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Laparoscopic versus open surgery for rectal cancer: results of a prospective multicentre analysis of 4,970 patients

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Abstract
Objective To compare laparoscopic versus open surgery for rectal cancer and analyse the results of the multidisciplinary audited project on total mesorectal excision conducted in Spain.
Background The safety and therapeutic efficiency of laparoscopic surgery for rectal cancer are controversial due to the technical difficulties it involves. A deviation from the oncological principles of mesorectal excision would mean a potential increase in local recurrence and shorter survival.
Methods This prospective non-randomised multicentre study includes 4,970 patients with rectal cancer. The study compares perioperative, postoperative, anatomicopathological and survival variables.
Results Five hundred and sixty five patients were excluded. Of the remaining 4,405, 3,018 (68.51 %) had open surgery (OS) and 1,387 (31.49 %) laparoscopic surgery (LS). The rate of anterior resections was higher in the LS group. The rate of intraoperative tumour perforation, number of red blood cell concentrates transfused and length of hospital stay were greater in the OS group, whereas surgical time was longer in the LS group. The incidence of complications was 45.6 % in the OS group and 38.3 % in the LS group. Involvement of the circumferential and distal margin, as well as unsatisfactory and partially satisfactory quality of the mesorectum, were greater in the OS group. There were no differences for local recurrence and survival rates.
Conclusions According to these results, laparoscopic surgery is the best option for the surgical treatment of rectal cancer, with similar rates of local recurrence and survival, although there are oncological indicators in this study to suggest that these results can be improved with laparoscopic surgery.

Keywords Rectal cancer · Total mesorectal excision · Laparoscopic surgery

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Laparoscopic surgery for colon cancer was first performed in 1991 [1], and it is generally acknowledged that the laparoscopic approach for the treatment of colon cancer has advantages over conventional surgery: less blood loss, quicker recovery, less paralytic ileus, less pain and shorter hospital stay, and at no detriment to oncological outcomes [2, 3]. However, laparoscopic surgery in the treatment of rectal cancer is controversial, as mesorectal excision is a technically difficult procedure and requires experience in not only advanced laparoscopic surgery but also open surgery. Randomised controlled trials have shown better results with laparoscopic surgery in the short term with

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rectal cancer, suggesting that it is a safe and feasible option [4, 5].

In 2006, the Spanish Association of Surgeons, realising that the outcomes of surgery for rectal cancer were related to a surgeon's learning and experience [6, 7], implemented an audited training process for total mesorectal excision in patients with rectal cancer [8], similar to that conducted in other countries [9], with the intention of improving surgeons' and pathologists' competence in the surgical treatment of rectal cancer and improving short- and long-term outcomes with this pathology.

The aim of the present study is to compare laparoscopic versus open surgery in the surgical treatment of rectal cancer and to analyse the results of the audited multidisciplinary training project in total mesorectal excision conducted in Spain.

Patients and methods

This prospective study included, up until July 2010, 4,970 patients with rectal cancer located 0–15 cm from the anal margin. Excluded from this analysis were patients not undergoing surgery, those receiving local resection and those undergoing emergency surgery. Seventy-two hospitals in Spain participated in the study. All patients were operated on by surgeons who had completed the training course in mesorectal excision. All patients were studied with clinical exploration, rectal palpation, complete colonoscopy plus biopsy, rigid rectoscopy, anorectal ultrasonography, thoracic and abdominal computed tomography, nuclear magnetic resonance of the rectum and opaque enema or colon computed tomography (CT) in patients in whom colonoscopy was incomplete. Preoperative anaesthetic evaluation was carried out in all patients to determine the American Society of Anesthesiologists (ASA) score.

Patients with stages II or III adenocarcinoma [International Union Against Cancer/American Joint Committee on Cancer (UICC/AJCC) colorectal cancer staging system] received neoadjuvant treatment with the following regimen of chemoradiotherapy (CRT): three-field pelvic radiation therapy with 50–54 Gy, 5 days a week, 1.8 Gy/day, together with oral capecitabine or continuous infusion of 5-fluorouracil (5-FU) throughout the duration of the radiation therapy. The surgical operation was performed between 6 and 8 weeks after the end of the neoadjuvant treatment. The patients with resectable distant metastases received surgery metachronously after recovery from the rectal surgery.

