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Strategies to Perform Curative Laparoscopic Repeat Hepatectomy for Recurrent Liver Tumors After Open Right Lobectomy

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Abstract. *Background: Although indications of laparoscopic hepatectomy have been expanded, the laparoscopic approach after right hepatic lobectomy has a very high burden. The purpose of this study was to evaluate patients undergoing laparoscopic repeat hepatectomy for recurrent hepatic tumors after open right lobectomy. Patients and Methods: Five cases of laparoscopic repeat hepatectomy for recurrent hepatic tumors after open right lobectomy were included in the study. Results: All the tumors in segment 3 were intraoperatively detected and curatively resected by partial hepatectomy. The tumors in segment 2 could not be detected intraoperatively due to hypertrophic liver deformity and adhesion. They were curatively resected by anatomical subsegmental approach. Conclusion: For recurrent tumors located in segment 2 after right lobectomy, anatomical subsegmental approach should be preferred, not only from an oncological standpoint, but also for securing curative laparoscopic resection and overcoming anatomical difficulties.*

Presently, laparoscopic hepatectomy is widely indicated due to the increasing number of experiences by surgeons and technical developments in the field of medicine (1). Hepatectomy has active application in cases of intrahepatic recurrence of hepatocellular carcinoma (HCC) and liver metastases. Although indications of laparoscopic repeat hepatectomy have increased, it poses several risks including conversion and post-surgical complications (2).

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The deformity of the liver and surrounding scars and adhesions after hepatectomy make the localization and identification of tumors difficult. Intraoperative ultrasonography (IOUS) of the liver is a mandatory step for detecting tumors in hepatectomy (3). Laparoscopic IOUS is as reliable as open IOUS in detecting liver tumors and planning liver resection (4), but the reliability of laparoscopic IOUS in repeat hepatectomy has been poorly evaluated.

Subcapsular hepatic tumors can be identified on the liver surfaces by intraoperative fluorescence imaging following preoperative intravenous injection of indocyanine green (ICG). This technique has potential benefit and compensates for the disadvantages of IOUS. However, ICG-fluorescence imaging can detect tumors which are located only up to 8 mm from the hepatic surfaces because of the limitation of tissue penetration of fluorescence signals (5).

With increasing laparoscopic repeat hepatectomy, we frequently come across cases in which tumors are not detected intraoperatively due to adhesions and deformity of the liver after hepatectomy. The purpose of this study was to evaluate patients undergoing laparoscopic repeat hepatectomy for recurrent hepatic tumors after open right lobectomy and establish the strategies for performing curative laparoscopic resection in them.

Patients and Methods

Between January 2020 and December 2020, 60 patients underwent laparoscopic hepatectomy including repeat hepatectomy (n=21) at the Department of Surgery, Jikei University Hospital, Tokyo, Japan. Of these, five patients with recurrent hepatic tumors after open right lobectomy were included in the study. This study was approved by the Ethics Committee of the Jikei University School of Medicine (27-177).

A 59-year-old man with a history of open right lobectomy for HCC had recurrent HCC in segment 2 (Figure 1A and B). The tumor was not detected using IOUS and we performed G2-oriented partial hepatectomy (Figure 1C). Postoperative computed tomography (CT) revealed that G2 was misrecognized with G3 (Figure 1D). Therefore,

