



# Meeting Abstracts of the 5th World Congress of the International Laparoscopic Liver Society & the 3rd International Consensus Conference on Minimally Invasive Liver Resections

Ho-Seong Han<sup>1,2</sup>

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The 5th World Congress of the International Laparoscopic Liver Society & the 3rd International Consensus Conference on Minimally Invasive Liver Resections, June 24-27, 2025 [Table 1].

## 1. Efficacy analysis of a novel indocyanine green-human serum albumin complex (ICG-HSA) assisted near-infrared fluorescence-guided laparoscopic anatomic liver resection for hepatocellular carcinoma: a single-center, double-blind, prospective randomized controlled trial

Qingyun Xie, Fengwei Gao, Kun Li, Hong Wu

Liver Transplantation Center, State Key Laboratory of Biotherapy and Cancer Center, West China Hospital, Sichuan University, Sichuan, Chengdu, China.

### Abstract

**Objectives:** The binding of indocyanine green (ICG) to vascular endothelium and degradation by free radicals lead to fluorescence drift and reduced efficiency. Additionally, ICG's poor solubility, concentration-dependent aggregation, and short liver retention time limit its application. To address these issues, we developed a novel ICG-human serum albumin (ICG-HSA) conjugate nanocomplex to stabilize ICG in the bloodstream and enhance liver-targeted uptake, reducing fluorescence heterogeneity and degradation. A prospective randomized controlled trial (NCT06219096) compared fluorescence navigation accuracy, success rate, and perioperative outcomes between ICG-HSA and conventional ICG in laparoscopic liver resection for hepatocellular carcinoma.

**Methods:** The ICG-HSA complex was tested *in vitro* for absorbance and stability under varying solvents, concentrations, ratios, injection rates, and temperatures. After optimization, it was applied clinically. From January to September 2024, hepatocellular carcinoma patients eligible for fluorescence-guided laparoscopic anatomic liver resection were randomly assigned to the ICG-HSA or free ICG group



<sup>1</sup>Department of Surgery, Seoul National University Bundang Hospital, Seongnam 13620, Republic of Korea.

<sup>2</sup>Department of Surgery, Seongnam Citizen Medical Center, Seongnam 13290, Republic of Korea.

**Correspondence to:** Prof. Ho-Seong Han, Department of Surgery, Seoul National University Bundang Hospital, Seongnam 13620, Republic of Korea. E-mail: hanhs@snuh.org

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(1:1). Both groups underwent Glissonean pedicle clamping with peripheral venous injection of either ICG or ICG-HSA, followed by fluorescence-guided resection. Surgical videos were scored by three experts for fluorescence imaging quality, and perioperative outcomes were compared.

**Results:** The ICG-HSA complex showed optimal stability and absorbance at a mass molar ratio of 1:6 and 37 °C. The optimal injection rate was 0.05 mg/min, and the optimal concentration was 0.01 mg/mL. A total of 62 patients were randomized (31 in each group). Baseline characteristics were comparable. The ICG-HSA group had significantly higher fluorescence imaging scores ( $4.78 \pm 0.92$  vs.  $3.99 \pm 1.01$ ,  $P = 0.002$ ), less intraoperative blood loss ( $100 [50-200]$  vs.  $200 [100-350]$ ,  $P = 0.017$ ), and lower alanine aminotransferase levels on postoperative day 3 ( $113 [66-202]$  vs.  $257 [201-370]$ ,  $P < 0.005$ ). No significant differences were found in operative time, postoperative complications, or hospital stay.

**Conclusion:** The ICG-HSA complex demonstrated superior optical performance and stability compared to free ICG, improving liver segment localization and reducing intraoperative blood loss. This novel complex provides a safe and effective alternative for fluorescence-guided laparoscopic anatomic liver resection, with potential to improve surgical outcomes and postoperative liver function.

## 2. Can an AI predictive model be integrated into clinical decision-making for predicting open conversion in minimally invasive liver resection?

Boram Lee, Ho-Seong Han, Yoo-Seok Yoon, Jai Young Cho, Hae Won Lee, Yeshong Park

Department of Surgery, Seoul National University Bundang Hospital, Seoul, Republic of Korea.

### Abstract

**Objectives:** Minimally invasive liver resection (MILR) offers significant benefits, but unplanned open conversion (OC) poses challenges, increasing complications and compromising oncologic outcomes. Identifying patients at high risk for OC based solely on preoperative factors could allow for better surgical planning, including selecting planned open surgery for high-risk patients. This study aims to develop and evaluate an artificial intelligence (AI) predictive model using preoperative data to guide clinical decision-making for MILR.

**Methods:** A retrospective cohort of 1,280 patients who underwent MILR between 2004 and 2022 was analyzed. Among these, 120 patients (9.4%) experienced unplanned OC. Preoperative variables such as patient demographics, comorbidities, tumor size, tumor location, liver function tests, and radiological findings were used to develop an AI model. The dataset was divided into training (80%) and validation (20%) cohorts. Model performance was assessed using the area under the receiver operating characteristic (AUROC), sensitivity, specificity, and accuracy. Clinical feasibility was evaluated by analyzing the model's potential impact on preoperative decision-making.

**Results:** The AI model achieved an AUROC of 0.89 [95% confidence interval (CI): 0.85 to 0.93] in predicting OC, with sensitivity and specificity of 83% and 81%, respectively. Tumor size (> 5 cm), proximity to major vascular structures (within 1 cm), and hypoalbuminemia (3.5 g/dl) were identified as key predictors. Integrating AI tools into preoperative planning simulations has been shown to reduce unplanned OC rates by 17.6% through more informed surgical strategy selection, including recommendations for planned open surgery in high-risk cases.

**Conclusion:** This study highlights the potential of an AI predictive model based on preoperative factors to guide clinical decision-making in MILR. By identifying patients at high risk for OC, the tool supports strategic planning, potentially improving patient outcomes and resource allocation. Further prospective validation is needed to facilitate clinical adoption and optimize its utility in diverse surgical settings.

## 3. 964 robotic hepatectomies: a bicentric analysis of short-term perioperative outcomes and evolution over time

Roberta Odorizzi<sup>1</sup>, Hasan Al Harakeh<sup>2</sup>, Cristiano Guidetti<sup>1</sup>, Giuseppe Esposito<sup>1</sup>, Jacopo Mascherini<sup>1</sup>, Beatrice Pelloni<sup>1</sup>, Garnet Vanterpool Jr.<sup>2</sup>, Kristina Milivojev Covilo<sup>2</sup>, Stefano Di Sandro<sup>1</sup>, Sharona B. Ross<sup>2</sup>, Fabrizio Di Benedetto<sup>1</sup>, Iswanto Sucandy<sup>2</sup>

<sup>1</sup>Hepato-pancreato-biliary Surgery and Liver Transplantation Unit, University of Modena and Reggio Emilia, Modena, Italy.

<sup>2</sup>Hepatopancreatobiliary and Gastrointestinal Surgery, Digestive Health Institute Advent Health Tampa, Tampa, FL, USA.

### Abstract

**Objectives:** To integrate bicentric experience from two high-volume hepatobiliary centers in robotic hepatectomy and evaluate real-time perioperative outcomes and the progression of surgical proficiency over time.

**Methods:** A retrospective observational study was conducted using prospectively maintained databases of consecutive robotic hepatectomies performed at AdventHealth Tampa, USA, and the University of Modena and Reggio Emilia, Italy, from August 2013 to December 2024. Patients were stratified into three groups

based on the learning phase, with comparisons made between initial (Group-A), intermediate (Group-B) and advanced (Group-C) phases. Demographics and perioperative outcomes were assessed, with data presented as mean ( $\pm$  standard deviation).

**Results:** Among 964 robotic hepatectomies, 49.3% were minor, 27.5% major, and 23.2% technically major resections. Mean patient age was 61.67 ( $\pm$  14.28) years, with a body mass index of 28.30 ( $\pm$  5.88) kg/m<sup>2</sup> and a Charlson Comorbidity Index of 5.03 ( $\pm$  2.72). Cirrhosis (Child-Pugh A/B) was present in 20.7% and 47.4% had prior abdominal surgery, including 6.8% with previous liver resections. Of 621 patients (64.4%) undergoing hepatectomy for malignant disease, 32 (3.32%) had perihilar tumors. R0 resection rate was 96.6%. The mean operative time was 277.7 ( $\pm$  138.7) min, with estimated blood loss of 206.1 ( $\pm$  256.1) mL. Conversion to open surgery occurred in 11 patients (1.14%). Mean hospital stay was 4.72 ( $\pm$  5.47) days, and the 90-day readmission rate was 11.1%. The overall complication rate was 27.5%, including bile leak (2.8%), postoperative hemorrhage (2.3%), and liver failure (1.4%). Major complications (Clavien-Dindo  $\geq$  3a) occurred in 7.9%, with 90-day mortality in 15 patients (1.6%). Full-robotic associating liver partition and portal vein ligation for staged hepatectomy (ALPPS) was performed in 11 patients (1.1%) and first-stage ALPPS in 9 (0.9%). Biliary and vascular resections and reconstructions were performed in 64 (6.64%) and 7 (0.73%) patients, respectively. A progressive trend was observed across all three phases, with a statistically significant increase in technically major hepatectomies and resections for perihilar cholangiocarcinoma and gallbladder cancer. Meanwhile, operative time, blood loss, open conversion rate, and 90-day morbidity decreased significantly over time, with median follow-up of 24, 14, and 6 months in the three groups.

**Conclusion:** This study highlights the successful real-time implementation of robotic hepatectomy at two high-volume hepatobiliary institutions, demonstrating favorable perioperative outcomes and the ability to perform increasingly complex procedures.

#### 4. Comparison of short- and long-term outcomes between robotic and laparoscopic operation in hilar cholangiocarcinoma patients: a case control study

Zhiheng Zhang<sup>1</sup>, Weihong Wang<sup>1</sup>, Jiawei Xu<sup>1</sup>, Jing Peng<sup>1</sup>, Yunfei Duan<sup>1</sup>, Decai Yu<sup>1,2</sup>

<sup>1</sup>Division of Hepatobiliary and Transplantation Surgery, Nanjing Drum Tower Hospital, Nanjing, Jiangsu, China.

<sup>2</sup>Department of General Surgery, Nanjing University, Nanjing, Jiangsu, China.

#### Abstract

**Objectives:** Robotic surgery (RS) has gained increasing acceptance due to its ability to overcome certain limitations associated with laparoscopic surgery (LS). However, the performance of RS in hilar cholangiocarcinoma (HCCA) patients compared with LS remains unclear. This study aimed to compare the short- and long-term outcomes of RS vs. LS in patients with HCCA.

**Methods:** This retrospective study included patients who underwent radical resection of HCCA between February 2020 and August 2024. Baseline characteristics, pathological findings, surgical outcomes, and long-term outcomes were analyzed and compared between the RS and LS groups.

**Results:** The baseline characteristics and pathologic findings of both groups were comparable. The RS group had less estimated blood loss [300 (175-400) vs. 700 (200-750) mL,  $P = 0.008$ ], and lower ALT, AST, TBIL, and DBIL compared to LS group, while no significant differences in postoperative complications. Regarding long-term outcomes, the overall survival rates and recurrence-free survival rates were comparable in the two groups ( $P = 0.77$  and  $P = 0.17$ , respectively).

**Conclusion:** This study demonstrated that RS for HCCA generally achieves satisfactory perioperative outcomes compared to LS. With continued advancements in surgical techniques and accumulation of experience, robotic radical resection for HCCA could become a routine approach in the future.



## 5. Feasibility of pure laparoscopic donor right hepatectomy compared to open donor right hepatectomy: a large single-center cohort study

Sang-Hoon Kim<sup>1,2</sup>, Ki-Hun Kim<sup>1,2</sup>

<sup>1</sup>Division of Liver Transplantation and Hepatobiliary Surgery, Asan Medical Center, Seoul, Republic of Korea.

<sup>2</sup>Department of Surgery, University of Ulsan College of Medicine, Seoul, Republic of Korea.

### Abstract

**Objectives:** Donor and recipient morbidity have not been sufficiently reported in large-scale comparisons of pure laparoscopic donor right hepatectomy (PLDRH) and open donor right hepatectomy (ODRH). This study aimed to compare morbidity of living donors and recipients after PLDRH and ODRH.

**Methods:** This retrospective study reviewed 3,348 donors who underwent PLDRH ( $n = 329$ ) and ODRH ( $n = 3,019$ ) and their corresponding recipients ( $n = 3,348$ ) between January 2014 and August 2023. Donor complications and recipient biliary complications within 90 days were evaluated before and after 1:3 propensity score matching (PSM). Multivariate logistic regression analyses identified significant risk factors for donor major and biliary complications, as well as recipient bile leakage and biliary stricture.

**Results:** For donors, PLDRH had fewer overall complications than ODRH (0.9% vs. 3.7%,  $P = 0.009$ ), with no significant differences in major (Clavien-Dindo III/IV) complications ( $P = 0.057$ ) and biliary complications ( $P = 0.067$ ), despite the absence of biliary complications in PLDRH. However, PLDRH showed longer warm ischemic time and operation time, and higher peak aspartate aminotransferase and alanine aminotransferase levels compared to ODRH in donors ( $P < 0.001$ ). These results remained consistent after PSM. Recipient biliary complications were comparable between PLDRH and ODRH, both before ( $P = 0.806$ ) and after PSM ( $P = 0.264$ ). Multiple portal veins were a significant donor risk factor for major ( $P = 0.022$ ), and biliary complications ( $P = 0.001$ ). Separated multiple bile ducts were a common significant recipient risk factor for bile leakage ( $P = 0.007$ ) and biliary stricture ( $P = 0.022$ ).

**Conclusion:** PLDRH could become the standard for donor right hepatectomy with careful consideration of portal and biliary variations for donor and recipient safety.

## 6. Discussion on key techniques of right anterior lobe resection by fluorescent laparoscopic reverse staining

Jiajie Lu, Wenlong He, Shuai Yan, Jianjun Wu, Jinzhu Wu

Department of Surgery, Medical School of Nantong University, Nantong, Jiangsu, China.

### Abstract

**Objectives:** Fluorescent laparoscopic reverse staining right anterior lobectomy is a new surgical method, which has been proven to be safe and effective in the radical resection of liver cancer. In recent years, laparoscopic hepatectomy has developed rapidly, and as a new technology, fluorescent laparoscopic reverse staining improves the accuracy and safety of surgery through fluorescent labeling. The combination of the two has obvious advantages in the resection of tumors in the right anterior lobe of the liver. However, there are still some shortcomings. Therefore, this paper will focus on the introduction of fluorescent laparoscopic reverse staining method of right anterior lobectomy and its advantages and limitations, in order to provide a reference for clinical surgery.

**Methods:** This paper describes seven aspects in detail: surgical background, patient selection, surgical position and layout, fluorescence exploration technique, operative key points, postoperative management, and surgical advantages and prospects. Additionally, the technical key points and clinical application value of fluorescent laparoscopic reverse staining right anterior lobe resection were comprehensively introduced.

**Results:** Fluorescent laparoscopic reverse-staining right anterior lobectomy is an accurate and safe minimally

invasive surgical method. By using fluorescence imaging technology, the surgeon can accurately understand the surface and deep anatomy of the liver segment, determine the boundary of the tumor liver (subsegment), determine the transverse fracture of the liver surface, and evaluate the blood perfusion of the liver parenchyma to be preserved. In addition, blood flow display and lymph node display were made clear during the operation, bile leakage was detected while bile duct was marked, and timely detection and repair were performed, thus reducing the incidence of postoperative bile leakage.

**Conclusion:** The surgical method improves the accuracy and safety of the operation through fluorescent labeling, thus providing better treatment effects and faster postoperative recovery for patients. In the future, we are expected to promote the development of relevant surgical techniques and the accumulation of clinical experience through the combination of positive and reverse fluorescent laparoscopic staining, so as to provide more treatment options for patients with liver diseases, seek more accurate and minimally invasive surgical treatment, and help them improve their survival.

## 7. The first international experience with histotripsy: a safety analysis of 230 cases

Chase Wehrle, Kevin Burns, Evan Ong, Allison Couillard, Neehar Parikh, Elaine Caoili, Jaekeun Kim, Federico Aucejo, Andrea Schlegel, Emily Knott, Paul Laeseke, J. Phillip Boudreaux, Phillip August Von Breitenbuch, Mikhail Silk, Mohamed Alassas, Andrew Guzowski, Erica Knavel Koepsel, Brock Hewitt, Mishal Mendiratta Lala, David Kwon

Hepato-Pancreato-Biliary Surgery & Liver Transplantation, Cleveland Clinic, OH, USA.

### Abstract

**Objectives:** Histotripsy is a novel, non-invasive, non-ionizing, non-thermal approach using focused ultrasound waves to treat liver tumors. The technology received the Food and Drug Administration (FDA) De Novo grant in late 2023. This is the first reporting of post-trial, real-world clinical outcomes. We aim to report short-term safety data from most centers performing histotripsy internationally.

**Methods:** Safety outcomes within 30 days of histotripsy were collected since FDA clearance (12/22/2023-7/25/2024). All centers that performed histotripsy were invited to participate. Complications requiring treatment were graded using Clavien-Dindo and comprehensive complications index (CCI).

**Results:** In total, 295 patients received histotripsy to 510 tumors at 18 centers. Treated liver tumor types included colorectal metastases ( $n = 140$ ), neuroendocrine ( $n = 46$ ), hepatocellular carcinoma ( $n = 31$ ), pancreas ( $n = 30$ ), and breast metastases ( $n = 26$ ). The most common number of tumors treated per procedure was 1 ( $n = 170$ ), 2 ( $n = 69$ ), and 3 ( $n = 37$ ). Tumors were treated in all eight liver segments. Safety data were available for 230 patients from 9 centers. A total of 12 out of 230 patients experienced complications of any grade (5.2%). Most ( $n = 9$ , 75%) were minor ( $<$  Clavien-Dindo Grade II). Median and mean CCI were 0 [interquartile range (IQR) 0-0] and 0 points [95% confidence interval (CI) 0-0.75]. All three major complications ( $>$  Clavien-Dindo grade II, 1.3%) were death from disease progression. All three of these patients had undergone histotripsy with palliative intent for known advanced intra- and extrahepatic disease.

