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Short-Term outcomes of robotic versus laparoscopic total mesorectal excision for rectal cancer

Ahmed M. Abou-Elseoud
General and Laparoscopic Surgery Registrar (Ali bn Ali Hospital Riyadh, Kingdom of Saudia Arabia)

***Abstract*---Background:** Robotic surgery is regarded as a new modality to surpass the technical limitations of conventional surgery. **Aim:** The purpose of this study was to assess and compare the intestinal function recovery time and other short-term outcomes between laparoscopic total mesorectal excision (L-TME) and robotic-assisted total mesorectal excision (R-TME) for rectal cancer. **Patients and methods:** This study was conducted at Ali bn Ali hospital in corporation with Soliman Fakeeh Hospital. This study was conducted on 150 patients those who received minimally invasive rectal resection with TME for curative intent were categorized into two groups: 75 cases were enrolled in L-TME and 75 cases in R-TME group. **Results:** There was no statistically significant difference between the studied groups regarding sex, age, BMI, ASA medical history, tumor characters, type of operation, operation time, lymph nodes harvested, duration of drainage tube, urinary tract infection, wound infection, anastomotic leakage, anastomotic bleeding and small bowel instruction. There was statistically significant difference between the studied groups regarding blood loss and urinary retention. There was highly statistically significant difference regarding length of hospital stays, time of first liquid diet and time of first flatus. **Conclusion:** We revealed that R-TME is a feasible and safe option associated with a more rapid recovery than that observed with L-TME for rectal cancer. The robotic technique revealed some advantages in rectal surgery that should be validated by further studies.

Corresponding author: *authorname; Email: email@gmail.com*
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***Keywords*---**Rectal cancer, robotic surgery, laparoscopy surgery, total mesorectal excision, survival.

Introduction

Rectal cancer (RC) is positioned as the 8th most prevalent type of cancer on a global scale. It has a global incidence rate of 3.8% and a mortality rate of 3.4% **(1)**. In patients with moderate to low RC, total mesorectal excision (TME) surgery is the gold standard for decreasing local recurrence and improving prognosis. **(2)**. Laparoscopic surgery is frequently used in rectal surgery as a result of enhanced workplace visibility; it is widely regarded as the second revolution in surgery. Multiple studies have found that laparoscopic total mesorectal excision (L-TME) can produce oncological outcomes that are not inferior. **(3)**. One subset of patients, including those who have undergone neoadjuvant chemoradiation therapy (NCRT) or have visceral obesity, a narrow pelvis, or a voluminous prostate, may find LTME challenging to execute. **(4)**.

Certain advantages of robotic surgery may be sufficient to compensate for a portion of these shortcomings of L-TME. The development of more sophisticated instruments for colorectal surgery has facilitated dissection in cases involving a low rectal tumor, a constricted pelvis, or anatomical complexity. Therefore, the primary advantage of these developments will be the specimen quality that is resected, resulting in decreased local recurrence and enhanced survival **(5)**.

The robotic total mesorectal excision (R-TME) surfaced as an innovative therapeutic approach targeting RC. The advantages of the Da Vinci robot encompass superior three-dimensional imaging, a function for scaling motion, operator-operated stable camera work, multi-joint forceps that can move freely, and significantly enhanced ergonomics. By increasing overall survival rates and decreasing the probability of local recurrence, these enhancements significantly enhance the dissection safety in a narrow pelvis. Numerous studies have thus far illustrated the immediate oncologic effects of R-TME surgery for RC **(6)**.

Due to the lack of sufficient data, it is not possible to recommend the robotic system as a substitute for laparoscopic surgery in the management of RC. Numerous prior investigations have established that robotic surgery exhibits comparable short-term perioperative and oncologic outcomes to laparoscopic surgery **(7-9)**. This study aimed to assess and compare L-TME and R-TME with regards to the duration required for intestinal function to recover and other short-term outcomes for RC.

Patients and Methods

This study was performed. at Ali bn Ali hospital in corporation with Soliman Fakeeh Hospital. The study was carried out on a population of 150 patients who undergone R-TME and minimally invasive rectal resection with TME for curative intent. Patients were categorized into two groups: 75 cases were assigned to the L-TME group, while 75 cases were enrolled in the R-TME group.

