의 학 석 사 학 위 논 문

로봇 직장절제술에서 문합부 누출과 항문내압과의 연관성에 대한 고찰

The Impact of Elevated Anal Sphincteric Tone on Anastomotic Leakage in Robotic Rectal Resection

울산대학교 대학원

의학과

김언빈

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지 도 교 수 윤 용 식

이 논문을 의학 석사학위 논문으로 제출함

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울산대학교 대학원

의학과

김언빈

김언빈의 의학 석사학위 논문을 인준함

심사위원 김 찬 욱 인

심사위원 윤 용 식 인

심사위원 이 종 률 인

울 산 대 학 교 대 학 원

2024년 2월

목 차

Abstract

Since the introduction of total mesorectal excision (TME) in 1982, surgical approaches for low rectal cancer have evolved, leading to reduced recurrence rates and improved survival. However, despite these advancements, anastomosis leakage remains a significant postoperative complication with incidence rates ranging from 2.5% to 21%. This study aims to explore the correlation between preoperative manometry results and surgical outcomes, particularly focusing on anastomosis leakage in robotic surgery.

Clinical data of patients who underwent robot-assisted low anterior resection or ultra-low anterior resection for rectal cancer at Asan Medical Center from April 2014 to July 2022 were reviewed. Patient demographics, postoperative outcomes, including anastomosis leakage, and preoperative anorectal manometry, focusing on maximum resting pressure (MRP) and maximum squeezing pressure (MSP) data, was analyzed.

Of the 248 patients analyzed, complications were observed in 42 patients (16.9%), with anastomosis stricture being the most common. Anastomosis leakage occurred in 10 cases, necessitating additional surgical interventions. The MRP in patients with and without leakage had shown no significant differences (p=0.297), while MSP showed significant differences (p=0.036). MRP exceeding the upper limit of 70 mmHg showed significant differences in anastomosis leakage(p=0.045). Rectal compliance (RC) in patients with and without leakage also showed significant differences (p=0.030). MRP over the upper limit of 70 mmHg, MSP over 224 mmHg, or RC over 2.25 mL/mmHg may have an impact on anastomosis leakage based on receiver operating characteristic (ROC) curve analysis.

In planning robotic surgery for rectal tumor, the results of anorectal manometry may help operator to decide whether to create ileostomy to reduce the risks regarding anastomosis leakage.

Introduction

Since Dr. Heald introduced the concept of total mesorectal excision (TME) in 1982, the surgical approach to low rectal cancer has evolved, demonstrating significant reductions in local recurrence rates and improved survival outcomes.[1] This groundbreaking technique has since become the gold standard for rectal surgery to fully evaluate the final pathologic stage of rectal cancer including sufficient lymph nodes into staging.[2]

The challenges posed by the confined pelvic surgical space have been progressively addressed with the evolution from open surgery to laparoscopic procedures, and further to robotic surgeries, providing safe and feasible outcomes.[3-7] Particularly when working in a small space like the male pelvic cavity, robot-assisted surgery is gaining popularity due to its many benefits.[8] Improved dexterity, less tremors, and an enlarged three-dimensional perspective are some other benefits of robot-assisted surgery.[9, 10]

The frequency of postoperative morbidity, such as anastomosis leakage and other surgical site infections, is higher in patients with rectal surgery.[11, 12] These infections can need reoperation and ultimately result in postoperative mortality. A significant proportion of patients experience permanent stoma, low anterior syndrome, bowel and bladder problems, and sexual dysfunction, all of which have an impact on their long-term quality of life.[13, 14]

Especially, anastomosis leakage has been one of the most significant postoperative complications.[15, 16] It is alarming that despite the progression in surgical techniques and an accumulation of experience over time, the reported incidence rates for anastomosis leakage still range widely, from 2.5% to as high as 21%.[17-19] Not only can this complication lead to increased morbidity and mortality on its own, but it also has been linked to a higher rate of local recurrence, which has detrimental effects on the oncologic outcomes.[20-22] Many surgeons decide to simultaneously perform a preventive ileostomy during rectal cancer surgery to reduce the dangers associated with leaks.[23] Preoperative assessments are crucial for determining whether to apply an ileostomy and for identifying probable causes of leaking. This led to development in series of

classification system for anastomosis leakage severity and appropriate management plans.[12]

Anorectal manometry has been extensively studied as a tool to measure functional outcomes of rectal surgery, such as low anterior resection syndrome. [24] Also, the examination is widely used to evaluate other anorectal disease, from perineal descent, rectal intussusception, and rectal prolapse, and so on.[25] Its potential as a predictive tool for surgical outcomes, however, particularly anastomosis leakage, remains largely unexplored.[26, 27]

To date, there has been almost no study connecting manometry with the results of robotic surgery. In this study, we aim to analyze the correlation between preoperative manometry results and surgical outcomes, focusing on the incidence of anastomosis leakage.

