REVIEW ARTICLE

Laparoscopic Surgery for Rectal Cancer

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Abstract

Laparoscopic surgery for rectal cancer is much more challenging than that for colon cancer because of the confined space within the pelvis. Further, because of the tumor's location in the pelvis, maintenance of resection margins is of greater concern. Nonrandomized studies by groups experienced in laparoscopic surgery have shown both that it produces short-term outcomes equivalent to those for open surgery and that it can be performed safely from an oncologic perspective. Nonsurgical complications appear to be fewer, but conversion to open surgery may become a real issue. This review summarizes these findings by addressing technical considerations, early outcomes, late outcomes, costs, and complications.

Introduction

Laparoscopic colectomy for malignant disease is widely used and has been readily accepted as being more advantageous than the open approach. Its benefits include less intraoperative blood loss, less postoperative pain, shorter hospital stay, faster return to work, and fewer adhesions.[1–3] Initial concerns about port-site recurrence and adequacy of the extent of resection have been dismissed.[3]

Laparoscopic surgery (LS) for rectal cancer, however, has not been as universally accepted. We summarize here the short- and long-term results of LS and note some of the technical aspects that influence results.

Surgical resection for rectal cancer mandates at least total mesorectal excision (TME) for middle and low rectal cancers. This procedure regards the rectum and mesorectum as one lymphovascular structure and requires its excision within an intact fascia propria.[4] This has conclusively shown to reduce the rate of local recurrence and increases the rate of survival.[5,6]

We searched MedLine for the terms *laparoscopic surgery* and *rectal cancer* and retrieved 499 publications. Selected articles consisted of meta-analysis, randomized controlled trials, and prospective case series. We considered only English-language articles focusing on rectal cancer only in adults or both colon and rectal cancers in adults where the two groups were considered separately. We excluded articles that commented only on colon cancer or were case reports.

We summarize some of the studies' results and present the important outcomes in tables in an attempt to standardize these heterogeneous studies. The results are not uniform, so we outline the common trends and raise points of concern that can be addressed by future randomized controlled trials.

Technical Considerations

Circumferential sharp dissection within the *holy plane* around the mesorectal package, while maintaining an intact mesorectal fascia and avoiding injury to the nervi erigentes, is fundamental to rectal cancer resection.[4] Because the rectum is closely surrounded by the other pelvic organs and the pelvic side walls, it is imperative to ensure adequate circumferential margins during rectal cancer resection. An involved resection margin is one of the major factors that determine local recurrence[7,8] and subsequently prognosis. This is avoided by performing adequate preoperative staging, making a proper selection for neoadjuvant therapy, and using meticulous surgical technique with TME, using sharp dissection for cancers in the middle and lower thirds of the rectum.

Acquisition of advanced laparoscopic skills and familiarity with rectal cancer resection are the biggest factors in determining technical success. Male patients have a narrower pelvis than female patients do—and thus visibility and access, though better than with the open technique—are still a challenge. Obese patients frequently require the use of long instruments that are usually reserved for bariatric surgery, and abdominal wall distention may require higher insufflation pressures if possible. An assistant who is similarly competent with the

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procedure is invaluable for providing adequate and timely retraction of the rectum, which allows the primary surgeon not to have to switch operating sides. Several series listed in Table 1 and 2 have shown that this is technically possible with the laparoscopic method when done by surgeons who are familiar with pelvic anatomy and have advanced laparoscopic skills.

A high-quality camera with an angled laparoscope is required to provide excellent magnified views of the pelvis, managed by an assistant experienced in laparoscopy. The lack of adequate articulation of endoscopic staplers can be a problem in performing rectal transection at the level of the anorectal ring and could result in an obliquely long stapler line on the anorectal stump, especially in the presence of a bulky tumor in the heavier or male patient. Such situations demand a suprapubic incision in some patients undergoing standard laparoscopic-assisted resection[9] or a mucosectomy with a hand-sewn coloanal anastomosis.

Table 1. Studies showing early outcomes after laparoscopic surgery for rectal cancer

