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Original Article

A Rookie in Laparoscopic Liver Resections: Initial Performance of 22 Cases at Lampang Regional Hospital

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Abstract

Objective: To review the initial 22 cases of laparoscopic liver resections (LLRs) by a general surgeon to enhance the quality of patient care and implementation for the broader medical community in the northern region of Thailand.

Materials and Methods: This descriptive retrospective study analyzes the author's liver surgery registry data from August 2018 to December 2023. Patients included underwent LLRs for various provisional diagnoses. All received computed tomography (CT) triple-phase liver protocol scans to assess provisional diagnosis and resectability. The IWATE score was used to evaluate procedural difficulty, and inflow control techniques were identified.

Results: A total of 22 patients underwent LLRs between August 2018 and December 2023, with a mean age of 63.8 ± 13.8 years; 68.2% were male. Most patients were classified as Child Turcotte Pugh (CTP) A. The most common preoperative and postoperative diagnosis was hepatocellular carcinoma (HCC). The mean IWATE score was 5.6 ± 2.2, and 40.9% of the surgeries were classified as major procedures. The most common resection was left hepatectomy, while the procedure with the highest difficulty score was anterior sectionectomy for HCC. Estimated blood loss was 125 [100, 300] milliliters, and the mean operative time was 4.1 hours ± 105.9 minutes. One patient died postoperatively due to a ruptured abdominal aortic aneurysm (rAAA).

Conclusion: LLRs are feasible for surgeons with a learning curve. IWATE difficulty scoring can assist surgeons in deciding on minimally invasive surgery, albeit with some limitations.

Keywords: Laparoscopic, Liver resection, Minimally invasive surgery, Resources

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Introduction

Laparoscopic liver resection (LLR) emerged as a groundbreaking surgical technique in 1991 and has since been accepted as an alternative operation in liver surgery.[1] By 1996, formal LLRs were revolutionized by a Japanese group, making a significant advancement in hepatobiliary surgery.[2] A comprehensive review has outlined the historical evolution of LLRs, highlighting key milestones and challenges encountered in the first 25 years, which paved the way for modern surgical innovations.[3]

Despite these advancements, the adoption of laparoscopic techniques in liver resection has progressed more slowly compared to other areas of laparoscopic surgery. The primary challenges include technical difficulties, particularly in controlling bleeding. To aid decision-making, various scoring systems have been developed to assess the complexity of LLRs. These systems typically consider factors such as tumor location, size, liver function, and proximity to major vessels, stratifying cases into different levels of difficulty.[4-6] Over the past two decades, LLRs have demonstrated their safety, resulting in reduced bleeding, shorter hospital stays, and fewer complications.[7-9] As a result, new-generation surgeons are encouraged to practice LLRs, though mastering the learning curve remains essential.

This study provides a comprehensive analysis of the first 22 patients who underwent LLRs in Lampang Regional Hospital by a general surgeon. The aim is to enhance the quality of patient care and facilitate the broader implementation of LLR techniques within the medical community in northern Thailand.

Materials and Methods

Participants

This descriptive study retrospectively reviewed data from the author's personal liver surgery registry, covering the period from August 2018 to December 2023. All patients included in the study were admitted to the general surgical ward at Lampang Regional Hospital. Data were collected from electrical medical records (EMR). The study received Ethical approval from the institutional review board (IRB) number EC 012/67.

Eligible participants in the study included all patients who underwent LLRs. There were no exclusion criteria. Demographic characteristics and laboratory findings were collected from each patient. All patients underwent a computed tomography (CT) triple-phase liver protocol scan to assess provisional diagnosis and resectability.

Operative considerations

The difficulty of each operation was classified by the IWATE criteria score,[10] which ranges from 0 to 12, based on six clinical parameters: tumor location, extent of hepatic resection, tumor size, proximity to a major vessel, liver function, and the use of hand-assisted laparoscopic surgery (HALS) or hybrid techniques. The difficulty levels were stratified into four categories: low (0 - 3), intermediate (4 - 6), advanced (7 - 9), and expert (10 - 12). Each patient's CT scan was evaluated, and an IWATE score was recorded to determine the feasibility of undergoing LLRs, with informed consent obtained from the patients.

Patients undergoing LLRs were positioned supine under general anesthesia (GA). Central lines were used in major hepatectomies for close hemodynamic monitoring. The surgical technique employed was developed during fellowship training, complemented by novel techniques from the literature, and adapted to the hospital's available resources.

