Outcomes of Laparoscopic Left Lateral Sectionectomy vs. Open Left Lateral Sectionectomy: Single Center Experience

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Purpose: Laparoscopic surgery has become the mainstream surgical operation due to its stability and feasibility. Even for liver surgery, the laparoscopic approach has become an integral procedure. According to the recent international consensus meeting on laparoscopic liver surgery, laparoscopic left lateral sectionectomy (LLS) might be a new standard of care for left lateral surgical lesions. This study was designed to compare open LLS to laparoscopic LLS.

Methods: In total, 82 patients who had undergone LLS at Chonnam National University Hwasun Hospital between 2008 and 2015 were enrolled in this study. Among them, 59 patients underwent open LLS and 23 underwent laparoscopic LLS. These two groups were compared according to general characteristics and operative outcomes.

Results: The data analysis results showed that laparoscopic liver resection is superior to open liver resection in terms of the amount of bleeding during the operation and the duration of hospital stay. There was no statistical difference between the two groups in terms of operation time (p value=0.747). The amount of bleeding during the operation was 145.5 ± 149.4 ml on average for the laparoscopic group and 320 ± 243.8 ml on average for the open group (p value=0.005). The mean duration of hospital stay was 10.7 ± 5.8 days for the laparoscopic surgery group and 12.2 ± 5.1 days for the open surgery group (p value=0.003).

Conclusion: This study showed that laparoscopic LLS is safe and feasible, because it involves less blood loss and a shorter hospital stay. For left lateral lesions, laparoscopic LLS might be the first option to be considered.

Keywords: Laparoscopy, Left lateral sectionectomy

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INTRODUCTION

The areas of application of the laparoscopic technique have increased of late, and as a useful tool for minimally invasive treatment, it is being adopted by many surgeons in various fields.^{1,2} Surgery using the laparoscopic technique is being

widely performed for cholecystitis, appendicitis, and gastric, small bowel, and colon tumors. The laparoscopic approach for the treatment of these diseases has shown better outcomes than open surgery in terms of the operation duration, amount of bleeding during the operation, degree of wound pain, duration of hospital stay, etc.³⁻⁵

Liver resection is a surgical treatment for various conditions, including hepatocellular carcinoma, metastatic liver malignancy, intrahepatic cholangiocarcinoma, hemangioma, and intrahepatic duct stones. Liver resection using the laparoscopic technique was first attempted several years ago, and it is still developing. The relatively slow development is due to the complexity of liver resection. Thus, despite its many advantages, laparoscopic liver resection is not yet the preferred treatment modality for surgical liver diseases.

The first laparoscopic surgery for cholecystectomy was performed in 1985, while the first laparoscopic liver resection was performed in 1992. With the advanced laparoscopic tools and techniques available at present, many studies have shown that laparoscopic liver resection is safe and feasible for liver disease treatment.⁶⁻¹¹ Despite these advantages, laparoscopic liver surgery is not yet being considered by all surgeons, simply because laparoscopic liver surgery has been challenging until now. According to the recommendations for laparoscopic liver resection from the two international consensus meetings, however, the laparoscopic approach to left lateral sectionectomy (LLS) should be considered the new standard of care.¹²⁻¹⁴

This study aimed to verify the feasibility and safety of laparoscopic liver resection by comparing laparoscopic LLS with open LLS and to determine if the laparoscopic approach can be recommended as a gold standard for the treatment of liver diseases requiring LLS.

MATERIALS AND METHODS

In this retrospective study, the cases of 82 patients who underwent LLS at Chonnam National University Hwasun Hospital within the period from 2008 to 2015 were reviewed.

A group of 59 patients who underwent open LLS (OL group) was compared with a group of 23 patients who underwent laparoscopic LLS (LL group) with respect to demographic characteristics and operative outcomes. Patient data were retrieved from medical records. To compare the operative outcomes between the OL and LL groups, operation time, bleeding amount, and postoperative hospital stay were included as variables.

