Impact of the approach on conversion to open surgery during minimally invasive restorative total mesorectal excision for rectal cancer

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Abstract

Background: The aim of this study is to explore the impact of the approach on conversion in patients undergoing minimally invasive restorative total mesorectal excisionwithin a single unit.

Methods:A retrospective cohort study was conducted at a public quaternary and a private tertiary centre. Patients with rectal cancer undergoing minimally invasive restorative total mesorectal excision between January 2006 and June 2020 were included. Subjects were grouped according to the presence of conversion. Baseline variables and short-term outcomes were compared. Regression analyses were performed to examine the impact of the approach on conversion.

Results: During the study period, some 318 patients had a restorative proctectomy. Of these, 240 met the inclusion criteria. Robotic and laparoscopic approaches were undertaken in 147 (61.3%) and 93 (38.8%) cases, respectively. A transanal approach was utilised in 62 (25.8%) cases (58.1% in combination with a robotic transabdominal approach). Conversion to open surgery occurred in 30 cases (12.5%). Conversion was associated with an increased overall complication rate (P=0.003), surgical complications (P=0.009), superficial surgical site infections (P=0.02) and an increased length of hospital stay (P=0.006). Robotic and transanal approaches were both associated with decreased conversion rates. The multiple logistic regression analysis, however, showed that only a transanal approach was associated with a lower risk of conversion (OR 0.147,0.023–0.532,P=0.01), whilst obesity was an independent risk factor for conversion (OR 4.388,1.852–10.56,P<0.00).

Conclusions*:* A transanal component is associated with a reduced conversion rate in minimally invasive restorative total mesorectal excision, regardless of the transabdominal approach utilised. Larger studies will be required to confirm these findings and define which subgroup of patients could benefit from transanal component when a robotic approach is undertaken.

Background

Total mesorectal excision (TME) is a key component of the curative-intent treatment of patients with mid and low rectal cancer[1]. Currently, multiple randomised controlled trials support the oncologic equivalency of laparoscopic TME and highlight its enhanced recovery compared to open TME[2–5]. The limitations of conventional laparoscopic TME, however, make this approach technically challenging even for experienced minimally invasive surgeons. This is reflected by the high conversion rates reported in the literature[6]. A combination of a challenging dissection secondary to limited manoeuvrability and impaired visibility in the confined space of the pelvis, and poor ergonomics which are further aggravated in males with narrow pelvises, obese patients with a bulky mesorectum, or in the presence of low or bulky tumours. Not surprisingly then, conversion in this setting is associated with impaired postoperative and long-term outcomes[6–9].

Novel minimally invasive approaches such as robotic and minimally invasive transanal TME (taTME) have emerged as alternatives to conventional laparoscopic TME during the last decades[10]. Robotic platforms provide a surgeon-controlled camera, 3-dimensional vision, wristed instruments, and improved ergonomics that can theoretically enhance dexterity and refine pelvic dissection, despite the lack of tactile feedback. Additionally, supporters of taTME state that a transanal approach improves control of the distal resection margin and dissection along the lower and middle thirds of the pelvis[11]. Hence, these approaches may allow for higher rates of completed minimally invasive (MIS) TME and potentially deliver improved-quality specimens by optimising visualisation and diminishing manipulation and traction of the mesorectal envelope whilst dissecting along the TME plane in the distal pelvis. Nevertheless, there is a lack of data comparing the outcomes of the range of MIS approaches to TME.

This study aims to explore the impact of different MIS approaches on conversion to open surgery in patients undergoing restorative TME for rectal cancer within a single unit.

Materials & Methods

Study design

A retrospective review of two prospectively maintained rectal cancer databases from a single unit in a public quaternary centre (Peter MacCallum Cancer Centre, Melbourne, Australia), and a private tertiary centre (Epworth Healthcare, Melbourne, Australia), was carried out to identify patients undergoing MIS TME. Consecutive patients who underwent MIS restorative TME due to rectal cancer between January 2006 and June 2020 were included. Patients who had surgery due to lesions higher than 15 cm from the anal verge, benign polyps, non-curable metastatic rectal cancer, or non-restorative resection were excluded.