A 12-mm camera port was inserted using an open technique at the vertical line above the umbilicus, followed by sequential placement of 5-mm, 12-mm, and 5-mm subcostal ports. After completing the cholecystectomy, an additional port was adjusted along the left costal margin under laparoscopic visualization. Carbon dioxide (CO_2) gas insufflation was maintained at 12 - 15 mmHg. The working port position was adjusted by direct visualization depending on liver position and parenchymal transection line. The variation of the port placement is demonstrated in Figure 1. A 12-mm working port was positioned at the transection line for intraoperative ultrasound (IOUS), and a Cavitron ultrasonic surgical aspirator (CUSA: Sonoca300, Soring GmbH), with a 5-mm port at another location. IOUS was used to assess transection margins, hepatic venous guidance, and any remaining lesions in the liver parenchyma.

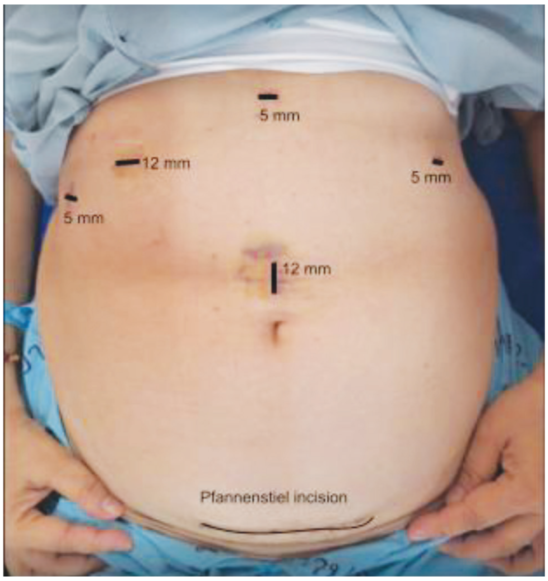

Figure 1 Port position for standard hepatectomy procedure; Right subcostal 5 mm and 12 mm port primarily performing cholecystectomy and parenchymal transection. Epigastric port 5 mm is employed for dissecting around the hepatocaval confluence and conducting parenchymal transection in the cephalad direction. The left subcostal 5 mm port serves the purpose of liver traction. When using an Endostapler for transecting the portal pedicle or hepatic vein, both 12mm ports (the camera port and the right subcostal port) are utilized to ensure the Endostapler is properly positioned.

For inflow control, Pringle's maneuver was prepared for inflow control by occluding the hepatoduodenal ligament. Inflow control approaches varied based on anatomical variations: the extrahepatic Glissonean pedicle method for standard hepatectomy and anterior sectionectomy (Figure 2), hilar dissection for lymph node dissection, and transfissural approach for lateral sectionectomy or masses near the Glissonean pedicle (Figure 3).

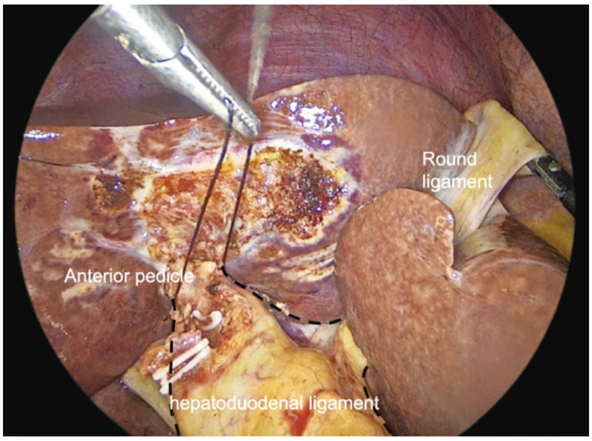

Figure 2 Extrahepatic glissonean approach in anterior sectionectomy

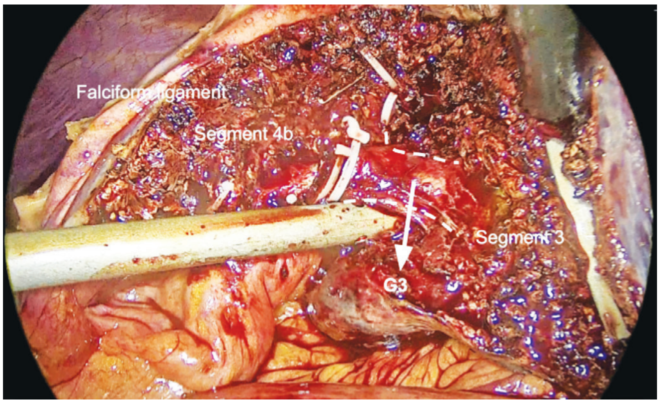

Figure 3 Transfissural approach in lateral sectionectomy. G3 = Glissonean pedicle of segment 3.

