

Laparoscopic Liver Resection: Current Status and Techniques

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ABSTRACT

Laparoscopy has forever changed the landscape of surgery. Although hepatobiliary surgery remained the last bastion of 'maximal invasiveness,' recently there has been a rise in the implementation of laparoscopy for complex liver operations. Liver surgeons have been slow to adopt the laparoscopic technique for liver resections. This new approach has offered the patient an alternative to the traditional bilateral subcostal incision, and thereby tendered the marked benefits of limited incisions inherent to minimally invasive surgery.

As efficiency pressures continue to rise, the laparoscopic approach for liver resection will likely be further embraced. To this end, we surmise that the hybrid technique will gain favor, as it more closely assimilates the skills that hepatobiliary surgeons already possess.

Moreover, this technique offers the most palatable setting of safety with the use of the hand for liver mobilization and prompt control of bleeding vasculature.

Liver surgery, although initially late to embrace laparoscopy, is now gaining momentum in this paradigm shift. The advent of innovative tools that mirror what is used conventionally have facilitated this transition.

Keywords: Hybrid technique, Laparoscopic liver resection, Laparoscopy.

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INTRODUCTION

Laparoscopy has forever changed the landscape of surgery. Although hepatobiliary surgery remained the last bastion of 'maximal invasiveness,' recently there has been a rise in the implementation of laparoscopy for complex liver operations. Liver surgeons have been slow to adopt the laparoscopic technique for liver resections.

Understandably, they are concerned about the control of bleeding, difficulty in retraction and exposure, and

the risk of air embolism. For malignant tumors, many expressed concerns about compromising oncological clearance and tumor seeding in the peritoneal cavity.^{1,2} Despite these difficulties, instruments have improved and surgical techniques have been refined to ensure that laparoscopic liver resection is not only feasible and safe, but also beneficial in terms of blood loss, length of hospital stay, and severity of wound pain. More than a thousand laparoscopic liver resections have been performed worldwide since 1992, after Gagner et al³ performed the first nonanatomical resection of a liver tumor. Although most of these involved resections of only one or two liver segments,⁴⁻⁷ major hepatectomies have also been achieved laparoscopically.⁸⁻¹⁰ While some attempted the relatively straightforward left lateral segmentectomy laparoscopically, it was not until the advent of the hand-assisted technique that formal liver resection became feasible for many hepatobiliary surgeons. This divergence from the purely laparoscopic instrumentation of the liver had many distinct advantages. Practically, the hand is the most useful retractor, offering expedient conformational change and unmatched haptic feedback. As such, intracorporeal hand insertion during laparoscopic resection gives the surgeon enhanced tactile stabilization of the liver, allowing for more precise mobilization and dissection of the target lobe. In addition, the hand port serves as a retrieval site for the surgical specimen. This new approach has offered the patient an alternative to the traditional bilateral subcostal incision, and thereby tendered the marked benefits of limited incisions inherent to minimally invasive surgery. This laparoscopic advance has extended into all forays of surgery with an ensuing decrease in incision size, which translates into less pain for the patient. With less pain comes earlier mobility, which results in decreased morbidity and reduced length of stay. Secondly, direct costs may be reduced with the use of laparoscopic techniques as a result of the earlier hospital discharge.

Heretofore laparoscopic hepatic resection has seemed far afield, but the subsequent innovation has shifted the paradigm. To this end, laparoscopy as applied to hepatic surgery is germane to discussions of 'best practices' and offers a technical approach that should be considered for many patients with liver pathology.

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RELATIVE CONTRAINDICATIONS TO LAPAROSCOPY

Although refractory hypotension is the only absolute contraindication to laparoscopy, there are many situations that make its use ill advised. In general, patients with an American Society of Anesthesiologists (ASA) classification of four or higher should not undergo laparoscopic procedures because hemodynamic instability is likely to arise in the setting of a pneumoperitoneum. As such, patients with poor cardiopulmonary reserve should temper the surgeon's enthusiasm for laparoscopic pursuits. However, rarely is the surgeon confronted with such obvious and straightforward clinical decisions.

