

# Minimally Invasive Hepatic Surgery



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## KEYWORDS

• Minimally invasive • Laparoscopic • Robotic-assisted • Resection • Hepatectomy

## KEY POINTS

- Minimally invasive hepatectomy is safe and feasible in properly selected patients.
- Preoperative workup, anesthetic management, and postoperative management are similar to open hepatectomy.
- Minimally invasive hepatectomy is associated with fewer perioperative complications and shorter hospital length of stay.
- Short- and long-term oncologic outcomes are similar between minimally invasive and open hepatectomy done for malignancy.
- Minimally invasive hepatectomy is best performed by surgeons who are trained in open liver surgery and at high-volume hepatopancreaticobiliary centers.

## INTRODUCTION

The application of minimally invasive techniques has transformed the surgical landscape over the past 20 years. This approach has demonstrated benefit in surgical subspecialties, including colorectal surgery,<sup>1,2</sup> gynecology,<sup>3</sup> urology,<sup>4</sup> and thoracic surgery.<sup>5</sup> Multiple studies have demonstrated reduced postoperative pain, reduced morbidity, decreased length of stay, improved cosmesis, and improved overall cost-effectiveness without compromising oncologic outcomes.<sup>1,2,6–8</sup> These complex procedures require advanced laparoscopic skills, including suturing, knot-tying, and bimanual tissue manipulation. Limitations of conventional laparoscopic techniques include reduced visualization, amplification of physiologic tremor, and suboptimal ergonomics. Range of motion is restricted to 4 degrees of freedom, compared with the 7 degrees of freedom of the human wrist.<sup>9,10</sup> These limitations become increasingly

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apparent as the complexity of the procedure increases, translating to a steep learning curve, and have likely slowed the application of minimally invasive approaches to hepatopancreaticobiliary procedures, which are generally performed at high-volume tertiary care centers.

As the comfort and understanding of hepatopancreaticobiliary surgery have grown, minimally invasive approaches have been applied with increasing frequency to the field.<sup>11–21</sup> Laparoscopic liver surgery affords the same universal benefits of minimally invasive surgery elsewhere, including reduced postoperative pain and decreased length of hospital stay, and it has demonstrated safety in experienced hands.<sup>7</sup> However, the laparoscopic approach to the liver is challenging due to complex vascular and biliary anatomy, risk of bleeding, fragile parenchyma, and difficult exposure secondary to size and deep, posterior retroperitoneal attachments. The minimally invasive approach is being used more frequently, but mainly for nonanatomic resections. The learning curve is approximately 60 cases.<sup>22</sup> In a large review by Nguyen and colleagues<sup>7</sup> of more than 2800 laparoscopic liver resections, nonanatomic wedge resections and left lateral sectionectomy comprised nearly two-thirds of cases, whereas fewer than 10% of cases were formal right or left hepatic lobectomies.

In an effort to standardize and summarize the current position on laparoscopic liver surgery, an international conference was held in Louisville, Kentucky in 2008.<sup>23</sup> Consensus recommendations included the following: (1) the best indications for laparoscopic liver resection are in patients with solitary lesions, 5 cm or less, located in peripheral liver segments II to VI; (2) the laparoscopic approach to left lateral sectionectomy should be considered standard practice; and (3) although all types of liver resection can be performed laparoscopically, major liver resections (right or left hepatectomy) should be reserved for experienced surgeons already skilled at more complex laparoscopic hepatic resections. Lesions adjacent to major vessels or near the liver hilum were not considered appropriate for laparoscopic resection because of the potential risk of massive bleeding and need for biliary reconstruction. However, surgeons at high-volume centers may choose to operate beyond these criteria, provided that the surgeon is comfortable with minimally invasive methods to achieve hemostasis should significant bleeding be encountered. Despite the technical limitations of laparoscopy, malignant tumors are not a contraindication to minimally invasive resection as demonstrated in many comparative studies, and laparoscopic resection does not appear to compromise the oncologic integrity of the procedure with regards to margin status and local recurrence rate when compared with the open approach.<sup>7,17,24,25</sup>

The inherent visual and ergonomic limitations of laparoscopy have played a major role in the development of robotic surgery, which allows surgeons to perform advanced laparoscopic procedures with greater ease. Currently, the da Vinci Surgical System (Intuitive Surgical, Inc, Sunnyvale, CA, USA) is the only commercially available robotic surgical system approved by the US Food and Drug Administration for use in surgery. Advantages include articulating instruments that re-create the 7 degrees of freedom of the human wrist, 3-dimensional view of the operative field in high-definition, and complex algorithms that minimize physiologic tremor. These features allow for precise dissection and intracorporeal suturing, thus expanding the scope and complexity of procedures that can be performed in a minimally invasive fashion. Disadvantages include high cost, loss of haptic feedback, inability to operate in multiple fields, and need for a skilled bedside assistant. The lack of haptic feedback is generally overcome by enhanced 3-dimensional visualization, which allows the operating surgeon to “see” how much tension or force is being applied to tissues and suture within the operative field.<sup>26</sup> The first major series reporting the use of robotics in

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