RESEARCH ARTICLE

Comparative Analysis of Surgical and Pathological Outcomes between Laparoscopic and Open Rectal Cancer Surgeries: Single Institution Experience

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Abstract

Background: The purpose of our review is to analyze and compare the perioperative and clinicopathologic outcomes of laparoscopic-assisted rectal surgeries (LARS) and open rectal surgeries (ORS) for rectal malignancies.

Patients and methods: A retrospective analysis of data available from June 2015 to October 2018 was performed. Patient's demographic profile, tumor characteristics, perioperative, and short-term clinicopathological outcomes were compiled and contrasted. Statistical tests used were Student's *t* test and Fischer's exact test.

Results: During the study period, 34 and 24 patients underwent laparoscopic and open rectal cancer surgeries, respectively. Of 58 patients, there were 30 men (51.7%) and 28 women (48.3%) with average age group of 51.7 years. The median tumor distance was 4 cm and 6 cm from the anal verge in the laparoscopic and open groups, respectively ($p = 0.03$). 70.1% of patients underwent preoperative chemoradiation. Conversion rate noted was 14.7%. Operative duration was prolonged for laparoscopic resection (194.7 vs 178.3 minutes, $p = 0.168$). Blood loss (395.58 vs 506.66 mL), postoperative hospital stay (8.3 vs 11.5 days: mean difference, 3.2 days), 30-day mortality (3% vs 0% $p = 0.81$), and major complications (11.8% vs 16.7%) failed to differ significantly. Negative circumferential radial margin was noticed in 98.4% of the overall group (94.1% laparoscopic resection and 95.8% open resection; $p = 0.93$).

Conclusion: There were certainly no significant differences between laparoscopic and open surgeries in operative time period, complications, and duration of hospital stay. Hence, laparoscopic surgery is oncologically safe in rectal cancer patients.

Clinical significance: Laparoscopic rectal cancer surgeries could be feasible with equivalent short-term outcomes as with open surgeries with less morbidity, even among patients treated with preoperative chemoradiation.

Keywords: Laparoscopic resections, Pathological outcomes, Perioperative outcomes, Rectal cancers, Retrospective comparative study.

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Introduction

Surgical therapy plays an integral role in the comprehensive management of rectal cancer. Total mesorectal excision (TME) done as a part of radical resection significantly improves the prognosis.[1] Though laparoscopic rectal surgeries have been associated with a steep learning curve, high conversion rate, and in need of consistent practice, it has been evolving as an alternative to open procedures.[2] However, few technical difficulties like suboptimal traction and countertraction applied during surgeries, especially in mid- to low-rectal bulky cancers, in obese patients with narrow pelvis are causing concerns for laparoscopic surgeons.[3]

There have been many studies reporting better short-term outcomes after laparoscopic surgery such as lower morbidity, reduced blood loss, reduced pain, and faster recovery.[4] Although laparoscopy may be considered the gold standard for the treatment of rectal cancers, the results of recently published well-designed randomized controlled trials, such as COLOR II, ALACART, and ACOSOG Z6051 and a meta-analysis surprisingly showed no significant differences in terms of short-term morbidity between laparoscopy and open surgery, with very narrow 95% confidence intervals.[5–9] This raised the interest and made us to compare and contrast the short-term outcomes of open and laparoscopic rectal cancer surgeries performed in our institution.

Patients and Methods

Patients Assortment

Retrospective analysis of all the patients who had been subjected to elective laparoscopy or to laparotomy for rectal malignancy between June 2015 and October 2018 was conducted on the basis of a prospectively recorded database. Records pertaining to age group, gender, comorbidities, tumor site and stage, neoadjuvant treatment, operative time period, surgical and pathologic data, complications, postoperative intestinal activity, and time period of stay were investigated; almost all patients underwent curative resection. Exclusion criterion comprised tumors with complications like obstruction, perforation, recurrence and patients who underwent synchronous colectomies. A series of 24 patients who underwent standard open rectal surgeries and operated prior to the laparoscopic aided rectal procedures were commenced and was compared to a group of 34 consecutive

