

Laparoscopic low anterior resection for rectal carcinoma: Complications and management in 132 consecutive patients

Qian-Lin Zhu, Bo Feng, Ai-Guo Lu, Ming-Liang Wang, Wei-Guo Hu, Jian-Wen Li, Zhi-Hai Mao, Min-Hua Zheng

Qian-Lin Zhu, Bo Feng, Ai-Guo Lu, Ming-Liang Wang, Wei-Guo Hu, Jian-Wen Li, Zhi-Hai Mao, Min-Hua Zheng, Department of General Surgery, Shanghai Ruijin Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai 200025, China; Shanghai Minimally Invasive Surgery Center, Shanghai 200025, China

Author contributions: Zhu QL and Feng B contributed equally to this work; Zhu QL, Feng B, Lu AG and Zheng MH designed the research; Zhu QL, Feng B, Lu AG, Mao ZH and Zheng MH performed the operations; Hu WG and Li JW assisted in the reference search; Zhu QL, Feng B and Wang ML analyzed the data; Zhu QL, Feng B and Zheng MH wrote the paper.

Correspondence to: Min-Hua Zheng, Professor, Department of General Surgery, Shanghai Ruijin Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai 200025, China. zqlalani@163.com

Telephone: +86-21-64458887 Fax: +86-21-64458887

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Abstract

AIM: To analyze the clinical manifestations and risk factors of complications in laparoscopic low anterior resection (LAR) for rectal cancer patients.

METHODS: A series of 132 consecutive patients who received laparoscopic LAR for rectal cancer in our center were included. The etiology, diagnosis, treatment and prevention of rectal cancer were studied among the patients with surgery-related complications using both univariate and multivariate regression analysis.

RESULTS: No conversion to open surgery was observed and 5 cases converted to hand-assisted laparoscopic operation. The overall morbidity rate was 20.5%. Complications occurred during the operation in 7 patients (5.3%), within 30 postoperative days in 24 patients (18.2%), and within 3 mo in 2 patients (1.5%). The most significant complications were anastomotic leakage (9.1%) and anastomotic hemorrhage (5.3%). Size

and location of tumor, pathological staging and preoperative nutrition were significant factors associated with LAR complications, while gender, age and pathological type showed no relevance. Binary logistics regression showed that the size and location of tumor, and pathological staging were independent factors of laparoscopic LAR. All the complications were treated during their onset of clinical manifestations by interventional or conservative therapy.

CONCLUSION: Anastomotic leakage is a major complication in laparoscopic LAR. The complications may be associated with tumor size and site, and pathological stage. Interventional therapies are of value in the management of laparoscopic LAR complications.

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Key words: Laparoscopy; Low anterior resection; Complication; Rectal cancer; Logistic regression analysis

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INTRODUCTION

Despite important progress made in the past decade regarding surgical staplers, techniques and perioperative management, patients who receive low anterior resection (LAR) for rectal cancer may still inevitably experience surgical complications. With the lowering level of colo-anal anastomosis and increasing demands for anal-sphincter

preservation, risks such as anastomotic leakage are still the major concerns of the surgeons. It is crucial to understand their risk factors of complications for clinical applications and their impact on patient survival. The laparoscopic approach has been regarded as an attractive surgical alternative for low rectal cancer management because it offers better visualization and more delicate instrumentation and may reach an adequate dissection up to the pelvic floor with a better preservation of the hypogastric plexus and erigent nerves, thus resulting in an improved functional and oncological outcome, ensuring a relatively lower anastomosis and a reduced occurrence of complications.

Several recently published randomized studies have shown the better short-term benefits of the laparoscopic approach in colorectal cancer treatment compared with the open approach. However, such data are limited to the common complications related to laparoscopic LAR during or after surgery. Hence, we conducted this trial to study laparoscopic LAR in terms of perioperative and oncological outcomes in patients with rectal cancer. The aim of this study was to analyze the clinical manifestations and risk factors of the complications following LAR, and to summarize the management of the patients who suffered from these complications.