Demographic characteristics, clinical and tumour baseline variables, neoadjuvant treatment, operative procedure details, and postoperative and histopathological outcomes were recorded. Patients were subsequently grouped according to the presence or absence of conversion to open surgery and baseline variables and outcomes were compared. Simple and multiple logistic regression analyses were performed to identify factors associated with conversion, and particularly determine the role of the approach on conversion.

Definitions and outcomes of interest

All cases were discussed in a multidisciplinary team meeting before treatment. When neoadjuvant treatment was required, surgery was scheduled at 8–12 weeks from LCCRT and after one week of short-course neoadjuvant radiation completion.

The surgical approach and timing to surgery were decided on a case-by-case basis with input from a multidisciplinary team discussion.

The clinical and histopathological staging was recorded according to the TNM classification (AJCC 8th Edition for Cancer Staging)[12]. Clinical staging was based on computed tomography (CT), positronemission CT (PET-CT) and pelvic magnetic resonance imaging (MRI). Tumour height was defined clinically, endoscopically or by the pre-treatment MRI taking the anal verge as reference.

Conversion was defined as an intraoperative switch from a laparoscopic to an open abdominal approach because of anticipated operative difficulty or logistic considerations, or because of a complication or operative difficulty after a considerable amount of dissection[13].

Postoperative complications, readmissions and mortality were considered during the first 90 postoperative days. Postoperative complications were classified according to Clavien-Dindo[14]. Surgical site infections (SSI) were grouped according to the definitions of the US Centre for Disease Control and Prevention in incisional SSI, or organ/space SSI[15]. Ileus was defined as the absence of peristalsis, usually accompanied by abdominal bloating, and nausea and vomiting, requiring nasogastric tube insertion for more than 24 hours post-operatively. Anastomotic leak was defined as any clinical or radiological evidence of a defect of the intestinal wall at the anastomotic site, communicating the intra- and extra-luminal compartments. The histopathological evaluation considered an R0 resection as a resection margin of >1 mm. R1 resection was the presence of microscopic residual disease 1 mm or less from the resection margin, whereas R2 resection was the presence of macroscopic residual disease.

Procedures

All robotic procedures were performed by robotically credentialled surgeons and extensive previous experience in laparoscopic colorectal resections. SW and AH performed all the taTME components of the operations. Both SW and AH are proctors for taTME, conduct related courses and have been involved in more than 150 and 70 taTME cases since 2015, respectively.

All patients had mechanical bowel preparation. General anaesthetic was given and prophylactic antibiotics were administered at induction. An indwelling urinary catheter was inserted, and the patient was placed in the Lloyd-Davies position. All patients had sequential compression devices and low molecular weight heparin was given on induction, and throughout the hospital stay.

The abdominal component involved a high ligation of the inferior mesenteric vessels and full mobilisation of the splenic flexure in all cases, regardless of the approach.

Laparoscopic TME

A five-trocar technique was utilised. A 30-degree laparoscope was inserted through a periumbilical port and the rest of the ports were placed in both iliac fossae and flanks. The dissection followed the TME plane which was continued down to the level of the pelvic floor. Then, the rectal transection was carried out using laparoscopic linear staplers.

Robotic TME

The da Vinci Surgical System (Intuitive Surgical, Sunnyvale, CA, USA) was used for all robotic resections throughout the study period. The Si platform was used from 2010 to 2017 and the Xi platform was used from 2017 to 2020. For all robotic resections, four robotic ports and one assistant port were used. Procedures performed with the Si platform were hybrid, with laparoscopic mobilisation of the splenic flexure and high ligation of the inferior mesenteric vessels. The robot was then docked for the pelvic dissection. With the Xi platform, procedures were performed in a totally robotic fashion. After the pelvic dissection, rectal transection was carried out using a robotic linear stapler.

