REVIEW ARTICLE

Laparoscopic *vs* Open Anterior Resection

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ABSTRACT

Background: Worldwide about 782,000 people are diagnosed with colorectal cancer each year. Colorectal cancer is the third leading diagnosed cancer in the United States and the second leading cause of cancer-related deaths in Western countries. Surgery is the primary treatment modality in colorectal cancer. The laparoscopic approach to colectomy is slowly gaining acceptance for the management of colorectal pathology. The cost-effectiveness and long-term outcomes with laparoscopic colectomy (LAC) for malignancy are less well accepted. This review article was aimed to compare laparoscopic with open anterior resection and ascertain the therapeutic benefit, if any, in the overall management rectal cancer.

Keywords: Anterior resection, Laparoscopy, Open surgery, Comparison.

INTRODUCTION

Laparoscopic resection of the colon was first described in 1990. Early reports regarding laparoscopic-assisted colectomy revealed a more rapid recovery from surgery and decreased surgical complications. Yet, wound site recurrence, which reached 21% in some studies, raised significant concerns about this technique.[1] The cost-effectiveness and long-term outcomes with laparoscopic colectomy (LAC) for malignancy are less well-accepted. Smaller incision size leads to improved cosmesis and reduced postoperative pain. The laparoscopic approach is also associated with less postoperative ileus and earlier tolerance of diet. These factors contribute to earlier recovery of the patient with a reduced hospital stay and earlier return to normal activity.[2]

Laparoscopic colorectal surgery can be done in three ways:

- Purely laparoscopic
- Laparoscopic assisted
- Hand-assisted laparoscopic surgery (HALS).

AIMS

The aim of this study was to compare the effectiveness and safety of laparoscopic and conventional 'open' anterior resection (AR) in the treatment of rectal cancer. The following parameters were evaluated for both laparoscopic and open procedures:

1. Method of patient selection
2. Operative technique
3. Operating time
4. Intraoperative and postoperative complications
5. Postoperative pain and amount of narcotic used
6. Time until resumption of diet
7. Postoperative morbidity
8. Hospital stay
9. Cost-effectiveness
10. Quality of life analyses
11. Circumferential resection margin and distal cut margin
12. Long-term outcome.

MATERIALS AND METHODS

A literature review was performed using SpringerLink, Journal of MAS and major general search engines like Google, MSN, etc. The following search terms were used: AR, laparoscopy, open surgery, comparison. Criteria for selection of literature were the number of cases (excluded if less than 20), methods of analysis (statistical or nonstatistical), operative procedure (only universally accepted procedures were selected) and the institution where the study was done (specialized institution for laparoscopic AR was given more preference).

CONTENT

Choice of Surgical Approach for Rectal Lesion

In the abdominoperineal resection (APR) a double approach is employed, abdominal and perineal, often with two operative teams working simultaneously. The procedure chosen for midrectal carcinoma depends on different variables, the decision often not being made until during the procedure depending on the size of the tumor, localization, invasion, etc. If the lesion can be palpated easily on rectal examination, APR is indicated (this is approximated at 3 to 7 cm from the anal verge). If at the time of the resection the remaining rectum is enough to perform an anastomosis, a low AR could be safely performed. Generally, APR is required for lesions distal to 7 to 8 cm from the anal verge. For lesions above 12 cm, AR perhaps is always done. For lesions between 8 and 12 cm, the procedure may depend on the above-mentioned factors. The approach to the tumor for a low AR is similar to that used in APR, including removal of ischiorectal fat and

sigmoid mesentery and rectal mobilization to the level of the levator ani muscles. The low AR with primary anastomosis below the level of the peritoneal reflection is completed if the distal margin is clear and enough rectal tissue is viable to perform an end-to-end anastomosis safely. However, if the surgeon believes that anastomosis cannot be completed safely, an APR is recommended.

Procedure for Laparoscopic Anterior Resection

Place the patient in steep Trendelenburg position with the right side of the table down. A thorough inspection is required for patients with cancer to exclude any metastatic disease. Place the first three (10-12 mm) trocars in the supraumbilical region and right upper and right lower quadrants, lateral to the rectus muscle. Place a fourth (10-12 mm) trocar in the left upper quadrant lateral to the rectus muscle. This will be exchanged for a 33 mm trocar later. Additional (10-12 mm) trocars may be needed for retraction. After mobilizing the left colon, grasp the sigmoid colon with an endoscopic Babcock clamp and retract it medially to expose the white line of Toldt (Fig. 1). Using either an ultrasonically activated scissors or a cautery scissors, incise the peritoneum to mobilize the sigmoid and left colon to the level of the splenic flexure. Continually, regrasp and manipulate the colon as the dissection progresses medially to expose Gerota's fascia, the ureter, and the sacral promontory. Grasp the rectosigmoid junction using an endoscopic Babcock clamp and retract it anteriorly toward the abdominal wall.

