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Effect of anastomotic reinforcement with barded suture on anastomotic leakage prevention following laparoscopic low anterior resection for rectal cancer: a retrospective single-center study

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Abstract

Background Anastomotic leakage (AL) is a serious complication that may occur following the double stapling technique (DST). The study aims to investigate the efficacy of anastomotic reinforcement using barbed sutures in preventing AL after laparoscopic low anterior resection (LAR) for rectal cancer.

Methods During the period from November 1, 2018 to November 1, 2023, a total of 725 consecutive patients who had underwent laparoscopic LAR for rectal cancer were enrolled in this study. The patients were divided into two groups: the continuous barbed suture reinforcement group ($N=296$) and the control group ($N=429$). Inter-group comparisons were used the chi-squared test, Fisher's exact test, and nonparametric tests. Independent risk or protective factors for AL were analyzed using the multivariate logistic regression.

Results Among the 725 patients enrolled in this study, 24 patients (3.3%) were diagnosed with AL following surgery. The incidence of AL was lower in the reinforcement group when compared with the control group (1.4% *vs.* 4.7%, $P=0.014$). In multivariate regression analyses, the neoadjuvant therapy (OR = 11.994, $P<0.01$), tumor location (OR = 5.306, $P=0.015$), anastomosis bleeding (OR = 58.822, $P<0.01$), and number of staple firings used (≥ 3) (OR = 24.752, $P<0.01$) were independent risk factors for AL, whereas the defunctioning stoma (OR = 0.051, $P<0.01$) and reinforcing sutures (OR = 0.054, $P=0.001$) were independent protective factors for AL in this study. No statistically significant differences were found in 36-item short-Form (SF-36) when evaluating the quality of patient's life between the two groups.

Conclusions Laparoscopic continuous barbed suture reinforcement of anastomosis could reduce the incidence of AL without affecting the quality-of-life following LAR. Further popularization of this approach in clinical is warranted.

Trial registration Retrospectively registered.

Keywords Anastomotic leakage, Barded suture, Anastomotic reinforcement, Rectal cancer, Quality life

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Background

Currently, laparoscopic low anterior resection (LAR) has been considered as the standard surgical procedure for rectal cancer. The widespread use of neoadjuvant therapy and advancements in minimally invasive surgery have led to a rapid increase in sphincter-preserving surgeries worldwide. However, postoperative anastomotic leakage (AL) remains a challenge, with reported incidence rates of up to 10% in clinical practice [1]. Multiple consecutive studies have corroborated the finding that AL not only escalates short-term healthcare costs and mortality rates, but also contributes to a diminished long-term oncological prognosis and quality of life [2, 3]. During intraoperative reconstruction of the digestive tract, surgeons commonly utilize linear cutters and circular staplers for end-to-end or end-to-side anastomosis, a technique known as the double stapling technique (DST), first reported by Griffen and Knight [4]. While this technology has notably simplified the procedure and operability of laparoscopic rectal surgery, the safety of anastomosis still requires further investigation. The discrepancy may stem from the inability of the distal rectal incision made by the linear stapler to align completely with the proximal rectal incision created by the circular stapler during in digestive tract reconstruction. This could result in one or two intersections of cutting lines, which were named as "dog ears" structure (Fig. 1A) in previous literatures [5, 6]. Meanwhile, the intersection of these intersections might create a vulnerable area that could result in AL, which has been reported in previous studies [7–9]. Thus, more and more surgeons tried to reduce the incidence of AL by reinforcing the anastomotic site, especially in the "dog ears" area. With the advancement of materials and technology, numerous new types of sutures have emerged. Among these, the absorbable barbed suture, as a type of single strand barbed suture that has the characteristic of being opposite in direction to the suture direction, has gained wide acceptance among surgeons as it requires no knot with the self-maintenance of tension in sutures running and does not require repetitive re-tightening of the sutures during stitching under laparoscopy. Compared with other none-barbed sutures, this technique reflects the better security and convenience during in surgery. In recent years, a series of studies have consistently shown that reinforcing anastomosis with barbed sutures may decrease the occurrence of AL following laparoscopic LAR [7, 9–11]. However, three main limitations were presented in the above publications. First, the learning curve of laparoscopic anastomotic reinforcement with barbed suture should be taken into consideration. Second, the small sample size might affect the reliability of conclusions. Third, there is minimal reporting on the quality of life for patients with and without anastomotic reinforcement.