MATERIALS AND METHODS

Patients

Using a prospectively constructed database, we reviewed the outcomes of 132 consecutive patients who underwent laparoscopic LAR for rectal adenocarcinoma within 8 cm towards the dentate line at our Minimally Invasive Surgery Center. Preoperative localization of tumor was determined using the colonoscopy, double contrast barium enema, endoscopic ultrasonography and contrast-enhanced computed tomography of the abdomen and pelvis. Transcutaneous ultrasonography was not routinely performed. The excluding criteria were as follows: (1) the tumor was recurrent or metastatic according to the imaging test or perioperative biopsy; (2) those who had received any chemo- or radiotherapy preoperatively; (3) no total mesorectal excision (TME) technique was used during rectal resection; (4) emergent operation was performed for bowel obstruction, acute hemorrhage or perforation; and (5) patients who had other bowel diseases such as ulcerative colitis or Crohn's disease. The present study was performed in compliance with the guidelines issued by our institutional review board (IRB) and fulfilled the requirements for informed consent, and approved by our IRB. All patients provided informed consent for the laparoscopic LAR procedure. The identified clinical manifestations or imaging test presentations were demonstrated in all the cases for risk analysis.

Surgical procedure

Using a 5-trocar approach, the inferior mesenteric vessels were ligated after left ureter identification, followed by retromesenteric dissection using a medial to lateral route. The splenic flexure was then mobilized, followed

by laparoscopic TME dissection with preservation of the hypogastric plexus and nerves.

For tumors located in the distal rectum (8 cm from anal verge), a complete TME was performed laparoscopically after splenic flexure mobilization. The rectum was transected with an endoscopic or conventional stapler through a low abdominal transverse incision at the level of the pelvic floor (with at least a 2-cm distal margin from the tumor). A colo-anal anastomosis was spared. Trans-anal anastomoses were performed at least 1 cm from the dentate line with an adequate oncological distal margin of 2 cm, using a double-stapling technique and end-to-end anastomosis (Tyco Healthcare Group LP, Norwalk, CT, USA, Proximate ILS, Ethicon-Endo Surgery, Inc., Cincinnati, OH, USA).

Protective loop ileostomy was not routinely performed on our patients. A conversion to hand-assisted laparoscopic LAR was carried out under conditions such as a thickening mesentery, enlarged tumor mass or a narrow pelvis for successful manipulation.

Study parameters included: (1) patient data: age, body mass index and preoperative morbidity; (2) perioperative data: operation time, blood loss and complications, including intraoperative complications of hemorrhage, bowel injury and anastomotic rupture, short-term complications such as anastomotic leakage, anastomotic hemorrhage, urinary retention, pulmonary or urinary infection and long-term complications such as anastomotic stricture, incisional hernia; (3) postoperative data: length of hospital stay (including preoperative night spent in hospital), time to first liquid intake, time to unrestricted food intake, time to first stool passage and postoperative complications; (4) pathological data: TNM staging, total number of lymph nodes harvested, length of the resected specimen, tumor diameter, tumor distance to distal resection margin and circumferential margin status; and (5) follow-up data: time to local recurrence, time to occurrence of distant metastases, overall survival and disease-free survival.

Statistical analysis

The SPSS 13.0 software package was used for statistical analysis. The results were presented as mean \pm SD using Student *t* test for parametric analysis and within-group analysis of variance was used when appropriate. Comparisons for variables were performed using χ^2 test. All *P* values less than 0.05 were considered statistically significant. For univariate analysis, the binary logistic regression model was used to identify independent prognostic factors for overall complications related to operations. Differences with *P* < 0.05 were considered statistically significant.

