RESEARCH ARTICLE

Seniors Have a Better Learning Curve for Laparoscopic Colorectal Cancer Resection

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Abstract

Purpose: This study was designed to evaluate the outcomes of laparoscopic colorectal resection in a period of learning curve completed by surgeons with different experience and aptitudes with a view to making clear whether seniors had a better learning curve compared with juniors. Methods: From May 2010 to August 2012, the first twenty patients underwent laparoscopic colorectal resection completed by each surgeon were selected for analysis retrospectively. A total of 240 patients treated by 5 seniors and 7 juniors were divided into the senior group (n=100) and the junior group (n=140). The short-term outcomes of laparoscopic surgery of the two groups were compared. Results: The mean numbers of lymph nodes harvested were 21.2±11.0 in the senior group and 17.3±11.5 in the junior group (p=0.010); The mean operative times were 187.9±60.0min as compared to 231.3±55.7 min (p=0.006), and blood loss values were 177.0±100.7ml and 234.0±185ml, respectively (p=0.001); Conversion rate in the senior group was obviously lower than in the junior group (10.0% *vs* 20.7%, p=0.027) and the mean time to passing of first flatus were 3.3±0.9 and 3.8±0.9 days (p=0.001). For low rectal cancer, the sphincter preserving rates were 68.7% and 35.3% (p=0.027). Conclusions: Seniors could perform laparoscopic colorectal resection with relatively better oncological outcomes and quicker recovery, and seniors could master the laparoscopic skill more easily and quickly. Seniors had a better learning curve for laparoscopic colorectal cancer resection compared to juniors.

Keywords: Laparoscopy - colorectal cancer - senior - junior - learning curve

Asian Pac J Cancer Prev, **15 (13)**, 5395-5399

Introduction

Colorectal cancer has become the third reason of cancer death in China and its incidence is increasing year by year (Chen et al., 2014). Surgical treatment is the most effective and preferred method for most resectable colorectal cancer. Minimal invasive surgery which has been extensively accepted by both patients and surgeons represents the development tendency of surgical therapy for colorectal cancer. Laparoscopic surgery for colon cancer has been recommended as one of selectable surgical modes (Kim et al., 2011), and for rectal cancer, the laparoscopic skill has also been applied in clinical practice although controversy is existing all along. Experience of open surgery may be the basic of laparoscopic skill. In theory, the learning curve of laparoscopic colorectal surgery for experienced surgeons should be shorter compared with inexperienced surgeons, and outcomes of laparoscopic surgery completed by experienced surgeons should also be better. However, some reports confirmed that inexperienced surgeons did not cause more conversions or postoperative morbidity in laparoscopic colorectal surgery if they were well supervised (Maeda et al., 2009). This study was designed to compare the different outcomes of laparoscopic colorectal surgery in period of learning curve for seniors and juniors and to evaluate whether seniors had a better learning curve for laparoscopic colorectal cancer resection.

Materials and Methods

Population

Data of 240 patients who underwent laparoscopic colorectal cancer surgery completed by 12 surgeons from May 2010 to August 2012 in cancer hospital, Chinese academy of medical sciences was analyzed retrospectively. All patients were made definite diagnosis by colonoscopy with biopsy, and physical examination, abdominal computed tomography scan, abdominal ultrasound and barium enema were routinely used for evaluation. Distance metastasis was excluded by imaging examination. Benign lesion, familial adenomatous polyposis coli and multiple primary carcinomas were excluded from this study.

Data of the first 20 consecutive patients treated by each senior and junior was collected respectively. A total of 240 patients were divided into senior group (100 patients treated by 5 seniors) and junior group (140 patients treated by 7 juniors). Seniors had completed more than 200

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open surgeries and juniors experienced less than 50 open surgeries, all these 12 surgeons were surgical oncologists and all of them had no laparoscopic experience. Working lives of seniors were more than 20 years and less than 10 years for juniors. Short-term outcomes including operative time, blood loss, conversion rate, number of lymph nodes harvested, length of distal margin, status of distal margin and CRM (circumferential resection margin), time to first flatus, time to first defecation, intra- and postoperative complications, sphincter preserving rate and so on were compared between the two groups.

