What has changed after the Morioka consensus conference 2014 on laparoscopic liver resection?

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Abstract: The 2nd International Consensus Conference on Laparoscopic Liver Resection (ICCLLR) was held 4th–6th October, 2014, in Morioka, Japan. The level of evidence appears to be low in the field of laparoscopic liver resection (LLR) to create strong recommendations. Therefore, an independent jury-based consensus model was applied to better define the current role of LLR and to develop internationally accepted recommendations. The three-day conference was very intense with full of insightful discussions on assessment of LLR and its future directions. The jury drew the statements based on the presentations and documents prepared by the expert. LLR is theoretically superior to open liver resection (OLR) because the laparoscope allows better exposure with a magnified view, and the pneumoperitoneum pressure reduces hepatic vein bleeding from the cut surface. During the ICCLLR, we shared these theoretical advantages in LLR and the conceptual change of liver resection. After the ICCLLR, a couple of important studies have been published to prove this theoretical superiority of LLR over OLR in short-term outcomes without deteriorating long-term outcomes. Another new concept was proposed at the ICCLLR: parenchyma sparing (limited) anatomical resection. Review of the literature supports anatomical resection with parenchyma sparing strategy for LLR irrespective of hepatocellular carcinoma (HCC) and colorectal liver metastasis (CRLM). Just after the ICCLLR, sensational news of clustered mortality after LLR was reported in the Japanese media and they impacted on daily practice of LLR in Japan. The most important message from the ICCLLR is to protect patients from this new surgical procedure. The ICCLLR recommended three actions for the protection of patients: (I) prospective reporting registry for transparency; (II) a difficulty scoring system to select patients; (III) creation of a formal structure of education. The online prospective registry system including items to calculate the difficulty score has been created in Japan after the ICCLLR for the safe development of LLR.

Keywords: Laparoscopic liver resection (LLR); anatomical liver resection; consensus; difficulty score; patient protection

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The 2nd International Consensus Conference on Laparoscopic Liver Resection (ICCLLR) was held 4th–6th October, 2014, in Morioka, Iwate Prefecture, Japan. As a chairman of the conference, I take this opportunity to elucidate the changes before and after the ICCLLR in our practice of laparoscopic liver resection (LLR) from my point of view. First, we had to realize that the level of evidence appears to be low in the field of LLR to create strong recommendations. This was most important start point for the preparation of the ICCLLR. The organizing committee (*Table 1*) applied an independent jury-based consensus model for the ICCLLR to better define the current role of LLR and to develop internationally accepted recommendations (1). We did not intend to have consensus statements created only by believers of LLR and tried to be fair under the circumstance with quite low

Table 1 Organizing committee of the 2nd ICCLLR

Go Wakabayashi (Chairman, Japan)
Daniel Cherqui (France)
David Geller (USA)
Joseph Buell (USA)
Hironori Kaneko (Japan)
Ho-Seong Han (Korea)
Steven Strasberg (USA)

ICCLLR, International Consensus Conference on Laparoscopic Liver Resection.

Table 2 Jury members of the 2nd ICCLLR

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)

ICCLLR, International Consensus Conference on Laparoscopic Liver Resection.

level of evidence. I asked Professor Steven Strasberg of Washington University to chair the jury (*Table 2*) to draw the consensus statements through analysis of the available literature presented by Expert panels. Expert panels were assigned into 17 subgroups to perform extensive literature reviews before ICCLLR in order to answer 17 questions (Q1 to Q17) (*Table 3*) related to the value (Q1 to Q7) and techniques (Q8 to Q17) of LLR. Q1 (short-term outcomes) was essentially the most important question to be answered with the largest number of articles existed. The extensive literature search was made to serve as basic information regarding safety and short-term outcomes of LLR based on the systematic review of over 9,000 cases reported by 179 single centers and it was published as a separate article in *Ann Surg* (2). Because all of the searched articles used the definition that minor resection included 2 or less segments and major resection included 3 or more contiguous segments, we had to follow the same definition for the creation of recommendations even though we discussed at the ICCLLR that one sectionectomy except left lateral sectionectomy (LLS) should be defined as major resection. Probably, in the near future, we need to redefine that major resection includes two or more contiguous segments and minor resection includes partial resection and LLS.

