Original Article

Robotic Colorectal Cancer Surgery – Early Experience at a Single Center

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Key Words
Robotic surgery;
Total mesorectal excision;
Neoadjuvant concurrent chemo-radiation therapy

Purpose. Colorectal cancer is the most prevalent malignancy in Taiwan. Surgical resection is the key to cure this disease and laparoscopic technique is widely adopted. Recently, robotic surgery has also gained popularity. This study reports our early experience with robotic surgery for rectal cancer.

Methods. Data of consecutive patients who underwent robotic proctectomy between Mar. 2012 and Jan. 2013 were retrospectively reviewed. Baseline demographic, intra-operative, and post-operative data were collected. Numerical data were reported as mean ± standard deviation, or median (range). Survival curve was analyzed by Kaplan-Meier estimator, and stratified by tumor stage and neoadjuvant chemo-radiation therapy status.

Results. Fifty patients with rectal cancer were included. Baseline demographic data were similar to those of general population with rectal cancer. Six patients were obese (12%). Twenty-two lower rectal lesions were treated with total mesorectal excision. Mean operation time was 283 ± 61 min for total mesorectal excision and 342 ± 69 min for abdominoperineal resection. No conversion was necessary. Two intra-operative small bowel injuries (4%) occurred, and five post-operative complications (10%) needed surgical intervention. The number of retrieved lymph nodes was 15 ± 7 in neoadjuvant chemo-radiation therapy group and 24 ± 10 in non-neoadjuvant chemo-radiation therapy group, and no circumferential resection margin involvement was detected. The out-of-pocket cost of robotic proctectomy was NT$ 181,500 ± 3000. Fiver-year survival was > 90% for stage 1/2 rectal cancer and 60% for stage 3 cancer.

Conclusions. Application of da Vinci robotic system in rectal cancer surgery yields acceptable short-term and long-term results.

[*J Soc Colon Rectal Surgeon* (*Taiwan*) *2019;30:45-55*]

Colorectal cancer is the most prevalent malignancy in Taiwan, followed by lung and liver cancer. Its annual incidence exceeded 15,000 cases per year (42.7 per 100,000 person years) since 2012 and plateaued in the following 3 years. Of these cases, the incidence of rectal cancer exceeded 5000 cases per year since 2010, even 6000 cases in 2014, and decreased slightly in 2015, when 5,754 cases were registered.[1]

With the advance of multi-modality treatment and the development of precision medicine, the survival rate of colorectal cancer increased. The relative five-year survival of patients with colorectal cancer who were diagnosed between 2011 and 2015 was 63.5%.[2]

Received: August 22, 2018. Accepted: February 20, 2019.
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High-quality surgical resection remained the only chance of cure for colorectal cancer. Since the world first publication about laparoscopic colon resection in 1991, it had been widely adopted. Some expert considered laparoscopic colon surgery the standard treatment modality for uncomplicated, non-locally advanced colon cancer, while it was still controversial for rectal cancer.[3,4] Moreover, even some expertise advocated for this type of surgery in colorectal cancer with adjacent organ involvement in selective cases. The COLOR I and COLOR II trials set up the cornerstone of laparoscopic surgery. The recently published ten-year follow-up study, which was based on cases from COLOR I trial, showed that oncological results of laparoscopic surgery were comparable to those of open surgery in colon cancer.[3] Moreover, COLOR II trial showed comparable mid-term outcomes, in terms of 3 year survival, between laparoscopic surgery and open surgery in rectal cancer.[5]

As an advanced version of laparoscopy, robotic surgery, specifically da Vinci system (Intuitive Surgical, Inc., Mountain View, CA, USA), was first approved by US FDA in 2000. Later on, the da Vinci system had been upgraded several times to the latest 4th generation, da Vinci Xi. The system, regardless of generation, provides 3D vision, stable camera platform, and ergonomic EndoWrist® instruments with 7 degrees of freedom and 90 degrees of articulation. It overcomes the limitations of conventional laparoscopic surgery, including the lack of stereovision, the straight instruments that limit accessibility to and flexibility in deep spaces such as pelvis, and the awkward working position that exhausts surgeons. Soon after marketing, da Vinci system gained great utilization in urological, gynecological, and colorectal practice.