taTME

The operation was carried out as a synchronous two-team procedure, including two consultants, two colorectal surgical fellows and two scrub nurses. The transabdominal component of taTME was either robotic or laparoscopic according to the surgeons’ preference and platform availability. The anus was everted with four 0 silk sutures placed in four quadrants, and a Lonestar (Lonestar, Cooper Surgical, Trumbull, CT, USA) was used to retract the anoderm. The anal canal was then washed with cetrimide. Then, a GelPoint Path (Applied Medical, Rancho Santa Margarita, CA, USA) was inserted, and a 0-polypropylene suture with a 26-mm rounded needle was used to create the purse-string to close the rectum distal to the tumour. The platform gel cap with three ports (one for the AirSeal®) was then placed, and a pneumorectum was established with an AirSeal® System (Conmed, Connecticut, USA) at a flow rate of five litres per minute, and a pressure of 5 mmHg. A 5 mm SILS™ Hook diathermy (Covidien, Dublin, Ireland) was used to perform a full-thickness circumferential rectotomy under a 0-degree laparoscope vision. The GelPoint Path was then removed and the pursestring reinforced with 0 polypropylene, inverting the mucosa. A cetrimide wash was again performed, the GelPoint Path repositioned, the camera switched to a 30-degree laparoscope, and pressure from the AirSeal was increased to 12 mmHg. ´Down-to-up´ dissection was continued through the TME plane. The resection was completed in a combined effort by the transabdominal and perineal teams.

Extraction site and anastomosis

A left iliac fossa muscle-splitting incision or a Pfannenstiel were used as extraction sites, protected by a wound retractor. For a few selected low body-mass-index patients, a transanal extraction was utilised when taTME was performed.

The anastomosis was hand-sewn or stapled according to the length of the remaining rectal cuff. Stapled anastomoses in the taTME group were all performed using a double purse-string single-stapled technique[16], with a 33-mm haemorrhoidal stapler (DST Series™ Technology - Covidien, Dublin, Ireland). An end-to-end, end-to-side, or colonic J-pouch-anal anastomosis was fashioned according to the surgeons’ preference and the patients’ pelvic anatomy[17].

A rectal tube was left in situ for 24 hours. All patients had a closed suction pelvic drain placed at the end of the procedure. Postoperatively, an ERAS (Enhanced Recovery After Surgery) protocol was followed.

Statistical analysis

Continuous variables were described as mean and standard deviations (SD). Categorical variables were described as frequencies and percentages. Chi-square or Fisher’s exact test were used to determine differences amongst categorical variables, and the t-test was used for continuous variables. Simple and multiple logistic regression analyses were performed to determine factors associated with conversion. Relevant variables in the simple logistic regression ($P < 0.05$) were included in the multiple logistic regression model. A second model including variables with a $P < 0.1$ was also performed. Results are shown as odds ratio (OR) with a 95 per cent confidence interval (95% CI). Only two-sided tests were utilised and a $P < 0.05$ was considered statistically significant. Statistical analyses were performed using Graph Pad Prism 9.3.0 for macOS (©1994–2021, GraphPad Software, LLC).

Results

During the study period, 318 patients underwent minimally invasive total mesorectal excision for rectal cancer. Of these, 240 were included in the analysis. Demographic and baseline clinical variables of the cohort are summarised in Table 1.