The inflow was effectively controlled by the Huang loop, eliminating the need for an Endobulldog. Huang loop was particularly useful for selective inflow control, especially the right and left portal pedicles.

After achieving inflow and mobilizing the liver, parenchymal transection was performed by CUSA, a bipolar sealing device (LIGASURE, Medtronic), and ultrasonic scissors for clamp crushing techniques. During this phase, patients were repositioned by the anesthesiologist, with their heads and legs elevated to reduce back bleeding from the outflow. The positive end-expiratory pressure (PEEP) was set to zero, and central venous pressure (CVP) was lowered to 3 – 5 mmHg while ensuring urine output and maintaining systolic blood pressure. The Glissonean pedicles and hepatic veins were divided using Echelon 60 Flex (Ethicon Endosurgery), With the Hepatic vein serving as a parenchymal guide in major hepatectomy (Figures 4 and 5). The smaller inflow vessels and hepatic veins were secured with double Hem-O-lock clips. Endostapler tools were essential for the safe and efficient division of vascular structures during the operation. The thick cartridges (ECHELON blue cartridge and COVIDIEN tri-stapler purple cartridge) were used for hepatic portal pedicle division, while thinner cartridges (ECHELON white cartridge and COVIDIEN tri-stapler gray cartridge) were employed for smaller hepatic veins.

Specimens were enclosed in plastic bags and extracted through the camera port extension. For larger specimens, a Pfannenstiel incision was made to facilitate removal. Negative pressure drains were placed intraperitoneally in all cases.

Figure 4 Hepatic vein guidance parenchymal transection in left hepatectomy. The Dot line is the transaction line that follows the medial aspect of the middle hepatic vein. (MHV=middle hepatic vein)

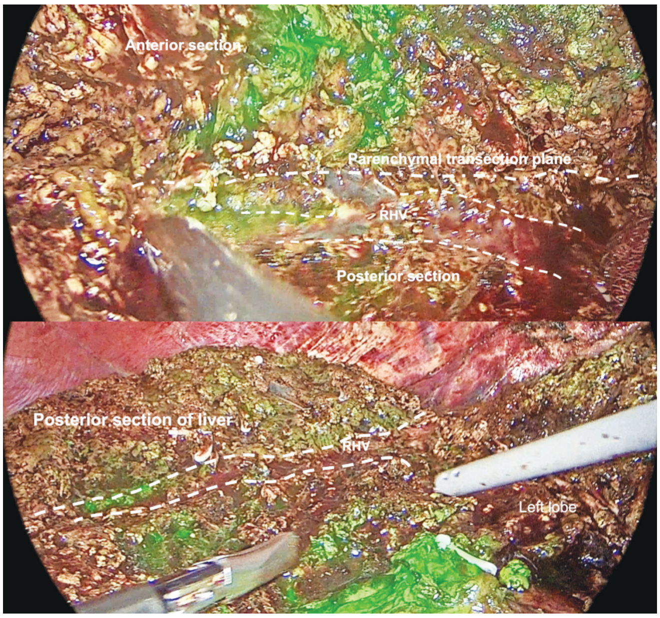

Figure 5 Demonstrated RHV guidance in anterior sectionectomy. Indocyanin green dye (Diagnogreen) was injected intravenous intraoperatively after selective portal pedicle clamping with a negative staining technique. After complete transection in midplane, the liver was transected from medial to lateral, guided by the right hepatic vein (upper). The right hepatic vein was barely seen after complete transection (lower). RHV = right hepatic vein.

Statistical Analysis

Categorical data were presented as frequencies and percentages. For data with a normal distribution, we calculated the mean and standard deviation (SD). Skewed data were reported using median and interquartile range (IQR). All statistical analyses were conducted using STATA version 16 (StataCorp. 2019. Stata Statistical Software: Release 16. College Station, TX: StataCorp LLC).

Results

Data were collected between August 2018 and December 2023 by the author, who also served as the operating surgeon. A total of 22 patients underwent laparoscopic liver surgery. The mean age of the patients was 63.8 ± 13.8 years, and 68.2% of them were male. Most patients were classified as Child Turcotte Pugh (CTP) class A, with only one patient classified as CTP class B. Details of underlying diseases and laboratory findings are presented in Table 1.

