

Repeat laparoscopic liver resection

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Ome *et al.* (1) and Noda *et al.* (2) recently published single institutional retrospective reports of repeat laparoscopic liver resection (LLR) in “Surgical Endoscopy”. In this editorial, the studies of repeat LLR are reviewed and the present status of the procedure is discussed.

Backgrounds

Liver metastases can be derived from various cancers, such as colorectal, lung, breast, and ovarian cancers. Also, hepatocellular carcinoma (HCC) arises in multifocal and metachronous fashion inside the liver with its preneoplastic chronic liver disease (CLD) backgrounds. Intrahepatic recurrences after previous resection of those metastases, mainly from colorectal cancer, and HCC with the need for repeat treatments can often occur.

Liver resection (LR) is now actively applied to those lesions, when the lesions are resectable and there is no other uncontrollable/distant disease, and the opportunity for repeat LR has increased (3,4). Currently, indications of LLR have been expanded with the accumulation of experiences and technical/conceptual and instrumental developments (5). Adhesions after previous surgery cause the increase of operative time of following surgeries and the risk of bowel injury, due to the need for adhesiolysis (6,7). Thus, there are increased risks of operative complications and, in laparoscopic procedure, conversion to open surgery in the patients with previous history of abdominal surgery (8). Although a previous surgical history had been in the contraindications for laparoscopic surgery, many laparoscopic procedures (7,8) can be applied to those patients nowadays with technical and instrumental

improvements. However, LLR still remains technically demanding and the discussion for indications and efficacy of repeat LLR are un-settled. Adequate adhesiolysis and mobilization in repeat LLR are needed for the tumor-involved liver area. The visualization and dissection of the hepatoduodenal ligament and hilar area, which are often crucial in LLR, can be compromised by adhesions. The deformity of the liver surrounded by the scars and adhesion makes the recognition of the location of tumors and the important structures (vessels) difficult. The easily bleeding liver capsule leads to increased bleeding and the subsequent suboptimal operative field during adhesiolysis and mobilization (9). These can cause intraoperative vascular or biliary injuries, other complications and conversion.

Reports of repeat LLR

Although the reports of repeat LLR are gradually increasing, Medline search under the words “repeat” and “laparoscopic liver resection” and their re-quotations found out only 16 reports of small series (1,2,10-23) (Table 1). Belli *et al.* (10) reported that LLR ensures meticulous dissection of adhesions, which are strained by the pneumoperitoneum, with magnified view under laparoscope. The fact that complete dissection of intraperitoneal adhesions can be avoided is also reported as a possible advantage of repeat LLR (14,19). In comparison with repeat open LR, these studies generally reported that repeat LLR has better short-term outcomes (such as similar or longer operative time, reduces blood loss, less blood transfusion rate, less or similar morbidity and shorter hospital-stay) without compromising the long-term outcomes. Each report

Table 1 Summary of previous reports of repeat LLR

Author [year]	n	Disease	First Hx (open:lap)	Procedure
Belli [2009]	12	HCC	4:8	LLS (n=5), Pt (n=4), Seg (n=3)
Nguyen [2009]	2	Met	ND	ND
Hu [2011]	6	HCC	3:3 (Lap RFA, n=2)	LLS (n=2), Pt (n=4)
Shafaei [2011]	76	Met (n=63), HCC (n=3), others (n=10)	28:44	LLS (n=4), Pt, seg (n=53), above-seg (n=19)
Ahn [2011]	4	HCC (n=3), Met (n=1)	0:4	LLS (n=1), Pt (n=3)
Tsuchiya [2012]	3	HCC	0:3	ND
Cannon [2011]	17	ND	ND	ND
Kanazawa [2013]	20	HCC	15:5	Pt
Shelat [2014]	20	HCC (n=2), Met (n=16), others (n=2)	0:20	Minor (n=14), major (n=6)
Isetani [2015]	12	HCC (n=8), Met (n=2), others (n=2)	8:4	Pt (n=9), Subseg (n=3)
Chan [2014]	11	HCC	6:5	LLS =2, Subseg =9
Hallet [2017]	27	Met	ND	Major =25, Minor=2
Goh [2017]	8	HCC	6:2	Sec=2, Seg=2, Subseg=4
Noda [2018]	20	HCC (n=15), Met (n=5)	12:8	Anatomical =1, non-anatomical =19
Ome [2018]	33	HCC & combined (n=18), Met (n=15)	21:12	Anatomical =11, non-anatomical =22