Methods

Patients

We conducted a retrospective review of medical records for rectal cancer patients who underwent robot-assisted surgery by a single surgeon, Y. S. Yoon, from January 2012 to December 2022 in Asan Medical Center (Seoul, South Korea). Among 324 patients who underwent robot-assisted rectal surgery, surgery without colon and remnant rectal anastomosis, such as abdominoperineal resection (n=18), total proctocolectomy with ileal pouch anal anastomosis, and ultra-low anterior resection with coloanal anastomosis (n=24) were excluded. Although 260 patients had robot-assisted rectal surgery with colon and rectal anastomosis, patients who did not undergo preoperative manometry (n=12) were excluded from the study. A total of 248 patients were included in the study and among 248 patients, 237 patients did not have anastomosis leakage and 11 patients occurred anastomosis leakage. (Figure 1)

Clinical information

Data included patient demographics including age, sex, diabetes mellitus (DM), hypertension (HTN), body mass index (BMI); tumor characteristics including tumor diagnosis, tumor height (distance from anal verge), treatment (preoperative chemoradiation therapy, adjuvant chemotherapy) and TNM stage based on the American Joint Committee on Cancer classification(AJCC), 8th edition;[2] operative details with operation type, ileostomy/colostomy formation. Surgical outcome included recurrence, local or distant; and postoperative complication, which was defined as morbidity occurred after surgery, were categorized into immediate postoperative complication and late complication. The criterion for this division was based on 90 postoperative days. Anastomosis leakage was defined as the presence of clinical signs indicating peritonitis, such as fever, elevated inflammatory markers, and signs of peritoneal irrigation. The presence of fecal matter observed through the surgical drain or the detection of abnormal fluid accumulation in the pelvis as seen on a computed tomographic scan is also defined as an anastomotic leakage.

Anorectal manometry

The examination was conducted using a Microcapillary Infusion System (J.S. Biomedicals INC., USA) with a distilled water micro-infusion method. The pressure-measuring catheter inserted into the anus was a conduit with eight radial pressure measuring channels, located 5 cm from the end. The conduit had a diameter of 5 mm, and pressure was measured by infusing distilled water at a constant rate (0.5 mL/channel/min) through the eight pressure-measuring channels. (Figure 2) The measured pressures were automatically inputted into a computer and analyzed using LGI Polygram software (Synetics Liberty System, USA). This software calculated and outputted anal sphincter pressure indicators such as vector volume, maximal pressure, mean pressure, and sphincter length indicators like sphincter length, high pressure zone length (HPZL), and maximal pressure position. The changes in pressure were also displayed graphically on the screen. For the rapid pull-through test, a catheter fixation device capable of traction at a constant speed (1 cm/sec) was used. Additionally, a balloon was attached to the end of another conduit of the same diameter with eight spiral channels. (Figure 3) This setup was used to measure rectal volume indicators such as minimal sensory volume and maximal tolerance volume while inflating the balloon in the lower rectum. The minimum volume at which the rectoanal inhibitory reflex occurred was also measured.

The examination process began by operating the micro-infusion device with distilled water and calibrating the equipment's zero point. The patient was then positioned in the left lateral decubitus position, and a zero-point adjustment was made relative to the height of the patient's anus. After applying sufficient examination gel to the catheter, it was gently inserted into the anus, ensuring that the pressure measurement channels were positioned 6 cm above the anal verge. The examination commenced once the pressure inside the rectum stabilized on the screen. The catheter was fixed to a device capable of continuous traction and the sphincter pressures during resting and contracting phases were alternately measured three times each at a speed of 1 cm/sec. Maximum resting pressure (MRP) was calculated by maximum pressure in the anal canal at rest. Maximum squeeze pressure (MSP) was determined by calculating the difference between intrarectal pressure and the peak pressure recorded at any point in the anal canal during a squeeze maneuver.

