

Original Article

Surgical Outcomes of Minimally Invasive Abdominoperineal Resection for Distal Rectal Cancer: A Single-center Retrospective Analysis

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Key Words

Low rectal cancer;

Minimally invasive surgery;

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Surgical complication

Purpose. Colorectal cancer ranks as the third most common cancer and the second leading cause of cancer-related deaths globally. Despite the decline in abdominoperineal resection frequency due to advancements in neoadjuvant chemoradiation and minimally invasive techniques, it remains vital for certain lower rectal cancers. In this study, we aim to conduct a rigorous single-center retrospective analysis of oncologic outcomes following MIS APR for colorectal cancer.

Methods. A retrospective study was conducted at the National Taiwan University Hospital's Coloproctology Unit, focusing on patients who underwent minimally invasive surgery abdominoperineal resection for low rectal adenocarcinoma between February 2006 and June 2021. The study analyzed data including patient demographics, tumor characteristics, operative details, postoperative outcomes, and pathology reports, aiming to evaluate the safety, efficacy, and oncologic outcomes.

Results. The study enrolled 49 patients, with 36 undergoing laparoscopic and 13 robotic procedures. No significant differences were observed in blood loss, operative time, or hospital stay between the two groups. The robotic group had a higher rate of lateral lymph node dissection. Postoperative complications were more common in the robotic group, but severe complications (Clavien-Dindo Grade III) were low in both groups, indicating safety. Pathology reports showed negative margins and comparable lymph node examination results in both groups. The one-year disease-free survival rates were 75.0% for the laparoscopic group and 80.0% for the robotic group.

Conclusion. Minimally invasive surgery abdominoperineal resection, whether laparoscopic or robotic, is a safe and effective approach for rectal cancer, achieving satisfactory oncological outcomes with comparable short-term results.

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Colorectal cancer is a significant health issue, ranking as the third most common cancer and the second leading cause of cancer-related mortality worldwide. Surgical resection remains the curative treat-

ment for this malignancy, aiming to completely remove the tumor while preserving bowel function and quality of life. In case of low rectal cancer, there are several procedure options, including local excision,

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total mesorectal excision (TME) with sphincter preservation, and with abdominoperineal resection (APR). In the past, traditional open APR was recommended for tumors located less than 5 cm above the anal verge or when there was suspicion of invasion into local structures such as the external sphincter.

Over the past few decades, advances in surgical techniques have revolutionized the field of colorectal surgery. The introduction of minimally invasive surgery (MIS) and the increasing use of neoadjuvant chemoradiation therapy for eligible patients,¹ have led to a gradual rise in the implementation of sphincter-preserving surgery. However, certain indications, including an inability to ensure clear negative distal resection margins with a sphincter-preserving operation, tumor involvement in the anal sphincters, and poor sphincter function, make it necessary to perform an APR. As a result, this procedure remains an appropriate option for about 30% of patients with low rectal cancers.^{2,3}

Minimally invasive surgical approaches, including laparoscopic and robotic-assisted surgery, have been demonstrated to be feasible and safe with numerous advantages over traditional open surgery, such as reduced postoperative pain, shorter hospital stays, quicker recovery times, and improved cosmetic outcomes.^{4,5} The oncological noninferiority of minimally invasive surgery to open surgery for rectal cancer has also been confirmed by several well-designed studies.⁵⁻⁷ Consequently, MIS has become the preferred approach for many colorectal procedures, including APR.

In this study, we aimed to conduct a rigorous single-center retrospective analysis of oncologic outcomes following MIS APR for colorectal cancer. By focusing on a homogeneous patient cohort treated at our institution, we intended to provide a nuanced understanding of the safety, efficacy, and oncologic outcomes of MIS APR.

Materials and Methods

A retrospective study was conducted at the Colorectal Unit of National Taiwan University Hos-

pital, focusing on patients who underwent elective MIS APR for low rectal adenocarcinoma (defined as a tumor located less than or equal to 5 cm above the anal verge, as determined through colonofibroscope) between February 2006 and June 2021. The surgeries were performed by a single surgeon. Patients with other malignancies and those who underwent palliative surgery were excluded from the study.

The criteria for opting for MIS APR included suspected cancer involvement of the sphincter as indicated by preoperative imaging, cases where a sphincter-preserving procedure could not achieve adequate margins, and elderly patients with anticipated poor postoperative sphincter function. Some patients underwent lateral lymph node dissection if preoperative imaging indicated lower rectal cancer with metastasis to the lateral lymph nodes. After surgery, all patients followed a routine check-up schedule: first, at 2 weeks, then every 3 months in the first year, every 6 months in the second year, and annually thereafter. Adjuvant chemoradiation, guided by the NCCN guidelines for rectal cancer treatment based on TNM staging, was administered when necessary.

