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Original Article

Clinical analysis of the application of hand-assistant laparoscopic surgery with D3 lymph node dissection for right colon cancer

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Abstract: Objective: This retrospective study aims to compare the clinical outcomes between conventional laparotomy and hand-assisted laparoscopic surgery (HALS) with D3 lymph node dissection in the treatment of right colon cancer and to analyze and evaluate the feasibility and safety of HALS with D3 lymph node dissection. Methods: Among 63 patients, 35 underwent HALS with D3 lymph node dissection (study group) and 28 underwent conventional laparotomy (control group). The operation durations, the number of lymph node harvest, bleeding volumes, postoperative draining volumes, recovery time of gastrointestinal function, hospitalization time, hospitalization expenses, postoperative complications rate and cosmetic satisfactory scores were compared between the two groups. Results: The bleeding volume, postoperative draining volume and the hospitalization expenses in study group were lower than control group. The hospitalization time in study group was shorter than control group. The cosmetic satisfactory scores in study group were higher than in control group. The number of lymph node harvest, the recovery time of gastrointestinal function and the postoperative complications rate were no significantly differences between the two groups. Conclusion: HALS with D3 lymph node dissection got the same clinical curative effect compared with traditional open surgery for right colon cancer.

Keywords: Hand-assistant laparoscopic surgery, right colon cancer, D3 lymph node dissection

Introduction

Colon cancer is the common clinic malignant tumor. Its incidence accounts for approximately 8% of the digestive tract tumors and continues to increase. Open radical resection of colon cancer is a major component of treatment and could effectively remove cancerous tissue, but it causes a large trauma in the abdomen, leads to a variety of complications and seriously affects the recovery of intestinal function [1, 2].

Laparoscopic surgery has rapidly become a popular procedure worldwide and has been widely carried out in recent years because of the advantages of less trauma, less pain and quicker recovery since its first report in 1993 [3]. Accumulating evidence has shown that laparoscopic surgery is similar to the clinical outcomes of open surgery [4-8], so it is a promising alternative method for curing colon cancer. Since laparoscopic surgery derived many kinds, surgeons have been faced with a variety of operative techniques, such as hand-assisted or conventional laparoscopic surgery and single-port laparoscopic surgery [9-11]. All kinds of operations have their own merits. Hand-assisted laparoscopic surgery (HALS) incorporating the laparoscopic surgery and the traditional open surgery is a kind of hybrid laparoscopic technique [12-15]. HALS is a kind of minimally invasive surgery and its most important advantage is that the surgeon regains tactile feedback. Surgeons can palpate the tumor or organs, which is benefit for surgeon to perform blunt dissection, retraction, control of bleeding, and specimen removal [16-21].

Many Japanese surgeons routinely perform extended D3 lymph node dissection for the treatment of advanced colon cancer with a view to achieving better tumor control. The current

Table 1. Patients' characteristics and pathologic variables

Variable	Control group (n=28)	Study group (n=35)	*P* value
Gender			0.821
Male	16 (57.1%)	19 (54.3%)	
Female	12 (42.9%)	16 (45.7%)	
TNM stage			0.862
I or II	17 (60.7%)	22 (62.9%)	
III or IV	11 (39.3%)	13 (37.1%)	
Diabetes mellitus			0.806
Yes	8 (28.6%)	11 (31.4%)	
No	20 (72.4%)	24 (68.6%)	
Hypertension			0.751
Yes	7 (25%)	10 (28.6%)	
No	21 (75%)	25 (71.4%)	
Histological type			0.907
Well or moderately differentiated	18 (64.3%)	22 (62.9%)	
Poorly differentiated	10 (35.7%)	13 (37.1%)	
Age	62.32±5.84	63.46±7.33	0.507
BMI (kg/m^2)	21.45±2.84	21.92±2.88	0.518
Tumor size (cm)	3.57±0.234	3.53±0.345	0.554
Level of preoperative CEA (ng/ml)	5.61±0.26	5.51±0.41	0.243

Values are presented as mean ± standard deviation (SD) or number (%). TNM, tumor-node-metastasis; BMI, body mass index; CEA, carcinoembryonic antigen. Control group: the patients underwent conventional open right hemicolectomy; Study group: the patients underwent hand-assisted laparoscopic right hemicolectomy with D3 lymph node dissection.