The assessment of the risks and benefits of alternative operative approaches underscores the relative contraindications for laparoscopic liver resection. In our experience, patients who have had prior open foregut surgery are generally poor candidates for a laparoscopic approach, given the likely adhesive disease. Moreover, bulky pathology or hepatomegaly usually predicates open surgery, as hepatic mobilization can be problematic (Box 1). In contrast, laparoscopic resection for malignancy has been shown to be safe, which parallels the findings for treatment of other intra-abdominal organ cancers.

OPERATIVE TECHNIQUES

Numerous methods of laparoscopic resection have gained popularity with increased sharing and collaboration in the surgical community. Recognizing the diversity of these laparoscopic techniques used for liver resection, a panel of 45 well-known hepatobiliary surgeons worked to establish a standard classification system and summarize a unified position statement on safety and efficacy of laparoscopic liver resection.

PURE LAPAROSCOPY

Pure laparoscopy is usually used for wedge resections of anterior lesions of the liver or masses located in the left lateral segment, but it has been used for major lobe resections as well. Access is gained into the abdomen, depending on the surgeon's preference, and an umbilical 10 mm trocar is placed. After insufflation, the patient is moved into the reverse Trendelenburg position to enable

Box 1: Relative contraindications to laparoscopic hepatic resection

- ASA classification ≥ 4
- Poor cardiopulmonary reserve
- Prior open foregut surgery
- Large (> 10 cm) posterior lesions
- Hepatomegaly

ASA, American Society of Anesthesiologists

sighting of the hilar structure and to position the small bowel in the lower abdomen and pelvis. Two to three trocars are placed under direct visualization to facilitate triangulation of the intended surgery site. Here, laparoscopic ultrasound is of great use to determine the depth of the mass and its juxtaposition to vasculature.

Lesions on the liver surface may be wedged out with the use of laparoscopic adaptations of the Harmonic scalpel (Ethicon EndoSurgery, Blue Ash, Ohio), LigaSure (Covidien, Boulder, Colo), Enseal (Ethicon Endo-Surgery, Blue Ash, Ohio), or any other bipolar energy device.

Generally, the hilum is dissected and the respective hepatic artery ligated and divided. The portal vein to the affected side is then clamped. Transection then begins in the usual fashion, and major vasculature is controlled with laparoscopic stapling devices. The major bile ducts are also stapled, and the specimen is extirpated through an extended umbilical incision. For this reason, it is more prudent to attempt larger resections with the alternative hand-assisted and hybrid techniques, given the similarity in the incision size.

HAND-ASSISTED TECHNIQUE AND THE HYBRID TECHNIQUE

The incision that accommodates the hand port is the same for the hand-assisted and the hybrid techniques, there are some definitive differences. Both operative procedures employ the hand as a retractor, but hand-assisted liver resection implies that the resection is performed entirely intracorporeally. Conversely, the hybrid technique is a practice of using the hand to mobilize the liver with subsequent removal of the hand port so as to perform the liver transection in an open fashion without extending the incision.

Many favors the hybrid approach as they intuitively feel that this technique provides a more expeditious and practical manner for mobilization, parenchymal dissection, and removal of liver specimen. Here, I will describe the hybrid approach to liver resection, but the details are applicable to any system of laparoscopy using the hand.¹²

A 7.5 cm subxiphoid incision is made, and a hand port is inserted for hand assistance. A pneumoperitoneum is established after a standard Hassan trocar insertion periumbilically, and a 5 mm trocar is placed obliquely in the right or left subcostal margin depending on the location of the target lobe. The periumbilical trocar placement can be particularly risky because of its larger size and the relatively blind nature of insertion. This possibility can be minimized by introducing the trocar using the Hassan cut-down technique.

One hand should be placed into the abdomen through the subxiphoid incision to receive the trocar as the other

is used to gently advance the port-system through the fascia. After safe insufflation of the abdomen, the operation begins with mobilization of the liver after positioning the patient in reverse Trendelenburg.

Laparoscopic diathermic energy-based devices are used to divide the visceral attachments and triangular and coronary ligaments. The side of hepatic pathology dictates right or left hand insertion for hepatic lobe retraction.

The hand is an optimal retractor because of its ability to conform to the contours of the liver and displace pressure to the entire organ, preventing possible parenchymal injury. Hand assistance also promotes safety in affording the surgeon with an expedient method of manual control of hemorrhage during a potential vascular mishap.