In light of the aforementioned shortcomings, this study aimed to achieve two main objectives: 1) to further investigate the clinical impact of laparoscopic anastomotic reinforcement using barbed sutures in preventing AL after rectal surgery; and 2) to assess potential differences in the quality of life between patients with and without anastomotic reinforcement.

Materials and methods

Patients

From November 1, 2018 to November 1, 2023, 758 consecutive patients with primary rectal cancer underwent laparoscopic LAR at the Department of Gastrointestinal Surgery IV, Peking University Cancer Hospital and Institute. Among these patients, 11 patients who adopted laparotomy and 9 patients who adopted laparoscopy and then converted to laparotomy were excluded; 8 patients who underwent emergence surgery and 5 patients without intact data were also excluded. Hence, 725 patients were included in final analysis. This study was approved by the Medical Ethics Committee of the Peking University Cancer Hospital (2023YJZ57). As this was a retrospective study, informed consents from patients were not required.

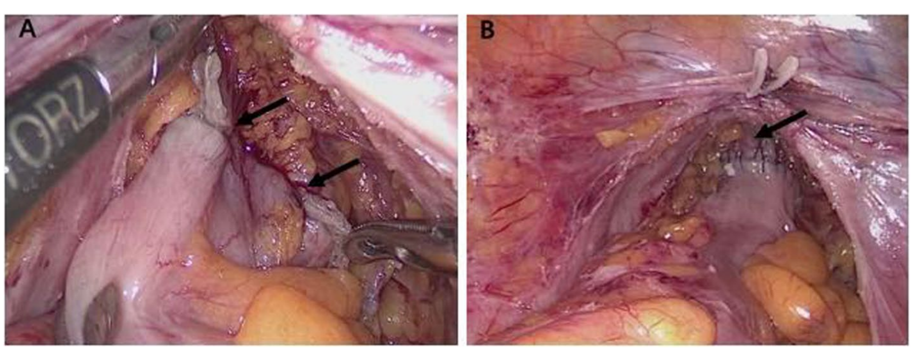

Fig. 1 **A** "Dog ear" structure. **B** Completion of continuous full-layer suture

For the follow-up of rectal cancer, all patients were followed-up every 3 months for the first 2 years after surgery and then every 6 months thereafter. The follow-up included physical examinations, monitoring of tumor biomarkers, and chest and abdominal/pelvic computed tomography or magnetic resonance imaging. Additionally, colonoscopy was conducted annually to monitor for relapse. To mitigate the potential influence of postoperative chemotherapy, the patients' quality of life was evaluated using the 36-item Short Form (SF-36) one month after surgery.

Inclusion and exclusion criteria

The inclusion criteria were as following: (1) Age≥18 years, and pathological biopsy confirmed as primary rectal cancer; (2) Cases who underwent laparoscopic LAR and the intraoperative digestive tract reconstruction was DST (end-to-end anastomosis); (3) The distance between the lower edge of the tumor and the anal edge is 5–15 cm; (4) American Society of Anesthesiologists (ASA) Grades I-III; (5) Cases who underwent defunctioning stoma or transanal tube drainage. The exclusion criteria were as following: (1) The tumor was tightly fixed with adjacent organs or tissues, or invaded the important nerves or vessels, which making it unresectable; (2) Cases who suffered laparotomy or conversed to laparotomy; (3) Emergence surgery due to intestinal bleeding or perforation; (4) Cases without intact data. The flowchart of screening process was summarized in Fig. 2.

