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ORIGINAL ARTICLE

The long-term oncological outcomes of the 140 robotic sphincter-saving total mesorectal excision for rectal cancer: a single surgeon experience

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Abstract

Robotic surgery became more popularly in the colorectal surgical field. The aim of the study was to evaluate of the oncological outcomes which patients who underwent the robotic total mesorectal excision for rectal cancer. A series of 140 consecutive patients who underwent robotic rectal surgery between January 2012 and June 2019 was analyzed retrospectively in terms of demographics, pathological data, and surgical and oncological outcomes. There were 104 (74.28%) male and 36 (25.71%) female patients. The tumor was located in the lower rectum in 84 (60%) cases, in the mid rectum in 38 (27.14%) cases, and in the upper rectum in 18 (12.85%) cases. Ninety-eight (70%) of the patients has received neoadjuvant chemoradiotherapy. All the patients underwent robotic sphincter-preserving surgery, 101 (72.14%) patients low-anterior resection, and 39 (27.85%) patients underwent intersphincteric resection with colo-anal anastomosis. There were no conversions. The circumferential resection margin was positive in five (3.57%) patients. The median distal resection margin of the operative specimen was 3.2 (0.2–7) cm. The median number of retrieved lymph nodes was 22 (16–42). TME quality in the in our study was rated as complete in 88.57% (*n*124) of patients, nearly complete in 7.14% (*n*10) of patients; and 4.28% (*n*6) of incomplete. The median hospital stay was 3.5 (3–12) days. In-hospital and 1-month mortality was zero. The median length of follow-up was 40 (2–80) months. The 5-year overall survival rate was 92.78%. The 5-year disease-free survival rate was 90%. Locally recurrence and distance recurrence rate was 3.57% (*n*5/140) and 2.85% (*n*4/140), respectively. Robotic rectal cancer surgery has a good oncological outcomes and feasible tool in the field of the rectal surgery, but required a steep learning curve.

Keywords Robotic approach · Rectal cancer · TME · Oncological outcomes

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Introduction

Over the last 2 decades, the management of rectal cancer (RC) has evolved with a fall in local recurrence rates and improvement in disease-free survival. This can be attributed to improved radiological staging, neoadjuvant chemoradiotherapy, and surgical technique [1–4]. Neoadjuvant long-course chemoradiotherapy downstages tumor, achieves complete response rates in 15–20% patients depending on the waiting period, and may improve sphincter preservation rate [5, 6]. However, operating on patients who have mid or low RC after neoadjuvant chemoradiotherapy (NCRT) is challenging with minimal invasive surgery. Additionally, laparoscopic resection of RC is a more technically demanding and has a steep learning curve, because it is performed in the narrow pelvic cavity [7, 8]. Results of the United Kingdom Medical Research Council Conventional vs Laparoscopic-Assisted Surgery in Colorectal Cancer (MRC-CLASICC) showed that laparoscopic surgery for RC was associated with high rates of conversion, circumferential resection margin (CRM) positivity, and urinary/sexual dysfunction especially in male patients. Additionally, converted individuals had more complications from surgery [9]. Additionally, conversion rates decrease with the learning curve, but are still high at Classic 34%, Color II (17%), ACOSOGZ51 (11.3%), and Alacart (9%) studies [10–13]. Considering the particular advantage of the robot in pelvic procedures, it is believed that the robotic system will overcome the limitations of laparoscopy in the narrow pelvis and could result in a benefit to the patient in the meaning of improved oncologic and functional outcomes [14, 15]. We have already published our study to compare perioperative and oncological short- and long-term outcomes of laparoscopic and robotic sphincter-saving resections for mid or low RC in male patients after NCRT [17, 29].

Materials and methods

Between January 2012 and June 2019, 140 consecutive patients undergoing robotic rectal resection for cancer were analyzed retrospectively. Informed written consent was signed by all patients. All the procedures were performed by single surgeon (OA) who was experienced in advanced laparoscopy and robotic surgery. We excluded patients with previous colonic surgery, carcinomatosis, and T4 tumors that required a multiorgan resection. The presence of liver metastasis was not an exclusion criterion.