Table 1
Demographic and baseline clinical variables

Variables	Whole cohort (n = 240)	No conversion (n = 210)	Conversion (n = 30)	P
Age, years (SD)	60.3 (13.2)	60.6 (13.2)	57.6 (12.9)	0.25
Sex, n (%)				0.19
Male	169 (70.4)	147 (70)	25 (83.3)	
Female	71 (29.6)	63 (30)	5 (16.7)	
BMI kg/m^2 (SD)	27.2 (4.9)	26.8 (4.7)	29.9 (5.6)	0.003
BMI ≥ 30 kg/m^2, n (%)	60 (25)	45 (21.4)	15 (50)	0.003
ASA Score, n (%)				0.63
I - II	169 (70.4)	150 (71.9)	18 (60)	
III - IV	55 (22.9)	48 (22.9)	7 (23.3)	
Missing	16 (6.7)	11 (5.2)	5 (16.7)	
Tumour height, cm (SD)	8.1 (3.2)	8.2 (3.3)	7.7 (3)	0.44
Tumour location, n (%)				0.44
Mid/superior rectum	134 (55.8)	115 (54.8)	19 (63.3)	
Low rectum	106 (44.2)	95 (45.2)	11 (36.7)	
cT, n (%)				0.49
1	9 (3.8)	7 (3.3)	2 (6.7)	
2	49 (20.4)	45 (21.4)	4 (13.3)	
3	141 (58.8)	120 (57.1)	21 (70)	
4	31 (12.9)	28 (13.3)	3 (10)	
Missing/No MRI	10 (4.2)	10 (4.8)	0 (0)	
cN, n (%)				0.14
0	83 (34.6)	73 (34.8)	10 (33.3)	
1	86 (35.8)	74 (35.2)	12 (40)	
2	61 (25.4)	53 (25.2)	8 (26.7)	
Missing/No MRI	10 (4.2)	10 (4.8)	0 (0)	

Variables	Whole cohort (n = 240)	No conversion (n = 210)	Conversion (n = 30)	P
Stage IV, n (%)	14 (5.8)	10 (4.8)	4 (13.3)	0.08
Neoadjuvant therapy, n (%)	184 (76.7)	159 (75.7)	25 (83.3)	0.49

Robotic and laparoscopic approaches were undertaken in 147 (61.3%) and 93 (38.8%) cases, respectively. Additionally, a taTME component was utilised in 62 (25.8%) cases; 36 (58.1%) in combination with a robotic transabdominal approach, and 26 (41.9%) in combination with a transabdominal laparoscopic approach (Table 2). Of note, in the robotic group, the Si and Xi platforms were used in 55 (37.4%) and 92 (62.6%) cases, respectively.

Table 2
Operation variables

Variables	Whole cohort (n = 240)	No conversion (n = 210)	Conversion (n = 30)	P
Approach, n (%)				0.02
Robotic	147 (61.3)	135 (64.3)	12 (40)	
Laparoscopic	93 (38.8)	75 (35.7)	18 (60)	
TaTME component, n (%)	62 (25.8)	60 (28.6)	2 (16.7)	0.008
Robotic transabdominal	36 (58.1)	35 (58.3)	1 (50)	1
Laparoscopic transabdominal	26 (41.9)	25 (41.7)	1 (50)	
Extended resection, n (%)	14 (5.8)	13 (6.2)	1 (3.3)	1
Reconstruction method, n (%)				0.82
End-to-end	161 (67.1)	142 (67.6)	19 (63.3)	
Side-to-end or colonic J-pouch	78 (32.5)	68 (32.4)	10 (33.3)	
Missing	1 (0.5)	0 (0)	1 (3.3)	
Type of anastomosis, n (%)				0.14
Stapled	222 (92.5)	197 (93.8)	25 (83.3)	
Handsewn	17 (7.1)	13 (6.2)	4 (13.3)	
Missing	1 (0.5)	0 (0)	1 (3.3)	
Covering stoma, n (%)	232 (96.7)	202 (96.2)	30 (100)	0.60

Conversion to open surgery occurred in 30 cases (12.5%). Five of them were reactive conversions due to intraoperative complications, whilst the rest were pre-emptive conversions. The most common causes for conversion were locally advanced disease (n = 11) and technical difficulties associated with obesity (n = 8). The causes of conversion and distribution according to the approach are detailed in Fig. 1.

The laparoscopic and robotic groups had 18 (19.3%) and 12 (8.1%) conversions, respectively. Conversion occurred in 2 of 62 (3.2%) patients where a taTME component was utilised (one robotic and one laparoscopic transabdominal approach). Regarding perioperative outcomes, the converted group was associated with an increased overall complication rate (70% versus 40.5%, P = 0.003), increased overall surgical complications (63.3% versus 37.1%; P = 0.009), higher rates of superficial surgical site infections (20% versus 6.2%; P = 0.02), and an increased length of hospital stay (15 versus 11.6 days; P = 0.006). Other perioperative outcome comparisons are shown in Table 3.