Surgical procedures

Preoperative preparations, such as bowel preparation, prophylactic cephalosporin antibiotics, and lithotomy position, were same for all patients. All surgical procedures were performed by three senior surgeons from the same group in our center. Five-ports were used routinely, and the pneumoperitoneum of 12–15 mmHg was maintained during in surgery. All surgical procedures followed the principle of total mesorectal resection which was proposed by Heald et al. in 1982 [12]. Our team uniformly complied with the strategy of preserving the left colonic artery and dissecting the No.253 lymph node in surgery. According to the guidelines of Japanese Society for Cancer of the Colon and Rectum (JSCCR), the No.253 lymph node was in the area of tissue above the preinferior fascia of the infra-abdominal nerve located between the inferior mesenteric artery, left colic artery and inferior mesenteric vein [13]. Rectum transection was used the linear stapler and end-to-end anastomosis was performed with a circular stapler. Air leak test was conducted to evaluate the integrity of the anastomosis for patients. In patients with risk factors, such as positive air leak test, neoadjuvant radiotherapy before surgery, or incomplete doughnut ring of circular staples, the defunctioning stoma was given priority consideration. When there existed significant larger tension after anastomosis or intestinal obstruction before surgery, the transanal tube drain was placed during in surgery. In the reinforcing group,

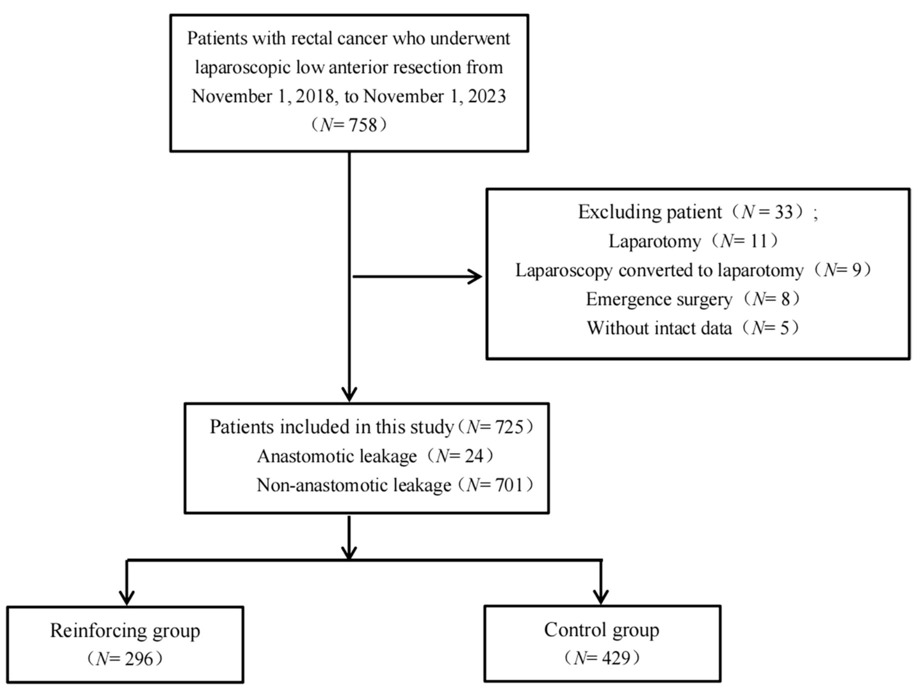

Fig. 2 The flowchart of patients included in this study

a 3–0 absorbable barbed suture (STRATAFIXTM Spiral PDSTM Plus) was used to reinforce all around the entire anastomosis by continuous full-layer suturing (Supplement attachment), namely from the one intersection to the other intersection of the DST staple following digestive tract reconstruction. To avoid anastomotic stenosis, 8–10 stitches are recommended with priority in our unit. The completion of continuous suture was also shown (Fig. 1B). The pelvic drain was routinely used for all patients in this study.