Japanese Classification of Colorectal Carcinoma states that a radical D3 lymph node dissection of colon cancer should be performed to remove the paracolic lymph nodes, intermediate lymph nodes and central lymph nodes. It could decrease the tumor recurrence and lead to good prognosis of tumor [22, 23]. However, the application of a hand-assisted laparoscopic approach to perform D3 lymph node dissection procedure for the treatment of right colon cancer has only been sporadically reported, and its oncologic benefits remain unclear. Therefore, this study was designed to compare the outcomes of a HALS with D3 lymph node dissection and a conventional laparotomy in patients with right colon cancer and to analyze and evaluate the feasibility and safety of HALS with D3 lymph node dissection.

Materials and methods

Patient population

This study was approved by the Institutional Review Board of Guizhou Provincial Hospital of Traditional Chinese Medicine, Anorectal Disease Hospital Two Wards in Guizhou Province. Due to its retrospective nature, the requirement regarding informed consent for the study was waived. But all patients who underwent surgical operation signed a standard informed consent form that we used in our surgical unit. On this standard consent form, we detailed the surgical procedures, including the risks and benefits of the operation that we performed. Before patients made the decision to undergo an open or a hand-assisted laparoscopic procedure, surgeons made a detailed discussion and comprehensive explanation of both treatment options to the patients to let them make decision.

The clinical data from 63 patients with right colon cancer who underwent conventional open right hemicolectomy vs hand-assisted laparoscopic right hemicolectomy with D3 lymph node dissection from March 2012 to April 2015 at our hospital were retrospectively reviewed. Among the patients, 35 patients who underwent a hand-assisted laparoscopic right hemicolectomy with D3 lymph node dissection and 28 patients who underwent a conventional open right hemicolectomy were enrolled as the study and the control groups, respectively. The control group was selected so as to be case-matched with the study group in the aspects of age, sex, medical history, tumor size, and tumor-node-metastasis (TNM) stage during the same period (**Table 1**).

All patients had conventional preoperative examinations including chest radiographs, abdominal computed tomography (CT), colonoscopy and biopsy, routine laboratory testing, and testing of tumor markers to confirm the tumor location and type. The following patients were excluded from the study: (1) patients who were performed a right hemicolectomy but colon cancer was not confirmed by pathology after surgery; (2) patients who had peritonitis, peri-

colic abscess or sepsis, etc.; (3) patients with metastatic disease on preoperative work-up; (4) patients who had received emergency surgery due to acute intestinal obstruction or perforation; and (5) patients who were pregnant, severely obese, or had serious diseases of the heart, lung, liver, or kidney.

Surgical procedure

Under general anesthesia with endotracheal intubation, a patient was positioned on the surgical table in the supine position with lags apart. The surgeon and camera holder stood on the left and the surgical assistant on the right side. A Foley catheter was inserted, but no nasogastric tube was used routinely. The operative field was covered with saline soaked sterile gauze.

Firstly, the navel as the center, surgeon made a mid-midline skin incision with a 6- or 7-cm length and put a Gelport (Applied Medical Resources Co., Rancho Santa Margarita, CA, USA) to the skin incision. The Gelport is a kind of hand-port device that can maintain the pneumoperitoneum while the surgeon's hand is in the abdominal cavity. The pneumoperitoneum was maintained at 10 mmHg using CO_2. Under visualization with a 30-degree laparoscope, two 12-mm trocars were inserted into the epigastric and the suprapubic area at the midline. Then, the camera assistant, who was located to the left of patient and to the left of surgeon, inserted the laparoscopic camera via the suprapubic port. The surgeon's left hand was inserted into the intraabdominal cavity via the hand-port, and the laparoscopic instrument was inserted via the epigastric port [24].

Then, complete dissection of all regional lymph nodes is recorded as D3 dissection. The extent of D3 lymph node dissection included paracolic lymph nodes, intermediate lymph nodes, and lymph nodes in the root of inferior mesenteric artery. The scope of extra-mesenteric dissection included the clearance of lymph nodes along common iliac artery and vein, to abdominal aorta, upward to the level of duodenal third portion, and to the left renal vein [23].