The collected preoperative data included age, sex, tumor location relative to the anal verge, preoperative tumor stage, and neoadjuvant treatment details. Intraoperative data encompassed the surgical approach, number of patients who underwent lateral lymph node dissection, operative duration, and estimated blood loss (EBL). Postoperative data collection included details of adjuvant chemotherapy, 30-day morbidity and mortality rates, and length of hospital stay (LOS). Surgical pathology reports were reviewed for standard oncological metrics, including margins (distal, proximal, circumferential), number of lymph nodes examined, perineural invasion, and lymphovascular invasion. Other oncological outcomes assessed were local and distant recurrence rates, time to recurrence, overall survival data, and disease-free survival rates.

Data analysis was conducted using the SPSS statistical package (version 23). Continuous variables were compared using the Student's *t*-test, while the χ^2 test or Fisher's exact test was used to compare proportions between groups, as appropriate. Disease-free survival differences were evaluated using the log-rank

test, and survival curves were generated using the Kaplan-Meier method. A two-sided p -value of less than 0.05 was deemed to indicate a statistically significant difference.

Results

During the study period, a total of 49 patients were enrolled. Among them, 36 underwent laparoscopic procedures, while 13 underwent robotic procedures. There was no conversion to open surgery. The demographics and preoperative evaluations of these patients are detailed in Table 1. Notably, the number of male patients was significantly lower in the laparoscopic group compared to the robotic group (38.9% vs. 75.0%, $p = 0.032$). The average ages in the laparoscopic and robotic groups were 65.8 and 60.3 years,

respectively ($p = 0.269$). The average distance from the primary tumor to the anal verge was 2.2 cm in the laparoscopic group and 2.0 cm in the robotic group ($p = 0.690$).

Regarding advanced disease, neoadjuvant therapy was administered to 26 patients in total (54.2%), including 18 patients (50%) from the laparoscopic group and 8 patients (61.5%) from the robotic group ($p = 0.505$). After undergoing neoadjuvant chemotherapy, 7 patients exhibited complete remission, 7 showed a decrease in disease stage, 2 experienced disease progression, and the rest of the patients maintained the same disease stage.

Operative and post-operative data are outlined in Table 2. The data showed a significantly higher rate of lateral node dissection in robotic group due to advanced tumor stages (2.8% vs. 25.0%; $p = 0.016$). The laparoscopic group experienced greater intraoperative

Table 1. Patients' demographics

Variable	Total (n = 48)	Laparoscopic (n = 36)	Robotic (n = 12)	p value
Sex: male, n (%)	23 (47.9%)	14 (38.9%)	9 (75.0%)	0.032
Age, mean \pm SD	64.4 \pm 12.7	65.8 \pm 11.6	60.3 \pm 15.2	0.269
Tumor distance from AV, cm: mean \pm SD	2.2 \pm 1.5	2.2 \pm 1.5	2.0 \pm 1.4	0.690
Neoadjuvant concurrent chemoradiotherapy, n (%)	26 (54.2%)	18 (50%)	8 (66.7%)	0.505
Pretreatment stage, n (%)				0.646
Stage I	9 (18.8%)	8 (22.2%)	1 (8.3%)	
Stage II	9 (18.8%)	6 (16.7%)	3 (25.0%)	
Stage III	24 (50.0%)	17 (47.2%)	7 (58.3%)	
Stage IV	6 (12.5%)	5 (13.8%)	1 (8.3%)	

Table 2. Operative and post-operative data

Variable	Total (n = 48)	Laparoscopic (n = 36)	Robotic (n = 12)	p value
Lateral node dissection, n (%)	4 (8.3%)	1 (2.8%)	3 (25.0%)	0.016
Estimated blood loss, mL: mean \pm SD	159 \pm 110	170.3 \pm 123.1	125.0 \pm 50	0.078
Operative time, min: mean \pm SD	315.2 \pm 77.9	311.3 \pm 68.5	327.1 \pm 103	0.629
Length of hospital stay, d: mean \pm SD	16.3 \pm 8.8	17.8 \pm 12.9	15.8 \pm 7.1	0.513
Adjuvant chemotherapy, n (%)	35 (72.9%)	29 (80.6%)	6 (50.0%)	0.061
30-day complication	26 (54.2%)	16 (44.4%)	10 (83.3%)	0.019
Intra-abdominal/pelvic abscess	3 (6.3%)	3 (8.3%)	0	0.302
Perineal wound infection	3 (6.3%)	1 (2.8%)	2 (16.7%)	0.085
Perineal hernia	1 (2.1%)	0	1 (8.3%)	0.08
Abdominal wound infection	1 (2.1%)	0	1 (8.3%)	0.08
Postoperative ileus	1 (2.1%)	0	1 (8.3%)	0.08
UTI	3 (6.3%)	3 (8.3%)	0	0.302
Urinary retention	17 (35.4%)	11 (30.6%)	5 (41.7%)	0.48
Stoma complications	1 (2.1%)	1 (2.8%)	0	0.56

