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机器人与腹腔镜直肠癌 TME 手术的近期疗效对照研究

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摘　要　**目的：**对比达芬奇机器人与腹腔镜应用于直肠癌全系膜切除术（Total mesorectal excision，TME）的近期疗效。**方法：**回顾性分析 2019 年 1 月 ~2019 年 12 月甘肃省人民医院肛肠科 235 例行直肠癌全系膜切除术患者的临床资料，其中机器人组 120 例，腹腔镜组 115 例，比较两组患者的手术情况、术后恢复情况、术后并发症及肿瘤学结果。**结果：**与腹腔镜组相比，机器人组出血量少 [（123.7 ± 103.4）ml Vs （167.2 ± 118.5）ml；t=–2.999，P=0.003]，通气时间短 [（79.2 ± 22.9）h Vs（118.3 ± 28.1）h；t=–11.762，P<0.001]，进食流质饮食时间短 [（91.0 ± 16.8）h Vs（123.0 ± 21.0）h；t=–12.968，P<0.001]，腹腔引流量少 [（315.4 ± 282.8）ml Vs （397.0 ± 327.9）ml；t=–2.045，P=0.042]，术后住院时间短 [（8.1 ± 2.6）d Vs （8.9 ± 2.5）d；t=–2.406，P=0.017]。然而，机器人组住院总费用高于腹腔镜组 [（80 193.9 ± 14 934.2）元 Vs（65 791.0 ± 17 399.0）元；t=6.823，P<0.001]。两组手术时间、淋巴结清扫、腹腔引流管留置时间、术后并发症和肿瘤学结果的差异无统计学意义。**结论：**相比于腹腔镜手术，机器人手术出血量少、住院时间短、术后胃肠道功能恢复快，可作为直肠癌 TME 手术治疗的有效途径之一。

关键词　直肠癌；机器人手术；腹腔镜手术；近期疗效

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Comparative study on short-term outcomes of robot-assisted and laparoscopic total mesorectal excision (TME) on rectal cancer: results of a single center in Gansu province

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Abstract Objective: To compare the short-term outcomes of conventional laparoscopic total mesorectal excision (L-TME) and robot-assisted total mesorectal excision (R-TME) on rectal cancer. Methods: A total of 235 patients underwent R-TME (120) or L-TME (115) after diagnosed with rectal cancer from January 2019 to December 2019 were included in this study. Patients' characteristics, perioperative characteristics and pathologic characteristics were evaluated between the R-TME group and the L-TME group. Results: Compared with the L-TME group, the R-TME group showed less intraoperative blood loss (123.7ml Vs 167.2ml, P=0.003), less first flatus time (79.2h Vs 118.3h, P<0.001), less first liquid diet time (91.0h Vs 123.0h, P<0.001), less volume of abdominal drainage (315.4ml Vs 397.0ml, P=0.042) and shorter hospital stay (8.1d Vs 8.9d, P=0.017) . However, the R-TME group had more expensive total hospitalization costs (80 193.9CNY Vs 65 791.0CNY, P<0.001). No significant differences were observed between the two groups in respect to operation time, total number of examined lymph nodes, time of abdominal drainage and postoperative complications. The pathologic characteristics of the two groups were not significantly different. Conclusion: This study shows that the robot-assisted total mesorectal excision is superior to laparoscopic one in terms of short-term outcomes in surgeries of rectal cancer, it is safe and feasible to treat rectal cancer.

Key words Rectal cancer; Robot-assisted surgery; Laparoscopic surgery; Short-term outcome

Laparoscopy has been widely applied to colorectal surgery with the aim of reducing morbidity and decreasing invasiveness[1]. Conventional laparoscopic total mesorectal excision surgery (L-TME) shows better advantages than open surgery in patients diagnosed with rectal cancer regarding early postoperative outcomes[2]. However, L-TME was not technically satisfying due to a higher conversion rate and more positive circumferential resection margins than open surgery when applied to rectal cancer[3]. Robot-assisted total mesorectal excision surgery (R-TME), the latest scientific and

technological invention for minimally invasive surgery, was first reported in 2002 by Weber et al.[4]. Since that, minimally invasive surgery of rectal cancer by R-TME with the Da Vinci Surgical System has attracted attentions worldwide. R-TME is equipped with high-quality of three-dimensional imaging, free-moving multi-joint forceps, stable camera with image stabilizer, motion-scaling function, and greatly ameliorated ergonomics[1, 5-6]. Some retrospective studies reported the benefits of R-TME compared with L-TME[6-8]. Nevertheless, R-TME benefits over L-TME should be further explored, since apart from studies analyzing more than 100 patients from a single center, the results of previous studies have been limited by the small number of samples[9].

