pISSN: 2508-5778 • eISSN: 2508-5859
Ann Hepatobiliary Pancreat Surg 2022;26:133-137
https://doi.org/10.14701/ahbps.21-161

AHBPS
Annals of Hepato-Biliary-Pancreatic Surgery

Original Article

Pure laparoscopic versus open left lateral sectionectomy for hepatocellular carcinoma: A propensity score matching analysis

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Backgrounds/Aims: Anatomical resection has superior oncologic outcomes over non-anatomical resection in hepatocellular carcinoma, and left lateral sectionectomy is the simplest and easiest perform anatomical resection procedure among liver resections. The purpose of this study was to find out the safety and feasibility of pure laparoscopic left lateral sectionectomy (PLLLS) for hepatocellular carcinoma.
Methods: Patients who underwent left lateral sectionectomy at a tertiary referral hospital, from August 2007 to April 2019 were enrolled in this retrospective study. After matching the 1 : 3 propensity score, 17 open and 51 pure laparoscopic cases were selected out of 102 cases of total left lateral resection for hepatocellular carcinoma. The group was analyzed in terms of patient demographics, preoperative data, and postoperative outcomes.
Results: During the study period, there was no open conversion case. The mean operative time and complication were not statistically significant different between the two groups. There was no statistically significant difference in disease-free survival and overall survival had no statistical between the two groups. There were no mortality cases, and postoperative hospital stay was significantly shorter in the PLLLS group than in the open left lateral sectionectomy (OLLS) group.
Conclusions: The oncologic outcomes and complication rate were the same in the PLLLS and OLLS groups. However, the hospital stay was shorter in the PLLLS group than in the OLLS group. The present study findings demonstrate that the PLLLS is a safe and feasible procedure for hepatocellular carcinoma.

Key Words: Pure laparoscopic left lateral sectionectomy; Hepatocellular carcinoma

INTRODUCTION

Laparoscopy, a representative of minimally invasive surgery, has been widely adopted by various surgical specialties including liver resection. Since the first procedure was reported in 1992, numerous laparoscopic liver resection (LLR) procedures have been performed [1]. Unfortunately, there was no guarantee of positive outcomes of malignant tumors procedures in the early days of LLR, so most of the surgeons preferred to operate on benign cases [2]. However, as time passed, LLR was applied to the malignant tumors, including hepatocellular carcinoma (HCC), and several studies showed that LLR had comparable oncologic outcomes with open liver resection [3-5].

It is well known that anatomical resection (AR) has superior oncologic outcomes over non-anatomical resection (NAR) in HCC [6-8]. In particular, left lateral sectionectomy is the most basic and straightforward procedure for AR, so it is easy to apply laparoscopy [2].

This study aimed to compare pure laparoscopic left lateral

Received: November 19, 2021, **Revised:** November 22, 2021,
Accepted: November 22, 2021

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sectionectomy (PLLLS) and conventional open left lateral sectionectomy (OLLS) in HCC patients in terms of the oncologic outcomes and to investigate the safety and feasibility of PLLLS.

MATERIALS AND METHODS

Ethical statement

This study protocol was reviewed and approved by the institutional review board of the Asan Medical Center in Seoul, Korea (no. 2021-1507). The requirement for informed consent was waived because of the retrospective nature of this study.

Patients

This was a retrospective study for 260 patients who underwent LLS from August 2007 to April 2019 at Asan Medical Center, Seoul, Korea. We included patients with HCC only at the liver lateral section, segment s2 and 3. We exclude other LLS cases: previous upper abdominal surgery history including liver surgery, HCC with combined pathology, and accompanying HCC other than the left lateral section. All the patients had no significant anesthetic problem ASA I–II (American Society of Anesthesiology classes) and only Child-Pugh classification A.

