Laparoscopic conversion to open in rectal cancer resection: effect on short-term and oncological outcomes

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Background
Laparoscopy has been accepted to be safe and feasible in rectal cancer resection. The effect of conversion to open on short-term and long-term oncological outcomes in colorectal patients with cancer is still unclear. The aim of this study was to evaluate the short-term and oncological outcomes of conversion in patients undergoing laparoscopic resection for rectal cancer.
Patients and methods
The data of 40 patients who underwent laparoscopic rectal cancer resection were prospectively collected. Of the 40 patients, eight (20%) patients underwent conversion to open surgery. Laparoscopic-successful group and laparoscopic-conversion group patients were compared.
Results
Locally advanced tumor was the commonest reason for conversion (37.5%). Laparoscopic-conversion group had more intraoperative complications (P=0.017), greater blood loss (P=0.051), longer operative time (P=0.001), and lower rate of total mesorectal excision completeness (P=0.046) compared with laparoscopic-successful group. Pathological T4 was significantly higher in laparoscopic-converted group than in laparoscopic-successful group. The rate of local recurrence (50 vs. 10.3%) was significantly higher in laparoscopic-conversion group than in laparoscopic-successful group (P=0.027). Two-year disease-free survival was significantly prolonged in laparoscopic-successful group than in laparoscopic-conversion group (P=0.033).
Conclusion
Conversion to open surgery in laparoscopic rectal resection has a negative effect on intraoperative outcomes and could be a negative predictive factor for long-term oncological outcomes.

Keywords:
conversion, laparoscopic resection, rectal cancer

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Introduction

According to several randomized clinical trials and review of literature, the laparoscopic approach has been accepted to be superior to the open surgery in colorectal cancer resection owing to its short-term advantages such as less intraoperative blood loss, earlier postoperative recovery, reduced postoperative pain, and shorter hospital stay without compromising long-term oncological outcomes [1–5].

The rate of laparoscopic conversion to the open surgery in colorectal cancer resection varies largely in randomized clinical trials and has been reported in up to 30% of patients [6–9]. Several risk factors for conversion have been identified: patient-related factors, such as BMI, American Society of Anesthesiologists grade, age, sex, and previous abdominal surgery; tumor-related factors, such as location, T-stage, acute surgery, and metastatic setting; and procedure-specific factors, such as visceral injury, problems with anastomosis, bleeding, perforation, adhesions, a short mesentery, and the surgeon's experience [10–12].

However, the effects of laparoscopic conversion to open surgery in rectal cancer resection on short-term and oncological outcomes remain controversial. Most of the literature studies included limited numbers of patients, did not analyze patients with colon cancer and those with rectal cancer separately, or did not analyze the cause for conversion as well [13–15]. The real effect of laparoscopic conversion to open surgery on short-term and long-term oncological outcomes in colorectal

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cancer patients is still unclear. As such, we wanted to include only patients with rectal cancer as well as to analyze the causes of conversion.

The aim of this study was to evaluate the influence of laparoscopic conversion to the open surgery on short-term and oncological outcomes in patients with rectal cancer.

Patient and methods

Data of 40 patients with rectal neoplasm who underwent laparoscopic resection from December 2014 to April 2017 were prospectively collected. A written concent was taken from the patients for the laparoscopy intention to treat including possible conversion to open and complications. Patients with rectal neoplasm, the lower end of the lesion located within 15 cm from anal verge by colonoscopy or per rectum examination, were included. Emergency surgery (perforation or obstruction), palliative surgery, concurrent inflammatory bowel disease, and uncorrectable coagulopathy were the exclusion criteria.

Definition of conversion and study groups

Conversion was defined as the use or extension of any incision to perform any part of the procedure other than specimen retrieval or port placement. However, using the incision for anvil placement or applying stapler for distal rectal resection was not considered a conversion.

Patients were classified into two group: laparoscopic-successful group for laparoscopic completed resection and laparoscopic-conversion group for laparoscopic converted resection.