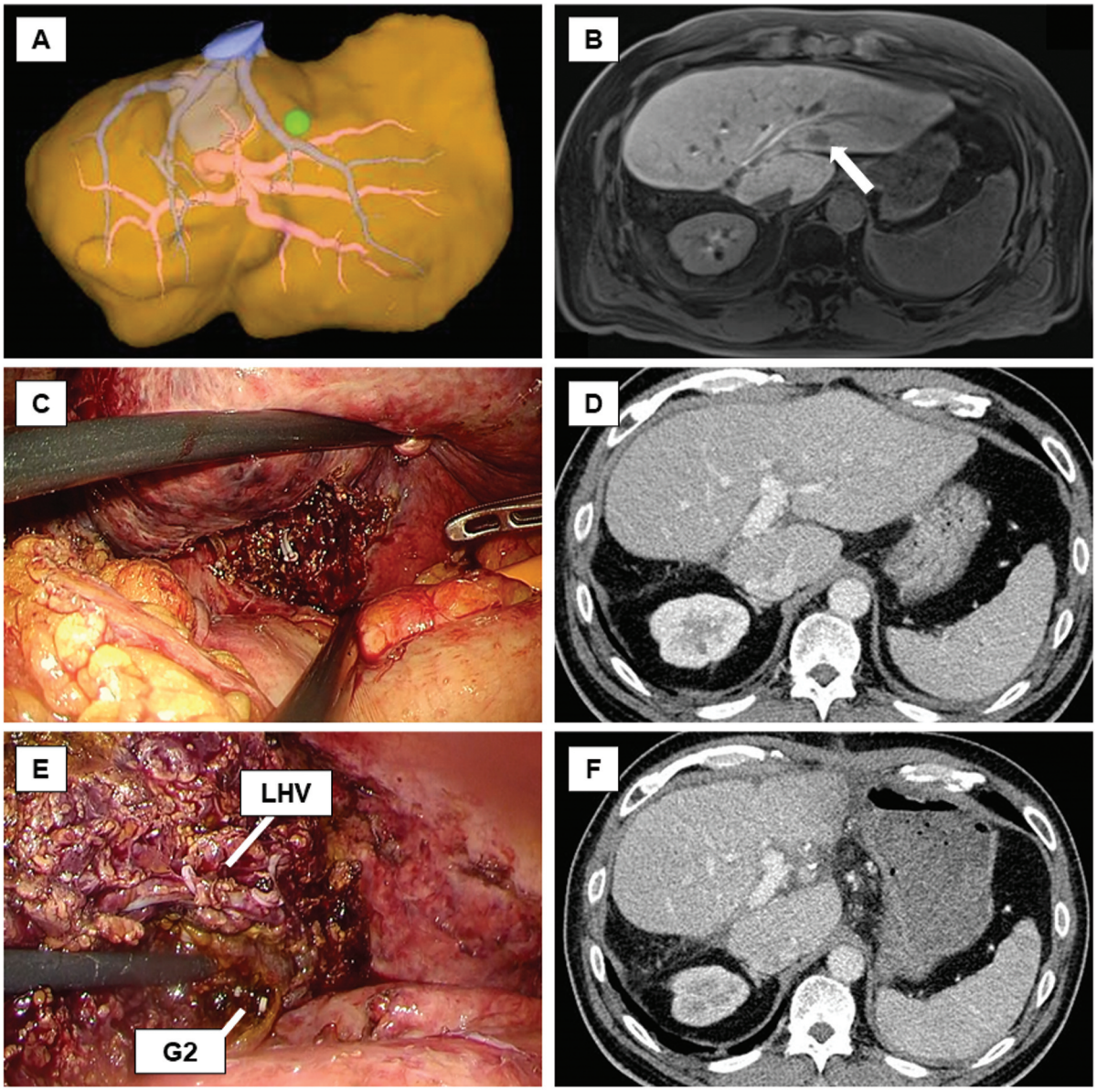

Figure 1. *The tumor located in segment 2 on three-dimensional reconstruction (A), and on hepatocyte phase in gadolinium ethoxybenzyl diethylene triaminepentaacetic acid enhanced magnetic resonance imaging (arrow) (B). Glissonean branch of segment 2-oriented partial hepatectomy (C). Postoperative enhanced computed tomography revealed that Glissonean branch of segment 2 was misrecognized with Glissonean branch of segment 3 (D). S2 Sub-segmentectomy (E). Postoperative enhanced computed tomography showed curative resection (F). G2, Glissonean branch of segment 2; LHV, left hepatic vein.*

we planned to perform S2 subsegmentectomy 5 months after the first repeat hepatectomy. The laparoscopic S2 subsegmentectomy was performed and curative resection was achieved (Figure 1E and F).

