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Transanal Total Mesorectal Excision for Malignant Rectal Lesion: A Prospective Cohort Study

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Abstract

AIMS: The main outcome of this study was to use the transanal total mesorectal excision (TaTME) technique for rectal cancer resection and to assess as a primary endpoint the short-term oncological outcome; in terms of circumferential resection margin, longitudinal resection margins (proximally and distally), and lymph nodes (LN) retrieval, while secondary endpoints were operative time, estimated blood loss, length of hospital stay, cost per case, and overall complication rate.

METHODS: This was a prospective cohort study. Forty patients were included and subjected to TaTME from May 2018 to January 2020 and patients were followed up for a period of 6 months.

RESULTS: Primary endpoint: Depending on the post-operative specimen pathological assessment; circumferential resection margin (CRM) was free in all patients, proximal resection margins had a mean 14.37 2.87 cm, distal resection margins had a mean 2.08 ± 0.4 cm and LNs retrieval had a mean 13.27 ± 5.9, and number of positive LNs had a mean 2.40 ± 3.77. Secondary endpoints: Mean total operative time (from induction of anesthesia till skin closure) was 179.10, estimated blood loss (using gauze visual analog plus what was obtained in the OR suction device) was 133.67 66.59 ml, the length of hospital stay (admission till discharge) was 5.27 ± 1.08 days, cost per case had a mean (in 1000 USD) 2.95 ± 0.12, and overall complication rate was 10%.

CONCLUSION: TaTME represents a promising complementary technique to laparoscopic TME in the step of low rectal dissection.

Introduction

Colorectal carcinoma is considered the most common malignancy of the gastrointestinal tract, with nearly the same incidence in males and females (ratio, 1.2:1). The incidence of colorectal cancer has been markedly rising following economic development and industrialization that start to increase after age 34 and rises rapidly after age 55, peaking in the seventh decade, but nowadays, younger ages are also affected. At present, colorectal cancer is the third leading cause of cancer deaths in both males and females [1]. Surgery is the main choice of treatment for patients with colorectal cancer. The concept of total mesorectal excision (TME), which was introduced by Heald *et al*. during the 1980s, has significantly improved the outcome for patients with rectal cancer, particularly with regard to local recurrence [2].

The adoption of TME was a major step toward better oncological outcomes [3] as was more precise definitions of distal and circumferential resection margins (CRM) and minimum number of retrieved lymph nodes (LNs) [4]. Indeed, achieving a good quality of surgery is of major importance for rectal resection [5].

Surgical resection of rectal cancer, and particularly low rectal cancer, poses a significant technical challenge for surgeons [6]. Limited access to the narrow space within the bony pelvis can impede a meticulous oncological dissection and lead to damage to critical neurovascular structures [7]. Various patient and tumor-related features can add to the complexity of a low rectal dissection. Therefore, it is no surprise that throughout history surgeons have alternated between abdominal and perineal approaches in an effort to improve access and outcomes [8].

In such circumstances, transanal TME (TaTME) has emerged as an alternative "down-to-up" solution in recent years. Since more and more studies have proven the feasibility and advantage of TaTME, it has become a hot topic in the field of colorectal surgery [9], [10].

Objectives

Primary endpoint

The main outcome of this study was to use the TaTME technique for rectal cancer resection and to assess short-term oncological outcome; in terms of CRM, longitudinal resection margins (proximally and distally), and LNs retrieval.

Secondary endpoints

Assessment of operative time, the length of hospital stay estimated blood loss, overall complication rate, and cost per case.

Patients and Methods

This was a prospective cohort study which included 40 patients of both sexes and different age group) who came to the outpatient clinics from May 2018 to January 2020. Patients were followed up for a period of 6 months. After the approval of the scientific and ethical committee, the procedure and the study were explained for all individuals participating in the study and all of them signed a written consent for agreement.

Inclusion criteria

The following criteria were included in the study:

- Patients with resectable mid and low rectal cancer
- Non-metastatic colorectal cancer
- Good general condition allowing surgical intervention
- With or without history of neoadjuvant therapy.