To calculate the MSP, the average of the highest pressure recorded at any location within theanal canal across two squeeze attempts is taken into consideration.

After the rapid pull-through test, the catheter was reinserted to position the pressure measuring channels 6 cm above the anal verge. Station pull-through tests were then conducted by traction at 1 cm intervals, measuring the pressures in both contraction and resting phases at each point. A balloon was attached to the end of a spiral channel-equipped catheter and positioned so that the pressure-measuring channels straddled the anal canal. The balloon was inflated with 10 mL of air, gradually increasing by 60 mL, and the patient was asked if they felt rectal fullness. The minimal volume at which this sensation was perceived was recorded as the minimal sensory volume. Rectal compliance (RC) was assessed using the data from intermittent rectal balloon distensions. When the rectum was distended with a balloon, there was an initial rise in intra-balloon (rectal) pressure due to air injection, followed by a gradual decrease to a stable pressure level as the rectum adjusts to the added volume.to ensure accuracy, the steady state of rectal pressure must be adjusted by substracting the pressure measured during the balloon's inflation in the open air. RC was then determined by charting the correlation between the change in balloon volume (dV) and the change in steady state intrarectal pressure (dP). This gives the rectal compliance value in mL/mmHg.

Manometry test was performed preoperatively; when patients received PCRT, the test was done between PCRT and surgery. HPZL, MRP, MSP, and RC data were collected in every patient. According to literature based on a healthy population, the normal ranges are: HPZL 2.5-3.5 cm for males and 2.0-3.0 cm for females; MRP 40-70 mmHg; MSP 100-180 mmHg; and RC 2-6 ml/mmHg.[28] We analyzed the MRP and MSP data by categorizing them into within upper limit of the normal range. For MRP, the thresholds for these categories were set at 70 mmHg, and for MSP, the categorization thresholds were 180mmHg.

Statistical analysis

Pearson's chi-square test or Fisher's exact test with two-sided verification was employed for categorical variables. For continuous variables, a Student's t-test was used. Independent risk factors for anastomosis

leakage were evaluated using multivariate stepwise logistic regression analysis. A two-sided p-value of less than 0.05 was considered statistically significant. Diagnostic performances were evaluated using receiver operating characteristic (ROC) curves and area under the curve (AUC) (with indicating threshold values). The maximum value of AUC was 1.0, indicating a perfect classifier, whereas 0.5 indicated a random chance with the model. Statistical analyses were conducted using SPSS version 21.0 (IBM, Armonk, NY) and STATA/se version 15.1 (StataCorp LP, College Station, TX).

This study was approved by the Institutional Review Board of Asan Medical Center (IRB no. 2023-1214).

Results

Clinicopathologic characteristics

We analyzed 248 patients within the study period. The patients were predominantly male, with a mean age of 57.9, a mean BMI of 24.4, DM and HTN patients were 41 (16.5%) and 87 (35.1%), consecutively. The tumors were diagnosed mostly as adenocarcinoma, and we had 7 cases of neuroendocrine tumor (NET). The mean distance of the tumor from anal verge was 5.6 cm. Patients who had received preoperative neoadjuvant chemoradiation therapy was 111 (44.8%), and who had received robot assisted low anterior resection was 95 (38.3%). (Table 1) Based on AJCC 8th edition TNM staging, the number of patients of was 20 (8%) for stage 0, 95 (38.3%) for stage I, 49 (19.8%) for stage II, and 84 (33.9%) for stage III.

The details of surgical outcome are shown in Table 2. Among the 22 patients (8.9%) had recurred tumor after surgery, most of them were distant recurrence (86.4%). Complications were observed in 42 patients (16.9%), of which 14 (5.6%) had immediate postoperative complications and 28 (11.3%) had late complications. Anastomotic leakage was the most common immediate postoperative complication, occurring in 10 cases. Of these, 8 patients required additional surgery, such as ileostomy or colostomy. Fortunately, all 8 patients recovered from the leakage without experiencing major complications like septic shock and successfully underwent stoma closure without any further leakage. The remaining 2 patients already had an ileostomy from their initial rectal surgery, due to preoperative chemoradiotherapy. One patient proceeded with a scheduled takedown after completing chemotherapy. This decision was supported by an immediate postoperative abdominal CT scan, which initially revealed a small abscess cavity that was later not visible in the follow-up CT scan after chemotherapy completion. The other patient exhibited prominent signs of anastomotic leakage on both the immediate postoperative abdominal CT scan and colon study. After 14 months of continuous monitoring and repeated testing, which showed no leakage evidence, the takedown was successfully carried out. The most common late complication was anastomosis stricture, which was dilated by Hegar or endoscopic balloon and cured without additional surgical procedure. There was no mortality within 90 postoperative days. The median follow-up was 39 months.