Considering the difficulties in intraoperatively detecting a tumor in segment 2 after right lobectomy because of adhesions and hypertrophic regeneration of the remnant liver after right lobectomy, we started to perform S2 subsegmentectomy for recurrent tumors in segment 2 after right lobectomy based on liver function and remnant liver volume. The following description was focused on the Case #5. A 68-year-old man with a history of open right lobectomy and laparoscopic S3 partial hepatectomy for HCC had a recurrent HCC in segment 2 (Figure 2A and B). His liver function was within Child-Pugh A with a retention rate of ICG of 21% at 15 minutes. Thus, we scheduled a laparoscopic S2 subsegmentectomy. The patient was placed in the supine position. The first port for a flexible laparoscope was inserted through the umbilicus. After pneumoperitoneum was reached and the abdominal cavity was deftly observed using the flexible laparoscope, two 12 mm ports

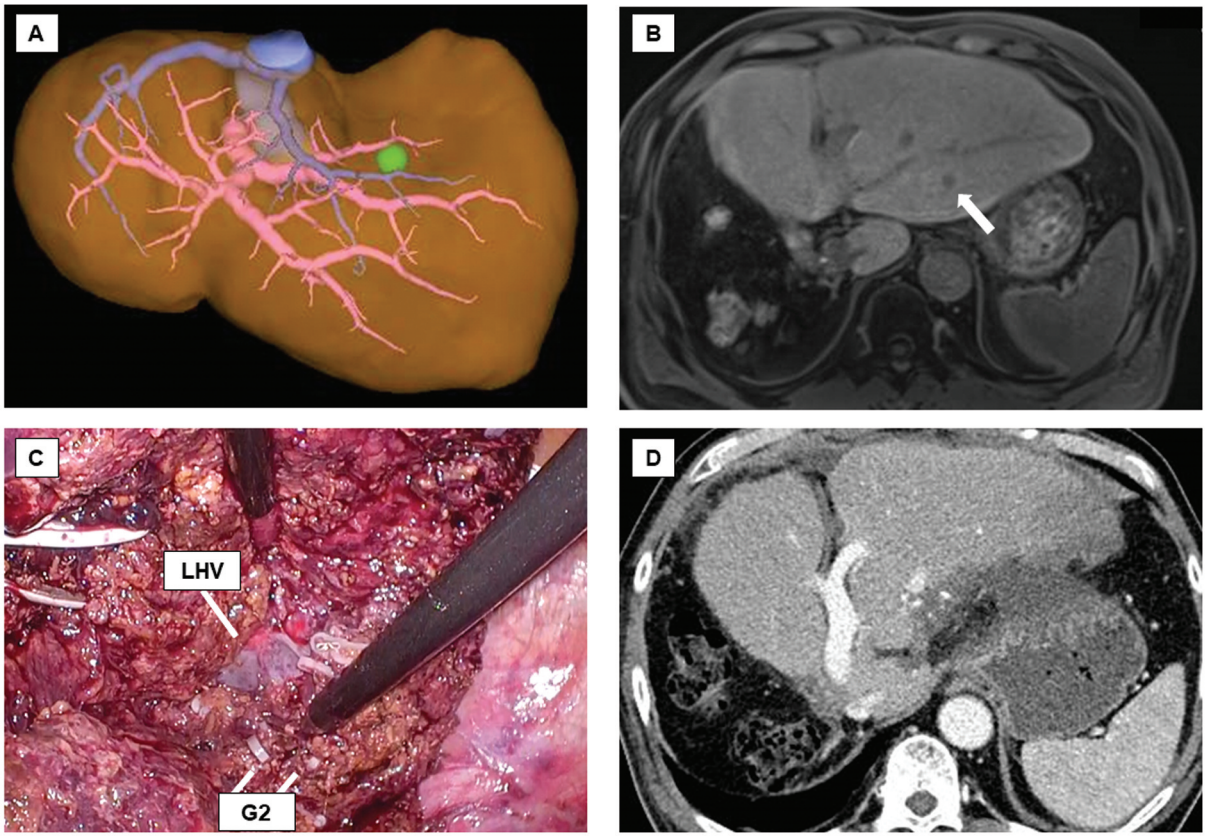

Figure 2. *The tumor located in segment 2 on three-dimensional reconstruction (A), and on hepatocyte phase in gadolinium ethoxybenzyl diethylene triaminepentaacetic acid enhanced magnetic resonance imaging (arrow) (B). S2 subsegmentectomy (C). Postoperative enhanced computed tomography showed curative resection (D). G2, Glissonean branch of segment 2; LHV, left hepatic vein.*

