DOI: 10.1002/jhbp.1279

ORIGINAL ARTICLE

Impact of tumor size on the difficulty of laparoscopic left lateral sectionectomies

Giada Aizza[1] | Nadia Russolillo[1] | Alessandro Ferrero[1] | Nicholas L. Syn[2] | Federica Cipriani[3] | Davit Aghayan[4] | Marco V. Marino[5,6] | Riccardo Memeo[7] | Vincenzo Mazzaferro[8] | Adrian K. H. Chiow[9] | Iswanto Sucandy[10] | Arpad Ivanecz[11] | Marco Vivarelli[12] | Fabrizio Di Benedetto[13] | Sung-Hoon Choi[14] | Jae Hoon Lee[15] | James O. Park[16] | Mikel Gastaca[17] | Constantino Fondevila[18] | Mikhail Efanov[19] | Fernando Rotellar[20,21] | Gi-Hong Choi[22] | Ricardo Robles-Campos[23] | Xiaoying Wang[24] | Robert P. Sutcliffe[25] | Johann Pratschke[26] | Chung Ngai Tang[27] | Charing C. Chong[28] | Mathieu D'Hondt[29] | Chee Chien Yong[30] | Andrea Ruzzenente[31] | Paolo Herman[32] | T. Peter Kingham[33] | Olivier Scatton[34] | Rong Liu[35] | Giovanni Battista Levi Sandri[36] | Olivier Soubrane[37] | Alejandro Mejia[38] | Santiago Lopez-Ben[39] | Kazateru Monden[40] | Go Wakabayashi[41] | Daniel Cherqui[42] | Roberto I. Troisi[43] | Mengqiu Yin[44] | Felice Giuliante[45] | David Geller[46] | Atsushi Sugioka[47] | Bjorn Edwin[4] | Tan-To Cheung[48] | Tran Cong Duy Long[49] | Mohammad Abu Hilal[50,51] | David Fuks[37] | Kuo-Hsin Chen[52] | Luca Aldrighetti[3] | Ho-Seong Han[53] | Brian K. P. Goh[54,55,56] | International Robotic and Laparoscopic Liver Resection study group investigators

[1]Department of General and Oncological Surgery, Mauriziano Hospital, Turin, Italy

[2]Ministry of Health Holdings Singapore and Yong Loo Lin School of Medicine, National University of Singapore, Singapore

[3]Hepatobiliary Surgery Division, IRCCS San Raffaele Hospital, Milan, Italy

[4]The Intervention Centre and Department of HPB Surgery, Oslo University Hospital, Institute of Clinical Medicine, University of Oslo, Oslo, Norway

[5]General Surgery Department, Azienda Ospedaliera Ospedali Riuniti Villa Sofia-Cervello, Palermo, Italy

[6]Oncologic Surgery Department, P. Giaccone University Hospital, Palermo, Italy

[7]Unit of Hepato-Pancreatc-Biliary Surgery, "F. Miulli" General Regional Hospital, Acquaviva delle Fonti, Bari, Italy

[8]HPB Surgery, Hepatology and Liver Transplantation, Fondazione IRCCS Istituto Nazionale Tumori di Milano, Milan, Italy

[9]Hepatopancreatobiliary Unit, Department of Surgery, Changi General Hospital, Singpore City, Singapore

[10]AdventHealth Tampa, Digestive Health Institute, Florida, Tampa, USA

[11]Department of Abdominal and General Surgery, University Medical Center Maribor, Maribor, Slovenia

[12]HPB Surgery and Transplantation Unit, United Hospital of Ancona, Department of Sperimental and Clinical Medicine, Polytechnic University of Marche, Ancona, Italy

This paper has not been presented previously.

International Robotic and Laparoscopic Liver Resection study group investigators are listed in Appendix A.

[Correction added on February 7, 2023, after first online publication: The first author name is corrected to Giada Aizza in this version.]

[13]Hepatopancreatobiliary Surgery and Liver Transplant Unit, University of Modena and Reggio Emilia, Modena, Italy

[14]Department of General Surgery, CHA Bundang Medical Center, CHA University School of Medicine, Seongnam, South Korea

[15]Division of Hepato-Biliary and Pancreatic Surgery, Department of Surgery, Asan Medical Center, University of Ulsan College of Medicine, Seoul, South Korea

[16]Department of Surgery, University of Washington Medical Center, Washington, Seattle, USA

[17]Hepatobiliary Surgery and Liver Transplantation Unit, Biocruces Bizkaia Health Research Institute, Cruces University Hospital, University of the Basque Country, Bilbao, Spain

[18]General and Digestive Surgery, Hospital Clinic, IDIBAPS, CIBERehd, University of Barcelona, Barcelona, Spain

[19]Department of Hepato-Pancreato-Biliary Surgery, Moscow Clinical Scientific Center, Moscow, Russia

[20]HPB and Liver Transplant Unit, Department of General Surgery, Clinica Universidad de Navarra, Universidad de Navarra, Pamplona, Spain

[21]Institute of Health Research of Navarra (IdisNA), Pamplona, Spain

[22]Division of Hepatopancreatobiliary Surgery, Department of Surgery, Severance Hospital, Yonsei University College of Medicine, Seoul, South Korea

[23]Department of General, Visceral and Transplantation Surgery, Clinic and University Hospital Virgen de la Arrixaca, IMIB-ARRIXACA, Murcia, Spain

[24]Department of Liver Surgery and Transplantation, Liver Cancer Institute, Zhongshan Hospital, Fudan University, Shanghai, China

[25]Department of Hepatopancreatobiliary and Liver Transplant Surgery, University Hospitals Birmingham NHS Foundation Trust, Birmingham, UK

[26]Department of Surgery, Campus Charité Mitte and Campus Virchow-Klinikum, Charité-Universitätsmedizin, Corporate Member of Freie Universität Berlin, and Berlin Institute of Health, Berlin, Germany

[27]Department of Surgery, Pamela Youde Nethersole Eastern Hospital, Hong Kong SAR, China

[28]Department of Surgery, Prince of Wales Hospital, The Chinese University of Hong Kong, Hong Kong SAR, China

[29]Department of Digestive and Hepatobiliary/Pancreatic Surgery, Groeninge Hospital, Kortrijk, Belgium

[30]Department of Surgery, Chang Gung Memorial Hospital, Kaohsiung, Taiwan

[31]General and Hepatobiliary Surgery, Department of Surgery, Dentistry, Gynecology and Pediatrics, University of Verona, GB Rossi Hospital, Verona, Italy

[32]Liver Surgery Unit, Department of Gastroenterology, University of Sao Paulo School of Medicine, Sao Paulo, Brazil

[33]Department of Surgery, Memorial Sloan Kettering Cancer Center, New York, New York, USA

[34]Department of Digestive, HBP and Liver Transplantation, Hopital Pitie-Salpetriere, Sorbonne Universite, Paris, France

[35]Faculty of Hepatopancreatobiliary Surgery, The First Medical Center of Chinese People's Liberation Army (PLA) General Hospital, Beijing, China

[36]Division of General Surgery and Liver Transplantation, S. Camillo Hospital, Rome, Italy

[37]Department of Digestive, Oncologic and Metabolic Surgery, Institute Mutualiste Montsouris, Universite Paris Descartes, Paris, France