The following tests were run: blood test, a viral marker for hepatitis, indocyanine green retention rate at 15 minutes (ICG-R15), triphasic liver dynamic computed tomography (CT), double-contrast magnetic resonance imaging (MRI), positron emission tomography (PET) scans, chest CT scans, and tumor markers. A total of 102 LLS cases were selected; 21 open cases and 91 laparoscopic cases.

Surgical technique, pure laparoscopic left lateral sectionectomy

The patient underwent surgery at the lithotomy position after general anesthesia. The surgeon was located between the patient's legs, and the assistants were located on the patient's left side. The pneumoperitoneum pressure was maintained at 12 mmHg by carbon dioxide gas, and five trocars were used during the operation.

First, the left triangular ligaments and the coronary ligaments were detached using a Thunderbeat device (Olympus, Tokyo, Japan) to mobilize the left lateral segment of the liver. Parenchymal dissection was performed along the left side of the falciform ligament using a laparoscopic ultrasonic aspirator (CUSA Excel; Integra Lifesciences Corporation, Plainsboro, NJ, USA). During parenchymal resection, the Pringle maneuver was usually performed. When the top and bottom of the parenchyma were sufficiently dissected, the remaining part of the liver was excised using a unilateral linear stapler (Endo TA 30 mm; US Surgical, Norwalk, CT, USA). The specimen was put in the endo-bag and retrieved through a Pfannenstiel incision.

Surgical technique, open left lateral sectionectomy

The patients were under the supine position after general anesthesia. Usually, a midline or reverse-L incision was performed. The surgical method was not significantly different from that of PLLLS. The left triangular ligaments and the coronary ligaments were detached using a bovie, and the parenchymal dissection was performed using an ultrasonic aspirator (CUSA Excel; Integra Lifesciences Corporation). Likewise, the Pringle maneuver was usually performed.

Statistical analysis

The PLLLS and OLLS groups were compared using the chi-square test and Fisher's exact test for categorical variables, whereas continuous variables were assessed using the independent t-test. To minimize the effect of potential confounders on selection bias, 1 : 3 propensity score matching (PSM) between the two groups was applied using multiple logistic regression. Independent variables were entered into the propensity model included sex, age, body mass index, tumor marker, tumor size, tumor number, tumor sum, tumor size, tumor number, tumor size sum, disease type caused hepatitis, Child-Turcotte-Pugh grade, preoperative treatment (radiofrequency ablation or trans-arterial chemoembolization, smoking history, alcohol history, a pre-existing condition such as hypertension and diabetes mellitus. A p-value of < 0.05 was considered statistically significant.

Table 1. Demographic and preoperative characteristics of the patient before propensity score matching

Characteristic	PLLLS (n = 91)	OLLS (n = 21)	p-value
Age (yr)	54.68 ± 10.57	61.14 ± 9.64	0.01
Sex (male)	59 (64.8)	18 (85.7)	0.06
BMI (kg/m^2)	23.87 ± 2.73	24.99 ± 2.75	0.09
α-fetoprotein (ng/mL)	189.87 ± 633.74	82.47 ± 230.65	0.45
Tumor size (cm)	2.53 ± 1.26	4.20 ± 3.09	0.02
Tumor number	1.02 ± 0.15	1.19 ± 0.87	0.39
Tumor sum (cm)	2.57 ± 1.30	4.30 ± 3.04	0.02
Disease type			0.17
HBV	73 (80.2)	13 (61.9)	
HCV	3 (3.3)	2 (9.5)	
Others	15 (16.5)	6 (28.6)	
CTP grade	89 (97.8)	20 (95.2)	0.51
Preoperative treatment	17 (18.7)	3 (14.3)	0.64
Smoking	45 (49.5)	10 (47.6)	0.88
Alcohol	51 (56.0)	13 (61.9)	0.63
DM	21 (23.1)	6 (28.6)	0.60
HTN	26 (28.6)	10 (47.6)	0.09

Values are presented as mean ± standard deviation or number (%).
PLLLS, pure laparoscopic left lateral sectionectomy; OLLS, open left lateral sectionectomy; BMI, body mass index; HBV, hepatitis B virus; HCV, hepatitis C virus; CTP, Child-Turcotte-Pugh; DM, diabetes mellitus; HTN, hypertension.