The famous ROLARR trial demonstrated lower conversion rate and higher cost of robotic rectal cancer surgery, compared to conventional laparoscopic surgery.[6] Other aspects, including circumferential resection margin (CRM) involvement, complications, and postoperative bladder and sexual function, were not different. As a secondary outcome, the long-term oncological outcome is awaited.

Meta-analyses consistently showed lower conversion rate and longer operation time associated with robotic rectal cancer surgery. The length of hospital stay and functional outcomes were similar between robotic and laparoscopic surgery.[7,8] Long-term survival of colorectal cancer was similar between robotic and laparoscopic surgery.[9] However, post-operative survival focusing on rectal cancer was not individually reported and is under extensive study.

A study reported higher rate of complete total mesorectal excision (TME), despite similar CRM involvement rate.[10] Whether this result could be extrapolated to survival is to be studied.

In our institution, da Vinci Si, the 3rd generation system, was implemented in Dec. 2011. Thereafter, we started to perform robotic rectal surgery in a small number of cases. We previously reported our early experience in left colic artery-preserving D3 lymph node (LN) dissection by da Vinci Si system in total mesorectal excsion.[11] The present study enrolled consecutive patients since the first-ever case till the last patient operated within one year and investigated both the short-term and long-term outcome of robotic surgery for colorectal cancer.

Materials and Methods

Medical records of 50 consecutive patients diagnosed with rectal cancer who underwent robotic rectal surgery performed by a single surgeon in a single institution between Mar. 2012 and Jan. 2013 were retrospectively reviewed. These procedures included TME and abdominoperineal resection (APR). The choice between TME and APR depended on the comprehensive pre-operative assessment of patient's status and colorectal tumor condition. In general, patients with tumors involving dentate line, levator ani or external anal sphincter invasion in pre-operative studies were offered APR only. If not resisted, patients with clinical resectable T3/T4 or nodal positive diseases were given neoadjuvant chemoradiation therapy (NCRT) with standard radiation therapy plus capecitabine (Xeloda®, ROCHE) or tegafur/uracil (UFUR®, TTY Biopharm). Some of the patients had already received either complete or incomplete neoadjuvant NCRT in

other hospital before coming to our clinic and the regimen was missing.

All patients were planned to undergo totally robotic surgery with single docking during intra-abdominal phase. The surgical techniques of TME, including D3 LN dissection, left colic artery preservation, hypogastric nerves preservation, splenic flexure takedown, and total mesorectal excision, were similar to those performed in laparoscopic surgery and were described in detail elsewhere.[12] The surgical techniques of APR during intra-abdominal phase were similar to TME except that the splenic flexure was not taken down. The end-colostoma was created first and then perineal phase of surgery proceeded. In restorative proctectomy, that is, TME, protective ileostomy was routinely created in patients with neoadjuvant chemo-radiation therapy. The only exception was strong patient reluctance. Whether to create protective ileostomy in patients without NCRT was judged intra-operatively according to the surgeon's confidence in anastomosis. If the patients had clinical metastatic disease, additional procedures, such as metastatectomy or radiofrequency ablation (RFA) for liver metastasis, were allowed during the index procedure. In these cases, the surgery was defined as curative. Otherwise, the surgery was considered palliative. The adjuvant therapy followed National Comprehensive Cancer Network (NCCN) guidelines and was reviewed by a multidisciplinary team.

Baseline characteristics included age, sex, body mass index (BMI), American Society of Anesthesiology (ASA) classification, NCRT status, location of tumor, and tumor size.

Intra-operative and post-operative parameters and long-term oncological results were collected. Intra-operative parameters included total operation time, console time, and complications. Furthermore, post-operative pain scale, time to flatus, urinary catheter indwelling duration, complications, hospital stay, patient cost not covered by national health insurance, pain score, satisfaction score, re-operation, and re-admission rate as short-term outcome were assessed. Functional recovery was evaluated by time-to-return to partial activity, full activity, and work. Post-operative satisfaction score, time-to-return to partial activity, full activity, and work were collected by telephone or questionnaire interview. Additionally, long-term oncological outcome was analyzed in terms of overall survival calculated using Kaplan-Meier survival curves, stratified by cancer stageand NCRT status. Recurrent rate was only calculated for patients who underwent curative surgery. All statistics were performed using the SPSS® software, Version 25.

