

Learning Laparoscopic Liver Resection for Liver Cancer

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The number of laparoscopic liver resection performed every years has been increasing. There is a trend than more major hepatectomy and complex liver resection is being reported. However there has been a major obstacles in many centers because open liver resection is still considered as a gold standard and many surgeons are still getting used to the old method of liver resection. To start a new procedure, education and training is essential in order to achieve a good outcome without compromising the safety of the patients. A gradual progression is crucial in order to avoid dreadful complication. The development of the consensus meeting and difficulty score has facility the understanding of safe practice in the development of laparoscopic liver resection. In a long run, development of registry system will improve transparency and safety of this operation.

Key Words: Laparoscopic liver resection, Learning curve, HCC, Technique, Cirrhosis

INTRODUCTION

Laparoscopic liver resection has a relatively slow pace of development. But the number of operation done has exceed 9,000 cases in 2016 and the number of major hepatectomy and complex surgery is increasing.¹

The initial indication of laparoscopic liver resection was mainly limited to benign conditions.² With increasing number of successful reports, nowadays the indications was been broadened to other malignant condition liver colorectal liver metastasis and hepatocellular carcinoma (HCC).³⁻⁷

From Open Hepatectomy to Laparoscopic Hepatectomy

Open hepatectomy has been the gold standard treatment option for HCC even in patients with liver cirrhosis. This has a very good operative outcome with a low mortality rate in a range to near zero to 4% in patients with non-cirrhotic liver. The operation mortality rate nowadays for major hepa-

tectomy in patients with cirrhosis was 4.3% and operation mortality rate for minor hepatectomy in patients with cirrhosis was 1.5%.⁸

A good skill and adequate experience is a prerequisite for the development of laparoscopic hepatectomy.

In open hepatectomy, the skill of hilar dissection, parenchymal transection and hemostasis can be transferred to laparoscopic approaches. The experience and understanding of the complex anatomy of the liver in open liver resection will reduce the learning curve of laparoscopic hepatectomy.

The wisdom of open liver resection will help us in selecting cases for laparoscopic approach. In simple principle, there should be absence of extrahepatic disease, absence of tumor thrombus in the main portal vein and inferior vena cava and anatomically feasible for liver resection.

To prevent excessive bleeding from liver parenchymal transection, careful administration of intravenous fluid and meticulous central venous pressure control was administrated. With the help of vasodilators and diuretics, the anesthesiologist will cautiously kept the CVP at preferably less than 5 cm water. In laparoscopic approach, the venous oozing can be effectively manipulated by elevation of the pneumoperitoneal pressure.⁸ This is particularly important for patients with cirrhosis where venous oozing secondary to portal hypertension is a common phenomenon. It has been shown that laparoscopic hepatectomy performed in a range between 10-14 mmHg is safe.⁹⁻¹²

In Asia, liver function assessment was based largely on the result of the indocyanine green (ICG) clearance test. An

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ICG retention rate of 14% at 15 minutes after injection was considered favorable for major hepatectomy. For minor hepatectomy, the cut-off value for ICG clearance was 22%.⁸

In laparoscopic approach, surgical technique is comparable to that of open approach. For patients receiving major liver resection, the approach to the liver pedicle can varied. In some centers, intra Glissonian approach is used where the portal pedicle will be dissected clearly from the Glisson capsule and the portal vein, hepatic artery and bile duct were separately controlled and divided, while some centers may use Glissonian approach directly.

Three to four working ports sized between 5 mm and 12 mm were used. This allow the use of an ultrasonic dissector like Harmonic scalpel or Thunder beat and a CUSA for parenchymal transection.^{13,14}

The surgeons should have good understanding of the use of intraoperative ultrasound to evaluate the relationship of the tumour and other vital structures. Intraoperative ultrasound was performed as with the patients receiving the open approach. The small vessels were controlled with multi-fired metal clips. The Major hepatic vein were controlled with vascular staplers. Hemostasis was performed using metal clips, diathermy, and suturing.

Understanding the Difficulties Score of in Laparoscopic Approach

The 2nd International Consensus Conference on Laparoscopic Liver Resection (ICLLR) was held 4th-6th October, 2014, in Morioka, Japan in which a series of topic is discussed. One of the highlight is the development of a difficulty score which is important to facilitate safe practice in laparoscopic hepatectomy.¹⁵

A simple version of five factors from preoperative information form the basis of difficulty levels: (1) tumor location, (2) extent of liver resection, (3) tumor size, (4) proximity to major vessels, and (5) liver function. This difficulty index

is comprised of the cumulative score for the five individual factors.¹⁵⁻¹⁷

A score of 1-3 will be considered low complexity surgery and which will be the ideal cases for surgeons starting laparoscopic liver resection. A score of 4-6 will be considered as intermediate complexity which should be performed by surgeons who can consistently perform laparoscopic liver resection in low difficulty cases. A Score of 7-10 will be considered high complexity which should only be performed by surgeons with good experience in laparoscopic hepatectomy.

