

# Hybrid Hand-Assisted Colectomy for Transverse Colon Cancer: A Useful Technique for Non-Expert Laparoscopic Surgeons

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## Abstract

**Background** Laparoscopic assisted colectomy (LAC) is commonly performed, but LAC for transverse colon cancer is a complex procedure, even in the hands of experts. In particular, laparoscopic take-down of the splenic and/or the hepatic flexure and dissection of the lymph nodes around the middle colic vessels are extremely complicated maneuvers compared to the complexity of these procedures during open surgery. We herein describe a simple and less-invasive technique for performing hybrid hand-assisted laparoscopic colectomy (hybrid-HALC). This procedure combines the established convenient and safe techniques of open surgery with the less invasive hand-assisted laparoscopic approach.

**Methods** From 2000 to 2007, 22 patients with transverse colon cancer underwent hybrid-HALC at our facility. Short-term outcomes of hybrid-HALC were retrospectively compared with those of LAC over the same period and with those of conventional open surgery as a historical control.

**Results** The intraoperative and postoperative data indicating the short-term outcomes of the hybrid-HALC group were better than those of conventional open surgery and similar to those of the LAC group; the mean operative time for hybrid-HALC was 40 min shorter than that for LAC.

Furthermore, the reduction in the operative time in the hybrid-HALC group was more prominent in the case of non-expert surgeons.

**Conclusions** We conclude that hybrid-HALC for transverse colon cancer is a feasible, convenient, and less-invasive technique, and that it is a useful alternative, especially for non-expert laparoscopic surgeons.

## Introduction

Straight laparoscopic assisted colectomy (LAC) for colon cancer is reported to be less invasive than open surgery (as reflected by less postoperative pain and shorter hospital stay) [1–4]. Some studies have suggested that LAC can yield the same oncological outcomes as open surgery, even in patients with advanced colon cancer [1, 3]. However, these studies excluded all patients with transverse colon cancer. This indicates that laparoscopic surgery for transverse colon cancer is a highly difficult technique, even for expert laparoscopic surgeons.

With the laparoscopic approach, it is very troublesome to accomplish treatment of the middle colic vessels, division of the greater omentum, and mobilization of the hepatic and/or splenic flexure. Furthermore, the use of straight LAC in the treatment of transverse colon cancer is a daunting task for many surgeons. To perform these procedures safely while maintaining the minimal invasiveness of LAC, we have used hybrid hand-assisted laparoscopic colectomy (hybrid-HALC), in which lymphadenectomy is performed through a small incision and mobilization of the intestine is achieved by a hand-assisted procedure. In this study, we describe the method of hybrid-HALC and compare the usefulness of this technique with straight LAC and with conventional open surgery.

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## Patients and methods

The subjects were patients with transverse colon cancer who underwent hybrid-HALC (22 patients) or straight LAC (19 patients) at our facility from 2000 to 2007. In addition, 33 patients who underwent conventional open transverse colectomy between 1995 and 2000 were considered as a historical controls and were compared with the other two groups. Operative time, estimated blood loss, and complications during the early postoperative period were retrospectively compared among the groups. Additionally, the hybrid-HALC and LAC groups were further divided on the basis of the experience of the operating surgeons: expert laparoscopic surgeon (certified by the Japanese Society of Endoscopic Surgery [JSES] [5]) and non-experts (those not certificated by JSES), and the operative time and estimated blood loss were compared between these two subgroups. In this retrospective analysis, the patients were randomly assigned to either the expert group or the non-expert group. Table 1 shows the background of the patients.

Data were analyzed with the StatView 5.0 software package. The nonparametric Kruskal–Wallis test was used to compare discrete and continuous variables between the three groups. In cases where the *p* value was less than 0.05, a post-hoc analysis using the Mann–Whitney *U*-test was subsequently performed to compare each group. Either the

chi-square test or Fisher's exact test was used to compare categorical or dichotomous variables of the three groups, whenever appropriate.

### Hand-assisted device

We used the GelPort Laparoscopic System (Applied Medical Resources, Rancho Santa Margarita, CA) in the performance of hybrid-HALC. This system consists of an Alexis wound retractor and a GelPort system.

