

Controversy of hand-assisted laparoscopic colorectal surgery

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Author contributions: Meshikhes AWN solely contributed to this paper.

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Received: July 15, 2010 Revised: August 18, 2010

Accepted: August 25, 2010

Published online: December 7, 2010

Abstract

Laparoscopically assisted colorectal procedures are time-consuming and technically demanding and hence have a long steep learning curve. In the technical demand, surgeons need to handle a long mobile organ, the colon, and have to operate on multiple abdominal quadrants, most of the time with the need to secure multiple mesenteric vessels. Therefore, a new surgical innovation called hand-assisted laparoscopic surgery (HALS) was introduced in the mid 1990s as a useful alternative to totally laparoscopic procedures. This hybrid operation allows the surgeon to introduce the non-dominant hand into the abdominal cavity through a special hand port while maintaining the pneumoperitoneum. A hand in the abdomen can restore the tactile sensation which is usually lacking in laparoscopic procedures. It also improves the eye-to-hand coordination, allows the hand to be used for blunt dissection or retraction and also permits rapid control of unexpected bleeding. All of those factors can contribute tremendously to reducing the operative time. Moreover, this procedure is also considered as a hybrid procedure that combines the advantages of both minimally invasive and conventional open surgery. Nevertheless, the exact role of HALS in colorectal surgery has not been well defined during the advanced totally laparoscopic procedures. This article

reviews the current status of hand-assisted laparoscopic colorectal surgery as a minimally invasive procedure in the era of laparoscopic surgery.

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Key words: Colorectal surgery; Laparoscopic assisted colorectal surgery; Hand assisted laparoscopic colorectal surgery

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Meshikhes AWN. Controversy of hand-assisted laparoscopic colorectal surgery. *World J Gastroenterol* 2010; 16(45): 5662-5668 Available from: URL: <http://www.wjgnet.com/1007-9327/full/v16/i45/5662.htm> DOI: <http://dx.doi.org/10.3748/wjg.v16.i45.5662>

INTRODUCTION

Since its introduction in 1991, the number of performed laparoscopic colorectal surgery has remained a minority^[1-3]. This was attributed to the fact that such procedures are time-consuming, technically demanding and have a long steep learning curve^[4]. In the technical demand, surgeons need to handle a long mobile organ, the colon, and has to operate on multiple abdominal quadrants most of the time with the need to secure multiple mesenteric vessels. However, the most important deterring reason was the fear that laparoscopic colectomy was considered oncologically unsound in the management of colorectal cancers^[5]. Therefore, a new surgical innovation called hand-assisted laparoscopic surgery (HALS) was introduced in the mid 1990s as a useful alternative to totally laparoscopic procedures^[6-8]. This hybrid operation allows the surgeon to introduce the non-dominant hand into the abdominal cavity through a special hand port while maintaining the

pneumoperitoneum^[6,7]. This innovative technique met with fierce resistance and its validity was questioned. Nevertheless, there has been an upsurge in the performance of both laparoscopic and hand-assisted laparoscopic colectomy (HALC) over the past 5 years. The reasons are the introduction of more versatile laparoscopic instruments, the introduction of new vessel-sealing devices like the harmonic scalpel and Ligasure, and various laparoscopic endo-staplers. This has enabled surgeons to perform laparoscopic colorectal procedures without the need for a single intracorporeal knot or suture. Another important factor that has contributed tremendously to this upsurge is the emergence of a level I evidence confirming that the laparoscopic colorectal technique is as oncologically sound as the open procedure^[9,10]. The European Cooperation in Science and Technology (COST) multi-institutional study suggested that the laparoscopic approach is an acceptable alternative to open surgery for colon cancer with a similar rate of recurrent cancer after laparoscopically assisted colectomy (LAC) and open colectomy^[9]. However, the questions remain: is HALC an alternative to LAC? Is it second best? Or are they complementary to each other? This article reviews the current literature in an attempt to demonstrate the status of hand-assisted laparoscopic colorectal surgery as a minimally invasive procedure in the era of laparoscopic surgery.