Exclusion criteria

The following criteria were excluded from the study:

- Irresectable masses
- Inoperable cases
- Previous abdominal surgery
- Patients refusing the study
- Patients with obstructed or perforated tumors
- Contraindications of laparoscopy as cardiac failure and pulmonary failure.

Primary endpoints

- The usage of the transanal single incision laparoscopic surgery (SILS) port (TaTME) in resection of mid and low rectal carcinoma and to assess the feasibility of the technique in resection of challenging low rectal cancer (especially in narrow pelvis) as regards oncological outcome; in terms of CRM, longitudinal resection margins (proximally and distally), LNs retrieval, and integrity of mesorectum.

Secondary endpoints

- Operative time
- Intraoperative estimated blood loss
- The length of hospital stay
- Cost per case
- Overall complication rate.

Methodology

Pre-operative

Full history of the patient including (age, gender, presentation, medical and surgical history, and history of neoadjuvant therapy) was taken from all patients. Tumor localization was categorized as middle rectum (7–11 cm from the anal verge), or lower rectum (<6 cm) as measured by colonoscopy and digital rectal examination, patients were subjected to full colonoscopy and biopsy to make sure that the patients are fulfilling the inclusion criteria then they had full assessment including full laboratory and radiological assessment including metastatic workup local staging was done by magnetic resonance imaging rectal protocol.

- Overviews
  - Sagittal T2
  - Axial T2
- Small field of view T2 through tumor
  - Axial – perpendicular to the plane of the part of the rectum containing the tumor
  - Coronal – parallel to the plane of the part of the rectum containing the tumor
- Optional
  - Fusion-weighted imaging.

All our patients were presented in the MDT meeting (including surgeon, oncologist, radiologist, and pathologist); all patients in this study received neoadjuvant chemoradiation.

Neoadjuvant

Neoadjuvant therapy involved 28 fractions totaling 50.4 Gy (45 Gy to entire pelvis and 5.4 Gy to the tumor) over 5 weeks. This was supplemented with fluorouracil (5-FU) infusions at weeks 1 and 5. Surgery was performed 6–8 weeks after last chemoradiation session.

Concerning pre-operative preparation; first, mechanical bowel preparation was performed preoperatively with rectal enemas for all patients 2 times the day before surgery. A single pre-operative dose of antibiotics (oral metronidazole 500 mg and oral neomycin 1 g) was given. Second, from midnight before surgery, patients did not receive medications known to cause long-term sedation. Third, for prophylaxis against thromboembolism, subcutaneous enoxaparin 40 mg was given 12 h before the expected time of the procedure. Fourth, patients received single-dose antibiotic prophylaxis against both anaerobes and aerobes about 1 h before surgery. Finally, solid diet stopped the day before surgery with no starvation policy as fasting is just for 4 h for liquids before the procedure.

Intraoperative

Intraoperative data (preparation time, actual operative time, estimated blood loss, and conversion rate to open surgery).

Operation room arrangement

First, patient positioning in a manner precluding pressure or nerve injury so all pressure points were adequately padded; second, patient fixation to the operating table to prevent sliding, so chest strap is placed superior to the xiphoid process and leg strap is also applied over the pneumatic calf; and third, freeing the operative field by positioning IV lines, cardiac monitoring leads, ventilator connections, and urinary catheter in a manner that they do not obstruct the surgical team's operative field.

Patient positioning

The patient is positioned in a modified Lloyd Davis position with both arms tucked. The patient's abdomen and pelvis are prepared from the xiphoid process to the pubic symphysis and from the right posterior axillary line to the left posterior axillary line and the perineum draped (Figure 1).

Mark-up and trocar placement

A 10 mm port for the camera 1 cm above and to the right of umbilicus, a 12–15 mm port for the right working hand in the right iliac fossa, a 5 mm port as a left working in the right mid clavicular line below the costal margin, and a 5 mm port at the left midclavicular subcostal for the assistant (Figure 1).