The following were the criteria for inclusion: Biopsy-confirmed RC; robotic or laparoscopic rectal resection with tumor microenvironment (TME); and informed consent signatories.

The following were exclusion criteria: Individuals with the following conditions are considered contraindicated for prolonged pneumoperitoneum: those who have undergone palliative resection; those who have multiple colorectal cancers; those who have a medical history of malignancy in other organs; Patients who are undergoing preoperative chemoradiotherapy for serious basic diseases, as well as those who have tumors infiltrating neighboring organs or synchronous metastatic diseases.

Sample size

This study based on study conducted by **Liu et al.**, **(10)** Epi Info STATCALC was used to calculate the sample size by considering the following assumptions: - 95% two-sided confidence level, with a power of 80%. & α error of 5%, main Intraoperative outcomes was blood loss with mean 175.06 ± 110.77 and 123.91 ± 99.61after R-TME and L-TME respectively, the final maximum sample size taken from the Epi- Info output was 134. In consideration of possible attrition during follow-up, the sample size was increased to 150 subjects.

Ethical Consideration: Approval and Ethics Committee was taken before preceding the study. Obtaining informed consent was completed.

Each individual patient underwent the subsequent: Complete history taking: (Personal history, medical history and previous abdominal surgeries history).

Physical examination: including a colonoscopic examination to assess the entire colon and rectum and obtain a tissue diagnosis. And electrocardiography.

Investigational Studies: including **routine laboratory investigations and Radiological investigations:** Imaging including pelvic MRI and abdominopelvic CT to evaluate distant metastasis, nodal metastasis and the status of local tumor infiltration. All patients who had an MRI-detected mesorectal margin of less than 1 mm were classified as high-risk. Regarding the application of neoadjuvant therapy, these cases were discussed during the multidisciplinary treatment meeting.

Surgical Technique

Standardized preoperative preparation was implemented, including the use of polyethylene glycol for bowel preparation the day before surgery. A dosage of 2 g of prophylactic cefmetazole sodium antibiotic was administered prior to the procedure, following the guidelines set forth by the hospital infection control board. Following endotracheal intubation and general anesthesia, the patient was positioned in the lithotomy position.

During the robotic procedure, five trocars were used: Trocar of the camera C, auxiliary hole C, and operating holes R1, R2, and R3 on the arm. Trocar C, situated 3–4 cm superior to the right umbilical region, was outfitted with a 12-millimeter caliber camera. The 8 mm caliber R1 operating hole of the instrument was positioned along the rib margin, 7-8 cm below the midline of the right clavicle. The 8 mm caliber surgical hole R2 was positioned at the junction of the left midline of the clavicle on the manipulator and the trocar C line of the transverse camera. On the manipulator, the 8 mm caliber operating hole R3 was situated at the intersection of the transverse camera trocar C line and the left anterior axillary line. A 5 mm or 12 mm-diameter auxiliary hole A was positioned at the intersection of the R1 vertical line and the transverse Camera trocar C line. Dissection instruments (monopolar hook, harmonic scalpel or monopolar scissors) were designated with R1, R2 nontraumatic or bipolar graspers, and R3 nontraumatic graspers.

Throughout laparoscopic surgery, five trocars were used: A 10-millimeter-diameter observation hole was positioned one centimeter above the umbilical hole; An 8 mm caliber operating hole was inserted into the McBurney point using a manipulator; 5.mm caliber auxiliary hole was positioned at the point where the outer margin of the right rectus abdominis intersected with the transverse navel line; 5 mm caliber was inserted into the assistant operation hole at the point where the outer margin of the left rectus abdominis intersected with the transverse navel line. Similarly, a 5 mm caliber was introduced into the assistant auxiliary aperture situated at the McBurney point on the lateral side.