**Conclusion:** This is the first report on the real-world therapeutic use of histotripsy for liver tumors. Histotripsy was well tolerated with few overall complications and rare serious complications indicating a safety profile that compares favorably with other liver-directed and surgical therapies for the treatment of liver tumors. Long-term follow-up data including oncologic outcomes are being collected.

## 8. Evaluating laparoscopic and robotic liver resection in elderly patients: a National Surgical Quality Improvement Program (NSQIP) analysis of short-term outcomes

Alessandro Parente, Kevin Verhoeff, Mohamed Elmasry, Blaire Anderson, Khaled Dajani, A. M. James Shapiro, Krishna Menon

Institute of Liver Studies, King's College Hospital, London, UK.



## Abstract

**Objectives:** Results of minimally invasive laparoscopic (LLR) and robotic liver resection (RLR) have been promising, but the benefits of RLR in elderly patients are still unclear. This study aims to compare short-term outcomes of LLR and RLR in this group of patients.

**Methods:** The 2017-2021 National Surgical Quality Improvement Program (NSQIP) database was analyzed comparing patients  $\geq 65$  years old undergoing LLR vs. RLR. Baseline characteristics, post-operative outcomes, and risk factors for complications and mortality were assessed using univariate and multivariable logistic regression. Propensity score matching (PSM) analysis further evaluated serious complications, mortality, length of stay, Clavien Dindo Classification, and comprehensive complication index.

**Results:** We analyzed 2,210 patients undergoing liver resection, of whom 1,865 (84.4%) underwent LLR and 345 (15.6%) underwent RLR. Patients undergoing LLR were older (72.4 vs. 71.8 years;  $P = 0.04$ ), less likely to be female ( $P = 0.009$ ), and more likely to have ASA 4 status (11.1% vs. 4.9%;  $P = 0.001$ ). RLR patients had shorter hospital stays (3.5 vs. 4.4 days;  $P < 0.001$ ) but longer operative durations (221.4 vs. 203.5 min;  $P = 0.013$ ). On unadjusted analysis, RLR was associated with reduced rates of myocardial infarction (0.3% vs. 1.7%;  $P = 0.045$ ), post-operative liver failure (3.1% vs. 7.8%;  $P < 0.001$ ), and superficial surgical site infections (0.6% vs. 2.3%;  $P = 0.037$ ), but increased septic shock (1.7% vs. 0.6%;  $P = 0.038$ ). Adjusted analyses indicated that RLR was not associated with increased risks of serious complications [odds ratio (OR): 0.82, 95% confidence interval 0.42-1.58,  $P = 0.545$ ] or mortality (OR: 0.87,  $P = 0.851$ ). After PSM, RLR significantly reduced hospital stays (-0.72 days;  $P = 0.012$ ) but increased operative times (+32.62 min;  $P < 0.001$ ). Subgroup analysis of patients  $\geq 75$  years confirmed consistent findings.

**Conclusion:** RLR provides comparable safety and short-term outcomes to LLR, offering shorter hospital stays but longer operative durations. Findings support RLR as a viable option in elderly patients, but further studies evaluating long-term outcomes are warranted.

## 9. Propensity-score matched analysis comparing robotic and laparoscopic hepatectomy: a single-center study of 2,999 cases

Hucheng Ma, Decai Yu

Hepatobiliary and Transplantation Surgery, Nanjing Drum Tower Hospital, Nanjing, Jiangsu, China.

## Abstract

**Objectives:** This study aims to compare the safety and postoperative outcomes of laparoscopic vs. robot-assisted multiple liver resections in a single-center setting.

**Methods:** A retrospective analysis was conducted on patients who underwent minimally invasive liver resection between 2014 and 2023. Patient demographics, perioperative parameters, and postoperative outcomes were reviewed. Propensity score matching (PSM) was employed to reduce selection bias.

**Results:** A total of 2,999 patients were included in this study. After PSM, 82 patients who underwent right hemihepatectomy were categorized into the laparoscopic hepatectomy (Lap-H) and robotic assisted hepatectomy (Rob-H) groups. The results showed that, compared to the Lap-H group, the Rob-H group had a shorter portal clamping time [60.00 (45.00, 60.00) vs. 45.00 (30.00, 60.00),  $P = 0.031$ ] and a lower open conversion rate (17.1% vs. 2.4%,  $P = 0.031$ ). A total of 174 patients who underwent left hemihepatectomy were included. The Rob-H group had shorter operative times (225 [180.00, 280.00] vs. 190 [150.00, 250.00],  $P = 0.008$ ), less intraoperative blood loss (200.00 [100.00, 400.00] vs. 150 [100.00, 200.00],  $P < 0.001$ ), shorter portal clamping times (30 [0.00, 45.00] vs. 30 [30.00, 45.00],  $P = 0.026$ ), shorter postoperative hospital stays (8.00 [7.00, 12.00] vs. 8.00 [6.00, 11.00],  $P = 0.021$ ), and a lower open conversion rate (7 [8.05%] vs. 0 [0.00%],  $P = 0.016$ ). For 110 patients who underwent right posterior segmentectomy, the Rob-H group showed shorter operative times (220.00 [155.00, 290.00] vs. 160.00 [120.00, 200.00],  $P < 0.001$ ), shorter portal clamping times (45.00 [30.00, 60.00] vs. 30.00 [30.00, 45.00],  $P < 0.001$ ), and shorter postoperative hospital stays (9.00 [7.00, 11.00] vs. 7.00 [5.00, 10.00],  $P = 0.005$ ).

**Conclusion:** Compared with the Lap-H group, intraoperative blood loss, postoperative hospital stay, and operation time were lower in the Rob-H group, and the results were similar to those in previous studies, indicating that the robotic platform addresses some of the technical challenges associated with major hepatectomy.

#### **10. Experience of right-sided approach laparoscopic cholecystectomy in symptomatic gallstones: a modified incision based on anatomy of abdominal wall nerve**

Siqin Zhang, Zehong Zhang, Jiaying Ye, Zhongchang Weng, Yiling Chen, Songqiang Zhou, Yannan Bai

Department of Hepatobiliary Pancreatic Surgery, Fuzhou University Affiliated Provincial Hospital, Fuzhou, Fujian, China.

##### **Abstract**

**Objectives:** Laparoscopic cholecystectomy is a widely used method with excellent surgical outcomes. However, due to nerve injury, the traditional laparoscopic cholecystectomy approach (TLC) causes great pain in most cases. Therefore, this study aimed to identify a new minimally invasive surgical approach for less pain while maintaining surgical safety.

**Methods:** Data from patients who underwent laparoscopic cholecystectomy in the Department of Hepatobiliary Pancreatic Surgery of Fujian Provincial Hospital from January 2023 to December 2023 were retrospectively analyzed. Among them, 300 cases underwent the right-sided laparoscopic cholecystectomy approach (RLC), and 726 cases underwent the TLC. A 1:1 propensity score matching (PSM) method was performed to compare the perioperative indexes and Long-term postoperative pain score between the two groups.

**Results:** After 1:1 PSM, 600 patients were selected for further analysis. Compared to the traditional approach group, the postoperative pain scores for the right approach group were lower. There was no significant difference in postoperative complications. There was no significant difference in the critical view of safety between the two groups. In addition, no statistical differences were found in postoperative hospital stay and operation time between the two groups.

**Conclusion:** The RLC significantly reduces the postoperative pain scores, offering a promising approach for patients with gallstones.

#### **11. Laparoscopic posterosuperior segments resection: short- and long-term outcomes in high and low volume centers**

Mario Giuffrida, Raffaele Dalla Valle, Filippo Banchini

Department of General Surgery, Guglielmo da Saliceto Hospital, Piacenza, Italy.

##### **Abstract**

**Objectives:** Laparoscopic posterosuperior liver segments (segments 4s, 6, 7, 8, and 1) resection is considered technically challenging. Patients treated for liver cancer in both high- and low-volume centers were included. The aim was to evaluate short- and long-term outcomes across these centers.

**Methods:** This is a retrospective multi-center study. All consecutive adult (age > 18 years) patients who underwent laparoscopic posterosuperior segment resection (PSS-LLR) at the Division of General Surgery of the Parma University Hospital (high volume center with more than 50 liver resections per year) and Department of General Surgery of Guglielmo da Saliceto Hospital in Piacenza (low volume center with less than 20 liver resections per year) were included. The study timeline spanned from 1 January 2015 until 31 December 2022. Inclusion criteria: adult patients who underwent laparoscopic posterosuperior liver resections. Exclusion criteria: patients who underwent major liver resections or concomitant liver resection of other segments.

**Results:** A total of 97 patients were included. The high-volume center performed 62 laparoscopic liver resections (LLR, 63.9%) and the low-volume center performed 27 (36.1%). CRLM was the most common indication in both centers, 39 cases (62.9%) for Parma and 24 (88.8%) for Piacenza. The Iwate score was significantly higher in the Parma group ( $P < 0.001$ ). Anatomical resection was performed 77 times (79.3%). Bisegmentectomy (s6-7) was the most common PSS-LLR in Parma (20 cases; 32.2%). S7 segmentectomy was the most common PSS-LLR in Piacenza (7 cases; 25.9%). Operative time was significantly higher in Piacenza group ( $P = 0.009$ ). Median estimated blood loss was similar in both groups, 150 mL (range 50-950) for Parma group and 200 mL (range 50-750) for Piacenza group ( $P > 0.005$ ). Conversion rate was 5.9% for Parma and 7.7% for Piacenza. The median length of hospital stay was 4 (2-6) days for Parma group and 5 (3-7) days for Piacenza group. Severe complications (Clavien-Dindo  $> 3a$ ) occurred in 3 patients. Mean follow-up was  $42 \pm 17$  months. Overall survival was  $31.2 \pm 8.5$  months for Parma group and  $26.9 \pm 7.3$  months for Piacenza group.

**Conclusion:** PSS-LLR is a complex surgical procedure that should be performed by experienced surgeons. Despite differences in surgical volume, PSS-LLR can be performed safely in low-volume centers, with more complex resections reserved for high-volume centers.

## 12. A novel liver mobilization technique in minimally invasive hepatectomy: modified pulley maneuver

Takahiro Tomino, Keishi Sugimachi

Department of Hepatobiliary and Pancreatic Surgery, NHO Kyushu Cancer Center, Fukuoka, Japan.

### Abstract

**Objectives:** Achieving an adequate surgical plane through optimal traction is crucial for liver parenchymal transection in minimally invasive liver surgery (MILS). MILS is more technically demanding than open liver surgery because of limited instrument mobility and the inability to use the surgeon's hand, potentially leading to iatrogenic injuries. The Pulley maneuver using barbed sutures has been used for laparoscopic hepatectomy; however, the sutures are single-use and may pass through the liver parenchyma, making it uneconomical and inflexible. To address this, we developed a modified pulley maneuver using a barbed with a nonabsorbable polymer clip and metal clip for parenchymal transection in MILS.

**Methods:** Before liver transection, we prepared barbed sutures and attached nonabsorbable polymer and metal clips to the distal end. The metal clip prevented the nonabsorbable polymer clip from slipping, allowing one suture to be reused three times. Before liver transection, the suture was passed through the liver surface twice, with the clips to reduce iatrogenic damage. The sutures were anchored to the diaphragm or peritoneum for optimal liver traction. A laparoscopic or robotic grasper adjusted the suture tension for the appropriate transection plane. In open-pit-shaped resections, the liver is lifted ventrally for deeper access, whereas in wedge-shaped resections, it is elevated in the caudal view. The modified pulley maneuver provides stable liver traction.

**Results:** We have performed MILS using this method in seven cases so far. There was no iatrogenic injury.

**Conclusion:** The modified pulley maneuver is an economical, simple, and feasible method for enabling stable liver traction, thereby enhancing the versatility and safety of liver parenchymal transection in MILS.

## 13. Laparoscopic liver resection for liver metastatic colorectal cancer (MCRC) serial cases in North Sulawesi, Indonesia

Michael Tendean, Ferdinand Tjandra, Toar D. B. Mambu

General Surgery Department Digestive Surgery Division, Prof Dr. R.D. Kandou General Hospital, Sulawesi Utara, Indonesia.

## Abstract

**Objectives:** Laparoscopic liver resection (LLR) is gaining popularity due to improvements in surgical techniques and the development of specific instruments. The study aims to present the authors' experience with LLR for resections of liver metastatic colorectal cancer (MCRC).

**Methods:** This is a retrospective study in Prof. Dr. R.D. Kandou General Hospital (2019-2024). Patients with confirmed resectable liver MCRC during diagnosis and surveillance of colorectal cancer were assigned to have LLR performed. Various LLR procedures, duration of operation, and intra-operative bleeding were recorded. Morbidities, mortalities, and post-hepatectomy liver failure (PHLF) were evaluated.

**Results:** Of the total 92 liver resections, 25 patients had liver MCRC and 6 of these patients underwent LLR for metastasectomy. From the 6 LLR, 66.7% are synchronous liver MCRC, 33.3% are metachronous liver MCRC. Rectal cancer was the primary tumor in 60% of cases, and the remaining cases originated from colon cancer. Simultaneous resections were performed in 33.3% cases of the LLR and delayed resections in 66.7%. Two laparoscopic left lateral sectionectomies were performed, and the remaining procedures were non-anatomical liver resections across various segments, including segments 7 and 8. Intermittent Pringle was used in 33.3% of cases, on-demand Pringle in another 33.3%, and the remaining 33.3% did not require any Pringle maneuver. An ultrasonic dissector and endo-staplers were used as energy devices. Intraoperative blood loss was  $158.1 \pm 55.73$  cc. No PHLF and no mortality were recorded within the 30-day postoperative period.

**Conclusion:** LLR is feasible for resectable liver MCRC, although an experienced team and specialized instruments are needed to minimize bleeding, morbidity, and mortality.

## 14. Breaking through limitations in laparoscopic liver resection: a single-center experience in Indonesia

Michael Tendean, Ferdinand Tjandra, Toar D. B. Mambu

General Surgery Department Digestive Surgery Division, Prof Dr. R.D. Kandou General Hospital, Sulawesi Utara, Indonesia.

## Abstract

**Objectives:** Laparoscopic liver resection (LLR) is gaining popularity due to advances in surgical techniques and the development of specialized instruments. The authors aim to share their experience with LLR despite the limitations in their hospital.

**Methods:** This is a retrospective study in Prof. Dr. R.D. Kandou General Hospital (2019-2024). Patients with various etiologies, preoperative determined abdominal computed tomography scan, and Child-Pugh A liver function were assigned to receive LLR. Indocyanine green (ICG fluorescence) and laparoscopic ultrasound (LUS) are not available. Various LLR procedures, duration of operation, and intra-operative bleeding were recorded. Morbidities, mortalities, and post-hepatectomy liver failure (PHLF) were evaluated.

**Results:** Out of the total 93 patients, 19 underwent laparoscopic procedures. The etiologies included liver metastatic colorectal cancer (MCRC, 28.57%), hepatocellular carcinoma (HCC, 21.43%), liver haemangioma (21.43%), and other causes (28.57%). Anatomical LLR was performed in 7 cases and non-anatomical LLR in 12 cases, with most anatomical LLR being left lateral sectionectomy (75%). The Pringle manoeuvre was applied in all procedures, with a mean duration of  $1.28 \pm 2.56$  periods. An ultrasonic dissector was used as the energy device. Intraoperative blood loss was  $289.71 \pm 65.73$  cc. No PHLF was recorded during the 30-day postoperative period; mortality occurred in one case due to sepsis. During long-term surveillance of liver MCRC cases, three recurrences were noted.

**Conclusion:** Despite the absence of ICG and LUS, LLR is feasible for various resectable liver pathologies. When available, ICG and LUS, combined with an experienced surgical team, can help minimize bleeding, morbidity, and mortality, while improving oncological outcomes.

## 15. Combined ablation and resection for colorectal liver metastases: the laparoscopic approach vs. the open approach

Jizhou Wang, Huachuan Song, Bing Han, Lianxin Liu

Department of Hepatobiliary Surgery, The First Affiliated Hospital of USTC, Hefei, Anhui, China.

### Abstract

**Objectives:** Combined ablation and resection (CARE) is a well-established treatment strategy for multiple colorectal liver metastases (CRLM). In this study, laparoscopic CARE was compared with open CARE in terms of perioperative and oncological outcomes.

**Methods:** This was a multi-center retrospective cohort study. Patients with CRLM who underwent CARE at three medical centers from 2018 to 2023 were enrolled. Perioperative and oncological outcomes were compared between the two groups. Recurrence-free survival (RFS) was calculated from the date of surgery to either the date of disease recurrence, as evidenced by radiographic findings, or the date of death. According to the timing of recurrence, recurrences are divided into early (RFS < 6 months), intermediate (RFS 6-12 months), and late (RFS > 12 months) recurrences. Propensity score matching (PSM) was employed in this study.

**Results:** Of the 107 patients who underwent CARE, 65 (60.7%) underwent laparoscopic CARE, and 42 (39.3%) underwent open CARE. After PSM, the patients who underwent laparoscopic CARE had significantly less blood loss (55 vs. 100 mL,  $P = 0.028$ ) and a shorter hospital stay (6 vs. 8 days,  $P = 0.005$ ) than those who underwent open surgery; complication rates were comparable ( $P = 0.415$ ). No differences in median RFS (14.9 vs. 13.5 months,  $P = 0.781$ ) or overall survival (70.9 vs. 48.7 months,  $P = 0.183$ ) were observed. The recurrence site and timing were similar between the two groups. Notably, laparoscopic CARE was associated with a higher rate of repeat resection after intrahepatic recurrence (52.94% vs. 20.00%,  $P = 0.036$ ).