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patients who underwent laparoscopic TME for rectal cancer. Patients from laparoscopic groups were operated on by the exact same surgical personnel. Tumors situated within 17 cm of the anal verge were considered as: lower rectum (<7 cm from anal verge); mid-rectum (7.1–12 cm from anal verge); higher rectum (>12 cm from anal verge). Patients with T3 and or T1 or T2 N1 tumors in the middle or lower third of the rectum underwent neoadjuvant chemoradiation (50.4 Gy given over 5 weeks in combination with 5-fluorouracil or with oral capecitabine at a dosage of 1000–1500 mg per m^2 every day for the entire timeframe of radiotherapy-based chemotherapy) and after that surgical procedures 6–8 weeks eventually. Preoperative planning was exactly the same in both categories.

Surgical Technique

Oncological concepts adopted were (1) ligation of the inferior mesenteric artery and the inferior mesenteric vein to offer sufficient colon extent for a tension-free anastomosis, (2) sharp TME for middle and lower rectal cancer, (3) preservation of the autonomic pelvic nerves, and (4) appropriate distal and radial surgical margins. All patients were operated under general anesthesia. A 10-mm camera port was placed 0.5 cm above the umbilicus. Another 10 mm port was introduced one-third of the distance from the right anterior superior iliac spine to the navel. Two 5-mm trocars positioned at the level of umbilicus on either side, lateral to rectus sheath, and an additional 5-mm port positioned in the left iliac fossa. After inspecting for the presence of peritoneal diseases, the peritoneum was incised from the level of the sacral promontory posterior to the rectum down to the summit of the coccyx. Anterior dissection started in the retrovesical septum in males and in the rectovaginal space in females. The rectosacral ligament and anococcygeal ligament were divided and incised at the level of the fourth sacral vertebra. The intact mesorectum was circumferentially mobilized. For tumors in the higher rectum, a higher TME or partial mesorectal excision was performed laparoscopically with transection of the mesorectum 5-cm distal of the tumor, followed by a stapled anastomosis. For tumors situated in the mid and distal rectum, a complete TME was done laparoscopically. The rectum was transected with an endoscopic or traditional stapler with the use of a Pfannenstiel incision. A coloanal anastomosis was performed if at least 1 cm from the dentate line often is spared with an adequate oncological distal margin of 2 cm. Typical lateral-to-medial mobilization was attempted of the sigmoid colon, descending colon, and the splenic flexure. After scoring the mesentery and separating the mesenteric fat with small vessels by applying harmonic scalpel, the inferior mesenteric vessels were identified, clipped, and transected with harmonic scalpel. A transverse incision of 3–4 cm was made to remove the specimen with the aid of a wound shield. Colorectal anastomoses were performed using circular staplers. Proximal and distal tissue donuts produced by the circular stapler were checked for integrity. The distal donut was sent for pathological assessment as the circumferential margin. Covering loop ileostomy or transverse colostomy was created for diversion of feces.

Open TME

Open cases were performed through a midline incision. Open TME was performed as outlined by earlier explained techniques.

Conversions was defined as operating any procedure using an open method, except the removal of the specimen or transection of rectal cancer through the anus.

Pathological Assessment

All specimens were analyzed by the same experienced pathologist who examined the involvement of the circumferential margin (distance of 1 mm and or less from the tumor to the mesorectal fascia), involvement of the distal margin (tumor approaching the distal portion), and the number of isolated lymph nodes.

Statistical Analysis

The statistical analysis was performed employing the SPSS software program version 22.0 (Chicago, IL, United States) and Windows. Parametric variables were expressed as mean ± SD. The Student's *t* test was used to analyze variations between the LARS and ORS groups. The χ^2 test (or Fisher's exact test where appropriate) and exact tests were performed to compare variables between the two groups. A *p* value less than 0.05 was considered statistically significant.

Results

A total of 58 patients participated in this study, including 34 in the LARS (15 males and 19 females, mean age 52.41 years) and 24 in the ORS (15 males and 9 females, mean age 50.62 years) (Table 1). There were no significant differences in baseline characteristics between the two groups. 23 patients (67.6%) in the LARS and 18 patients (75%) in the ORS underwent neoadjuvant chemoradiotherapy before surgery. Majority of patients in both the groups had TNM stage III disease (61.8% in LARS vs 70.8% in ORS). Surgery was not successfully completed by laparoscopy (converted to laparotomy) in 5 of 34 (14.7%) patients. The most frequently performed procedure was APR (52.9%) in LARS group and LAR (45.38%) in ORS group. The ORS included 5 patients, 11 patients, and 4 patients underwent APR, LAR, and anterior resection, respectively. 5.9% and 8.3% of patients underwent posterior pelvic exenteration in LARS and ORS groups, respectively (Table 2).

