoscopic and open total mesorectal excision for rectal cancer. *Br J Surg* 2013; **100**: 1368-1375 [PMID: 23939849 DOI: 10.1002/bjs.9211]

16 **Poon JT**, Law WL. Laparoscopic resection for rectal cancer: a review. *Ann Surg Oncol* 2009; **16**: 3038-3047 [PMID: 19641971 DOI: 10.1245/s10434-009-0603-5]

17 **Bretagnol F**, Rullier E, Couderc P, Rullier A, Saric J. Technical and oncological feasibility of laparoscopic total mesorectal excision with pouch coloanal anastomosis for rectal cancer. *Colorectal Dis* 2003; **5**: 451-453 [PMID: 12925079]

18 **Sylla P**, Rattner DW, Delgado S, Lacy AM. NOTES transanal rectal cancer resection using transanal endoscopic microsurgery and laparoscopic assistance. *Surg Endosc* 2010; **24**: 1205-1210 [PMID: 20186432 DOI: 10.1007/s00464-010-0965-6]

19 **Wolthuis AM**, Cini C, Penninckx F, D'Hoore A. Transanal single port access to facilitate distal rectal mobilization in laparoscopic rectal sleeve resection with hand-sewn coloanal anastomosis. *Tech Coloproctol* 2012; **16**: 161-165 [PMID: 22170250 DOI: 10.1007/s10151-011-0795-0]

20 **Buess G**, Theiss R, Hutterer F, Pichlmaier H, Pelz C, Holfeld T, Said S, Isselhard W. [Transanal endoscopic surgery of the rectum - testing a new method in animal experiments]. *Leber Magen Darm* 1983; **13**: 73-77 [PMID: 6621245]

21 **Marks J**, Nassif G, Schoonyoung H, DeNittis A, Zeger E, Mohiuddin M, Marks G. Sphincter-sparing surgery for adenocarcinoma of the distal 3 cm of the true rectum: results after neoadjuvant therapy and minimally invasive radical surgery or local excision. *Surg Endosc* 2013; **27**: 4469-4477 [PMID: 24057070 DOI: 10.1007/s00464-013-3092-3]

22 **Atallah S**, Albert M, Larach S. Transanal minimally invasive surgery: a giant leap forward. *Surg Endosc* 2010; **24**: 2200-2205 [PMID: 20174935 DOI: 10.1007/s00464-010-0927-z]

23 **Wolthuis AM**, de Buck van Overstraeten A, D'Hoore A. Laparoscopic natural orifice specimen extraction-colectomy: a systematic review. *World J Gastroenterol* 2014; **20**: 12981-12992 [PMID: 25278692 DOI: 10.3748/wjg.v20.i36.12981]

24 **Rattner D**, Kalloo A. ASGE/SAGES Working Group on Natural Orifice Translumenal Endoscopic Surgery. October 2005. *Surg Endosc* 2006; **20**: 329-333 [PMID: 16402290 DOI: 10.1007/

