A longer pelvis is associated with longer operative time in transanal total mesorectal excision (TME) but not in laparoscopic TME. Results from a retrospective cohort study

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Abstract

Introduction: *A narrow pelvis, obesity, and bulky low rectal tumor are perceived as risk factors for intraoperative difficulties during total mesorectal excision (TME), particularly in the laparoscopic approach. A transanal approach has been developed to overcome the difficulties encountered during laparoscopic TME. There is no clear definition of a narrow pelvis that would guide preoperative surgical planning.*
Aim: *To evaluate different MRI-based pelvic measurements in patients undergoing TME to identify factors predictive of intraoperative difficulties in transabdominal compared to the transanal approach.*
Material and methods: *A retrospective analysis of 48 patients treated with laparoscopic TME and 62 with transanal TME for rectal tumors was performed. Multiple logistic regressions analyzed demographic, tumor, and pelvimetry factors that correlate with intraoperative difficulties measured as intraoperative blood loss, operation time, and perioperative complications in both surgical approaches.*
Results: *Multivariate analysis showed that age was associated with higher blood loss (OR = 1.09, 95% CI: 1.00–1.18, p = 0.038), male gender (OR = 0.13, 95% CI: 0.02–0.86, p = 0.029) and body mass index with longer operating time (OR = 1.32, 95% CI: 1.06–1.64, p = 0.010) in the LAR group. Multivariate analysis showed that age increased the odds of intraoperative blood loss > 100 ml (OR = 1.08, 95% CI: 1.02–1.15, p = 0.013), and pelvic length > 119 mm increased operating time (OR = 5.76, 95% CI: 1.33–25.01, p = 0.016) in the TaTME group.*
Conclusions: *Pelvic measurements are not associated with intraoperative difficulties in LAR. Longer pelvis was associated with longer operative time in TaTME.*

Key words: *total mesorectal excision (TME), pelvimetry, transanal TME, TaTME, laparoscopic TME, narrow pelvis.*

Introduction

Transanal total mesorectal excision (TaTME) is a novel approach to rectal cancer surgery [1]. It was introduced to overcome the difficulties encountered during laparoscopic anterior resection (LAR), particularly for distal rectal tumors [2]. A narrow, funneling pelvic bony structure has traditionally been perceived as a challenging surgical field that impedes surgical instrument maneuvers in the transabdominal TME [3]. Compared to the abdominal approach, TaTME proved to be non-inferior in the quality of specimens and postoperative complications [4, 5]. The current consensus guidelines indicate that TaTME

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should be used when there are anticipated technical difficulties in pelvic dissection from the abdominal approach [6]. The patient selection criteria for the transanal approach include male sex, obese patients, and bulky tumors in a narrow pelvis [7]. However, to date, there is no clear definition of a narrow pelvis. Pelvic magnetic resonance imaging (MRI) is currently performed as part of the standard preoperative workup for rectal cancer. It defines the disease stage, tumor margins, and regional lymph node involvement as well as being used to delineate detailed pelvic anatomical relations which can aid to predict intraoperative difficulties. Several studies have analyzed various pelvimetric measurements to predict surgical difficulties in performing TME [8]. The results have been, however, inconsistent and mainly focused on patients undergoing the abdominal approach.

Aim

The aim of the study was to determine the clinical and anatomical factors, particularly MRI-based pelvic dimensions measurements that can predict intraoperative difficulties in laparoscopic and transanal TME.

Material and methods

Patients with mid and low-rectal cancers operated on by either the laparoscopic or the transanal approach in the 2nd Department of General Surgery, University Hospital in Poland between February 2013 and April 2020 were included in the study. A retrospective analysis was performed. Patients with rectal cancer who underwent abdominoperineal resection (APR), open anterior resection, and multiorgan resection such as combined with prostate, bladder, or uterus were excluded from the study.

Preoperative workup included computed tomography (CT) of the chest, abdomen, and pelvis to exclude distant metastases and MRI of the pelvis performed typically 3 weeks before the start of treatment.

Neoadjuvant radiotherapy was administered to all patients fulfilling the predetermined criteria (T3 tumor or positive lymph nodes).