Studies	Patients	Preoperative radiotherapy (%)	Conversion (%)	Diversion (%)	Mortality (%)	Morbidity (%)	Leak (%)	Reoperation (%)	Days in hospital (mean)	Blood loss (mL)
Hasegawa et al[20]	71 LS	N/A	4.2	30.9	N/A	28.2	13.6	N/A	10	25
Lelong et al[17]	104 LS vs 68 OS (historic)	78 vs 75	15	93 vs 85	1 vs 3	43.3 vs 48.5	11 vs 20	8.7 vs 7.4	10 vs 14	
Braga et al[14]	83 LS vs 85 OS	16 vs 14	7.2	26.5 vs 24.7 (NS)	1.2 vs 1.2 (NS)	29 vs 40 (NS)	9.6 vs 10.6 (NS)	7.2 vs 12.9 (NS)	10 vs 13	
Staudacher et al[16]	226 LS	48.6	6.1	365.8	0	31.8	16.8	6.6	10.4	203
Pugliese et al[23]	157 LS; TME in 62%	9.5	7.6	36	1.2	16	10.8	N/A	10.5	N/A
Rezvani et al[25]	60 LS	13.3	16.6		1.6	16.6		3.2		175
Ströhlein et al[13]	114 LS vs 275 OS	20.2 vs 14.2 (NS)	21.9	50.6 vs 49.5 (NS)	0	14.0 vs 21.4 (NS)	10.1 vs 15.3 (NS)		15.1 vs 18.7 (Sig)	
Kim et al[26]	312 LS; 138 EP vs 174 IP	13.8 vs 0.6 (NS)	1.4 vs 3.4 (NS)	42 EP vs 4 IP (Sig)	0.3 EP vs 0 IP (NS)	21.5	6.4; 9.7 EP vs 4.6 IP (NS)		12.7 vs 11.8 (NS)	
Ng et al[31]	51 LS APER vs 48 OS APER	N/A	9.8	N/A	1.9 vs 2.0 (NS)	45.1 vs 52.1 (NS)	N/A	2 vs 8	18.8 vs 11.5 (NS)	321 vs 555
Laurent et al[22]	200 LS	81.5	15.5	75	1	25	8		9 (4–42)	
Tjandra et al[9]	31 LS vs 32 hand assist	25 vs 28 (NS)	0 vs 0 (NS)			25.8 vs 21.9 (NS)	3 vs 3 (NS)		5.8 vs 5.9 (NS)	152 vs 158 (NS)
Gillou et al[15]	253 laparoscopic assistance vs 128 OS; 25% vs 27% APER		29		4 (9 in converted procedures)	40 vs 37 (NS)	10 vs 7 (NS)		2 more than open	
Staudacher et al[12]	108 LS vs 79 OS	63 vs 43 (NS)	12	66 vs 54 (NS)	0%	29.6 vs 27.8 (NS)	14.8 vs 12.6 (NS)		10 vs 12 (NS)	208 vs 356 (Sig)
Rosati et al[18]	20 LS after neoadjuvant therapy vs 26 LS		5 vs 11.5 (NS)	100 vs 15 (NS)		25 vs 35 (NS)	11.1 vs 26.9 (NS)	20 vs 35 (NS)	9 vs 8 (NS)	

APER = abdominoperineal excision of rectum; DFS = disease-free survival; EP = extraperitoneal; IP = intraperitoneal; LAR = low anterior resection; LS = laparoscopic surgery; NS = not significant; OS = open surgery; Sig = significant; TME = total mesorectal excision.

Early Outcomes

Previous meta-analyses have shown that LS for colorectal cancer is associated with lower morbidity, less pain, a faster recovery, and a shorter hospital stay than is open resection, without compromising oncologic clearance.[10] No significant differences in oncologic clearance or lymph node harvesting were identified.[11] These two studies failed to exclusively examine data on LS for rectal cancer.

Several prospective case series have shown that LS for rectal cancer is oncologically safe, with early outcomes for mortality, morbidity, anastomotic leak, length of hospital stay, and diversion rate equivalent to those of open surgery (OS)[12–15] (in patients whom the operation is completed successfully). Quoted morbidity rates are 11% to 37%.[16] Respiratory complications were significantly fewer in one study,[17] although this finding has been contradicted by another study.[15] Preoperative chemoradiation did not adversely influence rates for anastomotic leaks or overall morbidity (33% vs 23%) in LS when compared with OS.[12] Overall, neoadjuvant therapy did not have an adverse effect on early outcome (Table 1).[17,18]

Conversion rates to OS ranged from 3% to 29%.[13,15,18–20] Although high conversion rates can be attributed to surgeon inexperience, progression on the learning curve did not show any significant reduction in conversion rates.[21] The most common reasons for conversion were excessive tumor fixity or uncertainty of tumor clearance (41%), obesity (26%), anatomic uncertainty (21%), and inaccessibility of tumors (20%).[15] Conversion to OS did not show any difference in postoperative morbidity when compared to procedures that were completed laparoscopically or that were OS from the start.[13,22] However, a single study found that conversion was significantly associated with a higher incidence of anastomotic leaks (29%).[23] Male sex was a consistent factor associated with conversion to OS.[24]

Multivariable analysis showed that male sex, a stapled anastomosis, and an intraoperative finding of excess rectal fixity were independent factors for conversion. Further analysis revealed that men with a stapled anastomosis had a threefold higher rate of conversion than all other patients (34% vs 11%; $p < 0.001$).[22]

