



# The future of laparoscopic major liver resection

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**Abstract:** Laparoscopic liver resection has been gaining recognition in many parts of the world. The bloom is secondary to a successful consensus meeting in Morioka where surgeons around the world met and exchanged ideas. There is a strong need for laparoscopic major hepatectomy because the potential benefit is obvious if the risk and oncological outcome remain the same. It has been shown in many centers that laparoscopic liver resection can be done safely. Although there may be several variations in technique, the complex procedures of inflow control, bile duct division, parenchymal transection and hepatic vein division can be reproduced as in open hepatectomy. With appropriate coaching and increased case volumes, laparoscopic major liver resection will become a standard procedure in the near future.

**Keywords:** Cirrhosis; HCC; hemihepatectomy; hepatectomy; laparoscopic liver resection; technique

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## Introduction

In the Louisville consensus meeting, laparoscopic live resection was still in its infancy and far from popularity (1). A lot of technical advancement and experience were gained during the past years, allowing surgeons to do more complex surgery. The possibility of doing laparoscopic major liver resection increased with the development of high-definition camera and display unit and a better understanding of the use of pneumoperitoneal pressure and other energy devices. In the Morioka consensus meeting, evidence of the benefits of laparoscopic liver resection started to emerge, and it was suggested that laparoscopic major liver resection should be considered as a surgical advancement worth validation and development (2).

The number of laparoscopic hepatectomies performed worldwide was exponentially increasing in the recent 2 years. Laparoscopic major liver resection has become an accepted practice, particularly for patients without cirrhosis and T2 tumor (3-9).

## Technical considerations in laparoscopic major liver resection

One of the doubts about laparoscopic major liver resection

is its ability to reproduce the fine and meticulous dissection done in open liver resection. Is the surgeon capable of performing anatomical liver resection with full exposure of hepatic veins?

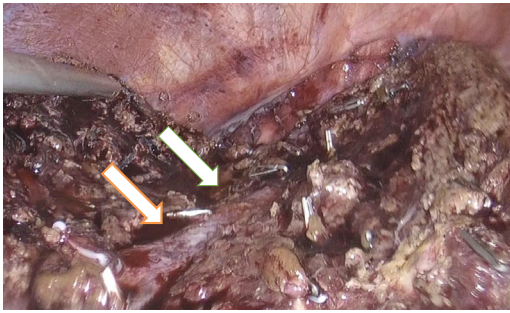
The answer is an obvious yes nowadays. Crystal-clear high-definition videos of the procedure are often exhibited in conferences, and there are various web-based educational systems.

*Figure 1* shows the clear exposure of the middle hepatic vein in a case of central hepatectomy.

To ensure safe practice of laparoscopic major liver resection, the surgical principle of liver resection has to be respected.

The selection criteria for laparoscopic liver resection follow exactly the same principle used for open surgery. For inclusion, liver resection has to be anatomically feasible, and there should be absence of extrahepatic disease and absence of tumor thrombosis in the main portal vein or the inferior vena cava. Patients should undergo strict preoperative liver function assessment, which includes blood test, volumetry assessment, clinical assessment and indocyanine green evaluation (10).

Meticulous anesthesia should be carried out. To prevent venous oozing from liver parenchymal transection, careful



**Figure 1** Middle hepatic vein exposed in central bisectionectomy for liver cancer.

intravenous fluid administration and meticulous central venous pressure control are required. With the help of vasodilators and diuretics, the anesthesiologist should cautiously keep the central venous pressure at preferably below 5 cmH<sub>2</sub>O.

In major liver resection, the portal pedicle is dissected clearly from the Glisson capsule. The portal vein, hepatic artery and bile duct are separately controlled and divided. The patient is usually placed in the Lloyd-Davis position. The primary surgeon stands between the legs with one assistant on each side. Pneumoperitoneum is usually done by subumbilical incision. Three to four working ports measuring from 5 to 12 mm are used. This allows the use of an ultrasonic dissector or a CUSA for parenchymal transection (10,11).

Pringle maneuver can be applied when necessary. The pneumoperitoneal pressure can be elevated up to 18 mmHg to reduce venous oozing when needed.