Anastomosis leakage

We attempted to identify factors before rectal surgery that predicted the anastomosis leakage. Patients without leakage had MRP of 53.7 ± 18.4 mmHg, whereas those with leakage had a mean of 59.6 ± 19.5 mmHg. There was no significant difference in MRP between the groups (p=0.297). However, a significant difference was observed in the category of MRP greater than the upper normal limit of 70 mmHg. (p = 0.045). MSP was 191.6 ± 64.5 mmHg in the no leakage group and 234.1 ± 82.0 mmHg in the leakage group, showing a statistically significant difference (p=0.036). MSP greater than the upper normal limit of 180 mmHg did not show significant difference. (p = 0.527). There was other significant variable in univariate analysis, including RC (p = 0.030), but some factors like adjuvant chemotherapy, recurrence, and operation type did not show statistically significant differences between the two groups. (Table 3) In ROC curve analysis, the area under the curve (AUC) was found to be 0.578 for MRP, 0.628 for MSP, and 0.662 for RC. The threshold for MRP was 71.45 mmHg with sensitivity 0.4, specificity 0.857, threshold for MSP was 224.15 mmHg with sensitivity 0.6, specificity 0.693, and threshold for RC was 2.25 mL/mmHg with sensitivity 0.4, specificity 0.870. (Figure 4)

Discussion

We identified that that parameters related to anorectal function were included in the analysis of anastomosis leakage after robotic low rectal surgery. Preoperative MRP above upper limit or MSP above 224 mmHg, RC above 2.25 mL/mmHg had correlation with anastomosis leakage.

Clinically significant anastomosis leakage is a major postoperative risk for patients undergoing rectal cancer surgery, often threatening their lives. The CT scans are commonly used for diagnosis, along with the contrast enemas, endoscopic evaluations, reoperations, and the identification of additional postoperative complications.[29] Clinically significant anastomosis leakage typically manifests between the third and fifth days following laparoscopic surgery for rectal cancer. Smaller leakages may often be managed conservatively with fasting water, nutritional support, anti-inflammatory treatments, and fluid replacements. In contrast, severe leakages necessitate surgical intervention.[30] Research on anastomotic leakage has predominantly centered on the role of protective ileostomy in reducing its occurrence, with minor leakage often going undetected in these studies. [31]

Extensive research has been conducted on the risk factors associated with anastomotic leakage. While it is challenging to pinpoint a specific pathophysiological reason for each risk factor due to the multifactorial nature of anastomosis leakage, certain factors are noteworthy. For instance, the relatively smaller pelvis may pose technical challenges during surgery.[32, 33] The risk of leakage may also be higher in low rectal anastomosis, possibly due to inadequate microvascular supply in the lower portion of the rectum.[34] Additionally, complex local pelvic anatomy can make anastomosis more difficult to execute, potentially leading to higher leakage rates.[33] Patients with higher ASA classifications might be a greater risk of CAL, especially if they have comorbidities, such as cardiovascular or pulmonary conditions that affect tissue perfusion and oxygenation. The use of steroids could compromise anastomotic healing, thereby increasing leakage risk[35] Furthermore, preoperative radiotherapy, which often leads to local inflammation and tissue fibrosis, may hinder wound healing and increase the likelihood of anastomosis leakage.[36] Although advanced age, diabetes mellitus (DM), and hypertension (HTN) are also well-known patient factors, [37, 38]

our study could not find their statistical significance. Interestingly, another study reported leakage only in males, [39] which was also observed in our research. However, we couldn't determine its statistical significance. The reason might be the overwhelming number of males in the non-leakage group and the small number of patients in the leakage group, influencing the findings.