Surgical Procedure

The following describes how the surgical procedure was executed: The area of operation being exposed: Surgical middle approach was used. To achieve blood vessel separation, the Toldt space was separated to expose the inferior mesenteric vein and artery. High ligation was consistently performed on both inferior mesenteric vein and the inferior mesenteric artery in every case that we examined. By laterally dissociating the visceral and parietal peritoneal spaces and pulling the sigmoid colon to the right, free lateral peritoneum was achieved. Efforts were made to prevent ureteral injury throughout this procedure. Dissection was performed on the descending colon and sigmoid colon at the level of the prerenal fascia and upper ureter, resulting in the liberation of the rectum and descending colon. The mesorectum, peripheral lymph nodes, and blood vessels were separated from the anterior sacrum, while the rectum was separated to a distance of 10-15 cm from the proximal end of the tumor and >2 cm from its lower edge. Splenic flexure mobilization was executed in a selective manner. Anastomosis: rectal transaction was performed using a linear stapler for anterior resection. The sample was obtained by an abdominal incision, and an end-to-end sigmoid colonrectum anastomosis was performed intracorporeally using a circular stapler. Miles surgery was carried to displace the rectum to the level of the levator ani muscle in patients diagnosed with low RC prior to surgery and for whom preservation of the anus was not possible; enterostomy and perineal surgery.

A tumor specimen was extracted via the perineum following perineal surgery performed by the surgeon. In the lower left abdomen, a permanent sigmoid colostomy was executed, including the flushing of the thematic incision, the placement of drainage, and the closure of the incision. Patients who had middle and lower RC anus reservation following surgery underwent a transanal tube decompression and drainage procedure. The surgical procedures, patient positioning, and intestinal preparation for L-TME and R-TME are identical.

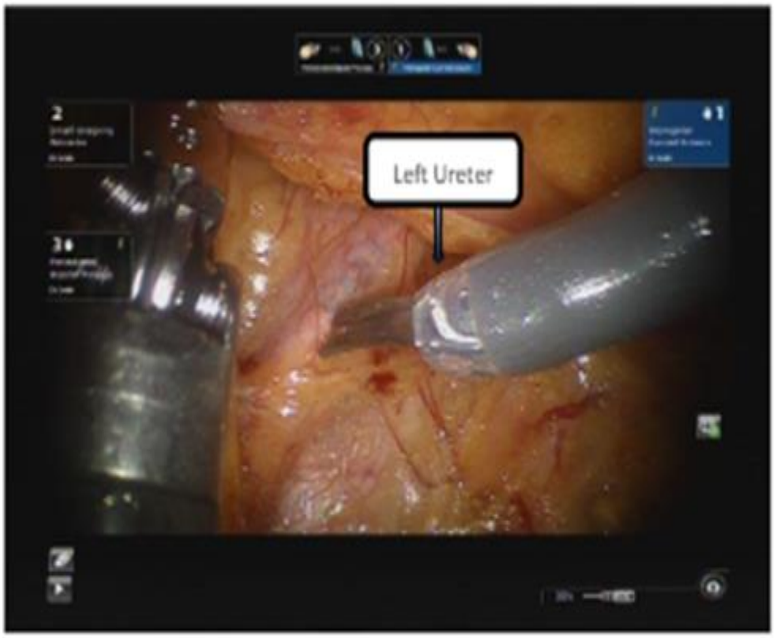

Figure (1): showing medial to lateral dissection with left ureter representation

Follow-Up

The follow-up with outpatients for colorectal cancer was carried out in adherence to the protocols established by the Chinese Society of Clinical Oncology (CSCO). Patients in stage I were subject to monitoring every six months by the American Joint Committee on Cancer (AJCC). Patients in stages II ~ III were monitored every three months.

Statistical analysis

Data analysis was performed using Statistical Package for Scientific Studies (SPSS) version 23 for Windows (IBM SPSS, Inc., Chicago, IL). The description of quantitative variables was in the form of mean, standard deviation (SD) and range for parametric data, and median and interquartile range for non- parametric data. The Kolmogrov-Simrnov test for detection of normality distribution was used. The description of qualitative variables was in the form of numbers (No.) and percent (%). Chi-square test was used to compare categorical variables while independent samples t-student test was used to compare the continuous variables between the two groups. The significance of the results was assessed in the form of P-value that was differentiated into: Nonsignificant when P-value > 0.05.