RESULTS

Demographic data

A total of 132 patients (80 men and 52 women) underwent curative laparoscopic LAR in our center. Their average age was 64.40 (33-90) years and average operation time was 106.33 \pm 42.45 (55-210) min, intraoperative blood loss was 49.02 \pm 56.50 (5-200) mL. The average

Table 1 Category, management and prognosis of intraoperative complications

Intraoperative complications	n (%)	Management	Prognosis
Anastomotic rupture	1	Intermittent suturing with absorbable sutures under laparoscopy	Anastomotic hemorrhage and leakage
Hemorrhage	2	Hemostat with Hem O-lok clip intraoperatively; Hemostat with titan clips under colonoscopy after completion of operation	Recovered
Ureter injury	2	Intraoperative cannulation of double J catheter under cystoscopy, saturation of the ends with absorbable sutures, extubation no earlier than 2 mo after operation	Recovered
Deferent duct injury	1	Occlusion of the distal end under laparoscopy by titan clips	Partial sexual dysfunction
Bladder injury	1	Intermittent suturing with absorbable sutures under laparoscopy	Recovered
Total	7 (5.3)		

Table 2 Category, management and prognosis of postoperative complications

Postoperative complications	n (%)	Management	Prognosis	
Short-term complications	Cardiopulmonary dysfunction	1	Cardiopulmonary resuscitation and tracheal intubation, the patient was transferred to SICU emergently	Dead
	Urinary retention and infection	2	Proper antibiotics and functional exercise	Recovered
	Incisional infection and colliquation	2	Frequent dressing	Recovered
	Anastomotic leakage	12	1 patient underwent proximal colostomy; others received abdominal lavage and intravenous fluid support	Recovered
	Anastomotic hemorrhage	7	Fluid expansion and proper hemostatics: 2 patients with detainment of anal tubes received irrigation of ice-cold saline dissolving noradrenaline, 2 patients with relative severe hemorrhage received a colonoscopy and finally the bleeding points were stopped using titanic clips	Recovered
Total (%)	24 (18.2)			
Long-term complication	Anastomotic stricture	2	Periodic distension under colonoscopy	Improved
Total (%)	2 (1.5)			

SICU: Intensive Care Unit of Surgery.

size of tumor was 12.4 ± 10.1 (2-49) cm^2 , and the average distance of tumor was 7.86 ± 2.60 (3-15) cm from the anal verge. Postoperative pathological examinations revealed 9 cases of mucinous adenocarcinoma, 36 tubular adenocarcinoma, and 31 papillary adenocarcinoma. In TNM staging, 46 were stage I, 51 stage II, and 35 stage III. The preoperative nutritional status was mainly evaluated by hemoglobin and albumin, 56 patients were found below the standard level, and all of those patients received preoperative intravenous nutritious support. Besides the 5 cases with hand-assisted LAR, all the operations were completed laparoscopically with no conversion to open surgery. Up till now within the follow-up period, we discovered no metastasis, no tumor-related mortality, and one fatality due to a cardiovascular accident.

Surgical complications and management

The overall incidence of surgical complications was 20.5% (27/132) and the incidence of intraoperative complications was 5.3% (7/132), including hemorrhage (2/132), ureter injury (2/132), bladder injury (2/132), and anastomotic rupture (1/132). The incidence rate for short-term complications (defined as occurring one month after the operation) was 18.2% (24/132), including one patient who was attacked with an severe cardiac dysfunction caused by acute myocardial infarction and immediately sent to the Intensive Care Unit of Surgery, anastomotic leakage (9.1%,

12/132), anastomotic hemorrhage (5.3%, 7/132), incisional colliquation or infection (1.5%, 2/132), and urinary infection (1.5%, 2/132). The long-term complication is anastomotic stricture (1.5%, 2/132).

