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Value of Mesorectum Excision in Cancer Rectum

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ABSTRACT

Background: Total Mesorectal Excision (TME) is the standard for rectal cancer with the pathological quality of the excised specimen being a critical prognostic factor. Suboptimal TME can compromise local control and survival.

Aim: This study aimed to assess the pathological quality of TME in patients undergoing surgery for mid to low rectal adenocarcinoma and to correlate these findings with locoregional recurrence rates, sphincter preservation and short-term disease-free survival.

Patients and methods: One hundred twenty consecutive patients undergoing TME were included. Mesorectal specimens were pathologically assessed as complete, nearly complete, or incomplete. Data on neoadjuvant therapy, surgical approach and outcomes were prospectively collected. Clinicopathological data, neoadjuvant therapy and surgical approach were collected. Patients were prospectively followed for locoregional recurrence, distant metastasis, sphincter preservation rates, and disease-free survival at 12 months.

Results: A complete TME was achieved in 80% (96/120) of patients, nearly complete in 15% (18/120), and incomplete in 5% (6/120). Locoregional recurrence at twelve months was significantly lower with complete TME (2.1%) compared to nearly complete (11.1%) or incomplete (33.3%) excisions ($p<0.001$). Sphincter preservation was higher with complete TME (75% vs. 60% nearly complete, 30% incomplete; $p=0.002$). Disease-free survival at 12 months was significantly higher in the complete TME group (95.8%) versus nearly complete (83.3%) and incomplete (66.7%) groups ($p<0.001$).

Conclusion: The quality of TME is an independent prognostic factor directly impacting locoregional recurrence and survival. Achieving a complete mesorectal excision is a primary surgical goal, associated with superior oncological outcomes and higher sphincter preservation.

Keywords: Rectal cancer, Mesorectal excision, Recurrence, Sphincter preservation, Disease-free survival.

INTRODUCTION

Rectal cancer accounts for approximately one-third of all colorectal malignancies and presents unique challenges in surgical management due to its anatomical location within the confined pelvic space [1]. For decades, surgical outcomes for rectal cancer were plagued by high rates of local recurrence and significant morbidity. The paradigm shifted dramatically with the widespread adoption of TME, pioneered by Professor R.J. Heald in the 1980s [2].

TME is a standardized surgical technique that involves sharp dissection along the embryologically defined fascial plane surrounding the rectum, ensuring the complete removal of the rectum and its intact mesorectum, which contains the lymphatic drainage, blood vessels and fatty tissue. This meticulous approach has been unequivocally shown to significantly reduce local recurrence rates and improve survival outcomes compared to conventional blunt dissection [3, 4].

Despite the established benefits of TME, variations in surgical technique, surgeon experience and patient-specific anatomical factors (e.g., narrow pelvis & obesity) can influence the quality of the excised mesorectal specimen. The pathological assessment of the TME specimen quality has emerged as a critical independent prognostic factor for rectal cancer outcomes [5].

A "complete" TME specimen implies an intact mesorectal envelope with a smooth, regular surface, indicating dissection within the correct anatomical plane. Conversely, an "incomplete" or "nearly complete" specimen suggests a breach of the mesorectal fascia, potentially leaving behind residual tumor cells or involved lymph nodes, thereby increasing the risk of local recurrence [6].

Standardized pathological classification systems, such as the Quirke classification, are now routinely used to grade TME specimen quality and provide crucial feedback to surgeons [7].

The quality of TME directly correlates with several key oncological endpoints. A complete TME is associated with lower rates of positive circumferential resection margins (CRM), reduced locoregional recurrence and improved long-term survival [8].

Furthermore, optimal TME quality can also influence the feasibility of sphincter-preserving surgery, as a clean dissection plane allows for a more distal transection of the rectum while maintaining oncological safety [9]. Despite the clear evidence, achieving consistently high-quality TME specimens remains a challenge, even in experienced centers, emphasizing the need for continuous audit and improvement in surgical practice.

While numerous studies have demonstrated the impact of TME quality on outcomes, ongoing research is vital to reinforce these findings in diverse clinical settings and to assess their correlation with modern multidisciplinary management strategies, including neoadjuvant chemoradiotherapy. Understanding the precise relationship between TME quality and specific

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outcomes, such as sphincter preservation and short-term disease-free survival, can further guide surgical training and quality assurance programs.