Results

There were 37 men and 13 women among the 50 patients that underwent robotic surgery. The mean age was 60.5 ± 13.7 years (range, 34-88 years), with the eldest patient having 88 years old and the youngest patient having 34 years old. The majority of patients were ASA class I-II (80%), but some patients were ASA class III. The mean BMI was 24.5 ± 4.3 kg/m^2 (range, 15.7-36.9 kg/m^2). Twelve patients had BMI above 27 kg/m^2. Of them, 6 had BMI above 30 kg/m^2 and 1 had BMI above 35 kg/m^2. Baseline characteristics were calculated and listed separately, according to the type of procedures (Table 1).

The surgical procedures included 44 TMEs (88%), and 6 APRs (12%). All patients who underwent APR had lesions located near the dentate line, while half of patients who underwent TME had tumors located ≤ 5 above the anal verge. Regarding lower rectal lesions (e.g., lower margin of tumor located ≤ 5 cm above the anal verge), the mean tumor size was 2.5 ± 2.4 cm for TME patients (22 patients), and 3.3 ± 1.5 for APR patients (6 patients). Five of the 22 lower rectal lesions with TME sized more than 4 cm and 3 lesions were even larger than 7 cm. Six patients had additional procedures. Two patients underwent percutaneous RFA. One patient underwent percutaneous RFA and robotic lateral pelvic lymph node dissection. One patient underwent robotic wedge resection of S3 of liver. One patient underwent inguinal lymph node dissection, which was not under robot. One patient underwent robotic bilateral salpingo-oophorectomy and hysterectomy. Among the 44 patients that underwent TME, protective ileostomy was routinely performed in all patients who received NCRT, except one patient who

Table 1. Baseline characteristics

	Procedure	
	TME	APR
Age, mean ± SD (range), years	61 ± 14 (34-88)	62 ± 9 (51-74)
Sex, n (%)		
Male	33 (75)	4 (66.7)
Female	11 (25)	2 (33.3)
BMI, mean ± SD (range), kg/m^2	24.0 ± 4.3 (15.7-36.9)	24.6 ± 3.4 (20.5-27.9)
ASA classification, n (%)		
I	20 (45.5)	0
II	16 (36.4)	4 (66.7)
III	8 (18.2)	2 (33.3)
NCRT, n (%)		
Yes	23 (52.3)	5 (83.3)
No	21 (47.7)	1 (16.7)
Location of tumor, cm from anal verge, n (%)		
≤ 5	22 (50)	6 (100)
5.1-10	15 (34.1)	0
> 10	7 (15.9)	0
Tumor size (for lesion located ≤ 5 above anal verge), mean ± SD (range), cm	2.5 ± 2.4 (0-9)[a]	3.3 ± 1.5 (0.5-5)

[a] Tumor size 0 cm indicates that no tumor was identifiable by gross pathological examination.

TME, total mesorectal excision; APR, abdominoperineal resection; SD, standard deviation; BMI, body mass index; ASA, American Society of Anesthesiology; NCRT, neoadjuvant chemo-radiation therapy.

was reluctant to have stoma. Four additional stomas were created for patients not receiving NCRT, depending on intra-operative judgment (Table 1).

The mean total operation time for TME and APR was 283 ± 61 min and 342 ± 69 min, respectively. The mean console time was similar for TME and APR (121 ± 33 min and 124 ± 38 min). No conversion to traditional open surgery was necessary. Two patients had minor small bowel injuries during the operation that were repaired immediately in both cases. The distal safety margin was 3.4 ± 2.4 cm and 2.2 ± 1.1 cm for each procedure (Table 2).

All resected tumors were adenocarcinomas in our study group. The oncological outcomes were calculated according to NCRT status. Eight of 28 patients (28.6%) with NCRT had pathologic complete response (pCR). The average number of LNs retrieved was 24 ± 10 and 15 ± 7 for each group (without NCRT vs. with NCRT). Three (13.6%) and 6 (21.4%) patients had stage 4 disease before surgery. Most of other patients had pathological stage I or stage III tumors. Three patients without NCRT had T4 lesions. Decision of directly going to surgery was based on presence of impending perforation. All but three patients with T4 lesion were negative for circumferential resection margin (CRM) involvement. However, the distance of CRM to tumor was not available in all patients and was therefore not reported. In addition, the completeness of TME was not routinely evaluated by pathologist and not reported either (Table 3).

