Oncological Efficiency Analysis of Laparoscopic Liver Resection for Primary and Metastatic Cancer

A Single-Center UK Experience

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Objective: To assess the oncological efficiency of laparoscopic minor and major hepatectomy for primary and metastatic liver malignant neoplasms.

Design: Retrospective single-center study.

Setting: Tertiary university hospital.

Patients: One hundred twenty-eight patients undergoing 133 laparoscopic liver resections for malignant diseases.

Main Outcome Measures: Perioperative results and midterm overall and disease-free survival.

Results: Surgical indications were colorectal carcinoma liver metastasis (n=83), hepatocellular carcinoma (n=18), neuroendocrine tumor metastasis (n=17), non–colorectal carcinoma liver metastasis (n=11), lymphoma (n=2), and intrahepatic cholangiocarcinoma (n=2). Two patients had 2-stage laparoscopic resections for bilobar colorectal carcinoma liver metastasis. Three patients had repeated liver resection for recurrent colorectal carcinoma liver metastasis. Forty-two major hepatectomies (32%) were performed. The median operative time was 210 minutes (range, 30-480 minutes). The median postoperative length of stay was 4 days (range, 1-15 days). Seven patients required conversion to formal open surgery and 4 patients required conversion to a laparoscopic-assisted procedure. Sixteen patients (13%) developed significant postoperative complications. One patient (0.8%) died in the hospital. In the 17 patients with neuroendocrine tumor metastasis, 6 (35%) had microscopic positive resection margins. Most of these patients underwent debulking and cytoreductive surgery. A microscopic negative resection margin was obtained in the remaining 112 of 116 resections (97%). We recorded 2-year overall survivals of 80%, 77%, and 91% in the groups with colorectal carcinoma liver metastasis, hepatocellular carcinoma, and neuroendocrine tumor metastasis, respectively.

Conclusions: Our data support the safety and oncological efficiency of laparoscopic resection for liver malignant neoplasms. Adequate patient selection and extensive experience in hepatic and laparoscopic surgery are essential prerequisites to optimize outcomes.

Arch Surg. 2012;147(1):42-48

Adoption of the laparoscopic approach for the surgical treatment of hepatic lesions is progressively expanding. This has been made possible by the encouraging results of earlier pioneering studies on minor liver resections suggesting that minimally invasive liver surgery is safe and offers significant advantages in terms of less blood loss, less pain and analgesic drug consumption, shorter hospital stay, and improved cosmetic results compared with open surgery.[1-6] Most laparoscopic resections were originally performed for benign lesions.[7,8] This appeared appropriate especially when considering initial concerns regarding tumor dissemination, incomplete tumor resections, and involved margins.[9-12]

See Invited Critique at end of article

To date, there is ongoing debate on whether the minimally invasive approach could be a valid alternative to open surgery in the treatment of primary and metastatic liver malignant neoplasms, particularly when major hepatectomies are required. Comparative studies are often criticized on the basis that the candidates for laparoscopic hepatectomy are usually highly selected and therefore not easily comparable in a retrospective manner with counterparts undergoing open surgery. On the other hand, most investigators recog-

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nize that conducting a proper randomized clinical trial could be a challenging task[1] considering the high number of patients required to gain appropriate statistical power and the potential difficulty in recruiting patients for open surgery in an accredited laparoscopic liver center, especially when a minor resection is planned.

Recent updated meta-analyses aimed to provide stronger evidence in favor of laparoscopic liver surgery by analyzing large numbers of pooled data. However, their conclusions are limited by the fact that most of the data come from retrospective studies including mainly minor liver resections.[13,14] Therefore, the advantages of laparoscopic surgery when dealing with complex oncological cases and/or when major hepatectomy is necessary remain to be confirmed.

Laparoscopic major hepatectomy requires both extensive liver surgery experience and advanced laparoscopic expertise.[15,16] This explains why few liver centers perform laparoscopic major liver resections at this time.