Table 1 Baseline characteristics of the patients who underwent laparoscopic liver resections

Parameters	Missing data, n (%)	Total, n = 22
Age, years (mean ± SD)	1 (4.6)	63.8 ± 13.8
Male sex, n (%)	0 (0.0)	15 (68.2)
Diabetic mellitus type 2, n (%)	1 (4.6)	5 (23.8)
Cirrhosis, n (%)	0 (0.0)	8 (36.4)
Laboratory findings:		
Albumin, g/dL (mean ± SD)	1 (4.6)	4.0 ± 0.5
Total Bilirubin, mg/dL [median, IQR]	1 (4.6)	0.5 [0.5, 0.7]
INR (mean ± SD)	1 (4.6)	1.1 ± 0.1
BUN, mg/dL (mean ± SD)	1 (4.6)	15.5 ± 6.1
Creatinine, mg/dL (mean ± SD)	1 (4.6)	1.0 ± 0.5

SD = standard deviation; g = gram; dL = deciliter; IQR = interquartile range; INR = international normalized ratio; BUN = blood urea nitrogen

The major preoperative diagnosis was HCC, accounting for 63.7% of cases, followed by IPNB and CRLM. The most common postoperative diagnosis remained HCC, at 54.6%. Detailed characteristics of diseases are provided in Table 2.

Table 2 Disease characteristics of the patients who underwent laparoscopic liver resections

Parameters	Missing data, n (%)	Total, n = 22
Preoperative diagnoses:	0 (0.0)	
HCC, n (%)	-	14 (63.6)
IPNB, n (%)	-	4 (18.2)
CRLM, n (%)	-	2 (9.1)
ICCA, n (%)	-	1 (4.6)
Liver nodule, n (%)	-	1 (4.6)
Postoperative diagnoses:	0 (0.0)	
HCC, n (%)	-	12 (54.6)
ICCA, n (%)	-	2 (9.1)
CRLM, n (%)	-	2 (9.1)
Liver nodule, n (%)	-	1 (4.6)
Abscess, n (%)	-	1 (4.6)
Chronic cholangitis, n (%)	-	1 (4.6)
Biliary cyst, n (%)	-	1 (4.6)
Adenoma, n (%)	-	1 (4.6)
Dilated duct with inflammation, n (%)	-	1 (4.6)

HCC = hepatocellular carcinoma; IPNB = intraductal papillary neoplasm of bile duct; CRLM = colorectal liver metastasis; ICCA = intrahepatic cholangiocarcinoma

The mean IWATE score for procedural difficulty was 5.6 ± 2.2. The difficulty levels were classified as low (27.3%), intermediate (45.5%), advanced (22.7%), and expert (4.6%). Major procedures accounted for 40.9% of operations. The most common resection performed was left hepatectomy (27.3%), followed by wedge resections (18.2%) and anatomical resections (18.2%). The procedure with the highest difficulty score was anterior sectionectomy for HCC, measuring 4.7 cm in segments 5 and 8. The median tumor size was 2.6 cm [1.8, 5.4], with a maximum size of 9 cm. The median waiting time was 36 days [32, 42].

During surgery, the surgeon achieved inflow control in 15 out of 22 cases (68.2%) using extrahepatic Glissonean pedicles (46.7%), transfissural approaches (40.0%), and hilar dissection (13.3%). All hilar dissections were performed for patients diagnosed with ICCA. Initially, extracorporeal Pringle's maneuver was performed using umbilical tape encircling the hepatoduodenal ligament, with both tape ends externalized through an 18 French nasogastric tube alongside a 5 mm working port channel.[11] Later, it was modified using a Foley catheter sling.[12] The median Pringle time was 30 minutes [25, 60]. The estimated blood loss during operation was 125 mL [100, 300], and the mean operative time was 4.1 hours ± 105.9 minutes. Intraoperative findings revealed no macroinvasion. Detailed operative characteristics are presented in Table 3.

Table 3 Operative characteristics of the patients who underwent laparoscopic liver resections

Parameters	Missing data, n (%)	Total, n = 22
IWATE score:	0.0	
Mean ± SD	-	5.6 ± 2.2
Low, n (%)	-	6 (27.3)
Intermediate, n (%)	-	10 (45.5)
Advanced, n (%)	-	5 (22.7)
Expert, n (%)	-	1 (4.6)
Operations:	0 (0.0)	
Major, n (%)	-	9 (40.9)
Left hepatectomy, n (%)	-	6 (27.3)
Wedge resection, n (%)	-	4 (18.2)
Anatomical resection, n (%)	-	4 (18.2)
Lateral sectionectomy, n (%)	-	3 (13.6)
Right hepatectomy, n (%)	-	2 (9.1)
Segmentectomy, n (%)	-	2 (9.1)
Anterior sectionectomy, n (%)	-	1 (4.6)
Tumor size, cm [median, IQR]	6 (27.3)	2.6 [1.8, 5.4]
Waiting time, days [median, IQR]	13 (59.1)	36 [32, 42]
Pringle time, minutes [median, IQR]	0 (0.0)	30 [25, 60]
Estimated blood loss, ml [median, IQR]	0 (0.0)	125 [100, 300]
Operative time, minutes (mean ± SD)	0 (0.0)	265 ± 105.9
Macroinvasion, n (%)	1 (4.6)	0 (0.0)

