



## Short-Term Outcomes of Three- Port Laparoscopic Right Hemi-Colectomy versus Five- Port Laparoscopic Right Hemi Colectomy: With a Propensity Score Matching Model

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### Abstract

**Objectives:** The aim of this study is to compare the short-term and pathological outcomes of TPLRC (Three-Port Laparoscopic Right hemi - Colectomy) and FPLRC (Five - Port Laparoscopic Right hemi - Colectomy), using propensity score matching analysis.

**Methods:** 168 patients who accepted laparoscopic right hemi - colectomy with either three ports or five ports from January 2013 to October 2017 were non-randomly selected and analyzed retrospectively. Propensity score matching model was used to eliminate the patient s' selection bias between two groups.

**Results:** A total of 168 patients were involved. After PSM, 39 for each group were compared. The number of harvested lymph nodes was significantly larger in the TPLRC group than in the FPLRC group ( $18.36 \pm 8.58$  vs.  $14.90 \pm 6.63$ ,  $p=0.048$ ). A lower mean operative time was observed in the TPLRC group ( $136.24 \pm 26.78$  vs.  $168.64 \pm 43.68$  min,  $p<0.001$ ). A less blood loss in the TPLRC group ( $62.44 \pm 55.17$ ,  $135.54 \pm 139.11$  ml,  $p=0.003$ ). No significant differences in the other short-term outcomes between the 2 groups.

**Conclusion:** TPLRC is a safe and feasible surgical procedure with similar results of FPLRC in short-term clinical outcomes. TPLRC has the advantages of shorter operative time, less blood loss and larger number of harvested lymph nodes. A randomized prospective clinical trial of long-term outcomes of TPLRC is required to further prove the present results.

**Keywords:** Colon cancer; Right hemi - colectomy; Laparoscopic surgery

### Introduction

Since being reported by Jacobs et al. [1], laparoscopic surgery has been gradually accepted as a common approach in the treatment of the colorectal diseases. Meanwhile, more and more randomized controlled trails have confirmed that the safety and long-term oncologic outcomes of the laparoscopic approach is not inferior to the conventional surgery [2,3], and was proven to have better short-term outcomes include less postoperative pain, better cosmetic result, shorter hospital stays and early recovery of bowel function [2,4,5]. As the new technology developed like NOTES (Natural Orifice Transluminal Endoscopic Surgery), SILS (Single Incision Laparoscopic Surgery), and RPLC (Reduced port Laparoscopic Surgery), the advantages of laparoscopic surgery are highlighted, and becomes the first choice for the colorectal surgery. We performed a newly developed procedure of laparoscopic colectomy, which demands only three ports, in other words, three regular trocars. It was not only a perfect transition from regular laparoscopic surgery to single incision laparoscopic surgery, but also reasonably decreased the iatrogenic injury caused by some inexperienced assistants.

### Methods

**Patients:** From Jan 2013 to Oct 2017, 168 patients (76 males and 92 females) with right hemi - colon cancer who accepted minimally invasive surgery included TPLRC (n=68) and FPLRC (n=100) at Ruijin Hospital had been retrospectively enrolled in this study. The diagnosis of right hemi - colon cancer was based on colonoscopy and biopsy. All the operations were performed by the same surgeon, who had the experience of more than 1500 laparoscopic colorectal surgery. The patients accepted either TPLRC or FPLRC. We use propensity score matching method to screen patients, there are

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**Table 1a:** Post-matching patient's characteristics.

Variables		TPLRC(n=39)	FPLRC(n=39)	P value	Standardized difference
Age		65.54 ± 8.65	66.54 ± 9.50	0.628	0.008
Sex	Male	16(41.1%)	18(46.2%)	0.82	0.103
	female	23(58.9%)	21(53.8%)		
BMI		23.10 ± 2.81	22.87 ± 3.32	0.742	0.016
ASA score	I-II	32(82.1%)	31(79.5%)	0.774	0.065
	III-IV	7(17.9%)	8(20.5%)		
History of abdominal operation		13(33.3%)	12(30.8%)	0.808	0.054
History of diseases (Diabetes, Hypertension, etc)		20(51.3%)	21(53.8%)	0.802	0.051
TNM stage	Stage I-II	22(56.4%)	24(61.5%)	0.645	0.104
	Stage III-IV	17(43.6%)	15(38.5%)		