Therefore, the aim of this study was to compare R-TME and L-TME in a single center in Gansu Province to evaluate their short-term outcomes for rectal cancer.

1　Materials and Methods

1.1　Patients and study design

The data of patients who underwent rectal surgery by either laparoscopic or robotic method from January 2019 to December 2019 were reviewed. Patients who had synchronous tumors, emergency admissions, distant organ metastasis, benign disease, or clinical T_4 stage tumors that did not react to a neoadjuvant treatment were excluded from this study. All patients were performed with abdominopelvic computed tomography (CT), chest radiography and pelvic magnetic resonance (MR). If necessary, chest CT or positron emission tomography (PET) shall be performed. The rectal database was retrospectively analyzed, containing information on patient characteristics, perioperative data, severity of complications according to Clavien-Dindo classification, and pathologic examination. Finally, 235 rectal cancer patients were enrolled in this study: 120 patients were subjected to R-TME group and 115 patients to L-TME group. This study was performed in a single center, and both the conventional laparoscopic and robotic approaches were managed by the same primary surgeon who has performed more than 2 000 cases of laparoscopic-assisted surgeries. This study was approved by the Ethics Committee of the Gansu Provincial Hospital and patients voluntarily chose the surgical approach to which they wanted to be subjected.

1.2　Robotic surgical technique

All patients underwent standard preoperative mechanical bowel preparation, antithrombotic and antibiotic prophylaxis before the surgery. The procedures for performing R-TME are similar to the standardized modular approach of laparoscopic surgery[10] and the Da Vinci surgical system (Intuitive Surgical, Sunnyvale, CA, USA) was adopted. R-TME was performed without changing the position of the robotic cart, but the robotic arms were repositioned between the abdominal and pelvic phases[11-12].

1.3　Outcome measures

Age, gender, body mass index (BMI), ASA score and tumor location were compared between the two groups and shown as in Table 1. Operation time, estimated blood loss, number of examined lymph nodes, time to first flatus and first liquid diet, time and volume to abdominal drainage, length of

hospital stay and total hospitalization costs were compared between the two groups shown as in Table 2. Severity of complications according to Clavien-Dindo classification, tumor characteristics and pathologic parameters including the pathologic type, tumor grade and AJCC stage were also compared between the two groups and shown as in Table 3 and Table 4.

1.4 Statistical analysis

Data management and analysis were performed with SPSS 20.0. Categorical data were summarized as numbers and percentages. Medians and ranges were used to summarize numerical data. The mean values were compared with the paired and unpaired Student's *t*-test. Frequency and distribution were compared by the Chi-square or Fisher's test. All *P*-values are two-sided with the statistical significance assumed at $P<0.05$.

2 Results

2.1 Patient characteristics

There were 64 males (53.3%) among the 120 patients in R-TME group and 55 males (47.8%) among the 115 patients in L-TME group. The mean age of patients in the two groups were 60.7 ± 11.3(R-TME group) and 59.7 ± 11.6(L-TME group) ($P=0.517$). The size of tumor was 9.3 ± 2.8cm^3 in the R-TME group and 9.5 ± 3.0cm^3 in the L-TME group ($P=0.634$). The mean distance from tumor location to the anal verge was 7.5 ± 4.0cm in the R-TME group and 7.3 ± 3.8cm in the L-TME group ($P=0.676$). No significant difference found between the two groups in respect to age, gender, BMI, ASA score, tumor size and the distance of the tumor to the anal verge (Table 1).

