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Two vs. Three-Stage Abdominoperineal Resection in Rectal Cancer: A Surgical Strategy Debate

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Abstract

Background: Although Abdominoperineal Resection (APR) rates have declined over the last fifty years, it remains the best treatment option in many circumstances.

Objectives: This study aimed to investigate the short-term outcomes of two-stage versus three-stage laparoscopic abdominoperineal resection in rectal cancer.

Methods: This retrospective cohort study included 113 patients with rectal cancer eligible for laparoscopic APR at Razavi Hospital in Mashhad from 2020 to 2023. Inclusion criteria were age over 18 and a confirmed diagnosis via pathology, while exclusion criteria included recurrent rectal cancer, anal canal, and rectosigmoidal tumors, tumors located more than 15 centimeters from the anal verge, and concurrent colonic lesions. Data analysis was conducted using R software and SPSS.

Results: The study included 42 patients undergoing a two-step surgical technique and 71 patients with a three-step technique. Results showed that the two-step group had a longer mean hospital stay (9.48 ± 4.09 days) than the three-step group (7.63 ± 1.30 days; p = 0.002). Surgical site infections occurred in 15.6% of the two-step patients, whereas none occurred in the three-step group (p=0.020). The mean surgery duration was also longer in the two-step group (222.18±56.08 minutes) than in the three-step group (170.78±29.13 minutes; p=0.00). Revision surgery was required in 23.8% of the two-stage group, compared with 4.2% in the three-stage group (p=0.002). Blood transfusion rates were similar: 23.8% in the two-step group and 22.5% in the three-step group (p=0.876).

Conclusion: The three-stage approach to APR may improve surgical outcomes. However, larger prospective studies are needed to confirm these findings.

Keywords: Abdominoperineal Resection, Rectal Cancer, Outcomes, Surgical Approach.

1. Background

Rectal cancer (RC), which is associated with high rates of morbidity and mortality, is a primary worldwide health concern. With an estimated 750,000 additional cases in 2020 and a predicted increase to 1.24 million by 2040, the global burden of RC is concerning. (1,2) Nonetheless, there are notable differences in the incidence rate of colorectal cancer (CRC) around the globe. Notably, the highest rates of CRC are reported in Australia and New Zealand, followed by North America and Western Europe. However, CRCs are less common in places like Africa and South-Central Asia. (3) With a rising prevalence over the previous 20 years, CRC is currently the

second most frequent cancer in Iran among women and the fourth most prevalent among males. (4) After age 50, the incidence rates exceeded 20 per 100,000 for both sexes, peaking in the 80–84 age group. The median age at diagnosis is 59, and the median at symptom onset is 58. Adenocarcinoma is the most common histological type. The projected survival rates at the 1, 3, 5, and 10 years were 85%, 59%, 47%, and 36%, respectively. (1) Age, male sex, inflammatory bowel disease, diet, and physical activity are some of the factors linked to CRC. (5)

Since the introduction of Miles' procedure in 1908, surgical advancements for rectal cancer have aimed to improve both oncological outcomes and functional preservation. Total mesorectal excision (TME), now the standard of care for advanced RC, was developed following clinical studies on lymph node metastases and resected stumps. The 1990s marked the introduction of laparoscopic surgery for colorectal surgery. The first laparoscopic surgical instance of CRC was described by Jacobs et al. in 1991. (6) The overall number of abdominoperineal resections (APR) has decreased, and the number of rectal resections with sphincter preservation has increased as a result of the development of surgical procedures used in low rectal cancer, the use of staplers, and better knowledge of the pathological causes of tumor dissemination. (7) Despite this decline, APR remains the preferred approach in specific clinical contexts, especially for tumors involving the sphincter complex or those with insufficient distal resection margins (DRM). Additionally, APR may be more suitable for elderly patients and those with reduced baseline functional status. (8).

2. Objective

This study aimed to assess the short-term outcomes of two-stage versus three-stage laparoscopic APR in rectal cancer. To the best of our knowledge, no prior studies have addressed this specific comparison, highlighting the novelty of our research.

3. Methods

3.1. study design

This retrospective cohort study included patients with rectal cancer (RC) who were candidates for laparoscopic abdominoperineal resection (APR) and were referred to the Colorectal Surgery Department at Razavi Hospital, a tertiary referral center in Mashhad, between 2020 and 2023.