PATIENTS AND METHODS

This prospective observational study was carried out at the Department of General Surgery, Al-Azhar University Hospitals, Cairo, Egypt over one year spanning from January 2023 to December 2024. The study was designed to systematically collect and analyze clinical, pathological, and surgical data in real time, ensuring accurate documentation of patient outcomes and adherence to standardized management protocols.

Patient selection: 120 consecutive patients diagnosed with mid- to low-rectal adenocarcinoma described as tumors located within 12 cm of the anal verge as determined by rigid proctoscopy were prospectively enrolled. All patients were scheduled for elective surgical resection TME, in accordance with standard oncological principles. This enrollment strategy aimed to capture a representative cohort undergoing uniform surgical management to facilitate reliable assessment of clinical and oncological outcomes.

Inclusion criteria: Patients aged ≥18 years. Histopathologically confirmed adenocarcinoma of the mid or low rectum. Clinical T1-T4, N0-N2, M0 (no distant metastasis) disease based on preoperative staging. Undergoing elective surgical resection with TME. American Society of Anesthesiologists (ASA) physical status I, II, or III. Can provide informed consent.

Exclusion criteria: Evidence of distant metastasis identified preoperatively or intraoperatively. Undergoing emergency surgery for rectal obstruction or perforation. History of previous pelvic radiation therapy or extensive pelvic surgery that could significantly alter anatomy. Patients with inflammatory bowel disease or familial adenomatous polyposis. Patients undergoing local excision or non-TME resections. Refusal to participate.

Preoperative assessment: Before surgery, every patient went through a detailed preoperative workup that included comprehensive medical history documentation, complete physical examination and standard laboratory profiling together with assessment of the serum carcinoembryonic antigen (CEA) level. Tumor localization and extent were established through a structured imaging protocol: Rigid proctoscopy was used to measure the distance of the lesion from the anal verge, pelvic magnetic resonance imaging (MRI) provided detailed evaluation of the depth of tumor invasion, mesorectal fascia proximity and lymph node status. Computed tomography (CT) of the chest, abdomen and pelvis was performed to rule out distant metastatic disease. Each case was subsequently reviewed in a multidisciplinary team (MDT) setting involving colorectal surgeons, oncologists, radiologists, and pathologists to determine the most appropriate management plan. The decision to administer neoadjuvant treatment, either long-course chemoradiotherapy or short-course radiotherapy, was made for patients with locally advanced disease, including those with cT3–T4 tumors, positive lymph nodes (cN+), or threatened circumferential resection margins (CRM).

Surgical procedure (TME): All surgical procedures were executed by colorectal surgeons with substantial experience in total mesorectal excision (TME). The choice of surgical approach, laparoscopic, robotic, or open, was guided by patient-specific considerations and intraoperative assessment, as well as the operating surgeon's judgment. Regardless of the chosen technique, the fundamental oncologic principles and technical standards of TME were meticulously adhered to in every case:

1. **Dissection plane:** The TME procedure involved meticulous sharp dissection along the embryologically defined mesorectal fascial plane (holy plane) from the sacral promontory down to the pelvic floor. This ensured the removal of the entire mesorectum as an intact, encapsulated specimen.
2. **High ligation:** High ligation of the inferior mesenteric artery (IMA) and inferior mesenteric vein was performed at their origins to achieve adequate lymphadenectomy.
3. **Distal resection margin:** The distal rectal transection was performed according to oncological principles, aiming for a minimum 1 cm distal margin after neoadjuvant therapy, or 2 cm for primary surgery.
4. **Sphincter preservation:** The decision for sphincter preservation (low anterior resection with anastomosis) versus abdominoperineal resection (APR) was made based on tumor distance from the anal verge, response to neoadjuvant therapy and patient preference with a strong emphasis on achieving a negative distal margin.
5. **Reconstruction:** For sphincter-preserving resections, a colorectal or coloanal anastomosis was performed, typically using a stapled technique. A diverting ileostomy was created at the surgeon's discretion, particularly for very low anastomoses or high-risk patients.
6. **Data collection:** Critical intraoperative details, including operative time, estimated blood loss, surgical approach and type of resection (LAR vs. APR), were meticulously recorded.

Pathological assessment of TME quality: All resected mesorectal specimens were immediately oriented and meticulously assessed by dedicated gastrointestinal pathologists according to a standardized classification system (Quirke classification) [7]:

- **Complete mesorectal excision:** Characterized by an intact, smooth, and regular mesorectal surface

with no visible defects or coning of the mesorectum.

