Original Article

Outcomes of Laparoscopic Hepatectomies at Rajavithi Hospital: 10-Year Experience

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Objective: The present study aimed to review the outcomes of 10 years' experience of laparoscopic hepatectomies at Rajavithi Hospital, a supertertiary hospital.

Materials and Methods: The medical records were reviewed of all patients who underwent laparoscopic hepatectomy at Rajavithi Hospital between January 2006 and December 2015. The outcomes of laparoscopic hepatectomies, the rates of conversion to open procedures, postoperative complications, and patient survival were analyzed.

Results: A total of 127 patients underwent laparoscopic hepatectomy, but medical records were complete in only 90 cases. Most of the patients were males (63.3%) diagnosed with malignant diseases and with many underlying disorders. The most common diseases were hepatocellular carcinoma, HCC, (44.4%), and colorectal liver metastasis (32.2%). Major hepatectomy was performed in one third of patients. The rate of conversion to open procedures was 32.2%, the median blood loss was 900 mL, and median length of hospital stay was 6.5 days. Post-operative complications were occurred in 21.1% of patients, with respiratory complications being the most common. The thirty-day mortality rate was 3.3%.

Conclusion: The conversion rates of our series were relatively high, probably because the majority of our subjects were complicated malignancy patients. To improve the outcomes, selecting patients using appropriate criteria and multidisciplinary care is essential.

Keywords: Laparoscopic hepatectomy, Hepatectomy, Hepatocellular carcinoma, Cholangicarcinoma, Liver metastasis

J Med Assoc Thai 2019;102(Suppl.4):1-5
Website: http://www.jmatonline.com

Hepatobiliary diseases are the leading problems that require surgical treatment with liver resection in most tertiary medical centers. These diseases can be categorized into malignant conditions, such as hepatocellular carcinoma (HCC), cholangiocarcinoma and metastatic tumor, and benign conditions such as hepatic adenoma. Liver resection was first successfully performed by Carl Johann August Langenbuch in 1888[1]. He resected a part of the left lobe of the liver by means of exploratory laparotomy, and this has become the standard treatment for patients with hepatobiliary diseases requiring surgical liver resection. Nevertheless, some drawbacks, such as wound pain, can result from this invasive procedure. After laparoscopic cholecystectomy was successfully carried out in 1985 by Erich Muhe[2], minimally-invasive approaches in other operations, including liver resection, were attempted. In 1991, Reich et al performed the first successful laparoscopic liver resection[3], and later, in 1992, Gagner et al performed laparoscopic resection of a larger liver tumor[4]. The first anatomical laparoscopic liver resection was reported by Azagra et al in 1996[5]. Finally, the first major laparoscopic hepatic resection was successfully conducted by Huscher et al in 1998[6]. Since then, minimally-invasive liver resection has been adopted by many medical centers around the world. In 2008, a consensus meeting on laparoscopic liver resection was held in Louisville, and a consensus was drawn up, known as the "Louisville Statement"[7]. Laparoscopic liver resection now has gained more acceptance in the surgical community and has become the standard surgery in minor liver resection such as left lateral sectionectomy. In the early period, laparoscopic liver resection was performed in patients with benign conditions, but after the technique became established, laparoscopic liver resection was employed in malignant conditions as well. Rajavithi Hospital has been using laparoscopic liver resection since 2006 when the first laparoscopic left lateral sectionectomy was successfully performed using a pure laparoscopic technique. Then major laparoscopic liver resection was performed using a hand-assisted laparoscopic technique. Finally, after a learning period, major laparoscopic liver resection was successfully carried out employing the pure laparoscopic technique in 2009. The present study aimed to review the outcomes of 10 years' experience of laparoscopic hepatectomies between 2006 and 2015 at Rajavithi Hospital.

