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Totally laparoscopic anatomical liver resection for centrally located tumors

A single center experience

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Abstract

Laparoscopic major hepatectomy is a common procedure that has been reported frequently; however, laparoscopic resection of centrally located tumors involving segments 4, 5, and 8 remains a technically difficult procedure because it requires 2 transection planes and dissection of numerous branches of the hepatic vein and glissonean capsule compared to hemi-hepatectomy. Here, we present 7 cases of totally laparoscopic right anterior sectionectomy (Lap-RAS) and 3 cases of totally laparoscopic central bisectionectomy (Lap-CBS).

Between May 2013 and January 2015, 10 totally laparoscopic anatomical resections of centrally located tumors were performed in our institution. The median age of the patients was 54.2 (38–72) years and the median ICG-R15 was 10.4 (3.9–17.4). There were 8 patients with hepatocellular carcinoma (HCC) and 2 with metastatic colorectal cancer. All the HCC patients has the liver function impairment on the degree of Child-Pugh score A.

The mean operation time was 330 ± 92.7 minutes with an estimated blood loss of 325 ± 234.5 mL. Only 1 patient required transfusion during surgery. Mean postoperative hospital stay was 9.5 ± 3.4 day and postop complication was reported only 1 case that has the fluid collection at the resection margin of the liver. Mean resection margin was 8.5 ± 6.1 mm and tumor size was 2.9 ± 1.9 cm.

Totally lap-RAS and lap-CBS are feasible operative procedures in patients with centrally located tumor of the liver and particularly in patients with limited liver function such as those with cirrhosis.

Abbreviations: CUSA = cavitron ultrasonic surgical aspirator, HCC = hepatocellular carcinoma, Lap-CBS = laparoscopic centralbisectionectomy, Lap-RAS = laparoscopic right anterior sectionectomy, LH = laparoscopic hepatectomy, OH = open hepatectomy, PT = prothrombin time, TACE = transarterial chemoembolization.

Keywords: anatomical resection, centrally located tumor, hepatocellular carcinoma, laparoscopic CBS, laparoscopic hepatectomy, laparoscopic RAS

1. Introduction

Since the first laparoscopic hepatectomy (LH) reported in the early 1990s, the use of laparoscopic liver surgery has increased markedly.[1,2]

The indications for LH expanded from nonanatomical resection to anatomical resection, in particular in the 2000s. A study reported no significant differences between open hepatectomy (OH) and LH in terms of the oncologic outcome.[3–7] This led to an increasing acceptance of LH, which is currently a common procedure for the surgical treatment of HCC.

Until the mid-2000s, there was no-consensus regarding the use of LH for the treatment of malignant tumors adjacent to major structures such as the hepatic vein and inferior vena cava, and central segments such asS4, S5, and S8;[8–10] however, increasing experience in surgical techniques and the development of laparoscopic instruments helped overcome the difficulties associated with the procedure.

Because cirrhosis is present in more than 80% of patients with HCC, maintaining adequate liver function during resection is extremely important for patient survival. In patients with HCC, particularly in those with centrally located tumors, achieving laparoscopic anatomic resection with adequate resection margins is difficult.[11–13] In addition, LH for centrally located tumors is technically demanding because it requires 2 transection planes and dissection of numerous branches of the hepatic vein and glissonean capsule compared to hemi-hepatectomy such as right hemi-hepatectomy.

For these reasons, LH for centrally located tumors is a specialized procedure that is performed in a few centers around the world.

In the present study, we present clinical data and follow-up results of patients who underwent totally LH for centrally located tumors and assess the safety and feasibility of the procedure.

2. Patients and methods

2.1. Patient information

Between May 2013 and January 2015, 7 cases of totally lap-RAS and 3 cases of totally lap-CBS for centrally located tumors were performed in our institution.

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Table 1

Demographic data of the patients.

Characteristics		N = 10
Age, mean, y		54 ± 12.54
Gender		
	Male	7
	Female	3
Body weight, kg		65.92 ± 11.84
Body mass index, mean		24.7 ± 2.41
ICG-R15, mean*		10.4 ± 3.64
Pathologic type		
	Hepatocellular carcinoma	8
	Metastatic colorectal cancer	2
Preoperative laboratory values	Total bilirubin, mg/dL	0.99 ± 0.41
	Aspartate transaminase, U/L	38.45 ± 21.56
	Alanine transaminase, U/L	44.23 ± 25.78
	Platelets, $\times 10^3/\mu L$	155.12 ± 52.67
	Prothrombin time, INR	1.11 ± 0.15

* ICG-R15 = indocyanine green retention 15 min test.