Recommendations by the jury

The three-day conference was very intense with full of insightful discussions on assessment of LLR and its future directions. The jury drew the statements based on the presentations and documents prepared by the expert. The statements regarding Q1 to Q4 (short-term, long-term, cost, pain and quality of life) were divided into three categories, i.e., minor, major, minor and major LLR and created according to comparators which were defined and ranked by the jury. Mortality and complications were ranked high, followed by margin negativity and overall survival. In contrast, cosmesis was ranked to be the lowest, followed by incisional sequelae and quality of life. The quality of evidence was rated low by grade (3) and it was adjusted to moderate by minors (4) in a couple of areas such as length of stay and cost. The two types of recommendations were made: type A and type B. Type A are based on (I) the quality of the body of evidence; (II) the benefit/risk ratio; (III) the benefit/cost ratio; and (IV) the preferences and values of patients. Type B are recommendations for future steps that would improve the level of evidence for the comparator. In addition, procedures were assessed as to their stage of development according to the Balliol classification of ideal (5). Type A recommendations regarding Q1 to Q4 and their strength are summarized in *Table 4*. Recommendations on Q5 and Q6 are summarized in *Table 5*.

Recommendations by the expert

It was wise decision to have video presentations in front of the jury so that they were able to witness how liver resection has changed. In my opinion, showing surgical procedures with videos should be more appreciated because it has a role for developing its field with precise techniques to be shared among surgeons. These videos provided a certain level of evidence showing the quality of LLR is superior to that of open liver resection (OLR). Once surgeons observe surgical procedures, they immediately understand the quality of these procedures and judge how good or bad they are. High quality LLRs were presented and these videos attracted the all attendance of the ICCLLR and shared by them.

The expert created technical recommendations that

Table 3 Questions for LLR

Comparative outcomes, value, safety
Q1: What are the comparative short-term outcomes of LLR *vs.* OLR, open liver resection? (minor and major)
Q2: What are the comparative long-term outcomes of LLR *vs.* OLR, open liver resection? (minor and major)
Q3: What are the comparative cost implications of LLR *vs.* OLR? (minor and major)
Q4: What are the comparative pain control and QOL, quality of life outcomes for LLR *vs.* OLR? (minor and major)
Robotic and donor hepatectomy
Q5: What is the role of robotic hepatectomy?
Q6: Is LLR applicable to donor hepatectomy?
RCT
Q7: Are RCTs feasible for LLR?
Spread, difficulty, alternatives
Q8: What is the spread of LLR?
Q9: What determines the difficulty of LLR?
Q10: What is the role of HAL and the hybrid method?
Techniques
Q11: What has changed in the concept of liver resection?
Q12: What are the essentials of bleeding control in LLR?
Q13: What is the best technique for parenchymal transection?
Q14: What kind of energy devices should be used for LLR?
Q15: What is the best approach to the hilar structures (individual or Glissonian approach)?
Q16: Is anatomical resection preferable for LLR?
Simulation, navigation
Q17: What is the role of simulation and navigation in LLR?

LLR, laparoscopic liver resection; OLR, open liver resection; QOL, quality of life; RCT, randomized controlled trial; HAL, hand-assisted laparoscopic.