The preoperative staging included chest X-ray, assessment of carcinoembryonic antigen (CEA) levels, total colonic examination with flexible or virtual colonoscopic technique, thoraco-abdominal computed tomography (CT), pelvic-phased array magnetic resonance imaging (MRI), and/or endorectal ultrasound. Preoperative clinical data included patient's characteristics and TNM staging. The final treatment plan was decided by a multidisciplinary team that included surgeons, radiologists, and oncologists and that followed the NCCN guidelines for rectal cancer. Patients with clinical T3, T4, or node-positive disease (stage II and III) initially treated with either neoadjuvant long-course chemoradiotherapy [45–50.4 Gy pelvic irradiation with concomitant 5-fluorouracil (5-FU) and leucovorin (FUFA)], or short-course radiotherapy (25 Gy pelvic irradiation). Short-course radiotherapy was preferred in a selected group of patients without any risk of lateral margin positivity. The waiting period was 4–8 weeks for long-course radiotherapy and 1–4 weeks for short-course radiotherapy.

Perioperative clinical data included general patient characteristics, history of abdominal surgery, and tumor location. The intraoperative results consisted of the type of 140 surgical procedure, operative time for each type of procedures (LAR, ISR), and volume of blood loss. The postoperative results included pathological data (tumor diameter, distal resection margins, number of retrieved lymph nodes, status of circumferential resection margin, and TNM stage), postoperative complications, hospital stay, and follow-up.

CRM positivity was defined as a distance from the circumference margin of ≤ 1 mm [16].

Follow-up consisted of a clinical examination within 1 month of surgery, examinations every 3–6 months after discharge with tumor markers, abdominal CT and chest CT in the first year, and examinations every 6 months in the second year. Colonoscopy was performed at the end of the first year and every 2 years thereafter. In patients with postoperative chemoradiotherapy, an abdominal/pelvic CT, MRI, or PET-CT was performed at the end of treatment or at the end of the first year in patients with early stage rectal cancer. Operative techniques have been described in our previous publications [17].

Statistical analysis

Data were expressed as the median (range) for continuous variable and number (percentage) for categorical variables. Overall survival was assessed using Kaplan–Meier method.

Results

The clinical characteristics of patients who underwent robotic rectal resections are listed in Table 1. From 140 of patients, male and female patients were 104 (74.28%) and 36 (25.71%), respectively. The median age was 56 (28–80) years. The median BMI was 24 (18–38). Almost half of the patients had significant comorbidities (mainly cardiovascular diseases). Number of the patients received neoadjuvant chemoradiotherapy (nCRT) was 98 (70%).

Table 1 Patient characteristics, $N = 140$

	Mean	
Sex		
Male	104	(74.28%)
Female	36	(25.71)
Age (years)—median, range	56	(28–80)
BMI—median, range	24	(18–38)
Comorbidity (ASA I–III)	58	
History of abdominal surgery	28	(20%)
Tumor location		
Low < 5 cm	84	(60%)
Mid 5–10 cm	38	(27.14%)
Upper 10–15 cm	18	(12.85%)
Preoperative CRT	98	(70%)

The tumor was located in the lower rectum in 84 (60%) cases, in the mid rectum in 38 (27.14%) cases, and in the upper rectum in 18 (12.85%) cases. From among the 140 rectal cancer patients, 101 (72.14%) underwent low-anterior resection (LAR) and 39 (27.85%) patients underwent intersphincteric resection with hand-sewn colo-anal anastomosis (Table 2). There were two patients with stage 4 rectal cancer, there were multiple liver metastases, due to recurrent bleeding from the rectal tumor and obstruction, and patients underwent robotic rectal resection only. Diverting loop ileostomy was performed in 130 (92.85%) cases. There was no conversion. The median operative time for sphincter-saving procedures was 110 (80–295) min (Fig. 3). Estimated blood loss was 90 (0–230) ml.

Table 2 Surgical outcomes, $N=140$

Type of operation	
LAR	101 (72.14%)
ISR with colo-anal anastomosis	39 (27.85%)
Diverting loop ileostomy	130 (92.85%)
Conversion	0
Operative time—min, median (range)	110 (80–295)
Estimated blood loss—median (range)	90 (0–230)
Tumor diameter—cm, median (range)	3.45 (0.5–10)
Distal resection margins—cm, median (range)	3.2 (0.2–7)
Circumferential resection margin positivity	5 (3.57%)
Retrieved lymph nodes—median (range)	22 (16–42)
Macroscopic quality of TME specimen	
Complete	124 (88.57%)
Nearly complete	10 (7.14%)
Incomplete	6 (4.28%)
ypTNM stage	
0	10 (7.14%)
I	46 (32.85%)
II	64 (45.71%)
III	18 (12.85%)
IV	2 (1.42%)
Postoperative stay (days)—median, range	3.5 (3–12)
Follow-up (months)—median, range	40 (2–80)