ARGUMENT FOR HALC

The proponents of HALC claim that a hand in the abdomen will restore the tactile sensation which is usually lacking in laparoscopic procedures. It also improves the eye-to-hand coordination, allows the hand to be used for blunt dissection or retraction and also permits rapid control of unexpected bleeding^[6-8,11,12]. All of those factors can contribute tremendously in reducing the operative time. Moreover, HALC is also considered as a hybrid procedure that combines the advantages of both minimally invasive and conventional open surgeries. It is also strongly argued that if an incision is needed to extract the resected specimen at the end of the laparoscopic procedure, then such an incision may be inflicted earlier in the procedure and be utilized as a hand port. However, this new innovation was not quickly embraced and has been fiercely rejected by the surgical community.

ARGUMENT AGAINST HALC

The opponents argued that introducing a hand in the abdomen during any laparoscopic procedure violates the fundamental principles of minimally invasive surgery (MIS) and makes maintenance of pneumoperitoneum difficult. Furthermore, if this new surgical innovation is adopted, one may witness the birth of a new generation of surgeons who is reluctant to learn totally laparoscopic techniques; a generation who will be offering their patients a “second” best procedure^[13]. Also, this new innovation is more aggressive and traumatic as the incision for the hand insertion and specimen extraction is inflicted earlier

in the operation with persistent and continuous stretch and compression on the wound. It is also speculated that the increased handling and mobilization of the bowel will result in the development of postoperative ileus and intra-abdominal adhesions. Moreover, there is uncertainty about the long-term results such as development of adhesive small bowel obstruction and ventral hernias, *etc.* Other arguments focused on the cost incurred by the use of the hand port, the comparatively larger size of the hand port and the extraction incision, obstruction of the operative view by the inserted hand and the ergonomics of this technique as up to 20% of surgeons reported forearm fatigue and wrist pain at the end of the procedure^[14]. Hence, it is difficult to convince experienced laparoscopic surgeons to introduce a hand in the abdomen in order to speed up the procedure and it remains questionable whether there is actually a need for them to do so^[13].

INDICATIONS AND CONTRAINDICATIONS OF HALC

HALC can be offered to all patients who are undergoing any form of colorectal resection for benign as well as malignant conditions. The procedure is best suited for the obese especially those with body mass index (BMI) of 40 or more, as the conversion rate is high if the procedure is conducted laparoscopically^[13]. HALC is also indicated in cases where the pathology is bulky and whenever the laparoscopic surgeon is contemplating conversion of the laparoscopic procedure to an open technique due to unexpected difficulties during the procedure^[13]. Similarly, it can be utilized whenever the surgeon encounters difficulty or wants to speed up the operation pace in areas where there is laparoscopic technical difficulties such as taking down the splenic or hepatic flexures. It can also be considered in cases of total colectomy when an hour saving in the operating time can be gained^[13]. However, there is a doubtful advantage of HALC in low rectal surgery over the laparoscopic technique.

Therefore, generally speaking, HALC should be avoided in patients with low BMI, thin patients with a small abdomen, and in pediatric patients. It is also contraindicated when the pathology is non-bulky and the surgeon's hand is huge.

HAND PORTS

Hand ports facilitate the hand insertion; act as specimen retrieval site and also as a wound protector. They further serve as portals for construction of extracorporeal anastomoses and can also serve as laparoscopic trocar sites. The latter permits selective use of HAL and laparoscopically assisted (LA) techniques at various times during the same operation. The first generation of hand ports was cumbersome, and allows loss of pneumoperitoneum due to gas leak. This gave HALS a bad reputation in its early days. However, newer hand ports devices have better sealing mechanisms and are more user friendly abolishing



Figure 1 An operative picture showing the placement of the hand port and other trocars.

the initial criticism of the old hand ports. Currently, there are varieties of hand ports, but the most commonly used are LapDisc (Johnson and Johnson Endosurgery, USA) (Figure 1) and Gelport (Covidien, Autosuture, USA)^[14,15].

Some new special finger mounted surgical instruments that may help some delicate steps of surgical procedures such as intracorporeal dissection and cutting, have been designed for HALS. However, there have been few reports about their efficiency and usefulness in clinical practice.