Pelvimetry

The imaging was conducted using T2 FRFSE, STIR FSE, T1 FSE, DWI plain and IDEAL LAVA-Flex (dynamic) and T1 FSE fs after intravenous contrast injection with Gadovist (9 ml), in coronal, axial, sagittal, and frontal views with the slice thickness 3 mm, 4 mm, 4.4 mm and 5 mm. The following nine pelvimetric parameters were assessed by two independent specialists who were blinded to clinical data: A – anorectal angle (angle between anal canal and rectum), B – pelvic inlet (distance between the pelvic promontory and superior surface of the pubic symphysis), C – pubococcygeal distance (between the tip of the coccyx and the superior surface of the pubic symphysis), D – sacral depth (perpendicular distance from the deepest point in the sacrococcygeal hollow and sacrococcygeal line), E – pelvic length (between the promontory and the tip of the coccyx), F – pelvic outlet (between the tip of the coccyx and inferior edge of the pubic symphysis), G – intertuberous distance (distance between the lowest points of the ischial tuberosities), H – interspinous distance (distance between tips of the ischial spines), I – anal canal length. All measurements were performed in either the sagittal or the axial plane.

Dependent and independent variables

Intraoperative difficulties were assessed using three variables: total operating time, intraoperative blood loss, and early overall postoperative complications. Postoperative complications were classified according to the Clavien-Dindo system [9].

Independent variables included: age, gender, body mass index (BMI), tumor distance from the anal verge (tumor depth), preoperative radiotherapy, anastomosis type, diverting ileostomy creation, distal margin, circumferential resection margin, length of hospital stay, tumor stage, and tumor size.

Surgical technique

Diverting ileostomy was created for patients who underwent neoadjuvant treatment and those with hand-sawn coloanal anastomosis.

All procedures were performed with minimally invasive techniques by experienced general surgeons who had completed their learning curve for both procedures.

Laparoscopic TME

A five-trocar approach was used with a 10 mm trocar above the umbilicus, a 10 mm trocar in the right iliac fossa, two 5 mm trocars in the left iliac fossa and the left subcostal area, and one 10 mm trocar in the suprapubic area. The two 10 mm trocars were utilized for the intracorporeal stapling depending on the anastomosis level.

The mesorectum was dissected intact, enveloped in the mesorectal fascia as in the standard TME technique. The anastomosis was performed either intracorporeally with the double stapling technique [10] or if the intersphincteric resection was required a hand-sawn colo-anal anastomosis was created. The leak test was performed using either methylene blue dye or inspected visually with colonoscopy. The specimen was extracted either through Pfannenstiel incision or transanally.

TaTME technique

The abdominal part of the procedure was performed as per laparoscopic TME. The transanal resection was performed with one-team approach. The anal retraction was secured with a Lone Star retractor system and a single GelPoint Port (Applied Medical, Rancho Santo Margarita, California) was used with standard laparoscopic instruments to perform dissection. The anastomosis technique and specimen extraction were analogous to the laparoscopic TME [11].

Ethical clearance

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Committee of the Jagiellonian University no. 1072.6120.14.2020.

Informed consent was waived because of the study's retrospective nature and the analysis used anonymous clinical data.

Statistical analysis

Calculations were performed using Statistica 13.3 PL software (Tibco, CA, USA). Continuous values were presented as means with standard deviations, or medians with interquartile ranges when appropriate. Qualitative variables were compared using the Pearson χ^2 with or without Yates' correction. A receiver operating characteristic (ROC) curve was used to determine significant cut-off points of pelvic measurements. Significant variables in univariate logistic regression models were then adjusted in multivariate analysis to obtain significant independent risk factors and to calculate the OR with a 95% confidence interval (CI). *P*-values ≤ 0.05 were considered statistically significant.

The study was designed according to STROBE guidelines for observational studies [12].

Results

A hundred and ten patients underwent surgery for rectal cancer between February 2013 and April 2020 in our department; there were 44 females (40%). LAR was performed in 48 patients (LAR group) and 62 patients underwent TaTME (TaTME group). No differences were observed between the study groups in demographic characteristics such as age, male-to-female ratio, and BMI. The tumor stage and tumor distance from the anal verge were comparable in both groups. Likewise, there were no differences in the preoperative workup and perioperative management, median operating time, or blood loss during the surgery. Significantly more patients suffered postoperative morbidity in the LAR group compared to the TaTME group (33% vs. 16%, $p = 0.043$). Baseline characteristics are presented in Table I.

