

# Complications of Liver Resection: Laparoscopic Versus Open Procedures

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## ABSTRACT

**Background and Objective:** Minimally invasive surgery for liver resection remains controversial. This study was designed to compare open versus laparoscopic surgical approaches to liver resection.

**Methods:** We performed a single-center retrospective chart review.

**Results:** We compared 45 laparoscopic liver resections with 17 open cases having equivalent resections based on anatomy and diagnosis. The overall complication rate was 25.8%. More open resection patients had complications (52.9% vs 15.5%,  $P < .008$ ). The conversion rate was 11.1%. The mean blood loss was  $667.1 \pm 1450$  mL in open cases versus  $47.8 \pm 89$  mL in laparoscopic cases ( $P < .0001$ ). Measures of intravenous narcotic use, intensive care unit length of stay, and hospital length of stay all favored the laparoscopic group. Patients were more likely to have complications or morbidity in the open resection group than in the laparoscopic group for both the anterolateral ( $P < .085$ ) and posterosuperior ( $P < .002$ ) resection subgroups.

**Conclusion:** In this series comparing laparoscopic and open liver resections, there were fewer complications, more rapid recovery, and lower morbidity in the laparoscopic group, even for those resections involving the posterosuperior segments of the liver.

**Key Words:** Liver resection, Laparoscopic, LigaSure.

## INTRODUCTION

Laparoscopic approaches to liver resection have found acceptance among institutions where surgeons have the requisite experience. Improved techniques and technologic advances have permitted better control of intrahepatic blood vessels and bile ducts, improving the safety and feasibility of laparoscopic liver resection.<sup>1-5</sup> Several studies have described laparoscopic liver resections as safe and have shown some advantages over open liver resections, especially in terms of decreased postoperative pain, less intraoperative blood loss, reduced recovery time, and shorter hospital stay.<sup>6</sup>

When one is evaluating the safety of surgical methods, the intraoperative and postoperative morbidity and mortality rates are considered the primary metrics of efficacy and safety.<sup>7</sup> Measures of outcome, such as blood loss, duration of hospital stay, and duration of postoperative ileus, are also important when one is determining the efficacy and cost-effectiveness of procedures. Postoperative morbidity for liver resection is predominantly associated with hemorrhage from the cut edge, ascites (especially in cirrhotic patients or patients with cysts), and intra-abdominal fluid collection or abscess, with reported rates of 11% to 34%.<sup>8</sup> Morbidity and mortality rates are increased with major resections and the presence of cirrhosis.<sup>9</sup>

Most published studies and reviews describing the safety and efficacy of laparoscopic liver resection are narrowly focused on a homogeneous type of procedure (e.g., left lobectomy) or specific diagnosis (e.g., hepatocellular carcinoma). To date, few studies have compared all-indication open and laparoscopic liver resections with respect to complications, morbidity, and outcome. The goal of this study was to assess the safety and efficacy of laparoscopic liver resection by comparing the outcomes of laparoscopic liver resections versus open procedures with equivalent resections based on anatomy and indication.

## METHODS

The study design was a single-center retrospective chart review, and institutional review board approval was obtained. We compared 45 consecutive laparoscopic liver resections with 17 open resections with similar indications

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and anatomy of resection. The 17 open cases were chosen because they closely matched the parameters recorded for the laparoscopic cases; all cases were performed within the same period, and no matched open cases were excluded. All resections were performed by 1 of 2 senior hepatobiliary staff surgeons, each of whom performed both laparoscopic and open resections, using similar techniques. Cases in which biopsy was the only procedure were not included in this study. Demographic information, operative details, and postoperative outcome data were analyzed. Results are expressed as mean  $\pm$  standard deviation. Statistical analyses included the odds ratio and relative risk with 95% confidence intervals, and results were verified by use of an online statistics calculator from the Centre for Evidence Based Medicine.<sup>10</sup> Cases converted from laparoscopic to open were included in the laparoscopic group for intent-to-treat analysis.