Finally, tumor resection, meticulous hemostasis and wound closure were performed. They were similar to those of open surgery. The terminal ileum and the ascending and transverse colon were exteriorized. The transverse colon and the terminal ileum were resected with sufficient margins from the tumor. Anastomosis was performed using the hand-sewn and end-to-end method or the side-to-side stapled method. After saline irrigation and meticulous hemostasis, a pneumoperitoneum was made using the Gelport. Then, anastomosis alignment and complete hemostasis were checked.

Postoperative care

During postoperative care, intravenous patient-controlled analgesics were applied for the first 2 or 3 days, according the condition of patients. Vital signs and urine output are monitored every 4 hours. Routine laboratory tests were performed on postoperative days 1, 2, 4 and 7; especially. Antibiotic therapy is discontinued after a few days or it will be continue to inject unless the patient has a continuing infection. Drinking water was started when patients had no abdominal discomfort after first flatus. If they were tolerable to this step, soft diet began.

Clinicopathologic, intraoperative and postoperative parameters were statistically analyzed between the study and the control groups, such as age, gender, body mass index (BMI), length of incision, total operative time, operative blood loss, number of resected lymph nodes, the recovery time of bowel function, the time of early ambulation after operation, postoperative hospital stay, and the incidence of postoperative complications, including frequency of postoperative respiratory complications, frequency of anastomotic leakage, frequency of incision infection, frequency of urinary tract infection, and retention of urine and so on.

Statistical analysis

The patients were analyzed according to the intent to-treat statistical principle. SPSS 19.0 software (SPSS, Inc., Chicago, IL, USA) was used to perform statistical analysis. Student's t-tests were used to analyze the difference between study group and control group. Measurement data were expressed as the mean ± standard deviation (SD) value. The differences between means were analyzed statistically using t-tests. Quantitative data were analyzed by chi-squared test or Fisher's exact test as appropriate. A P value of less than 0.05 was considered statistically significant.

Table 2. Operative variables in control and study group

Variable	Control group (n=28)	Study group (n=35)	*P* value
Operation time (min)	132.75±21.19	173.56±18.20	0.000
Blood loss (ml)	153.08±29.37	85.31±3.17	0.000
Length of incision (mm)	184.99±2.92	64.45±2.65	0.000
No. of harvested lymph nodes	20.36±2.96	19.69±2.50	0.339
Length of resected tumor (mm)	157.04±30.64	163.18±31.78	0.442
Anastomosis method			0.948
Stapled	21	26	
Hand-sewn	7	9	
Conversion to laparotomy			0.367
Yes	0	1	
No	28	34	
Operative mortality	0	0	None

Values are presented as mean ± standard deviation or number (%). Control group: the patients underwent conventional open right hemicolectomy; Study group: the patients underwent hand-assisted laparoscopic right hemicolectomy with D3 lymph node dissection.

Results

Comparison of basic clinical data between study group and control group

A total of 63 cases consisted of 35 cases in the study group and 28 cases in the control group were enrolled in this study. As shown in **Table 1**, the study group consisted of 19 males and 16 females with an average age of 63.46±7.33 years, and the control group consisted of 16 males and 12 females with a mean age of 62.32±5.84 years. There were no differences in gender (*P*=0.821) or age (*P*=0.507) between the groups. The two groups were similar with respect to histological type and tumor-node-metastasis (TNM) stage. In the study group, tumors were well or moderately differentiated and poorly differentiated in 22 (62.9%) and 13 (37.1%) patients, respectively, in the control group in 18 (64.3%) and 10 (35.7%) patients, respectively, and tumors were I or II stage and III or IV stage in 22 (62.9%) and 13 (37.1%) patients, respectively, in the control group in 17 (60.7%) and 11 (39.3%) patients, respectively. Moreover, there was no significant difference in diabetes mellitus and hypertension between the two groups (*P*=0.806 and *P*=0.751). Besides, the body mass index, tumor size and level of preoperative CEA of the study group and control group were similar (21.45±2.84 kg/m^2 vs. 21.92±2.88 kg/m^2, respectively, *P*=0.518; 3.57±0.234 vs. 3.53±0.345 cm, respectively, *P*=0.554; and 5.61±0.26 vs. 5.51±0.41 ng/ml, respectively, *P*=0.243).