Surgical technique

Total mesorectal excision was performed in patients with the tumour located between 0 and 10 cm, and partial excision in those located between 10 and 15 cm, with preservation of the hypogastric nerves. In cases where the tumour infiltrated the musculus levator ani or it was not possible to obtain a safe distal margin, abdominoperineal amputation (APA) was performed. A protection ileostomy was associated in the anterior resections, at the surgeon's discretion. Patients undergoing open surgery were placed in Lloyd–Davis position, and the cavity accessed via an infraumbilical midline laparotomy extended to supraumbilical. Patients receiving laparoscopic surgery were placed in Lloyd–Davis position with forced Trendelenburg (30°). The surgeon stands at the patient's right, the first assistant at the left and the second assistant between the legs, with the monitor placed at the patient's feet on the left. The pneumoperitoneum is created at a pressure of 12–15 mmHg with placement of five or six ports, depending on the surgeon's preference. Patients with anterior resection received a mini-incision, usually horizontal, for removal of the specimen and placement of the head of the autosuture stapler; the anastomosis was done intracorporeally. With abdominoperineal amputations and anterior resections with a manual colo-anal anastomosis the specimen was extracted via the perineum without the need for an abdominal incision. Conversion to laparotomy occurred when total excision of the mesorectum was not possible due to technical problems or incidences during dissection.

All the specimens were analysed by a pathologist who had completed the training course in anatomicopathological examination of rectal cancer, with evaluation of the quality of the mesorectum, involvement of the circumferential margin (distance $\leq$1 mm from the tumour to the mesorectal fascia), involvement of the distal margin (tumour reaching the distal section) and number of isolated lymph nodes.

A clinical anastomotic leak was considered when dehiscence was detected by digital examination, endoscopy or CT and the patient presented with peritonitis or an escape of gas or faecaloid material through the drain or pelvic abscess.

Postoperative complications are regarded as those occurring during admission or conditioning readmission within the first 30 days postoperatively.

Follow-up

All the patients were followed up in the outpatient department every 3 months for the first 2 years and then every 6 months. Each visit included anamnesis, physical and wound exploration, general blood test and carcinoembryonic antigen (CEA) determination. Every 6 months they alternated between a chest and abdomen CT scan or abdominal ultrasound and chest radiography. Colonoscopy was done yearly.

Local recurrence is understood as the reappearance of the tumour in the surgical field. Both local recurrence and distant metastases were confirmed by histological study.

The data obtained were submitted to the central study register on a 6-monthly basis, including the appearance of local recurrence, distant metastases, death and the causes of death.

Parameters analysed

The study compares the following variables: surgical technique performed, blood transfusion, surgical time, tumour perforation, rate of conversion, postoperative complications, length of hospital stay, circumferential margin involved, distal margin involved, isolated lymph nodes, quality of the mesorectum, local and distant recurrence and survival rate.

Statistical analysis

Data were processed using the software package SPSS 13.0 for Windows. Comparisons of two means were made with the combined Student *t* test or the Behrens–Fisher test, depending on whether or not there was homogeneity of variance between the two samples, or with the nonparametric Mann–Whitney test when distribution of the data was clearly not normal even after logarithmic transformation, for example for days of stay.

To study the relationship between qualitative variables and comparison of ratios in independent samples we conducted an analysis of contingency tables using Pearson's χ^2 test and subsequent analysis of residues, or using the Fisher exact test.

The rates of survival were calculated using the Kaplan–Meier estimator in the different groups, and the survival curves were compared with the log-rank test or the Breslow test if there was an accumulation of cases with little survival time censored. Similarly the survival analysis was done for local recurrence and distant metastases.

Finally, the possible prognostic factors for tumor perforation, complications, circumferential margin involved, distal margin involved, quality of the mesorectum, local recurrence, metastasis and survival were assessed with the Cox's proportional risk regression model.

Results

Of the 4,970 patients with rectal cancer diagnosed during the study period, 565 were excluded for the criteria mentioned. The remaining 4,405 were distributed into two groups depending on whether they had open surgery (OS) (3,018; 68.51 %) or laparoscopic surgery (LS) (1,387; 31.49 %). The two groups were homogeneous for sex, age and tumour location, with no significant differences. The LS group had more patients with ASA I–II and fewer with III, more patients at preoperative stage III and fewer at stage IV and a higher rate of neoadjuvance than the OS group, with significant differences (Table 1).

The rate of anterior resections was higher in the LS group, whereas the percentage of Hartmann and proctocolectomies was higher in the OS group, with significant differences. There were no differences in the rate of abdominoperineal amputations. Creation of a derivative stoma protection was similar in the two groups. The rate of intraoperative tumour perforation, number of red blood cell concentrates transfused during the operation and length of stay were significantly greater in the OS group, whereas surgical time was longer in the LS group (Table 2).

Two hundred forty-one patients from the LS group (17.37 %) were converted. The converted patients remained in the LS group for analysis of the results.

