

From Louisville to Morioka: where is now MILS?

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It is my great honor and privilege to write an Editorial on this special issue of Updates in Surgery focused on “Minimally Invasive Liver Surgery: an up-to-date.” One of the Editors-in-Chief, Professor Fulvio Calise, kindly asked me to contribute to this issue. I know he has dedicated many efforts to promote the diffusion of minimally invasive liver surgery in Italy, including the foundation of the Italian Group of Minimally Invasive Liver Surgery (I Go MILS) with Professor Luca Aldrighetti (I Go MILS—President) and Professor Giulio Belli (I Go MILS—Vice President, It. Chapter IHPBA—President). Both are the Expert panels of the 2nd International Consensus Conference on Laparoscopic Liver Resection (ICLLR) held on October 4–6, 2014, in Morioka, Iwate Prefecture, Japan. The ICLLR in Morioka was held in an effort to better define the current role of laparoscopic liver resection (LLR) and to develop internationally accepted guidelines [1].

The organizing committee (Table 1) applied an independent jury-based consensus model to achieve this goal through analysis of the available literature with presentations including videos by Expert panels in front of Jury panels [2]. We all know that the level of evidence is low in the field of LLR to create strong recommendations. Therefore, we tried to be fair to draw the consensus statements under the judge by Jury. Table 1 shows the panels of the ICLLR, and 43 respected surgeons, i.e., 34 expert panelists plus nine jury members not directly involved in LLR, were invited from 18 countries. Table 2

summarizes 17 clinical questions (CQs) related to the value and techniques of LLR, and 17 working groups assigned to answer these 17 questions by extensive literature reviews. The jury provided recommendations on CQ 1–7, which were related to benefits and risks of LLR [1]. However, the experts provided recommendations on CQ 8–17, which were related to technical aspects of LLR [1]. Expert consensus statements on CQ 8–17 were created from expert presentations, assessment of the literature, and experience on individual techniques.

One of the major achievements of the ICLLR was that all international experts were present in the same room at the same time. These are technical recommendations from experts that will never be proved by level 1 evidence and still need to be shared so that the beginners can benefit from the expert learning curve. Another major achievement of the ICLLR is publications of related activity to the ICLLR [3–7] and the systematic reviews that were prepared to create recommendations before the ICLLR [8–14]. A couple of more manuscripts are now under review to be published. A comprehensive literature review was performed, and analysis was done using multiple case series, case-control studies, reviews, and meta-analysis published over the last several years. It is our hope that all these publications from the ICLLR will contribute to the steady and safe spread of LLR.

During the 6 years between the 1st International Consensus Conference on Laparoscopic Liver Resection in Louisville and the ICLLR in Morioka, this comparatively new surgical technique has evolved and is rapidly being adopted worldwide (Table 3). In my opinion, LLR is superior to open liver resection (OLR) because the laparoscope allows better exposure with a magnified view, and the pneumoperitoneal pressure reduces hepatic vein bleeding from the cut surface [4]. The concept for liver

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Table 1 Invited panels of the 2nd International Consensus Conference on Laparoscopic Liver Resection (ICCLLR)

<i>Organizing committee</i>	Go Wakabayashi (Chairman, Japan), Daniel Cherqui (France), David Geller (USA), Joseph Buell (USA), Hironori Kaneko (Japan), Ho-Seong Han (Korea), and Steven Strasberg (USA)
<i>Jury members</i>	Steven Strasberg (Chairman, USA), Jeffrey Barkun (Canada), Pierre Clavien (Switzerland), Palepu Jagannath (India), William Jarnagin (USA), Norihiro Kokudo (Japan), Chung Mao Lo (China), Russell Strong (Australia), Masakazu Yamamoto (Japan)
<i>Chairs of the expert panels</i>	Daniel Cherqui (France), David Geller (USA), Horacio Asbun (USA), Nicholas O'Rourke (Australia), Allan Tsung (USA), Roberto Troisi (Belgium), Ronald Van Dam (Netherlands), Ho-Song Han (Korea), Minoru Tanabe (Japan), Alan Koffron (USA), Olivier Soubrane (France), Ibrahim Dagher (FRANCE), Hironori Kaneko (Japan), Brice Gayet (France), Marcel Machado (Brazil), Go Wakabayashi (Japan), Patrick Pessaux (France)

Table 2 Clinical questions for laparoscopic liver resection (LLR) and their working groups**Comparative outcomes, value, safety**

CQ1	<i>What are the comparative short-term outcomes of LLR versus open liver resection (OLR)? (minor and major)</i> Daniel Cherqui ^a , Olivier Scatton, Mohammad Abu Hilal, Luca Aldrighetti, Juan Pekolj, Kuo-Hsin Chen, Hironori Kaneko
CQ2	<i>What are the comparative long-term outcomes of LLR versus OLR? (minor and major)</i> David Geller ^a , Paulo Herman, Giulio Belli, Bjørn Edwin
CQ3	<i>What are the comparative cost implications of LLR versus OLR? (minor and major)</i> Horacio Asbun ^a , Sean Cleary, Ho-Seong Han
CQ4	<i>What are the comparative pain control and QOL outcomes for LLR versus OLR? (minor and major)</i> Nicholas O'Rourke ^a , Mohammed Abu Hilal, Minoru Tanabe

Robotic and donor hepatectomy

CQ5	<i>What is the role of robotic hepatectomy?</i> Allan Tsung ^a , Gi Hong Choi, Chung-Ngai Tang
CQ6	<i>Is LLR applicable to donor hepatectomy?</i> Roberto Troisi ^a , Go Wakabayashi, Olivier Scatton, Daniel Cherqui

Randomized controlled trial (RCT)