were placed in the left subcostal area to perform adhesiolysis between the omentum and the abdominal wall using the vessel sealing device (LigaSureTM Maryland Jaw, Medtronic Inc., Dublin, Ireland). The other two 12 mm ports in the right subcostal area were placed for the assistant. The adhesiolysis around the liver was performed for the identification of the caudal part of the Spiegel lobe, followed by introduction of laparoscopic Satinsky vascular clamp (K49310 SC, Karl Stortz SE & Co.KG, Tuttlingen, Germany) from the 5 mm port in the right abdomen to control hepatic inflow. The tumor was not detected either by IOUS or ICG-fluorescence imaging. Under intermittent hepatic inflow control using laparoscopic vascular clamp, hepatic parenchymal resection was initiated for the G2 using a Cavitron Ultrasonic Surgical Aspirator (CUSATM, Valletlab Inc., Boulder, CO, USA). Thereafter, the two G2s were isolated and divided. ICG was administered intravenously and infrared endoscopic imaging (VISERA ELITE IITM, Olympus, Tokyo, Japan) revealed a demarcation line of the segment 2 with ICG negative counterstaining. The liver parenchymal resection was continued along the left hepatic vein and demarcation line using the back-scoring technique. The V2 was divided using endo-stapling device (Powered Echelon Flex 7™ , Johnson & Johnson Inc., NJ, USA) (Figure 2C). The resected specimen was retrieved using a reinforced laparoscopic retrieval bag (Inzii Retrieval System, Applied Medical Inc., CA, USA). The laparoscopic S2 subsegmentectomy achieved curative resection (Figure 2D).

Results

The mean age of the five cases was 64.4±4.9 years. All the cases had a history of open right lobectomy. The indications for the laparoscopic repeat hepatectomy were recurrent intrahepatic HCC (n=4) and colorectal liver metastases (n=1). The mean diameter of the tumors was 11±4.2 mm, and all tumors were solitary. The location of the tumors included segment 3 (n=2) and segment 2 (n=3) (Table I).

The types of the laparoscopic repeat hepatectomy included partial hepatectomy (n=3) and subsegmentectomy (n=2). All the tumors in segment 3 were intraoperatively detected. The tumors in segment 2 were not detected intraoperatively. All the tumors in segment 3 were curatively resected by partial hepatectomy. Partial hepatectomy for the tumor in segment 2 did not achieve curative resection. All the tumors in segment 2 were curatively resected by subsegmentectomy. The mean operative time was 350±188 minutes and the mean

Table I. *Preoperative factors of the patients*.

Case	Age	Gender	Previous history of hepatectomy	Tumor				ICG-R15 (%)
				Diagnosis	Size (mm)	Number	Location	
#1	68	M	Open right lobectomy	HCC	5	1	S3	21
#2	68	M	Open extended right lobectomy Open partial hepatectomy (S2)	CRLM	15	1	S3	13
#3	59	M	Open right lobectomy	HCC	10	1	S2	24
#4	59	M	Open right lobectomy	HCC	15	1	S2	24
#5	68	M	Open right lobectomy Laparoscopic partial hepatectomy (S3)	HCC	10	1	S2	21

CRLM: Colorectal liver metastases; HCC: hepatocellular carcinoma; ICG-R15: indocyanine green retention rate at 15 min; S: segment.

Table II. *Operative factors of the patients*.

