Longterm Complications of Hand-Assisted Versus Laparoscopic Colectomy

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BACKGROUND: Hand-assisted laparoscopic surgery (HALS) requires a larger incision compared with standard laparoscopic surgery (SLS). Whether this leads to more longterm complications, such as incisional hernia (IH) and small bowel obstruction (SBO), has not been studied to date. This study compares the rates of SBO and IH after HALS and SLS in patients undergoing operations for colon and rectal diseases.

STUDY DESIGN: From a colorectal database, 536 consecutive patients were identified who underwent bowel resection using HALS (n = 266) and SLS (n = 270) between 2001 to 2006. All medical records were reviewed, and all subjects were contacted by telephone for accurate followup. Statistical analysis was performed using chi-square, Fisher's exact, and Mann-Whitney U tests, where appropriate.

RESULTS: Median followup was 27 months (range 1 to 72 months). Overall conversion rate was 2.2% (SLS, n = 4; HALS, n = 8). Median incision size in HALS (75 mm; range 60 to 140 mm) was larger than SLS (45 mm; range 30 to 130 mm; $p < 0.01$). Despite the larger wound, the incidence of IH was similar between both approaches (HALS, n = 16 [6.0%] versus SLS, n = 13 [4.8%]; $p < 0.54$). Rate of SBO was also comparable (HALS, n = 11 [4.1%] versus SLS, n = 20 [7.4%]; $p = 0.11$). Wound infections occurred similarly between both groups (HALS, n = 18 [6.8%]; SLS, n = 13 [4.8%]; $p = 0.33$). Converted patients had a higher rate of IH compared with nonconverted ones (25% versus 5%; $p = 0.02$), although the rate of SBO was similar (8.3% versus 5.7%; $p = 0.51$).

CONCLUSIONS: HALS does not lead to more longterm complications of IH and SBO when compared with SLS for resections of the colon and rectum. (J Am Coll Surg 2009;208:62–66. © 2008 by the American College of Surgeons)

Use of laparoscopic techniques to treat colon and rectal diseases, both benign and malignant, is becoming increasingly common. Both standard laparoscopic surgery (SLS) and hand-assisted laparoscopic surgery (HALS) are used for resection of the colon and rectum. HALS involves creation of a small incision at the beginning of the operation, through which a hand is inserted to assist in dissection of the bowel, and through which specimen extraction and anastomosis are performed. This is in contrast with SLS, where mobilization of the bowel is accomplished with laparoscopic tools only, and a minilaparotomy is created for the purpose of specimen extraction and anastomosis (when appropriate).

Although there are several theoretic advantages to HALS, such as restoration of spatial orientation and the ability to perform a complex laparoscopic operation with minimal assistance, the main benefit of HALS as compared with SLS is that it can shorten operative time. Although the first two randomized studies comparing HALS and SLS in segmental colectomy did not show a substantial time difference,[1,2] HALS demonstrates substantially shorter operative times in more complex operations, such as total colectomy.[3,4] In a previous study from our institution, use of HALS in complex diverticulitis not only led to a shorter length of operation compared with SLS, it substantially lowered the conversion rate as well.[5] In a recently completed multi-institutional randomized prospective study of HALS and SLS, operative time was improved substantially in both segmental and total colectomy by use of HALS.[6] Despite the slightly larger incision required in HALS, all previous randomized studies have demonstrated similar

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Abbreviations and Acronyms

HALS = hand-assisted laparoscopic surgery
IH = incisional hernia
LOA = lysis of adhesions
SBO = small bowel obstruction
SLS = standard laparoscopic surgery
WI = wound infection

short-term outcomes after colectomy between HALS and SLS in terms of return of gastrointestinal function and length of hospitalization.[1,2,6]

Use of HALS to perform colon and rectal resections still remains controversial. Some surgeons believe it is unnecessary, and others believe it is helpful in easing the learning curve of a difficult operation. Longterm effects of the larger incision compared with conventional laparoscopy (and of the hand inside the abdomen) are largely unknown. Does HALS lead to a higher incidence of incisional hernia (IH) compared with SLS? Is the rate of small bowel obstruction (SBO) higher in HALS, as a result of increased postoperative adhesions? Our study was undertaken to compare longterm complication rates (IH and SBO) between SLS and HALS in colon and rectal surgery.