blood loss, and the robotic group had a slightly longer operative time; however, neither of these differences reached statistical significance. The length of hospital stay was similar in both groups (17.8 ± 12.9 days for the laparoscopic group vs. 15.8 ± 7.1 days for the robotic group; $p = 0.513$). A higher percentage of patients in the laparoscopic group (80.6%) received adjuvant chemotherapy compared to the robotic group (50.0%), but this difference was not statistically significant ($p = 0.061$).

Postoperative complications were more common in the robotic group, with 16 patients (44.4%) in the laparoscopic group and 10 patients (83.3%) in the robotic group experiencing complications ($p = 0.019$). Specific complications included the following:

- In the laparoscopic group, 3 patients developed intraabdominal or pelvic abscesses requiring drainage, 1 patient had a perineal wound infection, 3 patients suffered from urinary tract infections, 11 experienced urinary retention, and 1 had a stoma infection.
- In the robotic group, 2 patients encountered perineal wound infections, 1 had perineal wound hernia, 1 had an abdominal wound infection, 1 experienced postoperative ileus which resolved with conservative treatment, and 5 suffered from urinary retention.

The pathology reports are summarized in Table 3. Microscopic examination confirmed negative circumferential, distal, and proximal margins in all cases included in the study. The number of lymph nodes examined, instances of perineural invasion, and occurrences of lymphovascular invasion were found to be comparable between the laparoscopic and robotic groups.

The median follow-up period for this study was 65 months, with a range of 2 to 187 months. Both the laparoscopic and robotic groups had a one-year overall survival rate of 100%. The one-year disease-free survival rates (Fig. 1) were 75.0% for the laparoscopic group and 80.0% for the robotic group, although this difference was not statistically significant ($p = 0.784$). The patterns of disease recurrence were similar between the groups, with most recurrences being distant (88.2% in the laparoscopic group vs. 66.7% in the robotic group; $p = 0.562$). The overall local recurrence rate was 6.5% during the study period, with 2 cases in the laparoscopic group and 1 case in the robotic group.

Overall, during the first year of postoperative follow-up, the recurrent cases were as follows. Two patients in the laparoscopic group and one patient in the robotic group were diagnosed with local recurrence. Two patients in the laparoscopic group developed both liver and lung metastases. In addition, three patients in the laparoscopic group developed liver metastases, and one patient had lung metastases.

Discussion

Laparoscopic surgery, which has been used for colorectal operations for over two decades, has been increasingly supplemented by robotic systems in recent years. These minimally invasive methods have been demonstrated to be safe, feasible, and effective for rectal cancer treatment.⁸ Despite a gradual decline in the frequency of abdominoperineal resections due to advances in neoadjuvant concurrent chemoradiation therapy and minimally invasive techniques, it remains a standard treatment for certain lower rectal cancers. Research indicates that a significant number

Table 3. Pathology results

Variable	Total (n = 48)	Laparoscopic (n = 36)	Robotic (n = 12)	<i>p</i> value
Involved distal margin, n (%)	0	0	0	Nonsignificant
Involved proximal margin, n (%)	0	0	0	Nonsignificant
Involved circumferential radial margin, n (%)	0	0	0	Nonsignificant
Examined node: mean \pm SD	15.5 ± 10.7	16.2 ± 12.1	13 ± 4.8	0.243
Perineural invasion, n (%)	18 (37.5%)	15 (41.7%)	3 (25.0%)	0.302
Lymphovascular invasion, n (%)	18 (37.5%)	14 (38.9%)	4 (33.3%)	0.731