### **Surgical Technique**

In patients receiving laparoscopic liver resection, both pure laparoscopic and hand-assisted techniques were grouped together. Only 2 of the 45 laparoscopic cases involved a hand-assisted technique, 1 for a large symptomatic cyst in the right lobe of the liver and the other for a large hemangioma in the left lobe. Ultrasonography with duplex was used in all cases, with the Aloka 7.5-MHz flexible linear laparoscopic transducer (Hitachi Aloka Medical, Ltd., Willingford, CT, USA) for laparoscopic cases and the Philips 15–6L intraoperative linear array transducer (Andover, MA, USA) for the open cases. For laparoscopic resections, supraumbilical trocars were placed first by use of the Hasson technique, and additional trocars were placed as needed based on individual anatomy. Laparoscopic resections used either three or four 10-mm to 1-mm trocars so that ultrasonography probes and staplers could be inserted through any trocar. For the 2 resections that used hand-assisted techniques, the Applied Medical GelPort (Rancho Santa Margarita, CA, USA) was placed in an incision in the right upper quadrant, with some variation based on anatomy and position of the masses. For right or left hemihepatectomy or left lateral lobectomy, the portal pedicles were most often divided within the liver parenchyma by use of a linear stapler. Similarly, hepatic veins were identified as the parenchymal dissection progressed cephalad, with dissection only as much as necessary to allow a linear stapler to be safely positioned and fired. Parenchymal dissection was primarily completed with the LigaSure Atlas 10-mm vessel sealing device during laparoscopic cases and the LigaSure Max (Covidien, Mansfield, MA, USA) device during open

procedures. Cholecystectomy and cholangiography were performed when indicated. The Pringle maneuver was only rarely used to aid in bleeding control and was never performed for >20 minutes. In laparoscopic cases, once a transected surgical specimen was detached, it was inserted into an Endobag (Cardinal Health, Dublin, Ott, USA) and extracted through either an enlarged epigastric port incision or a hand-port incision if present. Hemostasis was achieved by use of an argon beam coagulator and sometimes titanium clips and/or fibrin glue sealant. After irrigation of the surgical field, pneumoperitoneum was evacuated for 5 minutes in laparoscopic cases and then reinsufflated to inspect for hemostasis. Blake-type closed suction drains were used in <20% of cases (not different for open or laparoscopic). The nomenclature of Strasberg<sup>11</sup> was used to describe the types of resections. Anterolateral procedures were defined as resections involving liver segments II, III, IVa (the anterior part of segment IV), V, and VI. Posterosuperior procedures were defined as resections involving segments IVb (the posterior part of segment IV), VII, and VIII. No caudate resections were performed.

### **RESULTS**

A total of 62 liver resections are included in this cohort (45 laparoscopic and 17 open). Patient demographics, indications for resection, and tumor characteristics are summarized in **Table 1**. No significant differences were noted between the open and laparoscopic resection groups with respect to patient age, sex, severity of underlying liver disease, preoperative diagnosis, or indication for resection. The size, number, and location of the resected lesions were also similar. There were no significant differences between the open and laparoscopic groups with respect to operative procedures (**Table 2**). Conversion to an open approach was required in 5 of 45 laparoscopic cases (11.1%) because of inadequate visualization of the liver (n = 3) or an insufficient resection margin (n = 2). No conversion was performed for bleeding.

The indication for resection was hepatocellular carcinoma in 17 patients (27.0%), metastatic colon cancer in 8 (12.9%), symptomatic hepatic cyst in 8 (12.9%), hemangioma in 6 (9.6%), focal nodular hyperplasia in 14 (22.6%), hepatic adenoma in 3 (4.8%), other malignant lesion in 4 (6.5%), and other nonmalignant lesion in 2 (3.2%). Table 1 shows the number of laparoscopic and open cases for each indication. The “other” malignant lesions were carcinoid tumor (n = 1), sclerosing malignant epithelial neoplasm (n = 1), and cholangiocarcinoma (n = 2). The