Parameter

Clinicopathological characteristic of patients included age, sex, BMI, comorbidities, tumor location, tumor size, clinical TNM stage, and neoadjuvant therapy. Intraoperative parameters included type of procedure, conversions to open surgery and its cause, stoma and its type, intraoperative complications, anastomosis methods, duration of operation, amount of blood loss, and total mesorectal excision (TME) completeness. Postoperative progress was recorded with respect to duration of pain killer, return of bowel function, duration of hospital stay, postoperative complications, and pathologic parameters. Tumor classification was defined by the American Joint Committee on Cancer (AJCC), 7th TNM edition [16].

Oncological parameters were as follows: disease recurrence was defined as local tumor recurrence or development of distant metastasis. Two-year disease-free survival (DFS) was used to evaluate oncologic outcomes. DSF was calculated from the date of surgery to the date of recurrence or death. Patients without evidence of recurrence or lost follow-up were censored. Patients with early postoperative death (within 30 days after surgery) were not included in DFS calculation. All the patients were followed up via clinical examination and MRI abdomen and pelvis every 3 month and via colonoscopy every 6 months.

Surgery

All the procedures were performed under general anesthesia. Preoperative care including antibiotic prophylaxis, bowel preparation, and thromboembolism prophylaxis, was provided for all patients. All patients were operated on the principles of surgical oncology with curative intention, such as high inferior mesenteric artery ligation, TME, adequate margins, and wound protection.

Anterior resection was defined as resection of tumors located above peritoneal reflection with tumor-specific mesorectal excision. Low anterior resection was defined as resection of tumors located at or below peritoneal reflection with TME. Intersphincteric resection was defined as TME with intersphincteric dissection in low laying rectal cancer in case of neoplasm did not invade external anal sphincter, otherwise abdominoperineal resection was a must. Total proctocolectomy with ileoanal anastomosis was defined for rectal neoplasm in the context of familial adenomatous polyposis coli.

A double stapling technique was used for anastomosis in most of cases, whereas hand sewing anastomosis was performed in case of intersphincteric resection or failure of stapling procedure.

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics, version 22.0, software (IBM Corp., Armonk, New York, USA). Categorical variables were analyzed using the χ^2 test. Continuous variables were analyzed using Mann–Whitney *U* test. DFS was analyzed using the Kaplan–Meier method, and comparison of DFS between two groups was performed using the log-rank test. *P* values less than 0.05 were considered to be significant.

Results

In total, 40 patients with pathologically proven rectal cancer who underwent laparoscopic rectal resection were enrolled in this study. Mean±SD age was 51

±16 years old, and most of the patients were male (24, 60%). Among 40 patients, laparoscopic-successful group had 32 (80%) patients and laparoscopic-conversion group had eight (20%) patients.

Clinicopathological characteristics of patients

Patients and disease characteristics are summarized in Table 1. There was no significant difference in term of age, sex, BMI, patient comorbidities, tumor characteristics, and neoadjuvant therapy between study groups. However, tumor size was significantly higher in laparoscopic-conversion group (mean±SD, 6.6±2.3 cm) compared with laparoscopic-successful group (mean±SD, 4.7±1.3 cm) (P=0.015).

Operative outcomes

Intraoperative blood loss was greater in laparoscopic-conversion group (mean±SD, 400±205 ml) than in laparoscopic-successful group (mean±SD, 246 ±146 ml) (P=0.051). Duration of the operation in laparoscopic-conversion group (mean±SD, 278.7 ±64.4 min) was significantly longer than in laparoscopic-successful group (mean±SD, 198.7 ±55.8 min) (P=0.001). Moreover, the incidence of intraoperative complications in the laparoscopic-conversion group (62.5%) was significantly higher than in the laparoscopic-successful group (25%) (P=0.017). However, the incidence of TME completeness in laparoscopic-conversion group (62.5%) was significantly lower than in laparoscopic-successful group (93.8%) (P=0.046). Details of operative outcomes are summarized in Table 2.