LAR group

The median operative time in the LAR group was 210 min (IQR =180–240 min). The median estimated blood loss was 100 ml (IQR = 50–200 ml). Sixteen (33%) patients suffered postoperative morbidity. Among them, an anastomotic leak was detected in 5 patients, 2 patients suffered subhepatic abscesses, 2 required reoperations for obstruction and small bowel perforation, and 1 required 4 units of red blood cell transfusion due to pelvic hematoma. One patient died on the third postoperative day in an unknown mechanism. The median length of hospital stay (LOS) was significantly longer in patients suffering postoperative complications compared to the patients with uncomplicated postoperative stay (14.5 days (IQR = 7.5–17) vs. 5 days (IQR = 4–7), $p < 0.001$) (Table II).

ROC analysis was performed to establish the cut-off points of pelvic measurements' association with postoperative morbidity, blood loss above the median, and operating time above the median. No significant cut-off points were found to be associated with the risk of postoperative complications or for the operative time above the median, whereas an anorectal angle > 134° was found to be a potential predictive value for intraoperative blood loss above the median (AUC = 0.73, 95% CI: 0.54–0.91, $p = 0.016$). These factors and other factors potentially influencing intraoperative difficulties were included to build univariate and multivariate logistic regression models. Multivariate analysis showed that age (with every year) increased the odds ratio for higher blood loss (OR = 1.09, 95% CI: 1.00–1.18, $p = 0.038$), female gender was associated with shorter operating time (OR = 0.13, 95% CI: 0.02–0.86, $p = 0.029$) and BMI with every 1 kg/m^2 increased the odds for longer operating time (OR = 1.32, 95% CI: 1.06–1.64, $p = 0.010$). None of the pelvimetric mea-

Table I. Comparison of patients after low anterior resection and transanal total mesorectal excision

Parameter	LAR	TaTME	Total	*P*-value
n (%)	48 (44%)	62 (56%)	110	n/a
Males/females, *n* (%)	29/19 (60%/40%)	37/25 (60%/40%)	66/44(60%/40%)	1
Age [years] median (IQR)	62 (58–71)	65 (57–71)	63 (54–70)	1
BMI [kg/m^2] mean ± SD	26.6 ±4.5	26.29 ±4.04	26.44 ±4.25	0.7049
Depth of the tumor [cm] median (IQR)	4 (2.5–5)	3 (2–5)	4 (2–5)	0.849
Preoperative radiotherapy, *n* (%)	36 (75%)	51 (82%)	87 (79%)	0.4788
Bowel preparation, *n* (%)	41 (85%)	61 (98%)	102 (93%)	0.02
High/low ligature of vessels, *n* (%)	23/25 (48%/52%)	38/24 (61%/39%)	61/49 (55%/45%)	0.1801
Hand sewn/stapled anastomosis, *n* (%)	15/33 (31%/69%)	10/52 (16%/84%)	25/85 (23%/77%)	0.0701
Protective ileostomy, *n* (%)	40 (83%)	54(87%)	94 (85%)	0.597
Operative time [min] median (IQR)	210 (180–240)	242.5 (210–300)	225 (192.5–270)	0.699
Blood loss [ml] median (IQR)	100 (50–200)	100 (50–200)	100 (50–200)	0.231
T, *n* (%):				
0	9 (18.75%)	14 (22.58%)	23 (20.1%)	0,7605
1	9 (18.75%)	8 (12.90%)	17 (15.45%)	
2	5 (10.4%)	9 (14.52%)	14 (12.72%)	
3	25 (52.1%)	31 (50%)	56 (50.9%)	
N, *n* (%):				
0	36 (75%)	43 (68.35%)	79 (71.8%)	0,644
1	9 (18.75%)	12 (19.35%)	21 (19.1%)	
2	3 (6.25)%	7 (11.29%)	10 (9.1%)	
M, *n* (%):				
0	45 (93.75%)	57 (91.94%)	102 (92.73%)	0,716
1	3 (6.25%)	5 (8.06%)	8 (7.27%)	
Stage, *n* (%):				
0	8 (16.67%)	9 (14.52%)	17 (15.45%)	0,79
1	10 (20.83%)	11 (17.74%)	21 (19.1%)	
2	15 (31.25%)	16 (25.81%)	31 (28.18%)	
3	11 (22.92%)	16 (25.81%)	27 (24.55%)	
4	2 (4.17%)	5 (8.06%)	7 (6.36%)	
5	1 (2.08%)	0 (0%)	1 (0.91%)	
Distal margin [mm] median (IQR)	21 (11–30)	15 (10–20.5)	16 (10–28.75)	0.557
Radial margin [mm] median (IQR)	11 (3.5–19)	10 (5–18)	10 (5–19)	1
LOS [days] median (IQR)	6 (4–9)	6 (5–8)	6 (4–8)	0.559
With/without perioperative morbidity (%)	16/32 (33%/67%)	10/52 (16%/84%)	26/84 (24%/76%)	0.0431