There were complications in 1,375 patients (45.6 %) from the OS group and in 531 patients (38.3 %) from the LS group, with significant differences. On analysing the complications individually, we noted a significantly higher rate of wound infection, evisceration, perineal infection, urinary infection, multiorgan failure, cardiological complications and respiratory complications in the OS group; however, there were no differences with regard to anastomotic leak or other complications. The rate of reoperations in the postoperative period was similar. The death rate in

Table 1 Characteristics of both groups

	LS (1,387)	OS (3,018)	*p*
Age (years)	66.40 ± 13.20	67.47 ± 13.41	ns
Sex			
Male	903 (65.1 %)	2,022 (66.9 %)	ns
Female	484 (34.9 %)	996 (33.1 %)	
ASA			
I	123 (8.8 %)	154 (5.1 %)	<0.05
II	810 (58.4 %)	1,503 (49.8 %)	
III	422 (30.4 %)	1,204 (39.9 %)	
IV	32 (2.3 %)	157 (5.2 %)	
Tumour location (cm from anal margin)	7.86 ± 4.11	7.71 ± 3.90	ns
Neoadjuvance	806 (58.1 %)	1,582 (52.4 %)	<0.05
Preoperative staging			
0	17 (1.2 %)	11 (0.4 %)	<0.05
I	203 (14.6 %)	422 (14.0 %)	
II	242 (17.4 %)	578 (19.1 %)	
III	799 (57.6 %)	1,642 (54.4 %)	
IV	126 (9.1 %)	365 (12.1 %)	

ns Non-significant

Table 2 Intraoperative data and length of stay

	LS (1,387)	OS (3,018)	*p*
Technique			
LAR	963 (69.4 %)	1,841 (61.0 %)	<0.05
APA	327 (23.6 %)	696 (23.1 %)	
Proctocolectomy	6 (0.4 %)	36 (1.2 %)	
Hartmann	66 (4.8 %)	321 (10.6 %)	
Non-resectable	25 (1.8 %)	113 (3.7 %)	
Exenteration	0	11 (0.4 %)	
Derivative stoma	517 (53.7 %)	1,014 (55.1 %)	ns
Tumour perforation	63 (4.5 %)	249 (8.3 %)	<0.05
Surgical time (min)	217.83 ± 103.48	186.38 ± 106.35	<0.05
Number of intraoperative red blood cell concentrates	0.15 ± 0.57	0.35 ± 0.91	<0.05
Length of stay (days)	8 [6, 13]	11 [8, 17]	<0.05

LAR low anterior resection, *APA* abdominoperineal amputation

the postoperative period was 3.6 % in the OS group and 1.2 % in the LS group, with significant differences (Table 3).

The mean number of isolated lymph nodes was similar in the two groups, but the rate of circumferential and distal margin involvement, as well as unsatisfactory or partially satisfactory quality of the mesorectum, was significantly higher in the OS group (Table 4).

Mean follow-up was 21.98 ± 12.39 months for the OS group and 23.58 ± 11.77 months for the LS group. There were no differences for rate of local recurrence and survival, whereas there were significantly more metachronous liver metastases in the OS group (Figs. 1, 2, 3).

The regression model shows that laparoscopic surgery is one of the prognostic factors for tumor perforation, complications, circumferential margin involved, distal margin involved, quality of the mesorectum, local recurrence, metastasis and survival along with other variables as shown in Table 5.

Discussion

Laparoscopic surgery for colon cancer has advantages over open surgery, as demonstrated by randomised prospective multicentre studies [2, 3], and is widely accepted. On the other hand, use of laparoscopic surgery for rectal cancer is still controversial. This is particularly due to the complexity of performing TME, due on the one hand to the anatomical position of the rectum, for which the surrounding bone structures of the pelvis make access more complex, and on the other, and much more importantly, to the need to perform TME with adequate margins to avoid local recurrence. Moreover, as the rectum is continuous with the sphincter apparatus and joined to the hypogastric plexus, the surgeon must attempt conservative sphincter surgery to preserve the sexual and urinary functions, which improve quality of life after surgery [10, 11].