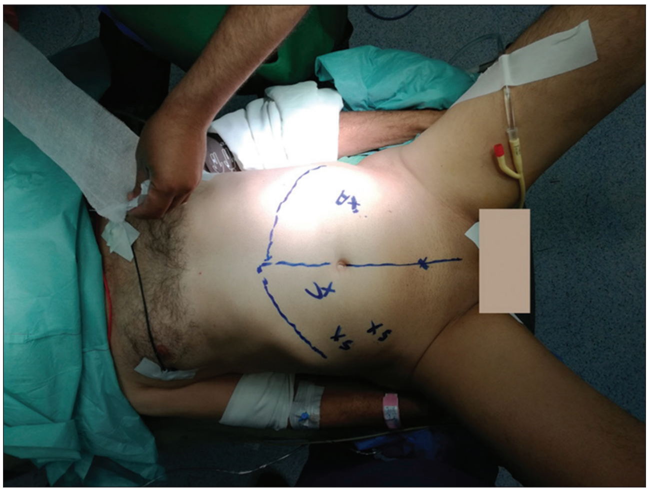

Figure 1: Positioning and trocar placement TaTME

Abdominal phase The patient is placed in steep Trendelenburg position with the right side tilted downward allowing the small bowel and the greater omentum to be reflected toward the right upper quadrant and the liver. We prefer in female patients to put a suture transabdominally straight forwardly through the fundus of the uterus to suspend the uterus to get a wide see into the pelvis.

Dissection is conveyed upward along the posterior part of the mesorectum toward the inferior mesenteric artery (IMA) (medial to lateral approach), taking consideration not to break the fascia propria of the rectum and avoiding damage to the superior hypogastric nerves. We dissect specifically underneath the IMA course and above the retroperitoneal fascial planes, the left ureter, and gonadal vessels. The ureter and the gonadal vessels could be distinguished simply over the lateral pelvic wall and the pelvic brim. The IMA is elevated from the retroperitoneum, and the ureter and gonadal vessels can be effortlessly swept bluntly posteriorly to keep up their situation inside the retroperitoneum, back, and lateral to the IMA. We either control the IMA, IMV with clips, sutures, or sometimes harmonic. The colonic mesentery would now be able to be lifted off the retroperitoneum proximally and along the side.

The extent of dissection is superior to the inferior border of the pancreas and laterally overlying the Gerota's fascia. Now, one can rapidly disengage the lateral peritoneal connections to the left colon and sigmoid by beginning at the pelvic brim and continued proximally toward the splenic flexure.

Pelvic phase

We commonly start this dissection along the posterior, right side, and proceed caudally, left working hand pushes the rectum toward the patient's left side, and right working is utilized to perform the dissection which is continued as far to the left pelvic side wall.

The posterior dissection is continued distally just behind the fascia propria of the rectum leaving behind the fascia of the neurovascular corridor intact to protect the hypogastric nerve plexuses. On approaching the lateral stalks, they are cut with monopolar cautery. Attention is then turned toward the anterior dissection. The assistant withdraw the rectum down and outside the pelvis. Left working port aids tension anterior at the level of the seminal vesicle or posterior vagina by retracting it superiorly and anteriorly. In patients with a tumor involving the posterior rectal wall, our dissection plane is always behind the Denonvilliers' fascia to get it out with the specimen. With anterior-based tumors, our dissection plane is almost always anterior to it.

Transanal technique

Then, the patient is positioned in modified Lloyd Davis position to start the transanal part.

First, we do proper exposure of the anal canal by taking four silk sutures at 12, 3, 6, and 9 o'clock (Figure 2).