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Materials and Methods

After the research proposal was approved by the

How to cite this article: Treepongkaruna S, Bangkhao S, Chaiyabutr K, Subwongcharoen S. Outcomes of Laparoscopic Hepatectomies at Rajavithi Hospital: 10-Year Experience. J Med Assoc Thai 2019;102(Suppl.4):1-5.

Institution Review Board (No. 175/2558), the medical records were reviewed of all patients who underwent laparoscopic hepatectomy at Rajavithi Hospital from January 2006 to December 2015. The procedure was performed by three hepatobiliary surgeons, and data collected included indications for surgery, types of resection, operative time, intra-operative blood loss, length of hospital stay, conversion to open procedures, post-operative complications, 30-day mortality rates, 1-year, 3-year and 5-year survival and rates of recurrence of disease. Primary outcomes were short- and long-term results of laparoscopic hepatectomy, rates of conversion to open procedures, and post-operative complications. Secondary outcomes were 1-year, 3-year and 5-year survival rates. The data were divided into two periods for comparison. The first period was from 2006 to 2011, and the second from 2012 to 2015. Major hepatectomy was defined as liver resection of more than 2 hepatic segments, such as right or left hepatectomy. Minor hepatectomy was defined as liver resection of 2 or fewer segments or non-anatomical resection.

Statistical analysis

The results were expressed as percentage, median (range), mean (standard deviation). Statistical comparison between data in the two periods was performed by Student's t-test in the case of normal data distribution. For data that did not have normal distribution, Man Whitney U-test was used for comparison. A *p*-value of below 0.05 was considered statistically significant. The IBM SPSS Statistics version 22 was used.

Results

Between January 2006 and December 2015, laparoscopic hepatectomies were performed in 127 patients at Rajavithi Hospital. Medical records of 37 patients were incomplete (most of these had laparoscopic hepatectomy in 2006 and 2007); therefore, only the remaining 90 patients were included in the study. Demographic data are shown in Table 1.

Indications for laparoscopic hepatectomy were malignant tumors in 83.3% of cases, benign tumors in 11.1% and intrahepatic duct stone in 5.6%. HCC was the leading indication with 40 cases (44.4%), followed by metastatic tumors in 29 patients (32.2%) and cholangiocarcinoma in 6 cases (6.7%). Indications for benign tumors consisted of 5 cases of cystadenoma (5.6%), 4 of hepatic adenoma (4.4%) and one case of intraductal papillary mucinous neoplasm of bile duct.

Anatomic resection was the most common type of successful laparoscopic liver resection with 61 cases (29 were conversions). Of these 61 cases, 51 were anatomical liver resections leading by right hepatectomy in 17 cases, segmentectomy in 15, left lateral sectionectomy in 13, left hepatectomy in 4, extended right hepatectomy in 1 case and caudate hepatectomy in another case. Non-anatomical liver resection, such as wedge liver resection, was successfully performed in 10 cases, including one first single-port left lateral sectionectomy.

Rates of conversion for each diagnosis were as follows: HCC 36.8% (14 out of 38 cases); colorectal liver metastasis 31.6% (6 out of 19); cholangiocarcinoma 33.3% (2 out of 6); intrahepatic duct stones 60% (3 out of 5); regenerative nodule 66.7% (2 out of 3); and cystadenoma 20% (one out of five cases).

The peri-operative outcomes of laparoscopic hepatectomy were as follows: median operative time was 285 minutes; median blood loss was 900 mL; median volume of packed red cell transfusion was 219.5 mL; and median length of stay was 6.5 days (Table 2).

When comparing the peri-operative outcomes of laparoscopic hepatectomy during the first (n = 43) and second (n = 47) periods, the better results were demonstrated during the latter in terms of operative time, blood loss, packed red cell transfusion, and length of hospital stay. However, the difference between these parameters were not statistically significant with the exception of the length of hospital stay ($p = 0.01$) (Table 3).