Table 3 Complications

	LAP (n = 1,387)	Open (n = 3,018)	*p*
Complications	**531 (38.3 %)**	**1,375 (45.6 %)**	<0.05
Reoperations	*117 (8.4 %)*	*290 (9.6 %)*	*ns*
Wound haemorrhage	14 (1.0 %)	25 (0.8 %)	ns
Wound infection	92 (6.6 %)	311 (10.3 %)	<0.05
Evisceration	12 (0.9 %)	64 (2.1 %)	<0.05
Perineal infection[a]	58 (17.7 %)	184 (26.4 %)	<0.05
Perineal cicatrisation[a]	24 (7.3 %)	60 (8.6 %)	ns
Anastomotic leak[b]	81 (8.4 %)	172 (9.3 %)	ns
Anastomotic bleeding[b]	12 (1.2 %)	12 (0.7 %)	ns
Haemoperitoneum	3 (0.2 %)	19 (0.6 %)	ns
Peritonitis	10 (0.7 %)	30 (1.0 %)	ns
Abdominal abscess	85 (6.1 %)	206 (6.8 %)	ns
Intestinal ischaemia	4 (0.3 %)	9 (0.3 %)	ns
Cholecystitis	1 (0.1 %)	1 (0.04 %)	ns
Iatrogenic	15 (1.1 %)	19 (0.6 %)	ns
Paralytic ileus	133 (9.6 %)	269 (8.9 %)	ns
Mechanical ileus	16 (1.2 %)	19 (0.6 %)	ns
Urinary infection	36 (2.6 %)	116 (3.8 %)	<0.05
Cardiological	21 (1.5 %)	75 (2.5 %)	<0.05
Hepatic	1 (0.1 %)	6 (0.2 %)	ns
Respiratory	37 (2.7 %)	133 (4.4 %)	<0.05
MOF	6 (0.4 %)	44 (1.5 %)	<0.05
PTE	1 (0.1 %)	8 (0.3 %)	ns
Postoperative death	**16 (1.2 %)**	**108 (3.6 %)**	<0.05

[a] Calculated from abdominoperineal resections

[b] Calculated from anterior resections

MOF multiorganic failure, *PTE* pulmonary thromboembolims

Table 4 Anatomicopathological data

	LAP	Open	*p*
Number of isolated lymph nodes	14.53 ± 8.36	14.75 ± 9.49	ns
Circumferential margin involved	132 (9.5 %)	492 (16.3 %)	<0.05
Distal margin involved	7 (0.5 %)	36 (1.2 %)	<0.05
Quality of the mesorectum			
Satisfactory	1,143 (82.4 %)	2,282 (75.6 %)	<0.05
Partial	168 (12.1 %)	507 (16.8 %)	
Unsatisfactory	76 (5.5 %)	229 (7.6 %)	