surements were associated with factors predicting intraoperative difficulties (Table III).

TaTME group

The median operative time in the TaTME group was 242.5 min (IQR = 210–300 min). The median estimated blood loss was 100 ml (IQR = 50–200 ml). Ten (16%) patients suffered postoperative morbidity. Among them, 3 patients suffered an anastomotic leak, 2 patients were reoperated for mechanical bowel obstruction, 1 had postoperative ileus, 1 bleeding from an anastomosis site, and 1 had radi-

Table II. Comparison of patients with and without perioperative morbidity after low anterior resection

Parameter	With perioperative morbidity	Without perioperative morbidity	*P*-value
n (%)	16 (33%)	32 (67%)	n/a
Males/females, *n* (%)	11/5 (69%/31%)	18/14 (44%/56%)	0.535
Age [years] median (IQR)	58 (50.5–64.5)	62 (54–70)	0.291
BMI [kg/m^2] mean ± SD	25.9 ±3.8	27.0 ±4.9	0.466
Tumor depth [cm] median (IQR)	4 (2–5)	2.5 (2.5–5)	0.902
Preoperative radiotherapy, *n* (%)	11 (68.75%)	25 (78.13%)	0.500
Bowel preparation, *n* (%)	13 (81.25%)	28 (87.50%)	0.672
High/low ligature of vessels, *n* (%)	8/8 (50%/50%)	15/17 (47%/53%)	0.540
Hand sewn/stapled anastomosis, *n* (%)	6/10 (37.5%/62.5%)	8/24 (25%/75%)	0.324
Protective ileostomy, *n* (%)	12 (75%)	28 (87.50%)	0.413
Operative time [min] median (IQR)	210 (160–240)	210 (195–240)	0.554
Blood loss [ml] median (IQR)	100 (50–250)	50 (50–100)	0.067
T, *n* (%):			
0	2 (12.5%)	7 (21.88%)	0.204
1	1 (6.25%)	8 (25%)	
2	3 (18.75%)	2 (6.25%)	
3	10 (62.5%)	15 (26.88%)	
N, *n* (%):			
0	11 (68.75%)	25 (78.13%)	0.732
1	4 (25%)	5 (15.63%)	
2	1 (6.25)%	2 (6.25%)	
M, *n* (%):			
0	15 (93.75%)	30 (93.75%)	0.999
1	1 (6.25%)	2 (6.25%)	
Stage, *n* (%):			
0	2 (12.5%)	6 (19.35%)	0.609
1	2 (12.5%)	8 (25.81%)	
2	6 (37.5%)	9 (29.03%)	
3	4 (25%)	7 (22.58%)	
4	1 (6.25%)	1 (3.23%)	
5	1 (6.25%)	0	
Distal margin [mm] median (IQR)	23.5 (16–35)	17.5 (8–30)	0.060
Radial margin [mm] median (IQR)	14 (7–25)	5 (2.5–16)	0.168
LOS [days] median (IQR)	14.5 (7.5–17)	5 (4–7)	< 0.001

al nerve palsy. The mean operating time was significantly longer in the group of patients with postoperative morbidity than in patients with an uneventful postoperative stay (306 ±72 vs. 247 ±65, p = 0.013). Also the median length of hospital stay (LOS) was significantly longer in patients suffering postoperative complications (16 days (IQR = 12–35) vs. 6 days (IQR = 4–7), p < 0.001) (Table IV).