Subgroup analysis was performed according to the types of liver resection in the two periods which showed no difference in peri-operative outcomes in either major or minor liver resection (Table 4 and 5). The peri-operative results of patients who underwent conversion from laparoscopic to

Table 1. Demographic data (n = 90)

Characteristics	Values
Sex, n (%)	
Male	57 (63.3)
Female	33 (36.7)
Age (years), mean±SD	58.90±12.00
Body mass index (kg/m^2), mean (range)	23 (20.60 to 24.20)
Underlying diseases, %	
Hepatitis B carrier	23.3
Hypertension	20
Diabetes mellitus	20
Hepatitis C carrier	6.7
Rectal cancer	5.6
Cirrhosis	5.6
Colon cancer	4.4
Ischemic heart disease	2.2
Arrhythmia	1.1
Breast cancer	1.1
Cervical cancer	1.1

Table 2. Peri-operative outcomes

Outcomes	Median (IQR 25, 75)
Operative time (min)	285 (196, 370)
Blood loss (ml)	900 (300, 1,887.5)
Blood transfusion in operation (ml)	
- Packed red cell	219.5 (0, 774.5)
- FFP	0 (0, 411.25)
- Platelet	0 (0, 0)
Length of hospital stay (days)	6.5 (4.8, 9.3)

Table 3. Outcomes of laparoscopic hepatectomy in the first period comparing with the second period

OutcomesMedian (IQR 25, 75)	First period (n = 43)	Second period (n = 47)	*p*-value
Operative time (min)	300 (240, 370)	250 (180, 370)	0.37
Blood loss (ml)	1,000 (600, 2,000)	590 (200, 1,700)	0.15
Transfusion in operation (ml)			
Packed red cell	277 (0, 941)	0 (0, 476)	0.120
FFP	0 (0, 505)	0 (0, 346)	0.380
Length of hospital stay (days)	7 (6, 10)	5 (3, 8)	0.010*
Conversion (n, %)	16 (37.2)	13 (27.7)	0.370

Values are represented as median (IQR 25, 75) and number (%)
* Significant at $p<0.05$ using Man Whitney U-test

Table 4. Outcomes of major laparoscopic hepatectomy in the first period compared with the second period

Outcomes median (IQR 25, 75)	First period (n = 14)	Second period (n = 8)	*p*-value
Operative time (min)	355 (292.5, 390)	362.5 (258.8, 440)	0.660
Blood loss (ml)	950 (700, 1,425)	950 (522.5, 1,925)	0.860
Transfusion in operation (ml)			
Packed red cell	229 (0, 543.3)	0 (0, 263.5)	0.330
FFP	0 (0, 545.3)	0 (0, 182.3)	0.600
Length of hospital stay (days)	8.5 (6, 12.3)	6 (4.3, 22.8)	0.470
Conversion (n, %)	9, 39.1	6, 42.9	0.820

Values are represented as median (IQR 25, 75) and number (%)
* Significant at $p<0.05$ using Man Whitney U-test

Table 5. Outcomes of minor laparoscopic hepatectomy in the first period compared with the second period

Outcomes Median (IQR 25, 75)	First period (n = 13)	Second period (n = 26)	*p*-value
Operative time (min)	215 (147. 5, 277.5)	217 (175, 337.5)	0.340
Blood loss (ml)	300 (100, 800)	300 (175, 500)	0.980
Transfusion in operation (ml)			
Packed red cell	0 (0, 113)	0 (0, 194)	0.820
FFP	0 (0, 0)	0 (0, 0)	0.470
Length of hospital stay (days)	6 (4, 7.5)	4.5 (3, 5)	0.120
Conversion (n, %)	7, 35	7, 21.2	0.150

* Significant at $p<0.05$ using Man Whitney U-test

open hepatectomy during the two periods showed no statistically significant difference (Table 6). The conversion rate was 37.2% (16 patients) in the first period and 27.7% (13 patients) in the second period. The overall conversion rate was 32.2% and the conversion rates for each diagnosis in each period are shown in Table 7.