Causes of conversion

Locally advance tumor was the most common cause of conversion (37.5%) followed by large tumor size and tumor perforation (25% for each), and then instrumental failure of laparoscopy (12.5%) (Fig. 1).

Postoperative outcomes

Duration of pain killer was significantly longer in laparoscopic-conversion group (mean±SD, 5±0.5 day) than in laparoscopic-successful group (mean±SD, 3.6±1 day) (P=0.001), and length of hospitalization was significantly longer in laparoscopic-conversion group (mean±SD, 8.8±2 day) than in laparoscopic-successful group (mean±SD, 7.4±2.9 day) (P=0.013). The outcomes regarding parameters of return of bowel function showed no significant differences between the study groups (Table 3).

Table 1 Clinicopathological characteristics of patients

Variables	Total (N=40)	Laparoscopic-successful (N=32)	Laparoscopic-conversion (N=8)	P value
Age (year)				
Mean±SD	51±16	50.7±15.2	52.5±20	0.934[a]
Sex [n (%)]				0.229[b]
Male	24 (60)	21 (65.6)	3 (37.5)	
Female	16 (40)	11 (34.4)	5 (62.5)	
BMI (kg/m^2)				
Mean±SD	26.6±4.7	26.4±4.4	27.3±6.1	0.908[a]
Comorbidities [n (%)]				0.954[b]
Hypertension	3 (7.5)	3 (9.4)	0	
Diabetes	2 (5)	2 (6.3)	0	
Combined	4 (10)	3 (9.4)	1 (12.5)	
Other	3 (7.5)	2 (6.3)	1 (12.5)	
Tumor location [n (%)]				0.684[b]
Upper rectum	13 (32.5)	9 (28.1)	4 (50)	
Mid rectum	9 (22.5)	8 (25)	1(12.5)	
Low rectum	17 (42.5)	14 (43.8)	3 (37.5)	
FAP	1 (2.5)	1 (3.1)	0	
Clinical TNM				0.253[b]
Stage I	8 (20)	7 (25)	0	
Stage II	6 (15)	5 (15.6)	1 (12.5)	
Stage III	23(57.5)	16 (50)	7 (87.5)	
Stage IV	3 (7.5)	3 (9.4)	0	
Tumor size (cm)				
Mean±SD	5±1.7	4.7±1.3	6.6±2.3	0.015[a]
Neoadjuvant [n (%)]				0.349[b]
Yes	16 (40)	14 (43.8)	2 (25)	
No	24 (60)	18 (56.3)	6 (75)	

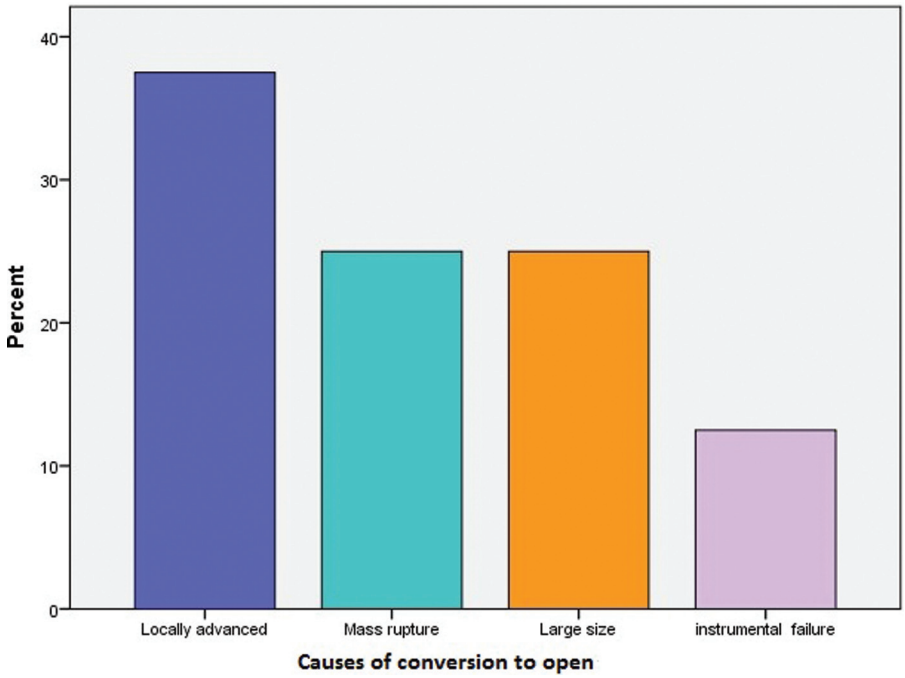
FAP, familial adenomatous polyposis coli. [a]Mann–Whitney U test. [b]χ^2 test.

