

with colorectal cancer who had no contraindications to laparoscopy.⁴ Despite the near unanimous agreement on the safety and efficacy of the laparoscopic approach, the uniqueness of rectal cancer has raised some concerns in the surgical community. The ability of a surgeon to abide by the oncologic principles of resection while performing laparoscopic proctectomy has been questioned by some experts.⁵ The Colorectal Cancer Laparoscopic or Open Resection (COLOR) II trial addressed these concerns after publishing their results which concluded that the laparoscopic approach for rectal cancer was associated with rates of loco-regional recurrence and overall disease-free survival similar to the conventional open approach.¹

In Saudi Arabia, the age-standardized incidence of colorectal cancer is less than that of North American and Europe, but it is nonetheless increasing at alarming rates.⁶ The Saudi Cancer Registry in 2010, reported that colorectal cancer is the most common cancer among Saudi men and the third commonest cancer among women with an incidence of 9.6/100,000 for both sexes.⁶ Adoption of the laparoscopic approach for rectal excision in Saudi Arabia has lagged behind North America and Europe. Concerns over the adequacy and safety of the procedure remain among local experts.

Consequently, this study aims to analyze the long term outcomes of curative laparoscopic rectal excision for non-metastatic rectal cancer in order to allay these concerns.

The study aims to assess the differences in overall three-year survival, 3-year disease free survival, local recurrence and distal recurrence after laparoscopic and open resection for potentially curable, non-metastatic rectal cancer.

PATIENTS AND METHODS

Patients' data:

The study was conducted at King Faisal Specialist Hospital and Research Center (KFSH&RC), which is a tertiary academic center. Approval was obtained from the Institutional Review Board (IRB) of this center for this retrospective study its number is 2161124 and REF is ORA/0890/37.

Patients' data was obtained from the operative database of the Section of Colon and Rectal Surgery at King Faisal Specialist Hospital and Research Center Riyadh (KFSH&RC). All patients who had non-metastatic rectal cancer and underwent laparoscopic (n= 34) or open (n= 86) resection with curative intent during the period from January 2012 to December 2015 were included in this study.

As per established protocols at KFSH&RC, all patients had received a full colonoscopy to evaluate the entire colon. An MRI of the pelvis and an endorectal ultrasound were performed to determine the local tumor stage and computed tomography of the chest, abdomen and pelvis was performed to detect the presence of distant metastasis. Serum carcino-embryonic antigen was determined in addition to basic and targeted blood panels according to requirements. All patients were discussed in

a dedicated, multidisciplinary colorectal cancer tumor board that included colorectal surgeons, gastrointestinal pathologists, abdominal radiologists and gastrointestinal medical and radiation oncologists. Treatment plans were tailored based on the international and local clinical practice guidelines.^{7,8}

The section of colon and rectal surgery at KFSH&RC employs of four certified colorectal surgeons, fellows, surgical residents and colorectal therapists. Data collected from the operative database included the patients that were operated by one of the four surgeons. All patients received oral mechanical bowel preparation the night before surgery and intravenous antibiotics one hour prior to skin incision. Skin preparation and draping is standardized among all surgeons.

The study included patients with cancers of the rectum (upper, mid, lower) regardless of their age or comorbid status. Exclusion criteria included local or distant metastasis, local invasion requiring a more extensive resection, e.g. pelvic exenteration and / or intraoperative radiation therapy (IORT). Patients who required conversion from laparoscopic to open surgery were included in the open surgery group. Cancers of the upper and mid-rectum generally require an anterior resection.

The surgical techniques:

1-Open surgery: The open procedure entails a midline laparotomy incision with the patient in the lithotomy position. After confirming the absence of metastatic disease in the liver and peritoneal cavity, resection was proceeded with lateral mobilization of the colon at the line of Toldt's. The mobilization was started at the sigmoid colon and extended distally to the pelvic inlet. Further mobilization of the mesentery was required to achieve medial mobilization of the colon. The left ureter was visualized and protected as the colon was rotated medially. A retromesorectal plane was entered and dissection was continued beyond the sacral promontory and anterior to the pre sacral fascia. Precautions were taken to protect the left ureter, sympathetic plexus and gonadal vessels. The inferior mesenteric artery was identified and ligated at its origin and the proximal end of the sigmoid colon was divided using a linear stapler. Posterior dissection was continued in the retrorectal space with meticulous, sharp technique to avoid breaching the presacral venous plexus. The lateral stalks were then sharply dissected and an anterior plane was created in a similar manner. Gentle cephalad and posterior traction on the rectum with the tumor in hand was performed in order to continue dissection anteriorly behind the seminal vesicles or the vagina and posterior to Denonvillier's fascia. A stapler was used to transect the rectum distally and the resected specimen was extracted and sent for pathological analysis. The anastomosis was created after confirming that the colon reaches down to the pelvis with no tension. Splenic flexure takedown was routinely performed. A double stapling technique was performed to create a colorectal anastomosis. The anvil was inserted into the proximal end of the colon and a purse string was tightened around it. The stapler was inserted transanally. The anastomosis was created and tested for any evidence