- **Nearly complete mesorectal excision:** Characterized by some irregularity of the mesorectal surface, with minor defects or coning, but largely intact.
- **Incomplete mesorectal excision:** Characterized by significant defects in the mesorectal fascia, jagged or irregular surface, or muscularis propria visible on the mesorectal surface.

In addition to TME quality, pathologists assessed tumor type, grade, depth of invasion (pT stage), lymph node status (pN stage, number of harvested and positive nodes), CRM status (distance from tumor to closest radial margin), distal resection margin (DRM) status and presence of lymphovascular or perineural invasion.

Postoperative management and follow-up: Postoperative care followed the principles of the enhanced recovery after surgery (ERAS) protocol, emphasizing early mobilization, optimized pain control and prompt resumption of oral nutrition. All postoperative complications occurring within 30 days of surgery were documented and classified using the Clavien–Dindo grading system. Additional recovery parameters, including duration of hospital stay, time to initiation of oral intake and time to independent ambulation were systematically recorded for each patient.

Patients were prospectively followed at regular intervals with evaluations scheduled every three months during the first postoperative year and subsequently every six months thereafter. Follow-up assessments comprised comprehensive clinical examinations, laboratory investigations—including serum carcinoembryonic antigen (CEA) measurement—and imaging studies. Imaging modalities included computed tomography (CT) scans of the chest, abdomen and pelvis for systemic surveillance, while pelvic magnetic resonance imaging (MRI) or endorectal ultrasound was performed when clinically indicated to evaluate local recurrence. This structured follow-up protocol aimed to facilitate early detection of disease recurrence and monitor postoperative outcomes systematically.

Outcome measures:

Primary outcomes:

- **Pathological TME quality:** Categorized as complete, nearly complete or incomplete.
- **Locoregional recurrence rate:** Any recurrence within the pelvis (e.g., anastomotic site, presacral space and pelvic sidewall) confirmed by biopsy or imaging, recorded at 12 months post-surgery.
- **Sphincter preservation rate:** The proportion of patients who underwent low anterior resection (LAR) with restoration of bowel continuity through an anastomosis, thereby avoiding the need for a permanent stoma.
- **Short-term disease-free survival (DFS):** The interval from the date of surgical resection to the occurrence of any cancer recurrence—either locoregional or distant—or death from any cause. DFS was evaluated at 12 months postoperatively to provide an early measure of oncological outcome.
- **Secondary outcomes:**
  - **Overall postoperative complication rate:** All complications within 30 days, graded by Clavien-Dindo.
  - **Length of Hospital Stay.**
  - **CRM positivity rate:** Referred as tumor cells within 1 mm of the CRM.

Ethical approval: The Institutional Review Board of Al-Azhar University approved the study protocol . All study procedures adhered strictly to the ethical standards of the Declaration of Helsinki to ensure the protection of participants' rights, safety and welfare. Before enrollment, each eligible participant received detailed information regarding the study's purpose, methodology, potential risks and anticipated benefits. Written informed consents were subsequently obtained from all participants confirming their voluntary agreement to take part in the research. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

Statistical analyses were conducted leveraging SPSS Statistics version 28.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were employed to sum up baseline demographic and clinicopathological characteristics with continuous variables presented as mean ± standard deviation (SD) or median with interquartile range (IQR), depending on data distribution. Categorical variables were expressed as frequencies and percentages. Comparisons of categorical variables, such as TME quality, recurrence rates, and sphincter preservation were performed leveraging χ^2 (Chi-square) or Fisher's exact tests as appropriate. Differences in continuous variables between study groups were evaluated using independent samples t-tests for normally distributed data or Mann-Whitney U tests for non-normally distributed data. Disease-free survival was estimated using Kaplan-Meier survival curves with differences between groups assessed via log-rank tests. Statistical significance was stated as a two-tailed p-value ≤ 0.05 for all analyses.

RESULTS

120 consecutive patients with mid to low rectal adenocarcinoma undergoing TME were enrolled in this prospective study. The patient cohort had a mean age of 60.3 ± 8.5 years (range: 45-78 years). Male patients constituted 60% (n=72) and females 40% (n=48). All patients underwent preoperative staging and 85% (n=102) received neoadjuvant chemoradiotherapy (CRT) or short-course radiotherapy (SCRT) prior to surgery. The remaining 15% (n=18) underwent primary surgery for early-stage disease. The most common pathological T-stage after surgery (or primary surgery)

was pT2 (30%, n=36) and pT3 (55%, n=66). Lymph node metastasis (pN+) was confirmed in 35% (n=42) of patients. Table (1) outlined the baseline characteristics of the study population, showing a typical distribution for patients undergoing TME for mid to low rectal cancer, with a high proportion receiving neoadjuvant therapy.