Table 2 Intraoperative outcomes

Variables	Total (*N*=40)	Laparoscopic-successful (*N*=32)	Laparoscopic-conversion (*N*=8)	*P* value
Procedures [*n* (%)]				0.925[a]
AR	9 (22.5)	7 (21.9)	2 (25)	
LAR	13 (32.5)	10 (31.3)	3 (37.5)	
ISR	8 (20)	6 (18.8)	2 (25)	
APR	9 (22.5)	8 (25)	1 (12.5)	
TPC	1 (2.5)	1 (3.1)	0	
Stoma [*n* (%)]				0.880[a]
Colostomy	8 (20.5)	7 (21.9)	1 (12.5)	
Ileostomy	21 (52.5)	16 (50)	5 (62.5)	
Complications [*n* (%)]				0.017[a]
Not exist	27 (67.5)	24 (75)	3 (37.5)	
Mass rupture	2 (5)	0	2 (25)	
Bowel injury	2 (5)	1 (3.1)	1 (12.5)	
Vascular injury	3 (7.5)	2 (6.3)	1 (12.5)	
Urethral injury	2 (5)	2 (6.3)	0	
Stapler failure	3 (7.5)	3 (4.9)	0	
Anal sphincter injury	1 (2.5)	0	1 (12.5)	
Anastomosis methods				1.000[a]
Hand sewing	8 (20)	8 (18.8)	2 (25)	
Stapled	32 (80)	26 (81.3)	6 (75)	
TME completeness				0.046[a]
Yes	35 (87.5)	30 (93.8)	5 (62.5)	
No	5 (12.5)	2 (6.3)	3 (37.5)	
Blood loss (ml)				
Mean±SD	291.2±166.4	264±146	400±205	0.051[a]
Operative time (min)				
Mean±SD	214.7±65.4	198.7±55.8	278.7±64.4	0.001[a]

APR, abdominoperineal resection; AR, anterior resection; ISR, intersphincteric resection; LAR, low anterior resection; TME, total mesorectal excision; TPC, total proctocolectomy. [a]χ^2 test. [b]Mann–Whitney *U* test.

Figure 1



Bar chart showing causes of laparoscopic conversion to open in rectal cancer resection.

Postoperative complications

Intestinal obstruction was observed in six (15%) patients; most of them were diagnosed as ileus except a case of internal herniation was observed in laparoscopic-successful group and readmission for open exploration was mandatory. Anastomotic disorders were observed in five (12.5%) patients, exclusively in laparoscopic-successful group: A anastomotic leakage occurred in two cases and were treated by percutaneous drainage; two cases of anastomotic stricture and ulceration were managed by repeated dilatation; and one case of anastomotic bleeding was associated with marked drop in hemoglobin level needed only blood transfusion and watchful waiting. A single case of early postoperative death was documented owing to massive pulmonary embolism. Colovaginal fistula was observed following repeated dilatation for anastomotic stricture, and recurrence
was histologically excluded. Neither postoperative complications nor reoperation showed significant difference between the study groups (Table 3).