Definition

Basing on the International Study Group of Rectal Cancer recommendations of 2010, the definition of AL was a defect at the anastomotic site with communication between intraluminal and extraluminal compartments [14]. According to the severity and treatment, the AL was further divided into three grades (Grade A, B, and C). The grade A leaks refers to those patients who were diagnosed with imaging evidence, and without requiring any treatment. The grade B leaks refers to those patients who were dealt with conservative treatment including fasting, parenteral nutrition, antibiotics, and puncture catheter drainage. The grade C leaks refers to those patients who required surgical treatment including repair, irrigation, drainage and defunctioning stoma. In this study, the AL was finally proved by abdominal and pelvic computed tomography and/or transanal X-ray imaging with a water-soluble contrast medium. Anastomotic stenosis was defined as narrowing of the intestinal lumen at the anastomosis site which kept from passing through a colonoscopy with a 12-mm external diameter [15]. Histopathological stage of rectal cancer was defined in accordance with the Union for International Cancer Control-TNM classification (8th edition) [16]. Surgery was performed 8 weeks after the completion of chemoradiation. Patients who accept the neoadjuvant therapy received 50.4–54.0 Gy of radiation and 5-FU-based chemotherapy (Capecitabine) before surgery. Postoperative chemotherapy (XELOX plan) was recommended to all patients with positive lymph nodes as described in the final pathology report.

Research variables

The research variables mainly including baseline clinical characteristics, surgical recordings and postoperative complications, and 36-item short-Form (SF-36). The former included gender, age, body mass index (BMI), neoadjuvant therapy, ASA scores, smoking, alcohol consumption, hypertension, diabetes, previous history of abdominal surgery and intestinal obstruction, preoperative hemoglobin and serum albumin levels, tumor location, and pathological TNM stage. The middle included duration of operation, intraoperative blood loss and transfusion, combined organ resection, defunctioning stoma, transanal tube drainage, number of staple firings used (≥ 3 or < 3), anastomotic leakage, stricture and bleeding, and hospital stay. The latter included physical functioning, role-physical, bodily pain, vitality, social functioning, role-emotional, mental health and general health. The quality of life was evaluated by SF-36, which was distributed and retrieved within 1 months following surgery.

Statistical analyses

SPSS version 19.0 software (IBM Corp., Armonk, NY, USA) was used for data statistics and analysis. All cases were divided into 2 groups, namely the anastomotic reinforcement group and the control group, and the intergroups comparisons were used the chi-squared test, Fisher's exact test, or nonparametric tests. The multi-variate logistic regression was performed to identify the independent risk or protective factors of AL. A two-tailed *P* value of < 0.05 was considered to be statistically significant.

Results

Baseline clinical characteristics

Of the 725 patients who underwent laparoscopic LAR for rectal cancer, 448 (62%) patients were male and 277 (38%) patients were female, with the median age and BMI of 60.01 years and 24.18 kg/m^2, respectively. The median distance from the anal verge to the tumor was 9.33 cm (range: 5.0–15.0 cm). Among those patients, 141 cases were evaluated as pathological stage I, 224 cases were evaluated as pathological stage II, 272 patients were evaluated as pathological stage III and 56 patients were evaluated as pathological stage IV basing on the AJCC stage.

All patients were classified into the reinforce group ($N=296$) and control group ($N=429$) based on whether they received reinforcing sutures or not. There were no statistically significant differences between the two groups on gender, age, BMI, neoadjuvant therapy, ASA score, smoking, alcohol consumption, hypertension, diabetes, tumor location, pathological TNM stage and preoperative intestinal obstruction, hemoglobin and serum album (Table 1).

Intraoperative and postoperative variables

The intraoperative and postoperative variables are presented in Table 2. The duration of operation in