Data from large series including primary and metastatic liver malignant neoplasms and major liver procedures are required to provide adequate evidence and guarantee the safe expansion of minimally invasive liver surgery.

The aim of this study is to assess the oncological efficiency of laparoscopic minor and major hepatectomy when dealing with primary and metastatic liver malignant neoplasms in a large single-center series.

METHODS

We reviewed a prospectively collected database of 128 patients undergoing 133 attempted pure laparoscopic liver resections for malignant diseases between August 2003 and August 2010. Main outcome measures were perioperative results and midterm overall and disease-free survival.

Routine blood tests, ultrasonography of the abdomen, computed tomography of the abdomen with triphasic liver contrast enhancement, and liver-specific double-contrast magnetic resonance imaging were performed, and the findings were reviewed in all patients. Prior to surgery, each case was individually evaluated at an open multidisciplinary team meeting with surgeons, pathologists, oncologists, gastroenterologists, and radiologists. Inclusion criteria were good performance status, absence of significant extrahepatic disease, resectable liver disease, and sufficient functional parenchymal remnant. The criteria for considering a liver lesion unsuitable for laparoscopic resection were the following: tumors within 2 cm of the portal vein bifurcation, the inferior vena cava, or the hepatic vein caval confluence; tumors involving the common hepatic duct; large fixed tumors; and cirrhosis of Child-Pugh category B or C.

We analyzed patient demographic characteristics, indication for surgery, type of resection, intraoperative blood loss (calculated by measuring the volume of blood in the suction bottles, after subtracting wash fluid at the end of surgery with the addition of weighed swabs), duration of surgery, conversion rate, resection margins, length of stay in a high-dependency unit, postoperative length of stay, postoperative complications, and mortality (within 30 days from surgery). Operative results and postoperative variables were analyzed by minor and major hepatectomy (eg, trisegmentectomy, right hepatectomy, or left hepatectomy)[17] where appropriate.

Two laparoscopic hepatobiliary-pancreatic surgeons (M.A.H. and N.W.P.) were involved in this series, and standard nomenclature was used to describe the resection performed.[18] Pure laparoscopic procedures were attempted in all patients. No hybrid techniques[17] were used.

SURGICAL TECHNIQUE

Our group has previously described in detail the techniques for segmentectomies, left lateral sectionectomy, and major hemihepatectomy.[16,19,20] Briefly, patients are positioned in the supine position with the surgeon standing on the patient's right for left-sided lesions, to the patient's left for right-sided lesions, and between the legs for hemihepatectomy. A 12-mm periumbilical port is placed for a 30° laparoscope. Other ports are positioned appropriately in the upper abdomen to allow optimal mobilization and dissection of the liver. For most cases, we use three 12-mm and two 5-mm ports. Pneumoperitoneum is established by maintaining an intraperitoneal pressure of 12 to 14 mm Hg and a differential pressure with the central venous pressure of 5 to 8 mm Hg. After laparoscopic evaluation of the liver, laparoscopic liver ultrasonography is used to determine the location and extent of intraparenchymal lesions, exclude the presence of unknown lesions, and identify potentially hazardous intrahepatic vascular and biliary structures. The inflow control is obtained extraparenchymally. A 5-mm nylon tape is loosely applied around the portal triad and then passed through an 8- to 10-cm-long 14-French plastic tube, with the ends brought out alongside the right lateral port. This is achieved after obtaining access to the foramen of Winslow by opening the gastrohepatic ligament and lifting the liver up by holding the falciform ligament and gallbladder fundus. The tape is held on an atraumatic grasper introduced through the right lateral port, passed between the vena cava (posteriorly) and the portal vein (anteriorly), and then picked up with another grasper introduced through the left lateral port. The appropriate resection line is marked with diathermy and can be seen on ultrasonography as casting a hyperechoic acoustic shadow into the liver parenchyma. Parenchymal transection is achieved using Laparoscopic Operation by Torsional Ultrasound (LOTUS; SRA Developments Ltd) or a harmonic scalpel (Harmonic ACE; Ethicon Endo-Surgery) in combination with a Cavitron Ultrasonic Surgical Aspirator (Valleylab). These permit safe dissection of the biliovascular structures, which are then divided between clips, Hem-o-Lock clips (Weck Closure Systems), or endoscopic staplers as required. The Pringle maneuver is used intermittently (10-15 minutes on and 5 minutes off), usually when more than 2 segments are excised. Resection margins are examined carefully for bleeding and bile leakage. Any bile leakage is controlled with Prolene 4-0 sutures or with clips if a duct with pedicle is clearly identified. Hemostasis is obtained using monopolar or bipolar diathermy for small bleeding points and with clips and Prolene sutures for any substantive bleeding. Hemostatic products such as fibrillar collagen and fibrin glue (Evicel; Johnson & Johnson Wound Management) are routinely applied to the cut liver surface to promote biliostasis and hemostasis. Prior to completion of the operation, the central venous pressure and blood pressure are restored to normal physiological parameters and a Valsalva maneuver is performed to confirm hemostasis. The specimen is removed in impermeable bags (Endocatch; Ethicon Endo-Surgery) introduced through a 15-mm suprapubic port that is subsequently extended to a Pfannenstiel incision.