During operation, all hemorrhage was hemostated by titan clips or proper sutures. Injuries of ureter, bladder, or anastomosis were repaired immediately, and the double J catheters were detained after repair of ureters to avoid stricture. All the anastomotic hemorrhage occurring intra- or postoperatively were treated by conservative therapy such as fluid expansion to stabilize the hemodynamics and proper hemostatics. Two patients with detainment of anal tubes received irrigation of ice-cold saline dissolving noradrenaline, and two patients with relatively severe hemorrhage received a colonoscopy and the bleeding was stopped finally using titanic clips. Only one patient underwent a protective proximal colostomy because of diffused abdominal and pelvic infection, and all the patients with anastomotic leakage were healed by continuous lavage of pelvic cavity via drainage tubes, detaining anal tube for a better decompression of lumen, as well as proper antibiotics treatment. Two patients with anastomotic stricture were also relieved by periodic distension therapy under colonoscopy (Tables 1 and 2).

Risk factor analysis

The above general statistics implied that the major clinical types of complications after LAR were anastomotic leak-

Table 3 Univariate analysis of factors for low anterior resection complications

Variables	n	Complication n (%)	χ^2 value	P value
Gender				
Male	80	20 (15.15)	3.743	0.053
Female	52	7 (5.30)		
Age (yr)				
≥ 55	104	21 (15.9)	0.021	0.886
< 55	28	6 (4.54)		
Tumor size (cm)				
$\Phi \geq 3$	86	24 (18.2)	8.424	0.004
$\Phi < 3$	46	3 (2.30)		
Pathological type				
Mucinous adenocarcinoma	9	3 (2.30)	2.440	0.486
Tubular adenocarcinoma	36	5 (3.80)		
Papillary adenocarcinoma	31	8 (6.06)		
Adenocarcinoma	56	11 (8.33)		
Tumor location (anal verge) (cm)				
> 6	88	10 (7.58)	6.615	0.010
≤ 6	44	17 (12.88)		
TNM staging				
Stage I	46	2 (1.52)	11.46	0.003
Stage II	51	14 (10.61)		
Stage III	35	11 (8.33)		
Preoperative nutritious status (g/L)				
HB > 100 and Ag > 32	76	11 (8.33)	3.938	0.047
HB ≤ 100 or Ag ≤ 32	56	16 (12.12)		

age and hemorrhage. The clinical parameters associated with surgical complications of LAR are listed in Table 3. The univariate analysis showed that the influencing factors for surgical complications were tumor size, location, pathological staging and preoperative nutrition while gender, age and pathological type were not significantly correlated with the occurrence of complications. To be specific, a neoplasm larger than 3 cm in diameter, 6 cm from anal verge, together with anemia or hypoproteinemia (HB ≤ 100 g/L or Ag ≤ 32 g/L) may significantly increase the risks of postoperative complications. Further multivariate analysis using binary logistic regression model demonstrated that tumor size, location and pathological staging were independent risk factors for surgical complications after LAR, their relative risk (RR) was 1.149, 0.552 and 2.816 (Table 4).

DISCUSSION

Laparoscopic LAR is minimally invasive with a rapid recovery and short length of hospital stay compared with laparotomic approach. Compared with the mortality rate (2%-3%) by the conservative surgery, the mortality rate remains about 1% and the main causes of death were systemic complications^[1]. As for postoperative complications, a serial clinical trials including a COST study have demonstrated no significant difference between these two kinds of techniques, which indicated that both methods are safe and feasible^[2-5]. The Randomized Controlled Trial-CLAS-ICC, which includes 484 cases of laparoscopic colorectal surgery and 253 cases of conservative ones, has listed the commonly encountered types of complications and their incidence rates^[2]: intraoperative complications (14%)

were severe hemorrhage (7%), cardiopulmonary dysfunction (4%), vascular/bladder injury (2%), and bowel injury (1%); short-term (within 30 d after operation) postoperative complications of LAP group were incision infection (13%), pulmonary infection (10%), anastomotic leakage (10%), deep vein thrombosis (0.4%) for LAP group (total 40%); and the most common long-term complications were bowel obstruction and persistent incision infection. Our results revealed that anastomotic leakage and hemorrhage more frequently appeared than the intraoperative bleeding, ureter or other visceral injury, incision infection, and anastomotic stricture. We found no obvious difference from the results of the CLASICC study in complication types, but only a proportional variation.