Pathologic outcomes

Analysis of pathologic outcomes, including pathology differentiation (P=0.503), lymphovascular (P=0.173), distal resection margin (P=0.539), number of harvested lymph nodes (P=0.325), and number of positive lymph nodes (P=0.359), revealed no statistically significant differences between the study groups (Table 4). However, subgroup analysis of pT stage categories revealed significant more frequent T4 stage in

Table 3 Postoperative outcomes

Variables	Total (N=40)	Laparoscopic-successful (N=32)	Laparoscopic-conversion (N=8)	P value
Duration of pain killer (day) (mean±SD)	3.9±1	3.6±1	5±0.5	0.001[a]
Duration of hospital stay(day) (mean±SD)	7.7±2.8	7.4±2.9	8.8±2	0.013[a]
1st day flatus (day) (mean±SD)	1.4±0.7	1.4±0.6	1.6±1	0.987[a]
1st day stool (day) (mean±SD)	2±0.9	1.9±0.9	2.2±1.2	0.703[a]
1st day oral intake (day) (mean±SD)	1.85±0.5	1.8±0.5	1.9±0.3	0.960[a]
Postoperative complications [*n* (%)]				
Intestinal obstruction	6 (15)	4 (12.5)	2 (25)	0.580[b]
Anastomotic disorders	5 (12.5)	5 (15.6)	0	0.563[b]
Wound sepsis	4 (10)	3 (9.4)	1 (12.5)	1.000[b]
Urogenital dysfunction	3 (7.5)	2 (6.3)	0	0.566[b]
Incisional hernia	3 (7.5)	2 (6.3)	1 (12.5)	1.000[b]
Colovaginal fistula	1 (2.5)	1(3.1)	0	1.000[b]
Reoperation	4 (10)	3 (9.4)	1 (12.5)	1.000[b]
Adjuvant therapy	34 (85)	7 (84.4)	7 (87.5)	1.000b

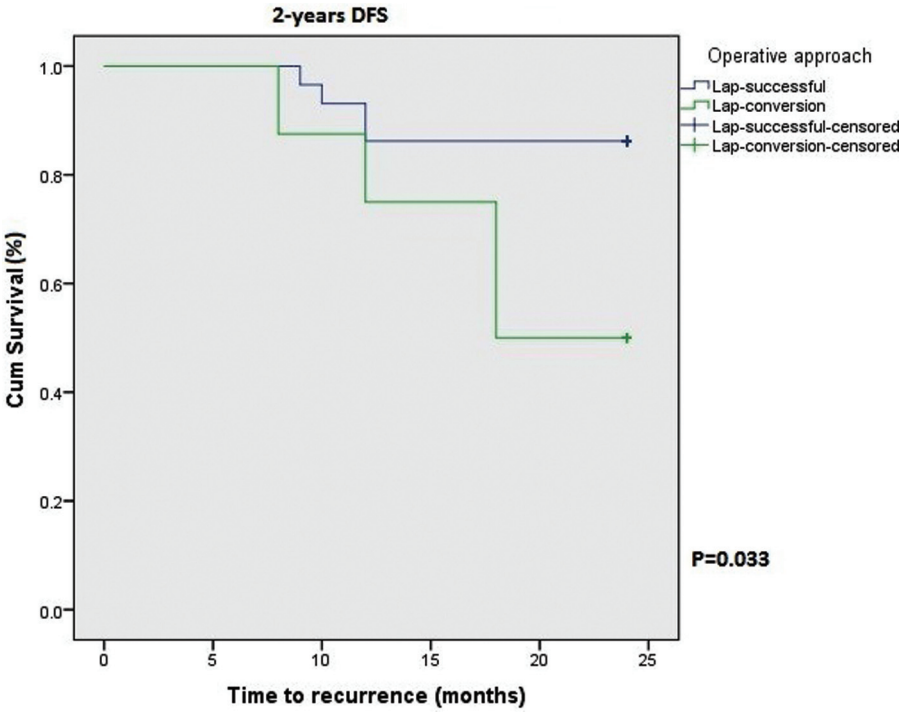
[a]Mann–Whitney U test. [b]χ^2 test.

