

Original Research Article

Usefulness of Hand-assisted Laparoscopic Restorative Proctocolectomy for Ulcerative Colitis in the Era of Laparoscopic Surgery - A Single-center Observational Study

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Abstract

Objectives: Hand-assisted laparoscopic surgery (HALS) combines the benefits of laparoscopic surgery with the tactile feedback from open surgery. In the current era of laparoscopic surgery, the significance of HALS as a technical transition has diminished. This study clarified the usefulness of HALS in restorative proctocolectomy (RPC) for ulcerative colitis (UC) in the era of laparoscopic surgery.

Methods: The 212 patients who underwent RPC with ileal pouch-anal anastomosis between 2007 and 2023 were included in this study. The patients were divided into three groups, open surgery (OS), HALS, and conventional laparoscopic surgery (LAP), and their characteristics, surgical outcomes, surgical complications, and functional outcomes were compared.

Results: The number of surgical techniques was OS in 21 cases, HALS in 184 cases, and LAP in 7 cases. The number of surgeons was two for OS and HALS, and four for LAP, with OS and HALS having fewer surgeons than LAP. The length of the skin incision was 13, 7, and 3 cm for OS, HALS, and LAP, respectively, and the operation times was 250, 286, and 576 minutes for OS, HALS, and LAP, respectively, with LAP having the longest operation time. The postoperative complications and function did not differ markedly among the three groups.

Conclusions: In RPC for UC, HALS involved fewer surgeons and a shorter operative time than LAP. Even in the era of laparoscopic surgery, HALS remains a useful option, especially when a shorter operation time is required or when the number of available surgeons is insufficient.

Keywords

hand-assisted laparoscopic surgery, HALS, restorative proctocolectomy, ulcerative colitis, era of laparoscopic surgery

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Introduction

Hand-assisted laparoscopic surgery (HALS) is a minimally invasive surgical technique that combines the benefits of laparoscopic surgery with the tactile feedback from open surgery[1]. The surgeon inserts one hand into the abdomen through a small incision while also using laparoscopic in-

struments to perform the surgery.

HALS has been reported to be useful in a various areas, including gastrointestinal surgery (colorectal resection[2-5], gastrectomy[6], splenectomy[7]), urology (kidney transplantation[8], nephrectomy[9]), and gynecology (hysterectomy[10]). It has also been used in restorative proctocolectomy (RPC) for ulcerative colitis (UC)[11-16]. It has been

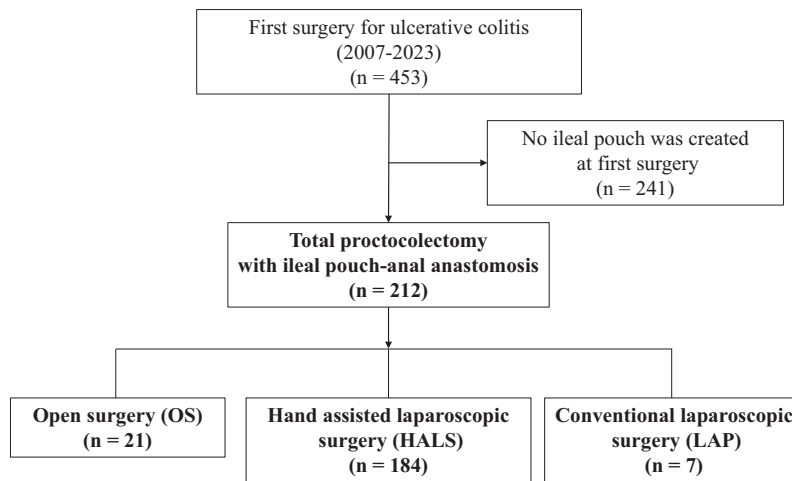


Figure 1. Flowchart of the study selection process. Cases of total proctocolectomy with ileal pouch-anal anastomosis for ulcerative colitis were performed (n = 212) were included in this study.

reported to result in a shorter wound length, less blood loss, and faster recovery than open surgery (OS)[11-14]. In addition, it is technically easier and requires a shorter operative time than conventional laparoscopic surgery (LAP)[15,16].