**Table 1.**  
Characteristics of Patients Who Underwent Laparoscopic and Open Resection of Hepatic Lesions

	Total (N = 62)	Laparoscopic Group (n = 45)	Open Group (n = 17)
Demographic factors			
Age, yr	53.1 ± 13.4	53.5 ± 13.9	52.4 ± 12.5
Sex (male/female)	28/29 (45.2%/46.8%)	19/26 (42.2%/57.8%)	12/5 (70.6%/29.4%)
Liver disease (normal/CLD <sup>a</sup> /C <sup>a</sup> )	31/17/20	22/16/16	7/5/6
Indications for liver resection, n			
Hepatocellular carcinoma	17	12	5
Colorectal metastasis to liver	8	5	3
Symptomatic cyst	8	7	1
Hemangioma	6	4	2
Focal nodular hyperplasia	14	10	4
Hepatic adenoma	3	3	0
Malignant lesion—other	4	3	1
Nonmalignant lesion—other	2	1	1
Tumor characteristics			
Size (cm)	7.3 ± 3.6	6.4 ± 3.6	10.5 ± 3.8
Number (single/multiple)	35/27	26/19	6/11
Location (AL <sup>a</sup> /PS <sup>a</sup> /both/indeterminate)	20/5/28/9	16/3/20/6	4/2/8/3

<sup>a</sup>AL=anterolateral segments; C=cirrhosis; CLD=chronic liver disease; PS=posterosuperior segments.

**Table 2.**  
Liver Resection Types

	No. of Resections/Procedures		
	Total No.	Laparoscopic Group	Open Group
Major resections			
Right hemihepatectomy (segments V, VI, VII, VIII)	2	0	2
Left hemihepatectomy (segments II, III, IV)	4	3	1
Right posterior sectionectomy (segments VII, VIII, IVb)	0	0	0
Minor resections			
Left lateral sectionectomy (segments II, III)	2	1	1
Right trisegmentectomy (segments V, VI, VII)	1	0	1
Bisegmentectomy (segments VII, VIII)	1	1	0
Segmentectomy			
Segment 3	1	1	0
Segment 4a	1	1	0
Segment 6	1	1	0
Nonanatomic	49	37	12

“other” nonmalignant lesions were a focus of mucinous epithelial metaplasia (n = 1) and fibrosis suspicious for schistosomiasis (n = 1).

The open resection group showed a significantly increased risk of having at least 1 complication ( $P = .007$ ) (Table 3). In addition, the open resection group showed significantly increased lengths of both intensive care unit stay and hospital stay ( $P = .05$  and  $P = .01$ , respectively). There was no significant difference in the need for intravenous narcotic pain medication, the length of postoperative ileus (expressed as time to initiation of oral intake), and 30-day or 1-year mortality rate between the open and laparoscopic resection groups. The amount of blood loss was greater in the open group than in the laparoscopic group (median, 988 mL vs 95 mL;  $P = .0001$ ). Overall, intraoperative bleeding was limited except in 3 open resection patients who required intraoperative blood transfusion. Postoperative transfusion was required in 6 patients (5 from the open group and 1 from the laparoscopic group). The overall complication rate was 25.8%, and complications included pleural effusion (2 patients), wound infection (2 patients), incisional hernia (4 patients), hematoma requiring drainage (1 patient), abscess requiring drainage (1 patient), upper gastrointestinal bleed (2 patients), bile duct stricture (1 patient), common bile duct obstruction (1 patient), bile leak (1 patient), ascites requiring drainage (5 patients), and retained drain requiring a procedure (1 patient). The complication rate in the laparoscopic group was 15.5%. The complication rate in open cases was 52.9%.

Twenty patients (32.2%) underwent resections of the anterolateral segments of the liver, and 33 patients (53.2%) underwent resections of the posterosuperior segments of the liver or resections of both the anterolateral and posterosuperior segments. Nine patients (14.5%) had resections that could not be categorized as anterolateral or posterosuperior. Laparoscopic and open complications and outcomes in each liver resection group are shown in Table 4. The open posterosuperior resection group had significantly more complications than the laparoscopic posterosuperior resection group ( $P = .002$ ).

## DISCUSSION

The indications and techniques for laparoscopic liver surgery have expanded during the past decade and today include major resections such as right and left hemihepatectomy. However, laparoscopic liver resection has remained limited for nonanatomic resections of the anterolateral and posterosuperior segments. This is because of