Enter the presacral plane posteriorly with ultrasonic or cautery scissors (Fig. 2). Dissect posteriorly to well below the level of the pathology, using sharp dissection. Intraoperative rigid proctoscopy is often helpful to confirm the exact level of the lesion. Mark the site with clips. Continue the dissection laterally and finally anteriorly to circumferentially free the mesorectum at least 5 cm distal to the distal edge of the tumor.

Serially divide and ligate the mesorectum (at right angles to the rectum) with a series of clips, vascular stapler, or ultrasonically activated scissors. Bare rectum should be demonstrated circumferentially. Perform a total mesorectum excision for tumors in the lower two-thirds of the rectum, to obtain adequate tumor control. Extrude the specimen through the port or in continuity with the port. If the specimen is too large, remove the port and deliver the bowel through an enlarged incision protected by a plastic wound drape. Perform the proximal resection extracorporeally in the conventional fashion. Place a purse string suture and insert the circular stapling anvil into the proximal end of bowel. Secure the purse string suture and replace the bowel into the abdominal cavity. Replace the 33 mm trocar (if it

was removed) and re-establish pneumoperitoneum. Grasp the anvil with an anvil-grasping clamp, usually passed through the right upper or lower quadrant trocar sites. Assess the ability of the anvil to reach the planned anastomotic site. Further mobilization and/or vascular division may be needed, and should be performed if necessary. Verify the correct orientation (i.e. no twist) for the proximal bowel. Insert a circular stapler transanally and advance it to the distal staple line. Under direct laparoscopic visual control, extend the spike of the stapler through the distal staple line. Move the laparoscope to the right or left lower quadrant port to best visualize the anvil and stapler head coming together. Once satisfied, close, fire and remove the stapler. Inspect the two donuts for completeness. Test the anastomosis by placing an atraumatic Dennis-type clamp across the bowel proximal to the anastomosis. Use the suction irrigator to fill the pelvis with saline and immerse the anastomosis. Insufflate the rectum with air, using a bulb syringe, proctoscope, or flexible sigmoidoscope, and observe for air bubbles. Irrigate the abdomen, obtain hemostasis, and close the trocar sites. Close the 33 mm port site with interrupted absorbable sutures.[3]
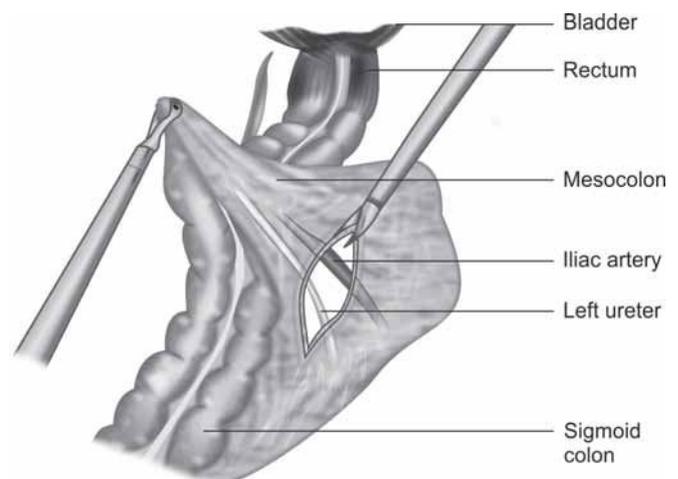

Fig. 1: Medial to lateral dissection taking care of left ureter
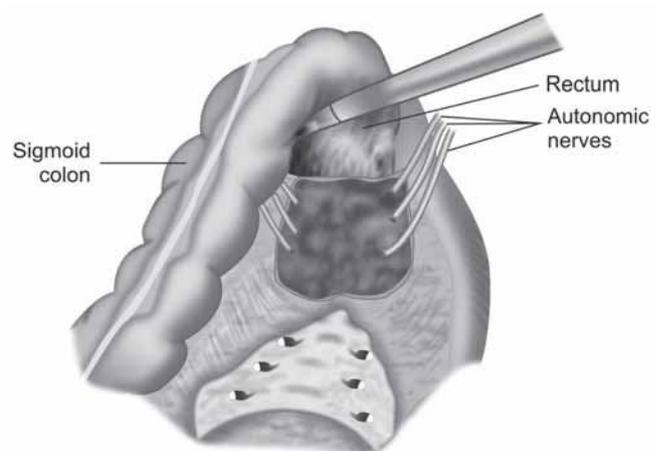