STATISTICAL ANALYSIS

The analyses were performed using Stata for Windows version 7.0 statistical software (StataCorp LP). Median values and ranges were considered for continuous variables as their values' distribution was skewed. The nonparametric Mann-

Whitney test was used to compare continuous variables, and χ^2 or Fisher exact test was applied for analysis of categorical variables. Overall and disease-free survivals were analyzed by the Kaplan-Meier method. Survival was calculated from the date of surgery until the date of death or the time of manuscript preparation for those patients known to be alive. The level of statistical significance was set at $P < .05$.

RESULTS

Between August 2003 and August 2010, 215 patients underwent laparoscopic liver resection in our unit. Of these, 133 pure laparoscopic excisions for malignant diseases were attempted in 128 patients (52 women and 76 men). The median age of the patients was 65 years (range, 32-85 years).

Indications for surgery were colorectal carcinoma liver metastasis (CRCLM; n=83), hepatocellular carcinoma (HCC; n=18), metastatic neuroendocrine tumor (NET; n=17), non-CRCLM (n=11), intrahepatic cholangiocarcinoma (n=2), and uncertain preoperative diagnosis (n=2). The definitive histological finding of the last 2 cases was lymphoma. In the HCC group, 10 (56%) had liver cirrhosis. The non-CRCLM group included patients with metastasis from gastrointestinal stromal tumor (n=3), renal cell carcinoma (n=3), breast cancer (n=1), pancreatic cancer (n=1), lung cancer (n=1), melanoma (n=1), and Ewing sarcoma (n=1).

Table 1. Laparoscopic Surgical Procedures

Type of Resection	No. (n=133)
Wedge excision	42
Single segmentectomy	10
Bisegmentectomy	9
Left lateral sectionectomy	30
Trisegmentectomy	2
Right hepatectomy[a]	34
Left hepatectomy[b]	6

[a] Includes 3 right extended hepatectomies.
[b] Includes 2 with segment 1 resection.

Forty-two major hepatectomies (32%) were performed, including 34 right hepatectomies, 6 left hepatectomies, and 2 trisegmentectomies. Left hepatectomy was associated with caudate lobe resection in 2 cases (intrahepatic cholangiocarcinoma). The types of resections performed are summarized in **Table 1**.

Notably, 3 patients had repeated liver resection for recurrent CRCLM and 2 patients had 2-stage pure laparoscopic resections for bilobar CRCLM. Patients in whom a 2-stage procedure was planned underwent clearing of the less diseased lobe (the left) during the first stage and had resection of the contralateral lobe performed after allowing time for ipsilateral lobe hypertrophy. Occlusion of the contralateral portal vein branches by radiological embolization was performed in both cases to stimulate hypertrophy of the future liver remnant.