[38]The Liver Institute, Methodist Dallas Medical Center, Texas, Dallas, USA

[39]Hepatobiliary and Pancreatic Surgery Unit, Department of Surgery, Dr. Josep Trueta Hospital, IdIBGi, Girona, Spain

[40]Department of Surgery, Fukuyama City Hospital, Hiroshima, Japan

[41]Center for Advanced Treatment of Hepatobiliary and Pancreatic Diseases, Ageo Central General Hospital, Saitama, Japan

[42]Department of Hepatobiliary Surgery, Assistance Publique Hopitaux de Paris, Centre Hepato-Biliaire, Paul-Brousse Hospital, Villejuif, France

[43]Department of Clinical Medicine and Surgery, Division of HPB, Minimally Invasive and Robotic Surgery, Federico II University Hospital Naples, Naples, Italy

[44]Department of Hepatobiliary Surgery, Affiliated Jinhua Hospital, Zhejiang University School of Medicine, Jinhua, China

[45]Hepatobiliary Surgery Unit, Fondazione Policlinico Universitario A. Gemelli, IRCCS, Catholic University of the Sacred Heart, Rome, Italy

[46]Department of Surgery, Division of Hepatobiliary and Pancreatic Surgery, University of Pittsburgh Medical Center, Pennsylvania, Pittsburgh, USA

[47]Department of Surgery, Fujita Health University School of Medicine, Aichi, Japan

[48]Department of Surgery, Queen Mary Hospital, The University of Hong Kong, Hong Kong SAR, China

[49]Department of Hepatopancreatobiliary Surgery, University Medical Center, University of Medicine and Pharmacy, Ho Chi Minh City, Vietnam

[50]Department of Surgery, University Hospital Southampton, Southampton, UK

[51]Department of Surgery, Fondazione Poliambulanza, Brescia, Italy

[52]Division of General Surgery, Department of Surgery, Far Eastern Memorial Hospital, New Taipei City, Taiwan

[53]Department of Surgery, Seoul National University Bundang Hospital, Seoul National University College of Medicine, Seoul, South Korea

[54]Department of Hepatopancreatobiliary and Transplant Surgery, Division of Surgery, Singapore General Hospital, Singapore, Singapore

[55]Department of Hepatopancreatobiliary and Transplant Surgery, Division of Surgical Oncology, National Cancer Centre Singapore, Singapore, Singapore

[56]Duke National University of Singapore Medical School, Singapore City, Singapore

Correspondence
Brian K. P. Goh, Department of Hepatopancreatobiliary and Transplant Surgery, Singapore General Hospital, Level 5, 20 College Road, Academia, Singapore City, 169856, Singapore.
Email: bsgkp@hotmail.com

Funding information
US National Cancer Institute MSKCC Core Grant, Grant/Award Number: P30 CA008747

Abstract

Background: Tumor size (TS) represents a critical parameter in the risk assessment of laparoscopic liver resections (LLR). Moreover, TS has been rarely related to the extent of liver resection. The aim of this study was to study the relationship between tumor size and difficulty of laparoscopic left lateral sectionectomy (L-LLS).

Methods: The impact of TS cutoffs was investigated by stratifying tumor size at each 10 mm-interval. The optimal cutoffs were chosen taking into consideration the number of endpoints which show a statistically significant split around the cut-points of interest and the magnitude of relative risk after correction for multiple risk factors.

Results: A total of 1910 L-LLS were included. Overall, open conversion and intraoperative blood transfusion were 3.1 and 3.3%, respectively. The major morbidity rate was 2.7% and 90-days mortality 0.6%. Three optimal TS cutoffs were identified: 40-, 70-, and 100-mm. All the selected cutoffs showed a significant discriminative power for the prediction of open conversion, operative time, blood transfusion and need of Pringle maneuver. Moreover, 70- and 100-mm cutoffs were both discriminative for estimated blood loss and major complications. A stepwise increase in rates of open conversion rate ($Z = 3.90$, $P < .001$), operative time ($Z = 3.84$, $P < .001$), blood loss ($Z = 6.50$, $P < .001$), intraoperative blood transfusion rate ($Z = 5.15$, $P < .001$), Pringle maneuver use ($Z = 6.48$, $P < .001$), major morbidity($Z = 2.17$, $P = .030$) and 30-days readmission ($Z = 1.99$, $P = .047$) was registered as the size increased.

Conclusion: L-LLS for tumors of increasing size was associated with poorer intraoperative and early postoperative outcomes suggesting increasing difficulty of the procedure. We determined three optimal TS cutoffs (40-, 70- and 100-mm) to accurately stratify surgical difficulty after L-LLS.

KEYWORDS
difficulty, laparoscopic hepatectomy, laparoscopic liver, left lateral sectionectomy, size

1 | INTRODUCTION

Laparoscopic liver resection (LLR) is now well-accepted globally as a safe and effective surgical procedure. Nonetheless, its implementation in clinical practice is associated with a learning curve and requires a stepwise approach when selecting cases of increasing complexity. During the Second International Consensus Conference on LLRs held in Morioka in 2014, the panel of experts recommended the use of difficulty scoring systems (DSS) to stratify the technical complexity and risks of LLR, in order to guide surgeons on selecting the appropriate procedure according to their level of experience.[1] Several DSSs have been developed and these are based on parameters such as lesion type, size, location, liver function, extent of liver resection and liver morphology.[2–5] Tumor size is presently well-recognized as having an important impact on the difficulty of LLR and it has been incorporated into most DSSs.[2,3,6] Larger tumors hinder liver mobilization, alter intraparenchymal vascular topographic anatomy and may require wider parenchymal transections and/or extensive vascular dissections. Their manipulation carries an inherent risk of vascular injury or tumor rupture, resulting in major bleeding and tumor seeding.[7]

To date, an optimal tumor size cutoff to stratify the complexity of LLR has not been well-established. The Iwate score uses a single cutoff of 30 mm,[2] while the Southampton score[3] categorize tumor size according to two thresholds: 30 and 50 mm; respectively. More recently, Kabir et al.[4] proposed 30 and 70 mm as ideal thresholds for the stratification of the difficulty of LLR. An important limitation of these studies was that the impact of tumor size had not been correlated with the extent of LLR. Intuitively, for example, one would expect that a tumor size >3 cm would have a greater impact on the complexity of LLR in the case of a monosegmentectomy but to a lesser extent in the case of a left lateral sectionectomy or right hepatectomy.[8]

Hence, we performed the present study with the aim of investigating the impact of tumor size on the surgical complexity of a single specific LLR procedure, that is, laparoscopic left lateral sectionectomy (L-LLSs). L-LLS is presently one of the most common and usually one of the earliest types of LLR that a surgeon attempts during his/her learning curve.[9] L-LLS is widely regarded as a relatively straightforward LLR, thanks to a wide operative field, an easy liver mobilization, and a relatively thin straight parenchymal transection plane. Hence, DSSs specifically tailored to LLS is of particular importance. The primary objective of this study was to examine the relationship between tumor size and difficulty of L-LLS, and to elucidate the optimal tumor size cutoff for this procedure.