### Surgical technique

Under general anesthesia, the patients were placed in the modified lithotomy position. First, minilaparotomy was performed through a midline incision. The lower edge of the pancreas was identified from a preoperative computed tomography (CT) scan, and an incision was made in that region to allow easy access to the root of middle colic vessels. The Alexis wound retractor was applied to the minilaparotomy site, the wound was protected, and the operative field was secured. Subsequently, the transverse colon was exteriorized through the small incision, and the greater omentum was dissected from the transverse colon as much as possible. The transverse colon was returned to the peritoneal cavity and displaced caudally, and the stomach and greater omentum were displaced cranially to

**Table 1** Characteristics of patients

	HALC	LAC	Open (historical control)	<i>p</i> value*	<i>p</i> value**	<i>p</i> value***
No. of patients	22	19	33			
Age, years	64 (33–91)	58 (36–94)	66 (29–84)	0.35	–	–
Sex, male/female	14:8	9:10	15:18	0.39	–	–
Body mass index	21.7 (16.8–25.6)	21.6 (17.2–25.7)	21.5 (16.8–26.7)	0.95	–	–
Stage				0.21	–	–
I	12	14	13			
II	4	2	8			
III	5	3	12			
IV	1	0	0			
Lymphadenectomy				0.19	–	–
D1	2	3	7			
D2	13	15	21			
D3	7	1	5			
Surgeon						
Expert	11	10	–			–
Non-expert	11	9	–			–

HALC hand-assisted laparoscopic colectomy, LAC laparoscopy-assisted colectomy

All values are median (range)

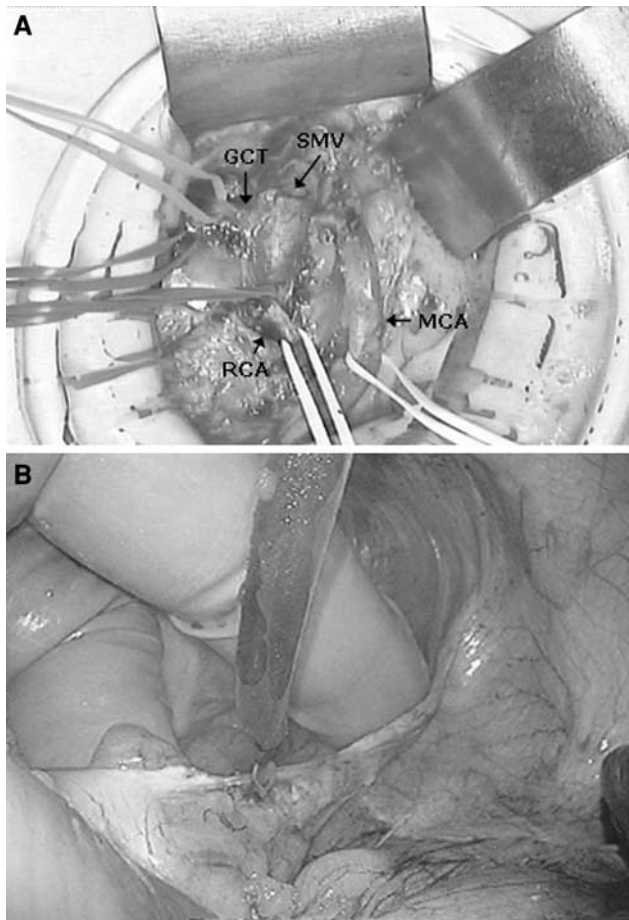
\* For HALC versus LAC versus Open

\*\* For HALC versus LAC

\*\*\* For HALC versus Open

expose the mesentery of the transverse colon. This procedure provided a favorable visual field, and the root of the middle colic vessels could be easily dissected using the techniques of open surgery (Fig. 1a). In some cases, Deaver retractors were used to hold the small bowel and omentum outside the operative field. After performing lymphadenectomy, we adopted hand-assisted surgery to mobilize the rest of the colon. A trocar was safely inserted under direct vision from the minilaparotomy site. The GelPort system was used to establish pneumoperitoneum, and after an additional trocar was inserted, the residual greater omentum was divided, and the relevant part of the colon was mobilized (Fig. 1b). Hybrid-HALC was generally performed using two trocars, but an additional trocar was used, if necessary.