During the follow-up period (median, 57.7 and 59.7 months for each group), 5 of 19 (26.3%) and 7 of 26 (26.9%) patients who underwent curative intent surgery had recurrence. Two patients in each group had local recurrence, which accounted for 10.5% and 7.7% of local recurrent rate. The 2-year overall survival rate of all patient was 89.6%. When the patients with palliative surgery were excluded, the 2-year overall survival rate was 93.1% and 2-year disease-free survival rate was 79.3% (Table 3).

The mean time to flatus was 3.0 ± 1.4 days (median, 3 days). The mean hospital stay was 16.3 ± 6.7 days (median, 11 days). The average post-operative visual analogue pain scale was 2.5 ± 0.5 (0-10, 10 most painful), while the satisfaction score was 8.2 ± 0.7 (0-10, 10 most satisfied). The mean time to return

Table 2. Intra-operative parameters

	Procedure	
	TME	APR
Operation time (mean ± SD), min	283 ± 61	342 ± 69
Console time (mean ± SD), min	121 ± 33	124 ± 38
Stoma formation, n (%)		
Yes	26 (59.1)	6 (100)
No	18 (40.9)	0
Additional procedures, n (%)		
Percutaneous RFA	2 (4.5)	0
Percutaneous RFA plus pelvic lateral lymph node dissection	0	1 (16.7)
Inguinal lymph node dissection	0	1 (16.7)
Bilateral salpingo-oophorectomy and hysterectomy	1 (2.3)	0
Wedge resection of S3 of liver	0	1 (16.7)
Conversion, n (%)		
Yes	0	0
No	44 (100)	6 (100)
Intra-operative small bowel injury, n (%)		
Yes	2 (4.5)	0
No	42 (95.5)	6 (100)
Distal margin (mean ± SD), cm	3.4 ± 2.4	2.2 ± 1.1

TME, total mesorectal excision; APR, abdominoperineal resection; SD, standard deviation; RFA, radiofrequency ablation.

to partial activity, full activity, and work were 2.1, 4.0, and 5.9 weeks, respectively. The average out-of-pocket cost at index admission was NTD 181,500 ± 3000 (Table 4).

There was no mortality within 30 days after surgery. There were 7 re-admissions (13.5%), including 2 related to wound infection, 2 to ileus, 1 to port-A site infection, 1 to high-output stoma-related acute kidney injury, and 1 to anastomosis leak with intra-abdominal infection.

Complications occurred in 14 (63.6%) and 22 (78.6%) patients. Most of them were Clavien-Dindo Class I-II. Five patients without NCRT (22.7%), while no patient with NCRT, had grade III or IV complications. The presence of superficial surgical site infection (SSI) were loosely judged as prescribing at least 2 weeks of oral antibiotics after discharge. The site of superficial SSI, abdomen, perineum, or anus, was not clearly recorded. Acute urine retention after removal of urinary catheter remained the most frequent complication. It was treated either by medication or by prolonged cauterization. Only 1 patient with NCRT was catheter-dependent 1 year after surgery. Clinically detectable anastomotic leakages occurred in 5 patients without NCRT and in 1 patient with NCRT. Two of the 5 patients without NCRT with leakage could be treated conservatively with total parenteral nutrition and the other three patients needed colostoma creation. The only patient with leakage in the NCRT group had no stoma creation at first operation and the leakage resolved after conservative treatment. One patient had ischemic stroke, probably related to accidental puncture of carotid artery during central venous catheter insertion, and was admitted to the intensive care unit. This patient was discharged with hemiplegia. Furthermore, 1 patient with bowel leakage also had ureteral injury, revealed by the presence of urine in drainage fluid in ward, and was treated by double-J catheter insertion at the time of colostoma creation. One patient had rectovaginal fistula, which was diagnosed after discharge, and was treated by colostoma creation. Successful repair of fistula was performed 3 months later. Of patients who underwent TME, 3 patients without NCRT and 3 patients with NCRT depended on stoma at 1 year after surgery. The causes were persistent leakage, rectovaginal fistula, and local recurrence in patients without NCRT. The causes in patients with NCRT were stool incontinence