2 | METHODS

This was a post hoc review of 17 680 patients who underwent pure LLR at 50 international centers between 2004–2020. Of these, 2698 pure LLS were performed. After excluding patients who underwent concomitant major surgical procedures (such as colectomies/gastrectomies/hilar lymphadenectomies/bile duct resections), repeat liver resections, multiple liver resections, cysts/cystic tumors or abscesses, the study population included 1913 patients. Tumor size for three patients was not recorded. Finally, 1910 patients were included in this analysis.

All institutions obtained their respective approvals according to the requirements of their local center. This study was approved by the Singapore General Hospital Institution Review Board (CIRB 2020/2802) and the need for patient consent was waived. Anonymized data were collected in individual centers then collated and analyzed centrally at the Singapore General Hospital.

2.1 | Definitions

Liver resections were defined according to the 2000 Brisbane classification.[10] Left lateral sectionectomies were defined as resections of segments 2 and 3. Tumor size was measured based on the longest diameter of the tumor on formalin-fixed specimens. Diameter of the largest lesion was used in cases of multiple tumors. Resection difficulty was graded according to the Iwate criteria.[2] Postoperative complications were classified according to the Clavien-Dindo classification and recorded for up to 30 days or during the same hospitalization.[11]

2.2 | Statistical analysis

The impact of tumor size cutoffs in intervals of 10 mm was systematically investigated by iteratively dichotomizing the tumor size at each 10 mm-interval and computing treatment effect sizes local to that cutoff. This was accomplished using a user-written Stata implementation of the Cutoff_Finder R package, with minor modifications to allow the use of Poisson models and quantile regression for computing adjusted relative risks and median differences. To handle baseline imbalances, effect sizes were conditioned on inverse probability-weights, which were estimated from a logistic regression incorporating the following as covariates: age, gender, year of surgery, ASA status, previous abdominal surgery, concomitant minor surgery, cirrhosis, multifocality, difficult posterosuperior segment, malignant pathology, and all components of the Iwate score excluding tumor size. Optimal tumor size cutoffs were then selected by taking into consideration the number of endpoints which show a statistically significant split around the cutoff points of interest, as well as the magnitude of the test statistic (z-score and t-score from modified Poisson and quantile regressions). As a sensitivity analysis, we also estimated empirical cutpoints obtained from maximizing the Youden index in receiver operating characteristics (ROC) analyses of open conversion and use of Pringle's maneuver.

Within tumor size categories, continuous and categorical variables were summarized as medians (IQR) and proportions, respectively. Tests of inequality across tumor size categories were performed using Kruskal-Wallis and Fisher's exact tests, respectively for continuous and categorical baseline and surgical characteristics. Finally, we assessed for the presence and strength of monotonic rank ordering using the Jonckheere-Terpstra and Cochran-Armitage trend tests for continuous and binary dependent variables, respectively, with the tumor size category regarded as an ordinal independent variable.

3 | RESULTS

3.1 | Baseline characteristics and perioperative outcomes

The baseline characteristics are summarized in Table 1. The median patient age was 61 years (IQR, 50–71), with a male: female ratio of 1124:786. Cirrhosis was diagnosed in 31.5% of patients and it was complicated by portal hypertension in 7.5% of cases. Malignant lesions were diagnosed in 79.8% of cases with a median tumor size of 35 mm (IQR, 23–58). The median Iwate difficulty score was 5 (IQR, 4–5) corresponding to an intermediate

TABLE 1 Comparison of baseline clinical and surgical characteristics of patients who underwent laparoscopic left lateral sectionectomy, stratified by tumor size

	All N = 1910	Tumor size ≤39 mm N = 1027	Tumor size 40–69 mm N = 528	Tumor size 70–99 mm N = 212	Tumor size ≥100 mm N = 143	*P*-value (inequality between groups)[a]
Median age (IQR), years	61 (50–71)	62 (53–71)	61 (49–72)	58 (45–68)	54 (41–69)	<.001
Male sex, n (%)	1124 (58.8%)	658 (64.1%)	289 (54.7%)	115 (54.2%)	62 (43.4%)	<.001
Year of surgery						
2004–2012	414 (21.7%)	244 (23.8%)	97 (17.8%)	48 (22.6%)	28 (19.6%)	.049
2013–2021	1496 (78.3%)	783 (76.2%)	434 (82.2%)	164 (77.4%)	115 (80.4%)	
Previous abdominal surgery, n/total (%)	555/1846 (30.1%)	317/988 (32.1%)	141/514 (27.4%)	55/205 (26.8%)	42/139 (30.2%)	.205
Concomitant minor surgery, n (%)	70 (3.7%)	35 (3.4%)	22 (4.2%)	10 (4.7%)	3 (2.1%)	.543
ASA score, n/total (%)						
1	285/1909 (14.9%)	136/1027 (13.2%)	78/528 (14.8%)	47/212 (22.2%)	24/142 (16.9%)	.017
2	1176/1909 (61.6%)	630/1027 (61.3%)	326/528 (61.7%)	126/212 (59.4%)	94/142 (66.2%)	
3	440/1909 (23.1%)	258/1027 (25.1%)	122/528 (23.1%)	37/212 (17.5%)	23/142 (16.2%)	
4	8/1909 (0.4%)	3/1027 (0.3%)	2/528 (0.4%)	2 (0.9%)	1/142 (0.7%)	
Malignant neoplasm, n (%)	1512 (79.2%)	922 (89.8%)	387 (73.3%)	124 (58.5%)	79 (55.2%)	<.001
Cirrhosis, n/total (%)	602/1909 (31.5%)	388/1026 (37.8%)	142/528 (26.9%)	49/212 (23.1%)	23/143 (16.1%)	<.001
Portal hypertension, n/total (%)	143/1900 (7.5%)	91/1021 (8.9%)	37/526 (7.0%)	14/211 (6.6%)	1/142 (0.7%)	.001
Median tumor size, mm (IQR)	35 (23–58)	25 (18–30)	50 (41–57)	80 (70–86)	120 (101–131)	<.001
Multiple tumors, n (%)	317 (16.6%)	177 (17.2%)	89 (16.9%)	35 (16.5%)	16 (11.2%)	.335
Median Iwate difficulty score, (IQR)	5 (4–5)	4 (4–5)	5 (5–6)	5 (5–6)	5 (5–6)	<.001
Median Iwate difficulty score excluding tumor size, (IQR)	4 (4–5)	4 (4–4)	4 (4–5)	4 (4–5)	4 (4–5)	<.001
Iwate difficulty, n (%)						
Low	131 (6.9%)	130 (12.7%)	1 (0.2%)	0 (0.0%)	0 (0.0%)	<.001
Intermediate	1763 (92.3%)	891 (86.8%)	519 (98.3%)	210 (99.1%)	143 (100.0%)	
High	16 (0.8%)	6 (0.6%)	8 (1.5%)	2 (0.9%)	0 (0.0%)	
Expert	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	

Abbreviations: IQR, interquartile range; ASA, physical status classification system.

[a]Kruskal-Wallis test for continuous variables and Fisher's exact test for categorical variables.

difficulty grade in 92.3% of cases. The median operative time was 160 min (IQR, 112–215) with a median blood loss of 100 cc (IQR, 50–200); open conversion and intraoperative blood transfusion were required in 3.1 and 3.3% of cases, respectively. Pringle maneuver was used in 19.5% of cases. The major morbidity rate, defined by a Clavien-Dindo severity score >2, was 2.7%, while 90-day mortality was 0.6%.