Results

Table (1): Distribution of demographic data between the studied groups

	R-TME group N= 75	L-TME group N= 75	Test	P-value
Age (years) Mean± SD	61 ± 9.7	59.6 ± 10.3	t = 0.85	0.39
Sex				
Male	50(66.7%)	47(62.7%)	X^2=0.26	0.6
Female	25(33.3%)	28(37.3%)		
BMI (kg/m2) Mean± SD	23.1± 3.2	23.4 ± 3.4	t = 0.55	0.57
ASA status				
1	10(13.3%)	11(15%)	X^2= 0.05	0.97
2	53(70.7%)	52(69%)		
3	12(16%)	12(16%)		

P value >0.05: Not significant, P value <0.05 is statistically significant, p<0.001 is highly significant., SD: standard deviation, t: T test, x2: qui square test, (R-TME): robotic total meso-rectal excision and (L-TME): laparoscopic total meso-rectal excision. According to this table, sex, age, ASA, and BMI did not differ among the groups that were examined in a statistically significant manner.

Table (2): Distribution of medical history and tumor characters between the studied groups

	R-TME group N= 75	L-TME group N= 75	Test	P-value
Previous surgery	14(18.7%)	18(24%)	X^2=0.63	0.42
Preoperative radiation	31(41.3%)	22(29.3%)	X^2= 2.36	0.12
Tumor Classification (cm)				
11–15	8(10.7%)	10(13.3%)	X^2= 0.61	0.98
6–10	41(54.7%)	35(46.7%)		
0–5	26(34.6%)	30(40%)		
AJCC stage				
0	3(4%)	4(5.3%)	X^2= 0.36	3.15
1	10(13.3%)	18(24%)		
2	32(42.7%)	28(37.3%)		
3	30(40%)	25(33.3%)		
Tumor size (cm3) Mean± SD	14.1 ± 17.7	16.4 ± 17.7	t = 0.79	0.42

P value >0.05: Not significant, P value <0.05 is statistically significant, p<0.001 is highly significant., SD: standard deviation, t: T test, x2: qui square test, AJCC: American Joint Committee on Cancer

This table shows that in terms of medical history and tumor characteristics, the groups being examined did not differ in a statistically significant way.

Table (3): Distribution of intraoperative outcomes between the studied groups

	R-TME group N= 75	**L-TME group N= 75**	**Test**	**P-value**
Type of operation				
Anterior resection	49(65.3%)	47(%)	X^2=0.73	0.11
Abdominoperineal resection	26(34.7%)	28(37.3%)		
Conversion	1(1.3%)	5 (6.7%)	X^2= 0.02	4.75
Blood loss (ml) Mean± SD	175.1±110.8	123.93 ± 99.7	t = 2.97	0.003
Operation time (min) Mean± SD	206.5 ± 59.1	201.7 ± 50.5	t = 0.53	0.59

P value >0.05: Not significant, P value <0.05 is statistically significant, p<0.001 is highly significant., SD: standard deviation, t: T test, x2: qui square test.

As indicated in the table, there was none statistically significant difference observed among the groups that were examined in regard to operation type and duration., A difference of statistical significance was noted regarding blood loss among the groups under investigation.