3.2. Participants

Inclusion criteria were a confirmed diagnosis of RC by pathological examination and age over 18 years. Exclusion criteria included recurrent RC, tumors located in the anal canal or rectosigmoid junction, tumors situated more than 15 cm from the anal verge, and the presence of concurrent colonic tumors. A total of 113 patients aged 18 or older were enrolled. All had been diagnosed with rectal adenocarcinoma, had received neoadjuvant chemoradiation, and underwent either two-stage or three-stage laparoscopic APR. Of these, 42 patients underwent the two-stage procedure, and 71 underwent the three-stage procedure.

3.3. Surgical Technique

Two experienced academic colorectal surgeons with over ten years of expertise performed all surgeries.

Two-stage surgical procedure

Four trocars are inserted after general anesthesia, preparation, draping, and establishment of pneumoperitoneum. A 10 mm camera trocar is positioned to the right of the umbilicus, a 12 mm trocar for the stapler is inserted into the right iliac fossa, and another 10 mm trocar is placed in the right flank of the abdomen. The trocar in the left iliac fossa is positioned at the site designated for the forthcoming stoma. The parietal peritoneum is opened on the right

side of the rectosigmoid junction. Dissection proceeds within the avascular presacral plane from lateral to medial. The superior rectal vessels are identified, tied off, and divided at their point of origin.

The sigmoidal vessels are also ligated. Posterolateral dissection of the mesorectum is carried out with care to preserve the fascia propria of the rectum. Clear visualization is maintained to avoid injury to the hypogastric nerves. Once the lateral dissection of the mesorectum is complete, the anterior plane is addressed next. The lateral cuts of the pelvic peritoneum are connected at the recto-uterine or recto-vesical pouch. By applying posterosuperior traction on the mesorectum, the anterior plane is dissected along the rectovaginal septum in women and posterior to the Denon Villiers fascia in men, extending down to the pelvic floor.

After identifying the entire pelvic floor circumference, the abdominal stage of the resection is concluded. The rectosigmoid junction is transected with an endoscopic stapler, and the pelvic peritoneum is then closed at this point. The abdominal operation proceeds with the formation of a colostomy and the insertion of drains through the existing trocar sites. The perineal surgery is carried out with the patient in the lithotomy position following the placement of a purse-string suture around the external anal sphincter. An elliptical incision is created and extended posteriorly between the coccyx and anus. Deep dissection is then performed through the ischiorectal fat, with ligation of the inferior hemorrhoidal vessels. Guided by a fingertip, the posterior dissection proceeds forward toward the coccyx after dividing the anococcygeal ligament. A connection to the pelvic cavity is identified posteriorly, followed by dissection of the levator ani muscle under direct visualization. After the specimen is freed posterolaterally, its only remaining attachment is in the anterior region. The specimen is then pulled backward to allow for anterior dissection and completion of the resection. Hemostasis is secured, drains are placed, and the perineal wound is sutured.

Three-stage surgical procedure

The steps were identical to the two-stage technique, with the addition of a third phase. After colostomy formation, pneumoperitoneum was re-established to inspect the abdominal cavity for bleeding and ensure hemostasis. A drain was then placed, and the colostomy was matured.

3.4. Variables

The researchers documented comprehensive information, including the patient's demographic characteristics, medical history (including underlying diseases and medication use), family history, and preoperative laboratory test results. Perioperative and postoperative variables included the duration of surgery, any transfusions received, length of hospital stay, occurrence of surgical site infections (SSI), bleeding complications, and rates of rehospitalization or reoperation.

3.5. Statistical Analysis

Data were matched using R software and analyzed in SPSS (version 26). Propensity score matching (PSM) was performed based on gender, history of previous abdominal surgery, ASA classification, and type of surgical procedure. Propensity scores were calculated using logistic regression. Matching variables included gender, age, and operative duration. Parametric data were reported as means; non-parametric data were reported as medians. Analyses were conducted using the χ^2 test, Fisher's exact test, Mann-Whitney U, and t-tests. A multivariate model adjusted for surgical approach, age, and gender. Results were presented as odds ratios (OR), confidence intervals (CI), and p-values.

4.Result

This study enrolled 42 patients who underwent the two-stage technique and 71 patients who underwent the three-step technique. In the two-stage group, 27 patients (64.2%) were male; in the three-stage group, 46 patients (64.7%) were male. The mean age was 63.64 ± 10.33 years in the two-stage group and 62.80 ± 12.41 years in the three-stage group. Compared with the three-stage group, the two-stage group had a significantly longer mean operative time ($p < 0.001$), a longer mean hospital stay ($p = 0.002$), a higher rate of surgical site infections ($p = 0.020$), and a higher rate of revision surgeries ($p = 0.002$). Table 1 presents baseline demographic characteristics and comorbidities before propensity score matching.