Open LLSs were initiated with upper midline incisions that extended just up to the umbilicus. Liver tissues were dissected mainly with a CUSA, and the S2 and S3 pedicles were selectively ligated, whereas laparoscopic LLSs were started with umbilical port placement. Superficial liver was usually cut by energy devices, either ultrasound-operating or bipolar instruments. The thinned liver parenchyma was easily divided using an endo-GIA stapler. Two staplers were used in most cases. Specimens were retrieved through a slightly widened trocar incision.

The data were analyzed using SPSS ver. 21 (IBM Co., Ar-

monk, NY, USA). Statistical tests included the Mann-Whitney test, Chi-square test, and Fisher's exact test. A *p* value < 0.05 was considered to be statistically significant. All data were reported as medians.

RESULTS

Patient demographics and clinical features are shown in Ta-

Table 1. General characteristics of subjects

Variables	Open (N = 59)	Laparoscopic (N = 23)	<i>p</i> value
Age (years)	60.0 ± 9.7	62.0 ± 11.7	0.380
Body mass index (kg/m ²)	22.8 ± 2.9	24.5 ± 4.0	0.078
Gender, No. (%)			0.658
Female	21 (35.6)	7 (30.4)	
Male	38 (64.4)	16 (69.6)	
Previous operation history, No. (%)			0.134
No	33 (55.9)	17 (73.9)	
Yes	26 (44.1)	6 (26.1)	
Malignancy, No. (%)			0.999
No	12 (20.3)	4 (17.4)	
Yes	47 (79.7)	19 (82.6)	
Hypertension, No. (%)			0.337
No	40 (67.8)	13 (56.5)	
Yes	19 (32.2)	10 (43.5)	
Diabetes mellitus, No. (%)			1.000
No	47 (79.7)	19 (82.6)	
Yes	12 (20.3)	4 (17.4)	
Hepatitis, No. (%)			0.038
No	47 (79.6)	12 (52.1)	
Yes	12 (20.4)	11 (47.9)	
Liver cirrhosis			0.430
No	54 (91.5)	22 (95.6)	
Yes	5 (0.5)	1 (4.4)	
AST	28.5 ± 11.1	34.2 ± 22.4	0.515
ALT	26.4 ± 15.0	28.8 ± 18.7	0.556
ALP	72.9 ± 20.7	89.0 ± 31.7	0.023
Total bilirubin	0.85 ± 0.5	1.2 ± 4.3	0.117
Direct bilirubin	0.2 ± 0.1	0.2 ± 0.2	0.199
Albumin	4.5 ± 0.3	4.3 ± 0.3	0.059
Prothrombin time	1.0 ± 0.8	1.0 ± 0.7	0.782

ble 1. The mean age of the OL group was 60 years, while the mean age of the LL group was 62 years ($p=0.380$). There were 38 males and 21 females in the OL group and 16 males and 7 females in the LL group ($p=0.658$). The mean BMIs of the OL and LL groups were 22.8 kg/m^2 and 24.5 kg/m^2 , respectively ($p=0.078$). Of the 23 patients in the LL group, six patients (26.1%) had histories of previous operations. In addition, there were no statistically significant differences between the two groups with regard to malignancy ($p=0.99$) or comorbidity ($p=0.752$).

Hepatocellular carcinoma was the most common indication for both groups. Colorectal liver metastasis and left intrahepatic bile duct stones were the second and the third most

common indications for LLS (Table 2).