**Conclusion:** Laparoscopic CARE was associated with less blood loss, shorter hospital stays, and higher feasibility of repeat resection for recurrent disease compared with open surgery. These advantages position laparoscopic CARE as a safe and effective strategy for multiple CRLM.

## 16. Indocyanine green navigated laparoscopic operation in resectable hepatocellular carcinoma after neoadjuvant combination therapy

Man Luo, Hongguang Wang

Hepatobiliary Surgery Department, National Cancer Center, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing, China.

### Abstract

**Objectives:** Preoperative neoadjuvant targeted therapy combined with immunotherapy for resectable hepatocellular carcinoma (HCC) is widely used as first-line treatment. Pathological responses after treatment affect the tumor margin judgement during operation. Indocyanine green (ICG) fluorescence-guided radical resection (R0) has gained attention in recent years; however, its clearance may be altered after treatment. Treated tumors often become necrotic and lack a clear border with viable tumor tissue, making R0 resection challenging under direct visualization. Evidence on optimal timing of ICG administration and its use for surgical navigation is limited. This study aims to evaluate the implications of preoperative ICG guidance in patients who have effectively undergone neoadjuvant therapy.

**Methods:** All patients were diagnosed with resectable HCC and received neoadjuvant immune-targeted therapy before surgery between October 2021 and October 2023. Preoperative imaging and postoperative pathology indicated a high risk of recurrence. Patients were classified into two groups based on whether ICG was used. In the ICG group, 0.5 mg/kg of ICG dye was injected three days before surgery. Patients without liver cirrhosis and with adequate liver clearance were selected for ICG use. The relationship between



treatment timing, ICG use, and progression-free survival was assessed using Kaplan-Meier analysis.

**Results:** A total of 39 patients underwent surgery after neoadjuvant immune-combined-target therapy. Targeted therapies included Lenvatinib (51%), Erlotinib (28%), Bevacizumab (8%), and others (13%), while immune therapies included TQB2450 (30%), Trelizumab (23%), Sindilizumab (11%), and others (36%). All patients, with or without ICG (71.4% vs. 72.2%), achieved R0 resection. Median postoperative survival (38 vs. 26 months) in unresected patients showed little difference, likely due to the small sample size. Surgical outcomes did not reveal a significant improvement in progression-free survival associated with ICG fluorescence compared to anatomical resection.

**Conclusion:** The study concludes that live tumor boundary assessment after preoperative systemic treatment remains to be explored. Notably, we observed that ICG clearance was not exacerbated along immuno-target cycles, suggesting that the advantage of precise surgical navigation still needs further investigation. This may provide a novel perspective on the optimal use of ICG navigation in pretreated patients.

## 17. Laparoscopic resection with or without ablation for multiple colorectal liver metastases

Jizhou Wang, Huachuan Song, Bing Han, Lianxin Liu

Department of Hepatobiliary Surgery, The First Affiliated Hospital of USTC, Hefei, Anhui, China.

### Abstract

**Objectives:** Laparoscopic resection is the standard treatment for resectable colorectal cancer liver metastases (CRLMs). The safety and efficacy of combined ablation and resection (CARE) for CRLM have been well established. This study aims to compare the short- and long-term outcomes of laparoscopic CARE vs. laparoscopic resection alone for multiple CRLMs.

**Methods:** This was a multicenter, retrospective cohort study. Patients with multiple CRLMs who underwent laparoscopic resection combined with or without ablation in three medical centers from 2018 to 2023 were enrolled. Perioperative and oncological outcomes were compared between the two groups. Postoperative complications within 30 days were graded according to the Clavien-Dindo classification system. Overall survival (OS) was calculated from the date of operation to the date of death. Recurrence-free survival (RFS) was calculated from the date of operation to either the date of disease recurrence, evidenced by radiographic findings, or to death. Propensity score matching (PSM) was employed in this study.

**Results:** Of the 218 included patients, 67 (30.7%) underwent laparoscopic CARE and 151 (69.3%) underwent laparoscopic resection alone. After PSM, 52 matched pairs of patients were included for each group. The postoperative complication rate was similar between the two groups ( $P = 0.921$ ). The median RFS (10.7 vs. 13.0 months,  $P = 0.781$ ) and OS (70.9 vs. 53.5 months,  $P = 0.808$ ) were not statistically different between the two groups. Multivariate analysis revealed that metastases number  $\geq 4$  was an independent factor associated with RFS [hazard ratio (HR) = 1.85, 95% confidence interval (CI): 1.15-2.95,  $P = 0.010$ ], while simultaneous colorectal resection (HR = 2.93, 95%CI: 1.22-7.03,  $P = 0.016$ ) and bilobar distribution (HR = 3.13, 95%CI: 1.12-8.78,  $P = 0.030$ ) were associated with OS. No statistically significant differences were observed in the timing of recurrence ( $P = 0.725$ ), the site of recurrence ( $P = 0.178$ ), or the treatment administered after recurrence ( $P = 0.544$ ) between the two groups.

**Conclusion:** Laparoscopic CARE should be considered as one of the available treatment strategies for multiple CRLM.

## 18. Systemic level of cluster of differentiation (CD)14+/CD16+ monocytes in surgically treated patients with liver malignancies in dependency of operation duration

Julia Nagelschmitz, Seong Jeong, Thomas Wartmann, Severin Gylstorff, Ahmed Sanin, Ronny Otto, Joerg Arend, Mareike Franz, Mirhasan Rahimli, Ulf Kahlert, Frederike Stelter, Roland S. Croner

Clinic for General-Visceral-Vascular-Medical Faculty and University Medical Center Magdeburg, Magdeburg, Germany.



## Abstract

**Objectives:** Monocytes are critical mediators of the postoperative immune response, and their activation can be influenced by surgical stress. Minimally invasive techniques - especially robotic surgery - are increasingly favored in liver surgery and often entail prolonged operative times, which may modulate monocyte behavior. We hypothesize that the degree of monocyte activation correlates with both surgical duration and approach. This study systematically evaluates changes in monocyte subsets in response to different surgical modalities and operative durations.

**Methods:** In a single-center prospective cohort study, 22 patients undergoing partial liver resection were enrolled. Serial blood samples were collected preoperatively and on postoperative days 1, 3, 5, 7, and 20 to assess cluster of differentiation (CD)14/CD16 monocyte levels. Patients were then stratified by operative duration into  $< 284.63$  min and  $\geq 284.63$  min groups.

**Results:** Mean operative times were  $197 \pm 53.5$  min ( $n = 9$ ) and  $345 \pm 40.9$  min ( $n = 13$ ) for patients in the short and long operative time groups, respectively. Of 22 patients, 11 underwent robotic liver resection and 11 underwent open surgery. Among them, 8 patients (88.9%) in the open surgery group and only 1 patient (11.1%) in the robotic surgery group had shorter operative times, while prolonged operative times were significantly more frequent in the robotic surgery group (76.9% vs. 23.1%,  $P = 0.008$ ). CD14+/CD16+ monocytes were significantly increased postoperatively on days 7 and 20 in patients with prolonged operative times compared to those with shorter operative times ( $P = 0.023$ ,  $P = 0.013$ ). Patients with prolonged operative times required more catecholamine therapy and postoperative mechanical ventilation than those with shorter operative times ( $n = 6$  vs.  $n = 0$ ,  $P = 0.046$ ;  $n = 0$  vs.  $n = 5$ ,  $P = 0.054$ ). Although the overall incidence of postoperative complications did not differ significantly between robotic and open surgery, systemic postoperative complications were more frequent in patients with prolonged operative times ( $n = 6$  vs.  $n = 0$ ,  $P = 0.046$ ).

**Conclusion:** Prolonged operative durations were significantly associated with increased postoperative levels of CD14+/CD16+ monocytes. Robotic surgery was linked to longer operation times, suggesting a potential link between this surgical approach and elevated CD14+/CD16+ monocyte levels. These findings highlight the dynamic nature of immune regulation in relation to operation duration and underscore the need for further research into the immunological consequences of modifying surgical parameters during hepatectomy.

## 19. Minimally invasive surgery for repeat liver resection of recurrent liver tumors

Parbatraj Regmi, Yahya Al Farai Abdallah, Sagar Regmi, Fu-Yu Li, Rakesh Gupta

Department of Surgery, BP Koirala Institute of Health Sciences, Dharan, Nepal.

## Abstract

**Objectives:** Repeat liver resection for recurrent liver tumors is associated with favorable prognostic outcomes. With advancements in minimally invasive surgery techniques, the rate of laparoscopic repeat liver resection (LRLR) is becoming increasingly common in high-volume medical centers worldwide. In this study, we aim to perform a meta-analysis to compare the safety and oncologic outcomes of LRLR and open repeat liver resection (ORLR) for recurrent liver tumors.

**Methods:** Multiple electronic databases were searched up to 10th December 2014. Based on the inclusion and exclusion criteria, 20 relevant studies were identified, including 1,442 patients treated by LRLR and 1,670 treated by ORLR. The fixed effects and a random-effects model were used to perform a meta-analysis.

**Results:** Compared with ORLR, LRLR for recurrent liver tumor was associated with significantly lower intraoperative blood loss [standard mean difference (SMD): -250.50; 95% confidence interval (CI) -358.26 to -142.74;  $P < 0.05$ ], transfusion requirement [odds ratio (OR): 0.38; 95%CI 0.21 to 0.69;  $P < 0.05$ ], overall morbidity (OR: 0.42; 95%CI 0.26 to 0.67;  $P < 0.05$ ), major morbidity (OR: 0.40; 95%CI 0.22 to 0.71;  $P < 0.05$ ), and shorter length of stay (LOS) (SMD: -3.04; 95%CI -3.15 to -2.94;  $P = 0.05$ ). However, there was no

significant difference in duration of operation and perioperative mortality (all  $P > 0.05$ ). In terms of oncological outcomes, ORLR achieved a significantly lower rate of R0 resection (OR: 2.31; 95%CI 1.60 to 3.34;  $P < 0.05$ ), but the 3-year and 5-year overall survival and disease-free survival were comparable ( $P > 0.05$ ).

**Conclusion:** LRLR for recurrent liver tumors seems to be safe and feasible in the hands of experts from high-volume centers. Further prospective randomized controlled trials may be necessary to provide strong evidence with higher certainty.

## 20. Outcome of laparoscopic liver resection after transarterial radioembolization with yttrium-90 for hepatocellular carcinoma: a propensity score matching analysis

Yi Ping Sng, Young Rok Choi, Su Young Hong, Hyo-Chol Kim, Jinwoo Choi, Jiyoung Kim, Jae-Yoon Kim, Jeong-Moo Lee, Suk Kyun Hong, Kwang-Woong Lee

Department of Surgery, Shuang Ho Hospital, Taipei Medical University, Taipei, Taiwan.

### Abstract

**Objectives:** Transarterial radioembolization (TARE) is increasingly used as a bridge therapy for hepatocellular carcinoma (HCC) when immediate resection is not feasible. However, the safety and oncologic outcomes of subsequent laparoscopic liver resection remain unclear compared to open surgery.

**Methods:** We conducted a retrospective analysis of patients who underwent liver resection after TARE for HCC between 2012 and 2023 at a single center. Propensity score matching was performed based on gender, age, tumor size, and tumor markers (alpha-fetoprotein, PIVKA-II), resulting in 18 matched pairs of laparoscopic and open resection cases.

**Results:** The laparoscopic group demonstrated shorter time from TARE to operation (99.7 vs. 166.9 days,  $P = 0.04$ ) and reduced hospital stay (11.2 vs. 15.6 days,  $P = 0.04$ ). Operative parameters were comparable between groups, including operative time (243.9 vs. 210.0 min,  $P = 0.13$ ) and blood loss (438.9 vs. 775.0 mL,  $P = 0.12$ ). Major complications (Clavien-Dindo grade  $\geq$  III) occurred in 11.1% of laparoscopic vs. 27.8% of open cases ( $P = 0.40$ ). Oncologic outcomes were similar between groups, with recurrence rates of 55.6% vs. 44.4% ( $P = 0.51$ ), overall survival of 56.5 vs. 44.7 months ( $P = 0.10$ ), and progression-free survival of 28.1 vs. 32.4 months ( $P = 0.815$ ).

**Conclusion:** Laparoscopic liver resection following TARE appears to be a safe and effective approach for selected HCC patients in high-volume centers, offering comparable oncologic outcomes to open surgery while achieving shorter hospitalization. These findings support the consideration of laparoscopic approach in appropriate candidates after TARE.

## 21. Re-staining method with indocyanine green fluorescence imaging for laparoscopic liver resection

Takeshi Urade, Masahiro Kido, Shohei Komatsu, Hidetoshi Gon, Kenji Fukushima, Toshihiko Yoshida, Kentaro Tai, Keisuke Arai, Hiroaki Yanagimoto, Hirochika Toyama, Takumi Fukumoto

Department of Surgery, Kobe University Graduate School of Medicine, Hyogo, Japan.

### Abstract

**Objectives:** Indocyanine green fluorescence imaging (ICG-FI) has been widely used to identify hepatic segments during anatomical liver resection. However, re-staining hepatic regions via indocyanine green (ICG) reinjection has been considered impractical due to the long-lasting fluorescence signals in liver parenchyma. Here, we report the feasibility of a re-staining method with ICG-FI for laparoscopic liver resection.

**Methods:** Three laparoscopic liver resections were performed using the re-stating method. The laparoscopic infrared imaging system (VISERA ELITE III, Olympus, Japan) was used and the negative staining method

was applied to identify fluorescence-defined areas. At first, 0.25 mg of ICG was injected after occlusion of Glissonean branches. Subsequently, 1.25 or 2.5 mg of ICG was reinjected following additional occlusion of other Glissonean branches. Case presentation: A 74-year-old man underwent laparoscopic anatomical liver resection of segment 2 (S2) for liver metastasis.

**Results:** The additional ischemic regions could be visualized using ICG reinjection in all three cases. In the case described, parenchymal transection began from the dorsal side, and the Glissonean pedicle to S2 (G2) was isolated using the intrahepatic Glissonean approach. After ligating G2, 0.25 mg of ICG was injected to perform negative staining, visualizing the portal region of the main G2 with a near-infrared imaging system (VISERA ELITE III, Olympus, Japan). This initial fluorescence revealed only the dorsal side of S2. As parenchymal transection progressed medially to laterally, several peripheral branches were transected. Subsequently, an ischemic region on the cranio-ventral side of the left lateral lobe became slightly apparent. Reinjection of 2.5 mg of ICG was performed after G2 was transected using a stapler. Adjusting the infrared gain allowed visualization of the additional ischemic region, which corresponded to the transection of several peripheral Glissonean branches from the other G2. Resection was completed along the new demarcation line, and the hepatic vein of S2 was divided.

**Conclusion:** Re-staining method with ICG-FI was feasible and useful for laparoscopic liver resection. An optimal re-staining protocol to identify fluorescence-defined areas again should be established.

## 22. Laparoscopic hepatectomy is suitable for patients diagnosed with hepatocellular carcinoma and cirrhotic liver

Krerkrit Kijpongpan, Shun-Ichi Ariizumi, Yusuke Ome, Yusuke Kawamoto, Yutaro Matsunaga, Goro Honda

Department of Surgery, Tokyo Women's Medical University, Tokyo, Japan.

### Abstract

**Objectives:** Laparoscopic hepatectomy (LH) has shown promising outcomes in patients diagnosed with hepatocellular carcinoma (HCC) and moderate cirrhosis, potentially yielding benefits over open hepatectomy (OH). The present study compared short- and long-term outcomes of LH and OH in patients with HCC and grade B liver damage classified according to the Liver Damage Grading System proposed by the Japanese Liver Cancer Study Group.

**Methods:** Data from 97 patients diagnosed with HCC and grade B or C liver damage between 2010 and 2022 at Tokyo Women's Medical University Hospital (Tokyo, Japan) were retrospectively analyzed. The patients were divided into two groups according to the procedure: LH ( $n = 26$ ) and OH ( $n = 71$ ). Patient characteristics, surgical outcomes, and survival rates were assessed using propensity score matching (PSM) to control for confounding factors, including tumor characteristics and liver function.

**Results:** After PSM, LH significantly reduced intraoperative blood loss (242 mL vs. 941 mL;  $P = 0.0495$ ) and postoperative ascites (0% vs. 21.2%;  $P = 0.0345$ ) compared with OH. No conversion from LH to OH was necessary, and the hospital stay was shorter in patients who underwent LH. The five-year overall survival rate was significantly higher in the LH group (91% vs. 36%;  $P = 0.021$ ), with comparable recurrence-free survival rates.

**Conclusion:** The Liver Damage Grading System is a comprehensive tool for evaluating surgical candidates with moderate cirrhosis. For patients diagnosed with HCC and grade B liver damage, LH yielded better long-term outcomes than OH, likely because of reduced morbidity and preservation of liver function.

## 23. Utilizing the characteristics of robotic hepatectomy: combined extra- and intra-hepatic Glissonean approach

Keishi Sugimachi, Takahiro Tomino, Emi Onishi, Takeshi Kurihara

Hepatobiliary-Pancreatic Surgery, NHO Kyushu Cancer Center, Fukuoka, Japan.

## Abstract

**Objectives:** In Japan, robotic liver resection (RLR) has been covered by insurance since 2022, leading to a rapid increase in cases. The multi-jointed function and magnified vision are extremely useful for performing the Glissonean approach, which may provide an advantage in anatomical liver resection (ALR). We selectively use the intrahepatic and extrahepatic approaches for the Glissonean approach based on anatomical factors and tumor location. Here, we present our techniques and outcomes.