HALS VS OPEN COLECTOMY

There is no doubt that HALC is far superior to open colectomy (OC) as it preserves the advantages of MIS. There are three randomized controlled trials (RCT) that compared HALC and OC surgery^[16-18]. The first RCT that compared two well matched groups: 41 patients with HALC vs 40 with OC undergoing elective management of right-sided colonic cancer^[16] found that HALC took significantly longer time to perform (110 min vs 97.5 min, $P = 0.003$), but resulted in significantly less blood loss (35 mL vs 50 mL, $P = 0.005$) and was associated with significantly less pain, less parenteral and enteral analgesia^[16]. Moreover, patients receiving HALC recovered faster, and had a shorter length of hospitalization (7 d vs 9 d, $P = 0.004$). The 5-year survival rate was similar between the two groups (83% vs 74%, $P = 0.90$)^[16].

The second RCT evaluated the postoperative recovery after HAL ($n = 30$) vs open ($n = 30$) restorative proctocolectomy with ileal pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis^[17]. The operating time was longer in the HAL group compared with the open group (210 and 133 min, respectively; $P < 0.001$). However, there were no significant differences in either narcotics requirement or morbidity or postoperative hospital stay (20% vs 17%, and 10 d vs 11 d, respectively). Moreover, there was no difference between the two procedures in quality of life (QOL) assessment score in the 3 mo after surgery. However, the HAL procedure was more costly than the open procedure^[17].

In the third RCT, Kang *et al*^[18] randomized 60 patients

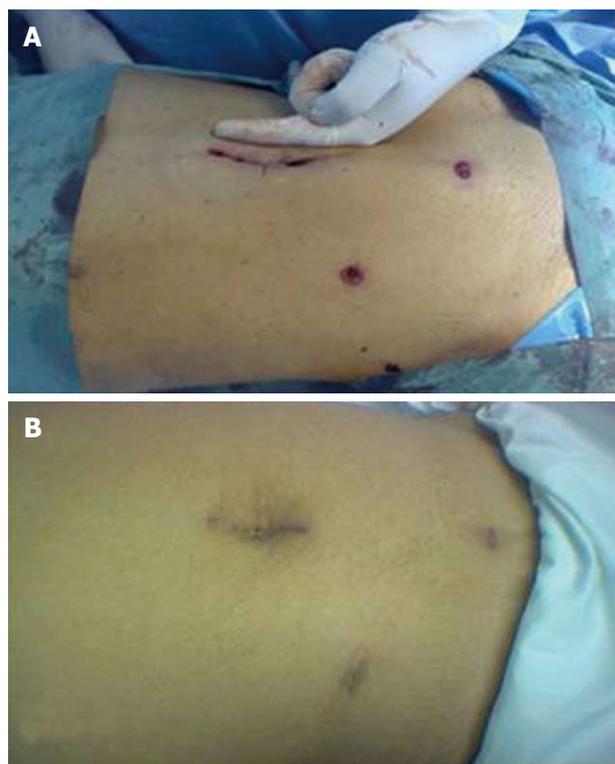


Figure 2 Cosmetic results after hand-assisted laparoscopic colectomy. A: It shows the hand port site closure and the trocar sites at the conclusion of hand-assisted laparoscopic sigmoid colectomy; B: It shows the operative wounds 2 mo after the procedure. Note the shrinkage of the port site scar and the acceptable cosmesis.

into two well-matched groups: HALC ($n = 30$) and OC ($n = 30$) for the management of benign or malignant colorectal diseases. The patients undergoing HALC had a significantly shorter hospital stay and incision length, faster recovery of gastrointestinal function, less analgesic use and blood loss, and lower pain scores on the 1st, 3rd and 14th postoperative days. Moreover, there were no significant differences in operating time, complications, or time to recover to normal^[18].

A fourth comparative study that aimed to compare the QOL, functional outcome, body image, and cosmesis after hand-assisted laparoscopic (HALRPC) vs open restorative proctocolectomy (ORPC) in 53 patients who completed the QOL and functional outcome questionnaires^[19] found no differences in the functional outcome, morbidity, or QOL between the two groups. However, at a median of 2.7 years after surgery, the body image and cosmesis scores of female patients were significantly higher in the HALRPC group^[19].