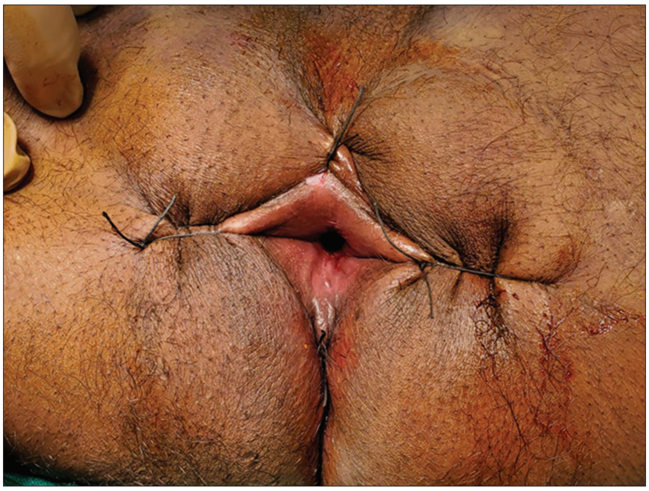

Figure 2: Anal canal exposure

Then, a purse string suture distal to the tumor is applied by adequate safety margin. Then, we do a circumferential rectotomy (above anorectal junction) distal to the purse string to reach our dissection plane just outside the mesorectum this was adequate in cases of mid rectal tumors in cases with lower rectum intersphinteric dissection replaces the rectotomy. The Gelpoint Mini access platform is applied to the plane acquired by open surgical transanal technique (Figure 3).

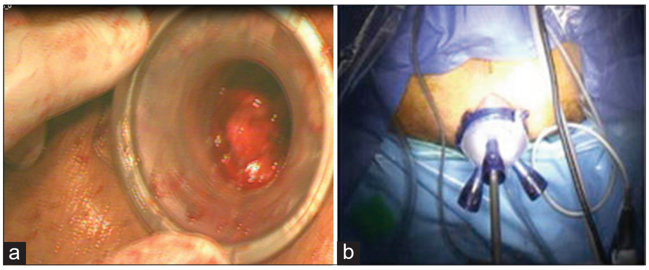

Figure 3: Gelpoint port application

Insufflation was done to a pressure 15 mmHg by means of intermittent insufflator we found that it gives better results with the fogging of the camera and also less hypercarbia. We used the zero cameras as it was found to give a better end on view and there is no need to adjust the light source so it's kept away from the surgeons working hands. By the means of a fenestrated, a traumatic grasper traction was done on the closed rectum and by a monopolar spatula dissection was done in the previously acquired plane totally outside the mesorectum to achieve a TME till we reach the dissection from above (Figure 4a-c).

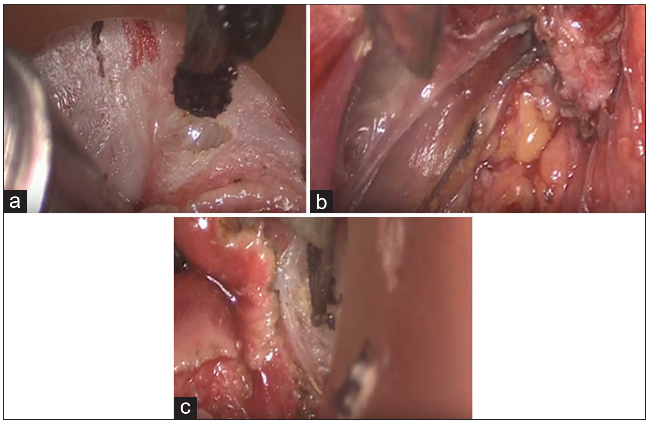

Figure 4: (a) Dissection from above, (b) right, and (c) left

Finally, the specimen was either delivered transanal so it is considered the last step in the evolution of rectal resections being a real "Natural orifice Surgery" or through a small Pfannenstiel incision if the specimen was quite large.

Anastomotic technique

Transanal circular stapler was used to perform a colorectal or coloanal anastomosis if it was not feasible, a hand sewn coloanal anastomosis is done. A diverting ileostomy or colostomy was done in 29 patients while 11 patients had primary anastomosis.