Surgical technique

In most cases, four trocars were used, a 12mm

Table 1. Comparisons of Two Groups for General Parameters

Parameters	Senior group (N=100)	Junior group (N=140)	*P*-value
Gender			0.053
Male	36	68	
Female	64	72	
Age, year (mean±SE)	60.8±1.0	58±0.8	0.118
BMI, kg/m2(mean±SE)	23.7±0.3	23.1±0.3	0.135
ASA			0.504
I	13	24	
II	82	106	
III	5	10	
Concomitant diseases			0.808
Yes	57	82	
No	43	58	
Abdominal operation history			0.776
Yes	87	120	
No	13	20	
Tumor size, cm(mean±SE)	5.0±0.2	4.6±0.2	0.082
Distance of tumor from anal verge, cm(mean±SE)	6.6±0.4	6.3±0.3	0.589
Operation type			0.196
Right hemicolectomy	19	13	
Left hemicolectomy	6	11	
Sigmoidectomy	14	26	
Anterior resection	41	54	
Abdomino-perineal resection	20	36	

Table 2. Comparisons between the Two Groups for Pathological Outcomes

Outcomes	Senior group	Junior group	*P*-value
T-classification			0.154
T1	2	8	
T2	20	31	
T3	68	78	
T4	10	23	
Number of lymph node harvested (mean±SE)	21.2±1.1	17.3±1.0	0.01
Tumor differentiation			0.547
Well	3	7	
Well-moderate	10	11	
Moderate	72	102	
Moderate-poor	6	13	
Poor	9	7	
Length of distal margin, cm (mean±SE)	1.9±0.1	1.9±0.2	0.809
Circumferential resection margin			0.228
Positive	2	7	
Negative	59	83	

Table 3. Comparisons between the Two Groups for Operative Outcomes and Postoperative Recovery

Outcomes	Senior group	Junior group	*P*-value
Operative time, min (mean±SE)	187.9±6.0	231.3±4.7	0.006
Blood loss, ml (mean±SE)	177.0±10.1	234.0±15.6	<0.001
Time to first flatus, day (mean±SE)	3.3±0.1	3.8±0.1	<0.001
Time to first defecation, day (mean±SE)	4.1±0.1	4.4±0.1	0.102
Hospital stay, day (mean±SE)	10.8±0.8	13.6±0.7	0.01
Conversion rate	10%	20.70%	0.027
Peri-operative complication	12	27	0.131
Length of incision, cm (mean±SE)	6.5±0.2	7.6±0.3	0.002

superumbilical port was created to introduce the laparoscope. For rectal cancer patients, the other three trocars were created in right lower quadrant (12-mm port), right upper quadrant (5-mm port) and left lower quadrant (5-mm port). For colon cancer, the three trocars were created in right or left upper quadrant (5-mm port), right or left lower quadrant (5-mm port) and paraumbilical (12-mm port).

According to en bloc resection principle, laparoscopic skill was applied for these patients with colorectal cancer. For right-side colonic resection, mobilization of the bowel, division and ligation of right colon vascule was performed laparoscopically; the anastomosis was performed extracorporeally through a small incision; for left-side colonic resection and sigmoidectomy, dissociation of intestinal canal, mesocolon excision and ligation of inferior mesenteric vessel were performed laparoscopically. The lymph node dissection was begun around the origin of the inferior mesenteric artery. Anastomosis was performed extracorporeally for all descending colon cancer and most of sigmoid cancer by using three linear cutting staplers, and circular stapler was used for distal sigmoid colon cancer. For rectal cancer, total mesorectal excision principle was followed. Bowel mobilization, ligation of inferior mesenteric vessel and dissection of lymph nodes were performed laparoscopically, transection of rectum was completed through abdominal incision, then the specimen was removed and the bowel was prepared for anastomosis. Circular stapler was used for rectal cancer which was performed anterior resection.

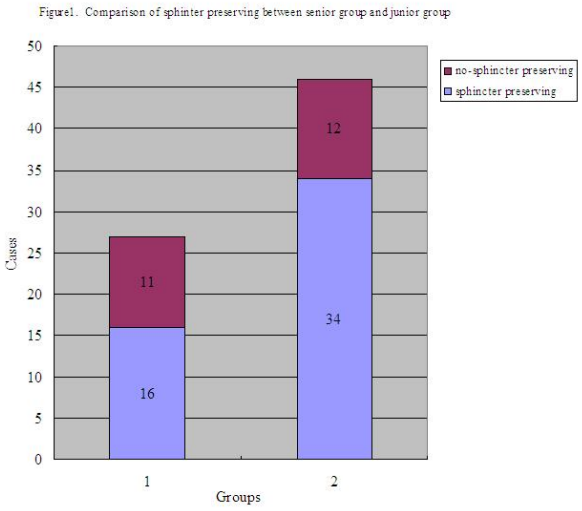

Figure 1. Comparison of Sphinter Preserving between Senior and Junior Groups

Statistical analysis

Statistical analyses were performed using statistical software package SPSS version 13.0. A P-value less than 0.05 was considered to be statistically significant. Categorical variables were analyzed by Chi-square test, and continuous variables were analyzed by the Student's t test.