From an oncologic perspective, the percentage of patients having an complete or radical (R0) resection ranged from 82% to 100% among all stages of tumor, regardless of the administration of neoadjuvant therapy.[13,19,22,23] The range of lymph nodes harvested was 12 to 22.[23,25,26]

A meta-analysis of 10 trials in which the radial margin status was evaluated reported a mean positive radial margin of 5% for laparoscopic resections, compared with 8% for open resections, although this was not statistically significant. The distal margin positivity rates were also not different between LS and OS.[27] The distal margin can be of concern in cancers of the lower one-third of the rectum, particularly in men.[22]

Late Outcomes

A meta-analysis of long-term outcomes of LS for colorectal cancer did examine the subgroup of patients with rectal cancer. It found no significant difference in local recurrence (7.2% vs 7.7%; 95% confidence interval [CI], 0.45–1.43; $p = 0.46$) or distant metastasis (11.3% vs 13.6%; 95% CI, 0.55–1.22; $p = 0.32$) between LS and OS for rectal cancer.[1]

The Medical Research Council Conventional versus Laparoscopic-Assisted Surgery In Colorectal Cancer Trial Group study did show a nonsignificant higher positive circumferential resection margin rate in patients undergoing laparoscopic anterior resection compared with open resection.[15] However, this has not translated into any detectable difference in terms of overall survival, disease-free survival, or local recurrence by three-year follow-up examination between the groups.[32]

No significant difference between LS and OS has been found in both overall five-year survival and disease-free five-year survival.[14] A prospective study of 389 patients undergoing either LS or OS for rectal cancer and with a mean follow-up period of 32 months found no difference in survival between the two groups at any stage. The actuarial five-year survivals for LS and OS, respectively, were 85% vs 75% in stage I, 67% vs 73% in stage II, and 60% vs 51% in stage III.[13] Probably unrelated to the mode of access, patients with stage III disease who benefited from adjuvant chemotherapy had better survival rates than did those with stage II disease who did not have chemotherapy.[23]

Reported series comparing LS with OS for rectal cancer found no difference in local recurrences (4% vs 5.2% at a mean follow-up point of three years; $p = .97$ and 6.9% vs 9.5% at a mean follow-up point of 32 months; $p = .52$). There was no difference in rates of neoadjuvant therapy between the groups (Table 1).[13,14]

A prospective study comparing patients with extraperitoneal rectal cancer vs those with intraperitoneal rectal cancer undergoing LS detected a local recurrence rate at three years of 7.6% for extraperitoneal and 0.7% for intraperitoneal ($p = 0.0011$).[26] Despite a significant difference in the rates of neoadjuvant radiotherapy between the groups, extraperitoneal location of rectal cancers was found, by multivariate analysis, to be a risk factor for recurrence.

Concern was raised in one study about the long-term oncologic outcome for patients whose LS was converted to OS. Twenty-six percent of a cohort of patients undergoing converted, curative surgery were found, at follow-up examination, to have metachronous metastasis. Their local recurrence rate was 16%.[13] These increased rates indicate the problems with conversion in LS for cancer. Conversion frequently occurs too late in the operation, after the surgeon has spent significant time with little progress or tries to correct surgi-

Table 2. Studies showing oncologic and long-term outcomes

Studies	Patients	R0 resection (%)	No. of nodes	Margin (mm)	Mean follow-up duration (months)	Local recurrence (%)	METs (%)	Port-site METs (%)	Five-year overall survival	Five-year DFS
Lelong et al[17]	104 LS vs 68 OS (historic)	9.7 vs 18	11 vs 9	21 vs 31						
Kim et al[26]	312 LS; EP (138) IP (174)	91.3 EP vs 99.2 IP (Sig)	22 vs 24 (NS)	21 vs 34 (Sig)	33	4–7.6 EP vs 0.7 IP (Sig)	13.3 EP vs 12.4 IP	0	N/A	
Ng et al[31]	51 LS APER vs 48 OS et al	94 vs 96 (NS)	12.4 vs 13 (NS)		87 vs 90	5 vs 11	N/A	0	Probability 75.2% vs 76.5%	Probability 78.1% vs 73.6%
Tjandra et al[9]	31pts LS vs 32 with hand assist	3.2 vs 3.1 (NS)	17 vs 17 (NS)	26 vs 26 (NS)						
Gillou et al,[15] Jayne et al[32]	253 laparoscopic assistance vs 128 OS; 25 vs 27% APER	84 vs 86 (NS)	13.5 vs 12 (NS)		36	9.7 vs 10.1 (NS)	18.6 vs 16 (NS)	1.7 vs 0.03 (NS)	3-year survival 74.6% vs 66.7% for patients with anterior resection	3-year survival 70.9% vs 70.4% for patients having anterior resection
Staudacher et al[16]	226 LS; 202 LAR, 24 APER	97.4	14.4	27	40	6.1			Cumulative survival: 81%	70%
Staudacher et al[12]	108 LS vs 79 OS		14.3 vs 15.2	24 vs 27	27	6.4 vs 5	14.8 vs 18.9 (NS)	1 vs 0		
Ströhlein et al[13]	114 LS vs 275 OS	96 vs 95	13.5 vs 16.4		31	6.9 vs 9.5 16 in converted procedures	17.8 vs 14.9	1 vs 0	Stage I: 85.4 % vs 75.2%; stage II 66.7% vs 73.4%; stage III 60.1% vs 51.3% (NS)	
Lee et al[33]	497 LS; All T3	N/A	18	31	29	Estimated 5 year (9.4%)				
Laurent et al[22]	200 LS	87.5	11	20						
Bianchi et al[34]	107LS	98	18	26	36	1		0	Actuarial survival 81.4%	Actuarial survival 79.8%
Pugliese et al[23]	157 LS; TME in 62%	N/A	12	48	39	4	11	0.7	Cumulative probability 0.73%	
Braga et al[14]	83 LS vs 85 OS	98.9 vs 97.6 (NS)		0 vs 0						
Rosati et al[18]	20 LS after neoadjuvant therapy vs 26 LS	100 vs 100 (NS)	13 vs 21 (NS)	10 vs 16 (NS)						