Table 3
Perioperative outcomes

Variables	**Whole cohort (n = 240)**	**No conversion (n = 210)**	**Conversion (n = 30)**	**P**
Operative time, minutes (SD)	273.3 (74.5)	272.7 (73)	281.5 (98.4)	0.86
Overall complications, n (%)	106 (44.1)	85 (40.5)	21 (70)	0.003
Medical complications, n (%)	25 (10.4)	24 (11.4)	1 (3.3)	0.21
Surgical complications, n (%)	97 (40.4)	78 (37.1)	19 (63.3)	0.009
Superficial SSI	19 (7.91)	13 (6.2)	6 (20)	0.02
Deep SSI	15 (6.3)	11 (5.2)	4 (13.3)	0.10
Ileus	33 (13.8)	28 (13.3)	5 (16.7)	0.58
Anastomotic leak	10 (4.2)	7 (3.3)	3 (10)	0.12
Clavien-Dindo, n (%)				0.28
I - II	73 (30.4)	60 (28.6)	13 (43.3)	
III - IV	32 (13.3)	25 (11.9)	7 (23.3)	
Return to theatre, n (%)	24 (10)	19 (9)	5 (16.7)	0.2
Length of stay, days (SD)	12 (10.9)	11.6 (10.6)	15 (12.7)	0.006
Readmission, n (%)	13 (5.4)	11 (5.2)	2 (6.7)	1

There were no significant differences between groups in terms of histopathological outcomes (Table 4).

Table 4
Histopathological outcomes

Variables	Whole cohort (n = 240)	No conversion (n = 210)	Conversion (n = 30)	P
pT, n (%)				0.8
0	47 (19.6)	39 (18.6)	8 (2.7)	
1	25 (10.4)	23 (11)	2 (6.7)	
2	44 (18.3)	39 (18.6)	5 (16.7)	
3	109 (45.4)	95 (45.2)	14 (46.7)	
4	4 (1.7)	4 (1.9)	0 (0)	
Missing	11 (4.6)	10 (4.8)	1 (3.3)	
pN, n (%)				0.5
0	153 (63.8)	131 (6.2)	22 (7.3)	
1	60 (25)	54 (25.7)	6 (20)	
2	16 (6.7)	15 (7.1)	1 (3.3)	
Missing	11 (4.6)	10 (4.8)	1 (3.3)	
Lymph node harvest, n (SD)	17.2 (7.96)	17.5 (8.1)	14.8 (6.3)	0.08
Mesorectal excision quality, n (%)				0.21
Complete or near complete	215 (89.6)	192 (91.4)	23 (76.7)	
Incomplete	8 (3.3)	6 (2.9)	2 (6.7)	
Not reported/Missing	17 (7)	12 (5.7)	5 (16.7)	
CRM involvement, n (%)	5 (2)	5 (2.4)	0 (0)	1
Distal margin involvement, n (%)	3 (1.3)	3 (1.4)	0 (0)	1
R1 resection, n (%)	6 (2.5)	6 (2.9)	0 (0)	1

In the simple logistic regression, conversion was associated with a BMI ≥ 30 kg/m^2 (odds ratio (OR) 4.154, confidence interval 95% (CI 95%) 1.844–9.494, P = 0.0006). A robotic approach (OR 0.370, CI 95%0.165–0.803, P = 0.01) and the addition of a taTME component (OR 0.179, CI 95% 0.028–0.620, P = 0.02) were associated with a decreased risk of conversion to open surgery. However, after performing a multiple logistic regression analysis including these variables in the model, only the addition of a taTME component was associated with a decreased risk of conversion (OR 0.142, CI 95% 0.022–0.518, P = 0.01), whilst a BMI ≥ 30 kg/m^2 was independently associated with an increased conversion rate (OR 4.445, CI 95% 1.888–10.63, $P < 0.00$). Similar results were obtained when inputting variables with a $P < 0.1$ in the multiple logistic regression model. Details of the logistic regression analysis are shown in Table 5.