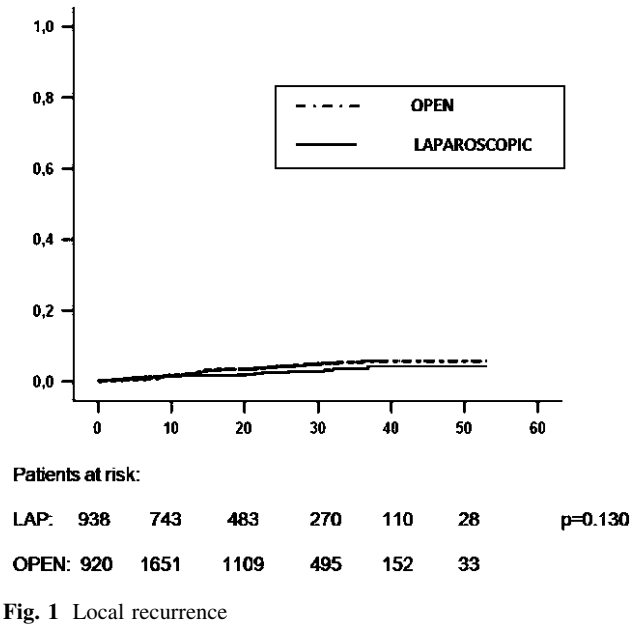

Fig. 1 Local recurrence

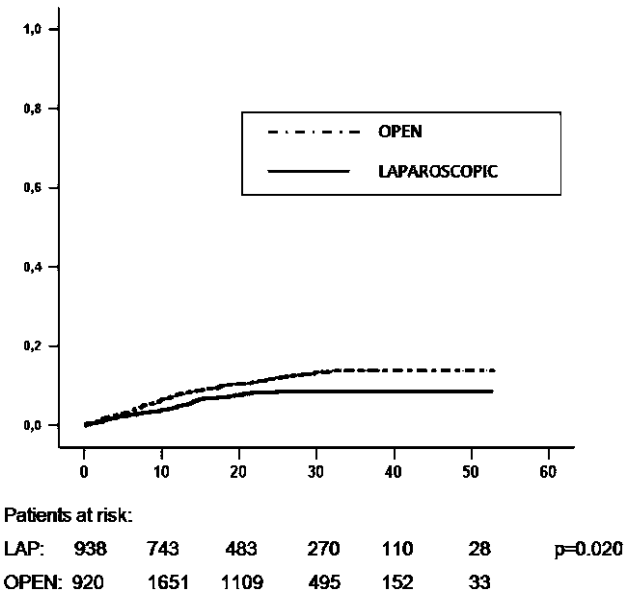

Fig. 2 Distance metastases

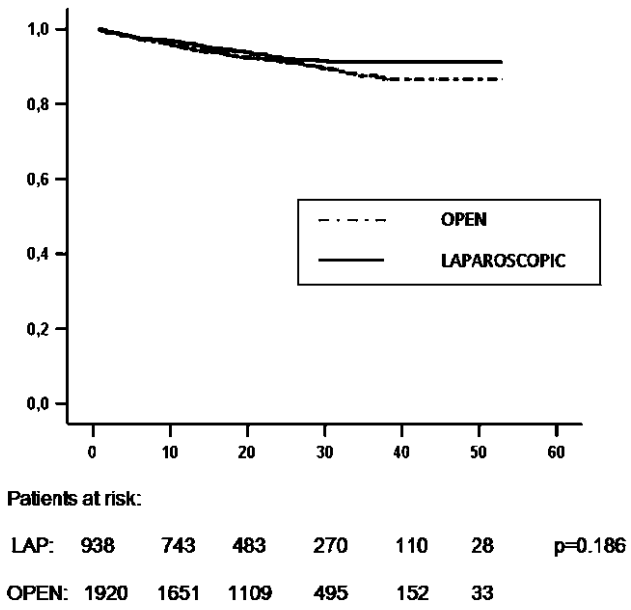

Fig. 3 Survival

Due to these demands, many surgeons doubt the effectiveness of laparoscopic surgery for total mesorectal excision; this doubt is based solely on unfavourable comments regarding laparoscopic surgery, rather than on randomised studies comparing laparoscopic with open surgery and demonstrating the advantages of rectal resection via laparoscopy [12, 13], and there are neither randomised studies nor cohort series to show that laparoscopic surgery is harmful and dangerous to the patient. On the other hand, the increase in surgeons' skill, training and experience in laparoscopic surgery, together with advances in instrumentation and imaging technology, have made it possible for this type of surgery to be performed safely and effectively. One of the fundamental advantages of laparoscopic surgery for rectal cancer is the clear, broad vision of the pelvis, which is not possible with open surgery. This makes it easy to identify the planes of dissection, blood vessels, nerves and genitourinary structures, which would potentially make for a better quality of the mesorectum, with less involvement of margins, less bleeding, less alteration in the sex and gallbladder functions and less injury to the neighbouring viscera and rectum. As with open surgery, all these benefits depend on the surgeon, who must go through a longer and steeper learning curve than for other pathologies to acquire the necessary skill to perform this surgery safely and effectively. This is why, for many surgeons, open surgery is still the chosen approach for treating rectal cancer.

There is steadily increasing evidence that laparoscopic resection of the rectum is an adequate surgical technique. The results of most randomised and non-randomised studies [3–5, 14, 15] comparing laparoscopic with open surgery for rectal cancer reveal smaller blood loss, shorter duration of ileus and shorter hospital stay with the laparoscopic approach compared with open surgery, with significantly longer surgical times and a similar—and in some studies even lower—incidence of complications [16].

There are few studies with large series of patients. In a multicentre study conducted in Japan, 1,057 patients with rectal cancer underwent laparoscopic surgery between 1994 and 2006 in 28 centres. Anterior resection was performed in 938 patients, with a conversion rate of 7.3 %. Postoperative complications occurred in 235 patients (22 %), with anastomotic leaks in 84 patients (9 %). The rate of local recurrence was just 1 % [17]. In our