After a statistical analysis of the factors which may influence the occurrence of surgical complications, we concluded that a tumor larger than 3 cm in diameter, less than 6 cm proximal to anal verge, and confirmed as stage III by pathological diagnosis, i.e. tumor location, tumor size and pathological staging, were independent risk factors for LAR surgical complications. Anastomotic leakage has been regarded as one of the major types of LAR complications^[5-7], a better understanding of the risk factors would certainly benefit the selection of appropriate treatment. In conservative therapy, the incidence of anastomotic leakage after LAR could rise up to 4%-25%^[6], however the CLASICC study revealed that the incidence rate was around 10%, which seems to have no significant difference. Insufficient blood supply, over-tension, and difficult anastomosis are the causes of anastomotic leakage in the conservative method. Patients with a tumor larger in size or later in TNM staging usually endured a worsened systemic physical status, and sometimes their bowels were found relatively edematous, or there was a pelvic adhesion due to invasion of the large tumor mass. Besides, the whole procedure routinely accomplished by TME principle will probably run into an insufficient blood supply around the location of anastomosis for a too thorough resection of mesentery^[8]. Our results also revealed that the tumor location influence the occurrence of leakage. To guarantee oncological safety, we may choose a more proximal anastomosis for a lower tumor mass, which would inevitably result in a higher tension or even anastomotic difficulty^[9]. Lipska *et al*^[10] performed a risk factor analysis for 98 cases of laparoscopic LAR and concluded that tumor located within 6 cm from the anal verge is an significant risk factor for surgical complications ($P = 0.01$). This reminds us that some modified techniques which can help relieve the regional tension could be used as alternatives when performing some critical anastomosis during operation^[11]. Our study indicated that tumor size, location and pathological staging are major independent risk factors for laparoscopic LAR. This conclusion is somewhat close to that in the previous literature.

With the extensive use of LAR, the prevention or management of surgical complications, especially some common types, has gained more attentions. Anastomotic leakage and hemorrhage are considered to be the two major complications which will directly influence the

Table 4 Multivariate analysis of factors for low anterior resection complications

Variables	Coefficient	Standard error	Wald statistics	Degree of freedom	P value	Exp (coefficient)
Location	-0.595	0.193	9.453	1	0.002	0.552
Size	0.139	0.039	12.989	1	< 0.001	1.149
Nutritious status	0.705	0.616	1.308	1	0.253	2.023
TNM staging	1.035	0.456	5.159	1	0.023	2.816

postoperative recovery of the patients^[5]. First of all, a leakage should be discovered promptly, and a fasting should be ordered with an intimate observation of the patient's regional signs and physical status. If the overall status is stable, an abdominal or pelvic lavage through a drainage tube is recommended so as to speed up the regional healing progress. For the patients who present with an ineffective response to preservative treatment or a severe systemic symptom, an interventional therapy or operation should be performed without hesitation, reconstruction of the anastomosis or an ileostomy is both a favorable choice. A defunctioning stoma has always been regarded as a useful method in both preventing and controlling of leakage in conventional colorectal surgery, which could even significantly decrease the occurrence of peritonitis or sepsis. We used to follow this concept to create preventive stomas for those "high risk" cases, but the additional procedure for stoma closure and the potential mentally discomfort of patients have made us continuously explore for better management. We found that postoperative placement of silicon drainage tubes near anastomosis or presacral space could not only minimize the possibility of local adhesion and sinus tract caused by rubber tube, but also serve as a monitoring "instrument" for surgical trauma healing by detecting the color and characteristics of fluid. Moreover, it could be transformed into multifunctional drainage such as suction by inserting some pinheads. Placement of anal tubes in certain cases is also very useful, especially in those who underwent a low or ultra-LAR. Since postoperative recovery of anal sphincter function, even evacuation and defecation resulted in elevation of intrarectal pressure, insertion of anal tube over the location of anastomosis would help relieve this pressure nearby, thus simultaneously decreasing the infection caused by early excreta. In this study, most of the patients who were recovered by conservative therapy were treated by these two methods. For anastomotic hemorrhage, although most of the conditions could be healed by intensive monitoring, sufficient fluid apply and proper intravenous hemostatics, in some recurrent cases, icy saline injection with noradrenaline through an anal tube was suggested in our center, and at the same time, attention should be paid to avoid artificial anastomotic eruption. If this method does not work well, detection for hemorrhaging spots under colonoscopy is also a worthy option, which could somewhat reduce the necessities of re-laparotomy for hemostasis. In this study, all the diagnosed hemorrhage cases were recovered by alternative conservative therapies so that patients could rescue from extra distress brought by another operation.

