Laparoscopic Liver Resection for Benign Disease

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Hypothesis: Resection for benign liver disease can represent a valid indication for the laparoscopic approach.

Design: Prospective case series.

Setting: Tertiary referral center.

Patients: Fifty patients with benign disease underwent laparoscopic liver resection. Indications for resection included preoperative diagnosis of adenoma or cystadenoma, uncertain preoperative diagnosis, and presence of symptoms. Inclusion criteria were lesions 5 cm or less located in the peripheral segments (segments 2-6).

Intervention: Laparoscopic liver resection using a surgical technique including 5 ports, harmonic transection, stapling of large vessels, and extraction in a bag through a separate incision.

Main Outcome Measures: Intraoperative results and postoperative morbidity.

Results: Thirty-five patients (70%) presented with solid tumor; 11 (22%), with cystic lesions; and 4 (8%), with biliary disease. Tumor was solitary in 41 cases (82%) and multiple in 9 (18%). Mean (SD) surgical time was 191 (77.5) minutes (range, 30-480 minutes). There were 4 conversions (8%) and 1 patient received a transfusion (2%). There was no mortality. The postoperative morbidity rate was 10% and included only nonspecific complications. Median hospital stay was 5 days.

Conclusions: Laparoscopic liver resection for benign disease can be recommended in patients with peripheral lesions requiring limited resection. Major resections may be performed in highly select patients but require further evaluation. Specific training is required. Indications for laparoscopic resection of benign liver disease must be the same as those for open surgery. Reduction of abdominal wall damage and cosmetic advantages of the laparoscopic approach represent a clear benefit in patients with benign liver disease.

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Most indications for liver resections include malignant disease. However, about 15% of hepatectomies are performed for benign liver tumors.1,2 Laparoscopic liver resection was first reported in 1992,3 but unlike other areas of abdominal surgery, this approach has been developed in a very limited number of institutions.4-10 Except for a few studies, most of the articles reported a limited number of patients, but it has been established that in select patients, laparoscopic liver resections, if performed in institutions with expertise in hepatic surgery and advanced laparoscopic procedures, are safe, with results identical to those of open surgery.5-11,12 Resection for benign liver disease can represent a valid indication for the laparoscopic approach because of the absence of risk of tumoral dissemination. Furthermore, most of these patients are young and undergoing definitive surgery where the advantages and benefits of the laparoscopic procedure can be particularly clear.9 Indications for benign liver tumor resection include preoperative diagnosis of adenoma or cystadenoma, uncertain preoperative diagnosis, and presence of symptoms.13-17 The aim of our study was to report the results of laparoscopic liver resections for benign disease performed at a single center with 10 years of experience in laparoscopic liver surgery.

METHODS

In January 1996, a prospective evaluation of laparoscopic liver resections was initiated.9 Between May 1996 and September 2005, 514 liver resections were performed in our unit and a laparoscopic approach was used in 120 (23.3%). Indications for surgery for the 514 hepatectomies were malignant disease in 420 cases (81.7%) and benign disease in 94 (18.3%). Laparoscopic liver resections were performed in 50 of the 94 patients (53.2%) with benign liver disease and they are the subject of this study.
Indications for laparoscopic resection of benign liver tumors were not different from those for the open approach: preoperative diagnosis of adenoma and cystadenoma, uncertain diagnosis on imaging or biopsy, and presence of symptoms. The laparoscopic approach was chosen with regard to the size and location of the lesion. Size of the lesions was 5 cm or less in diameter, except for pedunculated lesions, which could be larger. Only lesions that were located in the left or peripheral right segments of the liver (Couinaud segments 2-6) were included. Large tumors, tumors close to the major vascular structures, and those located in the posterior or central segments were excluded. Exclusion criteria for the laparoscopic approach are shown in Table 1.

Liver resections were defined according to International Hepato-Pancreato-Biliary Association terminology derived from the Couinaud classification. Resection of 3 or more segments was classified as major hepatectomy.