After mobilization of the colon was completed, division of the colonic mesentery and hand-sewn anastomosis were performed extracorporeally; no drain was placed.



**Fig. 1** **a** Lymph node dissection at the origin of the middle colic vessels via mini-laparotomy. *SMV* superior mesenteric vein, *MCA* middle colic artery, *GCT* gastrocolic trunk, *RCA* right colic artery. **b** Mobilization of the colon using hand-assisted technique via mini-laparotomy

## Results

There were no differences in the backgrounds of the patients in the three groups studied (Table 1). Table 2 shows the intraoperative and postoperative results. Among the 22 patients treated with hybrid-HALC, there were no instances of open conversion or any intraoperative complications. The mean operative time for hybrid-HALC (213 min) was significantly longer than the time for open surgery (175 min;  $p < 0.01$ ), whereas it was significantly shorter than the time for straight LAC (255 min;  $p = 0.03$ ). No significant difference was observed in the estimated blood loss between hybrid-HALC (58 g) and straight LAC (30 g); however, the blood loss in hybrid-HALC was significantly less than that in open surgery (110 g;  $p = 0.04$ ). As expected, the incision length was longer in the case of hybrid-HALC (7 cm) than in the case of straight LAC (5 cm;  $p < 0.01$ ). However, no significant difference was noted in the total dose of intravenous analgesics used after surgery, time of first flatus, or length of postoperative hospital stay between the hybrid-HALC and straight LAC groups. With regard to complications, no difference was observed in the rate of complications between the three groups, although the rate was higher in the conventional open surgery group. Wound infection was observed in 4 patients of the open surgery group (12.1%) and 1 patient each of the hybrid-HALC (4.5%) and straight LAC (5.3%) groups. Small bowel obstruction was observed in 2 patients in the open surgery group (6.1%) and in 1 patient in the hybrid-HALC group (4.5%). Intra-abdominal hemorrhage occurred in 1 patient in the LAC group. However, all the patients recovered after the administration of conservative treatment.

The expert surgeon required 200 min and 216 min to perform hybrid-HALC and straight LAC, respectively, whereas the corresponding times for the non-experts were 221 min and 275 min. The difference in the operative time between the expert and non-experts was 27% in the straight LAC group, but this was decreased to 10% in the hybrid-HALC group. The estimated blood loss did not differ between the expert and non-experts in either the hybrid-HALC group or the straight LAC group.

One patient in the hybrid-HALC group died of liver metastasis at 42 months of the median follow-up time for this group. Thus far, there have been no cases of recurrence in the straight LAC group.

## Discussion

Since Jacobs et al. first reported about LAC in 1991[6], this procedure has been used for a variety of conditions such as benign diseases and colon cancer. Some studies on LAC

**Table 2** Intraoperative and postoperative results

	HALC	LAC	Open (historical control)	<i>p</i> value*	<i>p</i> value**	<i>p</i> value***
No. of patients	22	19	33			
Operative time (min)	213 (139–364)	255 (185–640)	175 (90–340)	<0.01	0.03	0.01
Expert	200	216	–			
Non-experts	221	275	–			
Estimated blood loss (g)	58 (10–330)	30 (0–300)	110 (15–700)	<0.01	0.08	0.04
Expert	65	35	–			
Non-experts	50	30				
Incision length (cm)	5 (5–10)	7 (4–8)	16 (11–22)	<0.01	<0.01	<0.01
Time of first flatus (days)	3 (1–5)	2 (1–4)	4 (2–6)	<0.01	0.06	0.02
Use of analgesic (times)	1 (0–4)	0 (0–4)	2 (0–4)	<0.01	0.10	0.02
Postoperative hospital stay (days)	15 (8–32)	13 (8–35)	22 (10–51)	0.01	0.13	0.16
Complications	2 (9.1%)	2 (10.5%)	6 (18.2%)	0.57	–	–
Wound infection	1	1	4			
Small bowel obstruction	1	0	1			
Intra-abdominal hemorrhage	0	1	0			
Pneumonia	0	0	1			