concerns regarding the risks of bleeding and of jeopardizing oncologic principles by not achieving adequate margins, as well as difficulty in replicating the basic maneuvers of open liver resection (i.e., mobilization of the liver and maintaining vascular control) laparoscopically.<sup>8</sup> Starting in the late 1990s, published series showed that laparoscopic resection of select hepatic lesions not only is safe but also often has a better postoperative outcome than similar open procedures.<sup>1,3,5,9</sup> Biertho et al.<sup>12</sup> confirmed the safety of the laparoscopic approach for resection of minor hepatic lesions in a review of 186 laparoscopic liver resections between 1991 and 2001, showing a morbidity rate of 16%. More recent series have shown increasing rates of laparoscopy for resection of nonmalignant lesions, especially in the noncirrhotic liver.<sup>5,13–16</sup> Most series report that the laparoscopic approach to malignant hepatic lesions has been more narrow if these lesions often occur in patients with less hepatic reserve, such as patients with chronic liver disease, cirrhosis, or chemotherapy.<sup>13</sup> Despite this, the suitability and safety of benign and malignant lesion laparoscopic liver resection have been shown in a 2007 meta-analysis of 8 studies, which showed lower operative blood loss, fewer complications, and a shorter duration of hospital stay in the laparoscopic groups.<sup>17</sup> There are no randomized clinical trials comparing laparoscopic with open hepatic resection.<sup>18</sup>

The overall complication rate in our study was 25.8%, which corresponds to rates described in the literature.<sup>1</sup> Interestingly, the complication rate in the laparoscopic group was only 15.5%, significantly lower than that in the open cases. The incidences of pleural effusion and incisional infection were higher in the open group. Intraoperative bleeding was limited except in 3 open resection patients in whom a transfusion was required (4.8%). The incidence of significant bleeding in patients included in this study was lower than that for recent series in the literature.<sup>13,19–21</sup> Lesions adjacent to or invading large hepatic veins are recognized to be at increased risk of bleeding.<sup>22</sup> The major risk factors for significant or uncontrolled bleeding are the size and location of the lesion. Though difficult to quantify, expertise and available technology are recognized as major factors in maintaining vascular control.<sup>20,23</sup> The role of pneumoperitoneum in homeostasis and meticulous dissection enabled by laparoscopic magnification are also considered important factors contributing to decreased blood loss in laparoscopic procedures. Magnification may render laparoscopic dissection of large hepatic veins safer than in open laparotomy.<sup>13,15</sup> The use of vascular staples (with endoscopic linear staplers) for homeostasis and the use of the LigaSure device

**Table 3.**  
Complications

	Total	Laparoscopic Group	Open Group	OR <sup>a</sup>	Relative Risk	95% CI <sup>a</sup>	P Value
Cases with complications, n (male, female)	16 (11, 5)	7 (4, 3)	9 (7, 2)	6.11			.007
Mortality at 30 d, n (male, female)	1 (1, 0)	0	1 (1, 0)	5.63			.86
Mortality at 12 m, n (male, female)	3 (2, 1)	0	3 (2, 1)	19.29			.06
Blood loss, mean (male, female); range (mL)	427.4 (676.3, 240.8); 0–5000 (SD, 969.09)	95.0 (115.0, 88.4); 0–350 (SD, 88.75)	988.0 (1050.4, 850.0); 10–5000 (SD, 1450.5)				.0001
Measures of outcome, n (male, female)							
IV <sup>a</sup> pain medications >5 d	10 (7, 3)	5 (3, 2)	5 (4, 1)	3.33			.17
ICU <sup>a</sup> stay >5 d	8 (5, 3)	3 (2, 1)	5 (3, 2)	5.83			.05
Hospital stay >10 d	9 (8, 1)	3 (2, 1)	6 (6, 0)	7.64			.01
Postoperative ileus >4 d	4 (3, 1)	1 (0, 1)	3 (3, 0)	9.43			.10
Total No. of specific complications (male, female)							
Pleural effusion	2 (1, 1)	0	2 (1, 1)	12.0			.23
Incisional infection	2 (2, 0)	0	2 (2, 0)	12.0			.23
Incisional hernia	4 (1, 3)	1 (0, 1)	3 (1, 2)	9.43			.10
Hematoma requiring drainage	1 (1, 0)	0	1 (1, 0)	5.63			.86
Abscess requiring drainage	1 (1, 0)	0	1 (1, 0)	5.63			.86
Upper GI <sup>a</sup> bleed requiring EGD/epi <sup>a</sup>	2 (2, 0)	1 (1, 0)	1 (1, 0)	2.75			.94
Bile duct stricture requiring ERCP <sup>a</sup>	1 (1, 0)	0	1 (1, 0)	5.63			.86
CBD <sup>a</sup> obstruction	1 (1, 0)	0	1 (1, 0)	5.63			.86
Bile leak	1 (0, 1)	1 (0, 1)	0	0			.61
Ascites requiring drainage	5 (4, 1)	3 (2, 1)	2 (2, 0)	1.86			.89
Retained drain requiring procedure	1 (1, 0)	1 (1, 0)	0	0			.61
Having a complication in open group vs laparoscopic group					5.29	1.83–15.34	.003
Having [me]1 measure of poor outcome in open group vs laparoscopic group					3.67	1.48–9.07	.008