A total of 7 patients required conversion to formal open surgery (5 with CRCLM and 2 with HCC) and 4 patients required conversion to a laparoscopic-assisted surgery after laparoscopic completion of the transection (2 with CRCLM and 2 with HCC) (**Table 2**). Laparoscopic-assisted surgery involves either mini-laparotomy in the right upper quadrant to complete the procedure or insertion of a handport. Reasons for conversions were difficulty controlling bleeding, failed hilar dissection, failure to locate tumor with intraoperative ultrasonography, and difficulty in manipulating a large tumor.

The median overall operative time was 210 minutes (range, 30-480 minutes), with a median blood loss of 300 mL (range, 10-3000 mL). The median postoperative length of stay was 4 days (range, 1-15 days), with a median of 1 day in the high-dependency unit (range, 0-10 days). Surgical results and postoperative course analyzed by liver disease, and minor or major hepatectomy where appropriate, are summarized in Table 2 and **Table 3**.

Major postoperative complications occurred in 16 cases (13%). Severe postoperative bleeding requiring intensive care management or exploratory laparoscopy or lapa-

Table 2. Demographic Characteristics and Surgical Results

Variable	CRCLM (n=83)	HCC (n=18)	NET Metastasis (n=17)	Non-CRCLM (n=11)	Lymphoma (n=2)	Intrahepatic Cholangiocarcinoma (n=2)
Female/male, No.	30/53	6/12	10/7	6/5	1/1	0/2
Age at operation, median (range), y	66 (32-85)	64 (21-78)	65 (41-78)	67 (33-78)	53.5 (44-63)	80 (79-81)
Major hepatectomy, No. (%)	27 (33)	5 (28)	5 (29)	3 (27)	0	2 (100)
Conversions, No. (%)[a]	7 (8)	4 (22)	0	0	0	0
Minor hepatectomy	2 (4) (n=56)	2 (15) (n=13)				
Major hepatectomy	5 (19) (n=27)[b]	2 (40) (n=5)				
Estimated blood loss, median (range), mL	300 (20-3000)	350 (10-3000)	100 (10-4000)	200 (25-600)	75 (50-100)	345 (300-390)
Minor hepatectomy	175 (20-1400)	325 (10-2500)	70 (10-4000)	200 (25-600)		
Major hepatectomy	875 (75-3000)[c]	1500 (250-3000)	450 (50-800)	325 (250-400)		
Operative time, median (range), min	220 (40-540)	240 (30-480)	165 (30-420)	120 (45-290)	52.5 (45-60)	335 (310-360)
Minor hepatectomy	180 (40-340)	195 (30-420)	130 (45-360)	105 (45-240)		
Major hepatectomy	330 (180-540)[c]	330 (240-480)[b]	330 (30-420)	280 (270-290)[b]		

Abbreviations: CRCLM, colorectal carcinoma liver metastasis; HCC, hepatocellular carcinoma; NET, neuroendocrine tumor.
[a] Includes conversion to formal open surgery (n=7) and laparoscopic-assisted surgery (n=4, of which 2 were in patients with CRCLM and 2 were in patients with HCC).
[b] Significant difference between minor and major hepatectomy ($P < .05$).
[c] Significant difference between minor and major hepatectomy ($P < .01$).