Table 1. Baseline characteristics and comorbidities of the two-stage and three-stage technique groups

Variables		Two-Stage Technique (n=42)	Three-Stage Technique (n=71)	P-value
Sex	Men	27 (64.2%)	46 (64.7%)	0.957
	Women	15 (35.7%)	25 (35.21%)	
Age(year)		63.64 ± 10.33	62.80 ± 12.41	0.849
Duration of Surgery (min)		222.18 ± 56.08	170.78 ± 29.13	<0.001*
Length of Stay (day)		9.48 ± 4.09	7.63 ± 1.30	0.002*
Revision		10 (23.8%)	3 (4.2%)	0.002*
Surgical Site Infection (n/%)		7 (16.7%)	0 (0.0%)	
Response to Neoadjuvant	Poor response	14 (33.3%)	16 (22.5%)	0.531
	Partial response	5 (11.9%)	16 (22.5%)	
	Near complete response	16 (38.1%)	23 (32.4%)	
	Complete response	7 (16.7%)	16 (22.5%)	
Pack Cell Transfusion		10 (23.8%)	16 (22.5%)	0.876
T stage	0	20 (47.6%)	28 (39.4%)	0.327
	1	4 (9.5%)	2 (2.8%)	
	2	6 (14.3%)	14 (19.7%)	
	3	12 (28.6%)	25 (35.2%)	
	4	0 (0.0%)	2 (2.8%)	
N stage	0	33 (78%)	50 (70.4%)	0.480
	1	8 (19%)	16 (22.5%)	
	2	1 (2.4%)	5 (7%)	
DM		6 (14.3%)	17 (23.9%)	0.218
HLP		4 (9.5%)	10 (14.1%)	0.477
HTN		17 (40.5%)	21 (29.6%)	0.236

Table 2 displays surgical outcomes and postoperative complications after propensity score matching for sex, age, TNM stage, and comorbidities, including hypertension (HTN), diabetes mellitus (DM), and hyperlipidemia (HLP). Data were matched using R software. The variables used for propensity score matching included gender, prior abdominal surgery, ASA classification (I–II vs. III–IV), and surgical technique. The findings indicate that the two-stage group was associated with significantly greater operative time, length of hospital stay, revision surgery rate, and surgical site infection rate compared with the three-stage group.

Table 2. Comparison of surgical outcomes between the two-stage and three-stage technique groups after adjustment for baseline characteristics and comorbidities

Variables		Two-Stage Technique (N = 32)	Three-Stage Technique (N = 32)	P-value
Sex	Men	20 (62.5%)	23 (71.8%)	0.424
	Women	12 (37.5%)	9 (28.1%)	
Age (year)		62.44 ± 11.10	61.69 ± 13.38	0.808
T stage	0	16 (50%)	16 (50%)	0.835
	1	1 (3.12%)	1 (3.12%)	
	2	6 (18.75%)	4 (12.5%)	
	3	9 (28.12%)	10 (31.25%)	
	4	0 (0.0%)	1 (3.12%)	
N stage	0	25 (78.12%)	25 (78.12%)	0.497
	1	6 (18.75%)	4 (12.5%)	
	2	1 (3.12%)	3 (9.37%)	
DM		6 (18.75%)	3 (9.37%)	0.281
HLP		3 (9.37%)	6 (18.75%)	0.281
HTN		9 (28.12%)	9 (28.12%)	1.00
Response to Neoadjuvant	Poor Response	5 (15.62%)	6 (18.75%)	0.313
	Partial Response	13 (40.62%)	8 (25%)	
	Near Complete Response	3 (9.37%)	9 (28.12%)	
	Complete Response	11 (34.37%)	9 (28.12%)	
Duration of Surgery(min)		222.18 ± 56.08	170.78 ± 29.13	<0.001*
Length of Stay(day)		9.63 ± 4.3	7.50 ± 1.07	0.009*
Revision		8 (25%)	1 (3.12%)	0.012*
Surgical site infection		5 (15.62%)	0 (0.0%)	0.020*
Pack Cell Transfusion		8 (25%)	5 (15.62%)	0.351

5. Discussion

Our literature review revealed no prior studies directly comparing immediate postoperative outcomes between two-stage and three-stage laparoscopic APR, making this study unique. We evaluated and compared clinical outcomes across groups to better understand the short-term differences between the two approaches.