of air leak. The donuts resected by the stapler were included in the pathology specimen.

2- The Laparoscopic approach: The laparoscopic approach was carried out by placing the patient in a lithotomy position with trendelenberg tilt and arms tucked. Four trochars were placed in the umbilical region, left mid-quadrant, suprapubic and right mid-quadrant. After insufflation, the abdomen was inspected for any metastatic disease. A medial to lateral mobilization was performed first through identifying the inferior mesenteric artery and dividing the peritoneal reflection at the level of the sacral promontory on the right side of the rectum. A retrorectal plane was created from the right to the left side until the left ureter was identified and protected. The inferior mesenteric artery was skeletonized, clipped and transected. The medial dissection was continued by taking the mesocolon of the retroperitoneal fat up to the lower edge of the pancreas at which the inferior mesenteric vein was clipped and transected. Peritoneal dissection lateral to the sigmoid colon was taken down along the line of Toldt's up to the splenic flexure which was also taken down. Dissection then was proceeded in the retrorectal space dissecting the rectum off the pre sacral fascia down to the pelvic floor. The ureters, hypogastric plexus and gonadal vessels were visualized and protected. Dissection of the lateral rectal stalks was undertaken and a plane anterior to the rectum was created through posterior traction on the rectum and anterior retraction of the urinary bladder/vagina. The distal end of the rectum was transected using a laparoscopic stapler. A Pfannenstiel or umbilical incision was made and a wound protector was applied. The colon and transected rectum were exteriorized and a proximal point of transection was chosen. After extraction of the specimen, an end-to-end anastomosis was created using a circular stapler.

In both the open and laparoscopic approaches, abdomino-perineal resection was started with the patient in the lithotomy position and dissection proceeds in a similar manner to an anterior resection. An elliptical incision was

created in the perineum around the anus in the extra-sphincteric plane. The anus and distal rectum were dissected from surrounding ischio-rectal fat. The peritoneal cavity was entered through posterior dissection in the median raphe of the pelvic floor muscles and the specimen was delivered. Incisions were sutured after testing the anastomosis for leak. A loop ileostomy was created routinely in both the laparoscopic and open approaches, sometimes end colostomy was created. Then the abdominal and perineal incisions were sutured after placing a drain in the pelvis.

Postoperatively, all patients were cared for 5 to 7 days as inpatients. After discharge, patients had received adjuvant chemotherapy based on the clinical stage.

Surveillance for recurrence was performed using a standard approach that employs serial CEA measurements, CT scan of the chest, abdomen and pelvis and a colonoscopy according to a specified time frame. A recurrence was declared based on radiologic or tissue diagnosis.

The studied outcomes were the overall 3-year survival, disease free survival, local recurrence and distant metastasis. A student t-test was used to evaluate any significant differences between the laparoscopic and the open surgery groups at a level of significance $P < .05$.

RESULTS

One hundred and twenty patients were included in this study, out of them 86 (71.67%) were operated by the open method and 34 (28.33%) underwent the laparoscopic approach. 69 of the involved patients were males and 51 were females. After a mean follow up of 32.4 months: 104 patients were alive, 7 deceased and 9 were lost of follow up. Out of the 85 patients who underwent neoadjuvant chemoradiation in the open surgery group, 15 (17.6%) achieved a complete pathologic response, compared to 7 (21%) out of 32 patients who received the same protocol in the laparoscopic group as shown in **table 1**.