Table 1 Patient demographic data and characteristics*

	R-TME(*n*=120)	L-TME(*n*=115)	t/χ^2 value	*P*-value
Age	60.7 ± 11.3	59.7 ± 11.6	0.649	0.517
Gender			0.891	0.367
Male	64(53.3)	55(47.8)		
Female	56(46.7)	60(52.2)		
BMI(kg/m^2)	23.0 ± 2.9	22.7 ± 3.0	0.771	0.441
ASA score			0.734	0.693
I	107(89.2)	99(86.1)		
II	6(5)	6(5.2)		
III	7(5.8)	10(8.7)		
Tumor size(cm^3)	9.3 ± 2.8	9.5 ± 3.0	−0.476	0.634
Tumor location(cm)	7.5 ± 4.0	7.3 ± 3.8	0.419	0.676

R-TME: Robot-assisted total mesorectal excision surgery; L-TME: Laparoscopic total mesorectal excision surgery; BMI: Body mass index

*Data are presented as mean (SD) or as n (%)

2.2　Blood loss and operation time

The mean estimated blood loss was less in the R-TME group than that in the L-TME group (123.7 ± 103.4ml Vs 167.2 ± 118.5ml, *P*=0.003). However, the mean operative time on the L-TME group was shorter than the one on the R-TME group (206.5 ± 50.6min Vs 201.0 ± 51.4min, *P*=0.398, Table 2).

2.3　Lymph node yield and abdominal drainage

The number of the examined lymph nodes were no significant difference between the two groups (*P*>0.05, Table 2). No significant difference was observed between the two groups regarding the duration time of abdominal drainage (7.0 ± 2.3d Vs 7.3 ± 3.0d, *P*=0.007), while the volume of the abdominal drainage was less in the R-TME group than that in the L-TME group (315.4 ± 282.8ml Vs 397.0 ± 327.9ml, *P*=0.042, Table 2).

2.4　Time to first flatus, postoperative hospital stay and cost

A significant difference on the time to first flatus was found between the 2 groups. The R-TME group had a shorter time to first flatus (79.2 ± 22.9h Vs 118.3 ± 28.1h, *P*<0.001) than that in the L-TME group. Similarly, the time to first liquid diet was also shorter in the R-TME group (91.0 ± 16.8h Vs 123.0 ± 21.0h, *P*<0.001). The hospital stay of R-TME group was shorter than that in the L-TME group (8.1 ± 2.6d Vs 8.9 ± 2.5d, *P*=0.017, Table 2).

The total hospitalization cost of the R-TME approach was more expensive than the L-TME approach (80 193.9 ± 14 934.2CNY Vs 65 791.0 ± 17 399.0CNY, *P*<0.001, Table 2).

Table 2　Operation results*

	R-TME(*n*=120)	L-TME(*n*=115)	*t* value	*P*-value
OT(min)	206.5 ± 50.6	201.0 ± 51.4	0.847	0.398
EBL(ml)	123.7 ± 103.4	167.2 ± 118.5	−2.999	0.003
ELNs	11.8 ± 4.1	11.6 ± 4.8	0.392	0.696
PELNs	7.0 ± 3.4	7.4 ± 3.5	−0.905	0.367
FFT(h)	79.2 ± 22.9	118.3 ± 28.1	−11.726	<0.001
FLD(h)	91.0 ± 16.8	123.0 ± 21.0	−12.968	<0.001
ADT (d)	7.0 ± 2.3	7.3 ± 3.0	−0.978	0.329
VOAD (ml)	315.4 ± 282.8	397.0 ± 327.9	−2.045	0.042
LOS(d)	8.1 ± 2.6	8.9 ± 2.5	−2.406	0.017
Cost(CNY)	80193.9 ± 14934.2	65791.0 ± 17399.0	6.823	<0.001

R-TME: Robot-assisted total mesorectal excision surgery; L-TME: Laparoscopic total mesorectal excision surgery; OT: Operation time; EBL: Estimated blood loss; ELNs: Total number of examined lymph nodes; PELNs: Positive examined lymph nodes; FFT: First flatus time; FLD: First liquid diet; ADT: Abdominal drainage time; VOAD: Volume of abdominal drainage; LOS: Length of hospital stay.