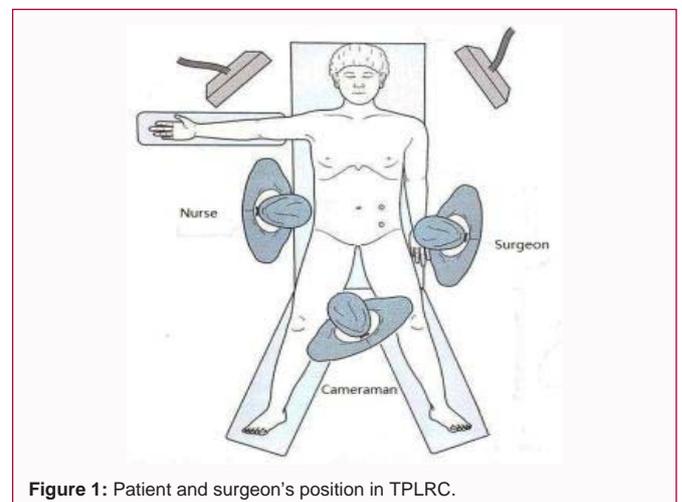
**Table 1b:** Pre-matching patient's characteristics.

Variables		TPLRC(n=68)	FPLRC(n=100)	P value	Standardized difference
Age		62.37 ± 13.55	65.33 ± 9.66	0.1	0.012
Sex	Male	29(42.6%)	47(47.0%)	0.637	0.088
	female	39(57.4%)	53(53.0%)		
BMI		22.16 ± 2.85	24.15 ± 3.66	<0.001	0.127
ASA score	I-II	51(75.0%)	84(84.0%)	0.214	0.224
	III-IV	17(25.0%)	16(16.0%)		
History of abdominal operation		19(27.9%)	32(32.0%)	0.574	0.089
History of diseases (Diabetes, Hypertension, etc)		29(42.6%)	45(45.0%)	0.886	0.047
TNM stage	Stage I-II	39(57.4%)	39(39.0%)	0.027	0.374
	Stage III-IV	29(42.6%)	61(61.0%)		

**Table 2:** Perioperative results.

Variables	TPLRC	FPLRC	P value
Operative time(min)	136.24 ± 26.78	168.64 ± 43.68	<0.001
Blood loss(ml)	62.44 ± 55.17	135.54 ± 139.11	0.003
Length of surgical specimens(cm)	26.77 ± 5.35	27.56 ± 10.02	0.663
Tumor size(cm)	4.47 ± 1.69	4.27 ± 1.60	0.588
Proximal resection margin(cm)	11.48 ± 5.71	11.74 ± 9.10	0.878
Distal resection margin(cm)	11.74 ± 6.04	12.00 ± 10.14	0.892
Number of harvested lymph nodes	18.36 ± 8.58	14.90 ± 6.63	0.048
Number of positive lymph nodes	0.92 ± 1.68	1.18 ± 2.11	0.555

78 patients (41 males and 37 females, TPLRC=39, FPLRC=39) finally been collected to this series. Comparing the distribution of baseline covariate between the 2 groups by standardized differences [6] proposed see in Table 1a,1b (Pre-matching patient's characteristics and post-matching patient's characteristics). Besides the clinical parameters above, the perioperative variables (operative time, blood loss, tumor size, length of proximal and distal resection margin) and short - term outcomes (bowel function recovery, hospital stays and complications) and pathological data(depth of invasion (T), Lymph node metastasis (N), distant metastasis (M), number of harvest lymph nodes, number of positive lymph nodes) were included. Postoperative complications are classified by the Clavien - Dindo system [7]: Grade 1: Any deviation from the normal postoperative course without the need for pharmacologic treatment or surgical, endoscopic, and radiologic interventions. Allowed therapeutic regimens are drugs as antiemetics, antipyretics, analgetics, and diuretics, and electrolytes

**Figure 1:** Patient and surgeon's position in TPLRC.

and physiotherapy. This grade also includes wound infections opened at the bedside. Grade 2: Requiring pharmacologic treatment with drugs other than such allowed for grade I complications. Blood transfusions and total parenteral nutrition are also included. Grade 3: Requiring surgical, endoscopic or radiologic intervention. Grade 4: Life -threatening complication (including CNS complications) requiring IC/ICU management. Grade 5: Death as a result of complications. We defined a paralytic ileus as a patient did not fart on the fourth day after the surgery without fever.

**Surgical procedure:** The patients were placed in a lithotomy, Trendelenburg position. After establishing pneumoperitoneum, slant



Figure 2: The port site of TPLRC.

the operation table to left so as to provide a better surgical view. In TPLRC, surgeons stood on patients' left side, while cameramen stood between patients' legs. In FPLRC, the assistant standard on the right side of the patient (Figure 1). The port site: trans-umbilical 12mm port was inserted for camera; another 2 ports (5 mm and 12 mm) were placed at the left mid - clavicular line in TPLRC. There were 2 more ports in FPLRC, placed at the right mid - clavicular line or other appropriate position. Dissection was performed by ultrasonic activated scalpel. Vessels were ligated with ultrasonic activated scalpel or clipped by hem - o - lock. The specimen was retrieved through an arc umbilical incision with wound protected, resection and anastomosis were performed extra corporeally by hand sutures or stapler (Figure 2).