Table 2. Demographic and paraoperative characteristics of the patient after propensity score matching

Characteristic	PLLLS (n = 51)	OLLS (n = 17)	*p*-value
Age (yr)	62.03 ± 10.31	62.64 ± 6.35	0.81
Sex (male)	38 (74.5)	14 (82.4)	0.51
BMI (kg/m^2)	24.25 ± 2.92	25.60 ± 2.85	0.19
α-fetoprotein (ng/mL)	49.59 ± 57.44	40.54 ± 106.21	0.72
Tumor size (cm)	2.92 ± 1.16	4.05 ± 3.84	0.15
Tumor number	1.00 ± 0.00	1.14 ± 0.62	0.34
Tumor sum (cm)	2.92 ± 1.16	4.25 ± 3.74	0.10
Disease type			0.44
HBV	41 (80.3)	13 (76.4)	
HCV	3 (5.9)	2 (11.8)	
Others	7 (13.8)	2 (11.8)	
CTP grade	51 (100)	17 (100)	> 0.99
Preoperative treatment	17 (33.3)	4 (23.5)	0.45
Smoking	18 (35.3)	7 (41.2)	0.66
Alcohol	16 (31.4)	5 (29.4)	0.88
DM	6 (11.8)	3 (17.6)	0.54
HTN	9 (17.6)	6 (35.3)	0.13

Values are presented as mean ± standard deviation or number (%).
PLLLS, pure laparoscopic left lateral sectionectomy; OLLS, open left lateral sectionectomy; BMI, body mass index; HBV, hepatitis B virus; HCV, hepatitis C virus; CTP, Child-Turcotte-Pugh; DM, diabetes mellitus; HTN, hypertension.

RESULTS

Table 1 shows the preoperative characteristics of the PLLLS and OLLS groups before PSM. The preoperative characteristics after PSM are shown in Table 2. Seventeen patients in the OLLS group and 51 patients in the PLLLS group were included in the study. There were no statistically significant differences in preoperative characteristics between the two groups.

The postoperative outcomes after PSM are summarized in Table 3. During the study period, there was no open conversion of the PLLLS group. There was no statistical significance in the mean operative time between the groups (172.55 ± 88.79 min vs. 133.18 ± 35.95 min; $p = 0.07$). Complications were not statistically different between the two groups, while the postoperative hospital stay was significantly shorter in the PLLLS group than in the OLLS (6.73 ± 1.44 day vs. 10.82 ± 3.79 day; $p < 0.01$).

Fig. 1 shows the disease free survival and overall survival between the two groups. There was no statistically significant difference between the two groups in terms of oncologic outcomes (disease free survival, $p = 0.69$; overall survival, $p = 0.38$).

Fig. 2 shows the operation time for each case. After the 20th case, it can be seen that the operation time was constant between 100 and 200 minutes.

Table 3. Postoperative outcomes of the patient after propensity score matching

Variable	PLLLS (n = 51)	OLLS (n = 17)	*p*-value
Operative time (min)	172.55 ± 88.79	133.18 ± 35.95	0.07
Open conversion	0 (0)	- (-)	> 0.99
Resection margin (R0)	51 (100)	17 (100)	> 0.99
Resection margin (mm)	28.18 ± 21.20	22.55 ± 20.11	0.44
Complication			0.98
Clavien-Dindo I, II	0 (0)	2 (11.8)	
Clavien-Dindo III, IIV	0 (0)	0 (0)	
Mortality	0 (0)	0 (0)	> 0.99
Postoperative diet (day)	2.27 ± 0.63	2.55 ± 1.51	0.40
Postoperative day (day)	6.73 ± 1.44	10.82 ± 3.79	< 0.01

Values are presented as mean ± standard deviation or number (%).
PLLLS, pure laparoscopic left lateral sectionectomy; OLLS, open left lateral sectionectomy.