Table 4 Summary of recommendations and their strength on Q1 to Q4

Q1 to Q4	Minor, IDEAL 3	Major, IDEAL 2b	Minor/major, IDEAL 3/IDEAL 2b
Q1: Short-term			
Mortality	Not inferior (S)	Not inferior (S)	
Complications	Superior or not different (S)	Not inferior or superior (S)	
Margin negativity	Not inferior (S)	Not inferior (S)	
LOS	Superior (S)	Superior (S)	
Blood loss			Superior
Recovery			Not evaluable
Q2: Long-term			
OS	Not inferior (S)	Not inferior (S)	
Q3: Cost			Not inferior (S)
Q4: Pain & QOL			
Pain			Improvement
QOL			Not different

(S): strong recommendation. LOS, length of stay; OS, overall survival; QOL, quality of life.

Table 5 Summary of recommendations on Q5 and Q6

Q5 and Q6	Type A recommendation	Type B recommendation
Q5: Robotic liver resection	IDEAL 2a	Institutional ethical approval, reporting registry, cost/benefit study
Q6: Laparoscopic donor hepatectomy: pediatric	IDEAL 2b	Institutional oversight, registry, benefit/risk ratio
Q6: Laparoscopic donor hepatectomy: adult to adult	IDEAL 2a	Institutional ethical approval, reporting registry

will never be proved by level 1 evidence but were based on experts' opinions with comprehensive literature reviews on multiple case series, case-control studies, reviews, and meta-analysis published over the last several years. However, by watching video clips, we extensively discussed how to improve the quality of LLR during the ICCLLR and the discussions were well shared to create consensus statements because all international experts were present in the same room at the same time. These consensus statements were summarized in *Table 6*. Systematic reviews that served to be basic information for these statements have been published elsewhere (6-12) along with publications of related activity to the ICCLLR (13-17). I hope that these technical recommendations and all these publications from the ICCLLR will contribute to the steady and safe spread of LLR.

Theoretical superiority of LLR and its proof by two large-scale propensity score analyses by Japanese high volume centers

The laparoscopic procedure is more difficult to master than the open procedure because of the movement restrictions imposed upon us when we operate from outside the body cavity. However, good visibility of the operative field especially around the liver, which is located deep inside the costal arch, and the magnifying provide for precise transection of the liver parenchyma (18). Another theoretical advantage is that pneumoperitoneum pressure reduces hemorrhage from the vein with low pressure (19). Therefore, LLR is theoretically superior to OLR because the laparoscope allows better exposure with a magnified view, and the pneumoperitoneum pressure reduces hepatic vein bleeding from the cut surface (14).

The concept for liver resection has also 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. 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. Unless I am not convinced that LLR is safer than OLR in my hand, I cannot offer this surgery to healthy donors where safety should be warranted most importantly (20).

During the ICCLLR, we shared these theoretical advantages in LLR and the conceptual change of liver resection. Moreover, these ideas convinced the expert that what they are advocating would be the right direction to the future in liver surgery. After the ICCLLR in Morioka, a couple of important studies have been published to prove this theoretical superiority of LLR in terms of short-term and long-term results (21,22). These two studies compared both short-term and long-term outcomes after LLR and OLR for hepatocellular carcinoma (HCC) (21) and colorectal liver metastasis (CRLM) (22) by using propensity score analysis on almost 5,000 patients' data that were gathered from over 30 high volume centers in Japan. At this moment without any randomized controlled trial, these two studies provide the second best evidence to prove the superiority of LLR over OLR in some short-term outcomes without deteriorating long-term outcomes for HCC and CRLM (23).

Parenchyma sparing (limited) anatomical resection

As a chairman of working group for Q16 to summarize benefits of anatomical resection in LLR, I also proposed another new concept at the ICCLLR: parenchyma sparing (limited) anatomical resection (24). The remnant liver volume and tumor clearance are important issues in LLR as in OLR. Two basic surgical techniques are commonly used to reduce recurrences: anatomical resection suggested for HCC and parenchyma sparing strategy with negative