Table1: comparison between the baseline characteristics of the studied groups

	Open surgery group	Laparoscopic group
Number (n= 120)	86 (71.7%)	34 (28.3%)
Male	50 (58.1%)	19 (55.9%)
Female	36 (41.9 %)	15 (44.1 %)
Age (mean)	59.9	56.6
ASA*		
I	3 (3.5%)	3 (8.8%)
II	56 (65.1%)	26 (76.5%)
III	26 (30.2%)	5 (14.7%)
IV	1 (1.1%)	0
Tumor site (rectum)		
Upper	15 (17.4%)	6 (17.6%)
Middle	35 (40.6%)	18 (52.9%)
Lower	36 (41.9%)	10 (29.4%)
Tumor stage		
I	0	3 (8.8%)
II	16 (18.6%)	3 (8.8%)
III	70 (81.4%)	28 (82.4%)
Neoadjuvant therapy	85 (98.8%)	32 (94.1%)
Adjuvant therapy	62 (72.1%)	23 (67.6%)

*ASA: American society of anesthesiologists' classification

Table 2 highlights the details of surgery in the two studied groups.

Where 19 (22.1%) patients of the open surgery underwent abdomino-perineal excision compared to 10 (29.4%) patients of the laparoscopic group. 67 (71%) patients in the open surgery group underwent lower anterior resection compared to 24 (70.6%) in the laparoscopic group.

The median operation time was 207 min. in the open surgery group compared to 401 min. in the laparoscopic surgery group. The median lymph node yield for the open and the laparoscopic group patients was 11 and 12 respectively. No intra-operative mortality occurred in the two groups. Post-operative leak and pelvic abscess percentages in the open and the laparoscopic groups were 2.3%, 8.8% and 7%, 2% respectively.

Table2: Comparison between the operative details in the studied groups

	Open surgery group (n= 86)	Laparoscopic group (n= 34)	p-value
Procedure			
APE*	19 (22.1%)	10 (29.4%)	
LAR**	67 (71.0%)	24 (70.6%)	
Median operation time (min)	207	401	0.0001
L.N† yield (median)	11	12	
L.N. yield (mean)	11.7 (C.I 10-13)	11.4 (10-14)	0.8018
Intra-operative mortality	0	0	
Post-operative leak	2 (2.3%)	3 (8.8%)	
Pelvic abscess	7 (8.1%)	2 (5.9%)	
Completeness of resection			
R0	85 (98.8%)	34 (100%)	
R1	1 (1.2%)	0	
R2	0	0	

*APE: abdomino-perineal excision ** LAR: lower anterior resection † L.N: lymph node

Figures 1 and 2 depict the Kaplan-Meier curve for the 3-year overall and disease free survival curves, respectively. Local recurrence was observed in three out of 86 (3.5%) patients from the open group, while it was seen in four (11.8%) patients in the laparoscopic group (P=.099). Distant metastasis occurred in 12 out of 86 (14.0%) versus 5 out of 34 (14.7%) in the open and laparoscopic surgery groups, respectively (P-value=1.00).

Figure 1. Kaplan-Meier curve for the overall (3 year) survival of the studied groups.

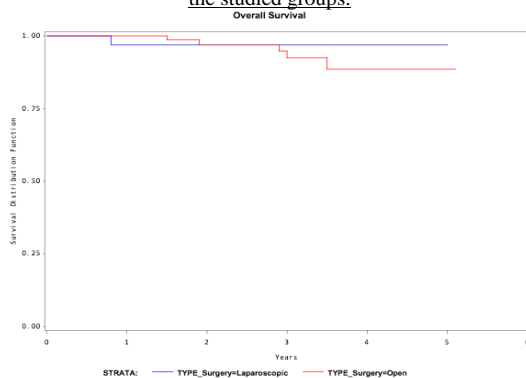
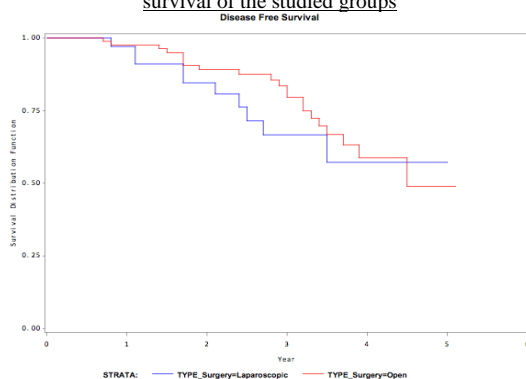


Figure 2: Kaplan-Meier curve for the three year disease free survival of the studied groups