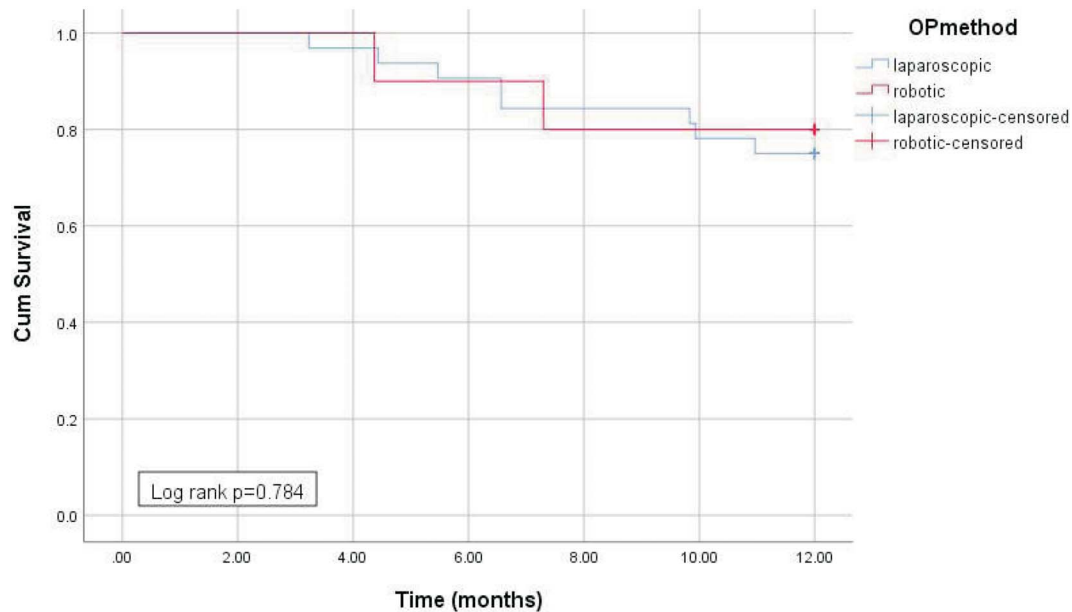


Fig. 1. One-year disease-free survival rates.

of patients prefer abdominoperineal resection over sphincter preservation due to functional impairments associated with the latter.⁹⁻¹¹ Therefore, the oncological outcomes of abdominoperineal resection continue to be a critical topic. Previous studies have shown that both laparoscopic and robotic abdominoperineal resections are safe, offering shorter hospital stays and a reduced risk of surgical wound infections compared to open surgery. Moreover, these minimally invasive surgeries yield similar oncological outcomes in terms of technical quality and long-term effectiveness as open surgery.^{6,12}

However, literature comparing laparoscopic abdominoperineal resection and robotic procedure is limited, especially in Taiwan.^{13,14} Some reports have expressed concerns about the incidence of positive circumferential resection margins in robotic surgeries, with rates as high as 13.6%, which raises doubts about their oncological efficacy.^{15,16} Our study aimed to shed light on the oncological outcomes of these two methods, while also evaluating their safety and pathological results.

In this study, we compared two groups of patients who underwent abdominoperineal resection through either laparoscopic or robotic procedures. These groups, which had similar characteristics, showed no significant differences in estimated blood loss, operative

time, or length of hospital stay. A noteworthy finding was the higher rate of lateral lymph node dissection in the robotic group, with about one-quarter of these patients undergoing the procedure. While previous studies have established the feasibility of laparoscopic lateral pelvic lymph node dissection,¹⁷ the challenging location and complex vascular structure of lateral lymph nodes make robotic surgery more advantageous due to its improved surgical view and better exposure. This advantage likely aids in overcoming the technical challenges associated with lateral lymph node dissection in the robotic group, contributing to the successful completion of the procedure.¹⁸ Regarding post-operative 30-day complications, it was noted that the robotic group experienced a higher complication rate. This increase could be explained by two primary reasons. First, the robotic group was subject to more comprehensive dissection plans, potentially increasing the risk of complications. Second, the laparoscopic group's surgeries span a more extended period in this study, beginning with the earliest procedure in 2006, compared to the first robotic surgery in 2012. This discrepancy in timelines suggests the possibility of missing data, which could impact the accuracy of the findings for the laparoscopic group. Overall, the robotic group experienced complications in 10 patients, but only 2 needed surgical debridement for perineal wound

dehiscence. Meanwhile, in the laparoscopic group, only one patient with a pelvic abscess required percutaneous drainage. Considering the low rate of Clavien-Dindo Grade III complications, both laparoscopic and robotic surgical approaches are deemed safe.