Table 1 Patient baseline clinical characteristics

Variables	Reinforcing sutures, No. (%)		*P* value
	Yes (*n* = 296)	**No (*n* = 429)**	
Gender			0.525
Male	187 (63.2%)	261 (60.8%)	
Female	109 (36.8%)	168 (39.2%)	
Age (years)	59.50 ± 10.65	60.36 ± 10.71	0.301
Body mass index (kg/m^2)	24.24 ± 3.03	24.13 ± 3.35	0.655
Neoadjuvanst therapy			0.029
Yes	89 (30.1%)	98 (22.8%)	
No	207 (69.9%)	331(77.2%)	
ASA score			0.104
I	30 (10.1%)	45 (10.5%)	
II	254 (85.8%)	350 (81.6%)	
III	12 (4.1%)	34 (7.9%)	
Smoking			0.460
Yes	103 (34.8%)	138 (32.2%)	
No	193 (65.2%)	291 (67.8%)	
Alcohol consumption			0.610
Yes	54 (18.2%)	72 (16.8%)	
No	242 (81.8%)	357 (83.2%)	
Hypertension			0.351
Yes	88 (29.7%)	114 (26.6%)	
No	208 (70.3%)	315 (73.4%)	
Diabetes			0.116
Yes	48 (16.2%)	52 (12.1%)	
No	248 (83.8%)	377 (87.9%)	
Previous history of abdominal surgery			0.718
Yes	44 (14.9%)	68 (15.9%)	
No	252 (85.1%)	361 (84.1%)	
Preoperative intestinal obstruction			0.732
Yes	32 (10.8%)	43 (10%)	
No	264 (89.2%)	386 (90%)	
Preoperative hemoglobin levels (g/L)	118.33 ± 8.98	121.45 ± 11.92	0.349
Preoperative serum albumin levels (g/L)	44.15 ± 3.88	43.39 ± 5.28	0.151
Tumor location (from anal verge, cm)	9.26 ± 2.51	9.38 ± 2.52	0.800
Depth of tumor invasion (T) category			0.233
T0	19 (6.4%)	13 (3%)	
T1	18 (6.1%)	27 (6.3%)	
T2	56 (19%)	80 (18.6%)	
T3	175 (59%)	258 (60.1%)	
T4	28 (9.5%)	51(11.9%)	
Lymph node metastases (N) category			0.855
N0	167 (56.6%)	240 (55.9%)	
N1	85 (28.8%)	120 (28%)	
N2	44 (14.6%)	69 (16.1%)	
Metastasis			0.080
M0	267 (90.2%)	402 (93.7%)	
M1	29 (9.8%)	27 (6.3%)	
Pathological TNM stage			0.296
I	57 (19.3%)	84 (19.6%)	
II	87 (29.4%)	137 (31.9%)	
III	104 (35.1%)	168 (39.2%)	
IV	29 (14.1%)	27 (6.4%)	

Abbreviation: *ASA* American Society of Anesthesiologists

reinforcing group was significantly longer than those in control group (195.51 ± 63.03 *vs.* 173.93 ± 54.87 min, $P < 0.01$), while there were no statistically differences in intraoperative blood loss ($P = 0.093$), combined organ resection ($P = 0.320$), intraoperative blood transfusion ($P = 0.076$), defunctioning stoma ($P = 0.141$), transanal tube drain ($P = 0.252$) and the number of staple firings used ($P = 0.370$). For the anastomosis-related complications following surgery, the incidence of AL in non-reinforcing group was significantly higher than those in control group (4.7% *vs.* 1.4%, $P = 0.014$), while there were no statistically differences in anastomosis stricture ($P = 0.147$) and anastomosis bleeding ($P = 0.478$). In addition, the length of hospital stay in control group was longer than reinforcing group, though with no statistically differences (6.60 ± 0.56 vs. 6.25 ± 0.42 days, $P = 0.287$). Among 24 patients who developed AL following surgery, 2 cases were classified as grade A, 5 patients were classified as grade B, and 17 patients were classified as grade C (Table 3). The time of occurrence of AL was later in reinforcing group when comparing with the control group, with no statistically differences (5.00 ± 0.82 vs. 4.65 ± 1.04 days, $P = 0.534$) (Table 3). Finally, no statistically significant difference was found in the treatment of AL between the two groups ($P = 0.061$) (Table 3).

Multivariate analyses

In multivariate regression analyses, the neoadjuvant therapy ($P < 0.01$, OR 11.994 [95% CI, 2.981 – 48.256]), tumor location ($P = 0.015$, OR 5.306 [95% CI, 1.383 – 20.358]), anastomosis bleeding ($P < 0.01$, OR 58.822 [95% CI,