Fig. 2: Complete posterior dissection identifying the autonomic nerves

TOTAL MESORECTAL EXCISION

Total mesorectal excision (TME) in conjunction with a laparoscopic AR or an abdominal perineal resection involves precise sharp dissection and removal of the entire rectal mesentery, including that distal to the tumor, as an intact unit. Unlike conventional blunt dissection, the rectal mesentery is removed sharply under direct visualization emphasizing autonomic nerve preservation, complete hemostasis, and avoidance of violation of the mesorectal envelope. Its rationale is underscored by the hypothesis that the field of rectal cancer spread is limited to this envelope and its total removal encompasses virtually every tumor satellite. The reduction of positive radial margins can be reduced from 25% in conventional surgery to 7% in cases resected by TME. Furthermore, Adam et al showed that patients with positive radial margins were three times more likely to die and 12 times more likely to have local recurrence than patients without radial margin involvement.[4]

BLOOD LOSS AND COLORECTAL SURGERY

According to study conducted by Kiran et al in 147 the open colectomy group required significantly more units of blood ($p = 0.003$) to maintain similar hemoglobin levels after surgery. Estimated blood loss ($p = 0.001$) and the number of patients who received transfusions on the day of surgery ($p = 0.002$), during the first 48 hours after surgery ($p = 0.005$), and during the entire hospital stay ($p = 0.003$) were significantly higher in the open colectomy group.[5] According to Wen-Xi Wu intraoperative blood loss was less in laparoscopic resection group than in open resection group.[6]

IMMUNE RESPONSE AND LAPAROSCOPY

According to Wichman et al 70 prospectively enrolled patients with colorectal diseases were undergoing laparoscopic ($n = 35$) or open ($n = 35$) surgery. Significant differences between study and control patients ($p = 0.05$) were detected regarding circulating interleukin-6 and C-reactive protein levels with a reduced proinflammatory response to surgery in patients after laparoscopic surgery. Furthermore, postoperative natural killer cell counts were significantly higher in patients after laparoscopic surgery. The levels of B lymphocytes and T lymphocytes and helper T-cell counts and cytotoxic (suppressor) T-cell counts did not show significant differences after open or laparoscopic surgery.[7]

COST AND LAPAROSCOPY

According to Chapman et al LAC patients ($n = 150$) were compared with the same number of open colectomy patients. Operating room costs were significantly higher after LAC ($p = 0.0001$), but length of hospital stay was significantly lower ($p = 0.0001$). This resulted in significantly lower total costs ($p = 0.0007$) owing to lower pharmacy ($p = 0.0001$), laboratory ($p = 0.0001$), and ward nursing costs ($p = 0.0004$).[8] According to Hoffman et al the length of the operative procedure, operating room charge, and the total hospital charge were greater for patients undergoing laparoscopic-assisted colectomies and were discharged from the hospital sooner than patients who underwent open colectomies.[9]

OPERATING TIME

According to Mathur et al median operating time for laparoscopic abdominoperineal resection was 296 minutes, initial 7 cases taking an average of 368 minutes, while subsequent 7 cases average operating time was 232.5 minutes. In laparoscopic AR, average duration of surgery was 356 minutes, first 4 cases taking 400 minutes while for last 2 cases, and mean operating time was 300 minutes.[10] According to Wen-Xi Wu the operative time was longer in laparoscopic resection group than in open resection group (189 ± 18 *vs* 146 ± 22 minutes, $p < 0.05$).[6] According to Tsang et al from March 1999 to September 2004, 105 patients underwent laparoscopic TME with colonic J-pouch reconstruction. The mean operating time was 170.4 minutes.[11] According to Chapman et al laparoscopic resection of colorectal malignancy was time-consuming.[8] According to Veenhof et al laparoscopic surgery took longer to perform (250 *vs* 197.5 minutes, $p = 0.01$), but was accompanied by less blood loss (350 *vs* 800 ml, $p = 0.01$).[12]