Our study demonstrated satisfactory pathological and oncological outcomes. All patients who underwent curative abdominoperineal resection achieved negative distal, proximal, and circumferential margins. The average number of dissected lymph nodes exceeded 12, indicating satisfactory surgical quality. However, few cases fell short of achieving the desired lymph node harvest, mostly among patients who underwent neoadjuvant concurrent chemoradiation therapy. This treatment can reduce the number of lymph nodes found in mesorectal specimens.¹⁹ All cases with fewer than 12 harvested lymph nodes occurred before 2016, a period when the recommended number of lymph nodes to be retrieved post-neoadjuvant therapy was still under debate.

The mean follow-up duration was 66 months, with the laparoscopic group having a longer follow-up than the robotic group, although this difference was not statistically significant (72.1 vs. 46.9 months; $p = 0.080$). We evaluated the one-year disease-free and overall survival rates, with no patient deaths recorded during this period. The one-year disease-free survival rates were 75.0% for the laparoscopic group and 80.0% for the robotic group. Most of the recurrent cases were distant metastasis. Our low local recurrence rate can be attributed to the complete resection of tumor and the achievement of a negative circumferential margin.

In recent years, there has been a global increase in the utilization of robotic surgery for treating rectal cancer. Robotic surgery offers several advantages compared to traditional laparoscopic methods, including the use of precise, multi-joint forceps and enhanced three-dimensional imaging. While research on long-term outcomes remains limited, studies conducted by Kim et al. have indicated that robotic surgery has a positive impact on both overall and cancer-specific survival rates.²⁰ Additionally, Yamaguchi et al. have found that robotic surgery is associated with a reduced rate of local recurrence.²¹ These findings suggest that robotic surgery not only enhances the safety of rectal

cancer operations but also improves patient prognosis.

However, the majority of these studies have concentrated on sphincter-preserving procedures. Our study contributes to this field by providing a single-center experience of performing abdominoperineal resection through minimally invasive techniques, either laparoscopic or robotic. Although our results do not show a marked advantage of robotic abdominoperineal surgery over laparoscopic approaches, factors such as the shorter learning curve, relatively low rate of Grade III complications, and promising short-term oncological outcomes in line aligned with established laparoscopic techniques, confirm the viability of robotic surgery as a favorable option for abdominoperineal resection.

Limitation

Our study has several limitations that should be considered. Firstly, it was retrospective in nature, involving consecutive cases managed by a single surgeon, which could introduce a degree of bias. Additionally, the limited duration and sample size, particularly in the robotic group, suggest that our findings may not fully represent reliable oncological outcomes. Last, given that the study spans over 20 years, changes in treatment guidelines and pathological reporting over time could potentially influence oncological outcomes.

Conclusion

In conclusion, this study underscores the safety and efficacy of both laparoscopic and robotic abdominoperineal resections for treating rectal cancer. Both procedures ensure satisfactory oncological outcomes, with negative distal, proximal, and circumferential margins. The higher rate of lateral lymph node dissections observed in the robotic group, without significant differences in estimated blood loss, operative time, and hospital stay, indicates a potential advantage in complex dissections. Importantly, the low rate of severe post-operative complications confirms the safety of these minimally invasive techniques. Our data,

which shows comparable one-year disease-free survival rates for both procedures, suggests that laparoscopic and robotic approaches are viable and effective options for patients requiring abdominoperineal resection, with the added benefits of minimally invasive surgery.

Conflicts of Interests

The authors declare no conflicts of interests.

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原 著

微創腹會陰切除術治療下段直腸癌的手術結果： 單中心回顧性分析

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目的 探討低位直腸癌接受微創腹會陰聯合切除手術之結果進行單中心回顧性分析。

方法 本回溯性研究分析 2006 年至 2021 年診斷為低位直腸癌並接受微創腹會陰聯合切除手術後之結果。旨在評估手術的安全性、有效性和預後。

結果 共納入 49 名患者：36 人接受腹腔鏡手術，13 人接受機器手臂手術。機器手臂組的骨盆腔側壁淋巴結清除術施行率更高，暗示其有更佳的手術視野與更自由的器械靈活度所帶來的優點。兩組的嚴重併發症發生率皆低且無顯著差異，表明微創腹會陰聯合切除手術之安全性。腹腔鏡組和機器手臂組的一年無病生存率分別為 75.0% 和 80.0%。

結論 微創腹會陰聯合切除手術是治療低位直腸癌的一種安全有效的方法。

關鍵詞 低位直腸癌手術、微創手術、手術結果、術後併發症。