Table 5
Simple and multiple logistic regression analyses for factors associated with conversion to open surgery

Parameters	**Univariate analysis**			**Multivariate analysis**		
	OR	**CI (95%)**	**P value**	**OR**	**CI (95%)**	**P value**
Patient related						
Age ≥ 70 years	0.477	0.156–1.210	0.15			
Male sex	0.849	0.339–1.940	0.71			
BMI ≥ 30 kg/m^2	4.154	1.844–9.494	0.0006	4.445	1.888–10.63	0.0007
ASA ≥ III	1.223	0.453–2.995	0.67			
Tumour related						
Low rectal cancer*	0.701	0.309–1.523	0.38			
cT3-4**	1.405	0.576–3.96	0.48			
cN+	1.150	0.521–2.685	0.74			
Neoadjuvant treatment	1.604	0.628–4.942	0.36			
Stage IV disease	3.077	0.799–9.954	0.07			
Operation related						
Robotic approach***	0.370	0.165–0.803	0.01	0.463	0.195–1.085	0.08
Added taTME component	0.179	0.028–0.620	0.02	0.142	0.022–0.518	0.01
Extended resection	0.523	0.028–2.778	0.54			

OR = odds ratio; CI = confidence interval; BMI = body mass index; ASA = American Society of Anaesthesiologists Classification; cT/N = clinical staging based on MRI.

* Mid-high rectal cancer is reference

** cT1-2 is reference

*** Laparoscopic approach is reference

Discussion

The current study is the first single-unit comparative study evaluating the impact of the range of MIS approaches on conversion to open surgery during restorative TME for rectal cancer. Our results show that a robotic approach and taTME are both associated with a decreased conversion rate compared to conventional laparoscopic surgery. However, after performing a multivariate analysis, only taTME was associated with a decreased conversion rate, whilst obesity was an independent risk factor for conversion.

The analysis of conversion as an outcome is relevant since the literature shows that conversion is associated with impaired outcomes in MIS rectal cancer surgery[6, 7, 9]. In this study, conversion had a negative impact on postoperative outcomes, as reflected by a higher overall and surgical complication rate, higher wound infection rate and an increased length of hospital stay. In their systematic review meta-analysis examining the impact of conversion in laparoscopic rectal cancer surgery, Gouvas et at.[6] showed that conversion was associated with a longer duration of surgery, hospital stay, and higher rates of wound infection compared with completed laparoscopic cases. Additionally, others have shown that conversion may influence long-term outcomes of patients undergoing MIS rectal cancer surgery. Clancy et al.[8] published a systematic review and meta-analysis evaluating the influence of conversion on the oncologic outcomes of colorectal cancer surgery. In their study, a successful laparoscopic surgery was associated with a lower risk of disease recurrence (OR 0.634, 95% CI 0.429–0.938, $P = 0.023$) and lower overall mortality risk (OR 0.512, 95% CI 0.417–0.629, $P < 0.0001$). Similarly, a large Dutch national cohort study recently analysed the influence of conversion and anastomotic leakage on long-term oncologic outcomes in rectal cancer surgery[7]. Of 745 attempted laparoscopic cases, 14.4% were converted. OS and DFS were significantly shorter in the conversion compared to the laparoscopic group ($p = 0.025$ and $p = 0.001$, respectively) as well as in anastomotic leakage compared to patients without anastomotic leakage ($P = 0.002$ and 0.024, respectively). In the multivariable analysis, anastomotic leakage was an independent predictor of OS and DFS. Although conversion did not influence OS, it was an independent predictor of DFS (1.525, 1.071–2.172). The authors concluded that technical difficulties during laparoscopic rectal cancer surgery, as reflected by conversion and anastomotic leakage have a negative prognostic impact on these patients. Whilst more studies on this subject may further clarify the impact of conversion in the short and long-term outcomes of rectal cancer, it seems that tailoring the utilisation of the different MIS alternatives to diminish conversion rates is sensible and may translate into postoperative and long-term benefits in this scenario.