Post-operative policy

We adopted during this work an enhanced recovery care protocol for patients following either robotic or transanal approach for rectal cancer. Pre-operative counseling, adequate fluid and pain management, early feeding, and mobilization following surgery were implemented. The patients were discharged when they fulfilled the discharge criteria which include tolerance to oral diet, adequate pain control with oral analgesics, patient ambulating independently, afebrile patient without tachycardia, non-rising leucocyte count or C-reactive protein, and adequate home support with ability to take care of the stoma.

Post-operative

Post-operative data (pathological stage, number of harvested LNs, macroscopic completeness of resection in the form of proximal margin, distal margin, and CRM), and immediate post-operative outcome within 1 month (days of hospital stay, complications, if any, like anastomotic leakage, ileus, wound problems and others, rate of reoperation, rate of readmission, and 30-day mortality).

The pathological reports of all specimens were collected and the following data were collected for statistical analysis: Gender, age, proximal margin, distal margin, circumferential margin, number of LN retrieved, and positive LNs.

Total operative time

It was classified into: preparation time from induction of anesthesia till start of abdominal phase, and actual time from abdominal phase till skin closure (Table 2).

Bleeding

Intraoperative blood loss was estimated using “Blood loss estimation using gauze visual analogue” [11] plus what was obtained in the OR suction device (Figure 5 and Table 3).

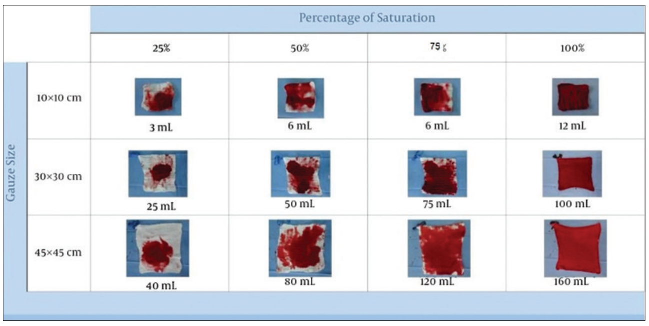

Figure 5: Gauze visual analog [11]

Hospital stay

It calculated in days from admission of the patient the night before the procedure till discharge of the patient (Table 6).

Complications

Intraoperative complications as bleeding, ureteric injury, and conversion to open technique were documented.

Early post-operative complication as ileus or leakage was documented.

Cost per case

Cost was calculated in (1000× LE) including hospital accommodation, OR expenses laparoscopy sets, and disposables, and staples if used in each patient (Table 7).

Statistical methods

Data were coded and entered using the Statistical Package for the Social Sciences version 26 (IBM Corp., Armonk, NY, USA). Data were summarized using mean, standard deviation, median, minimum, and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. Comparisons between quantitative variables were done using the non-parametric Mann–Whitney U-test [12]. For comparing categorical data, Chi-square (χ^2) test was performed. Exact test was used instead when the expected frequency is <5 [13]. $p < 0.05$ was considered as statistically significant.

Results

Demographic distribution

Gender and age distribution

This cohort study included 40 patients (19 males [47.5%] and 21 females [52.5%]) who were candidates for surgical resection as a management for mid and low rectal cancer with a mean age of 50.43 ± 10.03 years (range, 33–65 years).

Eighteen patients were overweight while 10 patients were obese, four patients were diabetic, five patients were hypertensive, and as for the American Society of Anesthesiologists (ASA) classes; 31 were ASA Class I and nine were ASA Class II (Table 1).

Table 1: Demographic data, histopathology, AJCC stage, tumor site, diversion, and neoadjuvant

Variable	Number	Frequency (%)	
Gender distribution			
Male	19	47.50	100
Female	21	52.50	
BMI			
Normal	12	30	100
Overweight	18	45	
Obese	10	25	
ASA classes			
Class I	31	77.50	100
Class II	9	22.50	
Other comorbidities			
DM	4	10	22.5
Hypertension	5	12.50	
Histopathology			
Adenocarcinoma	28	70	100
Mucoid carcinoma	8	20	
Complete response	4	10	
AJCC stage			
Stage I	4	10	100
Stage II	17	42.50	
Stage III	19	47.50	
Tumor site			
Midrectum	30	75	100
Low rectum	10	25	
Diversion versus 1ry anastomosis			
Diversion	29	72.50	100
1ry anastomosis	11	27.50	
Neoadjuvant	40	100	

AJCC: American Joint Committee on Cancer, ASA: American Society of Anesthesiologists, BMI: Body mass index, DM: Diabetes mellitus.