*Data are presented as mean (SD) or as n (%)

2.5 Postoperative complication

There was no significant difference between the two groups on the incidence of postoperative complication. In addition, it was not statistically different between the two groups on the number of patients with postoperative complications. Indeed, 10 patients (8. 3%) in the R-TME group and 12 patients (10. 4%) in the L-TME group occurred postoperative complication. Postoperative complications that occurred in the R-TME group were most of grade I according to the Clavien-Dindo classification, 3 patients had anastomotic leakage and treated with enterostomy. While 4 patients in the L-TME group were grade I, 2 cases found anastomotic leakage and treated with enterostomy (Table 3).

2.6 Pathological details

Patients who will be performed surgeries for rectal cancer shall also accept the appropriate oncological procedures. 96 patients (80%) in the R-TME group and 89 patients (77.4%) in L-TME group were diagnosed with adenocarcinoma. Mucous adenocarcinoma were found in 14 patients (11.7%) in the R-TME and 16 patients (13.9%) in the L-TME group, while other tumor types were found in 10 patients (8.3%) in the R-TME group and 10 patients (8.7%) in the L-TME group. It was not significantly different between the two groups in respect to AJCC stage, and tumor stage II was mostly found in the R-TME group (45%) through histopathological evaluations. Moderately differentiated tumors were found in both the two groups, with 98 patients (81.7%) in the R-TME group and 92 patients (80%) in the L-TME group, although the difference between the two groups regarding the histology of tumors was not significant. No significant difference was observed between the two groups in respect to pathological diagnosis, histology, or AJCC stage (Table 4).

3 Discussion

In order to evaluate the feasibility, potential

Table 3 Severity of complications according to Clavien–Dindo classifcation*

	R-TME(*n*=120)	L-TME(*n*=115)	χ^2 value	*P*-value
Complication			−1.207	0.384
Yes	10(83.3)	12(10.4)		
No	110(91.7)	103(89.6)		
Complication Clavien-Dindo Classification			2.711	0.607
0	108(90)	102(88.7)		
I	5(4.2)	4(3.5)		
II	2(1.7)	6(5.2)		
III	3(2.5)	2(1.7)		
IV	2(1.7)	1(0.9)		

R-TME: Robot-assisted total mesorectal excision surgery; L-TME: Laparoscopic total mesorectal excision surgery
*Data are presented as mean (SD) or as n (%)

Table 4　Comparison of the tumor characteristics and pathologic parameters*

	R-TME(*n*=120)	L-TME(*n*=115)	χ^2 value	*P*-value
Pathological diagnosis			1.346	0.056
adenocarcinoma	96(80)	89(77.4)		
mucous adenocarcinoma	14(11.7)	16(13.9)		
others	10(8.3)	10(8.7)		
Histology			2.337	0.051
poorly differentiated	13(10.8)	15(13.0)		
moderately differentiated	98(81.7)	92(80)		
highly differentiated	9(7.5)	8(7.0)		
AJCC stage			−1.462	0.051
0	7(5.8)	2(1.7)		
I	54(45)	29(25.2)		
II	38(31.7)	43(37.4)		
III	11(9.2)	33(28.7)		
IV	10(8.3)	8(7)		

R-TME: Robot-assisted total mesorectal excision surgery; L-TME: Laparoscopic total mesorectal excision surgery; AJCC: American Joint Committee on Cancer

*Data are presented as mean (SD) or as n (%)

superiority and short-term outcomes of R-TME and L-TME in the field of rectal cancer, the amount of estimated blood loss, operatiin time, time to first flatus, duration of liquid diet, number of lymph nodes yield, total cost, postoperative complications and the oncologic outcomes were compared. No significant differences were found between R-TME and L-TME regarding the volume of abdominal drainage, operation time, number of examined lymph nodes, abdominal drainage time, postoperative complications and oncologic outcomes. However, compared with the L-TME group, less blood loss, decreased time to first flatus and first liquid diet, less volume of abdominal drainage, shorter hospital stay, and more cost were found in the R-TME group.