APER = abdominoperineal excision of rectum; DFS = disease-free survival; EP = extraperitoneal; IP = intraperitoneal; LAR = low anterior resection; LS = laparoscopic surgery; MET = metabolic equivalent; NS = not significant; OS = open surgery; R0 = complete/radical; Sig = significant; TME = total mesorectal excision.

cal complications laparoscopically without success. The decision to convert should be seen as a good surgical decision rather than a failed operation.

Costs and Complications

The lack of widespread use of LS for colorectal cancer may be related to the associated increase in operating time, cost, and learning curve.

In a single-center randomized study to assess the difference in costs between LS and OS for rectal cancer, the extra operating room charges in the LS group were $1748 per patient (surgical instruments, $1194; longer room occupancy, $554).[14] In patients with an uneventful postoperative course, the mean cost of routine care in the LS group (mean length of hospital stay, 8.6 days) and in the OS group (mean length of hospital stay, 10.4 days) translated in savings of $647 per patient randomized to the LS group.[14] The additional cost of postoperative complications resulted in savings of $749 per patient randomized to the LS group. The overall savings per patient randomized to the LS group were $1396. Considering the additional OR charges in the LS group, there was $351 extra cost per patient.

The late complication rate in this study was 2.4% in the LS group, compared with 10.6% in the OS group ($p = 0.07$). Quality of life was significantly better in the LS group, but only in the first year after surgery.[14]

Sexual and urinary function were reported in two studies. Patients with T3 lower rectal cancer treated by preoperative chemoradiation underwent laparoscopic sphincter-saving TME, preserving the pelvic autonomic nerves. Seventy-four patients with normal preoperative sexual function were evaluated when the temporary colostomy had been closed and the patients were completely recovered. The voiding function was good in 72%, fair in 23%, and poor in 5%. Of the 17 patients with fair bladder function, 8 had transient function.[29] In 32 male patients, ejaculation was good in 56%, fair in 19%, and poor in 25%, whereas potency was good in 62% of patients, fair in 16%, and poor in 22%. In 28 female patients, sexual function was reported as good in 54%, fair in 14%, and poor in 32%.[29]

The second study that reported on patients undergoing laparoscopic (n = 34) or open (n = 29) TME between 2002 and 2006 found that LS for rectal cancer offers a significant advantage with regard to preservation of postoperative subjective sexual function in comparison to preoperative function. Postoperatively, only minor disturbances of bladder function were seen in 3% in LS and in 9% in OS ($p > .05$). Impotence after surgery in males who were sexually active before surgery was experienced by 5% who underwent LS and by 29% who underwent OS ($p = .04$). Similarly, 7% of women in the LS group and 50% in the OS group reported that their overall level of sexual function had decreased as a result of surgery ($p = 0.03$). The proposed advantages have been attributed to improvement in visibility in LS.[30]

Conclusion

Randomized controlled trials have shown that LS for rectal cancer is equivalent to OS in early outcomes, and in long-term outcomes on nonrandomized cohorts. Laparoscopic TME is technically feasible in the vast majority of patients with lower rectal cancer regardless of whether they have undergone chemoradiation therapy. Surgically, there are some aspects of the laparoscopic technique, such as access and visibility of the distal rectum in the depth of the pelvis, that are superior to those of the open method. Ultimately, the verdict on this surgery will await the outcome of two large multicenter, randomized, controlled trials (in Europe and North America) that are presently recruiting surgeons experienced in this technique to conclusively evaluate the overall status of LS for rectal cancer. ❖

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Disclosure Statement

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