3.2 | Optimal tumor size cutoff analysis

Relative risk (RR) for each outcome after correction for age, gender, year of surgery, ASA status, previous abdominal surgery, concomitant minor surgery, cirrhosis, multifocality, malignant pathology, and all components of the Iwate score excluding tumor size, are shown in Table 2.

Taking into consideration the number of endpoints which show a statistically significant split around the cutpoints of interest and the magnitude of RR, three optimal cutoffs were identified: 40-, 70-, and 100-mm (Table 1). All the selected cutoffs showed a significant discriminative power for the prediction of open conversion, operative time, blood transfusion and need of Pringle maneuver. Moreover, 70 and 100 mm cutoffs were both discriminative also for estimated blood loss and major complications (Figure 1, Table 2).

The cutoff of 30 mm was excluded in favor of 40 mm because in equal of number of predictive variables, the significance for blood transfusion was very “weak” (lower bound of the 95% CI: 1.06). ROC analyses **(**Figure S1) confirmed that the 40 mm cutoff was able to maximize the Youden index. The 100 mm cutoff was selected instead of 90 mm because associated to notably larger effect sizes, even if discriminated the same perioperative outcomes.

Finally, 60 mm (vs 70 mm) and 110 mm (vs 100 mm) were excluded because associated with lower number of predicted outcomes.

According to the selected cutoffs, four study groups were identified: small ≤39 mm (n = 1027), intermediate 40–69 mm (n = 528), large 70–99 mm (n = 212) and very large ≥100 (n = 143) lesions. The 4-level classification system thus established was able to increase the AUC for both open conversion (from 0.59 to 0.62) and application of pringle maneuver (from 0.59 to 0.61) compared to 40 mm cutoff alone (Figure S1).

3.3 | Comparison of perioperative characteristics stratified by tumor size

Comparison of preoperative characteristics of patients who underwent L-LLS stratified by tumor size showed that patients with very large lesions (≥100 mm) were younger (median age 54 years) with benign lesions in slightly less than 50% of cases (Tables 1 and 3). The diagnosis of cirrhosis and portal hypertension were less common (55.2 and 16.1%, respectively) compared to others cutoff groups.

The comparison of intraoperative outcomes between the groups showed a stepwise increase in rates of open conversion rate (Z = 3.90, $P<.001$), operative time (Z = 3.84, $P<.001$), blood loss (Z = 6.50, $P<.001$), intraoperative blood transfusion rate (Z = 5.15, $P<.001$) and Pringle maneuver use (Z = 6.48, $P<.001$) as the tumor size category increased.

A significant worsening trend was noted for Clavien-Dindo score >2 (Z = 2.17, $P = .030$) and 30-days readmission (Z = 1.99, $P = .047$) increasing the tumor size categories. Thirty and 90-days mortality rates did not significantly change among the study groups.

4 | DISCUSSION

Since the early experience of LLR, tumor size has been well-recognized as a critical parameter in the assessment of the difficulty of LLR. In the Louisville Statement, it was suggested that LLR should be restricted to lesions <50 mm.[12] However, with the accumulation of clinical evidence on the feasibility and safety of the laparoscopic approach for resection of larger tumors, this has culminated in the recent Southampton Guidelines which excluded tumor size as an independent exclusion criterion for LLR.[13] Recent studies have also confirmed the feasibility and safety of LLR for huge (≥10 cm) tumors.[7,14]

Today, L-LLS is one of the most frequently performed types of LLR and it has been proposed to be the standard of care for lesions located in the left lateral section.[12,13,15–17] This is due to the favorable anatomical morphology and topography of the left lateral section.[18] Nonetheless, unexpected difficulties may still be encountered during L-LLS and a small proportion of cases may undergo an unplanned open conversion even in expert centers.[18] Not unexpectedly, tumor size has also been shown to be an important predictor of open conversion during L-LLS.[18]

We performed this study with the primary objective of examining the relationship between tumor size and difficulty of L-LLS, and to elucidate the optimal tumor size cutoff for stratifying the difficulty of this procedure. Presently, commonly used DSS such as the Iwate Criteria[2] and Southampton score[3] have incorporated tumor size in the calculation of the difficulty score. A size cutoff of 3 cm was used for the Iwate criteria whereas the Southampton score utilized a cutoff of 3 and 5 cm. More recently, Ivanecz et al. proposed