Once the target liver lobe has been mobilized by division of all peritoneal reflections, the abdomen is exsufflated and the hand port is removed. Because exposure is of paramount importance, use of a retractor system is recommended. With adequate and uncompromised retraction, extrahepatic hilar vasculature ligation and division then ensue to lessen blood loss during liver transection.

Next, the parenchymal dissection through the hand port incision is accomplished with the aid of ultrasonography and ultrasonic surgical aspirators (CUSA, Integra LifeSciences Corp, Plainsboro, NJ) to identify the venous entities. During cases of major resection, the hanging maneuver as described by Dr Belghiti is used, with an umbilical tape passed anterior to the vena cava. Some ardently believe the biliary ductal system should be managed during intrahepatic dissection to prevent injury to the contralateral duct.¹¹

For living donor hepatectomies, the hepatic artery, portal vein, and hepatic vein branches are kept intact as the parenchymal division is completed. The patient is then heparinized prior to the dissection of the target vascular structures and ultimate division. Subsequently, the specimen is removed through the hand port site.¹³

RIGHT HEPATECTOMY USING THE HYBRID TECHNIQUE

After mobilization of the right hepatic lobe by division of the falciform and triangular ligaments, exsufflate the abdomen, remove the hand port, and secure the retractor system to expose the liver through the midline abdominal incision. Next, place lap pads behind the liver to bring the hilum into better view.

Prior to dissection, methodically palpate for a replaced right hepatic artery. The middle hepatic artery can be easily mistaken for a right hepatic artery, especially in the setting of a replaced artery, and division can have severe implications for segments 4A and 4B.

Ligate and divide the right hepatic artery and dissect posteriorly to delineate the portal vein. The right portal vein is circumferentially mobilized superiorly and divided. This devascularizes the right lobe inflow and results in demarcation of the liver. The right hepatic vein is then identified on the superior aspect of the liver and is divided using an articulating laparoscopic stapling device (EndoPath ETS, Ethicon Endo-Surgery, Blue Ash, Ohio) to ensure safe control of this very large vessel off of the inferior vena cava.

Using the aforementioned hanging maneuver, proceed with liver division, being mindful to stay to the right of the middle hepatic vein. We opt to ligate the right hepatic duct during intraparenchymal division because contralateral bile duct ischemia can occur if extrahepatic dissection is attempted. The specimen is then removed through this incision.

LEFT HEPATECTOMY USING THE HYBRID TECHNIQUE

A left hepatectomy using the hybrid technique follows many of the same steps that were previously discussed. Again, one should be mindful of arterial variances, especially a replaced left hepatic artery coming from the left gastric artery. After correct identification and division of the middle and left hepatic arteries, dissection of the left portal vein begins by working posteriorly to the ligated arterial vasculature. Traditionally, the caudate lobe is spared in formal left hepatic lobe resections, and therefore, the surgeon should preserve the portal venous branches from the left portal vein into this segment. The middle and left hepatic veins are then divided with a laparoscopic stapling device, and parenchymal transection begins in the standard fashion.

In a recent study, some compared experience of conventional open liver resection to laparoscopic liver resection. As expectant, the laparoscopic approach with hand assistance and parenchymal dissection through the hand port incision had equivalent operative metrics with shortened length of stay.^{14,15} Koffron et al have shown that laparoscopic resection is less expensive because of the shortened hospital stay. This finding reflects what has already been conclusively shown with laparoscopic cholecystectomy, fundoplication, and gastric bypass surgery.^{16,17}

CONCLUSION

Since Dr Jean Louis Lortat-Jacob¹⁸ detailed the first published hepatectomy using the roadmap laid out by Claude Couinaud, the field of liver surgery has seen a celebrated rise in the capability to offer resection with lower rates of

morbidity and mortality. It is evident that with the arrival of the twenty-first century, the emergence of laparoscopy embodies a marriage of uncompromised surgical technique and better outcomes for patients.

Laparoscopy has emerged as an advancement that embodies these efforts to improve medical care and represents a significant change to the landscape of surgery. Liver surgery, although initially late to embrace laparoscopy, is now gaining momentum in this paradigm shift.¹⁹ The advent of innovative laparoscopic tools that mirror what is used conventionally have facilitated this transition.

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