When HALS was first introduced, it was positioned as a technical bridge from OS to LAP because of its technical ease of introduction. However, within the current laparoscopic surgery landscape, the significance of HALS as a technical transition from open surgery to traditional laparoscopic procedures is diminishing.

To clarify the usefulness and characteristics of HALS in the era of laparoscopic surgery, we compared RPC for UC in three groups: OS, HALS, and LAP.

Methods

Ethics statement

This study complies with the provisions of the Declaration of Helsinki. All study protocols were approved by the Institutional Review Board (IRB) at Yokohama City University (F231200031). Informed consent was obtained from all patients using an opt-out procedure according to the instructions of the Yokohama City University ethics committee.

Patients

From 2007 to 2023, 453 patients underwent their first surgery for UC at our institution. Of these, 241 patients in whom the ileal pouch was not created during the first surgery were excluded, and 212 patients in who underwent total proctocolectomy (TPC) with ileal pouch-anal anastomosis (IPAA) (RPC) were included in this study (Figure 1). The patients were divided into three groups of OS, HALS, and LAP, and their characteristics, surgical outcomes, surgi-

cal complications, and functional outcomes were compared.

Outcomes

The primary endpoint was to clarify the usefulness of HALS for RPC for UC in the era of laparoscopic surgery compared with OS and LAP.

Surgical techniques

HALS

In HALS, the hand port is often placed in the umbilical region. However, in our facility, it was placed on the lower abdomen (Figure 2). This has the following advantages: part of the rectal manipulation can be performed directly, a suture device for open laparotomy can be used for anastomosis of the anorectal canal to allow deep dissection[17], and it is easy to check the reach of the ileal pouch to avoid not reaching it. For this reason, HALS is primarily performed for intra-abdominal manipulation (colonic resection). In principle, surgery is performed by two surgeons. HALS was performed as a standard procedure from 2007 to 2021.

Intra-abdominal manipulation (colonic resection)

Colonic resection via HALS in our facility is performed continuously in a counterclockwise direction without changing the surgeon's position or monitor location throughout the entire colon. The surgeon grasped and pulled the colon with the left hand and performed an incision and dissection with the right hand. The assistant operated the laparoscope with their right hand and the forceps with their left hand. In principle, the assistant's forceps provides countertraction to the traction of the main surgeon's left hand, but it was only used as needed, so the assistant could operate simultaneously with the laparoscope. Mobilization was performed first, followed by mesenteric incision. The surgical technique was similar to that of open surgery, as follows:

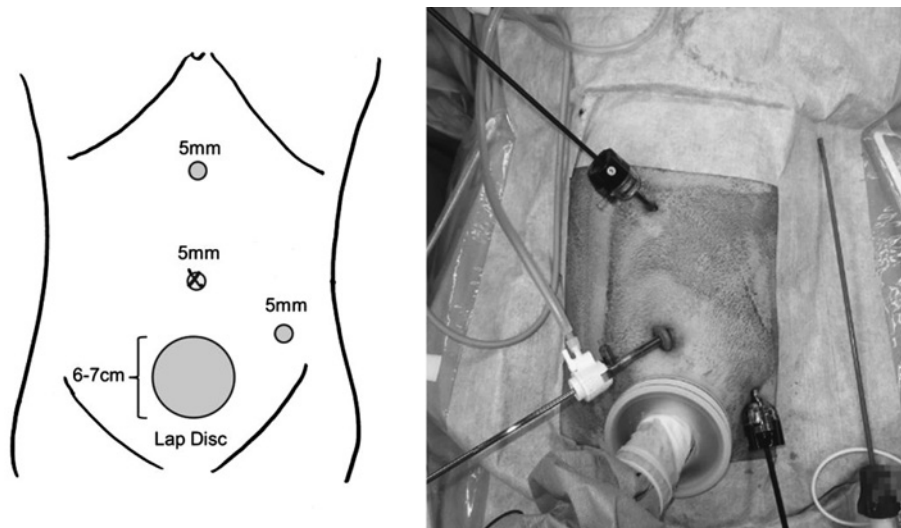


Figure 2. Port and incision placement for hand assisted laparoscopic surgery. We use three 5-mm ports in addition to a 6- to 7-cm lower longitudinal incision for the hand port.