Operative outcomes are presented in Table 3. Operation time showed no difference between the two groups (OL group, 153.1 ± 43.2 vs LL group, 149.57 ± 46.8 , $p=0.747$). Intraoperative bleeding was significantly less in the LL group than the OL group ($p=0.005$). Postoperatively, time of drain removal, start time of feeding, and PCA use were not significantly different between the two groups ($p=0.324$, $p=0.747$, $p=0.112$, respectively). However, there was a significant difference in postoperative hospital stay (OL group, 12.2 ± 5.1 vs LL group, 10.7 ± 5.8 , $p=0.003$). There were 16 patients who stayed over 14 days. Only one patient had complications, and the other patients stayed over 14 days based on personal preference. The patient with complication had paralytic ileus and stayed for 42 days. After conservative treatment, problem was resolved and

Table 2. Indications for open LLS vs laparoscopic LLS

Disease	Open LLS (N=59)	Lap LLS (N=23)	Total (N=82)
HCC	29	16	45
CRLM	7	2	9
Liver metastasis	5		5
IHCC	4	1	5
IHBD stone	7	3	10
Hemangioma	3		3
Cyst	2		2
FNH	1		1
Fibroma	1		1
Angiomyolipoma		1	1

LLS = Left lateral sectionectomy; HCC = Hepatocellular carcinoma; CRLM = Colorectal liver metastasis; IHCC = Intrahepatic cholangiocarcinoma; IHBD stone = Intrahepatic bile duct stone; FNH = Focal nodular hyperplasia.

Table 3. Operative outcomes

Variables	Open (N=59)	Laparoscopic (N=23)	p value
Intra-operative			
Operation duration (minutes)	153.1 ± 43.2	149.57 ± 46.8	0.747
Intraoperative Bleeding (ml)	320.6 ± 243.8	145.4 ± 149.4	0.005
Postoperative			
Hospital stay (days)	12.2 ± 5.1	10.7 ± 5.8	0.003
Drain removal (days)	3.6 ± 3.4	3.6 ± 2.0	0.324
Feeding start (days)	1.2 ± 0.8	1.1 ± 0.3	0.747
PCA use (days)	3.3 ± 1.1	3.0 ± 1.2	0.112

Table 4. Comparison of operation outcomes (HCC)

Variables	Open (N=29)	Laparoscopic (N=16)	p value
Preoperative			
Age (years)	61.34 ± 9.77	61.75 ± 10.73	0.9013
Gender, No. (%)			0.658
Female	9 (31.03)	5 (31.25)	
Male	20 (68.96)	11 (68.75)	
ASA Score	1.48 ± 0.57	1.31 ± 0.60	0.363
Hepatitis, No. (%)			0.5411
Yes	5 (17.24)	8 (50.00)	
No	24 (82.75)	8 (50.00)	
Liver cirrhosis, No. (%)			0.3989
Yes	2 (17.24)	1 (6.25)	
No	27 (82.75)	15 (93.75)	
Previous operation history, No. (%)			0.5411
Yes	12 (41.37)	5 (31.25)	
No	17 (58.62)	11 (68.75)	
Intraoperative			
Transfusion			0.3989
Yes	5 (17.24)	1 (6.25)	
No	24 (82.75)	15 (93.75)	
Bleeding amount (ml)	282.4 ± 260.37	152.18 ± 138.52	0.034
Operation Time (minutes)	149.1 ± 40.44	155.93 ± 42.23	0.603
Tumor size (cm)	4.65 ± 2.91	3.7 ± 1.76	0.1802
Postoperative			
Hospital stay (days)	11.82 ± 4.21	11.5 ± 6.78	0.862

started oral feeding.

Operative outcomes of the HCC group are presented in Table 4. We analyzed relationships between operative outcomes and age, gender, tumor size, previous operation history, hepatitis, liver cirrhosis, transfusion, bleeding amount, ASA score, operation time, and hospital stay. All patients underwent liver resection without the Pringle maneuver and with the same resection line. The comparison of bleeding amount between the OL and LL groups yielded a significant result (OL group, 149.1 ± 40.44 vs LL group, 155.93 ± 42.23 $p=0.034$).

