Technical Note&Original Article

Suture Fixation of Cecum May Facilitate Pure Single-incision Laparoscopic Right Hemicolectomy

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Key Words
Single-incision laparoscopic surgery

Introduction. Operative field is limited to approximately 3 to 5 cm in diameter based on abdominal incision width for Single-incision laparoscopic right hemicolectomy. To facilitate operation without an additional port, we performed some adjustments to shorten the duration of the operation and reduce difficulty.
Methods. A retrospective analysis of patient clinical data, and the surgical and pathology outcome from August 2012 to June 2016 was performed.
Results. Of 49 patients enrolled in this research, 16 underwent surgery with and 33 without cecum suture fixation. Operative time was less in the fixation group without an increase in complication rate (144.9 ± 42.6 minutes vs. 174.0 ± 42.6 minutes, $p = 0.03$). Tumor size (11.5 cm^2 vs. 13.2 cm^2, $p = 0.60$ and number of lymph nodes harvested (20.4 ± 5.6 vs. 21.2 ± 8.9, $p = 0.77$) showed no significant difference between the groups. Flatus starting (2.7 ± 1.1 days vs. 3.0 ± 0.8 days, $p = 0.27$) and discharge times were mild early in the fixation group but there was no statistical difference.
Conclusion. By fixating the cecum or ascending colon, pure single incision right hemicolectomy is made easier and faster without an additional port.
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Single-incision laparoscopic (SILS) right hemicolectomy has been performed for almost 10 years.[1,2] After improvements were made to the technique and equipment, SILS hemicolectomy was believed to be as safe as conventional laparoscopic surgery.[3] Typically, SILS hemicolectomy requires insertion of three to four instrument ports and use of a 5-mm diameter instrument. However, the operative field is limited to approximately 3 to 5 cm in diameter based on the abdominal incision width and instrument "fighting" is not rare during surgery.[4]

To facilitate the operation and shorten its duration, laparoscopic colorectal surgery via a single incision plus one port was used to overcome several conditions.[5] SILS "plus one" laparoscopic right hemicolectomy was introduced in 2009 and is considered a safe and feasible method.[4] A function of the added trocar is to help tent the colon and create a well plane to dissect down the colon. The importance of tenting was demonstrated for SILS right hemicolectomy in 2010. When performing laparoscopic medial-to-lateral hemicolectomy, well traction can aid in taking down the colon along the white line of Toldt and ligating the vessels. However, achieving traction on the colon within the port is not easy during pure SILS laparoscopic right hemicolectomy. Therefore, an alterna-

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tive method is needed to help the surgeon solve this problem.

Lifting the uterus during laparoscopic anterior and low anterior resection is a common procedure. This procedure can save insertion of one instrument during takedown of the sigmoid colon and rectum in female patients. We used the same concept to help the operator gain traction on the colon and expose the dissection plane. We evaluated the effect and benefit of cecum traction during pure SILS laparoscopic right hemicolectomy.

Patients and Methods

The operative records and clinical outcomes of patients who underwent SILS right hemicolectomy and SILS extended right hemicolectomy between August 2012 and March 2016 were reviewed retrospectively. Carcinoembryonic antigen (CEA) levels were obtained and abdominal computerized tomography (CT) scans were performed preoperatively for evaluation and every three to six months postoperatively. Colonoscopy every 12 months and other examinations, such as chest CT and positron emission tomography (PET)-CT, were added if necessary.

All patients were placed in the Lloyd-Davies position and prepared. An approximately 2.5 to 3 cm incision was made along the left side of the umbilicus and the fascia was exposed and entered. The Gel-Port access port was placed, through which four packaged 5-mm trocars were introduced and pneumoperitoneum was established. Standard 5-mm laparoscopic instruments and a 5-mm 30° laparoscopic camera were used through the ports, along with LigaSure for coagulation, tissue cutting, and dissection.