s00464-005-3006-0]
25 **Whiteford MH**, Denk PM, Swanström LL. Feasibility of radical sigmoid colectomy performed as natural orifice translumenal endoscopic surgery (NOTES) using transanal endoscopic microsurgery. *Surg Endosc* 2007; **21**: 1870-1874 [PMID: 17705068 DOI: 10.1007/s00464-007-9552-x]
26 **Stang A**. Critical evaluation of the Newcastle-Ottawa scale for the assessment of the quality of nonrandomized studies in meta-analyses. *Eur J Epidemiol* 2010; **25**: 603-605 [PMID: 20652370 DOI: 10.1007/s10654-010-9491-z]
27 **Wells G**, Shea B, O'Connell D, Peterson J, Welch V, Losos M. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. Ottawa, Canada: University of Ottawa, 2000
28 **Moher D**, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med* 2009; **6**: e1000097 [PMID: 19621072 DOI: 10.1371/journal.pmed.1000097]
29 **Atallah S**, Martin-Perez B, Albert M, deBeche-Adams T, Nassif G, Hunter L, Larach S. Transanal minimally invasive surgery for total mesorectal excision (TAMIS-TME): results and experience with the first 20 patients undergoing curative-intent rectal cancer surgery at a single institution. *Tech Coloproctol* 2014; **18**: 473-480 [PMID: 24272607 DOI: 10.1007/s10151-013-1095-7]
30 **Atallah S**, Martin-Perez B, Parra-Davila E, deBeche-Adams T, Nassif G, Albert M, Larach S. Robotic transanal surgery for local excision of rectal neoplasia, transanal total mesorectal excision, and repair of complex fistulae: clinical experience with the first 18 cases at a single institution. *Tech Coloproctol* 2015; **19**: 401-410 [PMID: 25708682 DOI: 10.1007/s10151-015-1283-8]
31 **Chouillard E**, Chahine E, Khoury G, Vinson-Bonnet B, Gumbs A, Azoulay D, Abdalla E. NOTES total mesorectal excision (TME) for patients with rectal neoplasia: a preliminary experience. *Surg Endosc* 2014; **28**: 3150-3157 [PMID: 24879139 DOI: 10.1007/s00464-014-3573-z]
32 **de Lacy AM**, Rattner DW, Adelsdorfer C, Tasende MM, Fernández M, Delgado S, Sylla P, Martínez-Palli G. Transanal natural orifice transluminal endoscopic surgery (NOTES) rectal resection: "down-to-up" total mesorectal excision (TME)--short-term outcomes in the first 20 cases. *Surg Endosc* 2013; **27**: 3165-3172 [PMID: 23519489 DOI: 10.1007/s00464-013-2872-0]
33 **Dumont F**, Goéré D, Honoré C, Elias D. Transanal endoscopic total mesorectal excision combined with single-port laparoscopy. *Dis Colon Rectum* 2012; **55**: 996-1001 [PMID: 22874608 DOI: 10.1097/DCR.0b013e318260d3a0]
34 **Fernández-Hevia M**, Delgado S, Castells A, Tasende M, Momblan D, Díaz del Gobbo G, DeLacy B, Balust J, Lacy AM. Transanal total mesorectal excision in rectal cancer: short-term outcomes in comparison with laparoscopic surgery. *Ann Surg* 2015; **261**: 221-227 [PMID: 25185463 DOI: 10.1097/SLA.0000000000000865]
35 **Gómez Ruiz M**, Parra IM, Palazuelos CM, Martín JA, Fernández CC, Diego JC, Fleitas MG. Robotic-assisted laparoscopic transanal total mesorectal excision for rectal cancer: a prospective pilot study. *Dis Colon Rectum* 2015; **58**: 145-153 [PMID: 25489707 DOI: 10.1097/DCR.0000000000000265]
36 **Kneist W**, Rink AD, Kauff DW, Konerding MA, Lang H. Topography of the extrinsic internal anal sphincter nerve supply during laparoscopic-assisted TAMIS TME: five key zones of risk from the surgeons' view. *Int J Colorectal Dis* 2015; **30**: 71-78 [PMID: 25310925 DOI: 10.1007/s00384-014-2026-4]
37 **Knol JJ**, D'Hondt M, Souverijns G, Heald B, Vangertruyden G. Transanal endoscopic total mesorectal excision: technical aspects of approaching the mesorectal plane from below--a preliminary report. *Tech Coloproctol* 2015; **19**: 221-229 [PMID: 25702172 DOI: 10.1007/s10151-015-1275-8]
38 **Lacy AM**, Adelsdorfer C, Delgado S, Sylla P, Rattner DW. Minilaparoscopy-assisted transrectal low anterior resection (LAR): a preliminary study. *Surg Endosc* 2013; **27**: 339-346 [PMID: 22806513 DOI: 10.1007/s00464-012-2443-9]
39 **Meng W**, Lau K. Synchronous laparoscopic low anterior and transanal endoscopic microsurgery total mesorectal resection. *Minim Invasive Ther Allied Technol* 2014; **23**: 70-73 [PMID: 24483132 DOI: 10.3109/13645706.2014.887022]
40 **Muratore A**, Mellano A, Marsanic P, De Simone M. Transanal total mesorectal excision (taTME) for cancer located in the lower rectum: short- and mid-term results. *Eur J Surg Oncol* 2015; **41**: 478-483 [PMID: 25633642 DOI: 10.1016/j.ejso.2015.01.009]