Table 6 Summary of consensus statements on Q8 to Q17

Spread, difficulty, alternatives
Q8: Spread
The number of LLRs, laparoscopic liver resection has increased steeply worldwide over the past five years, and published conversion rates have gradually decreased
Q9: Difficulty
The difficulty of LLR should be estimated by a combination of factors including the extent of liver resection, tumor location, tumor size, proximity to major vessels, and the severity of fibrosis
Preoperative estimation of the difficulty of LLR is useful in selecting appropriate patients according to the surgeon's experience and skill levels
Q10: HALS and hybrid
Pure LLR, HALS, hand-assisted laparoscopic surgery, and the hybrid method appear equivalent and are a matter of the surgeon's preference
HALS and the hybrid method are used to manage intraoperative difficulties anticipated for pure LLR
Techniques
Q11: Concept
The "caudal" approach is the main conceptual change in LLR, in contrast to the "anterior" approach in OLR, open liver resection
The "lateral approach" (left lateral decubitus) gives access to right posterior segments
Q12: Bleeding control
A temporary increase in CO_2 pneumoperitoneum pressure can be used to help control bleeding during LLR
Low central venous pressure (<5 mmHg) is recommended during LLR, as in OLR
Laparoscopic suturing skills are essential for LLR
Q13: Parenchymal transection
Currently, several techniques and devices are equivalent for parenchymal transection in LLR and should be left to the surgeon's preference, as in OLR
Q14: Energy devices
Various energy devices appear to be equivalent and should be left to the surgeon's preference and expertise, as in OLR
An argon beam coagulator, if used for hemostasis, requires caution to avoid potential gas embolism
Q15: Hilar approach
Individual hilar dissection and the Glissonian approach appear equivalent and should be left to the surgeon's preference and expertise, as in OLR
Q16: Anatomical resection
Anatomical resection for HCC, hepatocelluar carcinoma and parenchyma-sparing strategy for CRLM, colorectal liver metastasis are recommended as in the open approach and require continued evaluation of their application to LLR
Simulation, navigation
Q17: Simulation and navigation
Pre-operative simulation can be useful for measuring the remnant liver volume, visualizing the anatomy and tumor location, and planning the resection plane in selected cases

LLR, laparoscopic liver resection; HALS, hand-assisted laparoscopic surgery; OLR, open liver resection; HCC, hepatocellular carcinoma; CRLM, colorectal liver metastasis.

margins for CRLM. However, controversies exist about the definition of anatomical resection in LLR and the security of negative margins due to lack of tactile sensation during LLR. Review of the literature made me think to support anatomical resection with parenchyma sparing strategy for LLR irrespective of HCC and CRLM. Parenchyma sparing (limited) anatomical resection can be performed by the Glissonean approach for sectionectomy and less. All anatomical resection can be performed from the hilar plate. The caudal approach of LLR is beneficial to these limited anatomical resections from sub-segmentectomy, segmentectomy, to sectionectomy (25,26). 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. In my opinion, parenchyma sparing anatomical resection is the future direction in liver surgery and LLR will fit this direction perfectly. As we become aware of these essentials, LLR will be popularized more in the next several years.

Sensational reports of clustered deaths after LLR in Japan

A newspaper sensationally scooped eight deaths after major LLR at a Japanese University hospital as a headline on 14th November, 2014 (27,28). Together with this news, another media report of several deaths after major laparoscopic liver and pancreas resection at a regional cancer center in Japan impacted Japanese people and the field of LLR in Japan as well. These sensational media coverage on clustered mortality after LLR have a great impact on daily practice of LLR in our country and it has raised scrutiny about the safety of LLR itself (23). The investigational committee of the University disclosed the first report a few months later but the report did not explain what were wrong with LLR. Although these sensational media coverage gave an impression to the Japanese public that major LLR is not safe, the same newspaper also reported ten deaths after OLR as well at the same University. As autonomy of a professional society, the Japanese Society of Hepato-Biliary-Pancreatic Surgery (JSHBPS) conducted an emergent survey on operative mortality at board certified high volume centers all over Japan. The results clearly showed that the operative mortality after major LLR stayed low around 1.5% even though annual cases were gradually increased. Furthermore, the mortality was not higher if compared with reported mortality of open procedures except hemi-hepatectomy with bile duct resection (29).