In conclusion, there were no significant differences in gender, age, histological type, TNM stage, tumor size, preoperative comorbidities, BMI and level of preoperative CEA between the study groups and control group. So the patients could perform a case-control study.

Comparison of operative correlative index between study group and control group

As shown in **Table 2**, the mean operation time was 173.56 minutes in the study group and 132.75 minutes in the control group. It was 40 minutes longer in the study group than in the control group, and the difference was statistically significant (P=0.000). Besides, the study group had a significantly shorter total incision length (184.99±2.92 vs. 64.45±2.65 mm, respectively, *P*=0.000), and significantly less blood loss (153.08±29.37 vs. 85.31±3.17 ml, respectively, *P*=0.000) than the control group. However, between the two groups, no significant differences were noted in number of retrieved lymph nodes (*P*=0.339), length of resected tumor (*P*=0.442) or anastomosis method (*P*=0.948). In the study group, there was 1 case performing conversion to open surgery. In both group, there were no intraoperative complications, such as ureter injury, hemorrhage, reanastomosis, and so on. The most important thing was no death occurred during perioperative period.

Comparison of postoperative correlative index and complication between study group and control group

In the aspect of postoperative laboratory data, there were no significant differences in the difference between the preoperative and the postoperative white blood cell (WBC) counts and the difference in hemoglobin (Hb), as shown in **Table 3**. The mean of the difference between the preoperative and the postoperative WBC counts and the difference in Hb respectively was 5.73 and 1.39 in the study

Table 3. Postoperative laboratory data and recovery parameters

Variable	Control group (n=28)	Study group (n=35)	*P* value
WBC count difference[a]	4.60±1.98	5.73±2.29	0.051
Hb difference[b]	1.53±0.31	1.39±0.30	0.077
Days to flatus (d)	3.37±0.24	3.32±0.26	0.473
Days to soft diet (d)	5.55±0.269	5.55±0.29	0.934
Days to discharge (d)	13.5±0.27	10.4±0.26	0.000
Operation fare	6201.33±336.72	8975.88±302.82	0.000
Hospital stay and pharmacy cost	18545.2±2808.2	15372.4±2660.7	0.000
Cosmetic satisfactory scores	1.437±0.28	4.67±0.31	0.000

Values are presented as mean ± standard deviation or number (%). [a]Postoperative WBC count-preoperative WBC count; [b]Preoperative Hb-postoperative Hb. WBC, white blood cell; Hb, hemoglobin. Control group: the patients underwent conventional open right hemicolectomy; Study group: the patients underwent hand-assisted laparoscopic right hemicolectomy with D3 lymph node dissection.

Table 4. Postoperative complications

Variable	Control group (n=28)	Study group (n=35)
Incision infection	1	0
Anastomotic leakage	1	1
Pulmonary infection	0	1
Urinary tract infection	1	1
Acute adhesive ileus	1	1

Control group: the patients underwent conventional open right hemicolectomy; Study group: the patients underwent hand-assisted laparoscopic right hemicolectomy with D3 lymph node dissection.

group, 4.60 and 1.53 in the control group (*P*=0.051 and P=0.077, respectively).

Postoperative recovery parameters are also presented in **Table 3**. First flatus was shown on postoperative day 3.32 in the study group and 3.37 in the control group (*P*=0.473). Eating soft diet were started on postoperative days 5.55 in the study group and the control group (*P*=0.934). However, significant differences were noted in length of hospital stay, cosmetic satisfactory scores, operation fare and hospital stay and pharmacy cost. The study group had a significantly shorter length of hospital stay (13.5±0.27 vs. 10.4±0.26 days, *P*=0.000), significantly higher cosmetic satisfactory scores (1.437±0.28 vs. 4.67±0.31, *P*=0.000), significantly higher operation fare (6201.33±336.72 vs. 8975.88±302.82 RMB, *P*=0.000), and significantly lower hospital stay and pharmacy cost (18545.2±2808.2 vs. 15372.4±2660.7 RMB, *P*=0.000) than the control group.

Postoperative complications were summarized and described in **Table 4**. While urinary tract infection was noted in the study group, incision infection was noted in the control group. Besides, anastomotic leakage, urinary tract infection and acute adhesive ileus were noted in both study group and control group. The rates of complications were, respectively, 11.43% (4/35) in study group and 14.29% (4/28) in control group, and no statistical difference was noted between groups (*P*>0.05). All complications were successfully managed prior to discharge. All patients recovered after conservative management. No postoperative mortalities or reoperations occurred in either group.