Results

A total of 240 patients who received laparoscopic colorectal surgery completed by 12 surgeons between May 2010 and August 2012 met the criteria of our study. Age, gender, concomitant diseases, BMI (body mass index), ASA (American Society of Anesthesiologists), abdominal operation history and operation type were matched between the two groups. The mean tumor size in senior group was 5.0±1.9cm (range, 2-10cm) and 4.6±1.8cm (range, 1-10cm) in junior group (p=0.082); Distance of tumor from anal verge in senior group was 6.6±2.8cm (range, 1-12cm) and 6.3±2.7cm (range, 2-10cm) in junior group (Table 1).

Adenocarcinoma was confirmed by post-operative pathology for all patients. Comparisons of T-classification, number of lymph node harvested, tumor differentiation, length of distal margin and number of patients with positive circumferential resection margin between the two groups were shown in table2.

The mean operative times were 187.9±60.0min and 231.3±55.7min in senior group and junior group (p<0.001), and the mean blood loss in these two groups were 177.0±100.6ml and 234.3±55.7ml, respectively (p=0.006).The conversion rate was 10.0% (10/100) in senior group and 20.7% (29/140) in junior group, the difference was statistically significant (Table 3). Reasons for conversion showed in table 4 included abdominal cavity adhesion, intra-operative bleeding, adjacent structure invasion, obesity, bulky mass and unclear

Table 4. Comparisons of Reasons for Conversion in these Two Groups

Reasons for conversion	Senior group (n=10)	Junior group (n=27)
Adhesion	3	4
Bleeding	2	12
Unclear anatomy	0	5
bulky mass	2	2
adjacent structure invasion	2	2
obesity	1	2

Table 5. Regression Analysis for Gender and Tumor Size

	Gender		Tumor size	
	t	*P*-value	t	*P*-value
Number of lymph node harvested (mean±SD)	0.859	0.391	0.203	0.132
Operative time, min (mean±SD)	-1.509	0.133	-0.849	0.397
Blood loss, ml (mean±SD)	-1.406	0.161	1.328	0.186
Time to first flatus, day (mean±SD)	1.008	0.315	1.254	0.211
Hospital stay, day (mean±SD)	-0.789	0.431	1.783	0.076
Conversion rate	-0.49	0.625	0.975	0.331
Length of incision, cm (mean±SD)	0.413	0.832	0.102	0.153

anatomy. The most common reason for conversion in senior group was abdominal cavity adhesion, but intra-operative bleeding and unclear anatomy were the main reasons in junior group. The complication rates in the two groups were 12% (12/100) and 19.3% (27/140). Time to passing of first flatus was 3.3±0.9 days in senior group and 3.8±0.9 days in junior group ($p<0.001$). Time to passing of first defecation were 4.2±1.3 days and 4.4±1.4 days in the two groups ($p=0.102$). The hospital stay were 10.8±7.8 days and 13.6±8.0 days, respectively ($p=0.010$).

Either anterior resection or abdominoperineal resection could be applied for patients with rectal cancer which the distance of tumor from anal verge was between 4 and 6cm. In our study, 16 patients in senior group and 34 patients in junior group matched the criteria mentioned above. 11 patients in senior group underwent anterior resection and the sphincter preserving rate was 68.7% (Figure 1), whereas, 12 patients received anterior resection and the sphincter preserving rate was 35.3% in junior group ($p=0.027$).

Discussion

Laparoscopic surgery has been steadily established as a standard operative procedure for patients with colorectal cancer and advantages of this minimal invasive surgery have been confirmed by several studies (Yang et al., 2014; Zhou et al., 2004; Lujan et al., 2009;). In comparison to open surgery, there is less postoperative pain, quicker recovery, less blood loss and so on (King et al., 2006; Ng et al., 2008). However, laparoscopic skill has its limitations, and some factors may influence the learning of this operation. The limited visual operative field, the two-dimensional picture, unskilled of anatomy, and lack of experience of open surgery may be the obstacles for laparoscopic surgery (Rotholtz et al., 2008). Due to the differences in skilled of anatomy, experience of open surgery and adaptive faculty, surgeons will not be able to have the same learning curve. Some studies regarding the learning curve in laparoscopic colorectal resection have been reported. In previous studies, the learning curve of laparoscopic colorectal resection ranged from 16 to 70 cases (Park et al., 2009; Li et al., 2009; Liang et al., 2011). In our study, data of the first 20 consecutive patients of each surgeon was collected and analyzed. Some parameters which were used to determine learning curve were used here for comparing the differences between seniors and juniors.