**Methods:** We analyzed 39 cases of RLR performed at our department since 2022, including 17 cases of anatomical resection (R-ALR). As a comparison, we reviewed 180 cases of LLR, including 54 cases of anatomical resection (L-ALR). We analyzed the methods of the Glissonean approach and perioperative outcomes.

**Results:** The choice of Glissonean approach was determined preoperatively. The intrahepatic approach was selected when the target Glissonean pedicle was distant from the hepatic hilum or when preserving the hepatic hilum or gallbladder. This approach was frequently used in S8 and S7 segmentectomies, in which parenchymal transection was performed first, followed by securing the Glissonean pedicle. The extrahepatic approach was used for left lobe (G2-4), G5+8, G6+7, and G3 resections. The magnified vision enabled the preservation of Laennec's capsule while securing the Glissonean pedicle first, allowing for fast and precise systematic resection. However, when extrahepatic dissection was difficult, we performed minimal parenchymal dissection and temporary clamping of the target Glissonean pedicle, followed by liver parenchymal transection along the intersegmental plane toward the Glissonean root. Once sufficient exposure was achieved, the pedicle was secured and divided (combined extra- & intrahepatic approach). After Glissonean transection, indocyanine green negative staining was performed to complete ALR. Among the 17 R-ALR cases, there were 10 segmentectomies, 3 sectionectomies, and 4 hemihepatectomies. The Glissonean approach methods included intrahepatic (6 cases), extrahepatic (5 cases), and combined (5 cases). Comparison between R-ALR and L-ALR showed comparable surgical outcomes: Operative time: 361 vs. 311 min ( $P = 0.06$ ), Blood loss: 50 vs. 95 mL ( $P = 0.34$ ), Pringle time: 107 vs. 96 min ( $P = 0.66$ ), Complications (Clavien-Dindo grade  $\geq 2$ ): 23% vs. 30% ( $P = 0.62$ ).

**Conclusion:** Our selective use of intrahepatic, extrahepatic, and combined Glissonean approaches is beneficial in anatomical RLR.

## 24. Long-term outcomes of liver resection combined with microwave ablation compared with liver resection alone for patients with early and intermediate stage multifocal hepatocellular carcinoma: a retrospective, multicentric cohort study

Jizhou Wang, Shenyu Zhang, Dayong Luo, Jianhua Rao, Lianxin Liu

Department of Hepatobiliary Surgery, The First Affiliated Hospital of USTC, Hefei, Anhui, China.

## Abstract

**Objectives:** The integration of liver resection (LR) with microwave ablation (MWA) has the potential to offer curative treatment for patients with multifocal hepatocellular carcinoma (HCC). Nonetheless, the comparative short- and long-term outcomes of this combined approach vs. LR alone have yet to be fully elucidated.

**Methods:** This study included patients who underwent either LR combined with MWA or LR alone for multifocal HCC between 2014 and 2024. Propensity score matching (PSM) was employed to assess and compare the short- and long-term outcomes between the two patient groups.

**Results:** Of a total of 501 patients, LR combined with intraoperative MWA and LR alone were performed in 187 and 314 patients, respectively. The 1-, 3-, and 5-year overall survival (OS) rates after combined treatment or LR alone were 89.9%, 73.3%, and 50.8%, and 85.6%, 65.5%, and 54.5%, respectively ( $P = 0.843$ ); combined treatment provided similar recurrence-free survival (RFS) rates as LR alone at 1, 3, and 5 years (58.4%, 27.9%, and 15.5% vs. 62.7%, 33.9%, and 24.7%, respectively;  $P = 0.098$ ). Similar results were also observed after the

PSM ( $P = 0.580$  for OS and  $P = 0.370$  for RFS). Additionally, no significant differences were observed in postoperative recurrence patterns or post-recurrence treatments between the two groups before and after PSM. Consistent findings were observed in PSM-adjusted subgroup analyses stratified by factors such as Barcelona Clinic Liver Cancer stage, “Up-to-7” criteria, tumor numbers and bilobar HCC. However, the group undergoing LR combined with MWA demonstrated superior short-term outcomes, characterized by reduced intraoperative bleeding, decreased intensive care unit admissions, a lower incidence of serious complications, and a shorter hospital stay.

**Conclusion:** LR combined with MWA for multifocal HCC can achieve a long-term prognosis similar to that of LR alone, with better short-term outcomes. For selected multifocal HCC, the combined strategy can be an alternative to LR alone.

## 25. Comparison of perioperative outcomes between conventional approach and Arantius-first approach in laparoscopic left hepatectomy

Takumi Kitahama, Ryo Ashida, Katsuhisa Ohgi, Shimpei Otsuka, Yoshiyasu Kato, Hideyuki Dei, Katsuhiko Uesaka, Teiichi Sugiura

Division of Hepato-Biliary-Pancreatic Surgery, Shizuoka Cancer Center, Shizuoka, Japan.

### Abstract

**Objectives:** Our institution introduced laparoscopic major hepatectomy in 2017. Until 2021, liver transection was performed using a caudo-peripheral approach, in which the middle hepatic vein (MHV) was exposed from the periphery toward its root, similar to the technique used in open surgery (Conventional approach). Since 2021, we have adopted the Arantius-first approach, one of the cranio-dorsal approaches proposed by Honda *et al.* This technique involves dorsal exposure of the MHV from the root toward the periphery. This approach may reduce split injuries and intraoperative blood loss. However, few studies have compared it with the conventional approach.

**Methods:** We retrospectively analyzed 27 patients who underwent left hepatectomy at our institution between January 2017 and December 2023. Patients were classified into the Conventional Approach group (Conventional group) and the Arantius-First group (Arantius group). Patient characteristics and short-term perioperative outcomes were compared between the two groups.

**Results:** The Arantius group included 14 patients, and the Conventional group included 13 patients. There were no significant differences in baseline characteristics between the two groups, including age (73 [50-82] vs. 71 [48-81] years,  $P = 0.752$ ), sex (male: 11 [79%] vs. 10 [77%],  $P = 0.596$ ), diagnosis (hepatocellular carcinoma or cholangiocarcinoma: 7 [50%] vs. 6 [47%],  $P = 1.000$ ), tumor size (32.5 vs. 35.0 mm,  $P = 0.481$ ), and IWATE criteria (8 vs. 8,  $P = 0.470$ ). The Arantius group tended to have a longer liver transection time for left hepatectomy, although the difference was not statistically significant (94 [46-164] vs. 67 [45-215] min,  $P = 0.145$ ). Intraoperative blood loss, however, was significantly lower in the Arantius group (113 [0-245] vs. 270 [50-1,930] mL,  $P = 0.003$ ). Postoperative hospital stay (6 [5-12] vs. 6 [5-21] days,  $P = 0.480$ ) and Clavien-Dindo grade IIIa or higher complications (0 [0%] vs. 1 [8%],  $P = 1.000$ ) were comparable between the groups.

**Conclusion:** The Arantius-first approach was associated with lower intraoperative blood loss compared to the Conventional approach, suggesting that it may be a less invasive technique for laparoscopic left hepatectomy.

## 26. Cost-effectiveness of robotic vs. open liver resection: a propensity score matching analysis

Elias Khajeh, Ali Majlesara, Nastaran Sabetkish, Cordula Borm, Ali Ramouz, Behbood Moeini Chaghervand, Mohammad Golriz, Christoph Mayer, Matin Loos, Arianeb Mehrabi

Department of General, Visceral and Transplantation Surgery, Heidelberg University, Heidelberg, Germany.



## Abstract

**Objectives:** Robotic-assisted liver resection (RALR) has been increasingly used for liver resection. This study aimed to compare the intra- and postoperative outcomes of RALR with open liver resection (OLR), with a particular focus on total hospital costs.

**Methods:** Data of all consecutive patients undergoing RALR ( $n = 124$ ) between 2019 and 2023 were extracted and compared with a propensity score-matched group of patients undergoing OLR ( $n = 248$ ) in a 1:2 ratio. Patient demographics, tumor characteristics, intra- and postoperative outcomes, and in-hospital costs were compared between the two groups.

**Results:** Blood loss was significantly higher in the OLR group (890 vs. 646 mL,  $P = 0.013$ ), while operative time was significantly longer in the RALR patients (251 vs. 205 min,  $P < 0.001$ ). The length of hospital stays, as well as the rates of reoperation, overall complications, in-hospital mortality, and readmission, were significantly higher in the OLR group. Cost analysis showed that although operation costs were significantly higher in the RALR group ( $P < 0.001$ ), the total hospital costs were significantly higher in the OLR group ( $P = 0.017$ ). However, DRG reimbursement costs and final benefit were not statistically different between two groups ( $P = 0.064$  and  $P = 0.588$ , respectively).

**Conclusion:** RALR showed intra- and postoperative advantages over OLR regarding hospital stay and postoperative complications. Although the operative costs of the RALR are higher than OLR, total hospital costs are comparable due to shorter ICU/hospital stays and lower morbidity and mortality.

## 27. Modern aspects of treatment of intrahepatic cholangiocarcinoma recurrences

Denis Fisenko, Natalya Britskaya, Anna Koroleva, Pavel Tarakanov, Andrey Vankovich, Dmitriy Kovalenko, Nikita Solovyev, Valeriya Kheday, Mikhail Efanov

Hepatopancreatobiliary Surgery Department, Moscow Clinical Scientific Center named after A.S. Loginov, Moscow, Russia.

## Abstract

**Objectives:** The effectiveness of treatments for recurrent intrahepatic cholangiocarcinoma (RIHCC) is controversial and requires further study. The objective is to evaluate the outcomes of RIHCC patients.

**Methods:** A total of 104 patients who underwent liver resection for intrahepatic cholangiocarcinoma were included in the study. The frequency and terms of the occurrence of RIHCC, along with the results of combined treatment, were analyzed.

**Results:** RIHCC occurred in 57 (54.8%) patients. The structure of the recurrences included intrahepatic in 30 (52.6%) patients, extrahepatic in 12 (21.1%), and combined recurrences in 15 (26.3%) patients. Of the recurrences, 7 (12.3%) were related to the area of resection. Recurrence occurred within 6 months in 16 (15.4%) patients, between 6 months and 1 year in 16 (15.4%) patients, and after 1 year in 25 (24%) patients. Combined treatment (combination of surgical or locoregional treatment with chemotherapy/immunotherapy) was used in 24 (42.6%) patients. Repeat liver resection and locoregional treatment were only performed in patients with intrahepatic recurrence. Repeat liver resections were performed in 7 patients (23.3%). The selection criteria for resection were as follows: recurrence-free period  $> 12$  months, absence of lymph node metastases, and absence of extrahepatic recurrence. Of the local treatment methods, transarterial chemoembolization and radiofrequency ablation were used more frequently, more often together, in 12 (40%) patients. There was no significant difference between the frequency of resection and the use of other local techniques ( $P = 0.165$ ). All patients received systemic chemotherapy, including immunotherapy (35.3%). The five-year overall survival rate in RIHCC, regardless of recurrence location, was 26% (median 53 months); 40% (median 57 months) in patients receiving combined treatment; and 19% (median 53 months) in patients receiving systemic chemotherapy alone.

**Conclusion:** The use of combined treatment modalities with an expansion of the indications for local modalities allows for improved treatment outcomes in RIHCC.



## 28. Intraductal papillary mucinous neoplasia of the bile ducts: clinical presentation, diagnosis, treatment

Mikhail Efanov, Valeriya Khegay, Andrey Vankovich, Anna Koroleva, Pavel Tarakanov, Dmitriy Kovalenko, Denis Fisenko

Hepatopancreatobiliary Surgery Department, Moscow Clinical Scientific Center named after A.S. Loginov, Moscow, Russia.

### Abstract

**Objectives:** Intraductal papillary mucinous neoplasia of the bile ducts (IPNB) is a relatively rare and poorly understood condition within the spectrum of bile duct tumors. Given the rarity of this disease, there have been no large-scale, randomized clinical trials to standardize preoperative diagnosis or surgical treatment.

**Methods:** This study included 22 patients who underwent surgery for IPNB between 2016 and 2024, and their perioperative and long-term outcomes were examined.

**Results:** More than half of the patients with IPNB underwent surgery using minimally invasive techniques. Approximately 50% of patients underwent major liver resection with bile duct resection. Half of the patients had an uneventful early postoperative period. Among complicated patients, the rate of severe morbidity (Clavien-Dindo > II) was 92%, with anastomotic bile leakage occurring in 36% of patients. There was no in-hospital mortality. The median overall survival time for patients with IPNB and dysplasia was not achieved, while the median survival for patients with an invasive carcinoma was 22 months ( $P = 0.027$ ). The reasons for death in long-term follow-up included not only tumor progression ( $n = 5$ ) but also severe cholangitis and liver failure resulting from mucin obstruction of the bile ducts ( $n = 2$ ).

**Conclusion:** Approximately half of patients with IPNB have invasive carcinoma associated with IPNB. The prognosis for these patients is unfavorable. However, in cases of IPNB-carcinomas, the prognosis depends not only on the presence of a malignancy but also on cholangitis due to mucin hyperproduction and biliary obstruction. Due to the rarity of this disease, it is necessary to accumulate experience, including multi-center experience, to find optimal diagnostic and therapeutic solutions.

## 29. Prediction of textbook outcome in the surgical treatment of intrahepatic cholangiocarcinoma

Denis Fisenko, Natalya Britskaya, Anna Koroleva, Pavel Tarakanov, Andrey Vankovich, Dmitriy Kovalenko, Nikita Solovyev, Valeriya Khegay, Mikhail Efanov

Hepatopancreatobiliary Surgery Department, Moscow Clinical Scientific Center named after A.S. Loginov, Moscow, Russia.

### Abstract

**Objectives:** Liver resection for intrahepatic cholangiocarcinoma (IHCC) is associated with a high risk of complications; therefore, the development of a textbook outcome (TO) model, including the assessment of predictors of TO achievement, is relevant. The objective is to determine the factors affecting the achievement of TO, to develop a binary logistic regression equation with an estimate of the probability of achieving TO.

**Methods:** Patients with IHCC who underwent surgery between 2015 and 2024 were included in the study. Achievement of TO was defined by the simultaneous absence of intraoperative complications  $\geq$  grade 2, Clavien-Dindo complications  $\geq$  grade 3, biliary fistula grade B or C (ISGLS), hospital mortality, rehospitalization within 30 days, and R1 resection. Binary logistic regression was used to identify factors influencing the achievement of TO. Based on these factors, the most sensitive and specific logistic regression model was determined.

**Results:** Data from 104 patients were analyzed. Single-factor logistic analysis revealed the following factors as significant predictors of not achieving TO: tumor size ( $P = 0.022$ ), jaundice ( $P = 0.05$ ) and open surgery ( $P = 0.016$ ). Multivariate logistic regression analysis identified a combination of four factors that had a

significant negative impact on achieving TO: tumor size ( $P = 0.024$ ), jaundice ( $P = 0.001$ ), blood loss ( $P = 0.046$ ) and open surgery ( $P = 0.010$ ). When the ROC curve was constructed, the AUC of the model was 0.885. The logistic regression model for predicting the probability of achieving TO was constructed based on the factors described above.  $e = 2.71828$  (base of natural logarithm).  $Z = -2.694 \times (1 \text{ if jaundice} / 0 \text{ if not}) - 0.021 \times \text{tumor size (mm)} - 0.002 \times \text{blood loss (mL.)} + 1.558 \times (1 \text{ if minimally invasive surgery} / 0 \text{ if open surgery})$ .

**Conclusion:** The resulting analysis model is reliably significant as a predictor of potential failure to achieve TO in patients with IHCC.

### 30. Textbook outcome in the surgical treatment of intrahepatic cholangiocarcinoma

Denis Fisenko, Natalya Britskaya, Anna Koroleva, Pavel Tarakanov, Andrey Vankovich, Dmitriy Kovalenko, Nikita Solovyev, Valeriya Kheday, Mikhail Efanov

Hepatopancreatobiliary Surgery Department, Moscow Clinical Scientific Center named after A.S. Loginov, Moscow, Russia.

#### Abstract

**Objectives:** There is an increasing number of studies proposing textbook outcome (TO) models for liver resection. The assessment of TO after liver resection for intrahepatic cholangiocarcinoma (IHCC) is poorly understood. The objective is to evaluate the frequency of achieving TO after liver resection in patients with IHCC, the influence of factors on achieving TO, and the impact of TO on survival.

**Methods:** Patients with IHCC who underwent surgery between 2015 and 2024 were included in the study. Achievement of TO was assessed according to the criteria proposed by Gorgec *et al.* (2021): absence of intraoperative complications  $\geq$  grade 2, Clavien-Dindo complications  $\geq$  grade 3, biliary fistula grade B or C (ISGLS), hospital mortality, rehospitalization within 30 days, and R1 resection. The impact of TO on survival was evaluated. Factors influencing the achievement of TO were analyzed using binary logistic regression.

**Results:** A total of 104 patients were enrolled in the study. TO was achieved in 40 patients (38.5%). Factors significantly associated with failure to achieve TO (nTO) were tumor size ( $P = 0.024$ ), jaundice ( $P = 0.001$ ), blood loss ( $P = 0.046$ ) and open surgery ( $P = 0.010$ ). The rate of achieving TO in patients with IHCC in liver resections without vascular and biliary reconstruction was 57.2%. Median overall survival for TO and nTO was 53 and 25 months, respectively. Although there were no significant differences in survival ( $P = 0.076$ ), there was a trend towards improved overall survival in patients who achieved TO.

**Conclusion:** The introduction of the complex TO model into clinical practice is an effective way to assess the quality and plan the surgical treatment of patients with IHCC.