Our results are in keeping with the literature showing that robotic TME and taTME are associated with decreased conversion rates compared to conventional laparoscopic surgery[18, 19]. Nevertheless, few studies compare the outcomes of the full range of MIS approaches to TME. Two network metanalyses examining open, laparoscopic, robotic and transanal TME suggest that MIS approaches would provide similar oncologic outcomes and an enhanced postoperative recovery compared to open TME [20, 21]. Conversion, however, was absent as an outcome or not compared amongst MIS approaches in these studies. Moreover, the small proportion of robotic and taTME cases compared to open and laparoscopic

TME limit the extrapolation of these data. A recent multicentric Dutch study compared the outcomes of laparoscopic, robotic and transanal rectal cancer surgery[22]. After propensity score-matching their cohort, 108 patients were compared in each group. Conversion rates did not differ between approaches. The authors concluded that robotic and taTME expert centres perform more anastomoses in rectal cancer surgery. Although these publications reflect an effort to better understand the outcomes of the various MIS alternatives to TME, potential selection biases and the comparison of outcomes from multiple centres with different skill sets hamper the ability to draw clear conclusions about the real value of one approach over the other.

To our best knowledge, this is the first single-unit experience evaluating the impact of the whole spectrum of MIS approaches to restorative TME on conversion. The limitations of this study, however, are multiple and essentially related to its retrospective design. Statistical type 2 errors cannot be excluded. It is also worth noting that our series includes the institutional and surgeons' learning curves for robotic and taTME which could underestimate their benefit. Moreover, we do not provide long-term data to assess oncologic equivalency amongst the different approaches, especially in the light of recently published studies pointing to adverse oncological recurrence patterns associated with taTME[23, 24]. Our group along with other contributors from Australasia have previously published acceptable short-term outcomes as well as sound oncological outcomes associated with taTME[25]. These findings are similar to those reported in quaternary centres in the Netherlands[26], and combined series beyond the learning curve[27], but in contradiction to the previously cited series from the Netherlands and Norway[23, 24]. Further data on the learning curves and oncologic outcomes of taTME will be needed to validate this approach and tailor its utilisation in rectal cancer surgery.

Navigating the learning curve for new technology and techniques can be challenging. To overcome the learning curve for taTME, several studies have indicated that a case number between 30 and 70 cases is needed[28]. Our Australasian series suggests that 40 cases are required to navigate through the learning curve[25]. Similarly, data suggests that 40 to 50 cases are needed to overcome the robotic learning curve for low anterior resections[29]. Whilst this study evaluates the merits of the various MIS techniques within a quaternary setup, it is worth mentioning that we believe many to be complementary. For example, a low or very low rectal cancer in an obese male patient may be best served as a taTME in combination with a robotic transabdominal approach to enable safe reconstructive options and maximise the ability to dissect along correct oncologic planes. The current authors are strong advocates for appropriate training pathways for the adoption of novel MIS techniques such as robotic TME and taTME. Proctorship, case observations and finally appropriate case volume are required to allow such techniques to be safely implemented and skills to be maintained.

Conclusion

taTME is associated with a reduced conversion rate in MIS restorative TME, regardless of the transabdominal approach utilised. Larger studies will be required to confirm these findings and define which subgroup of patients could benefit from taTME when a robotic transabdominal approach is undertaken.

Declarations

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Authors' contributions:

Alexander Heriot, Satish Warrier and Jacob McCormick were amongst the surgeons who performed the procedures

Alexander Heriot and Satish Warrier administered the project and guided research

José Tomás Larach, Joseph Kong, Julie Flynn, Timothy Wright, Peadar Waters and Helen Mohan constructed the database and performed the statistical analyses

José Tomás Larach, Joseph Kong, Julie Flynn, Timothy Wright, Peadar Waters and Helen Mohan wrote the main manuscript

All authors contributed significantly with text revisions and manuscript editing

All authors approved the final version of the manuscript

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None

ETHICS

Institutional Review Board ethics approval were obtained from both sites. Reference numbers are PMCC-2021-252498 and EH-2021-688. Informed consent regarding the surgical approach was obtained from all participats.