Table (1): Patient demographics and clinicopathological characteristics (n=120)

Characteristic	Value (Mean ± SD or n/%)
Age (years)	60.3 ± 8.5
Gender (Male/Female)	72 (60%) / 48 (40%)
BMI (kg/m^2)	28.1 ± 4.2
Neoadjuvant Therapy	102 (85%)
Pathological T-Stage	
pT0	6 (5%)
pT1	6 (5%)
pT2	36 (30%)
pT3	66 (55%)
pT4	6 (5%)
Lymph Node Metastasis (pN+)	42 (35%)
Lymphovascular Space Invasion	30 (25%)
Perineural Invasion	18 (15%)

Table (2) showed that the majority of resections were laparoscopic (70.8%), and sphincter preservation (LAR) was achieved in 75% of cases. A complete TME specimen was obtained in a high proportion of patients (80%), while 15% were nearly complete and 5% were incomplete. CRM positivity was observed in 6.7% of cases.

Table (2): Surgical outcomes and pathological TME quality

Characteristic	Value (Mean ± SD or n/%)
Operative Time (minutes)	220 ± 45
Estimated Blood Loss (mL)	180 ± 50
Surgical Approach (Laparoscopic/Open)	85 (70.8%) / 35 (29.2%)
Type of Resection (LAR/APR)	90 (75%) / 30 (25%)
Pathological TME Quality	
Complete	96 (80%)
Nearly Complete	18 (15%)
Incomplete	6 (5%)
CRM Positivity	8 (6.7%)

Table (3) highlighted the strong correlation between TME quality and key outcomes. Patients with a complete TME had significantly lower locoregional recurrence rates at 12 months (2.1%) compared to those with nearly complete (11.1%) or incomplete (33.3%) excisions. Furthermore, sphincter preservation rates were significantly higher in the complete TME group (75%) compared to the other quality groups.

Table (3): Correlation of TME quality with locoregional recurrence and sphincter preservation

TME Quality	Number of Patients (n)	Loco-regional Recurrence at 12 Months (n/%)	Sphincter Preservation (LAR) (n/%)	p-value (LRR)	p-value (SP)
Complete	96	2 (2.1%)	72 (75%)	<0.001	0.002
Nearly Complete	18	2 (11.1%)	11 (60%)		
Incomplete	6	2 (33.3%)	2 (30%)		

Table (4) showed that disease-free survival at 12 months was significantly superior in patients with a complete TME specimen (95.8%) compared to those with nearly complete (83.3%) or incomplete (66.7%) excisions, underscoring the prognostic importance of TME quality.

Table (4): Correlation of TME quality with 12-months disease-free survival

TME Quality	Number of Patients (n)	12-Month Disease-Free Survival (DFS) (%)	p-value
Complete	96	95.8%	<0.001
Nearly Complete	18	83.3%	
Incomplete	6	66.7%	

Postoperative complications: Total 30-days postoperative complication rate (Clavien-Dindo grade ≥ I) was 20% (24/120) with no statistically significant difference in overall complication rates across the TME quality groups (Complete: 19.8%, Nearly Complete: 22.2%, Incomplete: 16.7%; p=0.89). Common complications included wound infection (8%), anastomotic leak (5%), and prolonged ileus (4%). There was no perioperative mortality in this study.

CRM Status: CRM positivity (tumor within 1 mm of the circumferential margin) was found in 6.7% (8/120) of all patients. When correlated with TME quality, CRM positivity was significantly lower in the complete TME group (2.1%, n=2/96) compared to the nearly complete (16.7%, n=3/18) and incomplete (50%, n=3/6) groups (p<0.001). This reinforces the link between TME quality and oncological clearance.

DISCUSSION

TME has revolutionized the surgical management of rectal cancer, establishing itself as the gold standard due to its proven ability to significantly reduce locoregional recurrence rates. Our prospective observational study further reinforces the paramount importance of TME quality, as assessed pathologically, in determining key oncological and functional outcomes for patients with mid to low rectal adenocarcinoma. The findings underscore that achieving a complete TME specimen is directly associated with superior locoregional control, higher rates of sphincter preservation and improved short-term disease-free survival.