41 **Procházka V**, Kala Z, Škrovina M, Grolich T, Klos K. [Transanal total mesorectal excision for low rectal cancer - first results]. *Rozhl Chir* 2015; **94**: 64-68 [PMID: 25659255]
42 **Rouanet P**, Mourregot A, Azar CC, Carrere S, Gutowski M, Quenet F, Saint-Aubert B, Colombo PE. Transanal endoscopic proctectomy: an innovative procedure for difficult resection of rectal tumors in men with narrow pelvis. *Dis Colon Rectum* 2013; **56**: 408-415 [PMID: 23478607 DOI: 10.1097/DCR.0b013e3182756fa0]
43 **Sylla P**, Bordeianou LG, Berger D, Han KS, Lauwers GY, Sahani DV, Sbeih MA, Lacy AM, Rattner DW. A pilot study of natural orifice transanal endoscopic total mesorectal excision with laparoscopic assistance for rectal cancer. *Surg Endosc* 2013; **27**: 3396-3405 [PMID: 23572214 DOI: 10.1007/s00464-013-2922-7]
44 **Tuech JJ**, Karoui M, Lelong B, De Chaisemartin C, Bridoux V, Manceau G, Delpero JR, Hanoun L, Michot F. A step toward NOTES total mesorectal excision for rectal cancer: endoscopic transanal proctectomy. *Ann Surg* 2015; **261**: 228-233 [PMID: 25361216 DOI: 10.1097/SLA.0000000000000994]
45 **Velthuis S**, Nieuwenhuis DH, Ruijter TE, Cuesta MA, Bonjer HJ, Sietses C. Transanal versus traditional laparoscopic total mesorectal excision for rectal carcinoma. *Surg Endosc* 2014; **28**: 3494-3499 [PMID: 24972923 DOI: 10.1007/s00464-014-3636-1]
46 **Wolthuis AM**, de Buck van Overstraeten A, D'Hoore A. Dynamic article: transanal rectal excision: a pilot study. *Dis Colon Rectum* 2014; **57**: 105-109 [PMID: 24316953 DOI: 10.1097/DCR.0000000000000008]
47 **Zorron R**, Phillips HN, Wynn G, Neto MP, Coelho D, Vassallo RC. "Down-to-Up" transanal NOTES Total mesorectal excision for rectal cancer: Preliminary series of 9 patients. *J Minim Access Surg* 2014; **10**: 144-150 [PMID: 25013331 DOI: 10.4103/0972-9941.134878]
48 **Chen CC**, Lai YL, Jiang JK, Chu CH, Huang IP, Chen WS, Cheng AY, Yang SH. The evolving practice of hybrid natural orifice transluminal endoscopic surgery (NOTES) for rectal cancer. *Surg Endosc* 2015; **29**: 119-126 [PMID: 24986014 DOI: 10.1007/s00464-014-3659-7]
49 **Rullier E**, Denost Q, Vendrely V, Rullier A, Laurent C. Low rectal cancer: classification and standardization of surgery. *Dis Colon Rectum* 2013; **56**: 560-567 [PMID: 23575394 DOI: 10.1097/DCR.0b013e31827c4a8c]
50 **Bujko K**, Rutkowski A, Chang GJ, Michalski W, Chmielik E, Kusnierz J. Is the 1-cm rule of distal bowel resection margin in rectal cancer based on clinical evidence? A systematic review. *Ann Surg Oncol* 2012; **19**: 801-808 [PMID: 21879269 DOI: 10.1245/s10434-011-2035-2]
51 **Wolthuis AM**, Penninckx F, Haustermans K, De Hertogh G, Fieuws S, Van Cutsem E, D'Hoore A. Impact of interval between neoadjuvant chemoradiotherapy and TME for locally advanced rectal cancer on pathologic response and oncologic outcome. *Ann Surg Oncol* 2012; **19**: 2833-2841 [PMID: 22451236 DOI: 10.1245/s10434-012-2327-1]
52 **Bislenghi G**, Wolthuis AM, de Buck van Overstraeten A, D'Hoore A. AirSeal system insufflator to maintain a stable pneumorectum during TAMIS. *Tech Coloproctol* 2015; **19**: 43-45 [PMID: 25421704 DOI: 10.1007/s10151-014-1244-7]
53 **Hackert T**, Uhl W, Büchler MW. Specimen retrieval in laparoscopic colon surgery. *Dig Surg* 2002; **19**: 502-506 [PMID: 12499745]
54 **Aigner F**, Hörmann R, Fritsch H, Pratschke J, D'Hoore A, Brenner E, Williams N, Biebl M. Anatomical considerations for transanal

minimal-invasive surgery: the caudal to cephalic approach. *Colorectal Dis* 2015; **17**: O47-O53 [PMID: 25418450 DOI: 10.1111/codi.12846]

55 **Bertrand MM**, Colombo PE, Alsaid B, Prudhomme M, Rouanet P. Transanal endoscopic proctectomy and nerve injury risk: bottom to top surgical anatomy, key points. *Dis Colon Rectum* 2014; **57**: 1145-1148 [PMID: 25101614 DOI: 10.1097/DCR.0000000000000187]

P- Reviewer: Piccinni G **S- Editor**: Yu J **L- Editor**: A
E- Editor: Ma S

Baishideng®

Published by **Baishideng Publishing Group Inc**
8226 Regency Drive, Pleasanton, CA 94588, USA
Telephone: +1-925-223-8242
Fax: +1-925-223-8243
E-mail: bpgoffice@wjgnet.com
Help Desk: http://www.wjgnet.com/esps/helpdesk.aspx
http://www.wjgnet.com

ISSN 1007-9327