### 31. Comparative analysis of outcomes after robotic and open resection for perihilar cholangiocarcinoma

Denis Fisenko, Natalya Britskaya, Anna Koroleva, Pavel Tarakanov, Andrey Vankovich, Dmitriy Kovalenko, Nikita Solovyev, Valeriya Kheday, Mikhail Efanov

Hepatopancreatobiliary Surgery Department, Moscow Clinical Scientific Center named after A.S. Loginov, Moscow, Russia.

#### Abstract

**Objectives:** The aim of the study was to compare the immediate and long-term outcomes of robotic and open resection for perihilar cholangiocarcinoma.

**Methods:** The data of patients with perihilar cholangiocarcinoma who underwent surgery between 2013 and 2024 were included. A propensity score matching with a 1:1 ratio was used to reduce selection biases. The robotic liver resection (RLR) technique involved major liver resection, caudal lobectomy, and regional lymph node removal (stations 8, 12, and 13). Immediate outcomes and survival were evaluated.

**Results:** The perioperative data of 189 patients were analyzed, including 39 robotic procedures. After propensity score matching (PSM) for nine criteria - age ( $P = 0.44$ ), ECOG status ( $P = 0.37$ ), ASA status ( $P = 0.31$ ), Bismuth type ( $P = 1.00$ ), TNM stage ( $P = 0.63$ ), complicated biliary drainage ( $P = 1.00$ ), portal vein embolization ( $P = 0.75$ ), FLR volume  $> 50\%$  ( $P = 0.15$ ), and vascular resection ( $P = 0.20$ ) - patients in both groups were well balanced. After PSM, there were no significant differences between the groups in blood loss ( $P = 0.78$ ), major morbidity ( $> \text{II Clavien-Dindo}$ ,  $P = 0.52$ ), or rate of biliary complications ( $P = 0.22$ ). Operative time was longer for RLR ( $P = 0.001$ ). The rate of R0 resections ( $P = 0.09$ ) and the number of lymph nodes harvested ( $P = 0.03$ ) were higher in the RLR group. The median overall survival after RLR and open resection was 44 and 32 months, respectively ( $P = 0.562$ ), while median disease-free survival was 26 and 17 months, respectively ( $P = 0.425$ ).

**Conclusion:** The robotic approach, during the initial implementation stage, demonstrates immediate and long-term oncological outcomes that are at least non-inferior, with a higher R0 resection rate and a greater number of lymph nodes retrieved, without increasing postoperative morbidity or mortality.

### 32. Textbook outcome and selection criteria for robotic resections in patients with perihilar cholangiocarcinoma

Mihail Efanov, Pavel Tarakanov, Andrey Vankovich, Dmitriy Kovalenko, Anna Koroleva, Denis Fisenko, Nikita Solovyev

Hepatopancreatobiliary Surgery Department, Moscow Clinical Scientific Center named after A.S. Loginov, Moscow, Russia.

#### Abstract

**Objectives:** To determine the selection criteria in patients with perihilar cholangiocarcinoma for robotic surgery.

**Methods:** The evaluation of textbook outcome (TO) achievement for robotic and open groups was performed to identify predictors for TO realization. The following criteria were used: no complications  $\geq 3b$  according to the Clavien-Dindo classification; R0 resection; length of hospital stay no more than 29 days (75th percentile in the current series); no 90-day readmissions; no 90-day mortality. The rate and reasons for conversion cases were evaluated.

**Results:** From 2013 to 2024, 40 patients received treatment with robotic approach and 151 were treated by open resection. The rate of TO achievement was 55% and 39% in robotic and open groups, respectively ( $P = 0.07$ ). There were fewer patients in the robotic group with ECOG  $> 1$  physical assessment ( $P = 0.01$ ) and stage TNM III-IV ( $P = 0.07$ ) as well as those who underwent biliary drainage ( $P = 0.01$ ). However, the groups were similar in terms of age, gender, body mass index, Bismuth type, number of extended liver resections and right hepatectomies, as well as the number of bile duct anastomoses. After adjusting for these factors, the rate of achieving TO remained 55% in the robotic group and 50% in the open group ( $P = 0.67$ ). There were seven (17.5%) conversions, including six due to vascular resection and reconstruction (15%) and one due to intraoperative bleeding (2.5%).

**Conclusion:** Robotic surgery is justified for selected patients. Selection criteria for the robotic approach are ECOG up to 1 and early TNM stages. Since avoiding biliary drainage improves surgery outcomes regardless of the type of approach, non-jaundiced patients may benefit from a robotic approach in terms of TO achievement. However, tumor invasion requiring vascular reconstruction is still a contraindication for robotic approach.

### 33. Comparison of the immediate results of laparoscopic and open isolated segment 1 resection

Mihail Efanov, Pavel Tarakanov, Anna Koroleva, Andrey Vankovich, Dmitriy Kovalenko, Denis Fisenko, Nikita Solovyev

Hepatopancreatobiliary Surgery Department, Moscow Clinical Scientific Center named after A.S. Loginov, Moscow, Russia.

## Abstract

**Objectives:** To compare the immediate outcomes of laparoscopic vs. open isolated resection of liver segment 1 (IRS1).

**Methods:** The study included patients treated from 2015 to 2024 who underwent IRS1 without another liver segment resection and other simultaneous interventions.

**Results:** The data of 20 patients were analyzed, including 11 (55%) with malignant tumors and 9 (45%) with benign lesions. Laparoscopic IRS1 was performed in 15 patients (75%) and open IRS1 in 5 patients (25%). Both groups were comparable in terms of gender ( $P = 0.075$ ), age ( $P = 0.290$ ), body mass index ( $P = 0.956$ ), ASA status ( $P = 1.000$ ), tumor size ( $P = 0.338$ ), and the number of malignant tumors ( $P = 0.56$ ). Total caudal lobectomy was performed in 10 patients (66.7%) in the laparoscopic group and 2 patients (40%) in the open group ( $P = 0.347$ ). The Pringle maneuver was applied in 4 and 1 cases, respectively ( $P = 1.00$ ). Estimated blood loss was  $124 \pm 150$  mL and  $154 \pm 95$  mL, respectively ( $P = 0.953$ ). Surgery time was  $262 \pm 105$  min and  $220 \pm 57$  min, respectively ( $P = 0.413$ ). R1 resection occurred only in the laparoscopic group ( $n = 1$ ) ( $P = 0.920$ ). The length of hospital stay was  $6.6 \pm 1.8$  days and  $6.2 \pm 1.9$  days, respectively ( $P = 0.678$ ). No severe postoperative morbidity (Clavien-Dindo grade > II) was observed.

**Conclusion:** Laparoscopic IRS1 is a feasible and safe procedure and may be the preferred option when performed in HPB centers with expertise in laparoscopic surgery. Larger series are needed to further clarify the advantages of the laparoscopic approach for IRS1.

## 34. Novel “inside-out transection” method in laparoscopic anatomical liver resection

Takuya Minagawa, Osamu Itano, Masahiro Shinoda, Sojun Hoshimoto, Kazuma Hasegawa, Takashi Oyama, Masashi Tsuruta, Yuki Hirano, Takashi Ishida, Ayako Shimada, Takuya Tamura, Ken Takeya

Hepato-Biliary-Pancreatic and Gastrointestinal Surgery, International University of Health and Welfare, Tochigi, Japan.

## Abstract

**Objectives:** We propose a novel “inside-out transection” method, a liver dissection technique focusing on the “chicken claw” sign as a new landmark to compensate for the shortcomings of indocyanine green (ICG) navigation. In this study, we examined the surgical outcomes of anatomical laparoscopic liver resection (LLR) using the “inside-out transection” method.

**Methods:** The “chicken claw” sign is a microstructure of the terminal branch of Glisson, easily visible in the near-field caudal view. Pathological studies have shown that the tips of this sign are very close to the intersegmental/sectional vein (IV), and the plane connecting them represents the anatomical boundary. The liver dissection technique involves an intrahepatic Glissonean approach to the root of the responsible Glisson and moving the CUSA peripherally from the Glisson root while recognizing the “chicken claw” sign. Considering the morphology of the Glissonean pedicle, this direction of liver dissection allows easy entry into the true anatomical boundary. In addition, this method does not require identification of the IV itself; the IV will spontaneously appear on the liver dissection plane by continuously following the tip of the “chicken claw” sign. Thus, this method can be applied to any type of anatomical LLR, including caudal unit resection. ICG negative staining may also be used to confirm the direction of liver resection. We reviewed the short-term results of anatomical LLR with subsegmental resection or greater performed at our institution from November 2020 to January 2025.

**Results:** Forty-two patients met the eligibility criteria for the study: 11 in the segmentectomy group, 14 in the sectionectomy group, and 17 in the hemihepatectomy group. Median operation time and liver resection time were 380/207 min, 402/241 min, and 309/134 min, respectively. Median estimated blood loss was 155, 260,

and 115 mL, respectively. The rate of ICG navigation use was 64%, 57%, and 76%, respectively. Postoperative complications occurred in four patients (bile leakage, abscess, and pneumonia). The rate of R0 resection was 95%.

**Conclusion:** The “inside-out transection” method demonstrates acceptable surgical outcomes and is a highly useful technique for truly anatomical LLR. When combined with ICG navigation, the anatomical boundary becomes more visible, making this approach versatile for all liver surgeons.

### 35. Laparoscopic living donor hepatectomy in liver transplantation: experience and outcomes

Georgina Maria Espejo, Gaston Ortigueira, Victoria Ardiles, Juan Pekolj

General Surgery, Hospital Italiano de Buenos Aires, Buenos Aires, Argentina.

#### Abstract

**Objectives:** The aim of this study is to describe the experience of laparoscopic hepatectomy (LH) in living donor liver transplantation (LDLT), evaluating perioperative outcomes for both donors and recipients.

**Methods:** Patients who underwent LH for pediatric LDLT between 2022 and 2024 at Hospital Italiano of Buenos Aires were analyzed. Data on donor and recipient outcomes were collected.

**Results:** A total of 10 donors (six women and four men) were included, all of whom were blood group compatible with their recipients. The median body mass index was 23.6 (IQR 21.8-25.8), with seven donors classified as ASA 1 and three as ASA 2. Four procedures were converted to open surgery due to technical difficulties. All grafts were obtained from segments 2-3 via left lateral sectionectomy. The median operative time was 4.22 h (IQR 4-5), with no intraoperative transfusions. Two donors who required conversion were admitted to the ICU for pain management, while the remaining eight were transferred to the regular ward. Three donors experienced Clavien-Dindo (C-D) grade 1 complications. The median hospital stay was 4 days (IQR 3-4). The recipients included six girls and four boys, with a median age of 11 months (IQR 10-12) and a median weight of 8.3 kg (IQR 7.6-9.75). The most common indication for transplantation was biliary atresia (nine cases), with one case of type 1 tyrosinemia. Portal reconstruction was required in one case, and intraoperative portal stenting was performed in two cases. Arterial anastomosis was performed using microsurgery, involving various hepatic arteries; one case required a double arterial anastomosis. Seven recipients required intraoperative transfusions. The median ischemia time was 4.4 h (IQR 3.5-5.5), and the median surgery duration was 6.9 h (IQR 6.6-7.1). Seven recipients experienced postoperative complications: one C-D 3a, five C-D 3b, and one C-D 4. There were no mortalities, and the median hospital stay was 36 days (IQR 20-57).

**Conclusion:** LH in LDLT is a safe option, although it presents technical challenges that may require conversion to open surgery. The absence of mortality suggests that the procedure is effective in managing end-stage liver diseases in children.

### 36. Comparative analysis of prognosis of hepatocellular carcinoma with microvascular invasion treated by laparoscopy and open surgery

Yong-Shuai Wang, Feng Zhang, Ji-Zhou Wang

Department of Hepatobiliary Surgery, The First Affiliated Hospital of USTC, Hefei, Anhui, China.

#### Abstract

**Objectives:** To investigate the prognosis of hepatocellular carcinoma patients with microvascular invasion treated by laparoscopic and open surgery.

**Methods:** Clinical data from 479 patients with hepatocellular carcinoma with microvascular invasion, admitted to the First Affiliated Hospital of the University of Science and Technology of China and Heze Municipal Hospital between January 2018 and December 2023, were retrospectively analyzed. Patients were



divided into a laparoscopic surgery group and an open surgery group. Propensity score matching (PSM) was performed using 1:1 nearest-neighbor matching, resulting in 172 patients in each group. Overall survival (OS) and tumor-free survival were compared between the two groups, and risk factors for OS were analyzed using a Cox regression model.

**Results:** (1) Before PSM, OS was longer in the laparoscopic surgery group compared with the open surgery group ( $P < 0.001$ ); After matching the PSM, the OS of patients in the laparoscopic surgery group was still longer ( $P = 0.026$ ); (2) Before PSM, disease-free survival was longer in laparoscopy surgery group compared with open surgery group ( $P < 0.001$ ); There was no significant difference in disease-free survival time between the two groups after matching the PSM ( $P = 0.310$ ); (3) After PSM, compared the treatment after recurrent hepatectomy between the two groups, the proportion of re-radical surgery in the laparoscopic surgery group was higher than that in the open surgery group ( $P = 0.010$ ); (4) After matching the PSM, the results of multivariate COX regression analysis showed that the maximum tumor diameter  $\geq 5$  cm [hazard ratio (HR) = 1.11, 95% confidence interval (CI) 1.05-1.17,  $P < 0.001$ ] was the independent risk factor affecting the OS of patients, while radical surgery after recurrence and metastasis (HR = 0.39, 95%CI 0.16-0.92,  $P = 0.031$ ), and targeted or immunotherapy after recurrence and metastasis (HR = 0.45, 95%CI 0.27-0.78,  $P = 0.004$ ) were the protective factors for the OS of patients.

**Conclusion:** Compared with conventional open surgery, laparoscopic surgery for patients with hepatocellular carcinoma with microvascular invasion is associated with a higher rate of repeat radical surgery after recurrence or metastasis and longer OS.

### 37. Overcoming the hurdles in robotic hepatic resection approach in patients with cirrhosis: the first report of 31 consecutive cases

Ali Majlesara, Nastaran Sabetkish, Elias Khajeh, Mohammed Golriz, Mohammadamin Shahrabaf, Christoph Michalski, Arianeb Mehrabi

Department of General, Visceral and Transplantation, Heidelberg University, Heidelberg, Germany.

#### Abstract

**Objectives:** Robotic liver resection (RLR) is a safe and feasible technique with favorable short-term outcomes. However, the role of RLR in cirrhotic patients is still unclear. The aim of this study was to report the outcomes and feasibility of RLR in cirrhotic patients in an experienced hepatobiliary center.

**Methods:** Data on RLR were collected until April 2023. Among 112 patients who underwent da Vinci-assisted surgery, 31 with cirrhosis were included in the present analysis.

**Results:** The mean age of the patients was  $64.0 \pm 12.7$  years, and 20 cases were male (64.5%). A total of 22 (71.0%), 7 (22.6%), and 2 (6.5%) patients were classified as Child-Pugh scores A-C, respectively. Right hemihepatectomy was performed in 1 case (3.2%), while 2 (6.5%), 13 (41.9%), and 15 (48.4%) patients underwent one, two, and three atypical resections, respectively. A total of 67.7% of cases had a difficult-to-reach lesion in the right posterior sector. Mean blood loss and operative time were  $1,024 \pm 1,614$  mL and  $241 \pm 102$  min, respectively. R0 resection was achieved in 27 patients (87.1%). Postoperative complications occurred in 9 patients (29.0%), of whom 1 (3.2%) underwent relaparotomy. Major complications (Clavien-Dindo  $\geq 3b$ ) were documented in 19.4% of patients ( $n = 6$ ). The total hospital stay was  $14.3 \pm 14.9$  days. The 90-day postoperative mortality rate was 6.5%. Surgical difficulty was classified as low, moderate, and high in 19.4%, 35.5%, and 45.2% of cases, respectively.

**Conclusion:** Based on our findings, the RLR program appears to be a reasonable alternative, offering favorable short-term outcomes in complex cases, such as cirrhotic patients with hard-to-reach liver lesions, for whom open or conventional laparoscopic approaches may not be feasible or safe.



### 38. Robotic-assisted living donor hepatectomy: a systematic review and meta-analysis

Ali Ramouz, Mohammedamin Shahrabaf, Ali Majlesara, Elias Khajeh, Arianeb Mehrabi

Department of General, Visceral and Transplantation, Heidelberg University, Heidelberg, Germany.

#### Abstract

**Objectives:** Liver transplantation is a complex surgical procedure that offers a lifeline to individuals with end-stage liver disease. Robotic technology has been integrated into the procedure to address the challenges posed by traditional open surgeries with large incisions. The aim of this study was to conduct a systematic review of the literature and synthesize data on robotic donor hepatectomy.

**Methods:** The literature search was conducted in PubMed, Scopus, Web of Science, and Embase databases up to the end of July 2024. Eligible studies included case series with 10 or more patients, as well as retrospective or prospective studies focusing on patients who underwent robotic donor hepatectomy. The study outcomes comprised operation time, blood loss, major complications, length of hospital stay, and 90-day mortality. Statistical analyses were performed using STATA with a random-effects model.

**Results:** Ten studies, including a total of 1,684 patients, were analyzed. Robotic donor hepatectomy had a mean operation time of 467 min [95% confidence interval (CI): 400-535] and a mean blood loss of 162 mL (95%CI: 79-245). The mean hospital stay was 7 days (95%CI: 6-9), and postoperative major morbidity (Clavien-Dindo  $\geq 3$ ) occurred in 3% of patients (95%CI: 0%-9%). The 90-day mortality rate was 1.4% (95%CI: 0%-4%).

**Conclusion:** Robotic-assisted donor hepatectomy demonstrates desirable outcomes characterized by efficient operation times, minimal blood loss, relatively short hospital stays and low incidence of major post-operative morbidity. Further studies are needed to evaluate the safety and efficacy of this method.