Research has previously examined surgical outcomes in correlation with anorectal manometry. Hallbook O. et al. compared matched 19 patients with and without leakage according to age, sex, height of anastomosis. They found that patients with anastomosis leakage had reduction in 'neorectal' reservoir function which was reflected in impaired anorectal manometry measurements after the surgery. [40] Moreover, Mongin C. et al. found that a significant deterioration in functional outcomes was reported in patients with leakage. [41] These two studies focused on postoperative measurements related to anastomotic leakage but had little focus on preoperative risk prediction about surgical complications. Most studies utilizing manometry so far have primarily described the changes in preoperative and postoperative manometry values based on surgical techniques. [42-48] As these studies have reported anorectal manometry values while measuring functional outcomes based on surgical techniques. Although our study had a different focus, we were able to use these values as a reference to compare with the data obtained from our research, establishing a benchmark for our study's outcomes.

Preoperative prediction of anastomosis leakage for low rectal cancers would be ideal to select patients for ISR. However, performing ARM with a tumor in situ is neither comfortable nor reliable with an intact low anorectal growth. Some studies have even attempted to predict postoperative functional outcomes using preoperative manometry values. [49-52] However, our study primarily focused on the association between preoperative manometry values and surgical outcomes, particularly with anastomosis leakage. A paper from our institution discussed that there was no relationship between complications, including leakage, and the execution of ISR surgery.[53] This correlates with our findings, but the study did not analyze manometry values associated with the surgical outcomes. A multicentric study did not find preoperative anorectal manometry measurements to independently predict permanent stomas.[54]

Although the clinical evidence of fecal diversion remains debatable, it is widely believed that the incidence of clinical anastomosis leakage can be significantly lowered by creating a diverting stoma. In a multicenter randomized trial involving 234 patients undergoing rectal surgery of anterior resection, Matthiessen et al[23] observed a higher rate of anastomotic leakage (28.0%) in patients without defunctioning stoma, compared to those who had stoma (10.3%). Further, two recent meta-analyses had demonstrated notable benefits of stoma construction, showing a clear reduced rates of leakage and subsequent surgeries[55, 56] In these studies, the variance in leakage rates across different institutions could be attributed to the varied criteria used by surgeons for deciding on a diverting stoma. Therefore, the influence of a diverting stoma should be considered in any nonrandomized study exploring the relationship between anastomotic leakage and clinical factors.

The decision making of using a protective stoma remains a topic of debate. The high-grade complication may escalate up to 20% as anastomotic leakage occurs, due to septicemia and peritonitis.[12, 19, 20, 38, 57, 58] Additionally, there is data suggesting an increased likelihood of local cancer recurrence and a decrease in long-term survival following pelvic sepsis.[20-22] Consequently, some researchers advocate for the routine use of fecal diversion after anastomosis of rectum. Nevertheless, the advantage of stoma must be weighed against is potential morbidities, its impact on life quality and the added financial burden. Notably, the morbidity associated with the elective stoma closure has been reported to be as high as 36.5%, with mortality rates reaching 1.4%. [55, 59, 60] It is also crucial to acknowledge that a significant number of patients end up with a permanent stoma for various reasons.[61] Many experts agree that a more selective approach to stoma formation would be preferable, provided that there were reliable methods to predict leakage. In routine clinical practice, it is often observed that patients may present with multiple risk factors simultaneously.

This study has a few limitations. Its retrospective and non-randomized nature cannot exclude selection bias. Furthermore, the relatively small number of participants limits the statistical power of the findings. Another potential issue is the underreporting of certain complications like urogenital dysfunction, as the

study did not actively seek out these outcomes but rather relied on data from electronic medical records.

Conclusion

Preoperative MRP over upper limit of 70 mmHg, preoperative MSP over 224 mmHg, or preoperative RC over 2.25 mL/mmHg can influence on anastomosis leakage in patients who underwent robotic rectal surgery. In planning robotic surgery for rectal tumor, the results of anorectal manometry may help operator to decide whether to create ileostomy to lower the risks regarding anastomosis leakage. This may help them decide whether to create an ileostomy.