Table 3. Postoperative Course

Variable	CRCLM (n=83)	HCC (n=18)	NET Metastasis (n=17)	Non-CRCLM (n=11)	Lymphoma (n=2)	Intrahepatic Cholangiocarcinoma (n=2)
Length of stay, median (range), d						
High-dependency unit or intensive care unit	1 (0-10)	1 (0-8)	1 (0-4)	1 (0-2)	1 (1-1)	3.5 (1-6)
Minor hepatectomy	1 (0-5)	1 (0-8)	1 (0-4)	1 (0-2)		
Major hepatectomy	1 (0-10)[a]	2 (1-8)	1 (1-3)	1		
Postoperative	4 (1-15)	4 (1-12)	4 (1-8)	3 (2-5)	2 (2-2)	6 (4-8)
Minor hepatectomy	3 (1-15)	4 (1-12)	4 (1-8)	3 (2-5)		
Major hepatectomy	5 (2-12)[b]	4 (3-7)	5 (3-7)	3		
Patients with major postoperative complications, No. (%)	9 (11)	3 (17)	2 (12)	1 (9)	0	1 (50)
Minor hepatectomy	4 (7) (n=56)	1 (8) (n=13)	0 (n=12)	1 (13) (n=8)		
Major hepatectomy	5 (19) (n=27)	2 (40) (n=5)	2 (40) (n=5)[a]	0 (n=3)		

Abbreviations: CRCLM, colorectal carcinoma liver metastasis; HCC, hepatocellular carcinoma; NET, neuroendocrine tumor.
[a] Significant difference between minor and major hepatectomy ($P<.05$).
[b] Significant difference between minor and major hepatectomy ($P<.01$).

Table 4. Characteristics of Malignant Lesions and Resection Margins

Variable	CRCLM (n=83)	HCC (n=18)	NET Metastasis (n=17)	Non-CRCLM (n=11)	Lymphoma (n=2)	Intrahepatic Cholangiocarcinoma (n=2)
No. of lesions/specimen, No. (%)						
1	54 (65)	14 (78)	2 (12)	6 (55)	1 (50)	2 (100)
2	21 (25)	1 (6)	4 (24)	3 (27)	0	0
≥3	8 (10)	3 (17)	11 (65)	2 (18)	1 (50)	0
Size of largest lesion, median (range), mm	25 (5-105)	40 (5-140)	25 (5-65)	37 (9-120)	22 (18-26)	15 (5-25)
Microscopic positive resection margins, No. (%)	3 (4)	1 (6)	6 (35)	0	0	0

Abbreviations: CRCLM, colorectal carcinoma liver metastasis; HCC, hepatocellular carcinoma; NET, neuroendocrine tumor.

rotomy was the most common complication (5 cases). Bile leakage requiring computed tomography–guided drainage occurred in 2 patients. Two further patients developed right upper quadrant abscess that healed after computed tomography–guided drainage. One patient had a splenic traction injury during surgery, requiring delayed laparoscopic splenectomy as bleeding was difficult to control. Two patients developed intraoperative pneumothorax requiring chest drain. Small-bowel obstruction requiring readmission occurred in 2 patients (1 after concomitant colon resection). Both patients were treated conservatively. One patient needed temporary hemofiltration as a consequence of acute renal failure. In-hospital mortality was 0.8%. One patient with liver cirrhosis who underwent a wedge resection of segment 5 for HCC died after developing bleeding from esophageal varices.

In the group of 17 patients undergoing laparoscopic liver resection for NET metastases, 6 (35%) had R1 resection (microscopic positive margins). Most of these patients underwent debulking and cytoreductive surgery with predetermined palliative intent for control of low-grade tumors with secretory symptoms rather than radical excision. In the remaining 116 resections, R0 resection (microscopic negative margins) was obtained in 112 (97%), with a median tumor-free resection margin of 12 mm (**Table 4**). The median tumor-free resection margin was 15 mm after major hepatectomy vs 10 mm after minor hepatectomy ($P=.13$, Mann-Whitney test).