Surgical innovation has historically focused on improving survival and reducing recurrence in rectal cancer. In 1826, Jacques Lisfranc performed the first successful excision of a rectal tumor. Emil Kocher introduced anus closure in 1874 to minimize spillage and infection. Carl Gaussenbauer performed the first abdominal resection in 1879, and Paul Kraske developed a perineal excision technique in 1885. Despite these advances, early surgical management was associated with high complication rates, poor functional outcomes, recurrence rates up to 80%, operative mortality rates of 20%, and three-year survival rates below 15%. (9)

A significant turning point occurred in 1908 when Sir William Ernest Miles proposed a radical resection technique to reduce local recurrence. In his landmark publication in The Lancet, he introduced the APR, which entailed en bloc removal of the rectum, pelvic colon, mesorectum, and regional lymph nodes, along with a wide perineal excision that included the anus and levator ani muscles. While the initial mortality rates remained high, recurrence dropped significantly to 29%. (10)

APR rates have declined over the past 50 years due to the acceptance of smaller distal resection margins, adoption of TME, improvements in neoadjuvant therapy, and

advancements in surgical technology. However, APR remains necessary in select cases. Patients undergoing APR face significant surgical challenges, including complex pelvic anatomy, extended operative times, and potential injury to nearby organs such as the spleen, small bowel, and pelvic structures. Rare but serious hemorrhagic complications may result from injury to the presacral venous plexus or internal iliac vessels. Minimally invasive techniques offer potential benefits; however, current evidence does not conclusively support superior oncologic outcomes. Surgeons may consider laparoscopic APR when preoperative MRI suggests favorable anatomical planes for safe resection. (8)

Among APR patients, nearly half experience a complication within the first 30 postoperative days. Common complications include anemia requiring transfusion, SSIs, and readmissions. Less frequent but notable complications include sepsis, urinary tract infections, and reoperations, occurring in approximately 5% of cases. Compared to open APR, laparoscopic APR is associated with significantly lower rates of SSIs, pneumonia, sepsis, deep vein thrombosis, pulmonary embolism, renal complications, transfusions, reintubation, and reoperation. The laparoscopic approach yields a 14% lower overall complication rate within 30 days, primarily due to reduced transfusion and SSI rates. Additionally, laparoscopic APR is associated with shorter hospital stays and fewer reoperations, with similar readmission and mortality rates between groups. (11) These improved outcomes are attributed to minimally invasive techniques, which reduce incision-related complications. Careful surgical dissection reduces the risk of pelvic infections, and early postoperative mobilization helps prevent pneumonia and thromboembolic events. (12,13) A systematic review of eight studies comparing open and laparoscopic APR confirmed a significantly lower rate of early postoperative complications in the laparoscopic group. (14)

In this study, the mean operative time for the two-stage and three-stage groups was 222.18 ± 56.08 minutes and 170.78 ± 29.13 minutes, respectively (p = 0.000). Gavrila (7) and Zixing Zhu (15) reported mean operative times of 191 ± 38 minutes and 209.6 ± 66 minutes, respectively. The SSI rate in our two-stage group was seven patients (16.7%), compared to 0% in the three-stage group. After adjustment for comorbidities, the SSI rate in the two-stage group was five patients (15.62%) (p = 0.020). In comparison, previous studies reported SSI rates of 5.5% (7), 15.5% (11), and 0.3% (15).

We also compared packed cell transfusion rates between groups. In the two-stage group, 10 patients (23.8%) required transfusion, compared with 16 patients (22.5%) in the three-stage group (p = 0.876). After adjusting for patient characteristics and comorbidities, eight patients (25%) in the two-stage group and five patients (15.62%) in the three-stage group required transfusion (p = 0.351). These findings suggest no significant difference in blood loss between the two approaches. In contrast, Tooley (11) and Zhu (15) reported transfusion rates of 10.7% and 2.4%, respectively.

Revision surgery was required in 10 patients (23.8%) in the two-stage group and three patients (4.2%) in the three-stage group (p = 0.002). After adjustment, eight patients (25%) in the two-stage group and one patient (3.12%) in the three-stage group underwent reoperation (p = 0.012). These rates are higher than those reported by Tooley (5.9%), Zixing Zhu (3.3%), and Gavrila (3.17%). (11,15,7).

5.1. Study Limitations

This study was conducted at a single institution using consistent facilities; however, two surgeons performed the procedures in each group, which may have introduced operator-dependent variability. Additionally, this study focused on short-term outcomes. Long-term outcomes, including disease-free

survival, overall survival, and quality of life, remain to be evaluated in future research.

6. Conclusion

The three-stage approach to APR may offer improved short-term surgical outcomes compared to the two-stage technique. However, larger, multicenter studies are needed to validate these findings and assess long-term oncologic and functional results.

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