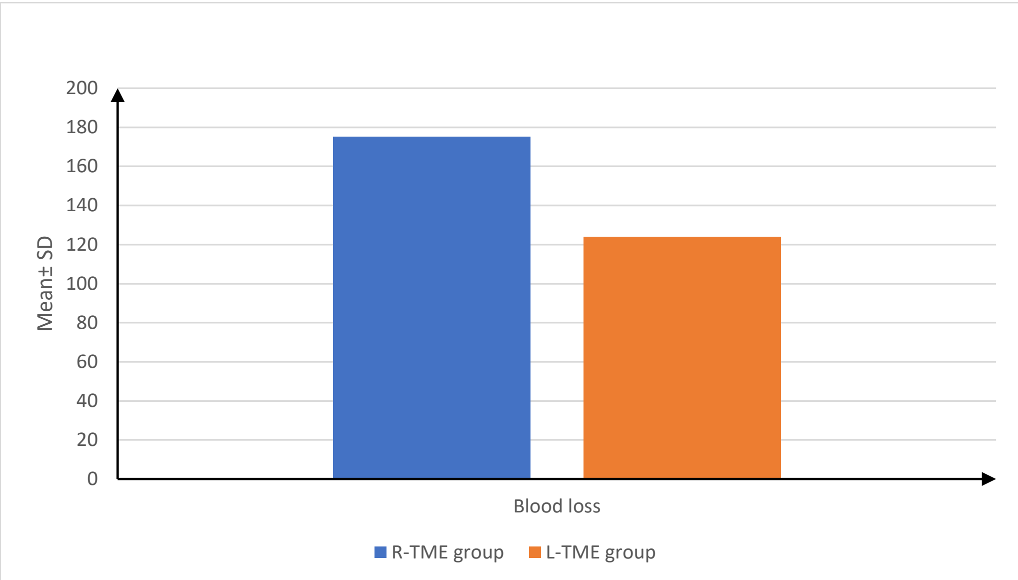

Fig (2): Shows blood loss distribution between the studied groups

Table (4): Distribution of oncologic outcomes and postoperative outcomes between the studied groups

	R-TME group N= 75	L-TME group N= 75	Test	P-value
Lymph nodes harvested Mean± SD	11.75 ± 5.2	12.3 ± 4.9	t = 0.66	0.51
CRM+	0	1(1.3%)		
Postoperative outcomes				
Length of hospital stays (day) Mean± SD	11.3 ± 5.9	14.8 ± 6.9	t = 3.33	0.001
Time of first liquid diet (day) Mean± SD	4.5 ± 1.62	6.3 ± 2.8	t = 4.81	< 0.001
Time of first flatus (day) Mean± SD	3.3 ± 1.6	6.01 ± 2.8	t = 7.2	< 0.001
Duration of drainage tube (day) Mean± SD	7.5 ± 2.5	7.4 ± 3.1	t = 0.21	0.82

P value >0.05: Not significant, P value <0.05 is statistically significant, p<0.001 is highly significant., SD: standard deviation, t: T test, x2: qui square test, (CRM+): positive circumferential resection margin.

As shown in the table, there was no statistically significant difference observed in the duration of drainage tubes used or lymph node harvested among the groups under investigation., in regard to the duration of hospital stays, the first liquid diet, and the onset of flatus, the groups being examined exhibited considerable statistically significant differences.