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Table 1. Patient demographics

	Total cohort (n=248)
Age (years) (mean ± SD)	58.0 ± 10.5
Sex	
Male	193 (77.8%)
Female	55 (22.2%)
DM	41 (16.5%)
HTN	87 (35.1%)
BMI (mean ± SD)	24.4 ± 3.3
Diagnosis	
CRC	241 (97.2%)
NET	7 (2.8%)
AV (cm) (mean ± SD)	5.6 ± 2.5
PCRT	111 (44.8%)
Adjuvant Chemotherapy	169 (68.1%)
Operation type	
LAR	95 (38.3%)
uLAR	153 (61.7%)
Ileostomy	181 (73.0%)

SD, standard deviation; DM, diabetes mellitus; HTN, hypertension; BMI, body mass index; CRC, co lorectal cancer; NET, neuroendocrine tumor; AV, anal verge; PCRT, preoperative chemoradiotherapy; LAR, low anterior resection; uLAR, ultra-low anterior resection

Table 2. Surgical outcome

	Total cohort (n=248)
Recurrence	22 (8.9%)
Local	3 (13.6%)
Distant	19 (86.4%)
Complication	42 (16.9%)
Immediate postoperative complication	14 (5.6%)
Anastomosis leak	10
Ileus	2
Anastomosis bleeding	1
Anastomotic ischemia	1
Late complication	28 (11.3%)
Anastomosis stricture	12
Rectovaginal fistula	2
Incisional hernia	2
Voiding difficulty	2
Erectile dysfunction	2
Retrograde ejaculation	1
Ureter stricture	1
Left sciatic neuropathy	1
Ileostomy take down anastomosis leak	1
Rectal ulcer due to radiotherapy	1
Lymphocele	1
Obturator nerve injury	1
Perirectal fistula	1

Table 3. Statistical analysis of anastomosis leakage (N=248)

	Leak (-) (N=237)	Leak (+) (N=11)	p
Age (mean ± SD)	57.9 ± 10.7	59.1 ± 6.3	0.717
Sex			0.150
Male	182 (76.8%)	11 (100.0%)	
Female	55 (23.2%)	0 (0.0%)	
DM	40 (16.9%)	1 (9.1%)	0.791
HTN	82 (34.6%)	5 (45.5%)	0.679
BMI (mean ± SD)	24.4 ± 3.4	23.2 ± 1.9	0.241
AV (mean ± SD)	5.6 ± 2.5	6.5 ± 2.2	0.201
Ileostomy	175 (73.8%)	6 (54.5%)	0.288
PCRT	109 (46.0%)	2 (18.2%)	0.133
Adjuvant chemotherapy	162 (68.4%)	7 (63.6%)	1.000
MRP (mean ± SD)	53.7 ± 18.4	59.6 ± 19.5	0.295
MRP > upper limit	40 (16.9%)	5 (45.5%)	0.045
MSP (mean ± SD)	191.6 ± 64.5	234.1 ± 82.0	0.036
MSP > upper limit	136 (57.4%)	7 (63.6%)	0.527
RC (mean ± SD)	1.5 ± 0.7	2.0 ± 0.9	0.030
Recurrence	21 (8.9%)	1 (9.1%)	1.000
Operation type			0.856
LAR	90 (38.0%)	5 (45.5%)	
uLAR	147 (62.0%)	6 (54.5%)	

SD, standard deviation; DM, diabetes mellitus; HTN, hypertension; BMI, body mass index; AV, anal verge; PCRT, preoperative chemoradiotherapy; MRP, maximum resting pressure; MRP > upper limit, maximum resting pressure higher than 70 mmHg; MSP, maximum squeezing pressure; MSP> upper limit, maximum squeezing pressure higher than 180 mmHg; LAR, low anterior resection; uLAR, ultra-low anterior resection;