CONVERSION RATE

Many different types of colectomies were performed successfully and safely for a variety of surgical indications. The conversion rate was 22.5%, which decreased to 15% in the second half of the series.[9]

USE OF NARCOTICS AND ANALGESICS

According to Anne-Marie Boller et al the following four phase III randomized controlled trials have completed accrual and reported early data on recovery benefits for LAC: Barcelona, Clinical Outcomes of Surgical Therapy Study Group (COSTSG), Colon Cancer Laparoscopic or Open Resection (COLOR), and Conventional versus Laparoscopic-Assisted Surgery in Colorectal Cancer (CLASICC). These trials have uniformly and consistently shown a significant reduction in the use of narcotics and oral analgesics.[1] According to Chapman et al laparoscopic resection procedure's advantages revolve around early recovery from surgery and reduced pain.[8] According to Hoffman et al patients who underwent laparoscopic operations had a shorter period of postoperative ileus and less pain, and were discharged from the hospital sooner than patients who underwent open colectomies.[9]

START OF ORAL FEEDS

According to Mathur et al oral feeds started on postoperative day 2.[10] According to Anne-Marie Boller et al for LAC the trials were: Barcelona, COSTSG, COLOR, and CLASICC. These trials have shown a significant reduction in the use of narcotics and oral analgesics and length of hospital stay, as well as a faster return of diet and bowel function, with LAC.[1] According to Wai Lun Law et al laparoscopically operated patients have significantly earlier return of bowel function, earlier resumption of diet, and shorter hospital stay.[13] According to Veenhof et al enteric function recovered sooner after laparoscopy.[12] According to Hoffman et al patients who underwent laparoscopic operations had a shorter period of postoperative ileus and less pain, resumed a regular diet sooner, and were discharged from the hospital sooner than patients who underwent open colectomies.[9]

POSTOPERATIVE MORBIDITY AND MORTALITY

According to Mathur et al, two out of 20 patients have wound infection.[10] According to Wen-Xi Wu et al the overall postoperative morbidity was 5.6% in the LAP resection group and 27.8% in open resection group ($p < 0.05$). No anastomotic leakage was found in both groups.[6] According to Tsang et al six patients underwent reoperation for major complications. Erectile dysfunction occurred in 13.6% of males, while two patients developed incomplete bladder denervation.[11] According to Wai Lun Law et al during period 2, the operative mortality rates of patients with laparoscopic (n = 401) and open resection (n = 255) were 0.8 and 3.7%, respectively ($p = 0.022$), and the morbidity rates were 21.7 and 15.7%, respectively ($p = 0.068$). The operative mortality rates were 4.4 and 2.6% in periods 1 and 2, respectively ($p = 0.132$). The 3-year overall survivals (OS) for patients with nondisseminated disease were 69.7 and 76.1% for periods 1 and 2, respectively ($p = 0.019$).[13] According to Jin-Tung Liang et al, in patients with a successful nerve-preserving surgery (96.4%, n = 108), 104 patients completed the evaluation of urinary function. The median duration for indwelling urine Foley catheter was 3.0 days (range: 1.0-7.0 days). The voiding function after removal of the urine Foley catheter was good (IPSS: 0-7) in 98 (94.2%) patients, fair (IPSS, 8-14) in 5 (4.8%), and poor (IPSS, 15-35) in 1 (1.0%).[14]

HOSPITAL STAY

According to Mathur et al median hospital stay was 11 days.[10] According to Anne-Marie Boller et al for LAC: Barcelona, COSTSG, COLOR, and CLASICC. These trials have shown a significant reduction length of hospital stay, a faster return of diet and bowel function, with LAC.[1] These

findings were also supported by Conor P Delaney et al, Wai Lun Law et al, Veenhof et al and George C Hoffman et al in their respective trials.[2,9,12,13]

PORT-SITE METASTASIS

According to Mathur et al, Tsang et al and Eric C Poulin et al in their trials there was no incidence of port metastasis in any patient.[10,11,15]