Though statistically borderline significant, laparoscopic group patients (LARS) had decreased length of hospital stay ($p = 0.0511$) and decreased blood loss ($p = 0.0491$). Mean operating time was 16 minutes longer for laparoscopic than open surgery. Return to oral diet was longer by a mean of 1.4 days in the open group. But these differences were not significant. Common procedure-related complications included anastomotic leakage, pelvic abscess, ileus, and urinary tract problems (Table 3).

The overall morbidity rate was 29.4% in the LARS as compared with 45.8% in the ORS. However, this difference was not statistically significant ($p = 0.1999$). Only one patient from the laparoscopic group had mortality within 30 days. 4.2% and 8.3% patients of open group had intestinal obstruction and wound dehiscence, respectively. 11.8% patients and 12.5% patients of LARS and ORS group had anastomotic leakage, respectively. The rate of wound infection and rate of delay in bladder emptying were more in ORS and LARS group, respectively.

Regarding oncologic adequacy of resection, a total of 21.9% (9/41) of patients showed a complete degree of response to NCRT; the proximal and distal resection margins did not differ significantly between the groups. A total of 2.9% of patients in the LARS group showed circumferential resection margin (CRM) involvement; however, none of the patients in the ORS group showed this involvement, although the difference was not significant. The distribution of pathological tumor and nodal stages was similar between the groups (Table 4).

The mean numbers of lymph nodes harvested were 10.8 in the LARS group (range: 8–13) and 12.6 (range: 8–19) in the ORS group.

Table 1: Patient's baseline characteristics

S. no.	*Parameters*	*Group*	*Laparoscopic-assisted rectal surgeries (LARS) N (%)*	*Open rectal surgeries (ORS) N (%)*	*p value*
1	No. of patients		34 (58.6%)	24 (41.4%)	–
2	Age (years)	Mean ± SD	52.41 ± 13.01	50.62 ± 13.01	0.6086
3	Sex	Male	15 (44.1%)	15 (62.5%)	0.1676
		Female	19 (55.9%)	9 (37.5%)	
4	Serum albumin (g/dL)	Mean ± SD	4.27 ± 0.55	3.76 ± 0.42	0.1171
5	Serum CEA* (ng/mL)	Median	9.85	22.25	0.9773
6	Distance from anal verge (cm)	Median	4	6	0.3369
7	Location of tumor	Upper third	8 (23.5%)	5 (20.8%)	0.6215
		(12–17 cm from AV)	4 (11.8%)	9 (37.5%)	
		Middle third	22 (64.7%)	10 (41.7%)	
		(7–12 cm from AV**)			
		Lower third (<7 cm from AV)			
8	Neoadjuvant chemo RT	Given	23 (67.6%)	18 (75%)	0.5445
		Not given	11 (32.4%)	6 (25%)	
9	Clinical T stage	cT2–T3	29 (85.3%)	20 (83.3%)	0.8390
		cT4	5 (14.7%)	416.7%)	
10	Clinical N stage	Negative	12 (35.3%)	7 (29.2%)	0.6243
		Positive	22 (64.7%)	17 (70.8%)	
11	Distant metastasis	Present	0 (0%)	0 (0%)	0.8011
		Absent	34 (100%)	24 (100%)	
12	Clinical stage group	Stage I–II	13 (38.2%)	7 (20.6%)	0.4742
		Stage III	21 (61.8%)	17 (70.8%)	