**Statistical analysis:** Statistical analysis was carried out by SPSS ver22.0. The t-test and u - test was used for continuous variables and the chi - square test was used for categorical variables. A P value <0.05 was considered to be statistically significant. Standardized differences were used for comparing the mean or prevalence of a baseline covariate between TPLRC and TLRC, a value of standardized differences <0.1 was considered a better equilibrium between 2 groups.

## Results

After propensity score matching, 39 patients were selected in each group, all the post-matching demographic data is shown in Table 1, including Age ( $p=0.628$ ), Sex ( $p=0.820$ ), BMI ( $p=0.742$ ), ASA score ( $p=0.774$ ), History of abdominal operation ( $p=0.808$ ), History of diseases ( $p=0.802$ ) and TNM stage ( $p=0.645$ ) were similar in both groups, and the pre - matching data is shown in Table 1 as well. There were neither additional trocars nor conversion to open surgery in both groups. The operative time was significantly longer in the TLRC group ( $168.64 \pm 43.68$  min) than that in the TPLRC group ( $136.24 \pm 26.78$  min), respectively ( $p<0.001$ ), and the mean blood loss in the TPLRC and TLRC group was  $62.44 \pm 55.17$ ,  $135.54 \pm 139.11$  ml, respectively ( $p=0.003$ ), the number of harvested lymph nodes was significantly larger in the TPLRC group than in the TLRC group,  $p=0.048$ . And there were no differences in the length of surgical specimens ( $26.77 \pm 5.35$  vs.  $27.56 \pm 10.02$  cm,  $p=0.663$ ), tumor size ( $4.47 \pm 1.69$  vs.  $4.27 \pm 1.60$  cm,  $p=0.558$ ), proximal resection margin ( $11.48 \pm 5.71$  vs.  $11.74 \pm 9.10$  cm,  $p=0.878$ ), distal resection margin ( $11.74 \pm 6.04$  vs.  $12.00 \pm 10.14$ ,  $p=0.892$ ) and number of positive lymph nodes ( $0.92 \pm 1.68$  vs.  $1.18 \pm 2.11$ ,  $p=0.555$ ). 18 cases of postoperative complication were observed (23.1%). Postoperative morbidity was similar in the two groups ( $p=0.584$ ). Most of the complications occurred in the TPLRC group were Clavien-Dindo grades I (included 4 postoperative ileus,

Table 3: Pathological data.

Variables		TPLRC	FPLRC	P value
Depth of invasion(T)	T1-2	4(10.3%)	9(23.1%)	0.224
	T3-4	35(89.7%)	30(76.9%)	
Lymph node metastasis(N)	Positive	16(41.0%)	13(33.3%)	0.64
	Negative	23(59.0%)	26(66.7%)	
Distant metastasis(M)	M0	37(94.9%)	37(94.9%)	1
	M1	2(5.1%)	2(5.1%)	

Table 4: Short-term surgical outcomes.

Variables		TPLRC	FPLRC	P value
Bowel function recovery (days)		$4.85 \pm 2.11$	$4.28 \pm 1.05$	0.139
Time to liquid diet (days)		$6.92 \pm 2.40$	$6.23 \pm 1.01$	0.101
Hospital stay (days)		$11.02 \pm 4.69$	$10.36 \pm 2.69$	0.443
Complication	None	29(74.4%)	32(82.1%)	0.584
	I	5	4	
	II	3	3	
	III	1	1	
	IV	1	0	

1 fever of unknown origin), meanwhile there were 4 Clavien - Dindo grade I complications (4 postoperative ileus) in the FPLRC group. And there was no significant differences in bowel function recovery ( $4.85 \pm 2.11$  vs.  $4.28 \pm 1.05$  days,  $p=0.139$ ), time to liquid diet ( $6.92 \pm 2.40$  vs.  $6.23 \pm 1.01$  days,  $p=0.101$ ), hospital stay ( $11.02 \pm 4.69$  vs.  $10.36 \pm 2.69$  days,  $p=0.443$ ). There was no postoperative mortality.