Distribution according the histopathological types of rectal cancer

Twenty-eight patients’ final pathology was adenocarcinoma, eight patients with mucoid adenocarcinoma, and four patients showed complete pathological response to neoadjuvant chemoradiation (Table 1).

Distribution according clinical staging American Joint Committee on Cancer of the rectal cancer

Among patients (n = 40), there were 4 patients (10%) with tumors of Stage I, 17 patients (42.5%) of Stage II, and 19 patients (47.5%) of Stage III (Table 1).

Table 2: Operative time

Time	Mean	Standard deviation	Median	Minimum	Maximum
Total time	179.10	23.45	177.50	139.00	225.00
Preparation	26.75	2.83	27.50	19.00	31.00
Actual time	152.35	22.82	149.00	113.00	198.00

Distribution according tumor site (mid vs. low rectal cancer)

There were 30 patients (75%) with tumors in midrectum. There were 10 patients (25%) with tumors located in the low rectum (Table 1).

Table 3: Estimated blood loss

Blood Loss	Mean	SD	Median	Minimum	Maximum
Bleeding (ml)					
TaTME	133.67	66.59	117.50	50.00	400.00

TaTME: Transanal total mesorectal excision.

Distribution according pre-operative systemic treatment (neoadjuvant chemoradiation)

All patients received pre-operative neoadjuvant EMO radiotherapy (100%) (Table 1).

Table 4: End margins

Margins cm	Mean	Standard deviation	Median	Minimum	Maximum
Distal margin	2.08	0.40	2	1.50	2.90
Proximal margin	14.37	2.87	14.00	10.00	19.00

Distribution according to diversion versus 1ry anastomosis

Eleven patients had 1ry anastomosis while 29 patients had a covering ileostomy (Table 1).

Table 5: Retrieved and positive LNs

Lymph nodes	Mean	Standard deviation	Median	Minimum	Maximum
Total number of LN	13.27	5.90	13.00	5.00	25.00
Number of positive LN	2.40	3.77	1.00	0.00	13.00

LN: Lymph node.

Analytical results

1. According to operative time (Table 2)
2. According to the intraoperative estimated blood loss (Table 3)
3. According to end margins (Table 4)

The mean distal safety margin was 2.08 ± 0.4 cm, the mean proximal safety margin was 14.37 ± 2.87 cm.

4. According to the quality of circumferential margin (complete vs. partly complete)

   The CRM was complete in all 40 patients (100%).
5. According to the LN retrieved (Table 5)
6. The length of hospital stay (Table 6)
7. Total hospital cost per case (1000× L.E.)

The mean cost was 46.43 ± 1.81. Total hospital cost per case (in 1000 USD.). The mean cost was 2.95 ± 0.12 (Table 7).

8. Complications

Overall complication rate was 10% in TaTME (four cases). Anastomotic leakage occurred twice (5%) both patients were managed operatively by a diverting ileostomy.

Table 6: Length of hospital stay

Hospital stay(days)	Mean	Standard deviation	Median	Minimum	Maximum
TaTME	5.27	1.08	5.00	4.00	10.00

TaTME: Transanal total mesorectal excision.

Post-operative ileus occurred in 1 (2.5%) patient managed conservatively. Despite our initial experience in this recent approach, there was only one case that was converted to open approach (2.5%).

Table 7: Cost per case in 1000 LE

cost X1000 LE	Mean	Standard deviation	Median	Minimum	Maximum
TaTME	46.43	1.81	46.00	44.00	54.00

Discussion

There was a smart shift from open to minimally invasive and robotic techniques, a worldwide application of neoadjuvant multimodal chemoradiation therapy for locally advanced stage disease, as well as optimization of surgical technique with nerve preservation together with the introduction of TME which was all largely happening in the preceding 10–15 years. The adoption of TME was a major step toward better oncological outcomes [3] as was more precise definitions of distal and CRM and minimum number of retrieved LNs [4]. Indeed, achieving a good quality of surgery is of major importance for rectal resection [5].