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Figures

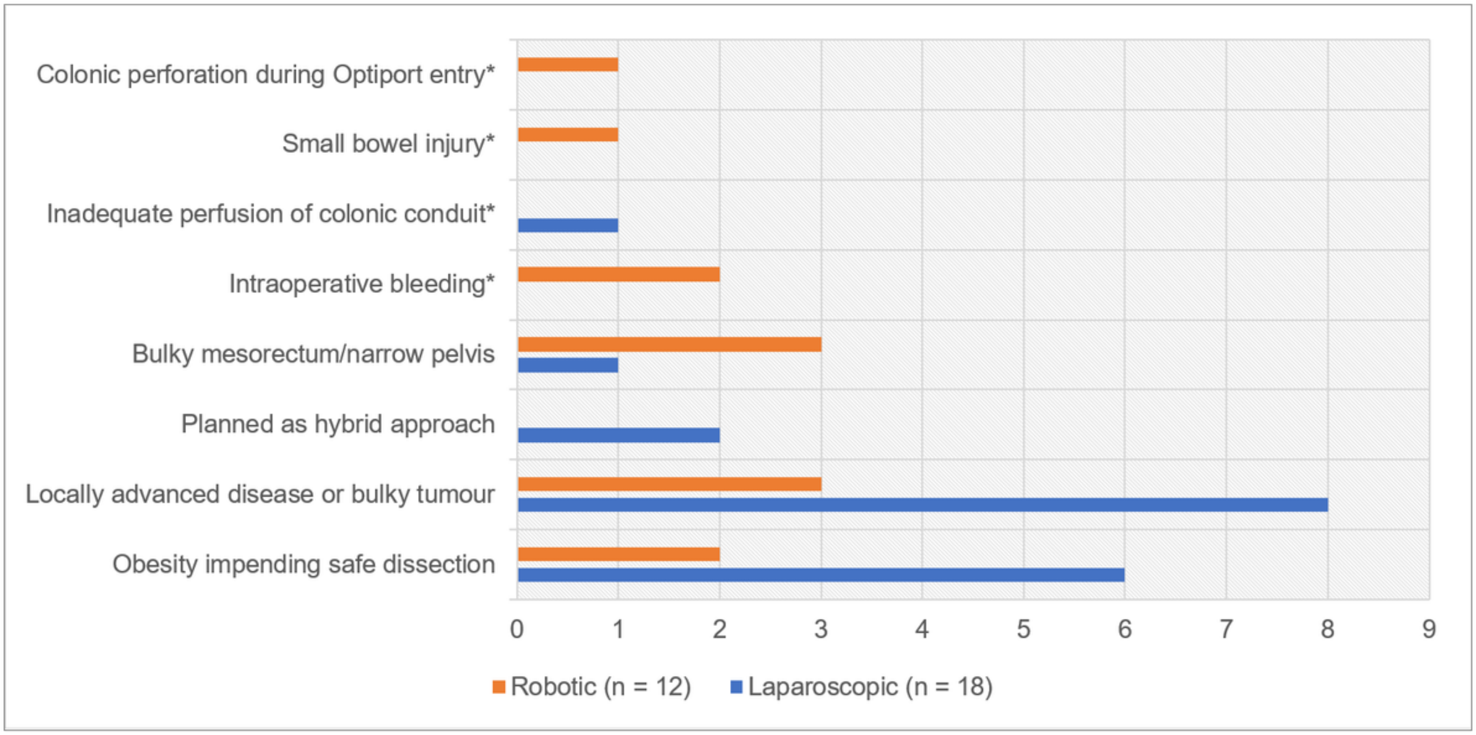

Figure 1

Causes for conversion according to approach

* Reactive conversion (n = 5, 16.7%). A taTME component utilised in one case where intraoperative bleeding (robotic) occurred and one case where inadequate perfusion of the colonic conduit (laparoscopic) triggered conversion, both reactive.