The operator and assistant stood on the left side during takedown of the colon and mesocolon. The colon was taken down using the medial-to-lateral method in all patients. After the intra-abdominal space was created by carbon dioxide (CO2) insufflation to a pressure of 12 mm water, the patients were placed in the right side up position. After pushing the small intestine to the left side and the omentum upwards, a 2-0 Prolene suture with a straight needle was used to fix the cecum percutaneously to the anterior abdominal wall (Fig. 1). Fixation was done by traction of the epiploic appendage near the cecum, on the medial side of the right lower abdomen (Figs. 2A, 2B). If there was no epiploic appendage near the cecum, we chose fat tissue near the appendix (Fig. 1, 2A). After lifting the cecum, we observed the triangle between the ileocecal vessel, colon, and a horizontal line. Then, the operator slit the mesocolon near the horizontal line and entered Toldt's fascia (Fig. 2C). This space is an avascular zone and we dissected until we crossed the hepatic flexure of the colon (Fig. 2D). Using the suture, the space was maintained without assistance. The operator used only two instruments to separate tissue and lyse the mesocolon from the duodenum. After the dissection plane was well established, the ileocecal vessel was ligated near the superior mesenteric vein (SMV), and the right colic artery was ligated with LigaSure sutures.

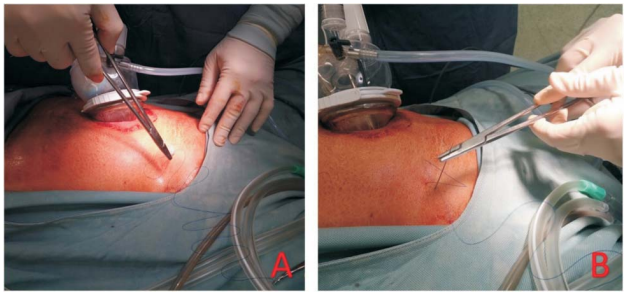

Fig. 1. Straight cutting needle is used to fix cecum over the lower-right quarter of the abdomen.

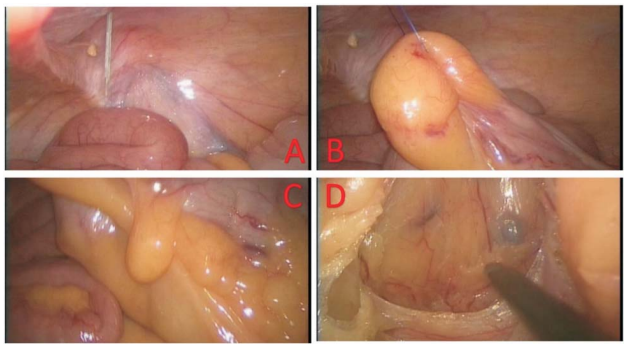

Fig. 2. (A, B) Fixation was done by traction of the epiploic appendage near the cecum, on the medial side of the right lower abdomen. (C, D) Sliting the mesocolon and entered Toldt's fascia with better visual field by using only two instruments.

The hepatic flexure was then taken down from the lesser sac. After separating omentum from the stomach near the middle portion, we visualized the transverse mesocolon. The mesocolon was separated and then dissected on the right side to the duodenum. The middle colic artery then was checked and ligated. Across to the duodenum, we visualized a thin membrane near the hepatic flexure of the colon. In obese patients, gauze can be placed when the colon is completely freed before ligation of the ileocecal artery. This procedure can help distinguishing the cutting plane near the hepatic flexure. Finally, the right paracolic gutter was slit down to the ileum and traction on the cecum was removed at the same time. The tumor was resected and the colon anastomosed extracorporeally. In some patients, a drainage tube was placed into Morrison's pouch. Postoperatively, only the wound made for the SILS port required closure layer by layer.

Patients' characteristic, surgical outcomes, and complications were compared by using Independent t-test with SPSS software, version 15.0 (SPSS Inc., Chicago, IL, USA).

Results

Of 49 patients enrolled in this study, one had adenocarcinoma in the appendix, seven in the cecum, 22 in the ascending colon, 11 in the hepatic flexure, and eight in the proximal transverse colon. Tumor directly invades or adheres to other adjacent organs or structures were excluded in our research. Average patient age was 66.1 years and average body mass index (BMI) was 24.4. There were 22 male and 27 female patients. Finally, 16 patients underwent surgery with and 33 without cecum suture fixation with 2-0 Prolene (Table 1). Operative time was less in patients who underwent cecum fixation (Table 2). No massive bleeding occurred in either group during the operation. However, in the nonfixation group leakage occurred in one patient and intra-abdominal infection without obvious leakage occurred in one. One patient in both groups had a complication not in the abdomen. No complication occurred over the fixation site on the abdominal wall within 30 days postoperatively. Onset of flatus was at 2.7 versus 3.0 days, postoperative recovery of