ROC analysis was performed to establish the cut-off points of pelvic measurement values potentially predicting postoperative morbidity, blood loss, and operating time. A pubococcygeal distance > 136 mm

Table III. Univariate and multivariate logistic regression model of factors potentially influencing odds ratio for blood loss above median (> 100 ml) and operative time above median (> 210 min) after low anterior resection

Univariate and multivariate logistic regression model for blood loss above median (> 100 ml)			
Variable	OR	95% CI	*P*-value
Univariate:			
Females	0.33	0.08–1.43	0.138
Age, with every year	1.08	1.00–1.16	0.046
BMI, with every kg/m^2	0.99	0.85–1.14	0.854
Depth, with every cm	0.70	0.44–1.10	0.121
Preoperative radiotherapy	2.46	0.46–13.25	0.297
Bowel preparation	2.50	0.26–23.67	0.424
Low ligature of vessels	0.54	0.15–1.94	0.347
Stapled anastomosis	0.46	0.12–1.75	0.257
Protective ileostomy	3.12	0.34–28.74	0.315
T	1.93	1.01–3.69	0.047
Stage	1.10	0.62–1.94	0.743
A > 134 mm	1.34	0.01–99.19	0.999
Multivariate:			
Age	1.09	1.00–1.18	0.038
T	2.02	0.98–4.15	0.057

Univariate and multivariate logistic regression model for operative time above median (> 210 min)			
Variable	OR	95% CI	*P*-value
Univariate:			
Females	0.23	0.06–0.89	0.033
Age, with every year	1.02	0.97–1.08	0.385
BMI, with every kg/m^2	1.25	1.05–1.49	0.014
Depth, with every cm	0.77	0.50–1.17	0.222
Preoperative radiotherapy	5.06	0.95–26.99	0.058
Low ligature of vessels	0.79	0.24–2.56	0.689
Stapled anastomosis	0.77	0.21–2.73	0.679
T	0.90	0.56–1.46	0.681
Stage	0.66	0.39–1.11	0.119
Multivariate:			
Females	0.13	0.02–0.86	0.029
BMI, with every kg/m^2	1.32	1.06–1.64	0.010

was found to be a potential predictive value for perioperative morbidity and longer operating time (AUC (95% CI), 0.69 (0.51–0.87), p = 0.042, 0.68 (0.52–0.84), p = 0.026), sacral depth < 53 mm for blood loss > 100 ml (AUC (95% CI), 0.31 (0.16–0.47), p = 0.021) and pelvic length for increased operating time (AUC (95% CI), 0.72 (0.57–0.88), p = 0.005). These factors and other factors potentially predicting intraoperative difficulties were included to build univariate and multivariate logistic regression models. Multivariate analysis showed that age, with every year, increased the odds of intraoperative blood

Table IV. Comparison of patients with and without perioperative morbidity after transanal total mesorectal resection

Parameter	With perioperative morbidity	Without perioperative morbidity	*P*-value
n (%)	10 (16%)	52 (84%)	n/a
Males/females, *n* (%)	8/2 (80%/20%)	29/23 (56%/44%)	0.182
Age [years] median (IQR)	60.5 (57–69)	65 (55–71)	0.838
BMI [kg/m^2] mean ± SD	27.17±4.6	26.12±4.0	0.486
Depth of the tumor [cm] median (IQR)	5 (2–5)	2 (2–4.25)	0.433
Preoperative radiotherapy, *n* (%)	9 (90%)	42 (80.77%)	0.674
Bowel preparation, *n* (%)	10 (100%)	51 (98%)	n/a
High/low ligature of vessels, *n* (%)	3/3 (50%/50%)	33/19 (63.46%/36.54%)	0.490
Hand sewn/stapled anastomosis, *n* (%)	1/9 (10%/90%)	9/43 (17.31%/82.69%)	0.999
Protective ileostomy, *n* (%)	10 (100%)	44 (86.42%)	n/a
Operative time [min] mean ± SD	306±72	247±65	0.013
Blood loss [ml] median (IQR)	175 (60–250)	100 (50–200)	0.301
T, *n* (%):			
0	2 (20%)	12 (23%)	0.881
1	2 (20%)	6 (12%)	
2	1 (10%)	8 (15%)	
3	5 (50%)	26 (50%)	
N, *n* (%):			
0	5 (50%)	38 (73%)	0.342
1	3 (30%)	9 (17%)	
2	2 (20%)	5 (10%)	
M, *n* (%):			
0	8 (80%)	49 (94%)	0.180
1	2 (20%)	3 (6%)	
Stage, *n* (%):			
0	2 (20%)	7 (15%)	0.349
1	1 (10%)	10 (21%)	
2	1 (10%)	15 (32%)	
3	4 (40%)	12 (26%)	
4	2 (20%)	3 (6%)	
Distal margin [mm] median (IQR)	17 (7–40)	15 (10–20)	0.420
Radial margin [mm] median (IQR)	8 (5–9)	10 (5–19)	0.435
LOS [days] median (IQR)	16 (12–35)	6 (4–7)	< 0.001