With vigilant dissection under optimized pneumoperitoneal pressure, the hepatic vein can be fully exposed without bleeding.

### Evidence of benefits of laparoscopic major hepatectomy

In 2011, there was very weak evidence that laparoscopic major liver resection was an accepted method for cancer treatment because the operation time was longer while the amount of blood loss was not less, and there were no long-term data of oncological outcomes (12). The data in 2011 were actually a reflection of accumulation of experience in major hepatectomy between 2005 and 2010. The experience at that time was still experimental and surgeons were struggling with low-definition cameras and basic laparoscopic instruments.

Evidence favoring laparoscopic major liver resection became stronger in 2016. More than 1984 cases of laparoscopic major hepatectomy have been performed worldwide (13).

Table 1 is a summary of outcomes of laparoscopic major hepatectomy reported by various studies (4-9). We can see that there is a consistency in reduction of overall complications, blood loss and hospital stay. However, up to this moment, operation time is still more or less the same. Laparoscopic major hepatectomy is a complex surgery and there is still plenty to learn.

The oncological outcomes of laparoscopic major hepatectomy still need to be validated, but some initial results showed that the oncological outcomes of laparoscopic major hepatectomy were not inferior to those of open liver resection.

### Learning laparoscopic major liver resection

Before doing laparoscopic major liver resection, a surgeon should have adequate experience in open hepatectomy and minor liver resection.

Understanding the difficulty score for laparoscopic liver resection is crucial for case selection. The operation can be carried out safely only when the surgeon's experience level matches the difficulty score. The scoring system was developed as a pre-conference task before the 2<sup>nd</sup> International Consensus Conference on Laparoscopic Liver Resection 2014 in Morioka, Japan (2).

The scoring system consists of five factors from preoperative information forming the basis of difficulty levels: (I) tumor location; (II) extent of liver resection; (III) tumor size; (IV) proximity to major vessels; and (V) liver function. This difficulty index is comprised of the cumulative score for the five individual factors (2,14,15).

A score of 1–3 means that surgery with low complexity is required, which is ideal for surgeons starting to do laparoscopic liver resection. A score of 4–6 means that surgery with intermediate complexity is required, which should be performed by surgeons who can consistently perform laparoscopic liver resection in low-difficulty cases. A score of 7–10 means that surgery with high complexity is required, which should only be performed by surgeons with ample experience in laparoscopic hepatectomy.

It is important to possess ample experience in laparoscopic minor liver resection before learning to do laparoscopic major liver resection.

In a study of 173 laparoscopic liver resections, Nomi *et al.*

**Table 1** Summary of outcomes of laparoscopic major hepatectomy

Authors	Year	No. of patients	Open liver resection	Laparoscopic major liver resection	Blood loss	Operation time
Yoon <i>et al.</i>	2016	152	115	37	136 vs. 110 mL, P=0.856	200 vs. 304 min, P<0.0001
Medbery <i>et al.</i>	2014	115	48	67	737 vs. 281 mL, P=0.002	285 vs. 233 min, P<0.001
Abu <i>et al.</i>	2013	84	46	38	435 vs. 100 mL, P<0.001	150 vs. 145 min, P=0.021
Topal <i>et al.</i>	2012	40	20	20	550 vs. 550 mL, P=0.884	233 vs. 258 min, P=0.228
Martin <i>et al.</i>	2010	450	360	90	400 vs. 150 mL, P<0.0001	160 vs. 150 min, P=0.009
Cai <i>et al.</i>	2009	38	19	19	895 vs. 462 mL, P=0.516	204 vs. 222 min, P=0.516

concluded that an experience of 45–75 cases is required for a surgeon to overcome all the difficulties in major liver resection. In a study of 159 laparoscopic liver resections, Poel *et al.* concluded that an accumulation of 55 cases is necessary in order to reduce the incidence of conversion and complication.

## Conclusions

Laparoscopic major hepatectomy remains a complex operation in the field of hepatobiliary and pancreatic surgery. Although the current evidence of its benefits is small when compared with that of open surgery, the number of laparoscopic surgery is exponentially increasing, and there is a lag time of 2–3 years for publication. More and more centers are doing laparoscopic major liver resection safely.

The future is now.

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