Table 4 Pathological and oncological outcomes

Variables	Total (N=40)	Laparoscopic-successful (N=32)	Laparoscopic-conversion (N=8)	P value
Differentiation [*n* (%)]				0.252[a]
Well differentiated	10 (25)	10 (31.3)	0	
Moderate differentiated	18 (45)	14 (43.8)	4 (50)	
Poor differentiated	8 (20)	5 (15.6)	3 (37.5)	
Signet ring	4 (10)	3 (9.4)	1 (12.5)	
LV invasion [*n* (%)]				0.173[a]
Yes	8 (20)	8 (25)	0	
No	32 (80)	24 (75)	8 (100)	
Pathological T Stage [*n* (%)]				
T1	4 (10)	4 (12.5)	0	0.566[a]
T2	6 (15)	5 (15.6)	1 (12.5)	1.000[a]
T3	16 (40)	15 (46.9)	1 (12.5)	0.114[a]
T4	14 (35)	8 (25)	6 (75)	0.014[a]
DRM (CM) (mean±SD)	4.5±3.3	4.5±3.2	4.5±4.2	0.539[b]
Harvested LN (mean±SD)	15.4±6.7	16±6.8	13.2±6.2	0.325[b]
Positive LN (mean±SD)	2.8±4.8	2.5±4.8	4.2±4.5	0.359[b]
Local recurrence [*n* (%)]	7 (18.9)	3 (10.3)	4 (50)	0.027[a]
Distant recurrence [*n* (%)]	6 (16.5)	3 (10.3)	3 (37.5)	0.101[a]
2-year DFS (%)	78.4	86.2	50	0.033[c]

DFS, disease-free survival; DRM, distal resection margin; LN, lymph node; LV, invasion, lymphovascular invasion. [a]χ^2 test.
[b]Mann–Whitney U test. [c]Log rank test.

Figure 2



Kaplan–Meier curve shows 2-years disease-free survival (DFS) after laparoscopic resection of rectal cancer in laparoscopic-successful versus laparoscopic-conversion group.

laparoscopic-conversion group (six, 75%) than in laparoscopic-successful group (eight, 25%) (*P*=0.014).

Oncological outcomes

Long-term oncologic outcomes are shown in Table 4. Tumor recurrence and DFS were used for assessment of oncologic outcomes. Local recurrence happened in seven (18.9%) patients. The rate of local recurrence was significantly higher in laparoscopic-conversion group (50%) compared with laparoscopic-successful group (10.3%) (*P*=0.027). Distant metastasis was diagnosed in six (16.5%) patients. Distant recurrence rate revealed no significant difference between laparoscopic-successful (10.3%) and laparoscopic-conversion group (37.5%) (*P*=0.101). Two-year DFS was significantly prolonged in laparoscopic-successful group 86.2% (mean, 22.1 months; CI 20.5–23.8 months) than in laparoscopic-conversion group 50% (mean, 19 months; CI, 14.9–23 months) (*P*=0.033) (Fig. 2).

Discussion

Laparoscopic surgery provides a magnified and well-illuminated image of the surgical field to allow for a more precise radical resection for colorectal cancer. However, there has been a rising concern about the worse outcomes of laparoscopic conversion to open in rectal cancer surgery.

The conversion rate in the present study was 20%, near to conversion rate in the COST trial (21%) [17], whereas it was lower than conversion rate in Rickert *et al*. [18] (23.5%) and much higher than COLOR II trials (16%) and other studies [1,19–22]. Herein, conversion rate could be accepted with technically challenging rectal resections conducted by different surgeons with different level of experience for laparoscopic resection. Tekkis *et al*. [11] reported a significant reduction of the conversion rate from 20.7 to 5.5% with increasing experience in laparoscopy and number of laparoscopic resections. In this study, we found that tumor-related factors, locally advanced tumor (37.5%) followed by large tumor size (25%), were the most common reasons for conversion, with cumulative percent constituting 62%. This is consistent with most of the studies reporting the reason of conversion, where the tumor-related factors were the most frequent reason for conversion [13,20,21,23].