DISCUSSION

The main aim of this study was to detect the long term outcomes of the laparoscopic approach to resect rectal cancers in comparison with the conventional open approach in Saudi Arabia. In this single center, retrospective study, 3-year outcomes were compared between the open and laparoscopic approaches for non-metastatic, resectable rectal cancer. Overall and disease free survival as well as distant metastasis, local recurrence rates and completeness of resection were compared between the two groups. In our study, complete resection was achieved in all patients in the laparoscopic group (n=34), whereas one out of the 86 patients who underwent open resection had a positive margin, where a positive distal margin was identified intra-operatively after an open ultra-low anterior resection was done. The issue was immediately rectified by proceeding with an abdomino-perineal resection.

Our median operative time for laparoscopic resections was (401.5 min) which was significantly longer than the median operative time reported in the COLOR II² trial (240 min) and the COREAN⁹ trial (245 min). The longer operating time is likely attributable to the fact that King Faisal Specialist Hospital and Research Centre is an academic institution where colorectal surgery fellows at different stages of their training participate actively in the operative procedures.

In our study, the overall survival (OS) rates for the laparoscopic versus the open approach were 97% and 89% respectively. These outcomes were similar to the results of the other international clinical studies as shown in table 3 where the overall survival for the laparoscopic versus the open approach for COLOR II² study, CLASSIC⁴ study and COREAN⁹ study were 86.7% &

83.6% , 82.7% & 65.5% and 91.7% & 90.4% respectively.

The disease free survival rates for the laparoscopic versus the open approach in our study were 57% and 49% respectively. This is close to the disease free survival for

the laparoscopic versus the open approach for COLOR II² study, CLASSIC⁴ study and COREAN⁹ study which were 74.8% & 70.8%, 70.8% & 67.1% and 79.2% & 72.5% respectively.

Table 3. Comparison of the outcome measures between our studied groups and those of the other international studies^{2,4,9}

	KFSH&RC		p-value	COLOR II ²		p-value	CLASICC ⁴		p value	COREAN ⁹		p-value
	Laparoscopic group	Open Surgery group		Laparoscopic group	Open Surgery group		Laparoscopic group	Open Surgery group		Laparoscopic group	Open Surgery group	
Overall survival	97%	89%	0.623	86.7%	83.6%	-	82.7%	65.8%	0.147	91.7%	90.4%	<0.0001
Disease free survival	57%	49%	0.409	74.8%	70.8%	-	70.8%	67.1%	0.925	79.2%	72.5%	<0.0001
Local recurrence	11.8%	3.5%	0.099	5%	5%	-	9.7%	10.1%	0.078	2.6%	4.9%	0.31
Distal recurrence	14.7%	14.0%	1.00	19.1%	22.1%	-	22.6%	20.1%	0.588	-	-	-

* For survival rates, two-sided 95% confidence intervals were calculated. ** Results are based on long term (10 years) follow-up.

The local recurrence rates for the laparoscopic versus the open approach in our study were 57% and 49% respectively. However the local recurrence rates for the laparoscopic versus the open approach for COLOR II² study, CLASSIC⁴ study and COREAN⁹ study were 5% & 5%, 9.7% & 10.1%, and 2.6% & 4.9% respectively.

The distal recurrence rates for the laparoscopic versus the open approach in our study were 14.7% and 14% respectively. However the distal recurrence rates for the laparoscopic versus the open approach for COLOR II² study and CLASSIC⁴ study were 19.1% & 22.1%, 9.7% & 10.1%, and 22.6% & 20.1% respectively.

The main limitations of our study was the retrospective design of the study, the small sample size and the fact

that data was collected from a single center which may not be representative. Due to the fact that our institution is a tertiary referral center, and as evidenced by our data, the majority of patients seen at KFSH&RC are stage III mid and lower rectal cancers. This factor may have contributed to the lower disease free survival rates.

CONCLUSION

Laparoscopic resection with curative intent for non-metastatic rectal cancer has similar long term outcomes to the open approach at tertiary care center staffed with dedicated colorectal surgeon.

AUTHORS' CONTRIBUTIONS

The participation of each author corresponds to the criteria of authorship and contributorship emphasized in the [Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly work in Medical Journals](#) of the [International Committee of Medical Journal Editors](#). Indeed, all the authors have actively participated in the redaction, the revision of the manuscript and provided approval for this final revised version.

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