The two most common reasons for conversion to the open procedures were bleeding from liver parenchyma (12 patients, 41.3%) and torn hepatic vein (5 patients, 17.3%). Other indications for conversion were: bleeding from concealed rupture in 3 cases (10.4%); massive adhesion from previous surgery in 3 cases (10.4%); right portal vein injury in 2 cases (6.9%); difficulty in liver transection in 2 cases (6.9%); injury to Glissonian pedicle in one case (3.4%); duodenal injury in one case (3.4%); and tumor invading diaphragm in one case (3.4%).

The 1-, 3-, and 5- year survival rates for HCC were 81.8%, 45.6%, and 13.6%, respectively. The 1- and 3- year survival rates for colorectal liver metastasis (CRLM) were 53.9% and 15.4%, respectively while those of cholangiocarcinoma were 100% and 25%, respectively.

Recurrence rates for HCC, CRLM, and cholangiocarcinoma were 66.7%, 13.3%, and 13.3%, and median recurrence times were 13.1, 21.5, and 15.5 months.

Nineteen of ninety patients (21.1%) had postoperative complications, of which respiratory tract difficulties were the most common (42.1%), followed by gastrointestinal complications (26.3%) including 4 cases of grade 2 bile leakage according to classification of the International Study Group of Liver Surgery (ISGLS); cardiovascular complication (2

Table 6. Outcomes of laparoscopic hepatectomy in patients who underwent conversion in the first period compared with the second period

Outcomes median (IQR 25, 75)	First period (n = 16)	Second period (n = 13)	*p*-value
Operative time (min)	347.5 (262.5, 368.8)	268 (195, 355)	0.190
Blood loss (ml)	2,450 (1,275, 4,075)	2,400 (1,400, 4,900)	0.950
Transfusion in operation (ml)			
Packed red cell	972.5 (791.3, 1,612.3)	1,012 (388, 1,311.5)	0.540
FFP	420.5 (0, 780)	600 (0, 1,167)	0.530
Length of hospital stay (days)	8.5 (7,11.8)	8 (6.5, 11)	0.830

* Significant at $p<0.05$ using Man Whitney U-test

Table 7. Diagnosis of patients who required conversion to open procedures

Diagnosis	n/N (%)
Hepatocellular carcinoma (HCC)	14/38 (36.8)
Colorectal liver metastasis (CRLM)	6/19 (31.6)
Cholangiocarcinoma	2/6 (33.3)
Intrahepatic duct stone	3/5 (60)
Regenerative nodules	2/3 (66.7)
Cystadenoma of liver	1/5 (20)
Atypical gland hyperplasia	1/1 (100)

n = number of patients who required conversion to open procedures; N = number of all diagnosed patients

cases of atrial fibrillation, one case of premature ventricular contraction, 15.8%); skin and musculoskeletal complications (one skin burn, one rectus muscle bleeding, 10.5%); and genitourinary complications in one case (5.3%). Mortality within 30 days after surgery was 3.3% (3/90). One patient developed severe coagulopathy and died one day after surgery; another who suffered from massive bleeding due to inferior vena cava injury died three days after surgery; and a third died 14 days after surgery due to severe pneumonia caused by antibiotic-resistant bacteria. All these patients required conversion to open surgery. Four patients had positive margin on pathological examination, 2 were CRLM, 1 was HCC, and 1 was intrahepatic cholangiocarcinoma.

Discussion

Laparoscopic liver resection had better short term outcomes than conventional liver resection, including less intra-operative blood loss, fewer blood transfusions, lower rates of post-operative complications and shorter hospital stay[8]. Patients with HCC who underwent laparoscopic liver resection had similar outcomes in terms of recurrence rates and 1-, 3-, and 5- year survival to those operated on with conventional methods[9], and wider tumor resection margins were also noted with laparoscopic techniques[10].