Table 2 Surgical recordings and postoperative complications

Variables	Reinforcing sutures, No. (%)		P value
	Yes ($n=296$)	No ($n=429$)	
Duration of operation (min)	195.51 ± 63.03	173.93 ± 54.87	**< 0.01**
Intraoperative blood loss (ml)	43.35 ± 37.76	54.15 ± 58.56	0.093
Combined organ resection			0.320
Yes	18 (6.1%)	19 (4.4%)	
No	278 (93.9%)	410 (95.6%)	
Intraoperative blood transfusion			0.076
Yes	4 (1.4%)	15 (3.5%)	
No	292 (98.6%)	414 (96.5%)	
Defunctioning stoma			0.141
Yes	123 (41.6%)	202 (47.1%)	
No	173 (58.4%)	227 (52.9%)	
Transanal tube drain			0.252
Yes	26 (8.8%)	49 (11.4%)	
No	270 (91.2%)	380 (88.6%)	
Number of staple firings, n (%)			0.370
≥ 3	14 (4.7%)	27 (6.3%)	
< 3	282 (95.3%)	402 (93.7%)	
Anastomotic leakage			**0.014**
Yes	4 (1.4%)	20 (4.7%)	
No	292 (98.6%)	409 (95.3%)	
Anastomosis stricture			0.147
Yes	23 (7.8%)	22 (5.1%)	
No	273 (92.2%)	407 (94.9%)	
Anastomosis bleeding			0.478
Yes	8 (2.7%)	19 (4.4%)	
No	288 (97.3%)	410 (95.6%)	
Hospital stay (day)	6.25 ± 0.42	6.60 ± 0.56	0.287

Abbreviation: Bold indicates statistical significance

15.294 – 226.233]), and number of staple firing used (≥ 3) ($P<0.01$, OR 24.752 [95% CI, 6.212 – 98.619]) were independent risk factors for AL, whereas the defunctioning stoma ($P<0.01$, OR 0.051 [95% CI, 0.012 – 0.221]) and reinforcing sutures ($P=0.001$, OR 0.054 [95% CI, 0.009 – 0.315]) were protective factors for AL in this study (Table 4).

Quality of life assessment

In SF-36, no statistically significant difference was noted between the two groups with regard to the physical functioning ($P=0.824$), role physical ($P=0.122$), bodily pain ($P=0.055$), vitality ($P=0.879$), social functioning ($P=0.448$), role emotional ($P=0.787$), mental health ($P=0.296$) and general health ($P=0.684$) (Table 5).

Table 3 Patient information to anastomotic leakage

Variables	Reinforcing sutures		*P value*
	Yes, $n=4$	No, $n=20$	
Classification of AL			**0.034**
Grade A	1	1	
Grade B	2	3	
Grade C	1	16	
Mean time of AL (day)	5.00 ± 0.82	4.65 ± 1.04	0.534
Treatment			0.061
Peritoneal tube drainage	2	1	
Transanal tube drainage	1	2	
Reoperation	1	17	

Discussion

Anastomotic leakage, as a catastrophic postoperative complication following rectal cancer surgery, could lead to severe intra-abdominal infection, which in turn affects the patient's quality of life. In present study, the incidence of AL was found to be 3.3%, which is consistent with a previous study that reported an incidence of 3.6% for AL [17]. Moreover, the incidence of AL was 1.4% in the group receiving continuous reinforcement with absorbable barbed suture, while it was 4.7% in the control group. This suggests that the clinical application of absorbable barbed suture for continuous anastomotic reinforcement is feasible. Neoadjuvant therapy, tumor location, anastomosis bleeding, and number of staple firings used (≥ 3) were independent risk factors for AL. Finally, regardless of whether anastomotic reinforcement was performed, no statistically significant differences were reported in quality of life during in follow-up.

Currently, it is generally believed that the incidence of AL is mainly associated with the blood supply and tension of anastomotic, intraluminal pressure of intestine, and surgical skills. With the widespread adoption and advancement of laparoscopic technology, surgical skills are gradually becoming less of a limiting factor for AL occurrence. Retention of the transanal tube is considered a practical and feasible strategy for reducing intraluminal pressure, as reported in several high-quality multicenter studies [18, 19]. Reinforcing the anastomosis has been acknowledged as an effective measure to lessen anastomotic tension. Nonetheless, reinforcing the anastomosis has proven to be particularly challenging in rectal surgery, especially for male patients with the restricted pelvic space. Moreover, repetitive manipulation of the anastomosis site may somewhat impede the healing process of the anastomosis site. To address the aforementioned issue, a novel form of barbed suture is increasingly

