Editorial Commentary

What is the next step in the expansion of applying laparoscopic liver resection as standard practices?

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Chen *et al.* recently published the paper named "Laparoscopic Liver Resection: Experience of 436 Cases in One Center" (1). In the article, they divided the 436 cases of laparoscopic liver resection (LLR) performed in their own single institute, into two (simple and difficult) groups and compared the short-term outcomes. They categorized patients depending on tumor size, location, proximity to major vessels, number of resected areas, style and extent of resection. The statement from the first international consensus conference of LLR in 2008 (2) concluded that patients with tumors which are either large (>5 cm), central, multiple, bilateral, or with connections to major vessels and those with the need of major hepatectomy were not candidates for LLR in most centers at the moment, although left lateral sectionectomy (LLS) and partial resections for anterolateral segments (segments 2, 3, 4b, 5, 6) could be standard practices. Depending on the statement, Chen *et al.* divided their cases into the two groups and showed the superiority of the short-term outcome from the simple group. They concluded that the selection criteria of LLR based on the Louisville statement are helpful to predict the difficulty and the results of LLR. However, they also concluded that LLR is feasible for selected patients in the difficult group. So, there is a new question "What is the next step in the expansion of LLR application as standard practices over the Louisville Statement?".

Hemi-hepatectomy in the Development history of LLR

Laparoscopic hemi-hepatectomy was reported in 1997 (3), only 1 year after the reports of LLS (4,5). The transection plane of hemi-hepatectomy lies in the caudal-to-cranial direction and is vertical in supine position like the one in LLS, making it easier to handle laparoscopically. Hemi-hepatectomies should have been the second-most straightforward procedure after anterolateral partial resection and LLS, as in open liver resection (OLR). Advances in techniques and instrumentation for stable transection with hemostasis were needed to make the step possible (6). Development of LLR transection maneuvers, such as crash-clamp and Cavitron ultrasonic surgical aspirator (CUSA) transections, was accomplished with various devices and inflow control (7). However, there are differences between the right and left hemi-hepatectomy, especially for mobilization of the liver and handling of the caudate lobe. Contrary to the left, the right hemi-hepatectomy necessitates dissection of the IVC and right adrenal gland. Furthermore, handling the large and heavy right liver is demanding, complicating the laparoscopic procedure without the surgeon's hands during mobilization and transection. The procedure of laparoscopic right hemi-hepatectomy has developed more slowly than that of left.

Left medial, right anterior and posterior sectionectomies, and thereafter

Medial, anterior and posterior sectionectomies have been often applied to patients with hepatocellular carcinoma and chronic liver diseases for the preservation of liver function, simultaneously for the oncological effect (8). The transection planes in these sectionectomies are larger and

more difficult to handle in LLR, although they are flat plane aligned in the caudal to cranial direction as that in hemi-hepatectomy. Furthermore, individual dissection for the pre-transection control of territorial vessels is difficult and the importance of the Glissonian approach (9) was greater in this level. Glissonian approaches in LLR had been reported for this step in the development (10,11).

Handling the transection plane—especially the boundary plane between the anterior and posterior sections—is one of the keys for anterior and posterior sectionectomies (12). Anterior and posterior sectionectomies in LLR are technically demanding to obtain a fine surgical field ensuring hemostasis beneath the large and heavy right liver in the small subphrenic rib cage. Postural changes, allowing for acquirements of fine surgical view and manipulation for those LLRs, have been employed to conquer this obstacle (13,14). Also, our paper of posterior sectionectomy in left lateral position (14) described the new concept of "caudal approach" in LLR. In laparoscopic "caudal approach", the specific view and manipulation in LLR is obtained with intrusions of laparoscope and forceps into the subphrenic rib cage from the caudal direction. The intersectional planes had become suitable for handling in LLR after developing technologies, techniques and concepts.

Thereafter, LLR was expanded to resections of posterosuperior segments (segments 7, 8, 1) (12,15-18) using additional techniques (12,16,17). Parenchymal preserving limited and modified (extended/combined) anatomical resections (19-21), using simulation and navigation from imaging studies, are recently discussed. Around the second international consensus conference of LLR in Morioka (2014) (22), studies for the learning curve and a difficulty scoring system of LLR for the appropriate patient selection were published (23-25), to help ensure the safe and consistent extended application of the procedure.

What and how is the next step in the expansion of LLR application as standard practices over the Louisville Statement?

From the view of the development history described before, left-hemihepatectomy, and then right-hemihepatectomy followed by sectionectomies (left medial, right anterior and posterior) should be the way-to-goes for the next steps of standard practices in LLR. In our hospital, senior residents often perform those LLRs for noncirrhotic liver under the supervision of experienced liver surgeon currently.

In laparoscopic hemi-hepatectomies and sectionectomies for the noncirrhotic liver, which is performed by young surgeons, we are trying to simplify the procedures and use water jet dissector for safe dissection on major vessels. First, after dissecting the front-side wall of the Glissonean pedicle with water jet dissector and clamping them with bulldog clamp, liver parenchymal transection on the ischemic demarcation line precedes to encircling and dividing the pedicle. Encircling and dividing the pedicle are performed safely and easily with well-opened transection plane and good space after the transection line reaching to the hilar level. Continuously, safe delicate dissection and exposure of the major hepatic vein on the plane are performed using the characteristics of water jet dissector. Besides the difference in water jet power and ultrasonic waves' generating energy, there is the other difference in the positions of active tip. In water jet dissector, only aspiration tube contacts to the tissue. On the other in CUSA, active oscillating tip contacts to the tissue directly. The fact makes water jet dissector possible to do more delicate and soft dissection. On the other, the facts make water jet dissector difficult to do the dissection of fibrotic hard liver. Furthermore, water jet dissector should be used vertically contacted to the tissue for water aspiration avoiding the flood of jet water, although CUSA can be used in any angle as the active tip directly contacted to the tissue. In LLR, the restriction of the contacting angle by the port positions may make water jet dissector use difficult. However, the transection planes in hemi-hepatectomies and sectionectomies are all flat plane aligned in caudal to cranial direction. In hemi-hepatectomies and sectionectomies, water jet dissector can handle the transection plane well even in LLR and also can make safe delicate dissection for the exposure of major hepatic veins on the transection plane. We believe that laparoscopic hemi-hepatectomies and sectionectomies for noncirrhotic liver would become safe standard surgical practices in the next step of LLR with some ingenuities.

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Footnote

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