In 14 (10%) of patients, a surgical complication occurred (Table 3). In ten patients, these complications were managed conservatively. The most frequent cause of postoperative morbidity was anastomotic leak (*n*3, 2.14%). All of three patients had diverting ileostomy, and they completely recovered with CT drainage. One patient underwent revision surgery for colonic ischemia which has occurred on 3rd postoperative days, laparoscopic left colectomy, and colo-anal anastomosis which was performed. General complications (Clavien–Dindo classification I–III) occurred in 16 (11.42%) patients (Table 4). There was no in-hospital mortality. Pathological outcomes are presented in Table 2. The median distal margin of the operative specimen was 3.2 (0.2–7) cm. The median number of harvested lymph nodes was 22 (16–42). The circumferential resection margin was positive in 5 (3.57%) cases. Six patients presented transitory postoperative urinary dysfunction, all of whom were medically treated (alpha 1 adrenergic receptor antagonist). Only two were discharged with a urinary catheter; the catheter was removed after 10 days following surgery in both of patients. Regarding oncological outcomes, the median follow-up time was 40 (2–80) months. The 5-year overall survival rate (OS) and disease-free survival (DFS) were 92.78% and 90%, respectively (Figs. 1, 2). Locally recurrence rate was 3.57% (*n*4/140), 3 of them underwent abdominoperineal resection (APR), and one patient carried out for cytoreductive surgery with hyperthermic chemotherapy (HİPEC). Distant metastasis developed in 2.85% (*n*4/140) patients. There were five deaths during the follow-up period, including two patients with stage 4 rectal cancer, two patients with stage 3 rectal cancer, and one patient with stage 1 rectal cancer.

Table 4 General complications

Complications	$n=16$
Respiratory problem	3
Ileus/obstruction	4
Urinary retention	8
Acute renal failure	1

Table 3 Surgical complications

Surgical complications 14 cases	Treatment
Anastomotic leak 3 cases	Conservative treatment, CT drainage
Ischemic colitis 1 case	Laparoscopic reoperation—revision surgery to colo-anal anastomosis
Bowel obstruction 3 cases	Laparoscopic reoperation—adhesiolysis
Postoperative bleeding 2 cases	Conservative, CT drainage
Pelvic abscess 3 cases	CT drainage
Wound infection 2 cases	Conservative

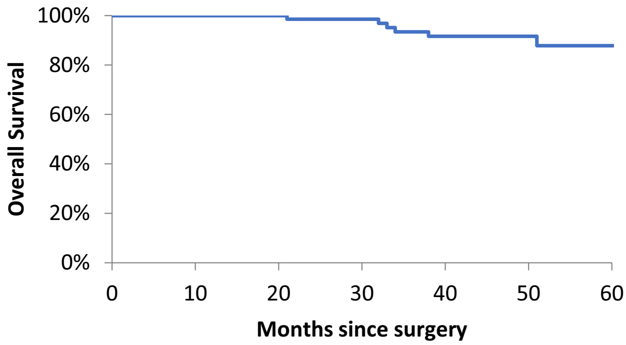

Fig. 1 5-year overall survival rate of 140 RC patients

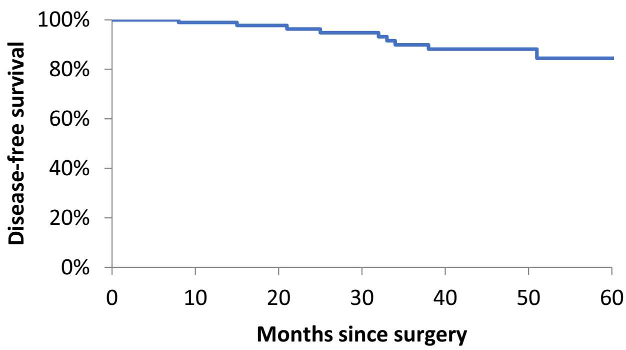

Fig. 2 5-year disease-free survival rate of 140 RC patients

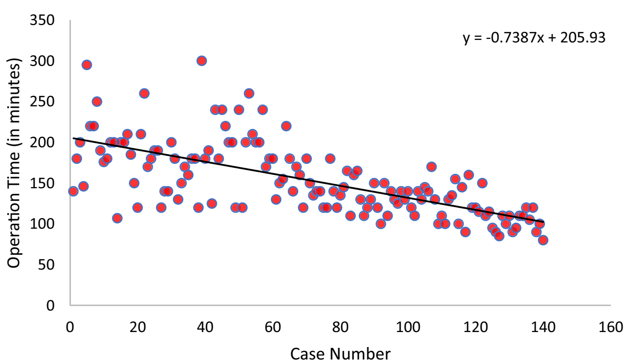

Fig. 3 Learning curve analysis of 140 R-TME rectal cancer patients according to date and duration of surgery