1. Mobilization of the left colon.
2. Ligation of the branches of the sigmoid and left colic vessels.
3. Division of the mesentery is performed using the energy device.
4. Mobilization of the right colon.
5. Ligation of the branches of the middle colic vessels.

Intra-pelvic manipulation (rectal resection)

Pelvic manipulation is performed under direct vision or by inserting a laparoscope through an open abdominal wound. In 2021, the hand port was closed, and conventional laparoscopic surgery was performed. The details were as follows:

1. Mobilization of the rectum.
2. Division of the hiatal ligament (coccygeal ligament, or rectococcygeal muscle).
3. Resection of the colon and rectum with stapled closure (stapled IPAA) or with mucosal resection (handsewn IPAA).
4. Construction of a J-sharped ileal pouch and IPAA was performed.
5. Diverting ileostomy was performed in 7 of 177 patients (4%) with stapled IPAA and in all patients (100%) with handsewn IPAA.

OS

All manipulations were performed using open abdominal wounds. Open surgery was mainly performed patients with comorbidities from 2007 to 2023.

LAP

All manipulations were laparoscopically performed. The patient's position was changed each time, in the order of the left-side colon, right-side colon, transverse colon, and rectum, and the position of the surgeon was also changed. LAP

was introduced in 2021. Indications for LAP include when the patient's general condition is stable and there is sufficient time for an operation to be performed and sufficient manpower available.

Statistical analysis

Non-parametric methods were employed for the statistical analyses to compare different groups. Continuous variables are summarized using the median (range). The Kruskal-Wallis test was utilized for the analysis of variance when comparing the three groups, and multiple comparisons were adjusted using the Steel-Dwass method. Categorical variables were compared using the χ^2 test or Fisher's exact test and post-hoc confirmation was performed using the Bonferroni test. Statistical significance was considered for p-values < 0.05, except for the Bonferroni test, where p < 0.017 was deemed statistically significant.

All statistical analyses were conducted using the JMP Pro 16 software program (SAS Institute Inc., Cary, North Carolina, USA).

Results

Patients' characteristics

Patient characteristics are shown in Table 1. The surgical technique used was OS in 21 cases, HALS in 184 cases, and LAP in 7 cases.

Cancer/dysplasia was the most common indication for LAP. Therefore, in LAP, the surgical procedure was often handsewn IPAA, and diverting ileostomy was more common, the body mass index higher, the age at surgery older, and the disease duration longer than OS and HALS.

Table 1. Patients' Characteristics.