Surgical resection of rectal cancer, and particularly low rectal cancer, poses a significant technical challenge for surgeons [6]. Limited access to the confined space within the bony pelvis can impede a meticulous oncological dissection and lead to damage to critical neurovascular structures [7]. Various patient and tumor-related features can further add to the complexity of a low rectal dissection. Therefore, it is no surprise that throughout history surgeons have alternated between abdominal and perineal approaches in an effort to improve access and outcomes [8].

In such circumstances, TaTME has emerged as an alternative "down-to-up" solution in recent years. Since more and more studies have proven the feasibility and advantage of TaTME, it has become a hot topic in the field of colorectal surgery [9], [10]. The objective of our study is to assess the usage of the transanal SILS port (TaTME) in resection of challenging low rectal cancer especially in narrow pelvis.

To date, numerous studies have evaluated the short-term outcomes of TaTME. In our study, there were 40 patients (19 males and 21 females) who were candidates for surgical resection as a management for mid and low rectal cancer with a mean age of 50.43 ± 10.03 years. We reported our findings during a short-term follow-up in a period of 6 months duration.

Oncological outcome

The better visualization of the distal rectum, the better deep pelvic dissection without the need for traction on the rectum, and an easier identification of the plan of dissection are theoretically reported advantages of TaTME which could determine a higher quality TME specimen and a reduction in CRM positive and distal resection margins rate [14].

In our study concerning early oncological outcome (margins assessment), we had 100% of patients with free circumferential margin, a distal safety margin of mean 2.08 ± 0.4 cm, and a proximal safety margin of 14.37 ± 2.87 cm. In 2015, Tuech *et al*. [15] in his study on 56 patients had complete mesorectal excision in 84% (intact) (vs. 100% in our study) and 16% nearly intact, distal safety margin of 1 cm (vs. 2.08 ± 0.40 in our study), and retrieved LNs were 12 (vs. 13.27 ± 5.9 in our study).

In 2013, Rouanet *et al*. [16] in his study on 30 patients had complete mesorectal excision in 100% (intact) and 0% nearly intact as our study, distal safety margin of 0.9 cm (vs. 2.08 ± 0.40 in our study), and retrieved LNs were 13 (vs. 13.27 ± 5.9 in our study). In 2015, Muratore *et al*. [17] in his study on 26 patients had complete mesorectal excision in 88.5% (intact) and 11.5% nearly intact, distal safety margin of 1.9 cm (vs. 2.08 ± 0.40 in our study), and retrieved LNs were 10 (vs. 13.27 ± 5.9 in our study).

In 2014, Atallah *et al*. [18] in his study on 20 patients had complete mesorectal excision in 89.5% (intact) and 10.5% nearly intact (vs. 100% in our study), distal safety margin of 5% of cases were positive while 100% of our cases were free, and retrieved LNs were 22.5 (vs. 13.27 ± 5.9 in our study). In 2015, Buchs *et al*. [19] in his study on 20 cases had complete mesorectal excision in 94.1% (intact) and 5.9% nearly intact (vs. 100% in our study), distal safety margin was 2.14 cm (vs. 2.08 ± 0.40 in our study), and retrieved LNs were 23.2 (vs. 13.27 ± 5.9 in our study).

Operative time

The mean operative time in our study was 179.10 ± 23.45 min. In 2015, Tuech *et al*. [15] in his study on 56 patients mean operative time was 270 min, Muratore *et al*. [17] in his study on 26 patients mean operative time was 241 min, and Buchs *et al*. [19] in his study on 20 cases mean operative time was 315.3 min. In 2014, Atallah *et al*. [18] in his study on 20 patients undergoing curative-intent rectal cancer surgery at a single-institution mean operative time was 243 min. In 2013, Rouanet *et al*. [16] in his study transanal endoscopic proctectomy: An innovative procedure for difficult resection of rectal tumors in men with narrow pelvis on 30 patients mean operative time was 304 min which is all more than our time 179.10 ± 23.45 min.