In summary of the above RCTs (Table 1), HALC takes longer time, but is associated with less blood loss, less pain, faster postoperative recovery with a shorter length of hospital stay and incision than OC. Furthermore, there is no difference in the complication occurrence, and HALC is associated with higher body image and cosmesis scores in female patients (Figure 2A and B), but is more costly than OC.

Table 1 Published studies comparing hand-assisted laparoscopic colorectal surgery with open colorectal surgery

Study, yr	Patients (HALC vs open)	Indication	Procedure	OT (min)	Blood loss (mL)	Analgesia narcotics or POD	Diet (POD)	Complications	LOS (d)
Maartense <i>et al</i> ^[17] , 2004	30 vs 30	UC and FAP	RPIPAA	214 vs 133	262 vs 300	30 mg vs 31 mg	6 vs 7	20% vs 17%	10 vs 11
Chung <i>et al</i> ^[16] , 2007	41 vs 40	Cancer	R. colectomy	110 vs 97	35 vs 50	19 mg vs 54 mg	3 vs 3	9.7% vs 22.5%	7 vs 9
Kang <i>et al</i> ^[18] , 2004	30 vs 30	Benign and malignant CR diseases	Colectomies (R, L and total), AP	169 vs 172	193 vs 84	2.6 d vs 3.3 d	3.7 vs 4.4	13% vs 30%	8 vs 10

UC: Ulcerative colitis; FAP: Familial adenomatous polyposis; RPIPAA: Restorative proctocolectomy and ileal pouch-anal anastomosis; OT: Operative time; POD: Postoperative day; HALC: Hand-assisted laparoscopic colectomy; R: Right; L: Left; AP: Anterior resection; CR: Colorectal.

HALC VS LAC

A review of the literature yielded 8 important studies which compare HALC and LAC; 4 randomized trials^[14,20-22], 2 prospective non-randomized^[23,24] and 2 large retrospective studies^[10,25]. The HALS study was conducted by 10 surgeons from Europe and America and included only 40 patients who were randomized into HALC (18 patients) and LAC (22 patients)^[14]. This study, though small in size, found no significant difference between the two groups in term of operating time (142 min vs 151 min), length of incision (7.4 cm vs 7.0 cm), rate of major complications and length of hospital stay (7 d vs 6 d). However, there were fewer conversions in the HALC group (14% vs 22%). The HALS study group concluded that HALC retains the benefits of MIS^[14]. The second study by Targarona *et al*^[20] included a larger number of patients: 54 patients randomized equally into HALC and LAC groups. The operating time and clinical outcome were similar. However, the conversion rate was much higher in the LAPC group (23% vs 7%). Of interest, 4 of 6 conversions in the laparoscopic group were completed with the hand-assisted technique. There is another interesting finding in this study that the inflammatory (tissue injury) markers such as interleukin-6 and C-reactive proteins were increased in the hand-assisted group. This may lead us to believe that HALC is a more aggressive procedure than LAC, but preserved the features of MIS. This has also opened the door for using HALC as a half-way house procedure and adjunct to LAC when difficulties are encountered and when conversion to the open procedure is contemplated during laparoscopic colectomy^[13].

The Minimally Invasive Therapy and Technology (MITT) group study^[21] consisted of a multi-centre (5 hospital, 11 surgeons), unblinded RCT which compared HALC and LAC for segmental (SC) and total colectomy/proctocolectomy (TC). The HALC group (47 patients: 33 SC and 14 TC) and LAC group (48 patients: 33 SC and 15 TC) were both matched for age, sex, diagnosis, BMI and previous surgery. There was no significant difference in the complication rates (19% vs 21%) and long-term clinical outcome, but the extraction incision was bigger (8.2 cm vs 6.1 cm) and the conversion rate was lower (2% vs 12.5%) in the HALC group. Moreover, there were no apparent differences in the time for bowel function recovery, tolerance of diet, length of hospital stay, postoperative pain scores, or narcotic use between the two groups. Another

interesting finding in this study is that the operating time can be reduced by more than 30 and 60 min in SC and TC, respectively if the procedure is conducted by HALC instead of LAC^[21]. The last RCT compared 35 HALRPC and 30 LARPC^[22]. There were neither conversions nor intraoperative complications, and the median operating time was longer in LAPRPC group (298 min vs 214 min, $P < 0.001$). Morbidity and reoperation rates were comparable (29% vs 20% and 17% vs 10%, respectively). The median hospital stay was 9 d in the laparoscopic group compared with 10 d in the HAL group. Moreover, there were no differences in QOL and the total costs^[22].