Table 1. Patient characteristics

characteristics	Fixation	Non-fixation	*p* value
Age (median), range	68.4 (±12.0)	65.0 (±10.0)	0.29
Sex			0.91
Male	7	15	
Female	9	18	
BMI (median), range	24.6 (±3.7)	24.6 (±3.0)	0.68
Tumor site			0.12
Appendix	0	1	
Cecum	0	7	
A colon	8	14	
Hepatic flexure	5	6	
Proximal T colon	3	5	
clinical Stage			0.41
0	1	2	
I	7	11	
II	0	4	
III	8	16	
ASA (I/II/III)	0/16/0	2/26/5	

Table 2. Surgical outcomes

	Fixation	Nonfixation	*p* value
Operative method			
SILS-right hemicolectomy	13	30	
SILS-extend right hemicolectomy	3	3	
Operation time (median), range	144.9 (±42.6)	174.0 (±42.6)	0.03
Blood loss (> 50 ml/total case)	1/16	3/33	
Drain insertion (yes/no)	(2/14)	(9/24)	0.30*
Complications	1 (0 leakage)	3 (1 leakage)	
Date starting flatus	2.7 (±1.1)	3.0 (±0.8)	0.27
Postoperative 1st defecation date	3.4 (±1.0)	3.9 (±1.0)	0.17
Hospital duration after operation (day)	5.8 (±1.7)	7.5 (±3.7)	0.08

* By Fisher's Exact Test.

defecation and feeding was 3.4 versus 3.9 days, and hospital course was 5.8 versus 7.5 days, respectively, in the fixation versus nonfixation groups (Table 2).

Tumor size was not statistically significantly different between the two groups. Number of lymph nodes harvested was 20.4 versus 21.2, which also was not significantly different between the groups. When comparing disease-free survival and local recurrence rates, abdominal recurrence was noted in three patients in the nonfixation group (all carcinomatoses) and none in the fixation group. Distal metastasis occurred in 6% in both groups (Table 3).

Discussion

SILS right hemicolectomy was introduced nine years ago and has been used initially to treat degenerated ascending colon polyps.[1] Two years later, SILS right hemicolectomy was regarded as a safe alternative method to traditional laparoscopic surgery for benign and malignant lesions of the colon.[3] In 2012, Waters also reported SILS right hemicolectomy to be a safe and feasible operation in 100 patients with an average BMI of 28.[6] Although this method has been introduced for several years, SILS right hemicolectomy still is not popular because of the need for a new learning curve.[7] A modified method using one additional port was reported in 2014.[8] In 2018, Nieto reported the "plus one" method for right hemicolectomy at the Society of American Gastrointestinal and Endoscopic Surgeons. The "plus one" method can provide a shorter learning curve when shifting from multiple-incision laparoscopic surgery and can provide better tissue traction during surgery. This additional port site also is used as the surgical drainage tube insertion site postoperatively.

For most patients who undergo right hemicolectomy smoothly, observing drainage is not necessary and sometimes will induce ileus near the drainage site. For those patients, we do not use a designated port. However, good traction still is needed for the operation. Because of the width of the SILS port and the angle of management, three instruments 5 mm in diameter constitute the ideal number to use during the operation. Under this condition, the surgeon only requires two trocars for pure SILS right hemicolectomy. Traditionally, well traction requires at least three traction sites and only one grasper can be used during pure SILS right hemicolectomy. To overcome this problem, we used suture fixation to create the traction triangle. When we performed medial-to-lateral dissection, we first fixed the cecum in the appropriate position to the abdominal wall. The ileocecal vessel, terminal ileum, and mesentery are the three borders of this triangle. After separating the mesentery and entering Toldt's space, those borders change to the mesocolon, ascending colon, and Toldt's fascia. Fixation is continued until total takedown of the ascending colon and hepatic flexure along with the SMV.

When we compared surgery with and without fixation with repositioning of the cecum (Fig. 3), we noted that a good dissection plane can be maintained easily. However, keeping air pressure is important for suture fixation. During our practice, we found that the effect of cecum fixation decreases when air pressure is

Table 3. Pathological results and oncological following

	Fixation	Nonfixation	*p* value
Tumor size (W*L, cm)	11.5	13.2	0.60
Lymph node harvest	20.4 (±5.6)	21.6 (±8.9)	0.77
Pathological stage			
0	1	1	
I	5	10	
II	3	8	
III	7	13	
IV	0	1	
Intra-abdomen recurrence	0	3	
Distal recurrence	1	2	