DISCUSSION

Laparoscopic surgery is already the mainstream method, even for major abdominal surgery. Laparoscopic surgery has proven feasible in terms of the operation duration, amount of bleeding during the operation, pain, and duration of hospital stay in many procedures, such as cholecystectomy, gastrectomy, and colectomy.³⁻⁵ It also has risks, however, including compromised oncological integrity,¹⁵⁻¹⁹ uncontrollable bleeding,¹⁸⁻²¹ and gas embolism,²²⁻²⁵ which have mostly been proven not to be major concerns.²⁶⁻²⁸ However, laparoscopic application to liver surgery was relatively delayed due to the complexity of the operation. Recently, two consecutive international consensus meetings made several points,¹²⁻¹⁴ including that LLS can be safely performed laparoscopically and should be the new standard of care. This study was designed to determine whether laparoscopic LLS can be considered the first choice for treating intrahepatic left lateral surgical diseases.

We performed 82 LLSs from 2008 to 2015. Among the 82 LLSs, 23 cases were performed laparoscopically and 59 were open. Indications for LLS did not differ according to the operation type. No differences were found between the two groups with regard to the patient demographics or clinical characteristics (Table 1).

Operative outcomes were also analyzed in terms of operation time and bleeding. Operation time showed no difference between the groups, but bleeding was significantly lower in the laparoscopic group, which is consistent with other reports. This is a key benefit of laparoscopic surgery compared to open surgery. The average amount of bleeding that occurred during the laparoscopic surgeries was 145.4 ml, while it was 320.6 ml during the open surgeries. The amounts of bleeding were checked by counting used gauze pads and measuring the contents of suction bottles. Based on these results, we assume that the differences in the two groups were caused by the operator's sensitive response to bleeding control. None of these liver resections was a major liver resection, and thus, they did not cause large amounts of bleeding. Another reason for the reduced amount of bleeding during laparoscopic liver resec-

tion is thought to be the difference in the surgical tools used. In the laparoscopic approach, the operator used a CUSA, harmonic scalpel (Ethicon Endo-Surgery, Cincinnati, OH, USA), radiofrequency probe (Habib 4X, Angiodynamics, Queensbury, NY, USA), and endo-surgical stapler with a vascular load (Ethicon Endo-Surgery or Covidien, Mansfield, MA, USA). In laparoscopic liver resection, no damage is done to the abdominal walls, except the hole through which the port enters and the hole for extracting the resected liver; energy devices are used when the liver resection range is secured and the liver is resected; and GIA is used for the major resection of the liver. Therefore, it is easy to control the bleeding. For laparoscopic surgery, various advanced tools are used, and the difference in the tools used causes a significant reduction in the average amount of bleeding that occurs during the operation.

Laparoscopic surgery has also an advantage in terms of the duration of hospital stay after the operation compared to open surgery. In this study, postoperative hospital stay was significantly shorter in the LL group ($p=0.003$, Table 3). These advantages have been mentioned in other studies as major benefits of laparoscopic surgery, and they are also shown in LLS. The smaller amount of damage on the abdominal walls in laparoscopic surgery is thought to have a beneficial effect on the duration of hospital stay after the operation. As the possibility of wound infection is lower in laparoscopic surgery than in open surgery, and as the level of pain is lower, laparoscopic surgery can reduce the duration of hospital stay.

Table 4 shows the relationships between many factors in HCCs. All operations had sufficiently long resection margins (over 1 cm) and produced curative resections. All liver resections were performed in the same resection line, and no masses were out of the left lateral segment. In addition, relevant numerical values were used in measuring bleeding amount in LLS.

All LLSs were performed by three operators. The OL group's LLSs were performed by two operators, and the LL group's LLSs were performed by one operator. Therefore, this may have caused errors in the data comparison.

This study showed that laparoscopic LLS can be a new standard of care for left laterally located surgical diseases. Unfortunately, this study's sample size was relatively small. Thus, a multicenter study or larger case study should be conducted in future.

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