A prospective non-randomized case control study on ultra-low anterior resection was reported by Tjandra *et al*^[23] with an equal number of patients (32 HALC and 31 LAC). There were no conversions in both groups with similar oncological harvest in term of tumor clearance and number of lymph nodes retrieved. The length of hospital stay was the same (5.9 d vs 5.8 d). But, the operating time was significantly shorter in the HALC group (170 min vs 188 min). The duration needed for postoperative narcotics was significantly longer (3.0 d vs 1.5 d) and the bowel function recovery and flatus passage were delayed (3.4 d vs 1.9 d) in the HALC group. This study has confirmed some difference in recovery in favor of the laparoscopic group. This difference is, however, of doubtful clinical significance as the length of hospital stay is unaffected^[23].

Also a prospective comparative study analyzed 258 well-matched patients undergoing HALS ($n = 109$) or LAC ($n = 149$)^[24]. A significantly greater proportion of HALS patients underwent complex procedures and extensive resections. However, there were no differences in the conversion rates (15% vs 11%, $P = 0.44$), intraoperative complications (4% vs 1%, $P = 0.17$), the 30-d morbidity (18% vs 11%, $P = 0.12$) and surgical reinterventions (2% vs 1%, $P = 0.58$). There was no difference in the recovery judged by days to pass flatus (mean 3 d vs 3 d), however HALS took a longer operating time (276 min vs 211 min, $P < 0.0001$) and resulted in 1 d longer stay in hospital (6 d vs 5 d, $P = 0.0009$). It was concluded that HALS facilitates the expansion of a minimally invasive colectomy practice to include more challenging procedures while maintaining the short-term benefits of LAC^[24].

A large retrospective single institution study from the Lahey clinic^[25] comparing HAL sigmoid colectomy ($n = 66$) with LA sigmoid colectomy ($n = 85$) revealed no

Table 2 Published studies comparing hand-assisted laparoscopic colorectal surgery with laparoscopically assisted colorectal surgery

Study, yr	Patients (HALC vs LAC)	OT (min)	Incision length (cm)	Complications (%)	Conversion rate (%)	LOS (d)	Bowel function (d)	Comments and conclusion
HALS study ^[14] , 2000	18 vs 22	142 vs 151	7.4 vs 7.0	4.5 vs 5.5	14 vs 22	7 vs 6	NA	HALC retains the benefits of MIS
Targarona et al ^[20] , 2002	27 vs 27	120 vs 135	NA	26 vs 22	7 vs 23	POD3: 6 vs 6	NA	Inflammatory markers such as interleukin-6 and C-reactive proteins were raised in HALC group
MITT study ^[21] , 2008	47 vs 48	163 vs 210	8.2 vs 6.1	19 vs 21	2 vs 12.5	5 vs 4	2.5 vs 3	The OT can be reduced by > 30 min and 60 min in SC and TC; respectively if conducted by HALC
Polle et al ^[22] , 2008	30 vs 35	214 vs 298	NA	Major: 16.5 vs 20	NA	10 vs 9	6 vs 5	No significant short-term benefits for total laparoscopic compared with HALRPC with respect to morbidity, OT, QOL, costs, and LOS
Tjandra et al ^[23] , 2008	32 vs 31	170 vs 188	NA	22 vs 25.8	0 vs 0	5.9 vs 5.8	3.4 vs 1.9	Some difference in recovery in favour of the laparoscopic group
Hassan et al ^[24] , 2008	109 vs 149	276 vs 211	NA	18 vs 11	15 vs 11	6 vs 5	3 vs 3	HALS facilitates expansion of a MIS colectomy to include challenging procedures while maintaining short-term benefits of LAC
Chang et al ^[25] , 2005	66 vs 85	189 vs 203	8.1 vs 6.2	21 vs 23	0 vs 13	5.2 vs 5	2.5 vs 2.8	No difference in return of bowel function, LOS or complications. Significant difference in the OT and conversion rate in favour of HALC group. The incision size was smaller in the LAC group
Ringley et al ^[10] , 2007	22 vs 18	120 vs 156	7 vs 5.5	Similar	NA	4 vs 4	NA	HALC is associated with shorter OT and greater lymph node harvest, but equal I.O blood loss, pedicle length and LOS