<sup>a</sup>CBD=common bile duct; CI=confidence interval; EGD/epi=esophagogastroduodenoscopy/episode; ERCP=endoscopic retrograde cholangiopancreatography; GI=gastrointestinal; ICU= intensive care unit; IV=intravenous; OR=odds ratio.

**Table 4.**  
Intraoperative and Postoperative Results by Location of Resection

	Anterolateral Group		Posterosuperior (PS and AL+PS) <sup>a</sup>		Other Resection Cases	
	Lap <sup>a</sup>	Open	Lap	Open	Lap	Open
Conversion, n	3	NA <sup>a</sup>	2	NA	0	NA
Blood loss requiring transfusion	0	0	0	0	0	1 (1, 0)
4 U, n (male, female)						
Mortality within 30 d after operation, n (male, female)	0	0	0	1 (1, 0)	0	0
Mortality within 12 m, n (male, female)	0	2 (1, 1)	0	1 (1, 0)	0	0
IV <sup>a</sup> pain medication	4 (2, 2)	2 (2, 0)	1 (1, 0)	2 (1, 1)	0	1 (1, 0)
5 d, n (male, female)						
ICU <sup>a</sup> stay 5 d, n (male, female)	2 (1, 1)	1 (1, 0)	1 (1, 0)	4 (2, 2)	0	0
Hospital stay 10 d, n (male, female)	2 (1, 1)	2 (2, 0)	1 (1, 0)	2 (2, 0)	1 (1, 0)	1 (1, 0)
Postoperative ileus	1 (0, 1)	2 (2, 0)	0	1 (1, 0)	0	0
4 d, n (male, female)						
Complications, n (male, female)						
Pleural effusion	0	0	0	2 (1, 1)	0	0
Incisional infection	0	0	0	1 (1, 0)	0	1 (1, 0)
Incisional hernia	0	1 (0, 1)	1 (0, 1)	1 (0, 1)	0	1 (1, 0)
Hematoma requiring drainage	0	0	0	1 (1, 0)	0	0
Abscess requiring drainage	0	0	0	1 (1, 0)	0	0
Upper GI <sup>a</sup> bleed requiring EGD/epi <sup>a</sup>	1 (1, 0)	1 (1, 0)	0	0	0	0
Bile duct stricture requiring ERCP <sup>a</sup>	0	0	0	1 (1, 0)	0	0
CBD <sup>a</sup> obstruction	0	0	0	1 (1, 0)	0	0
Bile leak requiring drainage	1 (0, 1)	0	0	0	0	0
Ascites requiring drainage	1 (1, 0)	1 (1, 0)	2 (1, 1)	1 (1, 0)	0	0
Retained drain requiring procedure	0	0	0	1 (1, 0)	0	0
Total complications (n = 21)	3 (2, 1)	3 (2, 1)	3 (1, 2)	10 (8, 2)	0	2 (2, 1)

<sup>a</sup>AL=anterolateral segments; CBD=common bile duct; ERCP=endoscopic retrograde cholangiopancreatography; EGD/epi=esophagogastroduodenoscopy/episode; GI=gastrointestinal; ICU= intensive care unit; IV=intravenous; Lap=laparoscopic; NA=not applicable; PS=posterosuperior segments.

to advance toward large vascular structures in the deeper parenchyma may also decrease the risk of bleeding.<sup>13,22,23</sup>

As hepatobiliary surgical teams gain experience with laparoscopic techniques, a significant percentage of liver resections may be accomplished laparoscopically. At our center, greater than two-thirds of the liver resections are performed by a laparoscopic approach. In this study only 11.1% of cases in the laparoscopic group required conversion to open resection. The reasons for conversion were unsatisfactory visualization and an inadequate mar-

gin of resection. The latter is likely because of the inability of the surgeon to palpate lesions with a laparoscopic approach, resulting in difficulty identifying an optimal margin.<sup>18,24,25</sup> The conversion rate in this study was low relative to that reported in the literature.<sup>15,20,26,27</sup> One relative contraindication to the laparoscopic approach in our experience has been previous upper abdominal surgery and the resultant adhesions.