### 39. Fluorescent outer edge for the evaluation of safe resection margins in colorectal liver metastases: a retrospective study

Yufan Yang, Yutong Zhao, Wenqiang Wang, Lei Yang, Xuechen Liu, Jingyi Xu, Liusheng Wu, Jun Yan

School of Clinical Medicine, Beijing Tsinghua Changgung Hospital, Tsinghua University, Beijing, China.

#### Abstract

**Objectives:** Currently, achieving an R0 resection of CRLM requires a tumor-negative margin of at least 1 mm. Due to the irregular shape of tumors and the lack of tactile feedback during laparoscopy, the R0 resection rate using IOUS alone is slightly lower than that of open surgery. In our center's clinical experience, we have found that the outer edge of indocyanine green (ICG) fluorescence can serve as a real-time, dynamic pre-cut line, promptly reflecting the irregularities of tumor shape.

**Methods:** We collected data from 26 patients with CRLM who underwent minimally invasive liver resection at Beijing Tsinghua Changgung Hospital, China, between July 1, 2020, and June 30, 2024. Surgery performed along the outer edge of the ICG fluorescence was defined as the OE group, while conventional minimally invasive surgery was defined as the non-OE group.

**Results:** Among the 26 patients, 10 patients with 17 tumor specimens were included in the OE group, and 17 patients with 19 specimens were included in the non-OE group. Chi-square analysis showed that the R0 resection rate was higher in the OE group than in the non-OE group (94.1% vs. 68.4%,  $P = 0.052$ ), although a larger sample size is required for confirmation. In addition, patients in the OE group had significantly lower hospitalization costs [ $61,173.9 \pm 17,789.8$  Renminbi (RMB) vs.  $87,083.8 \pm 26,503.9$  RMB,  $P = 0.023$ ] and shorter hospital stays ( $7.6 \pm 4.1$  days vs.  $11.9 \pm 5.3$  days,  $P = 0.036$ ). The OE group also tended to have shorter drainage duration ( $5.5 \pm 2.8$  days vs.  $8.8 \pm 4.9$  days,  $P = 0.065$ ), less intraoperative blood loss ( $45.6 \pm 45.6$  mL vs.  $131.3 \pm 94.2$  mL,  $P = 0.025$ ), and shorter operative time ( $197.9 \pm 33.8$  min vs.  $247.2 \pm 96.7$  min,  $P = 0.182$ ). Moreover, no postoperative complications of Clavien-Dindo grade III or higher were observed in the OE group.

**Conclusion:** We propose a minimally invasive resection of CRLM along the outer edge of ICG fluorescence, which appears to be safer and more effective than conventional minimally invasive surgery and aligns with the paradigm of Precision Liver Surgery and Enhanced Recovery After Surgery.

#### **40. Laparoscopic surgery experience and its impact on the efficacy of laparoscopic simulation training: a comparative study based on module examinations**

Xuechen Liu, Wenqiang Wang, Yufan Yang, Jingyi Xu, Yuehua Liang, Yutong Zhao, Lei Yang, Liusheng Wu, Jun Yan

School of Clinical Medicine, Beijing Tsinghua Changgung Hospital, Tsinghua University, Beijing, China.

##### **Abstract**

**Objectives:** Currently, there is no targeted laparoscopic teaching system. In our institution's graduate teaching experience, a uniform teaching format is commonly adopted. This study aims to explore differences in skill acquisition between graduate students with and without prior experience as laparoscopic surgical assistants after systematic training, thereby providing a basis for optimizing stratified teaching strategies.

**Methods:** This prospective study enrolled 41 newly admitted clinical medical graduate students in 2024. They were divided into an experienced group (Group A,  $n = 19$ ) and an inexperienced group ( $n = 22$ ) based on prior experience as laparoscopic surgical assistants. Both groups received a standardized 10-hour laparoscopic simulation training course over five weeks, covering basic tasks (grasping and transferring) and complex tasks (suturing and knotting). Assessments for each task were conducted after completion of the training, comparing operation time, performance quality, accuracy, and error rates between the two groups. The evaluation data were analyzed using SPSS version 27.

**Results:** Group A significantly outperformed the control group in complex tasks, including single figure-of-eight suture time ( $206.6 \pm 75.9$  s vs.  $303.6 \pm 94.2$  s,  $P < 0.001$ ) and three simple interrupted sutures in different directions ( $287.1 \pm 47.5$  s vs.  $346.1 \pm 67.9$  s,  $P = 0.003$ ). In basic manipulations, there were no statistically significant differences between the groups in transiting through a five-ring track ( $33.1 \pm 5.22$  s vs.  $35.0 \pm 5.5$  s,  $P = 0.267$ ), number of accurately placed beans within 30 s ( $6.2 \pm 1.2$  vs.  $5.5 \pm 1.1$ ,  $P = 0.063$ ), or number of transfers plus ring placements within 30 s ( $3.1 \pm 0.7$  vs.  $2.6 \pm 0.8$ ,  $P = 0.058$ ).

**Conclusion:** Prior experience as a laparoscopic surgical assistant significantly influences the training efficacy of advanced operative skills; however, training outcomes for basic manipulations are not limited by prior experience. Although experienced students tend to perform better than novices in basic tasks, the differences are not statistically significant. These findings suggest that laparoscopic training systems should incorporate differentiated modules tailored to trainees' experience levels. Overall, this study provides empirical evidence to support precise stratification in clinical skills education.

#### **41. Is there a need to update cirrhotic patient selection criteria in the era of minimally invasive liver surgery?**

Florian Pecquenard, Antoine Rouault, Emmanuel Boleslawski, Mehdi El Amrani, Stephanie Truant, Guillaume Millet

Digestive Surgery and Transplantation, Lille University Hospital, Lille, France.

##### **Abstract**

**Objectives:** We present a single-center series of consecutive minimally invasive liver surgeries (MILS) aiming to correlate operative difficulty with clinical outcomes in patients with liver cirrhosis.

**Methods:** The records of all consecutive MILS performed at our center were reviewed. Inclusion criteria for cirrhotic patients included Child-Pugh A status, MELD score  $< 11$ , remnant liver volume  $\geq 50\%$ , and a portal

pressure gradient (PPG)  $\leq 10$  mmHg for major resections ( $\geq 3$  segments). Intraoperative and postoperative data were collected. Each MILS was classified according to the IWATE criteria into either the low/intermediate (Iw1-2) or advanced/expert (Iw3-4) difficulty level group.

**Results:** From 2008 to 2024, 749 MILS were performed by four experienced HPB surgeons, including 218 procedures (147 laparoscopic and 71 robotic) in patients with liver cirrhosis. In these patients, the primary indication was hepatocellular carcinoma ( $N = 178$ ). The Iw1-2 (mean IWATE index 4.1) and Iw3-4 (mean IWATE index 8.8) groups included 171 and 47 patients, respectively. No significant differences in age, body mass index, or ASA score were observed between the groups. In the Iw3-4 group, although the use of the Pringle maneuver was similar, the duration of clamping was longer (43 vs. 26 min), the total operative time was increased (276 vs. 166 min), the blood loss was higher (828 vs. 386 mL), and transfusion rates were elevated (15% vs. 4%). The conversion rate was three times higher (23% vs. 7%), the average length of hospital stay nearly doubled (12 vs. 6.6 days), and complications were more frequent, particularly severe complications (Clavien-Dindo grade  $\geq 3$ : 29.8% vs. 8.2%). Postoperative liver failure (POLF) occurred more often (29.2% vs. 6.4%), and mortality was higher (10.9% vs. 0.5%). Severe morbidity, POLF, and mortality were comparable between minor (30/47) and major (17/47) Iw3-4 hepatectomies.

**Conclusion:** Iw3-4 MILS, although feasible, are associated with worse postoperative outcomes in patients with liver cirrhosis, with no significant differences between minor and major hepatectomies. Therefore, for these IWATE difficulty levels, preoperative selection should consider not only the extent of parenchymal resection, portal hypertension, and liver function tests, but also alternative surgical and non-surgical strategies.

## 42. Cost-effectiveness and clinical impact of robotic-assisted hepatectomy

Guillaume Millet, Florian Pecquenard, Antoine Rouault, Mehdi El Amrani, Emmanuel Boleslawski, Stephanie Truant

Digestive Surgery and Transplantation, Lille University Hospital, Lille, France.

### Abstract

**Objectives:** Robotic-assisted hepatectomy has gained traction in hepatobiliary surgery, but its cost-effectiveness relative to traditional approaches remains unclear. This study evaluates the clinical outcomes and economic impact of robotic-assisted liver surgery in a high-volume center, compared with open and laparoscopic techniques.

**Methods:** A retrospective cohort study was conducted on patients who underwent hepatectomy at Lille University Hospital between 2018 and 2021, all performed by the institution's first experienced robotic hepatobiliary surgeon. Patient demographics, intraoperative details, postoperative outcomes, and costs were analyzed. Cost calculations included hospital stays, surgical materials, and complications, based on national cost studies.

**Results:** A total of 111 patients were included, with the proportion of minimally invasive procedures increasing from 47.5% in 2018 to 75% in 2021. Robotic-assisted hepatectomy was associated with shorter hospital stays, lower overall complication rates, and fewer severe morbidities compared to open surgery. The average cost per procedure (all surgical approaches combined) decreased from €12,169 in 2018 to €8,513 in 2021, with robotic surgery providing a significant financial benefit. Total savings for the 71 patients in the 2021 cohort amounted to €259,576, primarily due to reduced hospitalization duration and fewer complications.

**Conclusion:** Robotic-assisted hepatectomy is both clinically safe and cost-effective, providing substantial financial savings compared with traditional approaches. The observed reductions in postoperative complications and hospital stay, especially in complex cases, underscore the advantages of robotic surgery in hepatobiliary procedures. With increasing surgical expertise, robotic hepatectomy represents a sustainable and efficient alternative for liver resection.

#### 43. Laparoscopic liver resection vs. percutaneous radiofrequency ablation in patients with hepatocellular carcinoma (HCC) and liver cirrhosis, a single center 20-year review

Yee Han Shum, Tan To Cheung

Department of Surgery, Queen Mary Hospital, The University of Hong Kong, Hong Kong, China.

##### Abstract

**Objectives:** The aim of this study is to analyze the perioperative and long-term outcomes of laparoscopic liver resection (LLR) vs. percutaneous radiofrequency ablation (RFA) in patients with hepatocellular carcinoma (HCC) and liver cirrhosis.

**Methods:** This retrospective study analyzed patients treated for primary early-stage HCC ( $\leq 3$  cm) at The University of Hong Kong, Queen Mary Hospital, China, from 2002 to 2022. A total of 152 patients underwent LLR and 100 patients underwent percutaneous RFA. Patient and tumor characteristics, complications, and long-term outcomes were compared between the two treatment groups.

**Results:** There were no significant differences in baseline patient characteristics between the two groups. Hospital stay was shorter in the percutaneous RFA group (2 days) compared with the LLR group (4 days,  $P < 0.001$ ). No in-hospital mortality occurred in either group. The incidence of complications was not significantly different (6.6% in LLR vs. 2.0% in RFA). Tumor recurrence was significantly higher in the RFA group. Both overall and disease-free survival were significantly greater in the LLR group, with a median overall survival of 199.7 vs. 93.5 months ( $P < 0.001$ ) and a median disease-free survival of 103.5 vs. 29.9 months ( $P < 0.001$ ).

**Conclusion:** This study demonstrates that both LLR and percutaneous RFA are viable options for treating early HCC. While percutaneous RFA provides a shorter hospital stay, LLR offers significantly better recurrence control and long-term survival outcomes, and should be preferred when resources and patient preference allow.

#### 44. Minimally invasive surgery in hepatopancreatobiliary cases: a survey of recent situations and challenges faced in Indonesia

Arnetta Naomi Louise Lalisang, Toar J. M. Lalisang, Agi S. Putranto, Yarman Mazni, Wifanto Saditya Jeo, Febiansyah Ibrahim, Ridho Ardhi Syaiful, Lam Sihardo, Vania Myralda Giamour, Anisa Ayu Maharani, Afid Brililana

Faculty of Medicine, University of Indonesia, Depok, Indonesia.

##### Abstract

**Objectives:** In Indonesia, liver cancer is the second leading cause of cancer-related deaths, underscoring the need for better diagnosis and treatment. Minimally invasive surgery (MIS) offers advantages but remains limited due to geographical and screening challenges. While its adoption is increasing in major centers, nationwide data are lacking.

**Methods:** This descriptive study surveyed surgeons in March 2023 using Google Forms, collecting information on their backgrounds, HPB case volumes, adoption of MIS, and associated implementation challenges.

**Results:** Among 45 participating surgeons, 95.6% were digestive surgeons, primarily working in Type A (58%) or Type B (22%) government hospitals. The most common laparoscopic HPB procedures performed were liver wedge resection (46.7%), distal pancreatectomy (42.2%), and cholecystectomy (28.9%). Experience in HPB laparoscopy varied: 20% had less than 5 years, and 24.4% had 11-15 years. Annual MIS utilization ranged from  $< 10\%$  to  $> 90\%$ , with major procedures performed infrequently. While 73.3% of surgeons sought to improve their MIS skills, 62.2% reported challenges including inadequate equipment, financial constraints, and a shortage of trained personnel.

**Conclusion:** This survey highlights a promising trend, showing that HPB surgeons in Indonesia possess MIS expertise despite its limited implementation. Challenges such as geographical barriers, inadequate screening, and resource constraints hinder widespread adoption. Nevertheless, there is a strong commitment within the surgical community to integrate MIS into routine practice. Expanding MIS accessibility beyond Java and improving early detection are crucial for enhancing HPB patient outcomes in Indonesia. Additionally, establishing a unified HPB society could promote knowledge sharing, training programs, and policy advocacy, ultimately facilitating broader MIS adoption and integration nationwide.

#### **45. A new laparoscopic and robotic flexible bipolar radiofrequency hollow needle for liver cancer ablation: preliminary study and prototype design**

Renato Patrone, Francesca Lodato, Elena De Vita, Stefania Campopiano, Rita Massa, Giuseppe Ruello, Francesco Izzo

Division of Hepatobiliary Surgical Oncology, Istituto Nazionale Tumori Fondazione G. Pascale IRCCS Naples, Naples, Italy.

##### **Abstract**

**Objectives:** Radiofrequency ablation (RFA) and microwave ablation (MWA) are established techniques for treating primary and metastatic liver tumors. Modern oncology increasingly employs sequential and repeatable treatments to manage cancer as a chronic condition, making ablation a key component of multimodal therapy. While RFA has traditionally been performed percutaneously, its application in laparoscopic and robotic surgery is expanding. However, the rigid needles used in minimally invasive procedures present challenges due to complex manipulation through multiple fulcrum points. To address these limitations, we developed a novel radiofrequency device designed to enhance maneuverability and precision during minimally invasive liver ablations.

**Methods:** Our first step was to analyze and test the currently available models. We selected two radiofrequency generators and two types of needles. During the RFA experiments, the radiofrequency probes were integrated with fiber-optic sensors to perform temperature measurements throughout the treatments. Simultaneously, we based the simulation parameters for a hypothetical prototype on real-life experience in the operating room. The numerical simulations were carried out using COMSOL Multiphysics® software.

**Results:** In our numerical simulations, the expected ablation areas were 3.5, 3.5, and 1.8 cm in the first two experimental settings. For the third and fourth cases, the expected ablation area was approximately 1.8 cm radially from the activated needle without saline infusion, increasing to 2.6 cm when the saline infusion pump was operational. Compared with clinical measurements, a standard deviation of 0.2 cm was observed in the absence of saline infusion.

**Conclusion:** Our target was to achieve an ablation area of 3 cm. Using a single perfused needle, the predictive numerical model reached 2.6 cm. The future direction of our study is to develop a prototype needle for an experimental series to validate (or refute) these expected results and evaluate its effectiveness. The next step will involve a prospective phase II study in both wet-lab and animal models to test not only the new needle tip but also the flexible segment designed for laparoscopic and robotic procedures.

#### **46. Feasibility of robotic liver resection compared with laparoscopic and open liver resection for hepatocellular carcinoma: a network meta-analysis**

Sang-Hoon Kim, Ki-Hun Kim

Division of Liver Transplantation and Hepatobiliary Surgery, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Republic of Korea.



## Abstract

**Background:** Robotic liver resection (RLR) has gained popularity in the treatment of hepatocellular carcinoma (HCC); however, its efficacy compared to laparoscopic liver resection (LLR) and open liver resection (OLR) remains unclear.

**Methods:** Comprehensive literature search of electronic databases from January 2010 to December 2024 identified studies comparing RLR, LLR, or OLR. Operative, postoperative, and survival data were extracted, and pooled odds ratios or hazard ratios with 95% confidence intervals were calculated using a frequentist network meta-analysis including RLR, LLR and OLR.

**Results:** A total of 69 studies, comprising 1 randomized controlled, 3 prospective, and 65 retrospective-matched studies, involving 13,257 patients were analyzed. This network meta-analysis showed that RLR had significantly lower blood loss than both OLR and LLR, with comparable operative time, RBC transfusion rates, Pringle maneuver use, Pringle time, and R1 resection rates. RLR showed similar rates of overall and major complications and hospital stay duration as LLR, with significant benefits over OLR. No significant differences in 90-day mortality were found among the three groups. For long-term outcomes, RLR showed no significant advantage over LLR or OLR in overall and recurrence-free survival, though it generally ranked higher with a greater P-score.

**Conclusion:** This network meta-analysis suggests that RLR is a feasible surgical treatment option for HCC, offering perioperative and long-term outcomes comparable to LLR, with reduced postoperative morbidity and shorter hospital stays compared to OLR. However, further studies are needed to confirm RLR's efficacy due to its limited sample size.