Another complication that is more likely to occur during operation is injury of ureter and bladder. The former occasion could happen whether in colon surgery or rectal surgery at some anatomical points, so we prefer to expose them at both sides in abdominal cavity when dissociating the bowels so as to avoid any useless dissection or clipping (especially near lateral- or retro-peritoneum). If any injury of ureter occurred, surgeons should quickly evaluate the severity before choosing the right method to repair. Under most circumstances, a side-to-side anastomosis of the injured ureter with catheterization of a "pigtail" ureteral catheter is sufficient, this procedure should better be completed under laparoscopy, but an open approach should be adopted as long as it is too difficult^[12]. The injury of bladder is commonly due to false dissection or electronic-coagulation, even the false insertion of Veress needle or Trocar. So surgeons should pay attention to those thickening mesentery, enlarged tumor mass or narrow pelvis when dissecting the anterior wall of the rectum, and tightly move close to the inferior border whatever manipulation (especially when using harmonic scalpel) he or she is performing. For small perforation of bladder (3-5 mm), a detainment of urethral catheter for 7-10 d is enough for wound healing; for relatively large or irregular lesions, saturation using absorbable sutures and detainment of urethral catheter for 4-10 d are necessary, however, this surely depends on the specific location and size of the lesion.

With the development of techniques, some intra-abdominal complications could be managed by laparoscopy. For the patients with anastomotic leakage who need a laparotomy, abdominal cavity lavage, or replacement of drainage tubes, we could also complete these procedures with minimal invasion; even the patient needs to create a temporary stoma, we only need to make a small incision for pulling out the bowel. Since the adhesion of intra-abdominal cavity is often much more improved after laparoscopic surgery compared with conventional approach, the re-establishment of insufflation space could be achieved without much difficulty. It is promising that laparoscopic re-operation could possibly become another trend in abdominal surgery.

With the improvement of laparoscopic technique, widespread application of anastomotic devices, and greater demands for quality of life, more patients would receive laparoscopic LAR. Up till now, surgery-related complications are major factors prohibiting the improvement of overall quality of the surgery, so studies on how to better handle these problems would be beneficial for surgeons in accumulating necessary experiences as well as expanding the extent of application.

COMMENTS

Background

Despite important progress in the past decade regarding surgical staplers, techniques, and perioperative management, patients who receive low anterior resection (LAR) for rectal cancer may still inevitably have surgical complications. It is crucial to understand the risk factors for clinical applications and its impact on patient survival.

Research frontiers

The advanced skills and modified methods of laparoscopic colorectal surgery are widely recognized by surgeons, and several recently published randomized studies have shown the better short-term benefits of the laparoscopic approach in colorectal cancer compared with the open approach. However, such data are only limited to the common complications related to laparoscopic LAR during or after surgery. The authors performed this trial to study laparoscopic LAR in terms of perioperative and oncological outcomes in patients with rectal cancer.

Applications

With the improvement of laparoscopic technique, widespread application of anastomotic devices, and greater demands for improving quality of life, more patients would receive laparoscopic LAR. Up till now, surgical related complications are major factors prohibiting the improvement of overall quality of the surgery, so studies on how to better handle these problems would be beneficial for surgeons in accumulating necessary experiences as well as expanding the extent of application.