Currently, laparoscopic liver resection is accepted as a standard technique even in cancer patients because of its many advantages over conventional methods, as described above. However, the survival rates are comparable. Koffron, et al[11] compared patients who underwent minimally-invasive liver resection with patients who had standard open liver resection: the overall incidences of complications were 9.3% vs. 22.0%; mean blood loss was 102 vs. 325 mL, and length of hospital stay was 1.9 vs. 5.4 days. However, most of the patients in this study had benign conditions such as hepatic cyst, hemangioma, or hepatic adenoma. Rehman et al[12] found that patients who underwent laparoscopic liver resections had significant post-operative complications of 9.0%, median blood loss of 250 mL, length of hospital stay 5 days, and a 30-day mortality rate of 1.0%. Most of the patients in this study were CRLM.

Three hepatobiliary surgeons performed the laparoscopic liver resections in Rajavithi Hospital. The energy device used was an ultrasonic shear. In our series, most patients (63.3%) were male, their mean age was 58.9 years, and they had many underlying diseases. The most common indications for surgery were malignant conditions including HCC, metastatic cancer and intrahepatic cholangiocarcinoma.

A review of 2804 cases of laparoscopic hepatectomy by Nguyen et al[13] found morbidity and mortality rates of 10.5% and 0.3%, respectively, and a conversion rate of 4.1%. In our series, the morbidity, mortality and conversion rates were 21.1%, 3.3% and 32.2%, respectively. The higher morbidity may be explained by high non-surgical-related complications, which may have been caused by post-operative care. Two-thirds of mortalities occurred in the first period which may be explained by poor case selection and inexperience in laparoscopic hepatectomy at that time. The high conversion rate may be a result of poor case selection and inadequate instrumentation, especially in energy and dissecting devices such as ultrasonic dissectors, and also the policy to start operating using laparoscopic techniques in every possible case. The conversion rate in the second period declined compared with the first period and has continued to decrease in recent years. These factors also contributed to higher blood loss in this series compared to the other studies[11,12].

With regard to survival rates, Komatsu et al[14] found that 3-year overall survival after laparoscopic major hepatectomy was 73.4% while Rehman et al[12] found that 3-year survival after laparoscopic liver resection in CRLM patients was 78%; the survival rate in our series, therefore,

appeared to be lower than in the previous studies. This could be because most of our patients had complicated malignant tumors and decisions were made by individual surgeons without multidisciplinary team discussion, particularly in the first period. To improve the outcomes and increase survival rates, criteria for patient selection should be used, including patient's status, and size and location of tumor. In addition, massive bleeding and severe complications often occurred with injuries to the hepatic vein and liver parenchyma, so an improvement in instrumentation, meticulous surgical techniques, and more experience in laparoscopic major hepatectomy could decrease the number of these complications. Brown et al[15] found that a learning curve of 45 to 60 cases is essential for surgeons to improve their surgical skill in major laparoscopic hepatectomy and achieve better short-term outcomes. Pre-operative, peri-operative and post-operative care by multidisciplinary teams are also important in order to improve the results.

Conclusion

The outcomes of laparoscopic hepatectomies in this series were not comparable to other studies because of multiple factors including patient selection, unsatisfactory instrumentation and surgical inexperience. However, the results in recent times are improving. The selection of patients by a multidisciplinary team could lead to better long-term results; furthermore, better instrumentation, greater surgical experience, and multidisciplinary patient care could enhance the short-term and long-term outcomes.

What is already known on this topic?

Laparoscopic hepatectomy has become one of the standard surgical modalities for liver diseases. There have been many reports of perioperative, short-term and long-term outcomes of laparoscopic hepatectomy in other countries; however, there are no such reports of studies conducted in Thailand.

What this study adds?

This literature reported perioperative, short- and long-term outcomes of laparoscopic hepatectomy from a leading care center in Thailand which has long-term experience of this surgery.

Acknowledgements

The authors would like to thank the Director of Rajavithi Hospital and the Head of the Department of Surgery for their support.

Potential conflicts of interest

The authors declare no conflict of interest.

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