Discussion

Nowadays, laparoscopic surgery has been increasingly practiced worldwide and has been extended to all areas of surgery. A surgical literature has reported that Laparoscopic colectomy was performed to colon cancer since 1991 [25]. The laparoscopic surgery as a minimally invasive therapy has obvious advantages in the treatment of cancer, including the smaller incision, the faster recovery, and the shorter hospital stay. But, some new problems in daily work has been discovered, such as the longer operative time, the need for more expensive instrumentation, risk of port-site cancer recurrences, the procedural complexity, the lack of optimal retracting devices, and the loss of tactile feedback. Besides, laparoscopic resections can be technically demanding and difficult to learn and teach [26-30]. Due to the above shortcomings of laparoscopy, some patients cannot be carried out laparoscopic surgery, such as patients with seriously dilated bowel loops and a distended abdomen and patients with bulky and fixed obstructing tumors [31, 32]. So we needed to improve the laparoscopic technology.

Along with the technical development, Kusminsky et al. [33] completed the first HALS

splenectomy. The advantages of HALS include better control of hemorrhagic accidents, thereby reducing the conversion rate, metastatic lesions, small lesions, and lymph nodes, which are hard to find by laparoscopic exploration, and the local staging of tumors can be detected. Insertion of the hand restores the tactile feeling and the sensation of depth and facilitates the exposure, traction, and retraction maneuvers during the procedure [34-36]. HALS may be a bridge of conventional laparoscopic and open surgery, because it incorporates elements of both the laparoscopic and the traditional open techniques. Besides, it simplifies the performance of difficult procedures of laparoscopic surgery and make the less experienced surgeons to initiate the advanced laparoscopic surgery [37]. In recent years, some scholars compared open surgery with HALS for colorectal diseases, the common conclusion was that HALS is a better choice because of a smaller incision, a faster recovery, and a shorter hospital stay [38, 39]. Our data showed similar results.

With the development of technology, researchers added D3 lymph node dissection to HALS. Jae-Hoon Sim et al. reported that with the current of laparoscopic technology, D3 lymph node dissection for rectosigmoid cancer could be performed by laparoscopic approach with acceptable oncologic results and quick postoperative recovery for the patients. It has been generally accepted that a progressive increase in recurrence rate is observed in parallel with a higher level and number of involved nodes [40].

In the present study, we explore the feasibility and safety of HALS with D3 lymph node dissection in the treatment of right colon cancer. According to our data, compared to the patients in the open right hemicolectomy group, those who underwent a hand-assisted laparoscopic right hemicolectomy with D3 lymph node dissection for right colon cancer had similar short-term clinical outcomes.

First of all, we counted the basic clinic data of all the participants. The results showed that there were no significant differences in gender, age, histological type, TNM stage, tumor size, preoperative comorbidities, BMI and level of preoperative CEA between the study groups and control group. So the patients could perform a case-control study. Then, we considered and evaluated the feasibility of surgery and its oncologic safety. We compared the operative variables in control group and study group. In our data, the mean of operation time was longer in the HALS group than in the open surgery group. Kang et al. [13] reported that operation times were similar between HALS and open surgery in the case of operations by one experienced surgeon. Thus, the longer operation time in the HALS group is mainly due to the lack of surgeon's experience, not the method of operation. In addition, we found the open surgery group had a significantly shorter total incision length and less blood loss than the HALS group. Lastly, we explored the clinical short-term outcomes between the two groups. Our results showed that HALS patients had a shorter incision and length of hospital stay, higher cosmetic satisfactory and lower hospital stay and pharmacy cost than the patients with conventional laparoscopic surgery.

In conclusion, patients with right colon cancer who underwent a HALS with D3 lymph node dissection had not only smaller incisions and shorter hospital stays but also a radicality of lymph-node dissection similar to that in patients with right colon cancer who underwent conventional open surgery. Therefore, a hand-assisted right hemicolectomy for the treatment of right colon cancer is safe and feasible, and can be considered as an alternative operation to conventional open surgery.

Disclosure of conflict of interest

None.

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