Allaix *et al*. [14] performed a systematic review and found male predominance and higher BMI in converted compared with laparoscopy-completed patients in many studies. Herein, there were no significant differences in term of patients and tumor characteristics between laparoscopic-successful and laparoscopic-converted group except tumor size, which was significantly higher in laparoscopic-conversion group compared with laparoscopic-

successful group (P=0.015). Tumor size was significantly larger in laparoscopy-converted than laparoscopy-completed patients in the three retrospective studies [13,18,23].

The present study demonstrated the laparoscopic-conversion group was characterized by an increased rate of intraoperative complications, greater blood loss, and a longer operative duration compared with laparoscopic-successful group, which is consistent with several previous reports [21,23–26].

Controversial results were reported by several authors on comparing postoperative short-term outcomes of laparoscopic-completed colorectal resections and converted surgeries. CLASSIC trial and many studies reported longer hospital stay, higher complication rate, and transfusion requirement in laparoscopy-converted patients [6,19,24,26]. However, several studies did not find any significant difference [18,20,21,23,25]. In contrast, Scheidbach *et al*. [26] reported a high reoperation rate and early return of bowel function in favor of laparoscopy completed (4.9 vs. 15.0%). In the present study, laparoscopic-conversion group was characterized by significantly longer hospital stay and pain killer duration, whereas postoperative complications together with return of bowel function and rate of reoperation showed no significant differences between the study group.

Most of the formerly cited studies revealed insignificant difference in T-stage, N stage, and positive margins between laparoscopy-completed and converted patients. However, three studies reviewed a higher frequency of T3 and T4 in laparoscopy-converted patients [19,21,27]. The present data revealed significant rise of T4 stage in laparoscopic-conversion group than in laparoscopic-successful group (P=0.014). The number of harvested lymph nodes was similar in both study group, and this is consistent with the series reporting this item [18–30].A difference in local recurrence rate between laparoscopy-completed and converted patients was reported by Chan *et al*. [13] (2.5 vs. 9.8%, respectively, P<0.001). However, many studies reported comparable differences in local recurrence rates between both groups but did not reach statistical significance [19,20,24]. Higher distant recurrence rates were reported by three studies in laparoscopy-converted patients but did not reach statistical difference [19–21]. Herein, the rate of local recurrence was significantly higher in laparoscopic-conversion group compared with laparoscopic-successful group (P=0.027), whereas distant recurrence rate revealed no significant difference between laparoscopic-successful and laparoscopic-conversion groups (P=0.101).

Favorable outcomes in DFS were found in multiple studies in the laparoscopy-completed rather than converted patients [13,20,21,23,31]. However, other two studies reported favorable outcomes in converted patients [24,26]. Our results demonstrated worse 2-year DFS rate in laparoscopic-conversion group (P=0.033). We suggest that the worse DFS in the laparoscopic-conversion group might be related to several factors other than conversion itself, such as locally advanced tumor; conversion may delay time to start adjuvant therapy, and furthermore, missing neoadjuvant therapy in some patients in laparoscopic-conversion group could explain high rate of local recurrence. Limitations of our study were small sample size and short period of follow-up. The small sample size of the laparoscopic-conversion group may lead to an unpowered conclusion. Further large-scale investigation is needed to establish the oncological effect of laparoscopic conversion to open for rectal cancer resection.

Conclusion

In conclusion, tumor-related factors (locally advanced tumor and large tumor size) are the major risk factors for laparoscopic conversion to open for rectal cancer resection. Conversion is associated with an increased rate of intraoperative complications. However, conversion per se could be a strong predictive factor, not an independent risk factor, for worse oncological outcomes.

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Conflicts of interest

There are no conflicts of interest.

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