Our study found no significant difference between the two group on operation time, which is consistent with previous studies[13]. However, some other studies shows that the R-TME had a longer operation time than the L-TME[14]. The influence on learning curve period might be one of the reasons for the longer operation time in R-TME. In addition, the operation time of R-TME depends on the surgeon's proficiency with Da Vinci surgical system and mastery on the surgical procedures. A systematic review shows that the operation time to perform R-TME can be rapidly decreased after 39 cases of surgeries, it can be faster than laparoscopic surgery only after this number achieved[15].

Our study found the intraoperative blood loss was significantly less in the R-TME group. Indeed, R-TME may help to decrease blood loss because the better visual field of surgery, which can make more precise dissections performed. In addition,

surgeons' proficiency and experience in this system may contribute to the decrease of blood loss, as reported by previous studies[16].

Furthermore, our study found no significant difference on lymph node yield between the two groups. In contrast, a previous study drawn different conclusions[17]. The difference might be due to the surgeons' experience with R-TME. It is important to declare that the adequacy of lymph node extraction and quality of collected specimens in operation are both of vital importance in long-term oncological outcomes. Therefore, it is essential to have a long-term follow-up for a reliable evaluation on oncological outcomes in respect to the comparison between R-TME and L-TME.

Our results show that patients in the R-TME group had a significantly faster recovery of intestinal function, which is similar to previous study[18]. One possible reason is that the Da Vinci surgical system armed with multiarticular instruments and high-resolution 3D camera, which could perform more precise surgeries. It can effectively reduce the intestinal stimulation during operation and accelerate recovery of intestinal function after surgery, which helps to maintain the balance of water and electrolyte and reduce intestinal adhesion after surgery and other complications.

Anastomotic leakage is the most common postoperative complication in patients who underwent rectal cancer surgery. As reported in patients with pelvic surgery, the incidence rate of anastomotic leakage was 3.5% after laparoscopic surgery and 3.6% after robotic surgery. In our study, 5 patients occurred anastomotic leakage, among which 3 patients were from R-TME group and 2 from L-TME group. Anastomotic leakages were all processed after the surgery of enterostomy. Dysfunction of urinary is a common complication after rectal cancer surgery. It may be caused by the injury of hypogastric nerve and sacral nerve during the operation. The hypogastric nerve governs urogenital function and locates under the loose connective tissue of pelvic fascia, which is adjacent to rectum and easy to be damaged. Panteleimonitis S et al.[19] reported that both robotic and laparoscopic surgery had certain effects on urinary and sexual function, but the injury degree of robot surgery on these functions is obviously smaller. According to the results of prospective cohort study by Kim J Y et al.[20], urination and sexual function of patients underwent robotic surgery returned to normal level 3 months and 6 months after surgery respectively.

As to the oncologic outcomes, R-TME, L-TME and open surgery are similar[21]. Current opinion agrees that the robot-assisted approach is reliable and effective, it has similar oncology results to the laparoscopic approach . According to our study, no difference was observed between the two approaches regarding the oncologic outcomes. An important result obtained was that robotic surgery is more frequently and effectively applied in resection of tumors with low location[7].

Our study also indicates that the total hospitalization cost of R-TME was higher than L-TME, same to most of previous studies[22-23].

Our study failed to further discuss the data of long-term complications, such as ileus, anorectal, urinary and sexual dysfunctions. Therefore, a prospective study shall be made to further explore the prognosis between robot-assisted and laparoscopic rectal surgery.

4 Conclusion

The blood loss, volume of abdominal drainage, recovery time of bowel function and hospital stay in R-TME have better results than that in L-TME, despite the shortage of higher cost. Undoubtedly, R-TME can break the limitations of previous surgical instruments and provides a technical support for the progress of minimally invasive surgery. According to the results of this study, it can be expected that R-TME will bring many more advantages in the treatment of rectal cancer. However, more studies with larger sample size are needed to make further assessment on the benefits and disadvantages in patients with rectal cancer undergoing R-TME.

Author contributions

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All authors approved the final version.

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