HCC, hepatocellular carcinoma; LLS, left lateral sectorectomy; Met, metastasis; Minor, resection of 2 segments or less; Major, resection of 3 segments or more; ND, not documented; Pt, partial resection; Sec, sectionectomy; Seg, segmentectomy; Subseg, subsegmentectomy.

concluded that repeat LLR is feasible and safe for selected patients. However, most studies include both HCC and metastatic cases. The settings of repeat LLR are different in HCC and metastatic cases. Metastatic patients often undergo major LR with the manipulation of hilar area for the not-fibrotic, but congested and/or with steatosis after chemotherapy, liver. On the other hand, HCC patients with CLD often undergo minor resection of the cirrhotic liver with poor function and blood and/or lymphatic collaterals surrounding the liver. The majority of the cases in previous reports were those with minor resection as repeat LLR for HCC patients with CLD. There are five reports only for HCC patients with CLD. Belli *et al.* (10), Hu *et al.* (14), Tsuchiya *et al.* (16), Kanazawa *et al.* (17), and Goh *et al.* (21) reported 12, 6, 3, 20 and 8 cases, respectively. All concluded that repeat LLR is a safe and feasible procedure even for recurrent HCC in CLD patients. Belli also reported that the operative time was shorter and the adhesiolysis was easier for repeat LLR patients with LLR history as previous treatment compared to those with open LR history. It is mentioned the advantages of laparoscopic approach in the management of the long oncologic history of cirrhotic patients. Kanazawa compared laparoscopic to open

patients in 20:20 groups of repeat LR and mentioned that morbidity and the postoperative stay have been decreased by laparoscopic procedure.

LLR characteristics

LLR reduces the rates of postoperative ascites and postoperative fatal liver failure for HCC patients with CLD (24), since it minimizes the destruction of collateral blood and lymphatic flow by laparotomy and mobilization, as well as the mesenchymal injury by compression on the liver. LR is the procedure that the liver protected inside the subphrenic rib cage is resected. In open LR, the cage is opened with a big subcostal incision and a lift of the costal arch, and then the liver is picked up for resection with the dissection of retroperitoneal attachments. On the other hand, in LLR, laparoscope and forceps intrude into the cage directly from the caudal direction ("Caudal approach" (25)) and perform LR in the small targeted area without any damage to the surrounding area. Furthermore, the same surgical view under position changes in LLR, acquired by the adjustments of laparoscope's positioning and rotation, allows for handling large-volume liver/

tumor by postural changes. This leads to the reduction of compression on the liver. In the same manner, repeat LLR also requires smaller working space between adhesion where laparoscope and forceps can intrude and do manipulation. This fact allows for minimal adhesiolysis and a direct approach to the tumor in repeat LLR (13,14,19). Therefore, some studies showed that operative time and blood loss were similar in primary and repeat LLR especially for partial resections (1,19), although the short-term results from open primary LR and open repeat LR are usually different especially in operative time (longer in repeat) and intraoperative blood loss (larger in repeat). With the usage of laparoscopic approach for repeat partial resection, operative time and blood loss could be reduced.

Our experiences and future perspectives of repeat LLR

As mentioned above, the majority of the cases in previous reports were those with minor resection as repeat LLR for HCC patients with CLD. Therefore, the impacts of alterations to hepatic parenchyma and anatomy from previous LR should be relatively small. However, in our experience of 33 repeat LLR and 12 three or more-time repeat LLR, three patients who underwent anatomical resection or resections exposing major vessels after preceding anatomical resection developed postoperative bile leakage and more than 30 days postoperative hospital stay. Since anatomical alterations and surrounding scars/adhesion of hilar and intrahepatic vessel structures should greatly impact on anatomical resection or resections exposing major vessels as repeat LLR, further experience and evaluation of those repeat LLR after anatomical resection are needed.

Furthermore, it is speculated that one of the advantages of laparoscopic approach for minor repeat LR of CLD liver is that the deterioration of liver function by LR can be minimized. The minimal requirements for adhesiolysis under a laparoscopic specific view and manipulation leads to the minimal destruction of collateral vessels in the adhesion tissue of CLD patients, and leads to minimal deterioration of liver function. There should be a chance to prolong the overall survival of the HCC patients with CLD by using LLR as a powerful local therapy which can be applied repeatedly.

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