Estimated blood loss

We had a mean of 133.67 ± 66.59 ml. In 2018, De Rosa *et al*. [20] in his study, mean blood loss was 175 ± 100 cc, which is more than our mean blood loss. In 2016, Chen *et al*. [21] in his study on 50 patients, mean blood loss was 68.0 ± 89.6 cc which is less than our result.

Hospital stay

In our study, mean was 5.27 ± 1.08 days. In 2015, Buchs *et al*. [19] in his study on 20 cases, mean hospital stay was 7 days, while Tuech *et al*. [15] in his study on 56 patients, mean hospital stay was 10 days. In 2013, Rouanet *et al*. [16] in his study on 30 patients, mean hospital stay was 14 days and these results were more than our result. In 2014, Atallah *et al*. [18] in his study on 20 patients, length of hospital stay was 4.5 days which was less than our result.

Complications

One of the major concerns in rectal surgery is the occurrence of post-operative complications. The safety of TaTME in terms of post-operative complications has been extensively investigated by various authors with retrospective small series or cohort studies with figures ranging from 27% to 35% [22].

In terms of safety, anastomotic leak represents the most dreaded complication after a low anterior resection of the rectum, which could seriously affect length of stay, early and long-term anorectal function and long-term oncologic outcome [23], [24]. We reported four cases with complications (10%). Regarding anastomotic leakage, we reported only 2 cases (5%) of minor leak and they were managed conservatively, it is to be stated that we had 1ry anastomosis in only 11 cases and diversion in 29 cases. Furthermore, we reported a case of post-operative ileus (2.5%), and another case was converted to open approach (2.5%).

Comparable to our results, data from the two largest meta-analyses including 510 and 794 patients reported anastomotic leakage in 5.7 and 6.1%, respectively [25], [26] (vs. 5% in our study). The reported incidence of conversion rate to open surgery following TaTME varies between 0% and 9.1% [27], [28].

In 2015, Tuech *et al*. [15] in his study on 56 patients, complications rate was 26%, Muratore *et al*. [17] in his study on 26 patients, complications rate was 26.9%, Buchs *et al*. [19] in his study on 20 cases, complications rate was 30%. In 2014, Atallah *et al*. [18] had complications rate was 65%. In 2013, Rouanet *et al*. [16] in his study on 30 patients, complications rate was 10% intraoperative and 30% post-operative, which all were more than our overall complication rate of 10%.

Cost

Not a single study was found assessing the total hospital costs using the TaTME approach in low rectal resection, we reported a mean cost per case about (in 1000 USD) 2.95 ± 0.12. This includes the cost of the surgical supplies and hospital resources used in the post-operative period.

Limitations of the study

Despite the small number of patients who were included in this study, our results are comparable to the previous studies. However, larger number of patients is needed to assess the efficacy of TaTME technique in rectal resection; also longer period of follow-up is needed to detect long-term outcome and complications.

Different surgeons and different pathology centers were indeed a limiting factor in this study. Post-operative functional assessment; urological, sexual, and continence needed longer period for assessment.

Conclusion

Although the experience with TaTME is still limited, it represents a promising complementary technique to laparoscopic TME in the step of low rectal dissection, especially for difficult cases where laparoscopy is too demanding. Furthermore, we consider it to be a cost-effective technique.

Declarations

Acknowledgment

Goes directly to Kasr Alainy faculty of medicine.

Ethical committee approval

The study was approved by the Research Ethics Committee of Cairo University. All authors have contributed to the conception or design of the work; interpretation of data for the work; drafting the work or revising it critically for important intellectual content; final approval of the version to be published; and agreement to be accountable for all aspects of the work.

Information and consent

All patients signed a written informed consent for the operation and the technique to which they are subjected.

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