HALC: Hand-assisted laparoscopic colectomy; LAC: Laparoscopically assisted colectomy; OT: Operative time; LOS: Length of hospital stay; NA: Not available; MIS: Minimally invasive surgery; HALRPC: Hand-assisted laparoscopic restorative proctocolectomy; QOL: Quality of life; POD3: Postoperative day 3.

significant difference in bowel function recovery (2.5 d vs 2.8 d), length of hospital stay (5.2 d vs 5.0 d) or short-term complications such as anastomotic leak, ileus and wound infection (21% vs 23%) between the two groups. However, there was significant difference in the operating time (189 min vs 203 min) and conversion rate (0% vs 13%) in favor of the HALC group. The incision length was, however, significantly smaller (8.1 cm vs 6.2 cm) in the LAC group^[25].

Another retrospective review of 40 patients (22 HALC and 18 LAC) comparing conventional laparoscopic and hand-assisted oncological segmental colonic resection was reported by Ringley et al^[10]. HALC was found to be associated with a shorter operating time (120 min vs 156 min, $P < 0.05$) and greater lymph node harvest (16 vs 8, $P < 0.05$), but equal intraoperative blood loss, pedicle length and hospital stay (4 d)^[10]. LAC was completed with smaller incision length to retrieve specimen (7 cm vs 5.5 cm, $P < 0.05$), but this 1.5 cm difference is of doubtful clinical significance^[10]. Table 2 summarizes the above studies that compare HALC and LAC and their conclusions. Based on the reviewed literature, the following results were found between HALC and LAC: (1) HALC offers the same MIS benefits as LAC; (2) HALC has a shorter operative time and lower conversion rate; (3) They both have comparable complication rate and length of stay; (4) The incision length is bigger in HALC; (5) There an increased level of inflammatory markers in HALC; (6) There is an increased need for postoperative narcotics analgesia after HALC; (7) Bowel function recovery and passage of flatus are some-

what delayed in HALC, but this is of doubtful clinical significance; and (8) HALC is more suitable for the obese patients.

IMPACT OF HALC ON SURGICAL TRAINING

It has been postulated that “It takes 6-12 mo to teach fellows how to take down the splenic flexure independently using straight laparoscopic methods whereas most fellows become proficient at the same task about HAL method after performing 10-15 cases”^[13] and it was also claimed that “a surgeon who uses either straight laparoscopic or HAL methods extremely will be handicapped”^[13]. It was therefore advisable that trainees embrace and master both techniques. A recent comparative study measuring the percentage of left-sided HALC or straight LAC cases completed by a trainee surgical resident found that straight laparoscopy were more likely completed by the resident without the intervention of the attending physician than HALC (LAC, 88%; HALC, 72%; $P = 0.06$)^[26]. Differences in the mean operating time favoring LAC were noted (HALC, 142 min vs LAC, 133 min; $P = 0.04$)^[26]. However, the occurrence of complications was similar in the two groups (HALC, 19% vs LAC, 21%), so was the rate of conversions (HALC, 5.6% vs LAC, 4.5%). It was concluded that trainee surgical residents may be more successful in completing LAC than in adjusting to the novel HALC approach during training. This is somewhat surprising, but it may be explained by the hindrance of

the laparoscopic view by the intervening hand during HALC, especially in the early learning curve of the trainee surgeons.