TABLE 2 Cutoff analysis for nine selected endpoints

Tumor size (cm)	Open conversion RR (95% CI)	Operation time (min) MD (95% CI)	Estimated blood loss (ml) MD (95% CI)	Blood transfusion RR (95% CI)	Pringle maneuver RR (95% CI)	Postop length of stay MD (95% CI)	Postop complications RR (95% CI)	Major complications RR (95% CI)	90-day mortality RR (95% CI)
>1.0 vs ≤1.0	0.9 (0.25 to 3.27)	7 (−11 to 26)	16 (−28 to 61)	4.58 (0.28 to 74.81)	0.96 (0.52 to 1.76)	0.6 (−0.3 to 1.6)	0.84 (0.43 to 1.64)	1.27 (0.25 to 6.57)	0.28 (0.05 to 1.55)
>2.0 vs ≤2.0	1.33 (0.7 to 2.54)	**9 (1 to 17)**	11 (−8 to 29)	2.1 (0.97 to 4.55)	**1.77 (1.3 to 2.4)**	0.2 (−0.2 to 0.6)	1.27 (0.91 to 1.78)	1.33 (0.65 to 2.71)	2.22 (0.4 to 12.23)
>3.0 vs ≤3.0	**1.98 (1.14 to 3.42)**	**10 (3 to 16)**	5 (−10 to 21)	**1.84 (1.06 to 3.21)**	**1.68 (1.32 to 2.13)**	0 (−0.3 to 0.4)	1.25 (0.96 to 1.64)	1.07 (0.61 to 1.85)	2.14 (0.63 to 7.33)
>4.0 vs ≤4.0	**2.21 (1.33 to 3.67)**	**11 (4 to 18)**	7 (−8 to 23)	**2.51 (1.48 to 4.23)**	**1.88 (1.49 to 2.36)**	−0.1 (−0.4 to 0.3)	1.2 (0.92 to 1.57)	1.42 (0.82 to 2.46)	1.52 (0.51 to 4.54)
>5.0 vs ≤5.0	**2.26 (1.37 to 3.73)**	**16 (8 to 23)**	15 (−2 to 31)	**2.86 (1.71 to 4.77)**	**2.17 (1.71 to 2.75)**	−0.2 (−0.6 to 0.2)	1.14 (0.86 to 1.52)	1.67 (0.96 to 2.91)	1.28 (0.41 to 4.02)
>6.0 vs ≤6.0	**2.33 (1.39 to 3.91)**	**18 (10 to 27)**	17 (−1 to 36)	**2.92 (1.74 to 4.91)**	**2.13 (1.65 to 2.75)**	−0.2 (−0.6 to 0.2)	1.03 (0.75 to 1.42)	**1.83 (1.02 to 3.27)**	1.94 (0.61 to 6.1)
>7.0 vs ≤7.0	**2.46 (1.43 to 4.26)**	**24 (14 to 33)**	**30 (8 to 51)**	**3.09 (1.8 to 5.3)**	**2.11 (1.59 to 2.8)**	0.1 (−0.4 to 0.5)	1.02 (0.71 to 1.46)	**2.09 (1.13 to 3.87)**	2 (0.58 to 6.86)
>8.0 vs ≤8.0	**2.69 (1.49 to 4.86)**	**24 (13 to 35)**	**33 (8 to 57)**	**3.43 (1.93 to 6.09)**	**2.21 (1.61 to 3.05)**	0 (−0.5 to 0.6)	1.05 (0.7 to 1.59)	**2.57 (1.34 to 4.93)**	1.92 (0.48 to 7.7)
>9.0 vs ≤9.0	**2.44 (1.26 to 4.72)**	**26 (14 to 39)**	**43 (16 to 71)**	**4.28 (2.38 to 7.73)**	**2.33 (1.63 to 3.32)**	0.2 (−0.5 to 0.8)	1.03 (0.65 to 1.65)	**2.41 (1.17 to 4.96)**	1.4 (0.25 to 7.71)
>10.0 vs ≤10.0	**3.35 (1.63 to 6.89)**	**38 (23 to 53)**	**62 (25 to 98)**	**4.58 (2.33 to 8.99)**	**2.34 (1.5 to 3.64)**	0.1 (−0.7 to 0.9)	0.74 (0.39 to 1.42)	**2.61 (1.12 to 6.09)**	2.36 (0.43 to 13.11)
>11.0 vs ≤11.0	**2.81 (1.21 to 6.55)**	**42 (25 to 59)**	**56 (14 to 98)**	**4.15 (1.94 to 8.91)**	1.65 (0.98 to 2.78)	0.2 (−0.7 to 1.1)	0.89 (0.45 to 1.79)	**3.5 (1.49 to 8.22)**	3.11 (0.56 to 17.33)
>12.0 vs ≤12.0	**4.59 (1.93 to 10.89)**	**34 (13 to 55)**	29 (−28 to 86)	**3.93 (1.56 to 9.92)**	1.31 (0.67 to 2.57)	0.1 (−1 to 1.2)	1.12 (0.51 to 2.46)	**3.62 (1.32 to 9.93)**	4.88 (0.87 to 27.39)
>13.0 vs ≤13.0	**4.95 (1.94 to 12.63)**	**45 (21 to 69)**	38 (−24 to 100)	**5.22 (2.04 to 13.35)**	1.82 (0.9 to 3.67)	0.4 (−0.9 to 1.6)	1.03 (0.42 to 2.57)	**3.53 (1.14 to 10.97)**	**6.31 (1.12 to 35.65)**
>14.0 vs ≤14.0	**4.92 (1.55 to 15.68)**	**37 (7 to 68)**	−22 (−107 to 63)	**5.18 (1.62 to 16.53)**	1 (0.36 to 2.83)	0.1 (−1.5 to 1.7)	1.06 (0.34 to 3.29)	**4.05 (1.06 to 15.39)**	**10.43 (1.81 to 59.97)**
>15.0 vs ≤15.0	**5.15 (1.31 to 20.18)**	**44 (6 to 81)**	−22 (−129 to 85)	2.99 (0.55 to 16.28)	1.26 (0.38 to 4.19)	0.1 (−1.9 to 2)	0.62 (0.12 to 3.36)	3.47 (0.63 to 18.96)	4.57 (0.26 to 80.46)

Note: Effect sizes were computed by dichotomizing the tumor size at every 10 mm-interval (for example, at the tumor size cutoff of 10 cm, the effect size of RR 3.35 [95% CI: 1.63–6.89] for the outcome of open conversion represents the risk ratio obtained when comparing the rate of open conversion among patients with tumor size >100 mm vs patients with tumor size ≤100 mm). Effect sizes were adjusted using inverse probability-weights from a logistic regression incorporating the following as covariates: age, gender, year of surgery, ASA status, previous abdominal surgery, concomitant minor surgery, cirrhosis, multifocality, difficult posterosuperior segment, malignant pathology, and all components of the Iwate score excluding tumor size. The bold values indicate statistically significant results.

Abbreviations: CI, confidence interval; MD, median; Postop, postoperative; RR relative risk.