Table 3. Oncological outcomes

	Without NCRT	With NCRT
pCR, n (%)		
Yes	NA	8 (28.6)
No		20 (71.4)
CRM involvement, n (%)		
Yes	3 (13.6)[d]	0
No	19 (86.4)	28 (100)
Lymph node retrieval number, mean ± SD	24 ± 10	15 ± 7
TNM stage, n (%)		
0	1 (4.5)	0
1	9 (40.9)	6 (21.4)
2	1 (4.5)	3 (10.7)
3	8 (36.4)	5 (17.9)
4	3 (13.6)	6 (21.4)
Not classified (pCR)[a]	NA	8 (28.6)
T, or yT		
is	1 (4.5)	0
0	0	8 (28.6)
1	4 (18.2)	0
2	7 (31.8)	7 (25)
3	7 (31.8)	13 (46.4)
4	3 (13.6)	0
N, or yN		
0	11 (50)	19 (67.9)
1	8 (36.4)	6 (21.4)
2	3 (13.6)	3 (10.7)
M[b]		
0	19 (86.4)	22 (78.6)
1	3 (13.6)	6 (21.4)
Any recurrence, n (%)[c]		
Yes	5 (26.3)	7 (26.9)
No	14 (73.7)	19 (73.1)
Local recurrence, n (%)[c]		
Yes	2 (10.5)	2 (7.7)
No	17 (89.5)	24 (92.3)
Distant recurrence, n (%)[c]		
Yes	4 (21.1)	6 (23.1)
No	15 (78.9)	20 (76.9)
Median follow-up, months	57.7	59.7
2-year overall survival (all)	89.6%	
2-year overall survival (curative)	93.1%	
2-year disease-free survival	79.3%	

[a] Staging of pCR was not classified since AJCC cancer staging guidelines only indicated pCR to be similar to stage 0 or 1. [b] M stage was determined clinically by image report or pathologically if metastatic lesion was resected. [c] Only patients that underwent curative procedures, including metastatectomy or radiofrequency ablation, were included to calculate recurrent rate. [d] All 3 patients with affected CRM had T4 lesions.

pCR, pathologic complete response; NCRT, neoadjuvant chemo-radiation therapy; CRM, circumferential resection margin; SD, standard deviation; TNM, tumor-node-metastasis; NA, not applicable.

Table 4. Post-operative data

	All patients
Time to flatus (median), days	3
Hospital stay (median), days	11
ICU stay (median), days	0
Pain score (1-10)	2.5
Satisfaction (1-10)	8.2
Re-admission, n (%)	7 (14%)
Return to partial activities (mean), weeks	2.1
Return to full daily activities (mean), weeks	4
Return to work (mean), weeks	5.9
Cost (mean), NTD	181,500

ICU, intense care unit; NTD: new Taiwan dollars.

in 1 patient with intolerable LAR syndrome, receiving maintenance chemotherapy for stage IV disease in 1 patient, and treatment for lung cancer in 1 patient (Table 5).

Kaplan-Meier survival analysis showed 100% 5-year overall survival for patients with stage 1/2 tumors without NCRT and for stage 2 tumors with NCRT. Two patients with stage 1 tumors and NCRT passed away due to liver metastasis and second malignancy (lung cancer). Concerning stage 3 patients, the 5-year overall survival were both 60% regardless of NCRT (Fig. 1). Among patients with NCRT, 1 died of liver metastasis and 1 died of urosepsis, secondary to local recurrence and urinary obstruction. Among patients without NCRT, 1 died of liver metastasis, 1 died of lung metastasis, and 1 died of peritoneal carcinomatosis.

Discussion

In our series, baseline patient characteristics revealed a slight selection bias. The average age was a little bit younger than nation-wide database (our series: 62 years old; Taiwan Cancer Registry: 64 years old). Furthermore, male sex was more dominant (our series: 74% male; Taiwan Cancer Registry: 62%). However, the wide range of age, BMI, and ASA class showed that these characteristics were not limiting factors to the use of robotic system. Moreover, more than half of our cases had tumor located within 5 cm above the anal verge. These are the most challenging cases in daily practice.