Discussion

Achieving a TME is a key oncological principle for mid or low localized rectal cancer, and is particularly challenging when laparoscopically attempting sphincter-saving TME. The reason of this is because performing an L-TME with meticulous and precise dissection of the mesorectum in a previously irradiated rectum down to the pelvic floor within the confines especially of a narrow pelvis requires a series of complex moves, which are not only operator but also assistant/camera-man dependent and demands a high level of experience and has a significant learning curve, which has been required 156 laparoscopic TME surgery [18, 19]. In addition, laparoscopic instruments are known to have several limitations such as inability to perform high precision suturing, poor ergonomics, and fixed tips with limited dexterity.

Conversion, which has been related to not only tumoral factors but also learning curve effect, has impaired survival in patients with rectal cancer in long-term follow-up. The average conversion rate of the studies was 17.9 ± 10.1%. A recent meta-analysis showed that a complete laparoscopic surgery favored lower 30-day mortality rate, lower long-term disease recurrence, and lower overall mortality. Especially, factors negatively associated with the completion of laparoscopic surgery were male gender, rectal tumor, T3/T4 tumor, node-positive disease, and the patients requiring sphincter-preserving surgery [19]. We have previously published our personal cases: laparoscopic sphincter-preserving TME was attempted in 217 unselected patients with rectal cancer, from 2005 to June 2012, with a 6.5% conversion rate [20]. There were 91 women and 126 men; the complication rate was 17.05%. The mean follow-up time of all patients was 36.12 months (range 1–89 months). The local recurrence rate was 3.6% and the distant recurrence rate was 8.7%. The 5-year DFS rate was 81.5% [20]. We evaluated the same group of patients 5 years later to show long-term oncological outcome [21]. The mean follow-up of all patients was a median of 91 months (range 3–164 months). The local recurrence rate was 6.5%, and the distant recurrence rate was 19.8%. The 10-year DFS rates were 67.1% and overall survival (OS) was 76.4%. In a subgroup analysis, in the converted group, DFS and OS were 46.7%, and 50%, respectively. In the laparoscopic group, DFS and OS were 68.5% and 78.3%, respectively [21]. The conversion rate in Color II study remained 16% throughout the study period, whereas a decline in the conversion rate from 38% in the first year to 16% in the last year of the trial was reported by the CLASICC group. A similar reduction in conversion rates with time has been reported in other conventional laparoscopic rectal cancer trials: ACOSOG Z6051, 11%; and ALaCaRT, 9%. Robotic rectal resection has been suggested as a means of overcoming the difficulties of the laparoscopic approach and improving the adoption of minimally invasive rectal surgery and to decrease the conversion rates, rather laparoscopic or open surgery [22, 23]. Pooled conversion rate of (11.89%) was reported in 49 of 412 patients who underwent laparoscopic resection and in 23 (5.72%) of 402 patients who underwent robotic resection [24]. ROLARR study showed that no significant differences in conversion rate between robotic surgery

Table 5 Oncological outcomes after R-TME

Study	Country	LR (%)	DM (%)	DFS (%)	OS (%)
Pai et al. [33]	USA (2015)	4	17	79.2% (3-year)	90.1% (3-year)
Kim et al. [34]	Korea (2016)	1.9	26.4	72.8% (4-year)	87.7% (4-year)
Feroci et al. [35]	Italy (2016)	1.9	17	79.2% (3-year)	90.2% (3-year)
Cho et al. [28]	Korea (2012)	1.8	12.2	81.8% (5-year)	92.2% (5-year)
Park et al. [36]	Korea (2015)	2.3	12.0	81.9% (5-year)	92.8% (5-year)
Hara et al. [37]	Korea (2014)	4.5	10	81.7% (5-year)	92.0% (5-year)
Presented study	Turkey (2019)	3.57	2.85	90% (5-year)	92.7% (5-year)

(8.1%) and laparoscopic surgery (12.2%) in RCT of 471 patients undergoing surgery for rectal cancer [19].