The high rate of complete TME (80%) observed in our cohort underscores strict adherence to standardized surgical principles and reflects the technical expertise of the surgical team at Al-Azhar University Hospitals. This outcome aligns well with previously reported rates in the literature, which generally range from 70% to 90% in high-volume centers, highlighting the consistency of TME quality in experienced hands [10, 11].

Most patients in our cohort underwent neoadjuvant therapy, which can contribute to a clearer dissection plane and enhance TME quality. This benefit arises from tumor downstaging and regression within the mesorectum, facilitating more precise surgical excision and potentially reducing the risk of residual disease [12].

A pivotal finding of our study was the strong inverse correlation between TME quality and locoregional recurrence. Patients with a complete TME specimen experienced a remarkably low 12-month locoregional recurrence rate of 2.1%, which is significantly lower than the rates observed in the nearly complete (11.1%) and incomplete (33.3%) groups ($p<0.001$). This directly supports the original premise of TME that careful dissection inside the mesorectal fascial plane minimizes the probability of leaving behind microscopic disease in the pelvis. Breaches in the mesorectal fascia, as indicated by nearly complete or incomplete specimens, expose the patient to a higher risk of residual tumor cells at the surgical margin or within fragmented mesorectal tissue, leading to local failure [5, 6].

Our results are consistent with numerous international studies that have identified TME quality as one of the most powerful predictors of local recurrence [8, 13]. Furthermore, the quality of TME significantly influenced sphincter preservation rates. Our study showed that 75% of patients with a complete TME underwent sphincter-preserving low anterior resection (LAR) compared to 60% with nearly complete and only 30% with incomplete excisions ($p=0.002$). This highlights that a well-executed TME, by providing a clean and adequate distal margin within the mesorectal envelope, facilitates safe anastomosis even for low-lying tumors, thereby improving functional outcomes and quality of life for patients. This finding aligns with the understanding that a clear dissection plane allows for a more confident and oncologically sound distal transection [9].

The impact of TME quality extended to disease-free survival, with patients achieving a complete TME demonstrating significantly higher 12-month DFS (95.8%) compared to those with nearly complete (83.3%) or incomplete (66.7%) specimens ($p<0.001$). This underscores that optimal local control achieved by high-quality TME contributes directly to improved short-term oncological outcomes. While long-term survival data are still maturing for this cohort, the strong early correlation suggests that TME quality is a fundamental determinant of overall prognosis.

CRM status is closely related to TME quality and is a well-established prognostic factor. Our study found a significantly lower CRM positivity rate in the complete TME group (2.1%) versus the nearly complete (16.7%) and incomplete (50%) groups ($p<0.001$). This reinforces the concept that an intact mesorectal plane naturally leads to a negative CRM, as the tumor is removed en bloc within its surrounding fascial envelope. CRM positivity is a key predictor of local recurrence and reduced survival [6, 8] and our data demonstrated how high-quality TME directly mitigates this risk.

Interestingly, our study found no statistically significant difference in overall postoperative complication rates across the TME quality groups. While one might hypothesize that more difficult or incomplete dissections could lead to higher complication rates. This finding suggests that complications are often related to other factors such as patient comorbidities, anastomotic technique, or general surgical factors, rather than solely the quality of the mesorectal plane achieved. This is a reassuring finding, indicating that the pursuit of a high-quality TME does not necessarily translate into a higher immediate surgical risk.

LIMITATIONS

Despite its prospective design and meticulous pathological assessment, it is a single-center study, which may limit the scalability of the results to centers with different surgical volumes, expertise, or patient populations. The 12-month follow-up period, while sufficient for assessing early recurrence and short-term DFS, is insufficient for definitive conclusions on long-term survival. Longer follow-up is ongoing to further validate these findings. Furthermore, while the Quirke classification is widely accepted, the subjective element in pathological assessment can introduce minor variability, though our use of dedicated pathologists aimed to minimize this.

CONCLUSION

This study provided strong evidence from our regional experience that the pathological quality of TME is a crucial independent prognostic factor in mid to low rectal adenocarcinoma. Achieving a complete mesorectal

excision is accompanied by significantly lower locoregional recurrence rates, higher rates of sphincter preservation and improved short-term disease-free survival. These findings emphasized the critical importance of meticulous surgical technique and standardized pathological assessment as cornerstones of high-quality rectal cancer care, ultimately leading to better patient outcomes.

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