## 47. Impact of malnutrition on short- and long-term outcomes in laparoscopic liver resection for hepatocellular carcinoma

Kentaro Oji, Takeshi Urade, Masahiro Kido, Shohei Komatsu, Kenji Fukushima, Shinichi So, Toshihiko Yoshida, Kentaro Tai, Keisuke Arai, Takumi Fukumoto

Department of Surgery, Division of Hepato-Biliary-Pancreatic Surgery, Kobe University Graduate School of Medicine, Hyogo, Japan.

## Abstract

**Objectives:** Liver resection is considered the most effective therapy for hepatocellular carcinoma (HCC). However, short-term outcomes, overall survival (OS), and recurrence-free survival (RFS) after surgery remain suboptimal, partly due to comorbidities and limited surgical tolerance in some patients. In particular, malnutrition has been reported to affect postoperative prognosis in HCC. Laparoscopic liver resection (LLR) may be suitable for such frail patients. This study aimed to investigate the impact of malnutrition on short- and long-term postoperative outcomes in LLR for HCC.

**Methods:** We retrospectively reviewed 121 patients diagnosed with HCC who underwent initial LLR at our hospital between January 2011 and December 2019. Prognostic nutritional index (PNI), calculated using Onodera's formula with a cutoff value of 40, divided patients into malnutrition (PNI < 40,  $n = 17$ ) and normal (PNI  $\geq 40$ ,  $n = 104$ ) groups. Postoperative outcomes, including complication rate, length of postoperative stay (LOS), and survival, were compared between groups.

**Results:** Baseline characteristics were comparable between groups. There were no significant differences between the malnutrition and normal groups in intraoperative blood loss, perioperative transfusion, complication rate, or LOS. In prognostic analysis, the malnutrition group had significantly shorter OS than the normal group (40 months *vs.* 107 months,  $P < 0.001$ ), whereas RFS was similar (not reached *vs.* 57 months,  $P = 0.770$ ). Multivariate analysis identified tumor stage [hazard ratio (HR) 3.98,  $P = 0.001$ ] and malnutrition (HR 7.15,  $P < 0.001$ ) as independent prognostic factors for OS.

**Conclusion:** Malnutrition did not affect short-term postoperative outcomes but was an independent poor prognostic factor in patients undergoing LLR for HCC.



#### 48. A novel approach to an ancient disease - minimally invasive surgery (MIS) in the treatment of liver hydatid disease

Yuliya Kalcheva, Daniel Kostov, Evgeni Nikolaev, Mirela Valcheva, Vladislava Slavcheva

General and Endoscopic Surgery, Military Medical Academy - Varna branch, Varna, Bulgaria.

##### Abstract

**Objectives:** Hydatid disease is a worldwide parasitic zoonosis, most frequently caused by the larval stage of *Echinococcus granulosus* (*E. granulosus*). The disease is most prevalent in temperate climate zones of Eurasia, Australia, South America, and North and East Africa. In Bulgaria, liver hydatid disease is mostly caused by *E. granulosus*, although sporadic cases of *Echinococcus multilocularis* have been reported. Given the high incidence of liver hydatid disease, even in developed countries, and the significant morbidity associated with treatment, this study aims to evaluate the feasibility of minimally invasive approaches, which are associated with shorter recovery times and higher patient satisfaction.

**Methods:** We performed a review of the relevant literature and a retrospective analysis of our experience over a five-year period (2019-2024).

**Results:** A total of 87 patients underwent surgery for liver hydatid disease. Patients with complicated cysts - such as those with biliary fistula, calcification, or suppuration - were treated with open surgery. Patients with uncomplicated cysts located in anterior segments were treated laparoscopically ( $n = 35$ ). Radical pericystectomy was performed in the majority of cases; nine patients underwent liver resection due to cyst size or location, and five patients had simple cystectomy. No significant differences were observed between the groups in terms of radicality or postoperative recurrence. Laparoscopic pericystectomy provided a radical procedure with advantages including shorter hospital stay, faster recovery, less blood loss, and improved cosmetic results. An organ-preserving strategy was favored due to the non-oncological nature of the disease. Our results are consistent with those reported in the literature.

**Conclusion:** Considering the well-known benefits of minimally invasive surgery, laparoscopic pericystectomy is a viable alternative to open surgery. This procedure should be performed in highly experienced centers to minimize complications such as cyst spillage, dissemination, biliary fistula, and abscess formation. Prospective studies are warranted to further evaluate minimally invasive surgery in the treatment of liver hydatid disease.

#### 49. Short- to medium-term results of laparoscopic gallbladder bed resection for suspected gallbladder cancer

Takahiro Shoda, Kenichiro Araki, Mariko Tsukagoshi, Ryosuke Fukushima, Takayuki Okuyama, Takaomi Seki, Koki Hosino, Kei Hagiwara, Shunsuke Kawai, Takamichi Igarashi, Norio Kubo, Ken Shirabe

Division of Hepatobiliary and Pancreatic Surgery, Integrative Center of General Surgery, Gunma University Hospital, Maebashi Gunma, Japan.

##### Abstract

**Objectives:** Laparoscopic gallbladder bed resection (LGBR) for gallbladder cancer has been covered by insurance in Japan since 2022. We compared LGBR with open gallbladder bed resection (OGBR) in patients diagnosed with gallbladder cancer postoperatively, and examined the clinical significance of LGBR.

**Methods:** LGBR was performed in 14 patients with suspected gallbladder cancer between July 1, 2022, and February 28, 2025. Patients with suspected T1a (M) to T2b (SS) depth and no evident lymph node metastasis (No) were considered eligible. Short-term outcomes, including postoperative complications, clinicopathological factors, and medium-term prognosis, were compared with 27 OGBR cases from January 1, 2017, to November 30, 2024.

**Results:** Short-term outcomes: The median age of LGBR patients was 71 years (range 51-86). Median

operative time was 278 min (119-492), blood loss 21 mL (0-265), and postoperative hospital stay 8 days (7-13). Compared with OGBR, LGBR patients had significantly less blood loss (18 mL vs. 75 mL,  $P < 0.05$ ). Operative time, Clavien-Dindo  $\geq$  IIIa complications, and hospital stay did not differ significantly. Pathological factors - including tumor diameter, vascular invasion, lymphatic invasion, pT (1/2/3), pN(+), and R0 resection - were also comparable between groups. Medium-term outcomes: Among six patients with gallbladder cancer who underwent LGBR, median follow-up was 497 days (118-842), with no recurrence in curatively resected cases. One-year overall survival was 100% for both LGBR and OGBR, and recurrence-free survival was 100% for LGBR and 90% for OGBR.

**Conclusion:** LGBR demonstrates comparable short-term outcomes to OGBR. Medium-term prognosis appears favorable, but careful case selection is essential to ensure safe and effective use of LGBR.

## 50. Histotripsy to achieve complete local tumor control for liver tumors: a national multi-center study

Chase Wehrle, Kevin Burns, Tarub Mabud, Ahmed Fayez, Emily Knott, Jimmy Ton, Mohamed Alassas, JaeKeun Kim, Federico Aucejo, Evan Ong, Mikhail Silk, Brock Hewitt, David Kwon

Hepato-Pancreato-Biliary and Liver Transplant Surgery, Cleveland Clinic, OH, USA.

### Abstract

**Objectives:** Histotripsy is a completely non-invasive, non-ionizing, and non-thermal method for treating liver tumors, receiving Food and Drug Administration (FDA) clearance in October 2023. National studies have demonstrated an excellent safety profile, yet only isolated case reports have been published regarding its oncologic efficacy.

**Methods:** All histotripsy procedures (Edison System, HistoSonics Inc., MI, USA) performed since FDA clearance at four academic institutions with at least 30 days of active follow-up were included. Cases were categorized as palliative intent or complete control, in which treatment aimed to achieve no evidence of disease (NED). Tumor viability was assessed using RECIST or mRECIST criteria as appropriate.

**Results:** A total of 161 patients were treated for 285 lesions. The most common tumor types were colorectal metastasis (CRLM,  $n = 84$ ), cholangiocarcinoma (CCA,  $n = 52$ ), neuroendocrine tumors (NET,  $n = 48$ ), breast ( $n = 34$ ), pancreatic (PDAC,  $n = 32$ ), and hepatocellular carcinoma (HCC,  $n = 21$ ). Treatment intent was palliative in 194 lesions (68%) and complete in 91 lesions (32%). Among 47 patients treated with curative intent, 30-day assessment showed 95% of lesions (86/91) were non-viable. Two patients required repeat treatment between postoperative day 30 and 90, achieving a complete response after the second session. Thirty-two patients treated for 62 tumors had a 90-day follow-up; 30 patients (94%) and 60 tumors (97%) achieved a complete tumor response. The two tumors with residual viability were one NET and one CRLM.

**Conclusion:** These preliminary data suggest histotripsy is a feasible option for complete treatment of liver tumors. Longer-term follow-up is needed to confirm durability of these results.

## 51. Robotic donor hepatectomy: early single-center experience and outcomes on the 19 consecutive cases

Nishtha Singh, Carolyn Waite, Ellie Brandon, Dustin Carpenter, Benjamin Samstein, Juan Rocca

HPB and Liver Transplant Division, Department of Surgery, Weill Cornell Medicine, NewYork-Presbyterian, New York, NY, USA.

### Abstract

**Objectives:** Robotic donor hepatectomy (RDH) is emerging as a preferred minimally invasive technique for living liver donation, offering enhanced dexterity and access for complex hepatectomies while preserving donor benefits. This study evaluates our initial RDH experience following nearly a decade of laparoscopic donor hepatectomy.

**Methods:** We retrospectively reviewed 19 RDH cases (18 completed, 1 aborted) from July 2023 to March 2025. Descriptive analysis included patient demographics and operative parameters: operative time (OT), estimated blood loss (EBL), anatomical complexity, conversion to open, length of hospital stay (LOS), and perioperative complications (Clavien-Dindo  $\geq 3$ ) within 30 days. Complex anatomy was defined as graft volume  $\geq 1,000$  mL, accessory hepatic veins,  $\geq 2$  hepatic arteries or bile ducts, or either a portal vein  $< 1$  cm or 2 portal veins. Temporal trends were analyzed to assess learning curve effects.

**Results:** Of the 19 RDH cases, one was aborted due to recipient issues. Eighteen procedures were completed: 16 right lobe grafts (88.8%) and 2 left lobes. Nine donors were female (50%), median body mass index was 25.27 (IQR: 22.60-27.37), and 6 donors (33.3%) had prior abdominal surgery. Mean OT was  $476 \pm 17$  min, and median EBL was 250 mL (IQR: 200-375). Mean preoperative total liver volume was  $1,609 \pm 51.95$  mL, with mean graft volume  $958 \pm 51.36$  mL. Complex graft anatomy was observed in 13 cases (72.2%). There were no conversions to open or hybrid approaches. Median LOS was 5 days (IQR: 4-6.75). Learning curve analysis showed that complex anatomy added an average of 39 min to OT compared with straight anatomy ( $P > 0.05$ ). Both EBL and LOS improved across successive cases, reflecting a maturing learning curve. Complications (CD  $\geq 3$ ) occurred in 3 cases (16.7%): 2 bile leaks requiring biliary intervention and drainage, and 1 subcapsular hematoma requiring robotic evacuation and hemostasis on the same day.

**Conclusion:** Our initial RDH experience demonstrated a short learning curve, improved perioperative performance, and the ability to manage increasing case complexity without conversions. Short-term outcomes were within benchmarks, supporting RDH as a safe and effective minimally invasive approach for living donor hepatectomy.

## 52. Transitioning from laparoscopic to robotic donor hepatectomy improves the practice of right donor hepatectomy

Juan Rocca, Nishtha Singh, Carolyn Waite, Ellie Brandon, Dustin Carpenter, Benjamin Samstein

HPB and Liver Transplant Division, Department of Surgery, Weill Cornell Medicine, New York-Presbyterian, NY, USA.

### Abstract

**Objectives:** A global survey on minimally invasive donor hepatectomy (DH) showed that pure laparoscopic donor hepatectomy (PLDH) was used in 48.8% of right hepatectomies. Eastern countries performed 96% of PLDH, while Western countries performed  $< 5\%$ , preferring laparoscopic-assisted or hybrid approaches (LADH) due to complexity. We recently reported that transitioning from laparoscopic to robotic liver surgery improves access and outcomes for more difficult hepatectomies. This study examines how transitioning to pure robotic donor hepatectomy (PRDH) affected our practice of living donor right hepatectomy.

**Methods:** Retrospective analysis of minimally invasive DH at our center since the introduction of PLDH in January 2018, divided into: ERA1 (Jan 2018-Jun 2023): PLDH or LADH performed according to preoperative surgical planning. ERA2 (Jul 2023-Mar 2025): Transition to PRDH. Analysis included demographics (age, gender, body mass index), liver/graft volumes, right vs. left hepatectomy (RightHep/LeftHep), and graft anatomy complexity. Outcomes assessed were estimated blood loss (EBL), operative time (OT), conversion to open surgery, length of stay (LOS), complications (Clavien-Dindo  $\geq 3$ ), and 90-day readmissions. ERA1 and ERA2 were compared for approach, outcomes, and graft complexity.

**Results:** Of 61 DHs, 1 was aborted due to recipient issues, leaving 60 for analysis. Overall, RightHep vs. LeftHep was 81.6% ( $n = 49$ ) vs. 19.4% ( $n = 11$ ). In ERA1, RightHep vs. LeftHep was 78.6% ( $n = 33$ ) vs. 21.4% ( $n = 9$ ). LADH was significantly associated with RightHep (21/33, 66.3%), while PLDH was more frequently used for LeftHep (6/9, 66.6%) ( $P < 0.001$ ). In ERA2, with a similar ratio of RightHep 88.8% ( $n = 16$ ) vs. LeftHep 11.1% ( $n = 2$ ), all RightHeps were performed as PRDH (100%,  $n = 16$ ), whereas in ERA1, only 36.3% (12/33) were PLDH ( $P < 0.001$ ). Outcome comparison for RightHep was similar between ERA1 and ERA2:

median EBL 200 mL (IQR 177-460) vs. 225 mL (IQR 200-325;  $P = 0.72$ ), median OT 450 min (IQR 150-350) vs. 485 min (IQR 420-541;  $P = 0.19$ ), LOS 6 days (IQR 5-7) vs. 4.5 days (IQR 4-7;  $P = 0.42$ ). Complications ( $CD \geq 3$ ) occurred in 7/33 cases (21.2%) vs. 3/16 (18.8%;  $P > 0.05$ ). Notably, no conversions occurred in PRDH, while 4/12 occurred in PLDH (33.3%;  $P = 0.28$ ). Complex graft anatomy was similar (33/42, 78.6% in ERA1 vs. 13/18, 72.2% in ERA2;  $P = 0.74$ ).

**Conclusion:** Transitioning to PRDH significantly improved our minimally invasive approach to donor hepatectomy, allowing 100% of right hepatectomies to be performed robotically, with no conversions or hybrid approaches, without negatively affecting perioperative outcomes.

### 53. Evolution of liver resection for hepatocellular carcinoma: change point analysis of textbook outcome over twenty years

Yeshong Park, Ho-Seong Han, Seung Yeon Lim, Hyelim Joo, Boram Lee, Hae Won Lee, Yoo-Seok Yoon, Jai Young Cho

Department of Surgery, Seoul National University Bundang Hospital, Bundang, Republic of Korea.

#### Abstract

**Objectives:** This study aimed to comprehensively analyze the evolution of textbook outcome (TO) achievement after liver resection for hepatocellular carcinoma (HCC) over two decades at a single tertiary referral center.

**Methods:** All consecutive liver resections for HCC at Seoul National University Bundang Hospital from 2003 to 2022 were analyzed. A total of 1,334 patients were divided into four groups based on time intervals identified through change point analysis. TO was defined as the absence of intraoperative transfusions, positive margins, major complications, 30-day readmission or mortality, and prolonged length of hospital stay (LOS).

**Results:** Multiple change point analysis identified three change points (2006, 2012, 2017), creating four groups. More recent time intervals were associated with older age (59 vs. 59 vs. 61 vs. 63 years,  $P < 0.0001$ ) and a higher prevalence of comorbidities. Minimally invasive procedures increased over time (open/laparoscopic/robotic: 37.0%/63.0%/0% vs. 43.8%/56.2%/0% vs. 17.1%/82.4%/0.5% vs. 22.9%/75.9%/1.2%;  $P < 0.0001$ ). TO achievement improved progressively (1.9% vs. 18.5% vs. 47.7% vs. 62.5%,  $P < 0.0001$ ), with LOS remaining the most frequent limiting factor.

**Conclusion:** TO after liver resection has improved over the past two decades, driven by advances in minimally invasive techniques and parenchymal-sparing procedures, even in older patients with more comorbidities and advanced tumors.

### 54. Comparison of open vs. laparoscopic approaches in salvage hepatectomy for recurrent hepatocellular carcinoma after radiofrequency ablation

Yeshong Park, Seung Yeon Lim, Hyelim Joo, Boram Lee, Hae Won Lee, Yoo-Seok Yoon, Ho-Seong Han, Jai Young Cho

Department of Surgery, Seoul National University Bundang Hospital, Bundang, Republic of Korea.

#### Abstract

**Objectives:** Although radiofrequency ablation (RFA) is widely used as an effective local treatment for hepatocellular carcinoma (HCC), evidence on salvage hepatectomy for local recurrence after RFA is limited. This study aims to compare open and laparoscopic approaches in salvage hepatectomy for recurrent HCC after RFA.

**Methods:** Among patients who underwent hepatectomy between January 2004 and August 2022 at a single tertiary referral center, 55 patients undergoing salvage hepatectomy for marginal recurrence after RFA were

included. Open surgery was performed in 23 patients (41.8%), and laparoscopic surgery in 32 patients (58.2%). Short-term and long-term outcomes were compared between the two groups.