The actual overall conversion rate in the ROLARR RCT was 10.1% [19]. Upon sex subgroup analysis, the ROLARR RCT also showed increased odds of conversion in men as compared with women 39 of 317 men (12.3%), underwent conversion to laparotomy, 25 of 156 (16.0%) in the conventional laparoscopic group, and 14 of 161 (8.7%) in the robotic-assisted laparoscopic group (unadjusted difference in proportions = 7.3%), while 8 out of 149 enrolled women (5.4%) underwent conversion to laparotomy, 3 of 74 (4.1%) in the conventional laparoscopic group, and 5 of 75 (6.7%) in the robotic-assisted laparoscopic group (unadjusted difference in proportions = 2.6%) [19]. Differences were apparent in the conversion rates for the conventional and robotic-assisted laparoscopic groups in men, with robotic-assisted laparoscopic surgery appearing to offer a benefit. Another cohort study used the National Cancer Database where 2472 patients underwent robotic approach. Where the overall conversion rate was 13% and was increased in the laparoscopic group [LAP: 15% vs. ROB: 8%; OR 0.47; 95% CI (0.39, 0.57), and also 9.5% [25]. In another single-center study, a statistically significant difference was reported between the two series regarding the rate of conversion, which was more frequent in the L-TME group (2% in the R-TME series vs. 9.5% in the L-TME series, $p = 0.001$). The risk of conversion was also significantly higher in the L-TME group for two known high-risk subgroups of patients; males (3.1% vs 9.6% in the R-TME and L-TME group) and patients who underwent low-anterior resection (1.3% vs. 9.5%, respectively) [26]. In the present series, none of the 140 R-TME patients were converted to laparotomy. Despite the challenges posed by the more complex surgical cases, the low number of conversions and the good pathological outcomes in our series might reflect the surgeon who completed the learning curve. Similar results were seen in single-center series which has only 1.23% (*n*81/1) and 0.35% (*n*1/278) conversion case [27, 28]. Conversion to open surgery is a complication that not only increases the risk of short-term morbidity and mortality but may also be associated with long-term disease recurrence [17, 19, 29]. This finding indicates that RRS provides a better management of complex procedures, allowing the number of patients who may benefit from the minimally invasive approach to be enlarged. To achieve the goal in robotic sphincter-preserving rectal surgery in the male patient with mid- and distal-tumor location, the number of performed cases should be at least 68, respectively, for learning curve and to obtain good oncological outcomes [19]. In the present study, operative time was significantly decreased after 60th case (Fig. 3).

The quality of the specimen is considered a parameter for the evaluation of prognosis. The integrity of the mesorectum and clear CRM and DRM are important oncological and surgical end points [30, 31]. Kim et al. [27] have showed TME quality 80.3% complete, 18.2% near complete, and incomplete 1.5%. TME quality in our study was rated as complete in 88.57% (*n*124) of patients, nearly complete in 7.14% (n10) of patients; and 4.28% (*n*6) of incomplete.

CRM, which has been reported to be associated with local recurrence, can be used as an indicator of the quality of TME [32]. In the present study, involved CRM were found in five patients (3.57%). All three patients with CRM positive were pathologically T3. Two of these patients had occurred locally recurrence during follow-up of 24 and 32 months, respectively. In another studies, it showed CRM positive 6.1% (*n*4/81) [27] and %5 (*n*13/278) [28].

Local recurrence has been the most common and major morbidity in patients with rectal cancer. TME was developed to reduce local recurrences and improve overall survival while maintaining an adequate quality of life. In our study, local recurrence rate was 3.57% (*n*5/140). Previous studies regarding R-TME showed that the local recurrence rate ranged from 1.8 to 4.5% and distant metastasis rate ranged from 6 to 26.4% with a mean follow-up period varies from 3 to 5 years (33–37). Our results also showed similar oncological results.

There are some studies regarding the survival of patients after robotic TME for rectal cancer (Table 5). We reported that the 5-year overall and disease-free survival rates were 92.78% and 90%, respectively, during the mean follow-up period of 40 months (range 2–80 months). The oncologic outcomes of this study are comparable to studies with longer follow-up periods mentioned studies in Table 5.

The limitation of our study is that this is not a prospective controlled randomized trial. It is a retrospective data evaluation of a single surgeon.

Conclusion

Laparoscopic TME still carries a high conversion risk in rectal cancer patients. Robotic surgery provides an advantage in this regard. Conversion not only influences the long-term oncological outcomes, but also provides a poor surgical specimen. Robotic surgery provides better mesorectal integrity and lower CRM positivity rates reflecting good oncological outcomes. In terms of lower recurrence and better overall survival can be obtained in a experience hands.

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Compliance with ethical standards

Conflict of interest Author Vusal Aliyev, Author Handan Tokmak, Author Suha Goksel, Author Serhat Meric, Author Sami Acar, Author Hakan Kaya, and Author Oktar Asoglu declare that they have no conflicts of interest or financial ties to disclose.

Ethical standard All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all patients for being included in the study.

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