Table 5 Regression model

Prognostic factor	OR	*p*	95 % CI
Tumour perforation			
Group	0.602	0.001	0.450–0.806
Sex	0.607	0.001	0.458–0.804
Preoperative staging	1.214	0.001	1.122–1.314
Preoperative radiotherapy	1.607	0.001	1.245–2.075
Tumour location	0.575	0.001	1.449–0.747
Complications			
Group	0.782	0.000	0.683–0.894
Sex	0.603	0.001	0.528–0.689
Tumour location	0.731	0.001	0.646–0.828
Age	1.007	0.002	1.003–1.012
Circumferential margin involved			
Group	0.591	0.000	0.476–0.733
Preoperative staging	1.351	0.000	1.266–1.442
Preoperative radiotherapy	2.035	0.000	1.671–2.478
Tumour location	0.696	0.000	0.575–0.844
Distal margin involved			
Group	0.394	0.037	0.164–0.946
Preoperative staging	1.232	0.034	1.016–1.494
Quality of the mesorectum			
Group	0.690	0.000	0.578–0.824
Age	1.009	0.006	1.003–1.015
Preoperative radiotherapy	1.191	0.040	1.008–1.407
Tumour location	0.628	0.000	0.533–0.740
Local recurrence			
Group	1.813	0.009	1.158–2.837
Preoperative staging	0.594	0.006	0.411–0.858
Preoperative radiotherapy	0.797	0.000	0.717–0.887
Metastasis			
Group	1.666	0.000	1.282–2.147
Preoperative staging	0.707	0.000	0.657–0.760
Preoperative radiotherapy	0.546	0.000	0.434–0.686
Survival			
Group	0.577	0.000	0.432–0.769
Preoperative staging	1.320	0.000	1.225–1.423
Preoperative radiotherapy	2.145	0.000	1.661–2.771
Age	1.042	0.000	1.030–1.053

OR odds ratio, *CI* confidence interval

multicentre study 4,970 patients with rectal cancer were operated on by surgeons trained in total mesorectal excision via open surgery, as well as having training and experience in colorectal and advanced laparoscopic surgery, which is why the bias of the surgeon's role is smaller. Our results show that the laparoscopic approach has several advantages for the patient when compared with open surgery; For example, the incidence of postoperative complications was lower: there were fewer cardiorespiratory complications than with open surgery. This may be because the minimally invasive approach of laparoscopic surgery would lead to better recovery of pulmonary function, as has been reported [18], although it may also be due to the significantly higher number of ASA III patients in the open surgery group. The incidence of abdominal wall-related complications, such as infection and evisceration, was lower with laparoscopic surgery, probably because the surgical wound is not so long, as it is only used to extract the surgical specimen, meaning shorter exposure to contaminating agents, and in our case accidental opening of the rectum was greater in the open surgery group, which would lead to a contaminated surgery and a higher incidence of surgical wound infection.

One of the most feared complications with this kind of surgery is anastomotic leak. Some authors do not recommend the laparoscopic approach for treating rectal cancer due to the high incidence of anastomosis-related complications [19]. However, in most studies, as in ours, the incidence of anastomotic leaks was similar for both techniques [3–5, 14, 20]. This complication is most often related to the surgical technique, as the linear staplers used for distal dissection of the rectum are not ideal and technically incorrect dissections are not uncommon (zigzag formation, ischaemic ends, non-watertight stapling, etc.), which may increase the risk of leakage; in such cases the surgeon must be familiar with, and perform, a manual coloanal anastomosis; if not, the rate of dehiscence will increase and there will be a reduction in conservative sphincter surgery at the expense of an increase in APA.

One of the most important prognostic factors with TME is involvement of the distal and circumferential margins, which implies an increase in local recurrence and a lower survival rate, as well as the opening of the rectum during dissection, which is associated with a higher incidence of local recurrence [21, 22]. There are various randomised and non-randomised studies and meta-analyses which show that laparoscopic TME, when compared with open surgery, is an oncologically correct technique, with rates of distal and circumferential margin involvement and number of isolated lymph nodes similar for both techniques [4, 5, 14, 15, 23]. However, an important randomised multicentre study comparing the treatment of colorectal cancer using the laparoscopic and open techniques initially showed greater involvement of the circumferential margin in laparoscopy-treated rectal cancer, with no significant differences, but after 3 years of follow-up there were no differences in overall survival, recurrence and quality of life [3]. In our study, the incidence of circumferential and distal margin involvement, as well as rectal perforation during dissection, was significantly higher in open surgery. This is because during laparoscopic surgery there is better visibility, magnification and exposure of the structures,

especially in narrow pelvises, with less manipulation of the mesorectum during dissection, which allows a better dissection and accuracy when operating. For these same reasons, this and other studies [24–26] have shown that the blood loss of patients undergoing laparoscopic surgery is smaller than with open surgery, which can reduce infectious complications, anastomotic leaks and the risk of tumour recurrence. All these results furnish further proof of the safety and effectiveness of laparoscopic rectal resection. If these results are confirmed by ongoing studies, laparoscopic surgery should be offered to the great majority of patients with rectal cancer.