*CEA, carcinoembryonic antigen
**AV, anal verge

Table 2: Surgical data

Parameters	*Group*	*Laparoscopic-assisted rectal surgeries (LARS)*	*Open rectal surgeries (ORS)*	*p value*
Type of surgery	Anterior resection	7 (20.6%)	4 (16.7%)	
	Low anterior resection	6 (17.6%)	11 (45.8%)	0.0749
	Abdominoperineal resection	18 (52.9%)	5 (20.8%)	
	Posterior pelvic exenteration	2 (5.9%)	2 (8.3%)	
	Total pelvic exenteration	1 (2.9%)	2 (8.3%)	
Operative time	Mean ± SD (in minutes)	194.7 ± 40.43	178.3 ± 48.51	0.1676
Intraoperative blood loss	Mean ± SD (in mL)	295.58 ± 83.55	406.66 ± 137.97	0.0491
Intraoperative complications	Present	0 (0%)	2 (8.3%)	0.3611
	Absent	34 (100%)	22 (91.7%)	
Incidence	Bladder injury	Nil	1	
	Ureteric injury	Nil	1	

Although the number of lymph nodes harvested tended to be more in the ORS group, the difference did not reach statistical significance.

Discussion

Three randomized controlled trials have demonstrated that the oncological outcomes of laparoscopic surgery for the rectal cancer are comparable to those of open surgery.[7,10,11]

In the first study, the COLOR II trial, Van der Pas et al. prospectively randomized 1,103 patients with rectal cancer to either laparoscopic or open proctectomy.[12] Although laparoscopic procedures took longer time (240 vs 188 minutes), the patients in that group had significantly less blood loss (200 vs 400 mL), earlier return of bowel (2 vs 3 days), and shorter hospital length of stay (LOS) (8 vs 9 days). The 28-day morbidity and mortality were similar in both groups. Similarly, our study cohorts also showed that patients treated with laparoscopic-assisted rectal resection though statistically not significant took longer operating time (195 vs 175 minutes) with minimal blood loss (295 vs 405 mL), 0.95 day earlier return of bowel movements, and shorter hospital day by 3 days. The morbidity and mortality patterns of our study cohorts are in concordance with COLOR II trial population.

Table 3: Postoperative outcomes

Parameters	*Group*	*Laparoscopic-assisted rectal surgeries (LARS)*	*Open rectal surgeries (ORS)*	*p value*
Morbidity incidence	Yes	10 (29.4%)	11 (45.8%)	0.1999
	No	24 (70.6%)	13 (54.2%)	
Major complications	Anastomotic leakage			
	Yes	4 (11.8%)	3 (12.5%)	0.9325
	No	30 (88.2%)	21 (87.5%)	0.8011
	Intestinal obstruction			
	Yes	0 (0%)	1 (4.2%)	0.3611
	No	34 (100%)	23 (95.8%)	
	Wound dehiscence			
	Yes	0 (0%)	2 (8.3%)	
	No	34 (100%)	22 (91.7%)	
Minor complications	Wound infections			
	Yes	6 (17.6%)	9 (37.5%)	0.0890
	No	28 (82.4%)	15 (62.5%)	0.9224
	Delayed urinary bladder emptying			
	Yes	6 (17.6%)	4 (16.7%)	
	No	28 (82.4%)	20 (83.3%)	
Time to first bowel movement	Days (range)	1.5 (1–2.5)	2.4 (1.5–3)	0.3625
Length of hospital stay	Mean ± SD (in days)	7.3 ± 2.13	11.5 ± 2.12	0.0511
Mortality before 30 days of surgery	Yes	1 (2.9%)	0 (0%)	0.8011
	No	33 (97.1%)	24 (100%)	

Table 4: Pathological outcomes

Parameters	*Group*	*Laparoscopic-assisted rectal surgeries (LARS)*	*Open rectal surgeries (ORS)*	*p value*
Histologic type	Adenocarcinoma	32 (94.1%)	24 (100%)	0.9363
	Adeno-squamous	1 (2.9%)	0 (0%)	
	Melanoma	1 (2.9%)	0 (0%)	
Grade	Grade 1	19 (55.9%)	10 (41.7%)	0.2860
	Grade 2	14 (41.2%)	11 (45.8%)	
	Grade 3	1 (2.9%)	3 (12.5%)	
Effect of NACT	Residual disease present absent	(23)	(18)	0.9704
		18 (78.2%)	14 (77.8%)	
		5 (21.8%)	4 (22.2%)	
Circumferential resection margins (cm)	Positive (<1 mm)	1 (2.9%)	0 (0%)	0.9363
	Negative (>1 mm)	33 (97.1%)	24 (100%)	
Proximal resection margins (cm)	Positive	0 (0%)	0 (0%)	0.8011
	Negative	34 (100%)	24 (100%)	
Distal resection margins (cm)	Positive	0 (0%)	1 (4.1%)	0.8011
	Negative	34 (100%)	23 (95.8%)	
Number of lymph nodes harvested	Median (range)	10.8 (8–13)	12.6 (8–19)	0.1206
Completeness of TME	In percentage	100%	100%	–