Oncological outcome is the focus of every surgeon's attention and it is the key factor which determining the success or failure of laparoscopic surgery (Ito et al., 2009). As is known to all, number of lymph nodes harvested, status and length of distal margin and CRM are indexes which are used to evaluate the oncological outcome (Yu et al., 2012; Gao et al., 2013). In our study, the mean numbers of lymph nodes harvested in both of groups were more than 12 which was recommended as the minimum number of lymph nodes by NCCN (Aly et al., 2009). But the difference in number of lymph nodes between the two groups was obvious. This result might present that the dissection of draining regional lymph nodes completed by seniors was more thorough than juniors. The mean length of distal margins in rectal resection between the two groups were nearly the same ($p=0.809$), and there was no positive distal margin in our study. The positive rate of CRM in senior group was 3.2% (2/61) which was lower than 7.8% (7/90) in junior group although no statistically significant difference ($p=0.228$) and the positive rates of the two groups were in the normal range which reported by several studies (Guillou et al., 2005; Soop et al., 2008). We thought that unclear anatomic dimensions or unskilled anatomy might be the reason for the relatively higher positive rate of CRM in junior group. So in our study the oncological outcomes which were completed by seniors and juniors were matched the radical resection criterion and we considered that seniors could give more thoroughly lymph node dissection and more standard TME.

Different experience and aptitude may show a distinct influence on operative time. Reduction in operative time with increasing experience and aptitude has been documented by some studies (Liem et al., 1996; Agachan et al., 1997). The operative time in senior group was obviously shorter than in junior group (187.9±60.0min *vs* 231.3±55.7min, $p=0.006$) in our study. So we confirmed that the experience of open surgery could have serious influence on the operative time of laparoscopic surgery. Meanwhile, we thought that short operative time, clear anatomy and skilled operation could result in the less blood loss and the result of our study showed that the blood loss in senior group was obviously less than in junior group ($p<0.001$).

Furthermore, the conversion rate reflects the importance of experience in laparoscopic colorectal surgery. Conversion rate is also an important factor for evaluating the learning curve. Several conditions can result in conversion in laparoscopic procedure, the common causes include intra-operative bleeding, bulky mass, abdominal cavity adhesion, unclear anatomy, etc. Some studies proved that conversion was associated with a greater postoperative morbidity and mortality (Sjodahl et al., 1998; Staudacher et al., 2007; Pugliese et al., 2008). For experienced surgeons, the reasons for conversion were tumor-associated problems, for example, more advanced tumor stage than expected, whereas for less experienced surgeons, the most common reasons for conversion were adhesion and intra-operative complications (Schlachta et al., 2004). In our study, the conversion rates in senior group and junior group were 10% and 20.7% ($p=0.027$) which were similar to previous results (Lourenco et al., 2008). The first two most common reasons for conversion were abdominal cavity adhesion and intra-operative bleeding in senior group, whereas in junior group the first two reasons were bleeding and unclear anatomy. So experienced in opening surgery and clear anatomy were crucial for reduction of conversion.

Evidence-based medicine has proven that abdominoperineal resection is not the gold standard for low rectal cancer any more, and it is not the only choice for some low rectal cancer. Sphincter preserving rate has increased accompanying by the renewal of idea and application of circular stapler. Whether the sphincter preserving can be applied is determined not only by

tumor-associated factors but by the experience and skill of surgeons. We studied the sphincter preserving rate for low rectal cancer which the distance of tumor from anal verge was between 4 and 6cm, and we found that the sphincter preserving rate in senior group was higher than in junior group (68.7% *vs* 35.3%). The result illuminated that seniors could dissociate the rectum to a deeper position and have the more accurate evaluation although lack of the sense of touch.

In our study there was no statistically significant difference in the perioperative complication rates between the two groups, and the times to first defecation in the two groups were similar (p=0.102). However, the length of incision in senior group was shorter than that in junior group, and the time to first flatus was obviously shorter than in junior group. We considered that juniors had to proceed with some operations which were unable to complete under laparoscopy through the relatively larger incision and they might stir the intestinal canal excessively in the laparoscopic procedure which led to the delayed gastrointestinal recovery, and the longer operative time might be another influence factor for delayed gastrointestinal recovery.

Our data showed that seniors could complete laparoscopic colorectal resection with relatively better oncological outcomes although both of the results performed by senior and junior were matched en bloc resection principle, more operative time and blood loss could be observed for juniors. Seniors could perform laparoscopic colorectal cancer resection with a lower conversion rate compared to juniors. Quicker recoveries, lower complication rates and higher sphincter preserving rates for low rectal cancer could be found in patients underwent laparoscopic colorectal cancer resection completed by seniors. So we considered that seniors could master the laparoscopic skill more easily and quickly and seniors had a better learning curve for laparoscopic colorectal cancer resection.

Acknowledgements

The authors thank Yuan Xing-hua, Zhang Hai-zeng, Tian Yan-tao, Zhao Dong-bing, Bai Xiao-feng, Liu Qian, Feng Qiang, Zheng Zhao-xu for providing the data of patients. Their support was the key factor in completing this paper.

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