Figure 1. Cohort patient selection algorithm

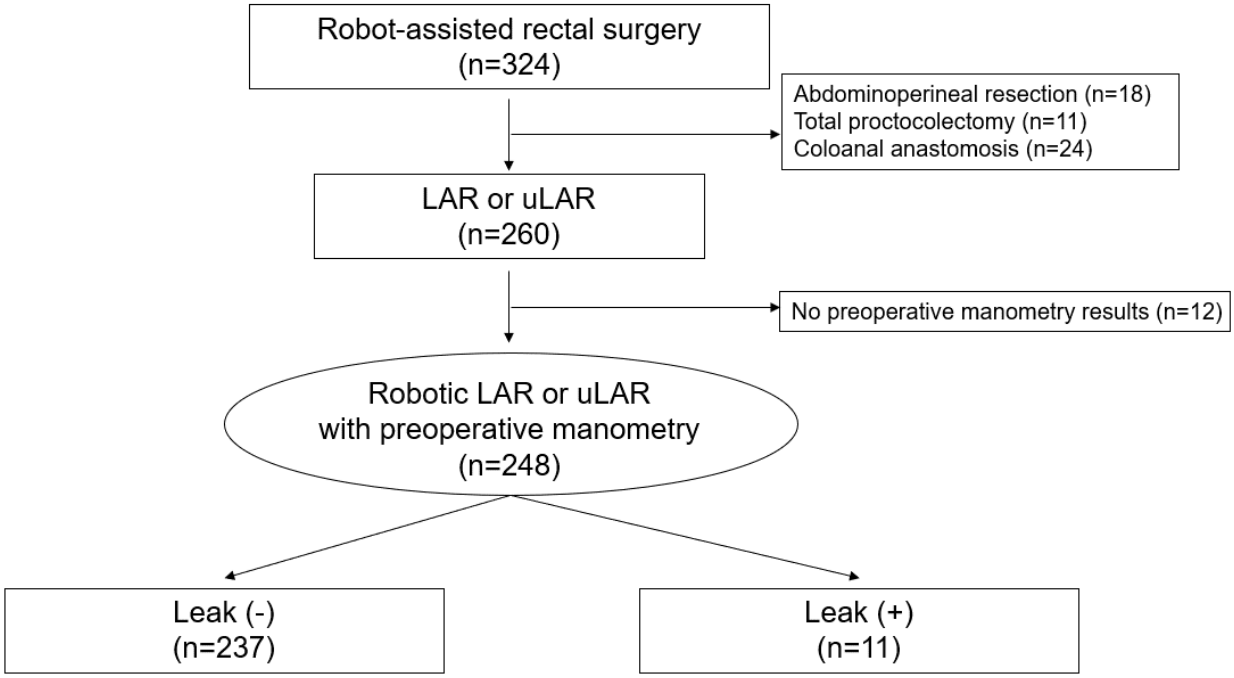

Figure 2. The pressure-measuring catheter with eight radial pressure measuring channels.

Figure 3. The balloon attached catheter measuring sensory by inflating balloon in the lower rectum.

Figure 4. Receiver operating characteristic curve of maximum resting pressure (MRP), maximum squeeze pressure (MSP), and rectal compliance (RC).