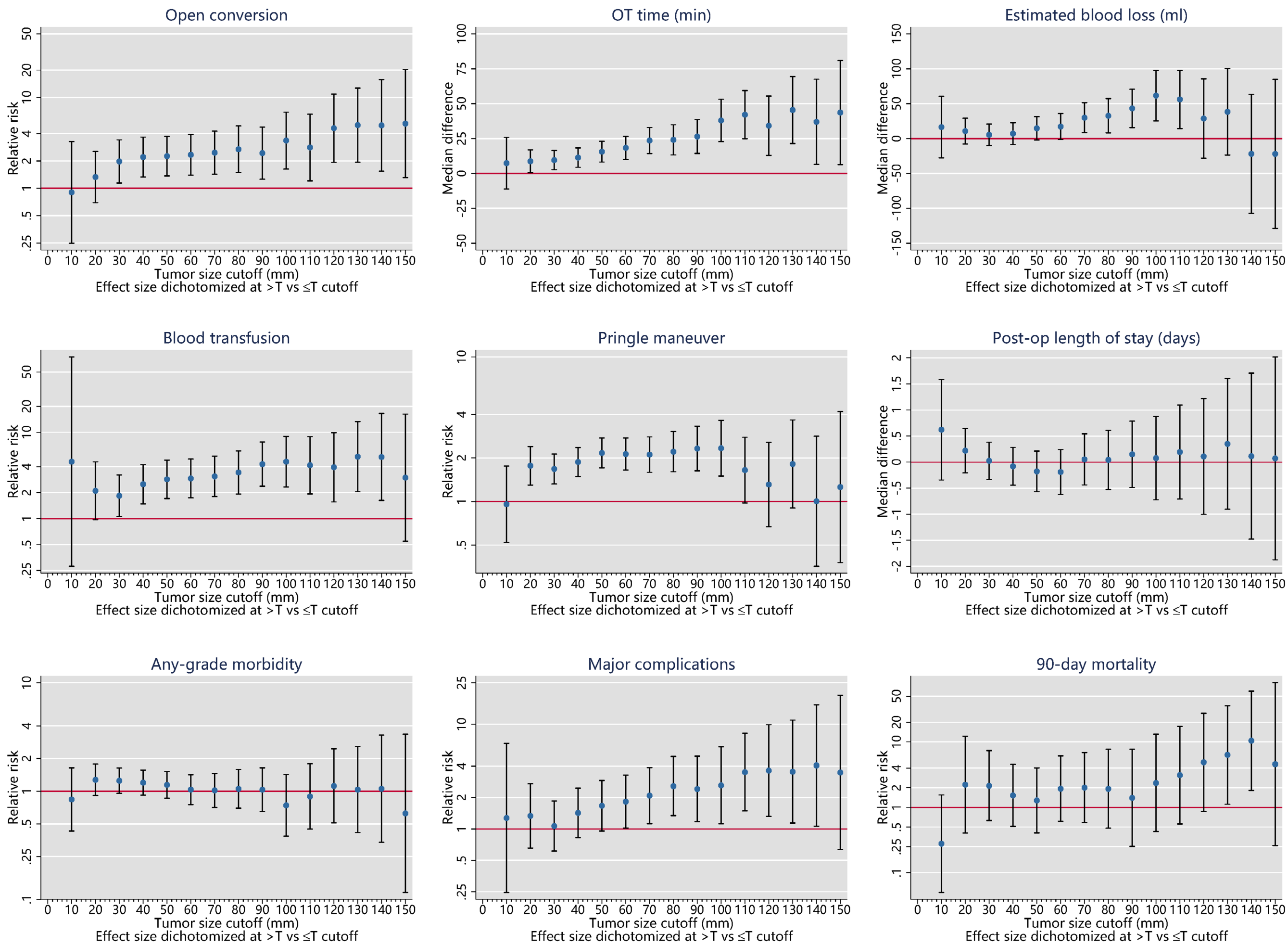

FIGURE 1 Cutoff analysis

a tumor size cutoff of 38 mm based on a small series of 142 LLR.[19] Subsequently, Kabir et al. performed a robust statistical analysis based on 461 LLR and determined that the optimal size cutoff was 3 and 7 cm.[4] A major limitation of these studies was that the proposed size cutoffs was not tailored to the extent of the LLR performed. Moreover, many of the cutoff values were arbitrarily chosen and not based on robust statistical analysis.

To the best of our knowledge, this is the largest study to date to analyze the correlation between tumor size and the outcomes for a specific type of LLR. In the present study, we identified three cutoffs (40, 70 and 100 mm) which consistently discriminated major intraoperative outcomes (open conversion rate, operative time, blood loss and transfusion, Pringle maneuver use) as well as postoperative major complications after L-LLS. These findings suggest that increasing tumor size correlated with higher difficulty of L-LLS. Notably, increased frequency of the use of the Pringle Maneuver may not necessarily be a detrimental outcome but may be a surrogate of surgical difficulty.

Previously, Yang et al. tested a tumor size cutoff of 50 mm specifically in a small series of 103 L-LLS, but found no significant discriminative value for perioperative complications. apart from intraoperative blood loss.[20] An important clinical application of our current findings is that it would help guide surgeons embarking on LLR in selecting L-LLS procedures appropriate to their level of experience based on tumor size. Furthermore, these findings should be taken into account when formulating new DSSs in future to enable more accurate discrimination of the complexity of L-LLS and better comparison between outcomes of LLR during surgical audits.

The main limitation of this study is due to its retrospective nature although many centers had a prospective database. Furthermore, as an international multicenter study, there would be heterogeneity in the surgical technique and perioperative management of L-LLS between the different centers. It is also important to note that tumor size in this study was measured based on postoperative pathological specimens which may vary from measurements made based on preoperative imaging.

TABLE 3 Comparison of perioperative outcomes of patients who underwent laparoscopic left lateral sectionectomy, stratified by tumor size

	All N = 1910	Tumor size ≤39 mm N = 1027	Tumor size 40–69 mm N = 528	Tumor size 70–99 mm N = 212	Tumor size ≥100 mm N = 143	Z-statistic and P-value for monotonic trend[a]
Open conversion, n (%)	63 (3.3%)	22 (2.1%)	18 (3.4%)	13 (6.1%)	10 (7.0%)	**Z = 3.90; *P* < .001**
Median operating time (IQR), min	160 (112–215)	155 (105–215)	157 (112–210)	180 (120–220)	180 (126–235)	**Z = 3.84, *P* < .001**
Median blood loss (IQR), ml	100 (50–200)	50 (30–153)	100 (50–200)	100 (50–250)	200 (50–300)	**Z = 6.50; *P* < .001**
Intraoperative blood transfusion, n (%)	60 (3.1%)	19 (1.9%)	16 (3.0%)	11 (5.2%)	14 (9.8%)	**Z = 5.15;*P* < .001**
Pringle maneuver applied, n (%)	365/1868 (19.5%)	157/1011 (15.5%)	99/514 (19.3%)	60 (28.8%)	48/135 (35.6%)	**Z = 6.48; *P* < .001**
Median postoperative stay (IQR), days	5 (3–6)	5 (4–6)	5 (3–6)	5 (3–6)	5 (3–6)	Z = 0.84; *P* = .399
Overall morbidity, n (%)	255/1909 (13.4%)	125/1026 (12.2%)	80/528 (15.2%)	32/212 (15.1%)	18/143 (12.6%)	Z = 0.97; *P* = .330
Major morbidity (Clavien-Dindo grade>2)	52/1909 (2.7%)	24/1026 (2.3%)	12/528 (2.3%)	8/212 (3.8%)	8/143 (5.6%)	**Z = 2.17; *P* = .030**
30-day readmission, n (%)	44/1901 (2.3%)	17/1021 (1.7%)	15/527 (2.8%)	7/211 (3.3%)	5/142 (3.5%)	**Z = 1.99; *P* = .047**
30-day mortality, n (%)	7 (0.4%)	2 (0.2%)	3 (0.6%)	1 (0.5%)	1 (0.7%)	Z = 1.19; *P* = .233
90-day mortality, n (%)	12 (0.6%)	4 (0.4%)	4 (0.8%)	3 (1.4%)	1 (0.7%)	Z = 1.34; *P* = .180
Close margins, n (%)	110/1902 (5.8%)	54/1020 (5.3%)	44/528 (8.3%)	6/212 (2.8%)	6/142 (4.2%)	Z = −0.57; *P* = .571

Note: The bold values indicate statistically significant results.

Abbreviation: IQR, interquartile range.

[a]Two-sided Cochran-Armitage or Jonckheere-Terpstra tests were used to evaluate the presence of a monotonic increasing or decreasing trend over the four tumor size categories, which was treated as an ordinal variable (i.e., Group 1: <40 mm, Group 2: 40–69 mm, Group 3: 70–99 mm, Group 4: ≥100 mm).

Nonetheless, its main strength was the large number of patients analyzed from an international database which allowed robust statistical analysis and providing a wide generalizable experience reflective of contemporary real-world practice.

5 | CONCLUSIONS

In this study, we found that L-LLS for tumors of increasing size was associated with poorer intraoperative and early postoperative outcomes suggesting increasing difficulty of the procedure. We determined three optimal tumor size cutoffs (40-, 70- and 100-mm) which accurately stratified the surgical difficulty of L-LLS.

FUNDING INFORMATION

Dr T. P. Kingham was partially supported by the US National Cancer Institute MSKCC Core Grant number P30 CA008747 for this study.

CONFLICT OF INTEREST

Dr Goh BK has received travel grants and honorarium from Johnson and Johnson, Olympus and Transmedic the local distributor for the Da Vinci Robot. Dr Marino MV is a consultant for CAVA robotics LLC. Johann Pratschke reports a research grant from Intuitive Surgical Deutschland GmbH and personal fees or non-financial support from Johnson & Johnson, Medtronic, AFS Medical, Astellas, CHG Meridian, Chiesi, Falk Foundation, La Fource Group, Merck, Neovii, NOGGO, pharma-consult Peterson, and Promedicis. Moritz Schmelzle reports personal fees or other support outside of the submitted work from Merck, Bayer, ERBE, Amgen, Johnson & Johnson, Takeda, Olympus, Medtronic, Intuitive. Asmund Fretland reports receiving speaker fees from Bayer. Fernando Rotellar reports speaker fees and support outside the submitted work from Integra, Medtronic, Olympus, Corza, Sirtex and Johnson & Johnson.

