# Validation of a Difficulty Scoring System for Laparoscopic Liver Resection: A Multicenter Analysis by the Endoscopic Liver Surgery Study Group in Japan

Shogo Tanaka, MD, PhD, Shoji Kubo, MD, PhD, Akishige Kanazawa, MD, PhD, Yutaka Takeda, MD, PhD, Fumitoshi Hirokawa, MD, PhD, Hiroyuki Nitta, MD, PhD, Takayoshi Nakajima, MD, PhD, Takashi Kaizu, MD, PhD, Hironori Kaneko, MD, PhD, FACS, Go Wakabayashi, MD, PhD, FACS

**BACKGROUND:** Laparoscopic liver resection (LLR) is widely used for hepatic disease treatment. Preoperative prediction of operative difficulty can be beneficial as a roadmap for surgeons advancing from simple to highly technical LLR. We performed a multicenter analysis to investigate a "difficulty scoring system" for predicting the difficulty of LLR.

**STUDY DESIGN:** The proposed "difficulty scoring system" includes 3 difficulty levels based on 5 factors. The system was validated in a cohort of 2,199 patients who underwent LLR at 74 Japanese centers between 2010 and 2014; the difficulty level was rated as low (n = 965), intermediate (n = 891), and high (n = 343). Operative parameters, postoperative complications, and outcomes were compared according to the difficulty levels.

**RESULTS:** The median operation time and blood loss were 258 minutes (range 30 to 1,275 minutes) and 75 mL (range 0 to 7,798 mL), respectively. The overall conversion rate was 5.0% (n = 110). The incidences of postoperative complications, liver failure, and in-hospital death were 5.3% (n = 116), 1.5% (n = 32), and 0.5% (n = 12), respectively. Median hospital stay was 9 days (range 1 to 189 days). Conversion rate, operation time, and blood loss showed a direct correlation with the difficulty level. A strong correlation was observed among the difficulty level, incidence of postoperative complications, and hospital stay. Incidence of postoperative liver failure and in-hospital death in the high difficulty group was higher than that in the low difficulty group.

**CONCLUSIONS:** Preoperative evaluation with the "difficulty scoring system" predicted the difficulty of the operation and the postoperative outcomes of LLR. In the beginning of LLR training, surgeons should start with low difficulty-level operations. (J Am Coll Surg 2017;225:249−258. © 2017 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)

**Disclosure Information: Nothing to disclose.**

Received January 9, 2017; Revised March 9, 2017; Accepted March 21, 2017.

From the Departments of Hepato-Biliary-Pancreatic Surgery, Osaka City University Graduate School of Medicine (Tanaka, Kubo) and Osaka City General Hospital (Kanazawa), Osaka, Japan; the Department of General and Gastroenterological Surgery, Osaka Medical College, Takatsuki, Japan (Hirokawa); and the Departments of Surgery, Kansai Rosai Hospital, Amagasaki, Japan (Takeda); Iwate Medical University School of Medicine, Morioka, Japan (Nitta); Meiwa Hospital, Nishinomiya, Japan (Nakajima); Kitasato University School of Medicine, Sagamihara, Japan (Kaizu); Toho University Faculty of Medicine, Tokyo, Japan (Kaneko); and Ageo Central General Hospital, Ageo, Japan (Wakabayashi).

Correspondence address: Shogo Tanaka, MD, PhD, Department of Hepato-Biliary-Pancreatic Surgery, Osaka City University Graduate School of Medicine, 1-4-3 Asahimachi, Abenoku, Osaka 545-8585, Japan. email: m8827074@msic.med.osaka-cu.ac.jp

Laparoscopic liver resection (LLR) is a minimally invasive treatment modality for patients with liver disease associated with lower morbidity and comparable oncologic outcomes relative to those of conventional open liver resection.[1-4] In Japan, after the introduction of LLR in specialized centers in 1993,[5-7] the number of patients treated by LLR has gradually increased, especially after 2009.[8] Partial resection and left lateral sectionectomy are performed largely because of restrictions imposed by the national insurance system (until April 2016); however, even for major hepatectomy (sectionectomy or more extended resection), laparoscopy-assisted and pure laparoscopic approaches have been safely performed.[9-11] The 2008 Louisville consensus statement recommends that





http://dx.doi.org/10.1016/j.jamcollsurg.2017.03.016
ISSN 1072-7515/17

solitary tumors $\leq$ 5 cm, located in the peripheral liver (segments 2 to 6), are good indications for LLR.[4] Nonetheless, in highly specialized centers, LLR is increasingly being used for major hepatectomy and resection of lesions located in the posterior segments.[1,12-15]

Laparoscopic liver resection is technically more challenging than open liver resection, and the operator must master the skills required for both laparoscopic surgery and open hepatectomy.[4,16] Currently, there is a broad consensus that major LLR is still in an exploratory or learning phase and that the associated risks are yet to be completely characterized.[16] So it is necessary to gradually increase operative skills before undertaking highly technical procedures, for which preoperative evaluation or scoring of difficulty is essential.