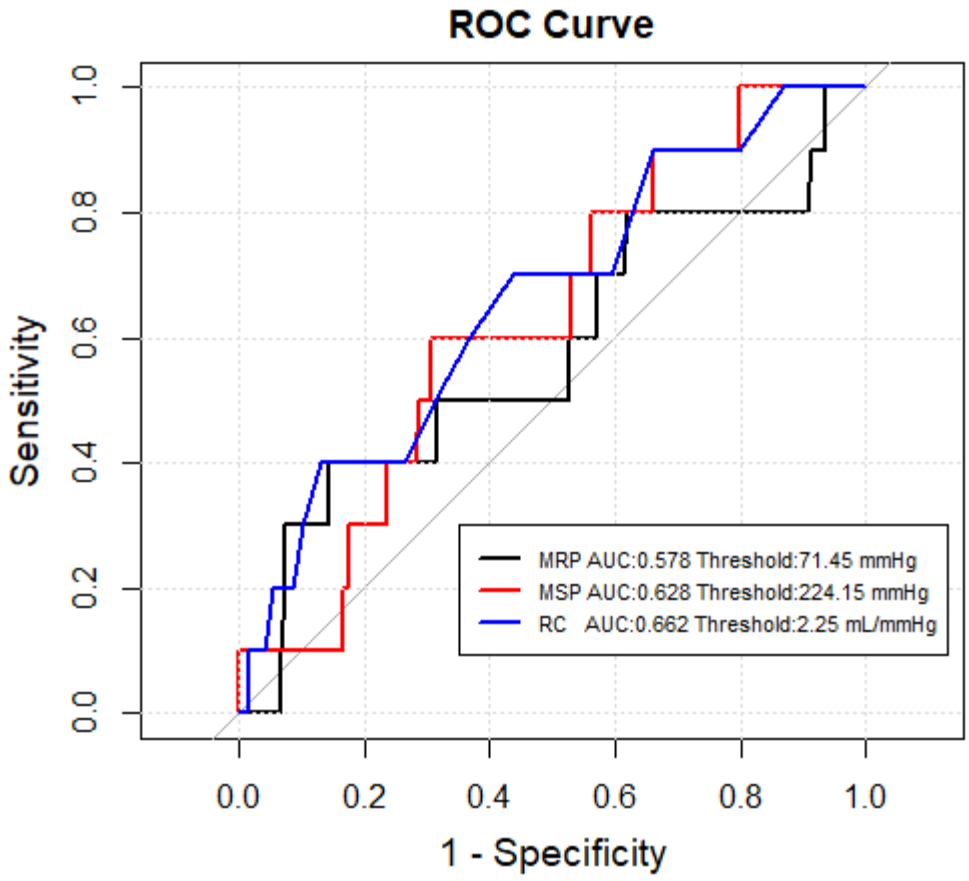

Figure legends

Figure 1. Cohort patient selection algorithm as described. A total of 248 patients were had robot-assisted low anterior resection or ultra-low anterior resection with preoperative manometry. 237 patients did not have anastomosis leakage and 11 patients occurred anastomosis leakage.

Figure 2. The pressure-measuring catheter with eight radial pressure measuring channels.

Figure 3. The balloon attached catheter measuring sensory by inflating balloon in the lower rectum.

Figure 4. ROC curve of MRP, MSP, and RC. The area under the curve for MRP, MSP, and RC are 0.578, 0.628, and 0.662, respectively. ROC = Receiver operating characteristic; MRP = maximum resting pressure; MSP = maximum squeeze pressure; RC = rectal compliance; AUC = area under the curve

국문 초록

1982년 전직장간막절제술(TME)이 소개된 이후로 저위부 직장암의 수술방법은 진화해 왔으며, 이로 인해 재발률이 감소하고, 생존률이 향상되었다. 그러나 발전에도 불구하고, 문합부 누출은 2.5%에서 21%까지 다양한 발생률로 중대한 수술 후 합병증 중 하나로 남아 있다. 본 연구는 수술 전 직장 항문 내압 검사의 결과와 수술 결과 간의 상관관계를 탐구하고, 특히 로봇 수술에서의 문합부 누출에 중점을 두었다.

본 연구에서는 2014년 4월부터 2022년 12월까지 직장암으로 진단되어 로봇 저위전방 절제술 및 초저위전방 절제술을 시행한 환자의 임상자료를 토대로 연구를 진행하였다. 환자의 인구 통계학적 정보, 수술 후 결과 (문합부 누출 포함), 그리고 수술 전 직장 항문 내압 검사 결과, 특히 최대 안정 압력 (MRP) 및 최대 압축 압력 (MSP) 데이터를 중점적으로 분석하였다.

분석한 248명의 환자 중 42 (16.9%)에서 합병증이 발생하였으며, 그 중에서 가장 흔한 것은 문합부 협착이었다. 문합부 누출은 10건에서 발생하여 추가적인 수술적 개입이 필요했다. 누출이 발생한 환자와 그렇지 않은 환자 사이에서 MRP 값에서는 유의한 차이를 보이지 않았으나, MRP가 정상 값의 최고 값인 70 mmHg 이상인 경우 누출이 유의하게 증가하는 현상을 확인하였다. MSP의 경우 문합부 누출과 연관성을 보였으나, 정상 값을 대입하였을 때에는 유의한 차이를 찾을 수 없었고, 직장 유연도 (RC)의 경우 유의한 차이를 보였다. ROC curve를 분석하였을 때, MRP 70 mmHg 이상이거나 MSP 224 mmHg 이상, RS 2.25 mL/mmHg 이상인 경우 문합부 누출과 연관이 있을 수 있음을 알게 되었다.

직장암의 로봇 절제술을 계획할 때 직장 항문 내압 검사의 결과는 수술자가 문합부 누출의 위험을 낮추기 위해 장루를 만들지 여부를 결정하는 데 도움을 줄 수 있을 것으로 보인다. 본 연구 결과 수술 전 항암 방사선 치료에 완전 관해를 보인 직장암에서 국소 절제의 시행은 타당한 치료가 될 수 있음을 확인할 수 있었다.