Table V. Univariate and multivariate logistic regression model of factors potentially influencing odds ratio for occurrence of perioperative morbidity, for blood loss above median (> 100 ml), and for operative time above median (> 242.5 min) after transanal total mesorectal resection

Univariate and multivariate logistic regression model for occurrence of perioperative morbidity			
Parameter	OR	95% CI	*P*-value
Females	0.32	0.06–1.63	0.169
Age, with every year	1.09	0.94–1.08	0.793
BMI, with every kg/m^2	1.07	0.89–1.27	0.479
Depth, with every cm	1.18	0.71–1.96	0.518
Preoperative radiotherapy	2.14	0.24–18.92	0.493
Low ligature of vessels	1.74	0.45–6.78	0.427
Stapled anastomosis	1.88	0.21–16.79	0.570
T	0.99	0.57–1.70	0.957
Stage	1.36	0.75–2.46	0.314
C > 136 mm	2.31	0.19–28.72	0.514

Univariate and multivariate logistic regression model for blood loss above median (> 100 ml)			
Parameter	OR	95% CI	*P*-value
Females	0.68	0.23–1.98	0.480
Age, with every year	1.08	1.02–1.15	0.013
BMI, with every kg/m^2	0.97	0.85–1.12	0.690
Depth, with every cm	0.87	0.60–1.26	0.456
Preoperative radiotherapy	4.70	0.92–24.10	0.064
Low ligature of vessels	0.54	0.18–1.65	0.278
Stapled anastomosis	0.28	0.06–1.22	0.091
T	1.01	0.67–1.54	0.959
Stage	0.97	0.63–1.50	0.892
D > 53 mm	No cases		

Univariate and multivariate logistic regression model for operative time above median (> 242.5 min)			
Variable	OR	95% CI	*P*-value
Univariate:			
Females	0.42	0.14–1.23	0.113
Age, with every year	1.00	0.95–1.05	0.862
BMI, with every kg/m^2	1.04	0.91–1.20	0.559
Depth, with every cm	0.98	0.68–1.40	0.889
Preoperative radiotherapy	6.08	1.18–31.25	0.031
Low ligature of vessels	0.24	0.08–0.77	0.017
Stapled anastomosis	0.36	0.08–1.57	0.175
T	0.93	0.62–1.42	0.750
Stage	0.87	0.56–1.34	0.518
C > 119 mm	3.85	1.09–13.66	0.037
E > 119 mm	6.5	1.64–25.76	0.008
Multivariate:			
Preoperative radiotherapy	3.80	0.31–47.19	0.285
Low ligature of vessels	0.40	0.10–1.69	0.201
E > 119 mm	5.76	1.33–25.01	0.016

loss > 100 ml (OR = 1.08, 95% CI: 1.02–1.15, p = 0.013), and pelvic length > 119 mm was associated with longer operating time (OR = 5.76, 95% CI: 1.33–25.01, p = 0.016) (Table V).

Discussion

In our study, the multivariate regression model indicates that more advanced age is significantly associated with higher intraoperative blood loss in both LAR and TaTME procedures. Male gender and higher BMI correlated with longer operating time for LAR procedures, whereas pelvic length was associated with longer operating time in the TaTME group.

Significantly more patients suffered overall morbidity in the LAR group compared to the TaTME group. Our findings are in keeping with the recent systematic review comparing both approaches [4]. Overall morbidity in our study was 33% for the laparoscopic TME vs. 16% for the TaTME approach, whereas in the van Oostendorp *et al*. [4] study the short-term overall morbidity was 39.6% compared to 31.5% for laparoscopic TME vs. TaTME respectively. The difference in the exact percentage between our analysis and the available literature may result from the heterogenicity in the definitions and classification systems for postoperative morbidity.