We achieved the informed consent with each patient and approved by the Ethics Committee of the Asan Medical Center.

Patients who underwent hepatectomy of more than 2 segments were included.

Selection criteria for laparoscopic surgery in our center included the following: Child's class A cirrhosis, solitary lesion with less than 7 cm, the lesion without major vessel, and hilar structure invasion.

All data were analyzed retrospectively. The baseline characteristics of the 10 patients included in the study are shown in Table 1.

2.2. Operative technique

Patients were placed under general anesthesia and positioned in the lithotomy position with slight right-side-up. After insertion of a 12 mm umbilical port using the closed method with a Veress needle, a pneumo-peritoneum was generated by insufflation of CO_2, and the intra-abdominal pressure was maintained below 12 mm Hg. Four additional ports (three 12 mm ports and one 5 mm port) were placed (Fig. 1).

The operator was positioned between the patient's legs. After performing cholecystectomy, the falciform ligament was dissected away from the anterior abdominal wall using a Ligasure device, (Thunderbeat, Olympus, Tokyo, Japan).

After isolation of the right anterior or right Glissonean pedicle from the hepatic parenchyma at the hilum using the endoscopic dissector (Goldfinger, Ethicon Endo-surgery, Cincinnati, OH). Glissonean capsule was lifted using the nylon tape. The right posterior Glissonean pedicle was isolated in cases of Lap-RAS and Lap-CBS, and the anterior pedicle of Glissonean capsule was clamped. After marking the ischemic demarcation line, a guidance line was drawn using the bovie device. The inferior right hepatic vein was ligated, and the right triangular ligament was dissected because of the mobility of the liver. Liver traction was done by atraumatic graspers (Direct Drive laparoscopic grasper; Applied Medical Resources, Rancho Santa Margarita, CA). The medial side of the liver parenchyma was then transected using the CUSA (cavitron ultrasonic surgical aspirator) and a Ligasure device, (Thunderbeat, Olympus, Tokyo, Japan) with the Pringles maneuver. The branches of the hepatic vein and

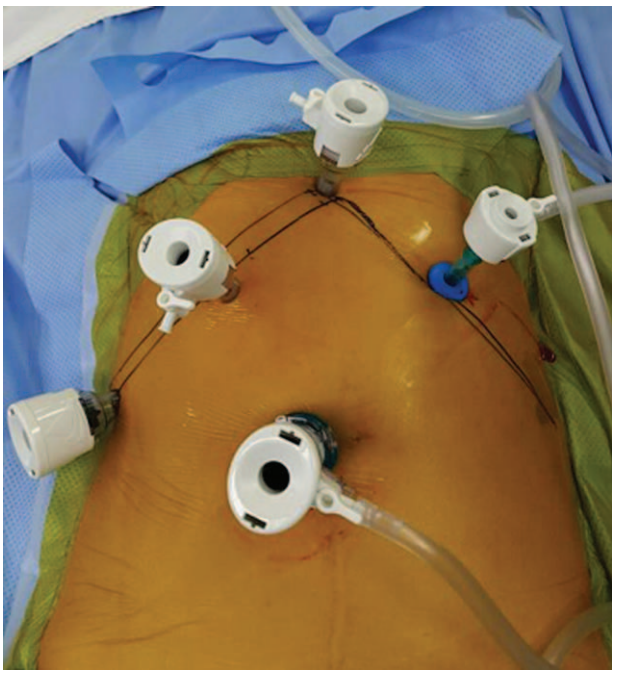

Figure 1. Location of trochar.

Glissonean capsule were ligated using the Hem-o-lok surgical clip or metal clip. In cases of Lap-CBS, the right side of the falciform ligament was transected at the line of the liver parenchyma.

After completion of the medial side dissection, transection of the lateral side was performed along the demarcation line between the right anterior and posterior sections or right anterior and left medial sections.

The small branches of the hepatic vein were controlled with endo-clips. After some degree of parenchymal dissection on the lateral side of the liver, the right anterior Glissonean pedicle was transected using an endoscopic linear stapler (Endo GIA Curved Tip Reload with Tri-Staple with iDrive Ultra Powered Stapling System; Medtronic, Minneapolis, MN).