ORCID

Nadia Russolillo https://orcid.org/0000-0002-0627-186X
Nicholas L. Syn https://orcid.org/0000-0002-6343-176X
Federica Cipriani https://orcid.org/0000-0002-8651-5982
Davit Aghayan https://orcid.org/0000-0001-7051-3512
Marco V. Marino https://orcid.org/0000-0002-0466-4467
Iswanto Sucandy https://orcid.org/0000-0003-2167-3215
Arpad Ivanecz https://orcid.org/0000-0002-1617-9709

Sung-Hoon Choi https://orcid.org/0000-0002-1664-3727
Gi-Hong Choi https://orcid.org/0000-0002-1593-3773
Giovanni Battista Levi Sandri https://orcid.org/0000-0002-7893-5047
Kazateru Monden https://orcid.org/0000-0002-0800-3973
Ho-Seong Han https://orcid.org/0000-0001-9659-1260
Brian K. P. Goh https://orcid.org/0000-0001-8218-4576

REFERENCES

1. Wakabayashi G, Cherqui D, Geller DA, Buell JF, Kaneko H, Han HS, et al. Recommendations for laparoscopic liver resection: a report from the second international consensus conference held in Morioka. Ann Surg. 2015;261(4):619–29.
2. Wakabayashi G. What has changed after the Morioka consensus conference 2014 on laparoscopic liver resection? Hepatobiliary Surg Nutr. 2016;5(4):281–9.
3. Halls MC, Berardi G, Cipriani F, Barkhatov L, Lainas P, Harris S, et al. Development and validation of a difficulty score to predict intraoperative complications during laparoscopic liver resection. Br J Surg. 2018;105(9):1182–91.
4. Kabir T, Syn N, Koh YX, Teo JY, Chung AY, Chan CY, et al. Impact of tumor size on the difficulty of minimally invasive liver resection. Eur J Surg Oncol. 2022;48(1):169–76.
5. Russolillo N, Casella M, Langella S, Lo Tesoriere R, Ossola P, Ferrero A. Correlation between anthropometric data and preparatory maneuvers difficulties during laparoscopic right liver resec-tions: a single center prospective study. Surg Endosc. 2022;36:7343–51.
6. Goh BK, Prieto M, Syn N, Koh YX, Teo JY, Lee SY, et al. Validation and comparison of the Iwate, IMM, Southampton and Hasegawa difficulty scoring systems for primary laparoscopic hepatectomies. HPB. 2021;23:770–6.
7. Cheung TT, Wang X, Efanov M, Liu R, Fuks D, Choi GH, et al. Minimally invasive liver resection for huge (≥10 cm) tumors: an interna-tional multicenter matched cohort study with regression discontinuity analyses. Hepatobiliary Surg Nutr. 2021;10(5):587–97.
8. Goh BK, Kabir T, Syn N. RE: new simple three-level liver resection classification without compromising the performance to predict surgical and postoperative outcomes. Eur J Surg Oncol. 2022;46:303–4.
9. Hasegawa Y, Nitta H, Sasaki A, Takahara T, Ito N, Fujita T, et al. Laparoscopic left lateral sectionectomy as a training procedure for surgeons learning lap-aroscopic hepatectomy. J Hepatobiliary Pancreat Sci. 2013;20(5):525–30.
10. Strasberg SM. Nomenclature of hepatic anatomy and resections: a review of the Brisbane 2000 system. J Hepatobiliary Pancreat Surg. 2005;12(5):351–5.
11. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004;240(2):205–13.
12. Buell JF, Cherqui D, Geller DA, O'Rourke N, Iannitti D, Dagher I, et al. World consensus conference on laparoscopic surgery. The international position on laparoscopic liver surgery: the Louisville statement, 2008. Ann Surg. 2009;250(5):825–30.
13. Abu Hilal M, Aldrighetti L, Dagher I, Edwin B, Troisi RI, Alikhanov R, et al. The Southampton consensus guidelines for laparoscopic liver surgery: from indication to implementation. Ann Surg. 2018;268(1):11–8.
14. Kabir T, Syn NL, Guo Y, Lim KI, Goh BKP. Laparoscopic liver resection for huge (≥10 cm) hepatocellular carcinoma: a coarsened exact-matched single-surgeon study. Surg Oncol. 2021;37:101569.
15. Goh BKP, Lee SY, Koh YX, Kam JH, Chan CY. Minimally invasive major hepatectomies: a southeast Asian single institution contemporary experience with its first 120 consecutive cases. ANZ J Surg. 2020;90(4):553–7.
16. Goh BKP, Lee SY, Teo JY, Kam JH, Jeyaraj PR, Cheow PC, et al. Changing trends and outcomes associated with the adoption of minimally invasive hepatectomy: a contemporary single-institution experience with 400 consecutive resections. Surg Endosc. 2018;32(11):4658–65.
17. Kawaguchi Y, Hasegawa K, Wakabayashi G, Cherqui D, Geller DA, Buell JF, et al. Survey results on daily practice in open and laparoscopic liver resections from 27 centers participating in the second international consensus con-ference. J Hepatobiliary Pancreat Sci. 2016;23(5):283–8.
18. Wang HP, Yong CC, Wu AG, Cherqui D, Troisi RI, Cipriani F, et al. Factors associated with an impact of open conversion on the outcomes of minimally-invasive left lateral sectionectomies: an international multicenter study. Surgery. 2022;172:617–24.
19. Ivanecz A, Plahuta I, Magdalenic T, Ilijevec B, Mencinger M, Peruš I, et al. Evaluation of the Iwate model for predicting the difficulty of laparoscopic liver resection: does tumor size matter? J Gastrointest Surg. 2021;25:1451–60.
20. Yang TH, Chen JL, Lin YJ, Chao YJ, Shan YS, Hsu HP, et al. Laparoscopic surgery for large left lateral liver tumors: safety and oncologic outcomes. Surg Endosc. 2018;32(10):4314–20. https://doi.org/10.1007/s00464-018-6287-9

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Aizza G, Russolillo N, Ferrero A, Syn NL, Cipriani F, Aghayan D, et al. Impact of tumor size on the difficulty of laparoscopic left lateral sectionectomies. J Hepatobiliary Pancreat Sci. 2022;00:1–12. https://doi.org/10.1002/jhbp.1279