Table 5. Complications

	Without NCRT	With NCRT
	n (%)	n (%)
Mortality	0	0
Short term, major[a]		
Any complications	5 (22.7)	0
Bowel leakage	3 (13.6)	0
Delayed ureter injury	1 (4.5)	0
Stroke	1 (4.5)	0
Rectovaginal fistula	1 (4.5)	0
Short term, minor[a]		
Any complications	9 (40.9)	22 (78.6)
Superficial SSI	3 (13.6)	16 (57.1)
Bowel leakage	2 (9.1)	1 (3.6)
Post-op ileus	1 (4.5)	4 (14. 3)
Urine retention	4 (18.2)	10 (35.7)
AKI	1 (4.5)	0
Pneumonia	1 (4.5)	0
UTI	0	1 (3.6)
Fever	1 (4.5)	0
Anemia	1 (4.5)	0
Longterm[b]		
Foley-dependent at 1 year	0	1 (3.8)
Stoma present at 1 year	APR (1/1) TME (3/18, 16.7%)	APR (4/4) TME (4/21, 19.0%)

[a] Major complication was defined as Grade III/IV, according to Clavien-Dindo classification, and minor complication was defined as Grade I/II. [b] Nineteen and 25 patients in each group who survived or were followed-up more than 1 year were considered for calculation.

NCRT, neoadjuvant chemo-radiation therapy; SSI, surgical site infection; AKI, acute kidney injury; UTI, urinary tract infection; APR, abdominoperineal resection; TME, total mesorectal excision.

ROLARR trial highlighted a lower conversion rate by robotic surgery compared to conventional laparoscopic surgery. However, it still reported 8.1% of conversion when operating robotic proctectomy. Multilevel logistic regression model showed that male sex, obesity defined as BMI > 30 kg/m^2, and intention to perform lower anterior resection were risks of conversion, while NCRT was not. However, all of our 50 cases were operated successfully with robotic system without conversion to open surgery. Thanks to the ergonomic EndoWrist® instruments, TME was successfully carried out even in patients with lesions larger than 7 cm and located within 5 cm above the anal verge. Moreover, all 6 obese patients with BMI > 30 were successfully operated.

A meta-analysis revealed a longer operation time (average, 57 min) by robotic surgery than by laparoscopy.[13] However, the operation time in our series was similar to that of our historic studies on laparoscopic colorectal surgery[12,14] (Table 6). We believe that an experienced surgeon and a cooperative, well-trained operation room team can lower the need of longer operation time.

Intra-operative complications included two minor small bowel injuries (4%). Major post-operative complications, defined as Clavien-Dindo grade III/IV, occurred in 5 of 50 cases (10%). Four of them were technique-dependent, including 2 anastomotic leakages, 1 ureteral injury, and 1 rectovaginal fistula. The latter two complications and small bowel injuries were probably the direct result from utilizing robotic surgery and could be avoided. The ureteral injury occurred in the case with bilateral salpingo-oophorectomy and hysterectomy. Overall, the complication rate was com-