Terminology

LAR: A common surgery for rectal cancer in the proximal (upper) two-thirds of the rectum. Protective loop ileostomy: a surgical opening constructed by bringing the end or loop of small intestine (the ileum) out onto the surface of the skin. Anastomotic leakage: An anastomosis is a surgical connection between the stomach and bowel, or between two parts of the bowel. The surgeon attempts to create a water-tight connection by connecting the two organs with either staples or sutures, either of which actually makes a hole in the bowel wall. If the seal fails to form, for any reason, fluid from within the gastrointestinal tract can leak into the sterile abdominal cavity and give rise to infection and abscess formation.

Peer review

This is a retrospective study on 132 patients with rectal cancer dealing with management and prevention of complications of low anterior rectal resection. It is important that surgical and gastroenterological communities have an idea of what is made in China concerning laparoscopic surgery for rectal cancer.

REFERENCES

- 1 Patankar SK, Larach SW, Ferrara A, Williamson PR, Galagher JT, DeJesus S, Narayanan S. Prospective comparison of laparoscopic vs. open resections for colorectal adenocarcinoma over a ten-year period. *Dis Colon Rectum* 2003; **46**: 601-611
- 2 Guillou PJ, Quirke P, Thorpe H, Walker J, Jayne DG, Smith AM, Heath RM, Brown JM. Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASICC trial): multicentre, randomised controlled trial. *Lancet* 2005; **365**: 1718-1726
- 3 A comparison of laparoscopically assisted and open colectomy for colon cancer. *N Engl J Med* 2004; **350**: 2050-2059
- 4 Leung KL, Kwok SP, Lam SC, Lee JF, Yiu RY, Ng SS, Lai PB, Lau WY. Laparoscopic resection of rectosigmoid carcinoma: prospective randomised trial. *Lancet* 2004; **363**: 1187-1192
- 5 Sonoda T, Pandey S, Trencheva K, Lee S, Milsom J. Long-term complications of hand-assisted versus laparoscopic colectomy. *J Am Coll Surg* 2009; **208**: 62-66
- 6 Tuson JR, Everett WG. A retrospective study of colostomies, leaks and strictures after colorectal anastomosis. *Int J Colorectal Dis* 1990; **5**: 44-48
- 7 Pera M, Delgado S, García-Valdecasas JC, Pera M, Castells A, Piqué JM, Bombuy E, Lacy AM. The management of leaking rectal anastomoses by minimally invasive techniques. *Surg Endosc* 2002; **16**: 603-606
- 8 Veenhof AA, Engel AF, Craanen ME, Meijer S, de Lange-de Klerk ES, van der Peet DL, Meijerink WJ, Cuesta MA. Laparoscopic versus open total mesorectal excision: a comparative study on short-term outcomes. A single-institution experience regarding anterior resections and abdominoperineal resections. *Dig Surg* 2007; **24**: 367-374
- 9 Lee WS, Yun SH, Roh YN, Yun HR, Lee WY, Cho YB, Chun HK. Risk factors and clinical outcome for anastomotic leakage after total mesorectal excision for rectal cancer. *World J Surg* 2008; **32**: 1124-1129
- 10 Lipska MA, Bissett IP, Parry BR, Merrie AE. Anastomotic leakage after lower gastrointestinal anastomosis: men are at a higher risk. *ANZ J Surg* 2006; **76**: 579-585
- 11 Person B, Vivas DA, Wexner SD. Totally laparoscopic low anterior resection with transperineal handsewn colonic J-pouch anal anastomosis for low rectal cancer. *Surg Endosc* 2006; **20**: 700-702
- 12 Degiuli M, Mineccia M, Bertone A, Arrigoni A, Pennazio M, Spandre M, Cavallero M, Calvo F. Outcome of laparoscopic colorectal resection. *Surg Endosc* 2004; **18**: 427-432

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