METHODS

Using a prospective colorectal surgery database, 536 consecutive patients were identified who underwent segmental colectomy, proctectomy, or total colectomy/proctocolectomy using both HALS (n = 266) and SLS (n = 270) between 2001 and 2006. Our practice of laparoscopic surgery evolved during the study period, with our initial experience using only SLS. In 2003, HALS was incorporated into our practice and used for cases of sigmoid colectomy and total colectomy. Right colectomies were performed preferentially using SLS because insertion of the hand seemed obstructive rather than helpful, except in complex Crohn's disease, such as with an ileosigmoid fistula. Placement of the hand-assist device (GelPort; Applied Medical) was in the lower abdomen, mostly as a Pfannenstiel incision (and occasionally a low midline incision) for left and total colectomies. Proctectomy in HALS was performed either laparoscopically with the hand outside of the abdomen, or through the low abdominal wound using open techniques after laparoscopic vascular ligation and splenic flexure mobilization, according to surgeon preference.

All patients undergoing elective colectomy were given a standardized mechanical bowel preparation without oral antibiotics, except in cases of a partial bowel obstruction, where bowel distention would be an issue, or in the case of fulminant colitis, where bowel preparation was omitted. All patients were administered intravenous antibiotics in the operating room before creation of an incision. Wound protectors were used routinely during specimen extraction and anastomosis, whether by SLS or HALS. Incisions were closed according to surgeon preference; the fascia of a midline minilaparotomy was closed by either running monofilament or interrupted absorbable sutures, and the fascia of the Pfannenstiel was closed using a running monofilament suture.

After IRB approval, all inpatient and outpatient medical records were reviewed retrospectively, and all patients were telephoned for accurate followup data. Telephone interviews were conducted by one surgeon using an IRB-approved standardized questionnaire and, overall, 96% of patients or families were successfully contacted.

Incisional hernias were diagnosed clinically by patient history and physical examination. Patients who did not have recent followup at our institution were asked on telephone interview if they had a known IH or bulging of the wound. If an affirmative answer was given, they were questioned again if another physician confirmed the presence of an IH. Only then was the patient considered to have an IH. Patients with an incidental hernia on CT scan without complaint or evidence of a hernia on physical examination were not included. Peristomal hernias were excluded from this evaluation as well.

SBO was defined as intolerance of oral intake with distention, together with radiographic evidence of an intestinal obstruction. All patients with longterm SBO required at least hospitalization and observation.

Conversion in SLS was defined as any unplanned and premature creation of an incision to complete dissection of the bowel, and conversion in HALS was defined as any extension of the hand-port incision by $\geq$ 2 cm, either laterally or vertically.

Nonparametric statistical analysis was performed using chi-square test, Fisher's exact test, and Mann-Whitney U test, where appropriate, using the program SPSS 11.0 (SPSS, Inc).

RESULTS

A total of 536 patients (279 men and 257 women) were analyzed. Median age was 57 years (range 18 to 96 years). Median followup was 27 months (range 1 to 72 months). The comparison of demographic data and short-term outcomes is seen in Table 1. Malignant disease was found in 224 patients. The distribution of diagnoses in HALS and SLS is seen in Table 2. Median incision size was longer in HALS (75 mm, range 60 to 140 mm) compared with SLS (45 mm, range 30 to 130 mm); $p < 0.01$. Overall conversion rate to open operation was 2.2% (SLS, n = 4; HALS,

Table 1. Demographics and Short-Term Outcomes

	HALS (n = 266)	SLS (n = 270)	p Value*
Median age (y), range	56 (19–93)	58 (18–96)	NS
Female gender, n	114	143	NS
Median body mass index, range	25.3 (16–50)	24.7 (14.2–65)	NS
Median ASA classification, range	2 (1–4)	2 (1–4)	NS
Median incision size (mm), range	75 (60–140)	45 (30–130)	<0.01
Median operative time (min), range	225 (100–575)	180 (60–435)	<0.01
Median postoperative length of stay (d), range	6 (2–129)	5 (3–129)	<0.01
Conversion, n (%)	8 (3)	4 (1.5)	NS

*$p < 0.05$; Mann-Whitney U test.
ASA, American Society of Anesthesiologists; HALS, hand-assisted laparoscopic surgery; SLS, standard laparoscopic surgery.

n = 8), similar between the two groups (p = 0.23). Rate of wound infection (WI) was similar between the two approaches, 6.8% in HALS (n = 18) and 4.8% in SLS (n = 13); p = 0.33.

Longterm complications

Rate of IH was similar between both groups, 6.0% in HALS (n = 16) compared with 4.8% in SLS (n = 13); p = 0.54 (Table 3). Of the patients in whom IH developed, 62% ultimately underwent hernia repair. There was no difference in the rate of operation for IH in both groups (HALS 62.5%, SLS 61.5%).