In CLASICC trial, Guillou et al. randomized 794 patients with colorectal cancers.[13] Of these patients, 381 had rectal cancer and underwent a low anterior resection or an abdominoperineal resection. Although laparoscopic procedures took longer time (180 vs 135 minutes), the patients in that group had earlier return of bowel (5 vs 6 days) and shorter hospital LOS (11 vs 13 days). The open and laparoscopic groups had no statistically significant difference in the perioperative morbidity. These results are in concordance with our results. In contrast to the CLASICC trial where both groups had a high rate of positive CRM (14% for open surgery and 16% for laparoscopic surgery), among our study population, only one patient of the laparoscopic group of patients had positive CRM when comparing open group patients.[14,15]

In the COREAN trial, Kang et al. enrolled 340 patients with locally advanced (T3N0-2) rectal cancer.[10] All patients had undergone neoadjuvant chemoradiation therapy and were randomized to

open vs laparoscopic resection. Although laparoscopic procedures took longer time (244.9 vs 197 minutes), the patients in that group had earlier return of bowel movements (38.6 vs 60 hours) and shorter hospital LOS (8 vs 9 days). The results of our study correlate with this randomized control trial (RCT).

With regard to operative morbidity, COLOR II trial documented equal complication rates in both laparoscopic and open surgeries (40% in lap vs 37% in open). CLASSIC trial documented intraoperative complications such as bowel injury (1% in lap vs 1% in open), bladder injury (2% in lap vs 0% in open), ureteric injury (0% in lap vs 3% in open) and postoperative complications (40% in lap vs 37% in open) such as anastomotic leakage rate (10% in lap vs 7% in open) and wound infection (5% in lap vs 5% in open). COREAN trial documented wound infection rate (1.2% in lap vs 6.5% in open), anastomotic leakage rate (2% in lap vs 0% in open), and pelvic abscess (0% in lap vs 0.6% in open). Our study reports revealed intraoperative complications such as bladder injury (0% in lap vs 4.5% in open) and ureteric injury (0% in lap vs 4.5% in open) and postoperative complications (29.5% in lap vs 45.8% in open) such as anastomotic leakage rate (11.8% in lap vs 12.5% in open) and wound infection (17.6% in lap vs 37.5% in open) with no statistical significant differences made between laparoscopic and open surgeries. Our results are therefore comparable with the existing international RCTs.

With regard to 30-day mortality, CLASSIC trial and COLOR II trial reported a mortality rate of 4% in laparoscopy, 5% in open, 1% in laparoscopy, and 2% in open surgeries, respectively. Our results showed a 30-day mortality of 0%. A meta-analysis of prospective trials was conducted by Arezzo et al. and included 23 studies, 8 of which were randomized, representing a total of 4,539 patients.[16] A mortality incidence of 1.0% was observed in the laparoscopic group compared with 2.4% in the open group ($p = 0.048$). A significant difference was also seen in the morbidity rate between the two groups (31.8% in the laparoscopic group vs 35.4% in the open group; $p < 0.001$).

Boutros et al. retrospectively compared 234 patients undergoing open or laparoscopic TME for rectal cancer.[17] Laparoscopy was associated with longer operative time (245 vs 213 minutes) but with less blood loss (284 vs 388 mL), shorter LOS (7 vs 8 days), and lower rates of 30-day morbidity (25 vs 43%) and surgical site infections (9 vs 20%). Similarly, Lee et al. included 160 patients in their retrospective study; however, all these patients had stage I rectal cancer.[18] Overall, morbidity and mortality were similar in both the laparoscopic and open groups. The laparoscopic group had longer operative time (221 vs 184 minutes) but significantly less blood loss (150 vs 200 mL), time to first bowel movement (2.44 vs 3.54 days), rate of superficial surgical-site infection (0 vs 7.5%), and LOS (8 vs 11 days).