All values are median (range)

\* For HALC versus LAC versus open

\*\* For HALC versus LAC

\*\*\* For HALC versus open

for colon cancer have shown that LAC is less invasive than open surgery, with the same oncological outcomes [1–3]. However, unlike laparoscopic cholecystectomy, LAC is far from widespread in clinical settings. The reasons for this are long operative time, the requirement of complicated techniques because of the lack of tactile feedback, the loss of normal stereoscopic vision, and inadequate exposure.

To solve the problems associated with LAC, hand-assisted laparoscopic surgery (HALS) was developed [7, 8]. The HALS procedure made it possible for the non-experts who had not acquired proficiency in laparoscopic surgery to perform a procedure that was less invasive than straight LAC after a shorter learning period, but still allowing tactile feedback by means of inserting the hand. We improved the technique of HALS and newly developed hybrid-HALC, in which minilaparotomy was performed for lymph node dissection and HALS was subsequently performed for mobilization of the intestine. We thought that hybrid-HALC might be particularly useful in the treatment of transverse colon cancer, as the treatment of this condition by LAC requires mastery of highly complex techniques.

Laparoscopic lymphadenectomy around the middle colic vessels, which have a variety of vessel branches, is an extremely difficult maneuver because of the anatomic features of this region, but it can be safely performed using the techniques of conventional open surgery during hybrid-HALC. In addition, the hepatic and splenic flexures, which

tend to obstruct the visual field in minilaparotomy, can be safely mobilized by HALS.

In this study, hybrid-HALC performed for transverse colon cancer reduced the operative time without affecting recovery, as compared with LAC. Although this study was retrospective and the open surgery group was a historical control, there were clear short-term advantages of hybrid-HALC over conventional open transverse colectomy.

Some investigators have suggested that minilaparotomy be used for all surgical procedures for colon cancer [9]. However, for this procedure, the minilaparotomy site has to be manipulated from right to left, and up and down to secure the operative field, which may damage the incision site and increase the invasiveness of this procedure. Furthermore, acute bleeding that occurs during this procedure is difficult to treat. Especially in the cases of transverse colon cancer, surgery on the splenic flexure is associated with a risk of bleeding, and HALS might be a safer and easier operation because of the favorable visual field it affords.

The GelPort Laparoscopic System is useful for performing hybrid-HALC. This system includes an Alexis wound retractor and a GelSeal cap. The GelSeal cap can be easily attached and removed, and it enables smooth transitions from minilaparotomy to HALS and from HALS to minilaparotomy. It has been reported that the Alexis wound retractor is effective for the prevention of surgical-site infection [10]. Furthermore, because the GelSeal cap is

airtight, pneumoperitoneum can be maintained even when the surgeon inserts or removes his/her hands. This too facilitates the performance of HALS.

In our study, because the number of subjects was small and the observation period was short, we could not assess the oncological validity. As already mentioned, patients with transverse colon cancer have been excluded from all of the randomized controlled trials (RCTs) published to date on LAC for colon cancer. In a single-center study, patients of transverse colon cancer treated by LAC showed the same morbidity and oncological outcomes as those with colon cancer of other areas treated by LAC [11]. An RCT on LAC for the treatment of transverse colon cancer is expected in the near future.

As previously described, it is very difficult even for experts to perform straight LAC for transverse colon cancer. On the other hand, our newly developed hybrid-HALC, which involves the techniques of conventional open surgery and is as minimally invasive as LAC, could be easily mastered even by surgeons who are not experts in laparoscopic surgery. Our results showed that hybrid-HALC tended to shorten the difference in the operative time between experts and non-experts. Although operative time alone is not an indicator of the adequacy of the operation, because the estimated blood loss was similar and the operative time was shorter for hybrid-HALC than for LAC, we believe that hybrid-HALC is a useful less-invasive operative technique, that could be especially valuable when performed by a non-expert surgeon.

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