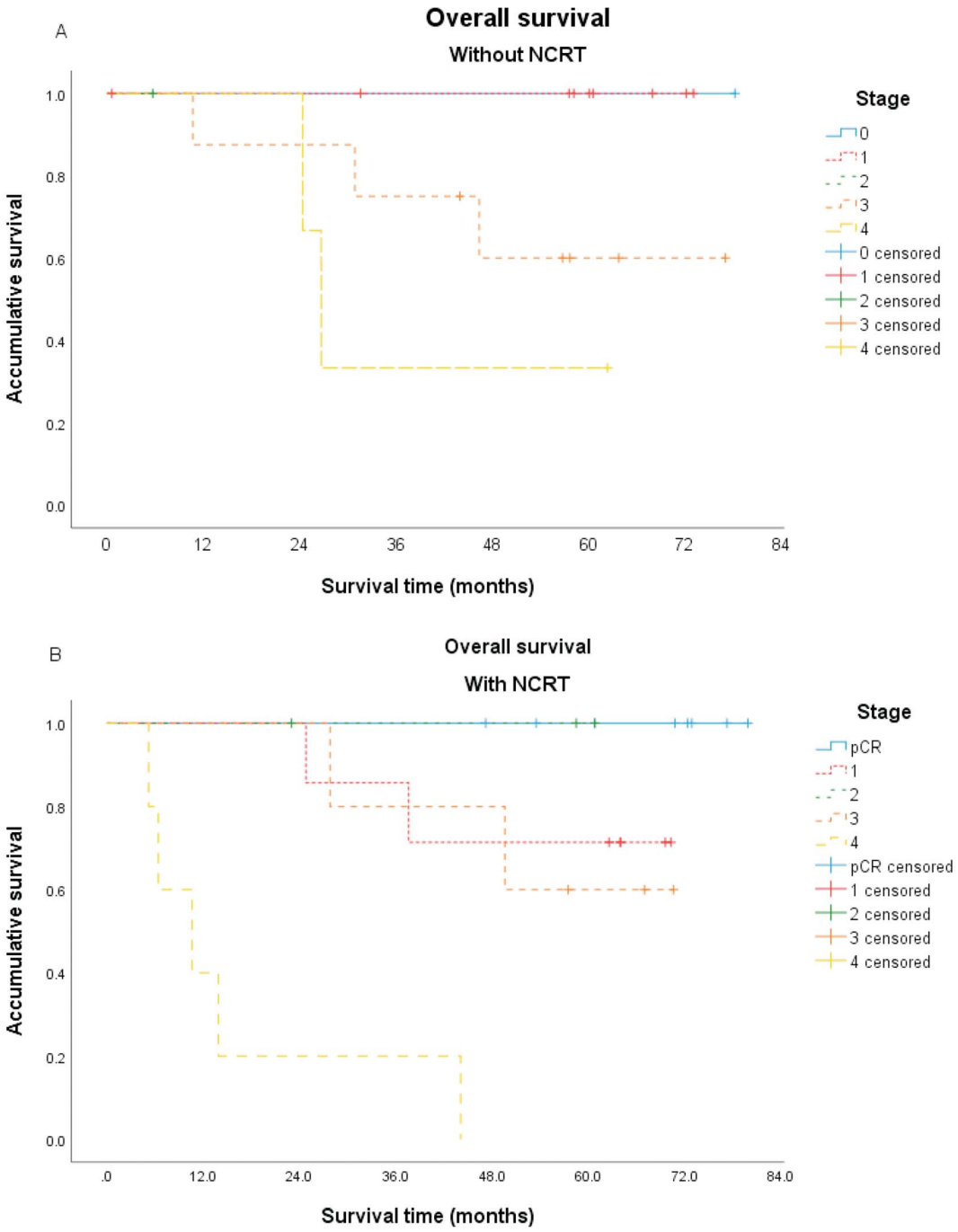

Fig. 1. Kaplan-Meier survival curves.

parable to ROLARR trial (intra-operative: 15.3%; within 30 days: 33.1%). The case number was too small to analyze the factors of robot-related complications. However, it's still worthy to address our lessons learned from these cases. Organ injuries could result from unexpected grasping and retracting force by robotic instruments. Besides, the 3rd arm for stable retraction might cause unnoticed injury when the camera turned and the 3rd arm became invisible, especially when there was external collision. Third, the discordant movements of robotic arms and patient side assistant could produce great force on tissue, causing in-

Table 6. Comparison of obtained results to those of historic series

	This study (total mesorectal excision)	Historic laparoscopic series	
		Distal rectal cancer[14]	Rectosigmoid colon cancer[12]
Patient number	44	98	98
Age (mean ± SD), years	61 ± 14	NA	62.5 ± 4.5
Sex (M/F)	33/11	50/48	98/0
BMI (mean ± SD), kg/m^2	24.0 ± 4.3	NA	25.9 ± 4.0
Tumor location		distal rectum	13.8 ± 2.1 cm
≤ 5 cm	50%		
5.1-10 cm	34.1%		
> 10 cm	15.9%		
LN retrieval (mean ± SD)	19 ± 10	16.4 ± 4.0	27.4 ± 4.2
Distal margin (mean ± SD), cm	3.4 ± 2.4	2.4 (range, 1.2-5.6)	NA
Operation time (mean ± SD), min	283 ± 61	284 ± 44.8	294.4 ± 34.8

NA, not available.

juries. To avoid technique-related morbidities, we recommend all beginners to beware of the above situations, do slowly, and check for possible injuries carefully before finishing the surgery.

The functional recovery of bowel function, reflected by flatus, and urinary function, reflected by urinary catheter indwelling time, was obtained in 3 days and 6 days, respectively. These results are similar to those of laparoscopic proctectomy in our historic series. Most patients could resume full activity and return to work in 4 and 6 weeks respectively. Postoperative pain scale was constantly low and patient satisfaction was high.