The median follow-up of patients was 22 months for CRCLM, 26.5 months for HCC, 21 months for NET metastasis, 14 months for non-CRCLM, 50.5 months for lymphoma, and 10 months for intrahepatic cholangiocarcinoma. The median overall survival has not yet been reached. There have been 25 deaths during follow-up: 17 (22%) among patients with CRCLM, 3 (18%) among patients with HCC, 3 (18%) among patients with NET metastasis, 1 (9%) among patients with non-CRCLM, 1 (50%) among patients with cholangiocarcinoma, and none among patients with lymphoma. We recorded an 80% 2-year overall survival and a 64% disease-free survival in the CRCLM group; a 77% 2-year overall survival and a 72% disease-free survival in the HCC group (**Figure**); a 92% 2-year overall survival in the NET metastasis group; and an 88% 2-year overall survival in the non-CRCLM group. The 2 patients with lymphoma are disease free at 69 and 32 months after surgery. One of the patients with cholangiocarcinoma is disease free at 12 months after surgery, and the other died 11 months after the operation.

No port-site metastasis or peritoneal seeding was observed.

COMMENT

In this study, we present a large consecutive single-center series of laparoscopic minor and major hepatec-

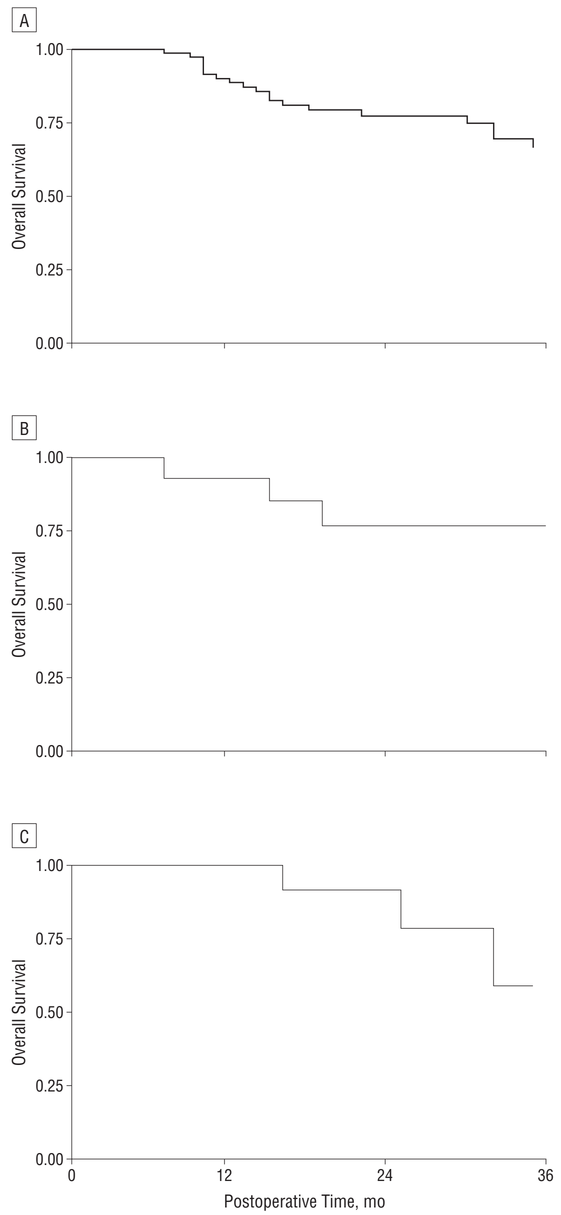

Figure. Overall survival curves (Kaplan-Meier method) of patients undergoing laparoscopic liver resection for colorectal carcinoma liver metastasis (A), hepatocellular carcinoma (B), and neuroendocrine tumor metastasis (C).

tomies for a variety of malignant liver diseases. Previously, few studies have described laparoscopic liver surgery for malignant neoplasms other than CRCLM or HCC, and these have been limited and unsystematic. Our data support the safety and oncological efficiency of minor and major liver resections when adequate patient selection is carried out and when high-volume hepatobiliary and laparoscopic surgeons are involved.