After discussion in the panel meeting some modification has been suggested to the difficulty scoer which incorporate HALS and the hybrid method with subtraction of 1 point for either of these two methods to reduce the overall difficulty score. But this modified difficulty score system has yet to be validated.

Understanding the difficulties of different surgery is important to ensure patients safety. Complications and misfortune usually occurs when there is a major mismatch in surgeons' experience and surgery complexity.

Liver resection remain one of the most challenging procedures in surgery. The liver is anatomically divided into different sections according to its complex vasculatures. Bleeding, biliary fistula, post-operative liver failure and mortality could happened even after a simple minor hepatectomy.¹⁸ In Asia, the incidence of HCC is highest in the world due to the presence of concomitant hepatitis B infection. Hepatitis B related HCC usually associated with liver cirrhosis in Asian countries. Without a proper screening program, most of the patients with HCC are considered unresectable due to the late presentation of the symptom.¹⁹ Only 25% of the patients can received live resection at the moment the diagnosis is made. The presence of portal hypertension, splenomegaly, presence of gastric or esophageal varices and thrombocytopenia make hepatectomy more difficult when compared to liver resection in the western countries.²⁰ The major hurdle to laparoscopic liver hepatectomy is obvious. It seems very difficult if not impossible to perform such a difficult operation

Table 1. Summary of learning curve in laparoscopic liver resection

Author	year	Total number of patient	CUSSUM	Laparoscopic minor liver resection	Laparoscopic major liver resection	Suggested number of patient for learning
Vilani et al	2016	150	-	124	26	30-60
Nomi et al	2015	173	+	0	173	45-75
Poel et al	2016	159	+	0	159	55
Tomassini et al	2016	319	+	279	40	50-160
Lin et al	2016	126	+	114	8	22
Giuliante	2015	74	-	68	6	>20

in difficult patients with minimally access surgery.

Currently laparoscopic left lateral sectionectomy has been considered a standard practice in many of the centers where there is expertise in hepatobiliary and laparoscopic surgery.²¹⁻²³ According to the current difficulty score, left lateral sectionectomy were ideal cases for learning. The anatomy of the left lateral section was always constant and the transection plane is technically less challenge location.

Laparoscopic major hepatectomy has been more controversial particularly when it involved patients with HCC and cirrhosis. The same argument applied to lesion located in more difficult location of the liver like section 1, 7,8 and superior part of section.²⁴

Evidence on Learning Curve of Laparoscopic Liver Resection

Several studies has been conducted to determine a “magical” optimal number of cases a surgeons should do to overcome all the barriers.

A summary of the evidence is shown in Table 1.²⁵⁻³⁰

From these studies we can understand that the development of laparoscopic liver resection has a rapid progression only in recent 5 years. Most of the centers started to accumulate their experience in these period of time as evident by the elevated number of major liver resection.

Although a lot of different confounding factors can affect the outcome, an average of 30-60 cases is required to build up the experience for laparoscopic liver resection. The factors affecting the learning includes indication of surgery, presence of cirrhosis, need of anatomical resection, proximity to major vessels, history of previous chemotherapy and surgeons experience.

It has been observed that the operation time, need of conversion and blood loss will be reduced after 20-30 cases for minor liver resection. After this time point, the surgeons could consider doing major liver resection under supervision. A 45-60 cases will be required to reduce the operation time, need of conversion and blood loss in case of major hepatectomy.

CONCLUSION

Laparoscopic liver resection is a technically challenging procedure but it has been shown to be safe in many centers. We have entered a phase where laparoscopic liver resection is becoming an expected mode of surgery and we have to ensure that the same good standard is maintained despite

the rapid expansion of the development. Careful case selection and structured training is the key to success of development in laparoscopic hepatectomy.