Rate of SBO was no different between the two methods (HALS, n = 11 [4.1%] versus SLS, n = 20 [7.4%]; p = 0.11). For patients who presented with a postoperative SBO, 61% (n = 19) required operations. There was no difference in the rate of operations between HALS (54%) and SLS (65%). Of the six patients who required operations for a bowel obstruction after HALS, one was treated with laparoscopic lysis of adhesions (LOA) alone, and two patients had open LOA and three required bowel resection (one laparoscopic-assisted, two open). Of the 13 patients who required operations for a bowel obstruction after SLS, 4 underwent laparoscopic LOA, and 5 required open LOA, and 4 underwent bowel resection (3 laparoscopic-assisted, 1 open). Overall, the ability to treat a bowel obstruction with a simple laparoscopic LOA was low whether the index procedure was performed using SLS (31%) or HALS (17%).

We evaluated outcomes of patients who were converted to open operation. Converted patients (n = 12) had an increased rate of IH (25%) compared with nonconverted patients (5%); p = 0.02. Rates of SBO in converted patients were similar to nonconverted patients (8.3% versus 5.7%, respectively; p = 0.52). Incidence of WI was not statistically different between the two groups (converted 16.6% versus nonconverted 5.5%; p = 0.15) (Table 4). Mean wound size in converted patients was 123.3 ± 7.8 cm, compared with 62.9 ± 17.7 cm for nonconverted patients (p = 0.001). On logistic regression analysis, incision size did not significantly correlate with IH (p = 0.13; odds ratio [OR]: 1.014; 95% CI, 0.996 to 1.033) or with WI (p = 0.38; OR: 1.008; 95% CI, 0.990 to 1.026). There was a significant correlation between WI and IH (p = 0.01;OR: 3.85; 95% CI, 1.361 to 10.917), signifying that a postoperative WI was predictive of an IH in the future.

From our anecdotal experience, it was our impression that Pfannenstiel incisions had fewer complications compared with midline minilaparotomies, and we evaluated the wound site to see if there was a difference in the rate of wound complications and SBO. The most common incision in HALS was the Pfannenstiel (91%) and in SLS it was

Table 2. Indications for Surgery

	HALS (n = 266)	SLS (n = 270)
Colon cancer	36	87
Rectal cancer	89	12
Benign polyp	6	31
Diverticulitis	55	40
Ulcerative colitis	52	21
Crohn's disease	14	53
Other	14	26

HALS, hand-assisted laparoscopic surgery; SLS, standard laparoscopic surgery.

Table 3. Long- and Short-Term Complications

	HALS (n = 266)		SLS (n = 270)		
	n	%	n	%	p Value*
Incisional hernia	16	6	13	4.8	0.54
SBO	11	4.1	20	7.4	0.10
Wound infection	18	6.8	14	4.8	0.33
Anastomotic leak	16	6	13	4.8	0.14

*$p < 0.05$ Mann-Whitney U test.
HALS, hand-assisted laparoscopic surgery; SBO, small bowel obstruction; SLS, standard laparoscopic surgery.

Table 4. Complications in Converted and Nonconverted Patients

	Converted (n = 12)		Nonconverted (n = 524)		p Value*
	n	%	n	%	
Small bowel obstruction	1	8.3	30	5.7	0.51
Hernia	3	25	26	5	0.02
Wound infection	2	16.7	29	5.5	0.15

*$p < 0.05$ Fisher's exact test.

the midline minilaparotomy (49%). Incisions placed in the midline did not have increased rates of WI (6.6%) or IH (7.9%) compared with Pfannenstiel incisions (WI 6.3%, IH 5.0%; $p = 0.91$ and 0.22, respectively). Incidence of SBO was similar between Pfannenstiel wounds (6.3%) and midline wounds (6.6%); $p = 0.91$.

Finally, the number of patients with either longterm complications (ie, IH or SBO) was compared to the best answer to the question of whether HALS leads to an increase in any longterm complication. This revealed no significant difference between HALS (n = 27 [10.2%]) versus SLS (n = 29 [10.6%]; $p = 0.82$). In the SLS group, four patients had both IH and SBO, but in this analysis the number of patients with either complication was compared instead of the number of events.