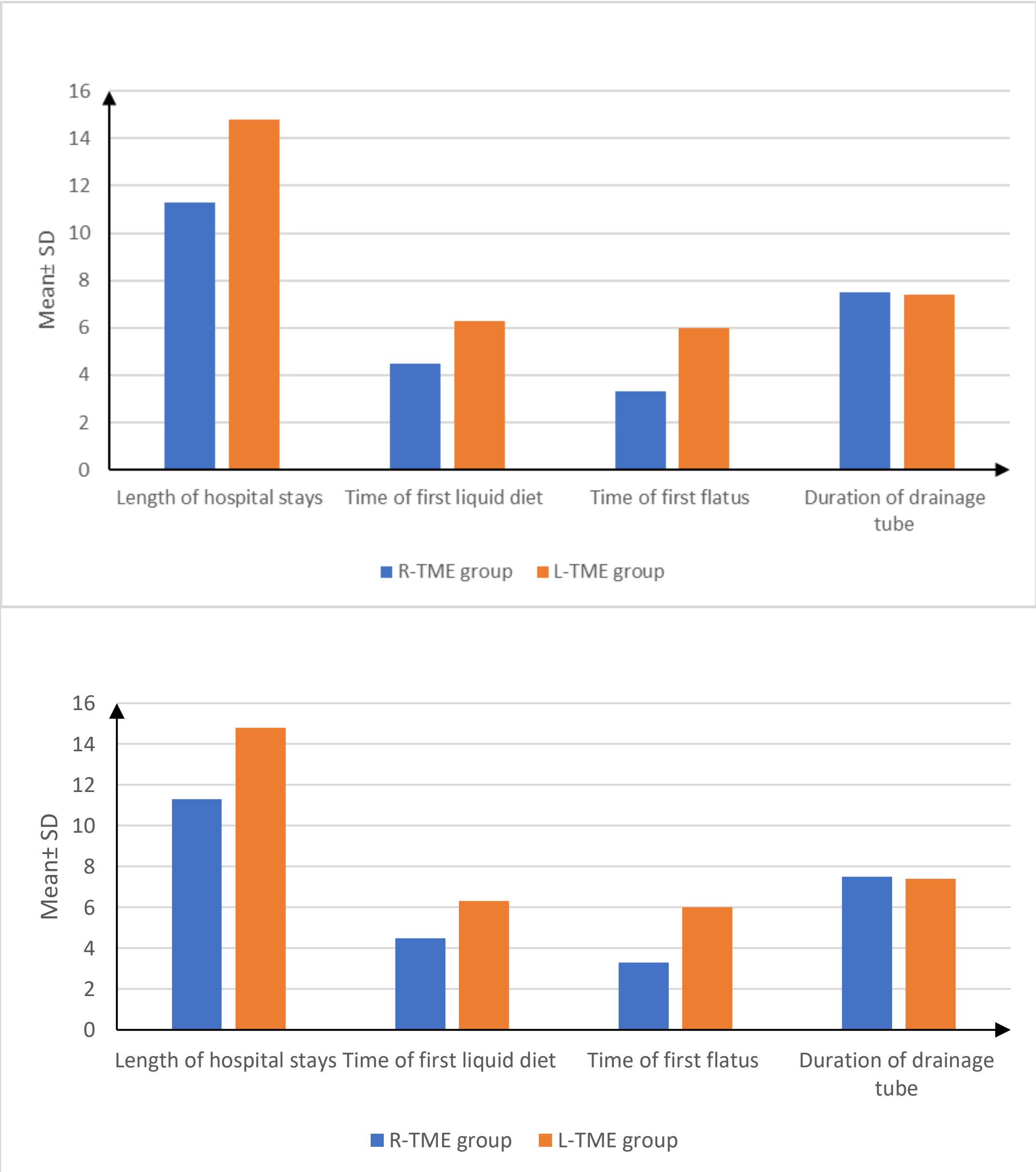

Fig (3): Shows postoperative outcomes distribution between the studied groups

Table (5): Distribution of Postoperative Complications between the studied groups

	R-TME group N= 75	L-TME group N= 75	Test	P-value
Wound infection	0	3(4%)	X^2=3.06	0.08
Urinary tract infection	0	1(1.3%)	X^2= 1.007	0.31
Urinary retention	3(4%)	10(13.3%)	X^2= 4.12	0.04
Anastomotic leakage	1(1.3%)	4(5.3%)	X^2=1.86	0.17
Anastomotic bleeding	3(4%)	3(4%)	X^2=0	1
Small bowel instruction	1(1.3%)	4(5.3%)	X^2=1.86	0.17

P value >0.05: Not significant, P value <0.05 is statistically significant, p<0.001 is highly significant., SD: standard deviation, t: T test, x2: qui square test.

No statistically significant difference was observed. among the groups under study in relation to the following variables: small bowel instruction, anastomotic leakage, urinary tract infection, or wound infection, in regard to urinary retention, a difference that was statistically significant was observed among the groups that were being examined.