Case	Tumor location	Laparoscopic repeat hepatectomy	Intraoperative detection of tumor	Curative resection	Operative time (min)	Blood loss (g)	Hospital stay (days)
#1	S3	Partial hepatectomy	Yes	Yes	217	65	8
#2	S3	Partial hepatectomy	Yes	Yes	120	80	12
#3	S2	Partial hepatectomy	No	No	404	20	7
#4	S2	Subsegmentectomy	No	Yes	605	1,350	6
#5	S2	Subsegmentectomy	No	Yes	408	450	9

S: Segment.

blood loss was 393±562 g. None of the patients had any postoperative complications and the mean postoperative hospital stay was 8.4±2.3 days (Table II).

Discussion

In the present study, all the recurrent tumors in segment 3 after open right lobectomy were detected using IOUS and curatively resected with laparoscopic partial hepatectomy. On the other hand, the recurrent tumors in segment 2 could not be detected using IOUS and ICG-fluorescence imaging and subsegmentectomy was found to be necessary to achieve curative resection.

The laparoscopic approach in repeat hepatectomy is a procedure which demands high technical expertise. Adequate dissection of adhesion and mobilization of the involved liver should be performed before parenchymal transection. The Pringle maneuver remains the standard inflow occlusion technique to reduce bleeding during hepatic transection (6). Because adhesions disrupt the dissection of hilar area and hepatoduodenal ligament, aggressive dissection of this area cannot be done as it can lead to possible injuries to the critical structures such as bile duct, portal vein and vena cava. Therefore, we applied laparoscopic vascular clamp and successfully performed inflow occlusion in all the cases.

In S2 subsegmentectomy, the identification of the G2 and parenchymal transection along the left hepatic vein are important procedures. Honda G *et al*. introduced the dissection of the intersegmental plane where no Glissonean cord runs by back-scoring technique, in which the CUSA tip is moved from the root toward the periphery of the Glissonean tree to avoid split injury (7). The important strategy in laparoscopic hepatectomy is parenchymal resection under blood-less surgical field, and therefore inflow control using laparoscopic vascular clamp and preventing split injury using back-scoring technique are the key steps.

The decline in HCC mortality rate is attributed to improvements in treatment including surgical technique and systemic chemotherapy (8). Several reports have demonstrated the effectiveness of anatomical resection for postoperative recurrence and survival in patients with HCC (9, 10). Sasaki K *et al*. reported that anatomical resection was superior to non-anatomical resection in preventing recurrence in patients with HCC in the left lateral segment (11). Subsegmentectomy for HCC in segment 2 may have a better impact on long-term outcomes with respect to both technical and oncological aspects with the consideration of hepatic function reserve.

Several limitations must be considered when interpreting the present findings. The study was conducted in a single

institution with a small sample size. Our results should be confirmed in larger prospective studies. A unique strong point however is that this was the first report to evaluate patients who underwent laparoscopic repeat hepatectomy for recurrent hepatic tumors after open right lobectomy. We believe that this study provides useful information for the management of patients who had recurrent hepatic tumors after right lobectomy.

In conclusion, we showed the strategy to perform curative laparoscopic repeat hepatectomy for recurrent liver tumors after open right hepatectomy. S2 subsegmentectomy is feasible to achieve laparoscopic curative resection for recurrent tumors in segment 2, which is difficult to be detected intraoperatively.

Conflicts of Interest

The Authors have no conflicts of interest to declare.

Authors' Contributions

Kenei Furukawa: Design of the study, collection and analysis of data and drafting of the article. Koichiro Haruki: Collection of data. Shinji Onda: Collection of data. Jungo Yasuda: Collection of data. Tomohiko Taniai: Collection of data. Ryoga Hamura: Collection of data. Hironori Shiozaki: Collection of data. Yoshihiro Shirai: Collection of data. Tomonori Iida: Collection of data. Taro Sakamoto: Collection of data. Takeshi Gocho: Collection of data. Toru Ikegami: Revision of the article and final approval of the article.