REFERENCES

1. Ciria R, Cherqui D, Geller DA, et al. Comparative Short-term Benefits of Laparoscopic Liver Resection: 9000 Cases and Climbing. *Ann Surg* 2016;263:761-777.
2. Shimada M, Hashizume M, Maehara S, et al. Laparoscopic hepatectomy for hepatocellular carcinoma. *Surg Endosc* 2001; 15:541-544.
3. Belli G, Fantini C, D'Agostino A, et al. Laparoscopic versus open liver resection for hepatocellular carcinoma in patients with histologically proven cirrhosis: short- and middle-term results. *Surg Endosc* 2007;21:2004-2011.
4. Tranchart H, Di GG, Lainas P, et al. Laparoscopic resection for hepatocellular carcinoma: a matched-pair comparative study. *Surg Endosc* 2010;24:1170-1176.
5. Cheung TT, Ng KK, Poon RT, et al. A case of laparoscopic hepatectomy for recurrent hepatocellular carcinoma. *World J Gastroenterol* 2010;16:526-530.
6. Cheung TT, Poon RT, Yuen WK, et al. Outcome of laparoscopic versus open hepatectomy for colorectal liver metastases. *ANZ J Surg* 2013;83:847-852.
7. Cheung TT, Dai WC, Tsang SH, et al. Pure Laparoscopic Hepatectomy Versus Open Hepatectomy for Hepatocellular Carcinoma in 110 Patients With Liver Cirrhosis: A Propensity Analysis at a Single Center. *Ann Surg* 2016;264:612-620.
8. Fan ST, Mau LC, Poon RT, et al. Continuous improvement of survival outcomes of resection of hepatocellular carcinoma: a 20-year experience. *Ann Surg* 2011;253:745-758.
9. Honda G, Kurata M, Okuda Y, et al. Totally laparoscopic hepatectomy exposing the major vessels. *J Hepatobiliary Pancreat Sci* 2013;20:435-440.
10. Troisi RI, Van HJ, Berrevoet F, et al. Evolution of laparoscopic left lateral sectionectomy without the Pringle maneuver: through resection of benign and malignant tumors to living liver donation. *Surg Endosc* 2011;25:79-87.
11. Aldrighetti L, Pulitano C, Arru M, et al. Ultrasonic-mediated laparoscopic liver transection. *Am J Surg* 2008;195:270-272.
12. Gayet B, Cavaliere D, Vibert E, et al. Totally laparoscopic right hepatectomy. *Am J Surg* 2007;194:685-689.
13. Cheung TT, Poon RT. Synchronous resections of primary colorectal tumor and liver metastasis by laparoscopic approach. *World J Hepatol* 2013;5:298-301.
14. Cheung TT, Poon RT, Yuen WK, et al. Long-term survival analysis of pure laparoscopic versus open hepatectomy for hepatocellular carcinoma in patients with cirrhosis: a single-center experience. *Ann Surg* 2013;257:506-511.
15. Wakabayashi G, Cherqui D, Geller DA, et al. Recommendations for laparoscopic liver resection: a report from the second international consensus conference held in Morioka. *Ann Surg* 2015;261:619-629.

16. Ban D, Tanabe M, Ito H, et al. A novel difficulty scoring system for laparoscopic liver resection. *J Hepatobiliary Pancreat Sci* 2014;21:745-753.
17. Ban D, Kudo A, Ito H, et al. The difficulty of laparoscopic liver resection. *Updates Surg* 2015;67:123-128.
18. Ishizawa T, Mise Y, Aoki T, et al. Surgical technique: new advances for expanding indications and increasing safety in liver resection for HCC: the Eastern perspective. *J Hepatobiliary Pancreat Sci* 2010;17:389-393.
19. Yau T, Tang VY, Yao TJ, et al. Development of Hong Kong Liver Cancer staging system with treatment stratification for patients with hepatocellular carcinoma. *Gastroenterology* 2014; 146:1691-1700.
20. Imamura H, Sano K, Sugawara Y, et al. Assessment of hepatic reserve for indication of hepatic resection: decision tree incorporating indocyanine green test. *J Hepatobiliary Pancreat Surg* 2005;12:16-22.
21. Cheung TT, Poon RT, Dai WC, et al. Pure Laparoscopic Versus Open Left Lateral Sectionectomy for Hepatocellular Carcinoma: A Single-Center Experience. *World J Surg* 2016;40: 198-205.
22. Dokmak S, Raut V, Aussilhou B, et al. Laparoscopic left lateral resection is the gold standard for benign liver lesions: a case-control study. *HPB (Oxford)* 2014;16:183-187.
23. Hasegawa Y, Nitta H, Sasaki A, et al. Laparoscopic left lateral sectionectomy as a training procedure for surgeons learning laparoscopic hepatectomy. *J Hepatobiliary Pancreat Sci* 2013; 20:525-530.
24. Han HS, Yoon YS, Cho JY, et al. Laparoscopic liver resection for hepatocellular carcinoma: korean experiences. *Liver Cancer* 2013;2:25-30.
25. Villani V, Bohnen JD, Torabi R, et al. "Idealized" vs. "True" learning curves: the case of laparoscopic liver resection. *HPB (Oxford)* 2016;18:504-509.
26. Nomi T, Fuks D, Kawaguchi Y, et al. Learning curve for laparoscopic major hepatectomy. *Br J Surg* 2015;102:796-804.
27. van der Poel MJ, Besselink MG, Cipriani F, et al. Outcome and Learning Curve in 159 Consecutive Patients Undergoing Total Laparoscopic Hemihepatectomy. *JAMA Surg* 2016; 151:923-928.
28. Tomassini F, Scuderi V, Colman R, et al. The single surgeon learning curve of laparoscopic liver resection: A continuous evolving process through stepwise difficulties. *Medicine (Baltimore)* 2016;95:e5138.
29. Lin CW, Tsai TJ, Cheng TY, et al. The learning curve of laparoscopic liver resection after the Louisville statement 2008: Will it be more effective and smooth? *Surg Endosc* 2016;30:2895-2903.
30. Giuliani F, Ardito F. Minimally invasive liver surgery in a hepato-biliary unit: learning curve and indications. *Updates Surg* 2015;67:201-206.