DISCUSSION

Although use of laparoscopy for colon and rectal diseases is becoming more common, it remains a difficult operation with a substantial learning curve. Insertion of the hand during laparoscopy can restore spatial orientation and help surgeons accomplish this complex operation, and appears well-suited for colorectal resections that require an incision for resection and extracorporeal anastomosis. Three randomized prospective studies that compare HALS with conventional open colorectal surgery exist to date. Two single-institution studies of segmental colectomies demonstrated a faster recovery of gastrointestinal function and shorter length of hospitalization with HALS compared with open surgery.[7,8] One randomized trial that did not show an improvement in postoperative recovery was in the setting of restorative proctocolectomy. This might have been because of the complexity of the operation and the postoperative management, which included clear liquids for 5 days in all patients without diversion.[9]

The role of HALS in colorectal diseases remains controversial, and surgeons competent in laparoscopic surgery debate whether it helps or hinders, or whether it is necessary or unnecessary. Despite a larger incision size, studies to date reveal similar short-term recovery between HALS and SLS.[1-6,10] Benefits in operative time and conversion rates have been realized, especially in complex operations, by insertion of the hand (complex diverticulitis and total colectomy).[3-6] The most compelling study favoring HALS to date is a recently completed randomized, prospective multi-institutional study (Minimally Invasive Therapeutic Trial) that compared use of HALS and SLS in left segmental colectomy and total colectomy. In this study of 95 patients, where operative time was the primary end point, a 28-minute time conservation was noted with HALS in left colectomies, and a 51-minute improvement was seen in total colectomies by insertion of the hand. Despite an increased incision size with HALS (8.2 cm versus 6.1 cm; $p < 0.01$), the pain scores and postoperative recovery (days to flatus and length of hospitalization) were similar in both groups.[6]

Although there appears to be no obvious short-term disadvantage to HALS compared with SLS (aside from wound size), the longterm impact of creating a slightly larger incision and inserting a hand into the abdomen has not yet been evaluated. The primary purpose of our study was to compare longterm complication rates, ie, IH and SBO, between SLS and HALS. The results of our study suggest that HALS could be used without the concern of increased longterm complications, as the incidences of both IH and SBO were similar between both methods. In addition, rates of infectious complications, such as WI and anatomotic leak, were similar in both groups. When bowel obstructions occurred, we found that the rate of reoperation was similar between SLS and HALS, and the ability to treat these obstructions with simple laparoscopic LOA alone was $\leq 30\%$ in both groups.

Our analysis of wound complications by wound location was interesting, as our general impression was that Pfannenstiel incisions had a lower rate of wound complications compared with midline incisions. We found that midline wounds were no worse than the Pfannestiel incision with regard to WI and IH and SBO.

The main criticism of this study is that it is uncontrolled, and that there is bias in the groups compared. Indeed, more patients undergoing left colectomy, proctectomy, and total colectomy had HALS, and the majority of patients with right-sided pathology underwent SLS. Patients with ulcerative colitis and rectal cancer preferentially underwent HALS, although more patients with colon cancer and Crohn's disease underwent SLS (Table 2). The fact that a longer median operative time was seen in HALS is indicative of the fact that more difficult and more extensive operations were performed with HALS compared with SLS. Despite this, there was no longterm disadvantage in HALS.

To control for the disparity in diagnoses, a subset analysis was performed of diverticulitis alone, where one pro-

cedure was compared (sigmoid colectomy) and the number of cases of HALS and SLS were similar (HALS, n = 54 versus SLS, n = 41; p = 0.12). Even in this subset analysis, the rate of IH (HALS, n = 1 [1.9%] versus SLS, n = 0; p = 0.38) and SBO (HALS, n = 2 [3.8%]; SLS, n = 1 [2.4%]; p = 0.72), were similar between the two approaches. An evaluation of longterm complications in the previously mentioned Minimally Invasive Therapeutic Trial (a randomized prospective multi-institutional study) would be helpful in verifying our study's primary outcomes.

Another criticism of this study is its relatively short followup. Our median followup was 27 months and, because HALS was incorporated into our practice later in the study period, the length of followup was different between the two groups (median 24 months in HALS versus 34 months in SLS). This is more likely to affect the incidence of SBO than IH, as episodes of bowel obstruction can occur several years after operation. There would be merit in longer followup of this patient population with regard to this.

The value of this study is in the large number of patients evaluated and the reliable longterm followup, as 96% of patients (or family) were successfully contacted by telephone.

In this analysis, we found no discouraging longterm outcomes with the hand-assisted laparoscopic method in performing resections of the colon and rectum. Combined with successful short-term outcomes (similar to SLS) and the potential time conservation in both left/sigmoid colectomies and total colectomies, its continued use, especially in complex operations, should be encouraged.

Author Contributions

Study conception and design: Sonoda, Pandey, Trencheva, Lee, Milsom
Acquisition of data: Pandey
Analysis and interpretation of data: Sonoda, Pandey, Trencheva, Lee, Milsom
Drafting of manuscript: Sonoda
Critical revision: Pandey, Trencheva, Lee, Milsom

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