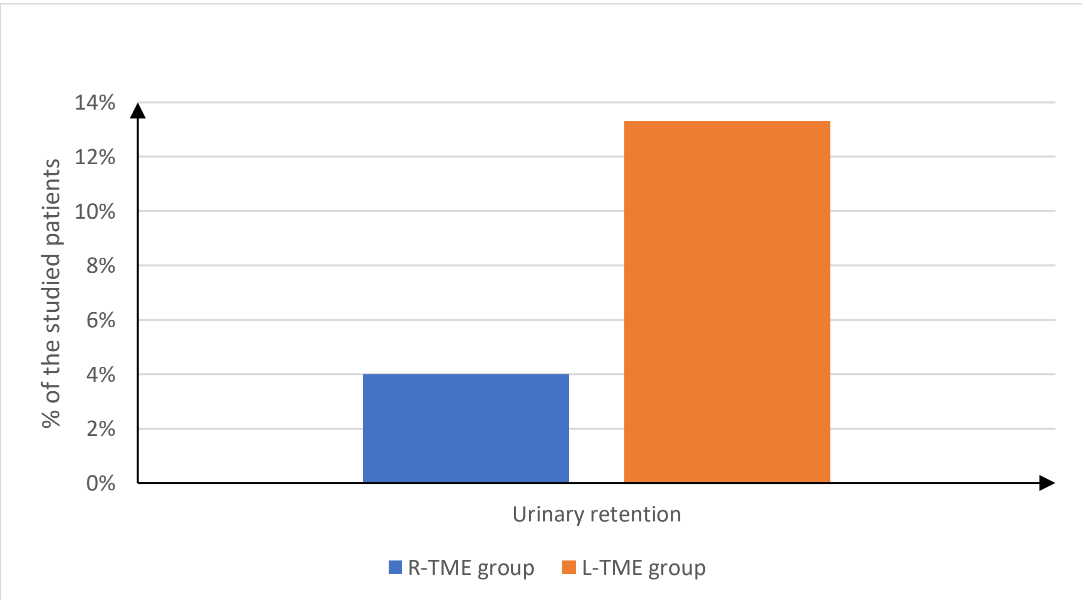

Fig (4): Shows urinary retention distribution between the studied groups.

Discussion

Age, sex, BMI, and ASA did not differ between the groups under investigation in a statistically significant manner, according to the findings of the present study. (P>0.05). The outcomes of our study align with those of **Liu et al. (10)**, whose aim was to compare the immediate effects of L-TME and R-TME on the length of time required for intestinal function to return, as well as other pertinent parameters within the context of RC. To compare histopathological stage of the tumors, 80 participants received R-TME, while 116 participants received L-TME. in this study. Age, sex, BMI, and ASA did not differ between the groups under investigation in a statistically significant manner, they disclosed. (P>0.05)

Furthermore, our findings align with those of **Burghgraef et al (11)**, whose objective was to compare L-TME and R-TME as executed by surgeons who have successfully navigated the technique's learning curve. As a consequence, 884 patients were treated, 559 of whom underwent L-TME and 325 underwent R-TME. Regarding the age, ASA, BMI, or sex of the groups under investigation, no statistically significant difference was found. (P>0.05)

Furthermore, **Feroci et al. (12)** performed an investigation aiming to compare the practicality of robotic surgery versus conventional laparoscopic surgery in cases involving moderate to low RC, with a focus on long-term and short-term viability. A total of 53 robotic rectal resections incorporating TME were executed, while 58 laparoscopic rectal resections incorporating TME were performed (L-TME). Regarding age, gender, and BMI, the groups did not differ significantly, according to the report. Regarding the ASA scores of laparoscopic and robotic patients, no difference that was statistically significant was observed.

In our trial we found that regarding medical history and tumor characters, no difference that was statistically significant was observed among the groups that were examined. with respect to prior surgical history, preoperative radiation exposure, tumor classification, AJCC stage, or tumor size. Consistent with our findings, **Liu et al (10)**. reported that with respect to tumor characteristics and medical history, regarding prior surgery, preoperative radiation, tumor classification, AJCC stage, and tumor size, there were no differences that were deemed statistically significant among the groups being examined. (P>0.05)

Furthermore, our findings align with those of **Pan et al. (13)**, whose aim was to compare the efficacy of L-TME and R-TME in the treatment of patients with challenging anatomical features and moderate to low RC. A total of 106 patients were categorized as L-TME (n = 50) and R-TME (n = 56). As far as preoperative radiation, tumor classification, and tumor size were concerned, none of the groups under investigation showed any statistically significant differences. (P>0.05)

Furthermore, the objective of the study by **Bianchi et al. (14)** was to assess the short-term oncologic safety, feasibility and short-term outcomes of L-TME and R-TME for RC. Regarding tumor classification and AJCC stage, no differences among the groups under investigation were found to be statistically significant.

Regarding operation time and type, our research did not reveal any statistically significant difference among the groups under investigation., in contrast, statistically significant difference in blood loss was observed among the groups that were investigated.

Our findings are consistent with those of **Liu et al. (10)** which also concluded that there was no statistically significant difference among the groups under investigation regarding the operation type and duration, in regard to blood loss, a difference that was statistically significant was observed among the investigated groups. The estimated intraoperative BL was greater in the R-TME group (175.06 ± 110.77 vs. 123.91 ± 99.61 mL, P = 0.031) than in the L-TME group. Both groups had an almost identical duration of operation.