In the case of lap-CBS, after parenchymal dissection, endoscopic linear stapler (Endo GIA Curved Tip Reload with Tri-Staple with iDrive Ultra Powered Stapling System; Medtronic, Minneapolis, MN) with 60 mm tan cartridge was used to ligate the middle hepatic vein.

Once the resected specimen was divided completely, it was inserted into an endobag and extracted via a separate Pfannenstiel incision at the pelvic area. After carefully performing hemostasis, fibrin glue and some of the hemostatic material were applied to the dissected liver surface. A drain was inserted and the wound was closed layer by layer (Fig. 2).

2.3. Statistical analysis

Data with a normal distribution are reported as mean (standard deviation). Variables not fitting a normal distribution are presented as median (range). Continuous variables were compared by Student's *t* test if normally distributed; otherwise, the Mann–Whitney *U* test was used.

Categorical variables were compared by the Chi-square test. Patient overall and disease-free survival rates were estimated

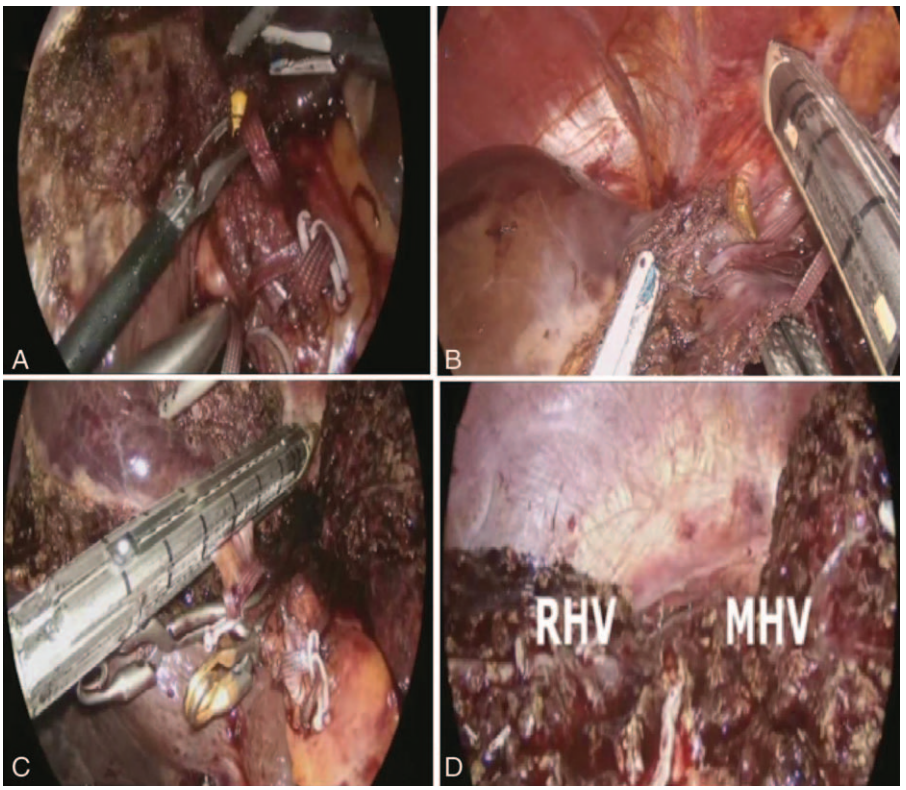

Figure 2. Intraoperative views of the major steps on total laparoscopic anterior sectionectomy. (A) Right anterior glisson was isolated using the nylon tape. (B) In the case of CBS, the middle hepatic vein was divided using a vascular endoscopic stapler. (C) Right anteriorglisson was divided using a vascular endoscopic stapler. (D) Laparoscopic view after completion of a right anterior sectionectomy. CBS = centralbisectionectomy, RHV=right hepatic vein, MHV=middle hepatic vein.

using the Kaplan–Meier method and compared with log-rank tests. Data were considered statistically significant at $P < 0.05$. Statistical analyses were conducted using SPSS 21.0 for Windows (SPSS, Chicago, IL)

3. Results

None of the patients required conversion to open surgery during the operation and no intra-operative mortality occurred. Only 1 patient required a blood transfusion during the operation. The overall postoperative outcomes of the patients are shown in Table 2.