## Discussion

Laparoscopic surgery has been playing an important role in colorectal surgery. Many multicenter trails have shown that the feasibility and safety of laparoscopic surgery are comparable to open surgery. New techniques have been presented to promote minimal invasiveness: NOTES, SILC and robotic surgery, etc. Although NOTES can achieve the aim of non-visible incision, it is always a difficulty in closing gastrointestinal incision. Meanwhile, the difficulty of operation and iatrogenic infection still remain the problems [8-11]. With the development of robotic surgery, more surgeons attempted to carry out colorectal surgery with the assistance of robotics. It provides a better view and a more elaborate manipulation. However, due to its expensiveness, it seems impossible to allocate a robot in every hospital at present. Single incision laparoscopic surgery requires some special instruments and needs to overcome the difficulty of the collision of the instrument and the lack of triangular traction [12,13], and the learning curve of this technique is relatively long. Therefore, the SILS had not been worldwide carried out in colorectal surgery. Some authors published a technique of three ports laparoscopic anterior resection and confirmed that three ports laparoscopic surgery is a feasible and safe procedure in colectomy [14,15]. There was little research focused on three - port laparoscopic right hemi-colectomy. In this series, we aimed at confirming the quality and short - term outcomes of TPLRC by comparing it with FPLRC. Without the assistance of the assistant, the difficulty of dissection increased. Some authors believed that the operative time would be prolonged. Although the operative time did not reflect the quality of the surgery, the longer operative time was associated with the higher postoperative morbidity [16,17]. In our study, the operative time in the TPLRC group was significant shorter than that of the FPLRC group ( $p<0.001$ ). Other studies

showed that the mean operative time of the FPLRC was from 175 to 236 min [18-22], longer than that of our TPLRC group (168.64 ± 43.68 min). We attributed this result to the absence of disturbance of inexperienced assistant; it might potentially decrease the operative time if the surgeon was experienced in laparoscopic colectomy, and this was also the reason why there was a significant difference in blood loss between the two groups. Some authors attributed the blood loss and bowel leakage to the wrong operation of the assistant during the exact dissection by traction and countertraction. Owing to the unergonomic operation, the operative time of the SILRC (Single Incision Laparoscopic Right hemi - Colectomy) shown by other authors was from 160 min to 207 min [23,24], much longer than the operative time in our TPLRC group. The number of harvested lymph nodes was considered to be associated with the oncologic adequacy of resection, some trials reported that the minimum number of harvested lymph nodes required for accurate staging was 12 [25]. In our study, the number of harvested lymph nodes in both groups reached the minimum of 12 lymph nodes, and the number of harvested lymph nodes in TPLRC group exceeded the FPLRC group. We speculate that the eradication of TPLRC is superior or similar to FPLRC. The laparoscopic surgery has the advantage of less pain, better cosmetic outcomes and better short-term outcomes. In this study, the postoperative morbidity was similar in the two groups. There were no significant differences in bowel function recovery; time to liquid diet (6.92 ± 2.40 vs. 6.23 ± 1.01 days) and hospital stay (11.02 ± 4.69 vs. 10.36 ± 2.69 days). An article analysed 24 patients accepted colorectal resection showed that time to liquid diet was 1.5 days and the hospital stay was 5 days [14], and the other article presented that the mean hospital stay was 9 days [19], shorter than our hospital stay. We speculated that these results were owing to our conservative postoperative care. In order to make the operation more minimally invasive and to avoid the difficulty of the single incision laparoscopic colectomy, we expect the TPLRC to be a good transitional procedure between TPLRC and SILRC because of the following advantages. First of all, without the collision of instruments and using special instruments, there is hardly any difference between the process of TPLRC and TPLRC so that surgeons can handle it easily. Secondly, it can not only eliminate the disturbance and mistake of assistants but also be more easily carried out in primary hospital compared to the SILRC. Finally, TPLRC can provide better minimally invasiveness and better cosmetic outcome by reducing two trocars (incisions), and surgeons can add trocars whenever they considered it's necessary, for example, when encountering intra-abdominal adhesions and anatomic abnormality, etc. This study has its limitation. First of all, the data was retrospectively collected, so the selection bias could not be avoided, and the sample size in this study is not large enough. Secondly, the long-term outcomes such as late complications, overall survival were not included in our study, the long-term life status and prognosis of patients cannot be compared. Therefore, a large number of prospective trials on short-term and long-term outcomes of TPLRC are needed to prove the benefit of TPLRC.

## Conclusion

In conclusion, the results of our study showed that the TPLRC has its advantages in operative time, blood loss and lymph nodes harvest, the short - term outcomes of TPLRC is superior or similar with the FPLRC, it may be a good option at laparoscopic right hemi - colectomy in any case. The technique of the three - port laparoscopic surgery also can be tried in other colorectal surgery.

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