	All patients (n = 212)	OS (n = 21)	HALS (n = 184)	LAP (n = 7)	Analysis of variance p value
【Patients' characteristics】					
Sex (male/female)	128/84	12/9	111/73	5/2	0.7988
Body mass index, kg/m ² (range)	20.1 (11.3-37.1)	18.8 (14.1-28.9)	20.3 (11.3-37.1)	23.4 (19.8-31.2)	0.0049*
Age at surgery, median year (range)	41 (10-82)	46 (12-82)	41 (10-80)	59 (33-74)	0.0328*
Disease duration, median months (range)	80.5 (1-473)	83 (1-374)	72 (3-473)	176 (121-251)	0.0347*
Type of colitis (Total/Left)	200/12	19/2	175/9	6/1	0.4135
【Preoperative medical therapy】					
Steroid, cases (%)					
Total amount of prednisolone, mg (range)	4,000 (0-80,000)	3,000 (480-80,000)	4,250 (0-72,000)	1,000 (0-21,900)	0.3564
One month preoperatively, mg (range)	0 (0-2,000)	150 (0-1,320)	15 (0-2,000)	0 (0-1,000)	0.1780
Apheresis, cases (%)	105 (49.5)	11 (52.4)	93 (50.5)	1 (14.3)	0.1635
Immunosuppressive therapy, cases (%)	84 (39.6)	7 (33.3)	77 (41.9)	0 (0.0)	0.0699
Biologics, cases (%)	94 (44.3)	2 (9.5)	87 (47.3)	5 (71.4)	0.0015*
【Surgical factor】					
Surgical indication, cases (%)					
Severe	5 (2.3)	3 (14.3)	2 (1.1)	0 (0.0)	<0.0001*
Refractory to medication	163 (76.9)	16 (76.2)	146 (79.3)	1 (14.3)	
Cancer/dysplasia	44 (20.8)	2 (9.5)	36 (19.6)	6 (85.7)	
Emergency surgery, cases (%)	2 (0.9)	1 (4.8)	1 (0.6)	0 (0.0)	0.1606
ASA physical status classification system, cases (%)					
I	13 (6.1)	0 (0.0)	13 (7.1)	0 (0.0)	0.0923
II	192 (90.6)	18 (85.7)	167 (90.8)	7 (100.0)	
II E	2 (0.9)	1 (4.8)	1 (0.5)	0 (0.0)	
III	5 (2.4)	2 (9.5)	3 (1.6)	0 (0.0)	
Surgical procedure, cases (%)					
TPC with stapled IPAA	178 (84.0)	21 (100.0)	156 (84.8)	1 (14.3)	<0.0001*
TPC with handsewn IPAA	34 (16.0)	0 (0.0)	28 (15.2)	6 (85.7)	
Diverting ileostomy, cases (%)	41 (19.4)	3 (14.3)	32 (17.5)	6 (85.7)	<0.0001*

OS: Open surgery, HALS: Hand assisted laparoscopic surgery, LAP: Conventional laparoscopic surgery

ASA: American society of anesthesiologists, TPC: Total proctocolectomy, IPAA: ileal pouch-anal anastomosis

* Statistically significant p < 0.05.

Surgical outcomes

The number of surgeons was 2 (2-3) for OS, 2 (2-5) for HALS, and 4 (3-6) for LAP, with OS and HALS having fewer surgeons than LAP. The lengths of the skin incisions were 13, 7, and 3 cm for OS, HALS, and LAP, respectively, with LAP being the shortest. The operation times were 250, 286, and 576 minutes for OS, HALS, and LAP, respectively, with LAP having the longest operation time. There were no marked differences in blood loss, blood transfusion, conversion to open surgery rate, or postoperative hospital stay among the three groups (Table 2).

Surgical complications

Perioperative (within 30 days after surgery) complications and mortality were examined. Rates of postoperative complications (Clavien-Dindo grade ≥ 3) and mortality did not dif-

fer markedly among the groups (Table 3).

Functional outcomes

The postoperative function (bowel movement per day, nocturnal defecation, soiling, spotting, and difficulty in distinguishing feces from flatus) one year after ileal pouch use did not differ markedly among the groups (Table 4).

Discussion

HALS provides gentler grasping and traction than forceps, simultaneous traction and field of view deployment, more intuitive manipulation, and confirmation of the dorsal status of organs, which is a blind spot for LAP, using the tactile senses and action of the inserting hand (left hand for right-handed surgeons)[1-16].

In the present study, the characteristics of HALS were

Table 2. Surgical Outcomes.