Performing major hepatectomy laparoscopically still represents an area of great concern among liver surgeons.[15,17,21] Technical complexity and fear of uncontrolled bleeding[22] have dissuaded many surgeons from embarking in this direction. Unsurprisingly, we showed that major hepatectomy carries higher risk of blood loss, higher conversion rate, longer operative time, and slightly longer length of stay compared with minor hepatectomy. In particular, hemorrhage is considered the "Achilles heel" of laparoscopic major liver surgery, and the quest for bloodless liver resections is still ongoing. We previously described in detail our techniques for preventing bleeding and the measures for managing hemorrhages when they occur.[22] However, when hemostasis is not easily achieved, we maintain a low threshold for conversion.

Safety was not compromised, as demonstrated by the low rate of major postoperative complications. Our results compare very favorably with the largest open liver surgery series reporting bile leakage in 4%, perihepatic abscess in 3%, and postoperative hemorrhage in 2.7% of patients, with a postoperative mortality rate ranging from 0% to 6.6%.[23] The only postoperative mortality we observed was due to a severe hemorrhage from esophageal varices in a patient who underwent segment 5 wedge resection for HCC.

The oncological controversies in laparoscopic liver resection relate to the risk of port-site metastasis and the risk of surgical resection margin compromise. In this series, we did not observe port-site malignant seeding. Recent large series analyzing surgical margin status after open liver resections for CRCLM reported positive margins in up to 46% of patients.[24-26] We routinely used laparoscopic ultrasonography and successfully obtained a median disease-free margin of 12 mm and an R1 resection proportion of 3% (4% when considering CRCLM), excluding patients with NET metastasis. In the patients with NET metastasis, 35% had positive resection margins. Most of the patients with NET metastasis underwent debulking and cytoreductive surgery, with 65% having 3 or more lesions.

The median survival of patients with CRCLM is 6 to 9 months.[27] Hepatic resection offers long-term overall survival in up to 60% of cases, and the present indication for surgical resection of CRCLM should include all disease patterns that can be excised completely with an adequate remnant liver volume that avoids hepatic failure.[28] Herein, we report a large single-center series of laparoscopic CRCLM resections confirming excellent short-term results regarding morbidity and conversion rate. We demonstrated that the laparoscopic approach is feasible and safe even when more extreme repeated hepatectomies for recurrent CRCLM or 2-stage laparoscopic liver resections for bilobar CRCLM are required. Our survival data are comparable to other series including minor and major liver resections, showing that the laparoscopic approach is associated with adequate midterm survival.[29]

The minimally invasive approach has been suggested to be particularly suitable for the surgical treatment of HCC in patients with cirrhosis because the collateral veins of the abdominal wall are more easily preserved, resulting in less portal hypertension and improved reabsorption of ascites.[30] We use the same technique for parenchymal transection but tend to preserve the round ligament and maintain small incisions. Also, as the laparoscopic approach induces fewer adhesions than open resection, it renders repeated operations for tumor recurrence or subsequent liver transplantation less technically demanding.[30] Our observations confirm that laparoscopic liver resection is an oncologically efficient alternative to open resection for HCC with satisfactory midterm survival.[30,31]

Aggressive resection of hepatic NET metastasis has now become accepted as one of the therapeutic modalities, providing long-term palliation with a 5-year overall survival between 50% and 70%.[32] In the laparoscopic context, the major concern is that manipulation of the tumor may lead to excessive hormone release and precipitate a life-threatening carcinoid crisis. However, with routine perioperative administration of octreotide infusion, no carcinoid crises were observed in this series. The excellent 92% 2-year overall survival in the NET metastasis group justified the aggressive management and confirms the efficiency of the laparoscopic approach.

The treatment of liver metastasis from noncolorectal, nonneuroendocrine primary tumor is largely restricted to chemotherapeutic and biological therapies. Liver involvement is managed surgically only under exceptional circumstances. In the highly selected cases we observed, surgery was advocated when preoperative differential diagnosis was unclear or in the context of a multimodality treatment in which surgery represented one of the various cytoreductive therapies.[33]

Lymphoma of the liver is a very rare event.[34] We planned surgical resection in our patients as the lesions were suspicious for liver malignant neoplasms of unknown origin and because disseminated disease was excluded.