Despite the increasing use of laparoscopy for hepatic procedures, the surgical techniques have been largely limited to patients who have lesions confined to the an-



terolateral segments of the liver.<sup>18</sup> This is primarily because laparoscopic liver resection of the posterosuperior segments is associated with poorer access and visualization compared with open resection.<sup>18,28</sup> To a large degree, lesions located in the posterosuperior segments of the liver are still considered relative contraindications to laparoscopy.<sup>13,15,18,29</sup> Of note, the posterosuperior group in our study had a greater number of tumors that involved >1 segment, as well as a greater proportion of deep-seated tumors requiring longer and more complicated procedures, than anterolateral cases. This may contribute to the greater number of complications and poor measures of outcome in the posterosuperior groups relative to the anterolateral groups. Interestingly, our study shows a significantly greater proportion of complications and poor measures of outcome in the open posterosuperior resection group than in the laparoscopic group. This observation may be tempered by the fact that most of the open posterosuperior resection recipients had a greater number of lesions overall (9 of 10 open posterosuperior resection patients had  $\geq 2$  lesions). Another potential limitation of the study is the smaller number of open cases. This indicates the value of developing a multicenter outcomes database as opposed to relying on single-center studies.

Although the demographic differences between the groups in this study were not statistically significant, a greater proportion of women underwent laparoscopic liver resections (57.8%) and a greater number of men underwent open resections (70.6%). Sex was not considered an indication or contraindication for either surgical approach. It is not clear from this analysis why more male patients had open resections, although it is possible that body habitus played a role. In larger male patients, some resections may not be amenable to resection given current limitations of laparoscopic instruments. Studies have noted that male sex is an independent risk factor for liver failure after hepatectomy, although other hepatic resection complications associated with sex have not been elucidated.<sup>30</sup> In our study, when the open and laparoscopic resection groups are stratified by sex, some of the differences in complications and measures of poor outcome between the open and laparoscopic resections do show statistical significance. Nonetheless, male patients undergoing open hepatic resection in this study show a significantly greater proportion of poor measures of outcome (most notably longer hospital stay) than those undergoing laparoscopic resection. Laparoscopic and open complications and outcomes stratified by sex are shown in **Table 5**.

For patients in whom hepatic reserve was a consideration, such as patients with chronic liver disease or cirrhosis, non-anatomic resections or tumorectomies are preferred as opposed to anatomic lobectomies. Nonanatomic resections in these segments can be considered major liver resections because of challenges with exposure, as well as the transection line, which is often curved.<sup>13,20</sup> One series by Dagher et al.<sup>13</sup> noted that nonanatomic resections in the posterosuperior segments are more difficult than other major resections (right hemihepatectomy, left hemihepatectomy, left lateral segmentectomy). They noted that nonanatomic resections in these segments resulted in more profuse bleeding, greater transfusion requirements, and more frequent conversion. Other series have recommended the hand-assisted laparoscopic technique for resection in these segments to improve exposure and assist in transection.<sup>18,31</sup> The hand-assisted technique allows for digital palpation that is usually not possible in laparoscopy, as well as manual control of bleeding. The hand-assisted technique does have several drawbacks including being generally more invasive, having a greater risk of air leakage, and causing operator fatigue.<sup>32</sup>

Laparoscopic liver surgery is being used with increasing frequency by abdominal surgery programs worldwide.<sup>1</sup> In the past 3 years, an increasing percentage of left lateral segmentectomies have been performed by laparoscopy.<sup>13</sup> A greater number of left and right hemihepatectomies are also being performed laparoscopically in select centers.<sup>13</sup> In our study 1 of the 2 left lateral sectionectomies and 3 of the 4 left hemihepatectomies were performed laparoscopically. Our analysis shows that laparoscopic liver resection can be considered as safe as open liver resection for most patients with lesions located in both the anterolateral and posterosuperior segments of the liver if performed by surgeons with the requisite expertise and experience in laparoscopy. Because laparoscopic liver resection is still in its nascency, further technologic innovations will be required before the laparoscopic approach can be considered the standard for the surgical resection of hepatic lesions.<sup>32</sup> The expansion of the use of laparoscopy for liver resection is limited by the necessity of specialized surgical training, as well as fear of loss of vascular control, but the scope of the laparoscopic approach will continue to expand to be considered suitable for any resection of hepatic tumors.<sup>33</sup> The lower operative and postoperative blood loss, shortened intensive care unit stay and overall hospital stay, shortened duration of postoperative ileus, and smaller incidence of complications and postoperative morbidities have significant ramifications in terms of reducing overall morbidity and health care costs.