Complete, en bloc, resection with adequate LN node retrieval was related to long-term survival. The NCCN guidelines recommend minimal LN retrieval more than 12 for accurate staging and consider it a quality assessment of surgery. However, NCRT decreases the LN number and makes LN retrieval > 12 a tough goal. Some recommended 8 or more LN examination in rectal cancer after NCRT.[15] Furthermore, it was reported that D3 LN dissection for rectal cancer avoids 5.1% of under staging.[12] We routinely performed D3 LN dissection and retrieved average 15-24 LNs in our series. It resulted in only one of 50 cases with permanent urinary dysfunction. This patient had NCRT, which might contribute to occult intra-operative hypogastric nerve injury. We did not report the completeness of TME, since it is not a routine pathological examination in our institution. However, no CRM involvement was detected in any patient, except for three T4 cases. This can be considered a surrogate marker for high-quality surgical resection. Therefore, the feasibility of robotic surgery was confirmed.

The overall survival for stage 2 and pCR patients receiving NCRT was near 100% in 5 years. Among stage 1 patients, the two fatality cases were not related to technical failure; one had liver metastasis and the other was died of second cancer. In case of stage 3 cases, 1 fatality in each group (1 obstructive urosepsis in NCRT and 1 peritoneal carcinomatosis in non-NCRT group) was probably related to technical failure, although surgical margin was free. A total of 4 patients had local recurrence in our series. It accounted for 8% local recurrence rate. A population-base study reported 5% local recurrence including 4% within 1 year.[16] Generally, local recurrence rate in our series is not different from those reported by other studies.

The study has several limitations. First, it is a retrospective, non-comparative study. It is also a series of a single surgeon in a single institution. Patients were the earliest cases operated by the surgeon using the robotic system. This means the outcome measures probably reflect learning curve, rather than the final result. Preoperative treatment was liberally used and was influenced by patient preference. It was reflected by high nodal positive rate in non-NCRT group. If the treatment is not strictly adhered to the current guidelines, the oncological outcomes may not be the best. Finally, the effect of functional preservation, say uri-

nary and sexual functions, was not evaluated using international scoring system, such as IPSS, IIEF, and SFQ, which were better collected prospectively and were not available.

In conclusion, application of da Vinci robotic system in rectal cancer had similar short-term results, such as operation time, complication rate, and recovery time, to those of laparoscopic surgery; moreover, the long-term survival was acceptable. Bulky lower rectal tumors were safely resected with safety margin, and the local recurrent rate was low. Further head-to-head comparative studies are needed to evaluate functional preservation that can be achieved by using da Vinci robotic system in colorectal cancer surgery.

Sources of Financial Support

There are no financial conflicts of interest to disclose.

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原　著

機器手臂大腸直腸癌手術 – 單一醫學中心之早期經驗

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目的　大腸直腸癌是台灣盛行率最高的惡性腫瘤，手術切除是治癒之關鍵，腹腔鏡技術已被廣泛使用，而近年機器手臂手術也日益普及，本研究報告本院機器手臂手術使用於直腸癌的早期經驗。

方法　我們回溯性收集連續於 2012 年三月至 2013 年一月，接受機器手臂直腸切除之患者資料；基本人口學資料、術中、術後資料皆分別收集，數值資料以平均標準差 ± 標準差，抑或中位數 (範圍) 呈現，存活曲線則是依照期別以及是否接受過術前輔助同步化放療分層，以 Kaplan Meier 計算式分析。

結果　研究共納入了 50 位病患，基本人口學資料與全國直腸癌患者相近，其中有 6 位肥胖患者 (12%)，22 個低位直腸癌接受括約肌保留的全直腸繫膜切除，平均手術時間全直腸繫膜切除為 283 ± 61 分鐘，腹部會陰聯合切除為 342 ± 69 分鐘，沒有需要改剖腹的案例，有 2 例 (4%) 發生術中小腸損傷，另外有 5 例 (10%) 發生需要手術治療之術後併發症。淋巴結採樣數目，有接受過術前輔助同步化放療者為 15 ± 7，而未接受過術前輔助同步化放療者為 24 ± 10，案例皆無環狀切除邊界之侵犯。機器手臂自費金額為新台幣 181,500 ± 3000 元。第 1/2 期病患之五年存活率 > 90%，而第 3 期則為 60%。

結論　達文西機器手臂手術應用在直腸癌手術，其短期及長期結果為可接受的。

關鍵詞　機器手臂手術、全直腸繫膜切除、術前輔助同步化放療。