CQ7	<i>Are RCTs feasible for LLR?</i> Ronald Van Dam ^a , Bjørn Edwin, David Kwon
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Spread, difficulty, alternatives

CQ8	<i>What is the spread of LLR?</i> Ho-Seong Han ^a , Michael R. Schön, Horacio J Asbun
CQ9	<i>What determines the difficulty of LLR?</i> Minoru Tanabe ^a , Luca Aldrighetti, Roberto Troisi
CQ10	<i>What is the role of HALS and the hybrid method?</i> Alan Koffron ^a , Joseph Buell, Go Wakabayashi

Techniques

CQ11	<i>What has changed in the concept of liver resection?</i> Olivier Soubrane ^a , Go Wakabayashi, Ibrahim Dagher
CQ12	<i>What are the essentials of bleeding control in LLR?</i> Ibrahim Dagher ^a , Nicholas O'Rourke, Atsushi Sugioka, Ronald Van Dam
CQ13	<i>What is the best technique for parenchymal transection?</i> Hironori Kaneko ^a , Joseph Buell, Xiujun Cai, Sean P. Cleary
CQ14	<i>What kind of energy devices should be used for LLR?</i> Brice Gayet ^a , Giulio Belli, Juan Pekolj, Olivier Scatton
CQ15	<i>What is the best approach to the hilar structures (individual or Glissonian approach)?</i> Marcel Machado ^a , Astushi Sugioka, Olivier Soubrane
CQ16	<i>Is anatomical resection preferable for LLR?</i> Go Wakabayashi ^a , David Kwon, Michael R. Schön

Simulation, navigation

CQ17	<i>What is the role of simulation and navigation in LLR?</i> Patrick Pessaux ^a , Brice Gayet, Allan Tsung
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Table 3 Evolutions in 6 years between two consensus conferences**Over 9000 cases published****Conceptual changes**

Caudal approach

Pneumoperitoneum and bleeding

Inflow occlusion (Pringle)

Parenchyma sparing anatomical resection**Pure laparoscopic donor hepatectomy**

resection has changed from the open ventral approach to the laparoscopic caudal approach. The important structures such as the hilar plate and the vena cava are clearly viewed just in front of you by the laparoscopic caudal approach. The better exposure with pneumoperitoneum is the main driving force that I began pure laparoscopic living donor hepatectomy based on our experience of laparoscopy-assisted donor hepatectomy [15]. The most dangerous event that can happen during liver surgery is the injury of major vessels. As long as you see it clearly, you will never injure it without knowing it. The liver is located deep inside of the abdominal cavity surrounded by the rib bones. Because I am convinced that LLR is safer than OLR in my hand, I can offer this surgery to healthy donors where safety should be warranted most importantly.

During this 3-day conference, we extensively discussed how to improve the quality of LLR. Improving quality includes how to use energy devices [9], how to perform parenchymal transection [13], how to avoid bleeding [14], and how to perform parenchyma sparing anatomical resection. Complications in liver resection mainly consist of these three factors as shown in Table 4. Hepatic reserve should be estimated correctly to preserve remnant liver function. This must not be different either in OLR and LLR. Meticulous transection and precise technique can be performed either in OLR and LLR; however, the better exposure with a magnified view and the reduction in venous bleeding with pneumoperitoneum might be beneficial for these two factors.

Because I was assigned to summarize benefits of anatomical resection at the ICCLLR, I proposed another new concept of parenchyma sparing anatomical (limited) resection. All anatomical resection can be performed from the hilar plate as described in Table 5. The caudal approach of LLR is beneficial to these limited anatomical resections from subsegmentectomy, segmentectomy, to sectionectomy [16, 17]. Parenchyma sparing resection is the key to preserve remnant liver volume and anatomical resection gives you clean resection not to leave non-perfused area of the liver. Therefore, parenchyma sparing anatomical resection is the future direction in liver surgery, and LLR will fit this direction perfectly. As we become aware of

Table 4 Complications in liver resection to be avoided**Liver failure**

Preservation of remnant liver function

Bleeding

Meticulous transection

Bile leakage

Precise technique

Table 5 Parenchyma sparing anatomical resection to preserve remnant liver volume with clean margin**Inflow occlusion from the hilar plate**

Glissonian approach from extra-hepatic to intra-hepatic

Resection of demarcated area

Limited anatomical resection from subsegmentectomy to sectionectomy

Exposure of main hepatic veins as the borders between sections

Exposure of hepatic veins with pneumoperitoneum

Usage of energy devices for hemostasis

these essentials, LLR will be popularized more in the next several years.

Finally, the most important message from the ICCLLR is to protect patients from this new surgical procedure. We recommended a broader-based registry because major LLR is still an innovative procedure although minor LLR is confirmed to be a standard practice in surgery. We are now in preparation of the registry worldwide. Furthermore, we proposed a scoring system to define the range of difficulty of LLR, similar to the Child–Pugh score, so that the beginner can start LLR easily and safely [7]. Selection of the appropriate patients according to the surgeon's skills will eventually protect patients. In Japan, clustered mortality was sensationally reported in Japan just after the ICCLLR, which highlights the need for a safe introduction of major LLR [18]. The identification of difficult cases should be deferred depending on one's individual learning curve of LLR.

In summary, the ICCLLR was very intense and successful. The judgment is a bit severe but the judgment is shared. We have to focus on more evidence, creation of registries, an implementation of master classes, and specific training. We discussed face to face our most up-to-date understanding, assessment of LLR, basic techniques, and its future directions. The future of LLR is in our hands. We certainly never imagined that we would come this far when the first LLR was reported.

Conflict of interest None.

Ethical standard All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Research involving human participants and/or animals This article does not contain any studies with human participants performed by the author.

Informed consent Informed consent was obtained from all individual participants included in the study.

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