Pathological Outcomes

Local recurrence is related to several oncological parameters that can be objectively measured. These include completeness of the TME, involvement of the CRM, and number of harvested lymph nodes.[19]

In fact, in three large randomized controlled trials (COLOR II, CLASICC, and COREAN) and in a large-scale multicenter prospective review by Lujan et al., there were no statistical differences in those parameters when laparoscopic and open approaches were compared.[7,10,13–15] However, different standards for pathological evaluation were applied to each study, and an overall comparison was difficult to make. Likewise, Lujan et al. included 4,970 patients with rectal cancer.[20] They found that laparoscopic surgery resulted in decreased blood loss, lower 28-day morbidity, increased completeness of TME, and a 3-day decrease in the hospital LOS. In contrast to the CLASICC trial, the rate of CRM positivity was significantly lower, prompting the authors' conclusions that laparoscopic resection is the preferred approach for patients with rectal cancer.

On the other hand, the American ACOSOG Z6051 trial comparing laparoscopic to open resection of stage IIA, IIIA, or IIIB rectal cancer originating within 12 cm from the anal verge[6] showed the quality of TME specimen in 462 operated patients. They reported surgeries as complete (77%) and nearly complete (16.5%) TME in 93.5% of the cases. Negative circumferential radial margin was observed in 90% of the overall group (87.9% laparoscopic resection and 92.3% open resection; $p = 0.11$). Distal margin result was negative in more than 98%of patients irrespective of the type of surgery ($p = 0.91$). The authors of ACOSOG Z6051 trial demonstrated that laparoscopic resection did not meet the criteria for noninferiority of pathologic outcomes compared with open surgery. Only one patient of LARS group had positive circumferential resected margin and one patient in ORS group had positive distal resected margin.

Stevenson et al. randomized 475 patients with T1–T3 low rectal cancer (<15 cm from the anal verge) to undergo laparoscopic or open resections.[8] The circumferential resection margin was clear in 222 patients (93%) in the laparoscopic surgery group and in 228 patients (97%) in the open surgery group (risk difference of −3.7%; $p = 0.06$), the distal margin was clear in 236 patients (99%) in the laparoscopic surgery group and in 234 patients (99%) in the open surgery group (risk difference of −0.4% $p = 0.67$), and TME was complete in 206 patients (87%) in the laparoscopic surgery group and 216 patients (92%) in the open surgery group (risk difference of −5.4%, $p = 0.06$). This study also failed to establish noninferiority of laparoscopic surgery compared with open surgery, especially in patients with larger T3 tumors. The authors concluded that there is not enough evidence supporting the routine use of laparoscopy in the management of rectal cancer.

The number of lymph nodes harvested is another parameter frequently adopted to evaluate the oncological quality of the surgical procedures. In our study, the mean number in the LARS group was slightly lower than ORS group. The requirement for accurate pathological staging was comparable to the reported numbers of 11–23 for the laparoscopic groups in other studies. Considering that the number of lymph nodes may decrease after neoadjuvant chemoradiation, the present findings were even more favorably comparable with previous findings in patients undergoing neoadjuvant chemoradiation as in COREAN trial (17 in lap vs 18 in open), CLASSIC trial (12 in lap vs 13.5 in open), and ACOSOG Z6051 trial (17.9 in lap vs 16.5 in open).

The analysis of long-term outcomes is necessary for establishing the value of laparoscopic surgery in the treatment of rectal cancer. None of the short-term advantages would be important if the incidence of local recurrence and survival was compromised.

Conclusion

Our study demonstrated that laparoscopic TME is safe and feasible, with an oncological adequacy comparable to the open approach. During surgery, it seems that the operating time is longer in the laparoscopic group with less blood loss. Important short-term advantages will be the quicker recovery of the bowel function and

decreased median length of hospital stay with similar morbidity and mortality. Further studies and trials are required before more conclusive arguments can be made to support the universal use of laparoscopy in the surgical management of rectal cancer.

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