One of the main reasons why scepticism exists regarding use of laparoscopic surgery for rectal cancer is because there are very few data on the long-term oncological results (local recurrence and survival). All the short-term advantages would be unimportant and irrelevant if the incidence of local recurrence and survival is compromised. In our study, with mean follow-up of 21 months for OS and 23 months for LS, survival and local recurrence were similar for both surgical techniques and comparable to those observed in other studies on the surgical treatment of rectal cancer via the open approach [9] and comparative studies and meta-analyses comparing the laparoscopic and open approaches [2–5, 14, 15, 20]. If the correctness of TME is related to the rate of local recurrence, TME via laparoscopy is as effective a technique as open TME, although some authors report an incidence of local recurrence in the upper range, for both open and laparoscopic surgery [27, 28], probably due to the fact that the series are small, the selection of patients includes tumours affecting adjacent organs and there are high rates of conversion to open surgery. Some authors find better rates of survival with laparoscopic surgery [20, 29], which may be due to excluding the results of patients converted to laparotomy, usually those with locally advanced tumours and a poorer prognosis [20], or due to the better immunological response in the group of patients undergoing laparoscopic surgery.

In conclusion, our study shows that laparoscopic surgery for the treatment of rectal cancer has fewer complications, less blood losses, shorter hospital stay and better oncological parameters than open surgery. If survival and local recurrence are also similar to those of open surgery, rectal resection via laparoscopy is the better option for the surgical treatment of rectal cancer. The limitation of the study are that the follow-up period is too short to be able to evaluate the oncological results, although there are indicators in this study that suggest that the results can be improved with laparoscopic surgery, mainly local recurrence as involvement of the circumferential and distal margins was greater in the open group, the same as with rectal opening, factors related to a greater incidence of local recurrence. Further studies and longer follow-up time are needed to confirm these results obtained by well-trained colorectal surgeons. The oncological safety of patients must be the top priority for all surgeons, independent of the type of surgery selected.

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References

1. Jacobs M, Verdeja JC, Goldstein HS (1991) Minimally invasive colon resection (laparoscopic colectomy). Surg Laparosc Endosc 1:144–150
2. Clinical Outcomes of Surgical Therapy Study Group (2004) A comparison of laparoscopically assisted and open colectomy for colon cancer. N Engl J Med 350:2050–2059
3. Jayne DG, Guillou PJ, Thorpe H, Quirke P, Copeland J, Brown JM, Medical Research Council Conventional versus Laparoscopic-Assisted Surgery In Colorectal Cancer Trial Group (2007) Randomized trial of laparoscopic assisted resection of colorectal carcinoma: 3-year results of the UK MRC CLASICC Trial Group. J Clin Oncol 25:3061–3068
4. Kang SB, Park JW, Jeong SY, Nam BH, Choi HS, Kim DW, Lim SB, Lee TG, Kim DY, Kim JS, Chang HJ, Lee HS, Kim SY, Jung KH, Hong YS, Kim JH, Sohn DK, Kim DH, Oh JH (2010) Open versus laparoscopic surgery for mid or low rectal cancer after neoadjuvant chemoradiotherapy (COREAN trial): short-term outcomes of an open-label randomised controlled trial. Lancet Oncol 11:637–645
5. Lujan J, Valero G, Hernandez Q, Sanchez A, Frutos MD, Parrilla P (2009) Randomized clinical trial comparing laparoscopic and open surgery in patients with rectal cancer. Br J Surg 96:982–989
6. Holm T, Johansson H, Cedermark B, Ekelund G, Rutqvist LE (1997) Influence of hospital and surgeon-related factors on outcome after treatment of rectal cancer with or without preoperative radiotherapy. Br J Surg 84:657–663
7. Rodríguez-Cuellar E, Ruiz López P, Romero Simó M, Landa García JI, Roig Vila JV, Ortiz Hurtado H (2010) Analysis of the quality of surgical treatment of colorectal cancer. A national study. Cir Esp 88:238–246
8. Ortiz H (2007) Total mesorectal excision: an audited training process by the Spanish Association of Surgeons. Cir Esp 82:193–194
9. Wibe A, Moller B, Norstein J, Carlsen E, Wiig JN, Heald RJ, Langmark F, Myrvold HE, Søreide O, Norwegian Rectal Cancer Group (2002) A national strategic change in treatment policy for rectal cancer-implementation of total mesorectal excision as routine treatment in Norway. A National audit. Dis Colon Rectum 45:857–866
10. Heald RJ (1995) Total mesorrectal excision is optimal surgery for rectal cancer. A Scandinavian consensus. Br J Surg 82:1297–1299
11. Bianche PP, Rosati R, Bona S, Rottoli M, Elmore U, Ceriani C, Malesci A, Montorsi M (2007) Laparoscopic surgery in rectal cancer: a prospective analysis of patient survival and outcomes. Dis Colon Rectum 50:2047–2053
12. Badvie S, Hallan RI (2009) Randomized clinical trial comparing laparoscopic and open surgery in patients with rectal cancer. Br J Surg 96(12):1494–1495 (author reply 1496)