APPENDIX A

International robotic and laparoscopic liver resection study group investigators

Chung-Yip Chan (Department of Hepatopancreatobiliary and Transplant Surgery, Singapore General Hospital). Mikel Prieto (Hepatobiliary Surgery and Liver Transplantation Unit, Biocruces Bizkaia Health Research Institute, Cruces University Hospital, University of the Basque Country, Bilbao, Spain). Juul Meurs (Department of Digestive and Hepatobiliary/Pancreatic Surgery, Groeninge Hospital, Kortrijk, Belgium). Celine De Meyere (Department of Digestive and Hepatobiliary/Pancreatic Surgery, Groeninge Hospital, Kortrijk, Belgium) (Department of Surgery, AZ Groeninge Hospital, Kortrijk, Belgium). Felix Krenzien (Department of Surgery, Campus Charité Mitte and Campus Virchow-Klinikum, Charité-Universitätsmedizin, Corporate Member of Freie Universität Berlin, and Berlin Institute of Health, Berlin, Germany). Moritz Schmelzle (Department of Surgery, Campus Charité Mitte and Campus Virchow-Klinikum, Charité-Universitätsmedizin, Corporate Member of Freie Universität Berlin, and Berlin Institute of Health, Berlin, Germany). Kit-Fai Lee (Division of Hepatobiliary and Pancreatic Surgery, Department of Surgery, Prince of Wales Hospital, The Chinese University of Hong Kong, New Territories, Hong Kong SAR, China). Kelvin K. Ng (Division of Hepatobiliary and Pancreatic Surgery, Department of Surgery, Prince of Wales Hospital, The Chinese University of Hong Kong, New Territories, Hong Kong SAR, China). Diana Salimgereeva (Department of Hepato-Pancreato-Biliary Surgery, Moscow Clinical Scientific Center, Moscow, Russia). Ruslan Alikhanov (Department of Hepato-Pancreato-Biliary Surgery, Moscow Clinical Scientific Center, Moscow, Russia). Lip-Seng Lee (Hepatopancreatobiliary Unit, Department of Surgery, Changi General Hospital, Singapore). Jae Young Jang (Department of General Surgery, CHA Bundang Medical Center, CHA University School of Medicine, Seongnam, Korea). Kevin P. Labadie (Department of Surgery, University of Washington Medical Center. Seattle, USA). Yutaro Kato (Department of Surgery, Fujita Health University School of Medicine, Aichi, Japan). Masayuki Kojima (Department of Surgery, Fujita Health University School of Medicine, Aichi, Japan). Asmund Avdem Fretland (The Intervention Centre and Department of HPB Surgery, Oslo University Hospital, Institute of Clinical Medicine, University of Oslo, Oslo, Norway). Jacob Ghotbi (The Intervention Centre and Department of HPB Surgery, Oslo University Hospital, Institute of Clinical Medicine, University of Oslo, Oslo, Norway). Fabricio Ferreira Coelho (Liver Surgery Unit, Department of Gastroenterology, University of Sao Paulo School of Medicine, Sao Paulo, Brazil). Jaime Arthur Pirola Kruger (Liver Surgery Unit, Department of Gastroenterology, University of Sao Paulo School of Medicine, Sao Paulo, Brazil). Victor Lopez-Lopez (Department of General, Visceral and Transplantation Surgery, Clinic and University Hospital Virgen de la Arrixaca, IMIB-ARRIXACA, El Palmar, Murcia, Spain). Paolo Magistri (HPB Surgery and Transplantation Unit, United Hospital of Ancona, Department of Sperimental and Clinical Medicine Polytechnic University of Marche. Ancona, Italy). Margarida Casellas I Robert (Hepatobiliary and Pancreatic Surgery Unit, Department of Surgery, Dr. Josep Trueta Hospital, IdIBGi, Girona, Spain). Kohei Mishima (Center for Advanced Treatment of Hepatobiliary and Pancreatic Diseases, Ageo Central General Hospital, Saitama, Japan). Roberto Montalti (Department of Clinical Medicine and Surgery, Division of HPB, Minimally Invasive and Robotic Surgery, Federico II University Hospital Naples, Naples, Italy). Mariano Giglio (Department of Clinical Medicine and Surgery, Division of HPB, Minimally Invasive and Robotic Surgery, Federico II University Hospital Naples, Naples, Italy). Alessandro Mazzotta (Department of Digestive, Oncologic and Metabolic Surgery, Institute Mutualiste Montsouris, Universite Paris Descartes, Paris, France). Boram Lee (Department of Surgery, Seoul National University Bundang Hospital, Seoul National University College of Medicine, Seoul, Korea). Mizelle D'Silva, (Department of Surgery, Seoul National University Bundang Hospital, Seoul National University College of Medicine, Seoul, Korea). Hao-Ping Wang (Department of Surgery, Chang Gung Memorial Hospital, Kaohsiung). Mansour Saleh (Department of Hepatobiliary Surgery, Assistance Publique Hopitaux de Paris, Centre Hepato-Biliaire, Paul-Brousse Hospital, Villejuif, France). Franco Pascual (Department of Hepatobiliary Surgery, Assistance Publique Hopitaux de Paris, Centre Hepato-Biliaire, Paul-Brousse Hospital, Villejuif, France). Amal Suhool (Department of Surgery, Fondazione Poliambulanza, Brescia, Italy). Phan Phuoc Nghia (Department of Surgery, University Medical Center, Ho Chi Minh City, Vietnam). Chetana Lim, (Department of Digestive, HBP and Liver Transplantation, Hopital Pitie-Salpetriere, Sorbonne Universite, Paris, France). Qiu Liu (Faculty of Hepatopancreatobiliary Surgery, The First Medical Center of Chinese People's Liberation Army (PLA) General Hospital, Beijing, China). Prashant Kadam (Department of Hepatopancreatobiliary and Liver Transplant Surgery, University Hospitals Birmingham NHS Foundation Trust, Birmingham, United Kingdom). Bernardo Dalla Valle (General and Hepatobiliary Surgery, Department of Surgery, Dentistry, Gynecology and Pediatrics University of Verona, GB Rossi Hospital, Verona, Italy). Eric C. Lai (Department of Surgery, Pamela Youde Nethersole Eastern Hospital, Hong Kong SAR, China). Maria Conticchio (Unit of Hepato-Pancreatc-Biliary Surgery, "F. Miulli" General Regional Hospital, Acquaviva delle Fonti, Bari, Italy). Ugo Giustizieri (HPB Surgery, Hepatology and Liver Transplantation, Fondazione IRCCS Istituto Nazionale Tumori di Milano, Milan, Italy). Davide Citterio (HPB Surgery, Hepatology and Liver Transplantation, Fondazione IRCCS Istituto Nazionale Tumori di Milano, Milan, Italy). Zewei Chen (Department of Hepatobiliary Surgery, Affiliated Jinhua Hospital, Zhejiang University School of Medicine, Jinhua, China). Shian Yu (Department of Hepatobiliary Surgery, Affiliated Jinhua Hospital, Zhejiang University School of Medicine, Jinhua, China). Francesco Ardito (Hepatobiliary Surgery Unit, Fondazione Policlinico Universitario A. Gemelli, IRCCS, Catholic University of the Sacred Heart, Rome, Italy). Simone Vani (Hepatobiliary Surgery Unit, Fondazione Policlinico Universitario A. Gemelli, IRCCS, Catholic University of the Sacred Heart, Rome, Italy). Epameinondas Dogeas (Department of Surgery, Division of Hepatobiliary and Pancreatic Surgery, University of Pittsburgh Medical Center, Pittsburgh, PA, USA). Tiing Foon Siow (Division of General Surgery, Department of Surgery, Far Eastern Memorial Hospital, New Taipei City, Taiwan). Federico Mocchegianni (HPB Surgery and Transplantation Unit, United Hospital of Ancona, Department of Sperimental and Clinical Medicine Polytechnic University of Marche, Ancona, Italy). Giuseppe Maria Ettorre (Division of General Surgery and Liver Transplantation, S. Camillo Hospital, Rome, Italy). Marco Colasanti (Division of General Surgery and Liver Transplantation, S. Camillo Hospital, Rome, Italy). Yoelimar Guzmán (General & Digestive Surgery, Hospital Clínic, Barcelona, Spain).