	OS (n = 21)	HALS (n = 184)	LAP (n = 7)	Analysis of variance p value	Multiple comparison p value
Number of surgeons, median (range)	2 (2-3)	2 (2-5)	4 (3-6)	<0.0001*	OS vs LAP: <0.0001**, HALS vs LAP: <0.0001**
Length of skin incision, median cm (range)	13 (6-22)	7 (6-19)	3 (3-5)	<0.0001*	OS vs HALS: <0.0001**, OS vs LAP: <0.0001**, HALS vs LAP: <0.0001**
Operation time, median minutes (range)	250 (195-315)	286 (175-620)	576 (467-676)	<0.0001*	OS vs HALS: 0.0068**, OS vs LAP: <0.0001**, HALS vs LAP: 0.0001**
Blood loss (including ascites), median grams (range)	302 (40-673)	254 (0-2,430)	474 (155-1,787)	0.4472	
Blood transfusion, cases (%)	2 (9.5)	10 (5.4)	0 (0.0)	0.5991	
Conversion to open surgery (HALS and LAP), cases (%)	-	7 (3.8)	0 (0.0)	0.5990	
Postoperative hospital stay, median days (range)	19 (14-64)	16 (12-62)	17 (14-40)	0.0601	

OS: Open surgery, HALS: Hand assisted laparoscopic surgery, LAP: Conventional laparoscopic surgery

* Statistically significant p < 0.05.

** Statistically significant p < 0.017.

Table 3. Surgical Complications (within 30 days after surgery).

	OS (n = 21)	HALS (n = 184)	LAP (n = 7)	Analysis of variance p value
Complications (Clavien-Dindo grade 3 or more), cases (%)	4 (19.1)	17 (9.2)	2 (28.6)	0.1209
Anastomotic leakage, cases (%)	3 (14.3)	15 (8.2)	1 (14.3)	
Bowel obstruction and paralytic ileus, cases (%)	1 (4.8)	2 (1.1)	2 (28.6)	
Mortality, cases (%)	0 (0)	0 (0)	0 (0)	1.0000

OS: Open surgery, HALS: Hand assisted laparoscopic surgery, LAP: Conventional laparoscopic surgery

Table 4. Functional Outcomes (1 year after ileal pouch use).

	OS (n = 21)	HALS (n = 184)	LAP (n = 7)	Analysis of variance p value
Bowel movement per day, median (range)	9 (5-15)	8 (3-20)	7 (5-12)	0.4297
Nocturnal defecation, cases (%)	10 (47.6)	75 (40.8)	3 (42.9)	0.4432
Soiling, cases (%)	3 (14.3)	23 (12.5)	3 (42.9)	0.0681
Spotting, cases (%)	10 (47.6)	64 (34.8)	3 (42.9)	0.4524
Difficulty in distinguishing feces from flatus, cases (%)	8 (38.1)	50 (27.2)	1 (14.3)	0.4499

OS: Open surgery, HALS: Hand assisted laparoscopic surgery, LAP: Conventional laparoscopic surgery

clarified by a comparison with OS and LAP. The length of the skin incision was shortest in LAP, followed by HALS and then OS, and the operation time was shortest in OS, followed by HALS and then LAP. The advantages of HALS include a shorter skin incision than OS, shorter operation time than LAP, and the possibility of surgery being performed with fewer operators available. HALS also allows for simultaneous traction and deployment with one hand, as well as field-of-view deployment with a plane, so that one hand can work with more than two forceps. Consequently, surgery can be performed by fewer surgeons than with other

modalities. In addition, the fact that the operation is gentler and more intuitive than using forceps may contribute to shortening the operation time. The results of this study indicate that, in addition to previous reports, HALS is useful in cases when a shorter operation time is required or when the number of surgeons available is insufficient. This is not a recommendation to reduce the number of surgeons in any given situation. Surgery is safer, more reliable, and more educational when performed by a sufficient number of surgical staff. If the roles are divided, each surgeon can focus on their own role. When surgery is performed by a small num-

ber of surgeons, the roles of each surgeon are more complex and broader, and thus require more attention.