As well, our findings align with those of **Bianchi et al (14)**, who found that the median operating time for the R-TME group was 240 minutes (range: 170–420 minutes), and for the L-TME group it was 237 minutes (range: 170–545 minutes) (p = 0.2). Both studies incorporated the time required for robot setup and docking.

Contrary to our findings, **Feroci et al (12)**. reported that the median duration of surgery in the R-TME group was 342 minutes (with a range of 249-536 minutes) In contrast, the median duration of surgery in the L-TME group was 192 minutes (range: 90-335 minutes) (P < 0.001). Regarding intraoperative bleeding, no significant differences were observed. Furthermore, **Pan et al. (13)** provided evidence that the operation time of R-TME was significantly longer than that of L-TME (median, 180 minutes), which contradicts our findings. [IQR: 156–209.3] versus 147.5 minutes [118.8–160], P < 0.001). Regarding the estimated blood loss, the groups under investigation did not differ in a statistically significant way. No statistically significant difference was observed among the groups with regard to the quantity of lymph nodes harvested or the length of time drainage tubes were utilized throughout our study. Strong statistically significant difference was observed. observed among the groups under study regarding the duration of hospital stays, initiation of liquid diet, and onset of flatus.

Our findings align with those of **Liu et al. (10)** who observed that the R-TME group experienced a decreased hospital stay length (11.2 ± 5.80 days versus 14.72 ± 6.90 days, P = 0.023) in comparison to the L-TME group. Additionally, the group that received oral fluids first after surgery consumed them in a shorter period of time (4.46 ± 1.62 days versus 6.28 ± 2.74 days, P < 0.001). Regarding the quantity of lymph nodes harvested, there were no intergroup differences that were statistically significant.

Furthermore, our findings are consistent with those of **Feroci et al. (12).,** who found a two-day increase in hospitalization following laparoscopic surgery relative to the robotic group (8 days for L-TME and 6 days for R-TME, respectively, P <0.001).

Furthermore, **Bianchi et al. (14)** discovered that the number of lymph nodes obtained did not differ among the groups being analyzed in a statistically significant manner.

Contrary to the findings of our study, **Pan et al. (13)** did not observe any statistically significant differences among the groups under investigation with respect to the length of time on a drainage tube, length of hospital stays, initiation of first liquid diet, or onset of first flatus.

Regarding postoperative complications, our study revealed that no statistically significant difference was observed among the groups under investigation regarding small bowel instruction, urinary tract infection, wound infection, or anastomotic leakage, in regard to urinary retention, statistically significant differences were noted among the groups being analyzed.

Similar results were observed by **Liu et al. (10),** who found no intergroup differences in postoperative complications such as anastomotic bleeding and/or leakage, urinary tract infection and wound infection, and small bowel obstruction that were statistically significant. However, the incidence of urinary retention was significantly decreased in the R-TME group when compared to the L-TME group. (P 4 < 0.016).

Furthermore, our findings align with those of **Pan et al (13)**, who observed that none of the investigated groups showed a statistically significant difference. regarding small bowel instruction, urinary tract infection, wound infection, or anastomotic leakage as postoperative complications. However, urinary retention differed significantly among the study groups in a statistically significant manner. Further, our findings align with those of **Feroci et al (12)**., who documented that with respect to complications that may arise after surgery, no statistically significant differences were observed in terms of peritoneal hemorrhage, wound infection, urinary tract infection, ileus, or anastomotic leakage between the groups under study.

Also, Burghgraef et al. (11) found no statistically significant difference among the groups examined regarding anastomotic leakage and abscess, and surgical complications were comparable in incidence (32.1% vs. 31.7%; p = 0.93). However, the wound infections incidence was significantly higher in the laparoscopic group (5.7% vs 1.9%; p = 0.01).

Moreover, **Bianchi et al. (14)** discovered that the R-TME group had a 16% overall complication rate, whereas the L-TME group had a 24% rate (p = 0.5). A total of one anastomosis leakage (4%) was observed in the L-TME group, while this number was double (8%) in the R-TME group.

Conclusion

Our trial indicated that R-TME is a viable and secure alternative for rectal cancer, accompanied by a quicker recuperation period compared to the recovery observed with L-TME. Additional research is needed to validate the demonstrated advantages of robotic technique in rectal surgery.

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