References

1 Wakabayashi G, Cherqui D, Geller DA, Buell JF, Kaneko H, Han HS, Asbun H, O'Rourke N, Tanabe M, Koffron AJ, Tsung A, Soubrane O, Machado MA, Gayet B, Troisi RI, Pessaux P, Van Dam RM, Scatton O, Abu Hilal M, Belli G, Kwon CH, Edwin B, Choi GH, Aldrighetti LA, Cai X, Cleary S, Chen KH, Schön MR, Sugioka A, Tang CN, Herman P, Pekolj J, Chen XP, Dagher I, Jarnagin W, Yamamoto M, Strong R, Jagannath P, Lo CM, Clavien PA, Kokudo N, Barkun J and Strasberg SM: Recommendations for laparoscopic liver resection: A report from the second international consensus conference held in Morioka. Ann Surg *261(4)*: 619-629, 2015. PMID: 25742461. DOI: 10.1097/SLA.0000000000001184

2 Morise Z: Laparoscopic repeat liver resection. Ann Gastroenterol Surg *4(5)*: 485-489, 2020. PMID: 33005842. DOI: 10.1002/ags3.12363

3 Bismuth H, Castaing D and Garden OJ: The use of operative ultrasound in surgery of primary liver tumors. World J Surg *11(5)*: 610-614, 1987. PMID: 2823488. DOI: 10.1007/BF01655836

4 Viganò L, Ferrero A, Amisano M, Russolillo N and Capussotti L: Comparison of laparoscopic and open intraoperative ultrasonography for staging liver tumours. Br J Surg *100(4)*: 535-542, 2013. PMID: 23339035. DOI: 10.1002/bjs.9025

5 Nakaseko Y, Ishizawa T and Saiura A: Fluorescence-guided surgery for liver tumors. J Surg Oncol *118(2)*: 324-331, 2018. PMID: 30098296. DOI: 10.1002/jso.25128

6 Weiss MJ, Ito H, Araujo RL, Zabor EC, Gonen M, D'Angelica MI, Allen PJ, DeMatteo RP, Fong Y, Blumgart LH and Jarnagin WR: Hepatic pedicle clamping during hepatic resection for colorectal liver metastases: No impact on survival or hepatic recurrence. Ann Surg Oncol *20(1)*: 285-294, 2013. PMID: 22868921. DOI: 10.1245/s10434-012-2583-0

7 Honda G, Ome Y, Yoshida N and Kawamoto Y: How to dissect the liver parenchyma: Excavation with cavitron ultrasonic surgical aspirator. J Hepatobiliary Pancreat Sci *27(11)*: 907-912, 2020. PMID: 32897631. DOI: 10.1002/jhbp.829

8 Sato N, Beppu T, Kinoshita K, Yuki H, Suyama K, Chiyonaga S, Motohara T, Komohara Y, Hara A and Akahoshi S: Conversion hepatectomy for huge hepatocellular carcinoma with arterioportal shunt after chemoembolization and lenvatinib therapy. Anticancer Res *39(10)*: 5695-5701, 2019. PMID: 31570469. DOI: 10.21873/anticanres.13768

9 Hasegawa K, Kokudo N, Imamura H, Matsuyama Y, Aoki T, Minagawa M, Sano K, Sugawara Y, Takayama T and Makuuchi M: Prognostic impact of anatomic resection for hepatocellular carcinoma. Ann Surg *242(2)*: 252-259, 2005. PMID: 16041216. DOI: 10.1097/01.sla.0000171307.37401.db

10 Regimbeau JM, Kianmanesh R, Farges O, Dondero F, Sauvanet A and Belghiti J: Extent of liver resection influences the outcome in patients with cirrhosis and small hepatocellular carcinoma. Surgery *131(3)*: 311-317, 2002. PMID: 11894036. DOI: 10.1067/msy.2002.121892

11 Sasaki K, Matsuda M, Ohkura Y, Hashimoto M and Watanabe G: Anatomical *versus* nonanatomical resection in patients with hepatocellular carcinoma located in the left lateral segment. Am Surg *79(11)*: 1163-1170, 2013. PMID: 24165251.

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