As expected, in both approaches, the median length of hospital stay was significantly longer in patients with postoperative complications. It can be explained by a longer stay in the hospital required to treat the most common morbidities such as an anastomotic leak or postoperative infections. Interestingly, the mean operating time was significantly longer in TaTME in patients with comorbidities. As such, this relationship was not demonstrated for laparoscopic TME. The correlation between operating time and the risk of postoperative complications was clearly demonstrated in several studies [13]. Multiple factors influence prolonged operating time and may include previous abdominal surgery, operating surgeons' experience, and intraoperative technical difficulties, which may be linked to postoperative complications.

Additionally, male gender and BMI were significantly associated with longer operating time in laparoscopic TME and older age was associated with increased intraoperative blood loss in both study groups. Male gender and higher BMI are known factors predicting intraoperative difficulties in rectal surgery [14]. Ogiso *et al*. in their study demonstrated that a higher BMI, larger maximum tumor diameter, a trainee performing the procedure, and extraperitoneal tumor were significantly associated with longer operating time in laparoscopic TME [15].

From all pelvic measurements collected, we found no significant cut-off points predicting technical difficulties in laparoscopic TME. Our results are contrary to the majority of previously published papers that utilized MRI or CT-based pelvimetry to predict intraoperative difficulties in laparoscopic TME. Akiyoshi *et al*. [14] demonstrated that the pelvic outlet was significantly associated with operative time and anastomotic leakage rate in a laparoscopic TME. Escal *et al*. [16] found intertuberculous distance to be a significant factor in predicting surgical difficulty. Ma *et al*. [17] identified an association between interspinous diameter and greater technical difficulties. Ferko *et al*. [8] demonstrated that the angle between the longitudinal axis of the symphysis and the lines between the symphysis and the promontory affected the quality of TME, whereas Yamamoto *et al*. [18] reported that an anorectal angle of 123° or more, and a pelvic outlet of less than 82.7 mm, were associated with higher grades of surgical difficulties.

The difference between our findings and the previously published literature may derive partially from the heterogenicity of the dependent variables. Most studies were assessing the grades of surgical difficulties based on several factors combined, including operating time, intraoperative blood loss, morbidity, conversion to open surgery, and length of hospital stay. In our study, we used operating time as a separate dependent variable, which may have influenced the statistical power of the analysis.

Yet, our findings are supported by the results published by Ogiso *et al*. [15], who similarly found no association of pelvic measurements with longer operating time in laparoscopic TME.

Clearly, although the majority of papers found a positive correlation between pelvimetry and intraoperative technical difficulties, none of the specific pelvic diameters were replicated between the studies.

In the present study, however, pelvic length above 119 mm (measured as the distance between the sacral promontory and the tip of the coccyx) was significantly associated with longer operating time in transanal TME. The results are contrary to the recently published study comparing the laparoscopic and transanal approaches to TME [19] in which Hasegawa *et al.* reported that obesity and a narrow pelvis, which characterized male gender, were associated with longer operating time in the laparoscopic but not the transanal approach.

Our findings on the contrary indicate that a longer pelvis is associated with longer operating time in the transanal but not the transabdominal approach.

This a retrospective study including all eligible patients operated on in our department in the predetermined timeframe. The statistical power of the sample size was not calculated and the analysis may be underpowered. The total operating time was used as a factor indicating intraoperative difficulties instead of the pelvic dissection operating time, which may not always directly correlate with difficulties encountered during pelvic dissection. That is why other factors that might have influenced the operating time such as time spent for adhesiolysis could be additional confounding factors that were not included in the analysis. However, due to the study's retrospective nature, the exact time of the pelvic dissection was unextractable.

Similarly, to increase the statistical power, the overall early postoperative complications were used instead of pelvic dissection-specific complications as one of the measures of intraoperative difficulties. This may not fully correlate with intraoperative difficulties, as their link to intraoperative technical problems may not be directly related.

Finally, only one-dimensional pelvic measurements were utilized in the analysis, which may not exactly delineate the term "narrow pelvis".

Conclusions

Our results indicate that pelvic measurements were not associated with intraoperative technical difficulties in laparoscopic TME, whereas a longer pelvis was associated with longer operative time in transanal TME.

Conflict of interest

The authors declare no conflict of interest.

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