NUMBER OF LYMPH NODES DISSECTED

According to Wen-Xi Wu et al the mean number of harvested lymph nodes in laparoscopic resection group was comparable to those in open resection group.[6] This is also supported by Hoffman et al.[9] According to George Pechlivanides et al in their trial group A included 39 patients who had an open TME with low AR of the rectum (LARR) and four with APR of the rectum. In group B, there were 34 patients who had a laparoscopic TME (27 with LARR and 7 with APR). The mean number of lymph nodes retrieved in group A specimens was 19.2 (5-45) and in group B 19.2 (8-41) ($p = 0.2$). In group A, 3.9 (1-9) regional, 13.9 (3-34) intermediate and 1.5 (1-3) apical lymph nodes were retrieved. The respective values in group B were 3.7 (3-7), 14.4 (4-33) and 1.3 (1-3). Differences between groups were not significant. Also, the incidence of lymph node involvement by the tumor was not significantly different between groups (group A: 23; group B: 19).[16]

CIRCUMFERENTIAL RESECTION MARGIN AND DISTAL CUT MARGIN

According to Jayne et al higher positivity of the circumferential resection margin was reported after laparoscopic AR, but it did not translate into an increased incidence of local recurrence[17] and according to Tsang et al there was 1 case of microscopic circumferential margin involvement and 1 case of microscopic distal margin involvement.[11]

LONG-TERM OUTCOME

According to Jayne et al 794 patients were recruited (526 laparoscopic and 268 open). Overall, there were no differences in the long-term outcomes. The differences in survival rates were OS of 1.8% (95% CI: 5.2-8.8%; $p = 0.55$), disease free survival (DFS) of 1.4% (95% CI: 9.5-6.7%; $p = 0.70$), local recurrence of 0.8% (95% CI: 5.7-4.2%; $p = 0.76$), and quality of life (QoL) (P = 0.01 for all scales).[17] According to Wai Lun Law et al the 3-year OS in those with nondisseminated disease were 74.4 and 78.8% for open and laparoscopic resection, respectively ($p = 0.046$). The operative morality rates were 4.4 and 2.6% in periods

1 and 2, respectively (p = 0.132). The 3-year OS for patients with nondisseminated disease were 69.7 and 76.1% for periods 1 and 2, respectively (p = 0.019).[13] Two trials, Barcelona and COSTSG, have sufficient maturation and follow-up to report recurrence and survival data, and neither has found a survival disadvantage in patients treated with LAC. Results of the Barcelona trial suggest a cancer-related survival advantage in patients treated with LAC, based solely on differences in patients with stage III disease; this is not confirmed by the COSTSG trial.[1] According to Tsang et al actuarial 5-year cancer-specific survival and local recurrence rates were 81.3 and 8.9%, respectively.[11] According to Hoffman et al for patients undergoing laparoscopic-assisted colectomies for primary colorectal malignancy, no adverse patterns of recurrence or decreased survival has been noted at 2-year follow-up when compared with standard open colorectal cancer surgery.[9] According to Poulin et al the median follow-up was 24 months for patients with stage I, II and III disease and 9 months for patients with stage IV disease. Observed 2-year survival rates were 100% stage I, 88.7% stage II, 80.6% stage III, and 28.6% stage IV. Survival rates at 4 years were 100% stage I, 79.5% stage II, 53.7% stage III and 0% stage IV. No trocar site recurrence was observed.[15]

DISCUSSION

Despite the potential advantages to be gained by the patient and the community from laparoscopic colorectal surgery (e.g. reduced postoperative pain, early return of gastrointestinal function, shorter hospital stay, and earlier return to full activity), laparoscopy is slowly gaining acceptance by the surgical community for rectal cancer.

The factors of concern in laparoscopy were:
1. Increased complexity of laparoscopic techniques
2. Duration of surgery and of the learning curve
3. Lack of data from randomized controlled trials
4. Port-site metastases in malignant disease
5. Adequacy of free resection margins and lymph node retrieval, while performing a TME for middle and low rectal cancer.

It has been shown that many nodal metastases in colorectal cancer are found in small lymph nodes of 5 mm in diameter and that a minimum of 12 to 18 lymph nodes must be examined, a very careful search for lymph nodes must be performed.[16] Two recently published meta-analyses show that laparoscopic rectal cancer surgery may accomplish an oncological clearance of similar quality to the open approach. The meta-analysis by Aziz et al including 1,375 patients from 17 studies shows no significant differences in the proportion of patients with positive radial margins and the number of lymph nodes harvested between laparoscopic and open LAR or APR for rectal cancer surgery. Of the six studies reporting on lymph node retrieval included in the meta-analysis by Gao et al, five report no difference in lymph node numbers removed with the specimen between the open and the laparoscopic resection of the rectum.