**Table 5.**  
Complications by Sex

	Total	Lap <sup>a</sup> Group	Open Group	OR <sup>a</sup>	Relative Risk	95% CI <sup>a</sup>	P Value
Cases with complications, male, n	11	4	7	5.25			.08
Cases with complications, female, n	5	3	2	5.11			.36
Mortality at 30 d, male, n	1	0	1	3.46			.90
Mortality at 30 d, female, n	0	0	0	5.20			.64
Mortality at 12 m, male, n	2	0	2	7.60			.46
Mortality at 12 m, female, n	1	0	1	13.0			.55
Measures of outcome, n							
IV <sup>a</sup> pain medications 5 d, male	7	3	4	2.67			.49
IV pain medications 5 d, female	3	2	1	3.0			.98
ICU <sup>a</sup> stay 5 d, male	5	2	3	2.83			.57
ICU stay 5 d, female	3	1	2	16.67			.09
Hospital stay 10 d, male	8	2	6	8.5			.04
Hospital stay 10 d, female	1	1	0	2.5			.56
Postoperative ileus 4 d, male	3	0	3	12.67			.17
Postoperative ileus 4 d, female	1	1	0	2.5			.56
Total No. of specific complications							
Pleural effusion, male	1	0	1	3.45			.90
Pleural effusion, female	1	0	1	13.0			.55
Incisional infection, male	2	0	2	7.6			.46
Incisional infection, female	0	0	0	5.2			.64
Incisional hernia, male	1	0	1	3.46			.90
Incisional hernia, female	3	1	2	16.67			.09
Hematoma requiring drainage, male	1	0	1	3.46			.90
Hematoma requiring drainage, female	0	0	0	5.2			.64
Abscess requiring drainage, male	1	0	1	3.46			.90
Abscess requiring drainage, female	0	0	0	5.2			.64
Upper GI <sup>a</sup> bleed requiring EGD/epi <sup>a</sup> , male	2	1	1	1.64			.68
Upper GI bleed requiring EGD/epi, female	0	0	0	5.2			.64
Bile duct stricture requiring ERCP <sup>a</sup> , male	1	0	1	3.46			.90
Bile duct stricture requiring ERCP, female	0	0	0	5.2			.64
CBD <sup>a</sup> obstruction, male	1	0	1	3.46			.90
CBD obstruction, female	0	0	0	5.2			.64
Bile leak, male	0	0	0	1.58			.42
Bile leak, female	1	1	0	2.5			.56
Ascites requiring drainage, male	4	2	2	1.7			.96
Ascites requiring drainage, female	1	1	0	2.5			.56
Retained drain requiring procedure, male	1	1	0	0.75			.49
Retained drain requiring procedure, female	0	0	0	5.2			.64



**Table 5. (continued)**

Complications by Sex

	Total	Lap <sup>a</sup> Group	Open Group	OR <sup>a</sup>	Relative Risk	95% CI <sup>a</sup>	P Value
Having a complication in open group vs lap group, male					2.77	0.66–11.52	.28
Having a complication in open group vs lap group, female					3.47	0.46–26.37	.52
Having [me]1 measure of poor outcome in open group vs lap group, male					3.62	1.15–11.37	.05
Having [me]1 measure of poor outcome in open group vs lap group, female					3.12	0.56–17.46	.40

<sup>a</sup>CBD=common bile duct; CI=confidence interval; EGD/epi=esophagogastroduodenoscopy/episode; ERCP=endoscopic retrograde cholangiopancreatography; GI=gastrointestinal; ICU= intensive care unit; IV=intravenous; Lap=laparoscopic; OR=odds ratio.

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