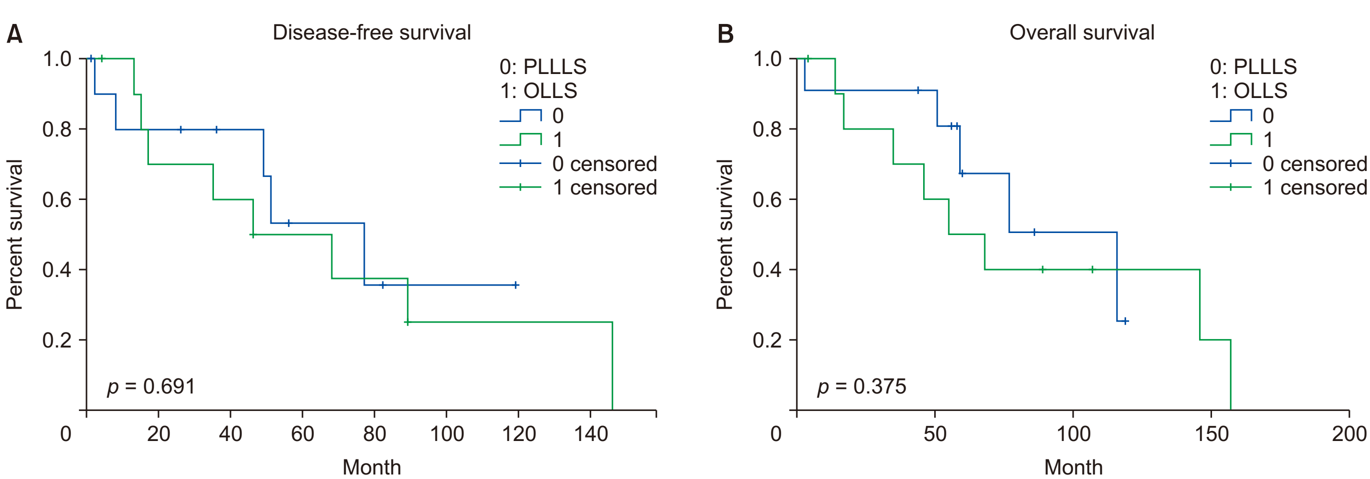

Fig. 1. Disease-free survival (A) and overall survival (B) of pure laparoscopic left lateral sectionectomy (PLLLS) and open left lateral sectionectomy (OLLS).

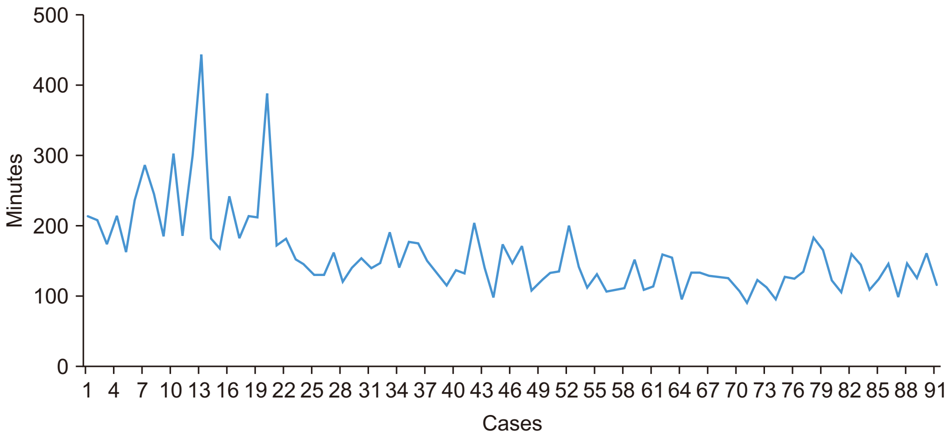

Fig. 2. Operative time according to the analysis of the consecutive cases.