Postoperative Pain

Regarding postoperative pain numerous randomized controlled trials have demonstrated a significant reduction in pain or analgesic requirements in the immediate postoperative period.

Bokey et al did not find a significant difference in analgesic requirements after laparoscopic when compared with open surgery. Reports on comparative operating times between the two procedures are also equivocal.[2]

Quality of Life

Exact QoL between two groups is difficult to measure because of lack of more sensitive and appropriate instruments. Therefore, based on literature the patient's experienced better QoL with reduced pain in the immediate postoperative period.

Recovery of Bowel Function

Faster recovery of bowel function is another significant advantage seen in the laparoscopic group.

Length of Hospital Stay

Most studies have reported a shorter duration of stay after laparoscopic-assisted colectomy. Others, however, report a similar length of stay for patients undergoing surgery by the two approaches, although this may be related to differing length of stay in different cultural environments and less experience with the technique in some reports.[2]

Cost

Direct costs following the laparoscopic surgery are higher than the open one. However, the diehard supporters of laparoscopic surgery have argued that the total costs to the society may actually be lower considering the improved short-term and potential long-term outcomes associated with the minimally access approach.

Port-site Recurrence

Concerning with port-site recurrence, numerous experimental studies have been published since 1991. They

have analyzed the possible role of pneumoperitoneum and carbon dioxide, the pathophysiology of minimally invasive techniques on tumor response and immunity. In laparoscopic procedure, the tumor was removed through small incisions in the abdominal wall or perineal, and this maneuver may theoretically lead to a risk of tumor contamination. To avoid port-site metastasis, Balli et al described a routine to follow in colorectal cancer resection: fixation of trocars to the abdominal wall, high vascular ligation, isolation of specimens before extraction from the abdominal cavity, and intraperitoneal and trocar site irrigation with a tumoricidal solution. With improved incision protection techniques, the reported port-site recurrence rate dropped rapidly. Zmora reported a pot-site recurrence rate of 1% in a review of 1,737 patients who have undergone laparoscopic colorectal resection for malignancy. Ramos et al reported abdominal wall metastases in only 3 of 208 patients with a minimum follow-up period of 1 year. All recurrences were in patients with Duke's C-stage carcinoma, and 2 of the 3 were found to have diffused peritoneal carcinomatosis at the initial surgery. The port-site metastasis has not been a significant issue in the presence of adequate training and laparoscopic skills.[6]

Long-term Outcomes

The long-term outcomes have been studied considering the following aspects:

- Tumor recurrence
- Disease free survival and
- Overall survival.

Another concern is regarding the accidental tumor spillage during laparoscopic colorectal resections that is caused by grasping and manipulating the bowel in the narrow pelvis. Recently, Franklin et al reported the results of LAC in 50 consecutive patients with stage III colorectal cancer, which was performed at a single hospital. The OS rates at 3 and 5 years were 54.5 and 38.5%, respectively, and the cancer-adjusted survival rates were 60.8 and 49%. For low rectal lesions laparoscopy-assisted APR (28.6% in our series) also allowed earlier postoperative recovery, with an equivalent tumor clearance, morbidity, mortality, disease free interval and duration of survival.[6]

The CLASICC trial has added to the body of evidence that vindicates the use of laparoscopic resection for colon cancer without detriment to long-term oncological outcomes. This study has now extended this conclusion to the use of laparoscopic resection of rectal cancer. Importantly, the higher positivity of circumferential resection margin seen after laparoscopic AR has not resulted in an increased

incidence of local recurrence, and supports the continued use of the laparoscopic approach in these patients.[17]

In vast majority of reports, postoperative mortality rates following laparoscopic rectal cancer excision were low—overall mortality rate in the literature is 1.3%.[10]

IMMUNITY

The postoperative immune dysfunction is important for patients undergoing surgery for benign as well as malignant disease because it influences the rate of infectious complications as well as the growth of disseminated tumor cells. Especially in patients with cancer, better preserved postoperative immunity could result in better long-term oncologic results.[7]

CONCLUSION

This literature review shown that with laparoscopic technique, all oncologic principles of rectal cancer surgery could be followed. With regard to morbidity, local disease recurrence and survival figures, laparoscopic surgery is at least comparable with open surgery and it offers distinct advantage in early postoperative period and in terms of cosmesis and with development of improved techniques and more experience, operating time can gradually be reduced. These favorable findings of laparoscopic resection for colorectal malignancy certainly warranted further longer follow-up and results of prospectively randomized studies.

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