SD = standard deviation; cm = centimeters; IQR = interquartile range; ml = milliliters

Postoperative outcomes are detailed in Table 4. The mean length of stay was 6.9 ± 2.7 days. The median ICU stay was 1 day [0, 1], with a maximum stay of 3 days. There were no cases of post-hepatectomy liver failure or recurrence. The most common postoperative complication was atelectasis (13.6%), which required physiotherapy. One patient was converted to open surgery due to uncontrolled portal pedicle bleeding with associated hypotension.

Ascites developed in one patient post-surgery, which was resolved with prolonged drainage and diuretic therapy. Another patient experienced a Class II complication involving bile leakage, which was treated with antibiotics and extended drainage. Eight patients required postoperative critical care in the surgical intensive care unit (ICU). No patients received neoadjuvant treatment before surgery.

Most resection margins in final pathological reports were free from malignancy, except for one case with a positive hepatic duct margin indicating malignant IPNB. Mortality occurred in 1 of 22 patients (5.3%) due to rupture abdominal aortic aneurysm (rAAA).

Table 4 Postoperative characteristics of the patients who underwent laparoscopic liver resections

Parameters	Missing data, n (%)	Total, n = 22
Length of stay, days (mean ± SD)	1 (4.6)	6.9 ± 2.7
ICU stay, days [median, IQR]	0 (0.0)	0 [0, 1]
Posthepatectomy liver failure, n (%)	2 (9.1)	0 (0.0)
Recurrence, n (%)	2 (9.1)	0 (0.0)
Clavien-Dindo Complication Classification[13]	2 (9.1)	
No complication, n (%)	-	15 (75.0)
Grade I, n (%)	-	1 (5.0)
Grade II, n (%)	-	3 (15.0)
Grade III, n (%)	-	1 (5.0)
Grade IV, n (%)	-	0 (0.0)
Mortality, n (%)	3 (13.6)	1 (5.3)

SD = standard deviation; ICU = intensive care unit; IQR = interquartile range

Discussion

Laparoscopic surgery has long been recognized as safe and feasible[14] for various abdominal procedures, including liver resections. It offers advantages such as reduced hospital stay, less postoperative pain, and quicker recovery time.[15] Importantly, LLRs did not increase mortality or readmission rates and proved to be cost-effective. Since 2009, the popularity of LLRs has surged, with over 9,000 cases performed worldwide.[7] The Enhanced Recovery after Surgery (ERAS) Society recommends minimally invasive surgery combined with multimodal analgesia to reduce postoperative complications.[16] However, LLRs demand expertise in hepatobiliary anatomy, experience in controlling intraoperative hepatic vascular bleeding, and proficiency with laparoscopic equipment.[17] The learning curve for major laparoscopic hepatectomy is estimated to be 45-60 cases.[18]

At our institution, surgeons perform over 50 open liver resections annually, with a total of 250 cases conducted by the author, who initiated LLRs with the first 22 cases since 2018 during the early learning curve. This study aims to review the safety of LLRs at a resource-limited institute, improve patient care quality, and share experiences with young surgeons interested in establishing LLRs in their practices.

The author began with patients diagnosed with resectable HCC due to its high prevalence and lower procedural complexity compared to CCA, which requires lymphadenectomy. The IWATE difficulty scoring system was employed in this study to stratify the difficulty level and aid in decision-making. Most cases were classified as low to intermediate difficulty, yielding satisfactory outcomes, including acceptable estimated blood loss (EBL), operative time, length of stay, and mortality. Complication-free recovery was observed in 75% of patients, with only one case converted to open surgery due to bleeding. There were no reoperations.

The author recommends that young surgeons start with patients who have a low IWATE score to build competency. The learning curve for surgeons performing LLRs with low IWATE scores warrants further study.

This study has limitations. Firstly, being retrospective in nature, there was some missing data and potential recall bias. Secondly, the small sample size limited the potential for more advanced statistical analyses. Future studies should explore external validation of difficulty scoring systems and include time-to-event or decision analysis based on registry data. Lastly, since the operations were performed by a single surgeon, future research could include LLRs from multicenter to help generalize the impact of surgical skills.

Conclusion

LLRs are a feasible option for surgeons who are on the learning curve, and the IWATE difficulty scoring system can assist them in deciding whether to perform minimally invasive surgery, although it has some limitations.

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