The use of a "difficulty scoring system" was recently proposed based on the experience with pure LLR at 3 high-volume centers in Japan.[17] This system indicates the prediction of "difficulty of LLR" and "the development of LLR from simple to highly difficult LLR." In this study, we investigated whether this "difficulty scoring system" could predict the difficulty of LLR and intra- and postoperative outcomes using prospectively collected data as part of a multicenter study by the Endoscopic Liver Surgery Group in Japan.

## METHODS

### Patients

This multicenter clinical study was conducted by the Endoscopic Liver Surgery Study Group in Japan. We retrospectively analyzed data from 2,199 patients who underwent initial pure LLR for hepatic tumors (hepatocellular carcinoma [HCC], intrahepatic cholangiocarcinoma, metastatic liver tumor, other malignant tumors, and benign liver tumors) between 2010 and 2014 at 74 Japanese institutions (listed in eDocument 1) in a study of the Endoscopic Liver Surgery Study Group, which approved this study. Exclusion criteria included LLR for hepatic diseases other than tumors or for donors of living-related liver transplantation; resection of multiple lesions; concomitant ablation therapy for daughter nodules with LLR; concomitant resection of other organs except the gallbladder; resection of the caudate lobe (segment 1); and insufficient clinical data to validate the "difficulty scoring system." The median number of LLR among the 74 institutions was 18.5 cases during 5 years (range 1 to 174 cases). During 5 years, less than 50 LLR cases were conducted in 62 (84%) of the 74 institutions (n = 1,088); 50 or more LLR were conducted in the remaining 12 institutions (16%, n = 1,111). This study was approved by the institutional review board at each of the participating institutions (approval number, 3187; Osaka City University) and conducted in accordance with the principles invoked in the Helsinki Declaration.

### Difficulty scoring system

To achieve a certain degree of consensus on the 10-level difficulty index among the expert surgeons who served as reviewers, small and simple partial hepatectomy (simplest LLR procedure) and hepatectomy (technical limitation of current laparoscopic surgery) were assigned a difficulty index of 1 and 10, respectively. Further, this 10-level difficulty index was stratified into 3 levels: low (index 1 to 3), intermediate (4 to 7), and high difficulty (7 to 10) levels. The experts assigned difficulty ratings based on surgeon assessments: lateral sectionectomy was defined as index 4 (the lowest rating in the intermediate category); simple hemihepatectomy was defined as index 7 (the lowest rating in the category of highly difficult procedures) (Fig. 1). We investigated the association between the difficulty level assessed by the surgeon, which showed a strong correlation with the reviewer's (expert) assessment, with clinical parameters, and a difficulty scoring system based on clinical parameters was proposed (Fig. 2). This scoring system corresponded with both the 10-level and 3-level stratification of difficulty level based on the operator's assessment.

The total score was the sum of 5 difficulty indices: tumor location, extent of hepatic resection, tumor size, proximity to a major vessel, and liver function (10-level difficulty, Fig. 2). The 10-level difficulty was stratified into 3 categories: low difficulty = 1 to 3, intermediate difficulty = 4 to 6, and high difficulty = 7 to 10 (3-level difficulty).[17] For the purpose of this analysis, a total score of greater than 10 corresponded to the highest difficulty level (Fig. 2).

### Clinical data

Baseline preoperative clinical data included age, sex, number, and proportion of patients disaggregated by the type of tumor (HCC, intrahepatic cholangiocarcinoma, metastatic liver tumor, other malignancy, and benign tumors); past surgical history (upper abdominal surgery and upper abdominal laparoscopic surgery); extent of liver resection (partial resection, left lateral sectionectomy, segmentectomy, and not less than a sectionectomy); tumor location (S2 to S8) and size ($\geq$3 cm or <3 cm); proximity (1 cm or less) of the hepatic tumor to major vessels (main or second branches of Glisson's tree, major hepatic veins, and inferior vena cava [yes or no]); Child-Pugh class (A or