RPC for UC has the following characteristics: the view changes sequentially in multiple directions and requires many manipulations. In addition, severe colitis requires gentle traction on the vulnerable intestinal tract. Conventional laparoscopic surgery for RPC has been reported in many cases, and its usefulness has been reported in terms of cosmetics, the early recovery of the bowel function, reduced hospital stays, improved fertility, and a reduced risk of adhesive bowel obstruction[18-20]. However, a common problem in all reports is the length operation time[19]. RPC using LAP often combines operations in different areas of colorectal cancer. If each region takes slightly more time to operate, the final result is a large time extension. It is necessary to change the standing position, body position, and monitor location for each region, which also increases the operation time. In addition, inflammation of the intestinal tract and peri-intestinal area can make manipulation difficult because forceps manipulation does not provide safe and well-tensioned grasping traction of the intestinal tract. Colonic resection of our HALS is performed continuously in a counterclockwise direction without changing the surgeon's position or monitor location throughout the entire colon, which may have contributed to the time savings. The ability to quickly grasp and pull even the inflamed intestine in a friendly manner may also contribute to a safe and rapid surgical progression. To reduce the operation time for conventional laparoscopic surgery, in addition to mastering the technique, it would be desirable to establish a surgical procedure specific to RPC for UC.

There are increasing numbers of reports of robotic surgery for RPC[18,21,22]; however, thus far, many of these reports have only been described procedures performed for intrapelvic manipulation and have used LAP or HALS for the intra-abdominal manipulation[21]. Currently, robotic surgery is not yet fully adapted to surgeries in which the field of view changes sequentially in multiple directions. The further spread of using robots that can respond in multiple directions without redocking is awaited.

In the case of UC, colorectal perforation, massive bleeding, and toxic megacolon are often treated by emergency surgery, and it is desirable to shorten the operation time. Additionally, the number of surgeons is often limited in emergency situations. Although this study did not demonstrate the usefulness of HALS in emergency surgery, we believe it is theoretically useful in terms of the operation time and the number of surgeons.

The present study found no marked difference in the frequency of postoperative complications or defecation function among the three techniques in terms of the long-term prognosis. Therefore, no single technique is best, and it is important to use each technique according to the patient's condi-

tion, surgeon's experience, number of surgeons, and operating room availability, taking advantage of the merits of each technique. In the case of RPC for UC, HALS seems to be effective in cases of severe intestinal inflammation, obesity, emergency situations, and technical difficulty of LAP, as well as in cases where a shorter operation time is required, or the number of surgeons is limited.

Several limitations associated with the present study warrant mention. This was an observational study and not a randomized controlled trial. Therefore, there was no equal grouping of patients. As HALS was the standard technique in this study period, the number of OS and LAP cases was markedly fewer. There was also a bias in patient background, which may have influenced the outcome of each surgical procedure owing to differences in surgical indications. Since LAP is a newly introduced technique, it is anticipated that experience will improve the results in the future. Therefore, we cannot deny that there are concerns regarding the statistical reliability of this study. However, since it is no longer realistic to distribute these procedures equally and accumulate them prospectively, we believe that it is worthwhile to compare each procedure even if the statistical problems involved.

Conclusion

In RPC for UC, HALS had a shorter wound length than OS and fewer surgeons and a shorter operative time than LAP. Even in the era of laparoscopic surgery, HALS remains a useful option, especially when a shorter operation time is required or when the number of available surgeons is insufficient. Surgical methods should be selected depending on the patient's condition and hospital situation.

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Conflicts of Interest

There are no conflicts of interest.

Author Contributions

Conception and design: H Kimura

Data acquisition, analysis, and interpretation: H Kimura

Drafting the article: H Kimura

Critical revision of the article: H Kimura, K Toritani, I

Endo

Final approval of the article: H Kimura, K Toritani, I Endo

Approval by Institutional Review Board (IRB)

All study protocols were approved by the Institutional Review Board at Yokohama City University (F231200031).

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