**Results:** Major hepatectomy was more frequent in the open group (9 [39.1%] vs. 4 [12.5%],  $P = 0.022$ ), and intraoperative blood loss was greater (450 [325-750] mL vs. 300 [200-600] mL,  $P = 0.034$ ). Operation time ( $P = 0.144$ ) and postoperative morbidity rates ( $P = 0.639$ ) were similar, and there was no postoperative mortality in either group. Postoperative hospital stay was longer in the open group (8 [6-11] days vs. 5 [4-7] days,  $P = 0.028$ ). The 1-, 3-, and 5-year disease-free survival rates did not differ (44.6% vs. 62.5%, 16.5% vs. 13.5%, and 8.3% vs. 13.5%;  $P = 0.154$ ), nor did overall survival rates (85.7% vs. 96.8%, 79.6% vs. 86.0%, and 79.6% vs. 79.4%;  $P = 0.480$ ).

**Conclusion:** Laparoscopic salvage hepatectomy provides oncologic outcomes comparable to the open approach, with faster postoperative recovery. Given the high recurrence rates after RFA, a laparoscopic approach should be considered as a first-line option in selected patients.

## 55. The glass ceiling and the thick cloud: a dual struggle for hepato-pancreatico-biliary (HPB) surgery in Asia

Ruby Cerdeno, Catherine Teh

Department of Surgery, Makati Medical Center, Makati City, Philippines.

### Abstract

**Objectives:** This study aimed to explore the perceptions of hepato-pancreatico-biliary (HPB) surgeons regarding the practice of HPB surgery overall, as well as their views on women in the field in the Asia-Pacific region.

**Methods:** A questionnaire-based, cross-sectional survey was conducted online from May to June 2021 among male and female Asian-Pacific Hepato-Pancreato-Biliary Association (A-PHPBA) members actively practicing in the field.

**Results:** Of the 108 participants, 46.3% reported choosing HPB specialization because they found it challenging and complex, while 34.3% found it interesting. The majority (84.3%) indicated that their mentor inspired them to pursue a career as an HPB surgeon. When asked what could increase interest in laparoscopic HPB surgery among those not currently practicing it, 60.2% suggested education, workshops, mentoring, or coaching, and 39.8% emphasized more opportunities to observe and practice. Additionally, 78.7% believed their mentor positively influenced their decision to pursue laparoscopic HPB surgery. Regarding barriers for women in HPB practice and leadership, 50.9% of participants perceived no significant obstacles, while 39.8% cited family responsibilities. To encourage women to enter HPB, 50.9% suggested education, workshops, mentoring, or coaching, 39.8% recommended increased opportunities to observe and practice, and 9.3% cited improved resources or equipment.

**Conclusion:** Mentorship plays a key role in encouraging women to pursue HPB careers. Both education and hands-on experience are also important in increasing participation. A combination of mentorship programs and practical opportunities may help bridge the gender gap in HPB surgery.

## 56. Comparison of short-term outcomes between open and laparoscopic surgery for multiple liver resections

Daisuke Takimoto, Takeshi Urade, Masahiro Kido, Shohei Komatu, Hidetoshi Gon, Kenji Fukushima, Toshihiko Yoshida, Kentaro Tai, Keisuke Arai, Hiroaki Yanagimoto, Hirochika Toyama, Takumi Fukumoto

Department of Surgery, Division of Hepato-Biliary-Pancreatic Surgery, Kobe University Graduate School of Medicine, Kobe, Japan.



## Abstract

**Objectives:** Laparoscopic liver resection (LLR) has been reported to offer better short-term outcomes than open liver resection (OLR) and is widely adopted for liver tumors. However, its use in multiple tumor cases remains limited. This study aimed to compare short-term outcomes between OLR and LLR in patients undergoing multiple liver resections.

**Methods:** We retrospectively analyzed patients who underwent liver resection at Kobe University Hospital between 2010 and 2023. Patients were classified into four groups based on the number of resected lesions: single, two, three, and four or more. Preoperative and operative outcomes - including operative time, blood loss, postoperative complications, and length of hospital stay - were compared between OLR and LLR.

**Results:** A total of 752 patients were included, with 387 undergoing OLR and 367 LLR. Among them, 612 had single lesions (OLR: 311; LLR: 300), 88 had two lesions (OLR: 49; LLR: 39), 26 had three lesions (OLR: 9; LLR: 17), and 24 had four or more lesions (OLR: 14; LLR: 10). LLR was associated with significantly lower intraoperative blood loss across all groups ( $P < 0.001$ ), with median blood loss consistently lower than in OLR. Postoperative hospital stay was significantly shorter in the LLR group for single, two, and four or more lesions ( $P < 0.001$ ,  $P = 0.002$ ,  $P = 0.017$ ), but not for three lesions. Operative time did not differ significantly between OLR and LLR in multiple lesion cases. Complication rates were lower in the LLR groups for single and four or more lesions ( $P < 0.001$ ), with no significant differences in the other groups.

**Conclusion:** Even in multiple liver resections, LLR reduces blood loss and shortens postoperative hospital stay compared to OLR. The comparable operative time and complication rates suggest that LLR is a feasible and advantageous approach for patients with multiple liver tumors.

## 57. Textbook outcome of open and minimally invasive liver resection in patients with colorectal cancer metastases

Andrei Kalganov, Nikita Soloviev, Anna Koroleva, Andrei Vankovich, Dmitriy Kovalenko, Pavel Tarakanov, Denis Fisenko, Mikhail Efanov

Department of Hepatopancreatobiliary Surgery, Moscow Clinical Scientific Center named after Loginov MHD, Moscow, Russia.

## Abstract

**Objectives:** To evaluate textbook outcome (TO), its predictors, and its relationship with survival after open (OLR) and minimally invasive liver resection (MILR) in patients with metastatic colorectal cancer (CRC).

**Methods:** This retrospective cohort study included CRC patients who underwent OLR or MILR for metastatic liver disease between 2014 and 2024. TO was assessed according to the criteria proposed by Gorgec *et al.* Demographic and perioperative data, TO achievement rates, predictors of TO, and the impact of TO on overall survival (OS) and disease-free survival (DFS) were analyzed.

**Results:** A total of 167 OLR and 175 MILR cases were analyzed. The groups were comparable in demographic characteristics, and the IWATE criteria for surgical complexity did not differ. Blood loss was significantly lower in the MILR group (240 mL vs. 450 mL,  $P < 0.001$ ). TO was achieved more frequently after MILR than OLR (62.6% vs. 50.3%,  $P = 0.02$ ). In the entire cohort, median OS was longer in patients achieving TO (42 vs. 29 months,  $P = 0.02$ ). Five-year OS was 37% in TO patients vs. 24% in non-TO patients. TO achievement did not significantly affect DFS (14 vs. 17 months,  $P = 0.48$ ). Across all patients, lower blood loss and shorter operative time were associated with higher TO achievement ( $P < 0.001$ ), while gender, age, and body mass index had no significant effect.

**Conclusion:** MILR increases the likelihood of achieving TO. Achieving TO is associated with improved OS after liver resection, independent of surgical approach. While a minimally invasive approach may confer survival benefits, this observation may be influenced by selection bias favoring patients with better prognoses.

### 58. Utility of novel ultrasound scoring system for preoperative prediction of difficult laparoscopic cholecystectomy: a five-year retrospective cohort study in a tertiary government institution, Valenzuela City, Philippines

Mirinis Cavaneyro, John Angelo Mendoza

Department of Surgery, Fatima University Medical Center - Valenzuela Medical Center Consortium, Valenzuela City, Philippines.

#### Abstract

**Objectives:** This study aimed to evaluate the utility of a novel ultrasound scoring system for the preoperative prediction of difficult laparoscopic cholecystectomy (LC).

**Methods:** This retrospective study reviewed 228 patients who underwent LC between 2019 and 2023 at a tertiary institution in Valenzuela City. Preoperative ultrasound findings and intraoperative difficulty of LC were extracted from medical records. Seven sonographic parameters with designated scores were calculated using the standardized ultrasound scoring system developed by Siddiqui *et al.* The primary outcome was the predictive performance of preoperative ultrasound for difficult LC.

**Results:** Difficult LC was associated with the type of gallbladder disease ( $P < 0.001$ ) and ultrasound scores  $> 5$  ( $P = 0.004$ ). Ultrasound parameters significantly associated with difficult LC included gallbladder wall thickness  $\geq 4$  mm ( $P = 0.001$ ), transverse diameter  $\geq 5$  cm ( $P < 0.001$ ), presence of impacted stones ( $P = 0.001$ ), common bile duct diameter  $> 6$  mm ( $P = 0.045$ ), and multiple stones  $> 1$  ( $P = 0.003$ ). In multivariate regression, the ultrasound scoring system was an independent predictor of difficult LC [odds ratio (OR) = 0.719; 95% confidence interval (CI): 0.616-0.84;  $P < 0.001$ ]. Using a cutoff score of 5, the system demonstrated a sensitivity of 21.51% (95%CI: 13.66-31.24), specificity of 91.85% (95%CI: 85.89-95.86), positive predictive value of 64.52% (95%CI: 47.78-78.32), negative predictive value of 62.94% (95%CI: 60.16-65.64), positive likelihood ratio of 2.64 (95%CI: 1.33-5.24), and negative likelihood ratio of 0.85 (95%CI: 0.76-0.96).

**Conclusion:** The novel ultrasound scoring system is an inexpensive, rapid, non-invasive, and reliable preoperative tool for predicting difficult LC. It can be easily incorporated into routine diagnostic evaluation to aid surgical planning.

### 59. Short-term outcomes of the first 50 cases of robot liver surgery

Shu-Cheng Chou

General Surgery, Taipei Veterans General Hospital, Taipei, Taiwan.

#### Abstract

**Objectives:** Minimally invasive liver surgery is rapidly evolving worldwide, and robot-assisted liver surgery (RLS) offers significant benefits for patients. Our center has performed over 500 laparoscopic liver surgeries in the past eight years. The robotic liver surgery program was initiated in March 2023.

**Methods:** We conducted a retrospective study of RLS performed between March 2023 and March 2025, including 50 patients operated on by the same surgical team. Patient characteristics and short-term operative outcomes were recorded.

**Results:** Fifty consecutive liver resections were analyzed. Nine cases were performed in 2023, 35 in 2024, and six in 2025 (up to March). Of these, 28 were minor resections and 22 were major resections. Pathological diagnoses included hepatocellular carcinoma ( $n = 26$ ), colorectal liver metastasis ( $n = 8$ ), cholangiocarcinoma ( $n = 8$ ), and benign diseases (including hepatolithiasis, hemangioma, focal nodular hyperplasia, giant liver cysts, and lymphoid hyperplasia). Operative times ranged from 185 to 1,080 min, with blood loss between 30 and 1,900 mL. Postoperative hospital stays ranged from 4 to 21 days. One case required open conversion due to bleeding, and there were no mortalities.

**Conclusion:** This report presents our initial experience with RLS during the early phase of implementation. Careful analysis of outcomes is essential during the transition from laparoscopic to robotic liver surgery.

## 60. Minimally invasive liver resections: an experience from an Indian tertiary care center

R. Theekarajan, Anil Agarwal, B. G. Vageesh, Prithvi Raj, P. S. Aravind, M. N. Saravanan, Amit Javed, Shivendra Singh, Shaleen Agarwal, Rajeev Uppal, Puja Sakhuja

GI Surgery, GB Pant Institute of Postgraduate Medical Education & Research, New Delhi, India.

### Abstract

**Objectives:** Over the past two decades, minimally invasive liver resection (MILR) has increased exponentially and is now an established approach. MILR offers several advantages, and this study aims to analyze its spectrum and outcomes.

**Methods:** We conducted a retrospective analysis of prospectively collected data from 504 patients who underwent MILR between March 2006 and December 2024. Both benign and malignant indications for liver resection were included. Outcomes analyzed included feasibility, intraoperative, and postoperative complications.

**Results:** Of 504 liver resections, 457 were laparoscopic and 5 were robotic. There were 127 (27.5%) benign lesions and 335 (72.5%) malignant tumors, including 272 gallbladder carcinomas and 38 hepatocellular carcinomas. The most common benign lesion was a hydatid cyst (14.2%). Resections included 240 segment 4b/5 resections (with 21 combined adjacent organ resections), 26 hemihepatectomies (10 right, 16 left), 44 left lateral sectionectomies, and 94 wedge/subsegment/sectionectomies. Mean operative time and blood loss were 240 min and 100 mL for segment 4b/5 resections, and 280 min and 200 mL for hemihepatectomies. Clinically significant complications (Clavien-Dindo  $\geq 3$ ) occurred in 26 patients (5.3%), including bile leak in 15 (3.2%) and hemorrhage in 6 (1.2%) - three of whom required reoperation during the early years of experience. The mean hospital stay was 5 days. Thirty-day mortality was 3 patients (0.55%), including two due to cardiac failure.

**Conclusion:** MILR is safe and yields short-term outcomes comparable to open surgery while offering the benefits of minimally invasive approaches. The spectrum of conditions treated in our series differs from other published series, reflecting regional disease patterns.

## 61. Laparoscopic resectional surgery for liver hydatidosis: an experience from a tertiary center in North India

Maktum Naik, D. Rahul, Athish Shetty, B. G. Vageesh, Anil Agarwal

GI Surgery, GB Pant Institute of Postgraduate Medical Education & Research, New Delhi, India.

### Abstract

**Objectives:** Liver hydatidosis is a significant health problem in India. Drainage procedures are easier to perform but are associated with high recurrence and cavity-related morbidity. Resectional surgery, performed either laparoscopically or via open approach, is now advocated. This study aims to evaluate the surgical outcomes of laparoscopic resectional surgery (LRS) for liver hydatidosis.

**Methods:** We performed a retrospective analysis of prospectively collected data of patients with liver hydatidosis who underwent LRS in our unit from January 2006 to December 2024. Clinical features, cyst location and size, operative parameters, and recurrence rates were analyzed.

**Results:** A total of 74 patients were scheduled for LRS, of whom 8 were converted to open surgery. We analyzed 66 patients who underwent either cystopericystectomy ( $n = 57$ ) or hepatectomy ( $n = 9$ ) (6 left lateral, 1 left hepatectomy, 1 left hepatectomy with caudate lobectomy, 1 right hepatectomy). Abdominal pain was the most common presenting symptom, and the majority of patients (53/66) had Gharbi type II/III cysts. Cystobiliary communication was identified in 15 patients preoperatively or intraoperatively. Mean intraoperative blood loss was 107.5 mL (40-250 mL) in the cystopericystectomy group and 210 mL (50-350 mL) in the hepatectomy group. Mean operative time was 285 min (180-330) for cystopericystectomy

and 266.5 min (180-320) for hepatectomy. No intraoperative spillage of cyst contents occurred. Four patients required postoperative biliary stenting for bile leak. At a median follow-up of 46 months (range 4-98), no recurrences were observed.

**Conclusion:** LRS is associated with no intraoperative spillage, no cavity-related complications, and low recurrence rates. Whenever feasible, LRS should be considered the preferred approach for managing liver hydatidosis.

## 62. Laparoscopic segment 4b(S4b)/5 resections in gallbladder cancer: an experience

R. Theakarajan, Anil Agarwal, B. G. Vageesh, Vidyasharad Bhat, Amit Javed, Raja Kalayarasan, M. N. Saravanan, Rajeev Uppal, Puja Sakhuja

GI Surgery, GB Pant Institute of Postgraduate Medical Education & Research, New Delhi, India.

### Abstract

**Objectives:** The laparoscopic approach for gallbladder cancer (GBC) is increasingly performed, offering superior short-term outcomes with comparable oncologic results. Although anatomical resection of segments 4b/5 has not been proven superior to wedge resections, it provides the advantage of addressing potential micrometastases in the liver via venous drainage.

**Methods:** We conducted a retrospective analysis of prospectively collected data of patients who underwent laparoscopic radical cholecystectomy (LRC) from January 2011 to December 2024. Various techniques have been described for segment 5 delineation, including surface marking, Glissonean approach, trial clamping of the sectoral pedicle, and intraoperative ultrasound. Our preferred method involved intraparenchymal isolation of the pedicle while deepening the transection plane through segment 4b. Intra- and postoperative outcomes of anatomical segment 4b/5 resection for GBC were evaluated.

**Results:** Among 272 patients undergoing LRC for suspected GBC, anatomical S4b/S5 resection was performed in 240 patients and wedge resection in 32 patients. Concomitant resection of one or more adjacent viscera was performed in 21 patients (common bile duct, gastroduodenal, colon). Median operative time and blood loss were 240 min and 100 mL, respectively, with a mean lymph node yield of 11. Eight patients developed bile leaks, all managed conservatively; two required re-exploration for bleeding. Morbidity and mortality rates were 5.8% and 0.8% (2/240), respectively. Median hospital stay was 5 days. Histopathology revealed liver infiltration in 54% of cases.

**Conclusion:** LRC with anatomical segment 4b/5 resection can be performed safely with favorable short- and long-term outcomes and provides the advantage of addressing intrahepatic micrometastases. Among techniques for segment 5 delineation, intraparenchymal isolation of the S5 pedicle is recommended as it is safe, feasible, and does not require intraoperative ultrasound or sectoral pedicle clamping.

## DECLARATIONS

### Authors' contributions

The author contributed solely to the article.

### Availability of data and materials

Not applicable.

### Financial support and sponsorship

None.

### Conflicts of interest

Han HS is the Guest Editor of the Special Issue *Topic: Proceedings of ILLS 2025 Congress*. Han HS is also an Editorial Board member of the journal *Mini-invasive Surgery*. Han HS was not involved in any steps of the editorial process, notably including manuscript handling or decision-making.

**Ethical approval and consent to participate**

Not applicable.

**Consent for publication**

Not applicable.

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