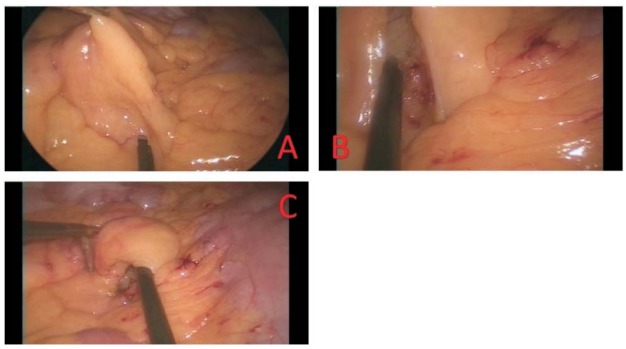

Fig. 3. Narrowing visual field during dissecting mesocolon and colon.

lost, especially if it decreases to below 9 mm water. This condition occurred during frequent suctioning of fluid and exhaustion of smoke. The operator may feel less and less traction tension from the grasper and limitation of movement of the instrument. Therefore, keeping abdominal pressure stable is more important during SILS surgery than during multiple port laparoscopic hemicolectomy, where traction is held by assistants.

Pure SILS also provides an extra benefit in hospitals that have no sufficient operative assistance. Training a good assistant requires a long time and surgeons also may deal with manpower loss of experienced assistants. A well-planned suture fixation can replace the function of some assistants and let junior assistants focus on holding the camera. In our study, no tumor seeding or recurrence occurred over the fixation site postoperatively. For tumors in or near the cecum, the fixation site of the colon is in the epiploic appendage or mesocolon, and passage of a needle through the colon is avoided during fixation. Also, no fixation-related infection occurred within 30 days postoperatively. Therefore, suture fixation is a safe procedure with no oncological side effect.

Well fixation can shorten the operative course in our analysis. In previous literature,[9] operative time has a statistical relationship with the first bowel movement or flatus. Our review of the data demonstrated that a good fixation can accelerate the operation. Although the *p* values were not less than 0.05, we still observed the trend of early first flatus, early defecation, and shorter hospital course in the fixation group. More assessment is suggested because our flatus and defecation records were documented by nurses once a day. If the timing of flatus and defecation were recorded in hours, maybe more precise data could be observed and analyzed. Then we could compare previous literature and begin feeding earlier.

In 2009, Hohenberger reported the clinical outcome of complete mesocolic excision (CME) and central ligation for colon cancer surgery.[10] In this study, CME had a better oncological outcome. During pure SILS right hemicolectomy for CME, keeping ileocecal vessel traction tension was helpful for exposure of the SMV and superior mesenteric artery. However, it was not easy when dealing with the region near the middle colic vessel. Thus, suture fixation maybe needs to be modified and can offer an alternative method to aid in pure SILS right hemicolectomy.

Conclusion

Appropriate traction and fixation of the colon can aid in surgery. Suture fixation of cecum is a feasible method and can shorten operation time without well-trained assistant. This method can help to show vascular structure and the layer between mesocolon and underlying retroperitoneum more clearly without risk of abdomen wall recurrence. However, study with more cases is needed to confirm the benefit about hospital course and development with more fixations is suggested to improve CME.

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創新技術與原著

盲腸縫合固定改善單孔腹腔鏡右半結腸切除術

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目的　單孔腹腔鏡右半結腸切除手術的切口寬度限制在直徑約 3 至 5 厘米。為了在無需額外的切口的條件之下，我們進行了一些調整用來縮短了操作的時間及減少器械互相干擾問題。

方法　回顧性分析 2012 年 8 月至 2016 年 6 月患者的臨床資料，手術病理結果。

結果　本研究納入的 49 例患者中，16 例行有進行手術治療合併盲腸固定，33 例無盲腸固定。手術結果有固定組手術時間較少 (144.9 ± 42.6 分鐘對比 174.0 ± 42.6 分鐘，p 值= 0.03) 且沒有增加併發症發生。所收集案例的腫瘤大小 (11.5 平方公分對比 13.2 平方公分，p = 0.60) 和淋巴結數量 (20.4 ± 5.6 顆對比 21.2 ± 8.9 顆，p = 0.77) 都顯示無顯著差異。有固定組較早排氣 (2.7 ± 1.1 天對比 3.0 ± 0.8 天，p = 0.27) 及出院時間較早，但無統計學差異。

結論　通過固定盲腸或升結腸，在不需要額外的腹腔鏡進入口的情況之下，單孔右半結腸切除術更容易，更快速。

關鍵詞　單孔腹腔鏡手術。