Protection of patients from this newly developed procedure

The most important message from the ICCLLR was to protect patients from this new surgical procedure. The ICCLLR recommended three actions for the protection of patients from this newly developed surgical procedure: (I) prospective reporting registry for transparency; (II) a difficulty scoring system to select patients; (III) creation of a formal structure of education. After the ICCLLR, we launched the online prospective registry system for LLR in Japan in October 2015 (29). All member institutions of the Japanese Study Group of Endoscopic Liver Surgery (JSGELS) and all board certified training institutions of JSHBPS are expected to participate at this online registry. The operator of LLR is requested to enter relatively simple items online at four time points, i.e., pre-operation, after-operation, after discharge, and readmission if it happens. The online prospective registry system incudes items to calculate the difficulty score so that the operator can recognize the difficulty of planned LLR preoperatively. We expect that it will become one of the largest prospective database of LLR and that it will serve as a protective mechanism for patients from this newly developed, technically demanding surgical procedure. We are now in preparation of the registry worldwide.

Furthermore, in an effort to estimate the difficulty of LLR easily before surgery, a novel difficulty scoring system was created for discussion at the ICCLLR to define the range of difficulty of LLR, similar to the Child-Pugh score, so that novices can start LLR easily and safely (17). Selection of the appropriate patients according to the surgeon's skills will eventually protect patients. Reports of clustered mortality in Japan also highlight the need for a safe introduction of major LLR (23). Hand-assisted laparoscopic surgery (HALS) and the hybrid method (in which the operation is begun laparoscopically and completed through a small open incision) are likely to reduce certain difficulties associated with pure LLR (8). The expert panel proposed criteria (IWATE criteria) based on the published difficulty scoring system, which incorporate HALS and the hybrid method but subtract 1 point for either of these two methods to reduce the overall difficulty score (*Figure 1*). After the discussion at the ICCLLR, the Iwate scoring system was modified from the original one published earlier and it now has a scale ranging from 0 to 12. Resection of a mass from segment 1 is assigned 4 points, and use of HALS/Hybrid method is reduced 1 point (–1) to the overall score. asses