Table 4 Multivariate regression analyses on anastomotic leakage-related factors

Variables	Odds ratio	95% CI	*P value*
Neoadjuvant therapy	11.994	2.981–48.256	**< 0.01**
Tumor location	5.306	1.383–20.358	**0.015**
Anastomosis bleeding	58.822	15.294–226.233	**< 0.01**
Number of staple firings used (≥ 3)	24.752	6.212–98.619	**< 0.01**
Defunctioning stoma	0.051	0.012–0.221	**< 0.01**
Reinforcing sutures	0.054	0.009–0.315	**0.001**

Table 5 Comparison of SF-36 between the two groups following surgery

Variables	Reinforcing sutures, No. (%)		*P value*
	Yes (*n* = 296)	No (*n* = 429)	
Physical functioning	48.29 ± 3.12	48.60 ± 3.71	0.824
Role physical	34.36 ± 4.24	31.90 ± 2.73	0.122
Bodily pain	43.07 ± 3.71	40.10 ± 3.28	0.055
Vitality	70.12 ± 2.81	69.80 ± 3.58	0.879
Social functioning	65.21 ± 5.82	67.30 ± 8.79	0.448
Role emotional	48.36 ± 5.85	47.80 ± 3.16	0.787
Mental health	67.00 ± 4.51	63.70 ± 8.78	0.296
General health	51.02 ± 2.24	50.60 ± 2.76	0.684

being adopted in clinical practice [8, 9, 20]. Bracale et al. reported that the barbed suture was safe and efficient for closure of the stapler-access enterotomy during totally laparoscopic right colectomy [20]. Jiang et al. compared 82 patients performing intermittent and continuous suture reinforcement with 42 non-reinforcement patients, and found that the incidence of AL in intermittent and continuous suture reinforcement groups were lower than those in non-reinforcement group [9]. Lin et al. retrospectively analyzed the clinical data of 292 rectal cancer patients and found intracorporeal barbed suture reinforcement was associated with lower AL incidence following laparoscopic LAR [8]. However, the sample size utilized in the aforementioned studies was insufficient. Consequently, the reliability of the conclusions drawn requires validation through larger sample sizes.

As mentioned above, the "dog ears" formation were the potential weak areas of anastomotic site due to the crossed staple lines followed by DST during in surgery [5]. Therefore, reinforcing the anastomotic site with barbed sutures, particularly at the "dog ears", may theoretically reduce the incidence of AL. Our study established that continuous full-layer suturing with 3–0 absorbable barbed suture was both safe and feasible, effectively reducing the probability of AL without an increase in anastomotic-related complications such as bleeding and stricture, as indicated in various retrospective studies [8–10]. The possible reasons might as follow. The reinforcement of the anastomosis may contribute to greater thickness of the staple line, thereby reducing tension and enhancing local blood supply, which can ultimately facilitate the healing process. Additionally, the continuous stimulation from excreta may create a more conducive environment for healing when the anastomosis is reinforced, thus potentially leading to an expedited recovery post-surgery. In laparoscopic surgery, the barbed suture eliminates the need for knotting, ensures consistent tension without repeated pulling, and thereby enhancing safety and convenience. Moreover, it was verified in this study that the patient's quality of life is not affected by continuous suturing with barbed sutures. Finally, despite the slightly longer duration of the operation in the reinforcing group, the author believes that surgeons with extensive experience in laparoscopic surgery can quickly overcome the learning curve of reinforcement methods. Therefore, the barbed suture deserves to be widely promoted in clinical practice.