DISCUSSION

Our results were not significantly different from those of the previous studies which showed that after PSM, complications were not significantly different between the two groups, and the hospital stay was significantly shorter in the PLLLS group than in the OLLS group [5,9,10]. In the present study the operation time was slightly longer in the PLLLS group than in the OLLS group, but with no statistically significant difference. These results are consistent with the meta-analysis study of Macacari et al. [10]. In general, it is known that the laparoscopic procedures have a longer operation time than the open procedures for major hepatectomy [3,4]. However, in the case of left lateral sectionectomy, the area of parenchymal dissection is not as wide as that of major hepatectomy, so the operation time gap between the laparoscopic and open procedures could be reduced. Previously, when there was no much LLR experience, open surgery was preferred in cases of large or multiple tumors. Reflecting this trend, there was no statistically significant difference after PSM, but there were cases in which the tumors were large or multiple in the open group.

In the early days of LLR, Vigano et al. [11] argued that for minor hepatectomies the conversion rate reaches the average value at the 60th consecutive case. According to a recent meta-analysis, the median number of cases required to surmount the learning curve for all the included LLR was 34 (range, 18–60). When only studies that used the CUSUM methodology were included, the median learning curve for LLR (excluding donor hepatectomy) was 50 (25–58) [12]. In our series, since there was no open conversion, our results showed that the operation time was constant—between 100 and 200 minutes after 446 minutes in the 13th case and 390 minutes in the 20th case out of a total of 91 consecutive cases (Fig. 1). This shows a smaller number of learning curves than in the previous studies because PLLS is a relatively easy-to-access minor resection.

During the study period, there were no reported complications in the PLLLS group after PSM. There was one wound problem, one Levin tube insertion due to postoperative ileus in the OLLS group. Although there was no statistically significant difference, there were fewer complications in the PLLLS group. These results are similar to those of the previous studies [5,9,10]. Our study did not show any difference in oncologic outcomes in the conventional OLLS group (disease free survival, p = 0.69; overall survival, p = 0.38). In addition, the PLLLS group had a shorter hospital stay (6.73 ± 1.44 day vs. 10.82 ± 3.79 day, p = 0.01). The fact that LLR has a faster recovery and shorter hospital stay than conventional open surgery has been proven in many studies, and this is a representative advantage of laparoscopy [3-5,9,10,13]. It is thought that because the incision is smaller than in conventional open surgery, the hospitalization period is shorter with less postoperative pain and enables early mobilization.

This study has some limitations. First, it was not a prospective randomized study and therefore carries the inherent biases of retrospective non-randomized study. However, the authors tried to correct the preoperative conditions in the same way by performing PSM to reduce this bias. Second, since our center is a high volume center that performs more than 500 liver resections per year, it may be difficult to apply our experience directly to surgeons in hospitals with a small number of cases. Third, in our experience, the advantages of PLLLS are so clear that it is difficult to compare the surgeries during the same period because OLLS is rarely performed now.

Minimally invasive surgeries such as laparoscopy have several advantages compared to conventional open surgeries. In the present study, there were no differences in oncologic outcomes, complications, and hospital stays among the groups. Therefore, compared to the conventional open procedure, there are no disadvantages and significant advantages in the PLLLS procedure. This is consistent with the results of the previous studies. Currently, laparoscopic minor liver resection such as left lateral sectionectomy is considered the golden standard [13,14]. Based on our findings, the authors predicated that PLLLS is a safe and reproducible procedure.

FUNDING

None.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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Conceptualization: KHK, SH, SGL. Data curation: SJB, HDC, YIY. Methodology: KHK, SH, GWS, DHJ, GCP. Visualization: CSA, DBM, TYH, DHJ. Writing - original draft: SJB, HDC. Writing - review & editing: HDC, KHK.

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