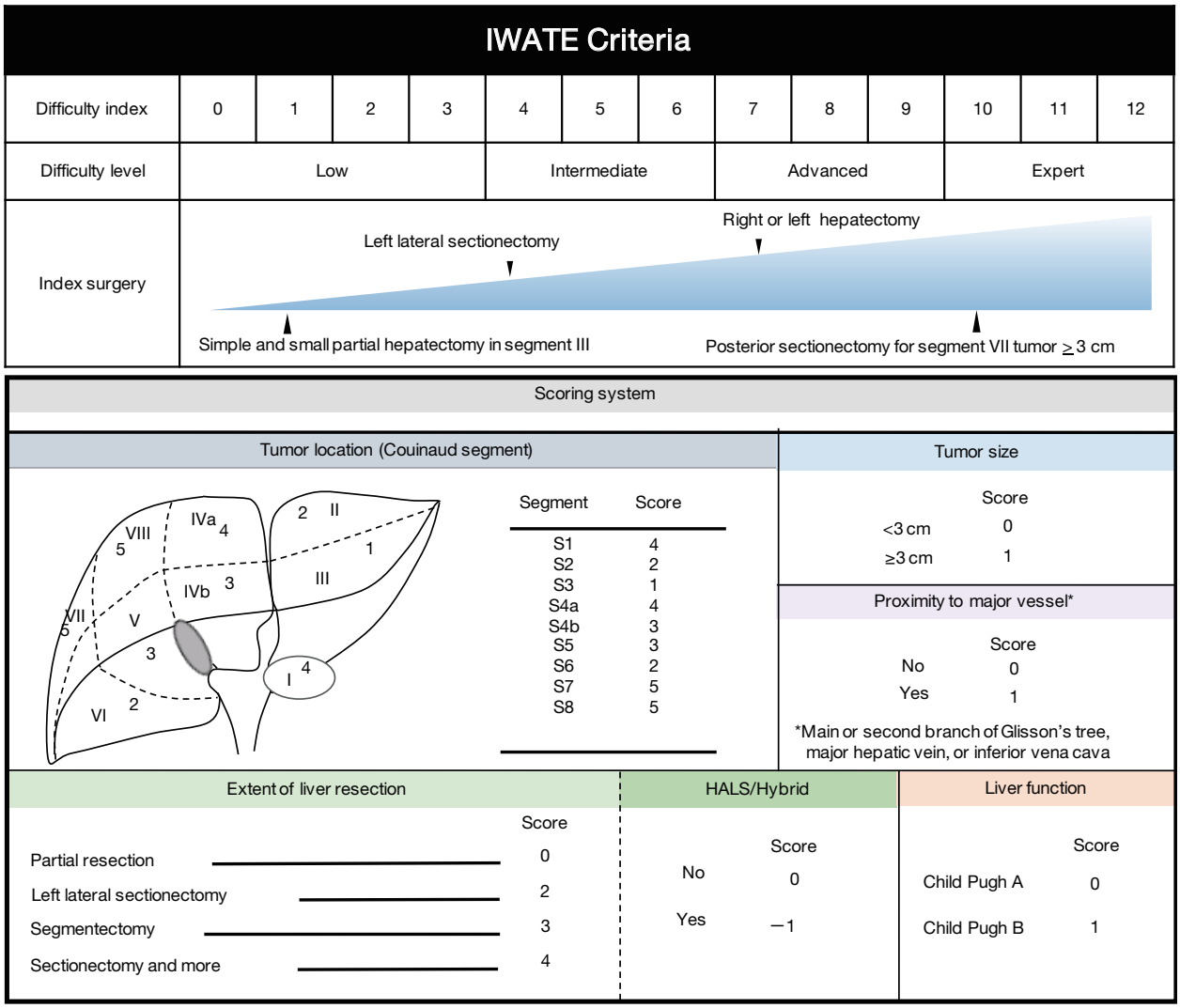

Figure 1 IWATE criteria proposed at the ICCLLR as an up-versioned difficulty scoring system. ICCLLR, International Consensus Conference on Laparoscopic Liver Resection.

in segment 4b and 4a were also differentiated as different points, 3 and 4 points, respectively. The IWATE criteria can be used to predict the difficulty of LLR from preoperative variables and to appropriately select patients according to the surgeons' skill level, ranked as low, intermediate, advanced, or expert. We tried to incorporate the IWATE criteria into the main report of the ICCLLR, but the reviewers did not allow us to present it without validation. We are now preparing the study to validate the proposed scoring system. The identification of difficult cases should be deferred depending on one's individual learning curve of LLR.

Finally, major LLR requires a high level of technical skill and has a steep learning curve. A major focused effort is required to determine how the laparoscopic skills needed for major LLR should be obtained by trainees and health promotion board (HPB) surgeons in practice. Certainly, we need to create a formal structure of education for novices in the near future.

In summary, the ICCLLR was very intense and successful. The judgment on the assessment of LLR was a bit severe but the judgment was shared with the expert. After the ICCLLR, two important studies have been published to show short-term benefits of LLR without deteriorating long-term results. We have been convinced that LLR is the correct future direction and laparoscopic parenchyma

sparing anatomical liver resection is the way to go. Finally, we also became aware to protect patients from this newly developed approach in liver surgery. We started an online registry in Japan, and are now in preparation of world registry. We discussed at the ICCLLR face to face our most up-to-date understanding, assessment of LLR, basic techniques, and its future directions. As a chairman of the ICCLLR, I hope that LLR will be more popularized safely and will benefit more patients suffering from liver diseases.

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Footnote

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