13. Shrikhande SV, Marda S, Goel M, Shetty G (2010) Laparoscopic surgery for rectal cancer. Lancet Oncol 11(10):919–920 (author reply 920–921)
14. Breukink S, Pierie J, Wiggers T (2006) Laparoscopic versus open total mesorectal excision for rectal cancer. Cochrane Database Syst Rev 18:4
15. Huang MJ, Liang JL, Wang H, Kang L, Deng YH, Wang JP (2011) Laparoscopic-assisted versus open surgery for rectal cancer: a meta-analysis of randomized controlled trials on oncologic adequacy of resection and long-term oncologic outcomes. Int J Colorectal Dis 26(4):415–421
16. Zhou ZG, Hu M, Li Y, Lei WZ, Yu YY, Cheng Z, Li L, Shu Y, Wang TC (2004) Laparoscopic versus open total mesorectal excision with anal sphincter preservation for low rectal cancer. Surg Endosc 18:1211–1215
17. Miyajima N, Fukunaga M, Hasegawa H, Tanaka J, Okuda J, Watanabe M, Society of Laparoscopic Colorectal Surgery (2009) Results of a multicenter study of 1057 cases of rectal cancer treated by laparoscopic surgery. Surg Endosc 23:113–118
18. Milsom JW, Bohm B, Hammerhofer KA, Fazio V, Steiger E, Elson P (1998) A prospective randomized trial comparing laparoscopic versus conventional techniques in colorectal cancer surgery: a preliminary report. J Am Coll Surg 187:46–54
19. Scheidbach H, Rose J, Huegel O, Yildirim C, Köckerling F (2004) Results of laparoscopic treatment of rectal cancer: analysis of 520 patients. Tech Coloproctol 8:S22–S24
20. Sröhlein MA, Grützner KU, Jauch KW, Heiss MM (2008) Comparison of laparoscopic vs open access surgery in patients with rectal cancer: a prospective analysis. Dis Colon Rectum 51:385–391
21. Quirke P, Steele R, Monson J, Grieve R, Khanna S, Couture J, O'Callaghan C, Myint AS, Bessell E, Thompson LC, Parmar M, Stephens RJ, Sebag-Montefiore D, MRC CR07/NCIC-CTG CO16 Trial Investigators, NCRI Colorectal Cancer Study Group (2009) Effect of the plane of surgery achieved on local recurrence in patients with operable rectal cancer: a prospective study using data from the MRC CR07 and NCIC-CTG CO16 randomised clinical trial. Lancet 373:821–828
22. Wibe A, Rendedal PR, Svensson E, Norstein J, Eide TJ, Myrvold HE, Søreide O (2002) Prognostic significance of the circumferential resection margin following total mesorectal excision for rectal cancer. Br J Surg 89:327–334
23. Biondo S, Ortiz H, Lujan J, Codina-Cazador A, Espin E, Garcia-Granero E, Kreisler E, de Miguel M, Alos R, Echeverria A (2010) Quality of mesorectum alter laparoscopic resection for rectal cancer. Results of an audited teaching programme in Spain. Colorectal Dis 12(1):23–32
24. Tang R, Chen HH, Wang YL, Changchien CR, Chen JS, Hsu KC, Chiang JM, Wang JY (2001) Risk factors for surgical site infection after elective resection of the colon and rectum: a single-center prospective study of 2,809 consecutive patients. Ann Surg 234:181–189
25. Amato A, Pescatori M (2006) Perioperative blood transfusions for the recurrence of colorectal cancer. Cochrane Database Syst Rev (1):CD005033
26. Mynster T, Nielsen HJ (2000) The impact of storage time of transfused blood on postoperative infectious complications in rectal cancer surgery. Danish RANX05 Colorectal Cancer Study Group. Scand J Gastroenterol 35:212–217
27. Fleshman JW, Wexner SD, Anvari M, LaTulippe JF, Birnbaum EH, Kodner IJ, Read TE, Nogueras JJ, Weiss EG (1999) Laparoscopic vs open abdominoperineal resection for rectal cancer. Dis Colon Rectum 42:930–939
28. Guillou PJ, Quirke Ph, Thorpe H, Walker J, Quirke P, Guillou PJ (2005) Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASSICC trial): multicentre randomized controlled trial. Lancet 365:1718–1726
29. Braga M, Frasson M, Vignali A, Zuliani W, Capretti G, Di Carlo V (2007) Laparoscopic resection in rectal cancer patients: outcome and cost-benefit analysis. Dis Colon Rectum 50:464–471