Basing on the multivariate regression analysis, the presence of reinforcing sutures and the use of defunctioning stoma were emerged as independent protective factors for AL, findings that are in line with those of prior studies [7, 21]. However, a high-quality nationwide retrospective study by Degiuli et al. demonstrated that the use of defunctioning stoma didn't decrease the incidence of AL, but it significantly mitigates the severity of AL following surgery [22]. In view of the stoma-related complications including infection, prolapse and obstruction, the rational screening of patients with high-risk factors for AL appears particularly important. Two variables, including tumor location and neoadjuvant therapy, have been identified as the independent risk factors in predicting the AL in this study. The inferior location of the tumor may lead to reduce blood supply and contribute to the challenges in laparoscopic surgery, potentially elevating the risk of AL [23]. Neoadjuvant therapy, particularly the long-course radiotherapy, could lead to tissue fibrosis and edema, potentially impacting the ultimate healing of anastomoses finally [24]. Moreover, this study also revealed that number of staple firings used (≥ 3) was associated with increased AL rate. Ito et al. firstly reported that number of staplers used (≥ 3) for rectal division was the factor found to be associated with a significantly risk of AL following surgery [25]. Afterwards, other researchers also explored the relationship between the two and arrived at the similar conclusions [26, 27]. Therefore, surgeons should minimize the number of linear stapler firings for rectal transection to reduce the incidence of AL.

The average reinforcement time was 19.86 ± 8.46 min in our unit. Several key points in our unit might help reinforce the anastomosis during in surgery, which were also as following. (1) When performing the digestive tract reconstruction with DST, removing one "dog ear" to reduce the weak area as much as possible; (2) When reinforcing the anastomosis with barbed suture, starting from the corner of one "dog ear" and performing continuous full-layer suture of rectal wall; (3) Inserting the needle approximately 0.5 cm from the anastomotic line and keeping needle distances of 1.0 cm; (4) Maximize the circumferential reinforcement of the anastomosis. When it is difficult to reinforce the posterior wall due to the lower position of the anastomosis, the assistant could push forward the anus to help finishing the reinforcement. Based on our personal experience, for the distance between the lower edge of the tumor and the anal edge greater than 7 cm, continuous reinforcement of the whole anastomosis under laparoscopy is feasible during in surgery. For the distance is 5–7 cm, female instead of male patients should be selected due to the wider pelvis. For the distance less than 5 cm, laparoscopic anastomosis reinforcement is extremely difficult and should be carefully considered.

The present study represents the largest sample size to date concerning continuous anastomotic reinforcement with barbed suture. Additionally, this is also the first preliminary exploration of the quality of life of patients who underwent anastomotic reinforcement with barded suture. These findings may provide valuable insights for the clinical diagnosis and treatment of rectal surgery. Nevertheless, several limitations also should be considered. Firstly, potential bias such as selection biases are inevitable due to the retrospective nature of the present study. Secondly, given the time span was nearly 5 years, we have to consider the impact of the learning curve. However, all surgical procedures were performed by three senior surgeons from the same group as mentioned above, which has greatly reduced heterogeneity. Thirdly, while no statistical difference was observed in the other two protective measures, namely defunctioning stoma and transanal tube drainage, future prospective studies need to independently verify the effectiveness and safety of anastomotic reinforcement.

Conclusions

In conclusion, laparoscopic reinforcement of the anastomosis with barded suture proved to be a safe and feasible technology for middle-high rectal cancer. This approach demonstrated a reduced incidence of AL without compromising postoperative quality of life following laparoscopic LAR for rectal cancer, suggesting that it is worth being widely promoted in clinical practice.

Abbreviations

AL	Anastomotic leakage
DST	Double stapling technique
LAR	Low anterior resection
ASA	American Society of Anesthesiologists
BMI	Body mass index
JSCCR	Japanese Society for Cancer of the Colon and Rectum
SF-36	36-Item short-Form
OR	Odds Ratio

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12893-024-02749-w.

Supplementary Material 1.

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None.

Authors' contributions
Kai Xu, Maoxing Liu and Xinyu Qi participated in the acquisition, analysis, and interpretation of data, as well as in the manuscript drafting; Pin Gao, Chuanyong Zhou and Fei Tan participated in data acquisition; Zhendan Yao and Hong Yang participated in analysis and interpretation of data. Xiangqian Su and Jiadi Xing contributed to the conception, design, and data interpretation. Ming Cui, Nan Zhang and Chenghai Zhang revised the manuscript for important intellectual content. All authors reviewed and approved the final manuscript.

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Data availability
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study complies with the Declaration of Helsinki and was approved by the Medical Ethics Committee of the Peking University Cancer Hospital (2023YJZ57). As this was a retrospective study, informed consents from patients were not required.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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