Intrahepatic cholangiocarcinoma is a rare tumor accounting for 5% to 10% of all primary malignant liver tumors, with an increasing trend particularly in the Western world.[35] The prognosis is poor, with a 5-year survival less than 40%. Surgical excision is the only effective treatment and requires extensive resection.[36] The 2 patients we described underwent a successful pure laparoscopic left hepatectomy plus caudate lobe resection and had microscopic negative resection margins.

Overall, our data including a large proportion of major hepatectomies confirm the well-established advantages of laparoscopic liver surgery in terms of reduced high-dependency unit and postoperative length of stay. This is a major achievement that contributes to lowering the cost of patients' hospitalization and favoring early return to normal life.

CONCLUSIONS

This study supports the safety and oncological efficiency of pure laparoscopic resection for primary and metastatic liver malignant neoplasms. The benefits of the laparoscopic approach can be maintained when dealing with complex liver malignant neoplasms only if adequate patient selection is achieved and extensive experience in hepatic and laparoscopic surgery is ensured.

Accepted for Publication: July 28, 2011.

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Author Contributions: Drs Abu Hilal and Di Fabio contributed equally to the scientific content of this article. *Study concept and design:* Abu Hilal, Di Fabio, Abu Salameh, and Pearce. *Acquisition of data:* Di Fabio. *Analysis and interpretation of data:* Abu Hilal and Di Fabio. *Drafting of the manuscript:* Abu Hilal and Di Fabio. *Critical revision of the manuscript for important intellectual content:* Abu Hilal, Abu Salameh, and Pearce. *Statistical analysis:* Di Fabio. *Administrative, technical, and material support:* Di Fabio. *Study supervision:* Abu Hilal, Abu Salameh, and Pearce.

Financial Disclosure: None reported.

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INVITED CRITIQUE

Laparoscopic vs Open Liver Resection

Time for a Randomized Trial

Major liver resection, although still a challenging operation, is performed on a routine basis. Advances in technology, a better understanding of liver anatomy, and concentration of skills in dedicated units have resulted in safe major resections. The fact that this operation can now be performed via the laparoscope is testament to technological innovation and skill. Laparoscopic liver resections (LLRs) are being performed routinely in several major liver centers around the world. Initially the experience was mainly with minor liver resections, but major liver resections, including right hepatectomy, for benign and malignant (primary and metastatic) disease are increasingly being reported.

Current evidence suggests that the operation can be performed safely, with morbidity and mortality equivalent to the open procedure and with lesser blood loss and earlier postoperative recovery rates. However, the oncological safety of LLR, as with any new surgical procedure for cancer, has always been a concern.

The relatively large series of patients described by Abu Hilal et al[1] is therefore important because the data confirm that LLR can achieve disease-free resection margin(s) and disease-free and overall patient survival similar to those of conventional open techniques.

For the moment, the laparoscopic technique for major liver resections should be confined to those centers that have both substantive experience with liver resection surgery and advanced laparoscopic skills. It is unlikely that LLR will be applicable to all patients, and the inclusion criteria still need to be determined.

For now, LLR appears to be as good as the open technique. Whether it is better can be addressed only in a randomized controlled trial.

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Author Contributions: *Study concept and design:* Krige and Kahn. *Drafting of the manuscript:* Krige and Kahn. *Administrative, technical, and material support:* Krige.
Financial Disclosure: None reported.

1. Abu Hilal M, Di Fabio F, Abu Salameh M, Pearce NW. Oncological efficiency analysis of laparoscopic liver resection for primary and metastatic cancer: a single-center UK experience. *Arch Surg*. 2012;147(1):42-48.