A 25-question survey organized by The American Society of Colon and Rectal Surgeons about hands-on training cadaver courses, found that a laparoscopic colon resection was performed within 1 wk of the course by 52% of participants and within 1 mo by 90%^[27]. Hand-assisted technologies have lowered the threshold for performing the first LAC in 62% of participants. Most participants (77%) declared that the most important factor in the course selection was a cadaver model. It was therefore concluded that cadaver courses enabled rapid integration of laparoscopic colon resection into clinical practice and that hand-assisted technologies promoted technique acquisition^[27]. The author conducted HALC workshops on live animal (sheep) which made consultant surgeons with no experience in laparoscopic colectomy more confident in using the HALS technology they obtained in the animal workshop as a bridge towards totally laparoscopic procedures in humans^[15].

COST ANALYSIS

A concern has been raised regarding the higher direct cost of HALC, however, the results are inconsistent. In a RCT that evaluated postoperative recovery after HALC *vs* open restorative proctocolectomy with ileal pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis^[17], the HAL procedure was found more costly than the open procedure (the median overall cost was \$16,728 for HAL procedure and \$13,406 for the open procedure; $P = 0.095$)^[17]. In a retrospective analysis of 73 patients undergoing LAC *vs* 101 undergoing HALC^[28], it was found that the operative cost and cost of consumables were higher for HALC (US\$4024.2 *vs* US\$3568.1, $P = 0.01$ and US\$1724.7 *vs* US\$1302.7, $P < 0.001$, respectively). However, the total costs were not significantly different between the two procedures (HALC US\$8999.8, LC US\$7910.7, $P = 0.11$). In a more recent US study that looked at direct costs for the operating room, nursing care, intensive care, anesthesia, laboratory, pharmacy, radiology, emergency services and consultation, and professional and ancillary services related to the initial hospitalization and readmissions associated with 100 HALC *vs* 100 matched LAC cases which were performed concurrently^[29], there were no differences in the operating time (168 and 163 min, respectively), length of hospital stay (4 d), readmission (6% and 11%, respectively), or reoperation rates (5% and 9%). The overall morbidity was 16% and 32% for HAL and LAC, respectively ($P = 0.009$). The major morbidities, including abscess, hemorrhage and anastomotic leak, were also similar in the two procedures. However, operating room costs were increased for HALC (US\$3476 *vs* US\$3167); the total costs were similar (US\$8521 *vs* US\$8373). Therefore, it can be concluded that the total costs for HALC and LAC are similar^[29] and HALC reserves the benefits of LAC at no extra cost^[30].

LONG-TERM COMPLICATIONS OF HALC

As HALS requires a larger incision that that used in totally laparoscopic procedures, it has been postulated that HALS may be associated with more long-term complications such as incisional hernias and adhesive small bowel obstruction. This has been addressed by Sonoda *et al*^[31] who compared HALS ($n = 270$) and LAS ($n = 270$) over a median follow-up of 27 mo (1-72 mo). Despite the larger wound in the HALS group (median 75 mm *vs* 45 mm), the incidence of incisional hernia was similar in both groups and the rate of small bowel obstruction was also comparable (4.1% *vs* 7.4%, $P = 0.11$)^[31]. Moreover, the incidence of wound infections was also comparable (HALS 6.8% *vs* LAS 4.8%, $P = 0.33$). Interestingly, the converted cases had a significantly higher incidence of incisional hernia than that of the non-converted patients (25% *vs* 5%), although the rate of small bowel obstruction was the same. It was therefore concluded that HALS does not lead to more long-term complications of incisional hernia and small bowel obstruction than totally laparoscopic procedures^[31].

CONCLUSION

Based on the available evidence, hand-assisted laparoscopic colorectal resection offers similar short and long-term MIS benefits to that of totally laparoscopically assisted procedures. It combines the advantages of both laparoscopic (minimally invasive) and conventional open surgery. It is safe and feasible in benign as well as malignant colorectal tumors. Furthermore, it is easy to learn, easy to teach and most useful in complex colorectal procedures. Hence, hand-assisted colorectal surgery is advocated first as a 'bridge' and later as an adjunct to laparoscopically assisted colorectal procedures. Moreover, it can be used as an alternative to laparoscopic colectomy in the complex colorectal procedures.

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