The mean operation time was 330 ± 92.7 minutes and the mean estimated blood loss was 325 ± 234.5 mL. The mean tumor size was 2.9 ± 1.9 cm and the mean resection margin was 8.5 ± 6.1 mm; all patients had clear resection margins.

Median follow period of the patients was 25.3 (20.4–41.4) months and last follow-up date was 30th, September, 2015. Follow-up loss has not occurred and also, there has not occurred fatal complication such as postoperative liver failure and in-hospital mortality.

In our study, we applied the "50–50 criteria" which the postoperative liver failure has defined prothrombin time (PT) <50% and total bilirubin> 50 μml/L at the POD 5.

Among the patients, only 1 patient relapsed HCC after surgery 6 months later and treated transarterial chemoembolization (TACE).

Patients were discharged on postoperative days 8–12, except 1 patient who underwent lap-RAS was discharged on postoperative day 20 because of fluid collection at the resection margin. This patient was managed with percutaneous drainage and showed complete recovery at the time of discharge.

4. Discussion

LH has been proposed as a safe and feasible treatment option for liver disease. In particular, studies have shown that LH has better results than open surgery in terms of a lower incidence of postoperative complications and shorter hospital stay.[1,13–17]

Despite a significant number of reported laparoscopic liver resections, laparoscopic surgery for centrally located tumors remains a difficult procedure because of poor visualization of the operative field and difficulty controlling bleeding during parenchymal transection.[8,18,19]

Surgery for centrally located tumors involves 2 transection planes in addition to the presence of many hepatic veins and

Table 2

Overall postoperative outcomes.

Variable	Mean ± SD
Operation time, min	330 ± 92.7
Estimated blood loss, mL	325 ± 234.5
Resection margin, mm	8.5 ± 6.11
Hospital stay, d	9.5 ± 3.41
Tumor size, cm	2.9 ± 1.94
Postoperative complications, n, %	1 (10.0)*

SD = standard deviation.
* Fluid collection at the resection margin.

glissonean pedicles in the operative field. Therefore, the risk of bleeding during surgery is higher than that associated with laparoscopic hemi-hepatectomy, leading to a higher number of required transfusions and extended operating times.[9,19,20]

Malignant liver tumors are associated with liver cirrhosis in more than 80% of cases, and structures such as veins, glissonean pedicles, and the liver parenchyma are difficult to distinguish in the cirrhotic liver during resection.[21]

Because of these difficulties, surgeons with extensive experience should perform LH for centrally located tumors.

Another important concern is how to precisely maintain 2 transection lines properly with a safe resection margin. This is an important factor in the resection of malignant tumors because the resection margin has a significant effect on the postoperative survival rate.[7,13,22,23]

In patients with malignant tumors who have a cirrhotic liver, a sufficient remnant volume should be secured to avoid fatal complications, such as the postoperative hepatic failure due to the lack of liver regeneration ability compared with that in patients with normal liver function.[24,25]

Since the important factors associated with resection are to ensure a sufficient remnant liver volume and safe resection margins, surgeons should perform a preoperative radiologic work-up including computed tomography (CT) and magnetic resonance imaging (MRI) to evaluate the anatomical features of the patient before surgery.[26–29]

Laparoscopic ultrasonography can help achieve a secure resection margin because laparoscopic surgery does not rely on tactile sensation.

In the present study, the mean operation time was 330 ± 92.7 minutes and the mean estimated blood loss was 325 ± 234.5 mL, which is consistent with previously reported data on LH and OH for centrally located tumors.[15,30,31] None of the patients required conversion to open surgery and the complication rate was low (10%).

Looking at the oncological perspective, the mean tumor size in the present study was 2.9 cm and tumors larger than 2 cm accounted for 70% (7/10) of the total.

The mean resection margin was 8.5 mm pathologically and there were no cases of positive resection margins, suggesting that centrally located tumors with a relatively large size can be treated by LH.

The median follow-up period was 25.3 months of our enrolled patients and only 1 case has tumor recurred.

These results look not bad in terms of mid-term prognosis although a relatively short follow-up period.

But, the present study had several limitations. The number of cases was small; therefore, additional studies should be performed to further verify the safety and feasibility of LH for centrally located tumors through a comparative study with OH and a larger number of cases.

5. Conclusion

Totally lap-RAS and lap-CBS are feasible operative procedures in patients with tumors located at the central portion of the liver and particularly in patients with limited liver function such as those with cirrhosis.

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