The surgical technique for laparoscopic liver resection used in our unit has been previously described. Briefly, the procedures were performed with pressure-controlled carbon dioxide pneumoperitoneum, maintained lower than 12 mm Hg. In all cases, a 30° laparoscope and 5 trocars were used (Figure). Liver transection was performed using a harmonic scalpel (Ultracision; Ethicon Endo-surgery, Issy-Les-Moulineaux, France) and ultrasonic dissector (Dissectron; Satelec, Merignac, France). Small vascular or biliary pedicles were divided after bipolar coagulation or between clips. Portal pedicles and major hepatic veins were divided using a linear stapler (EndoGIA, Tyco, Paris, France). The portal pedicle was systematically encircled with tape to allow intermittent clamping (15-minute clamping and 5-minute release periods) if required. The resected specimen was moved into a plastic bag through a Pfannenstiel incision or through a previous appendectomy incision. Abdominal drainage was usually omitted. More recently, the hand-assisted procedure was used for right hepatectomy, using a gas-tight device (Lap Disc; Ethicon Endo-surgery) inserted through an 8-cm, right, lower quadrant incision. The 10- and 12-mm port sites were closed using absorbable suture material. Recently, we have used noncutting trocars not requiring closure.

**RESULTS**

Characteristics of the 50 patients are summarized in Table 2. The mean age of the patients was 44 years (range, 15-79 years). Twelve patients (24%) were younger than 35 years and 84% (42) of the patients were female.

![Figure](typical5portplacementforlaparoscopicliverresection.png)

*Figure. Typical 5-port placement for laparoscopic liver resection. The patient is in the supine position with lower limbs apart, the surgeon between the legs. The specimen is extracted through a suprapubic incision or a previous appendectomy incision.*

<table>
<thead>
<tr>
<th>Table 2. Patient Characteristics</th>
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<tbody>
<tr>
<td><strong>Characteristic</strong></td>
</tr>
<tr>
<td>Age, y, mean (SD) [range]</td>
</tr>
<tr>
<td>Sex</td>
</tr>
<tr>
<td>M</td>
</tr>
<tr>
<td>ASA score</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>Tumor location</td>
</tr>
<tr>
<td>Right lobe</td>
</tr>
<tr>
<td>Left lobe</td>
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<tr>
<td>Bilobar</td>
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Abbreviation: ASA, American Society of Anesthesiologists.

The tumor was solitary in 41 cases (82%), while 3 patients (6%) presented with 2 nodules. In the other 6 patients (12%), there were multiple tumors. The lesions were located as follows: 18 in the right liver, 30 in the left liver, and 2 in both lobes. The lesion was located in a posterior segment (segment 7) in 1 patient. The lesion was hepatocellular adenoma and the patient underwent laparoscopic right hepatectomy by hand-assisted procedure. Mean (SD) tumor size measured on the surgical specimen was 50 (27) mm (range, 18-120 mm) (Table 2).

Table 1. Exclusion Criteria for the Laparoscopic Approach

<table>
<thead>
<tr>
<th>Criterion</th>
<th>No. of Patients</th>
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<tbody>
<tr>
<td>Living-donor right hepatectomy</td>
<td>13</td>
</tr>
<tr>
<td>Tumor location</td>
<td>26</td>
</tr>
<tr>
<td>Posterior</td>
<td>6</td>
</tr>
<tr>
<td>Central</td>
<td>1</td>
</tr>
<tr>
<td>Close to the cavohepatic junction</td>
<td>3</td>
</tr>
<tr>
<td>Large tumor</td>
<td>4</td>
</tr>
<tr>
<td>Previous upper abdominal surgery</td>
<td>2</td>
</tr>
<tr>
<td>Common bile duct resection and Roux-en-Y</td>
<td>2</td>
</tr>
<tr>
<td>Hepatic bile duct injury</td>
<td>7</td>
</tr>
<tr>
<td>Pseudotumoral cholecystitis</td>
<td>1</td>
</tr>
<tr>
<td>Early experience</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
</tr>
</tbody>
</table>

*Would now be considered for laparoscopy.*
Preoperative radiological investigations included ultrasonography in all 50 patients, computed tomography in 41 patients (82%), and magnetic resonance imaging in 32 patients (64%). Thirty-five patients (70%) had solid liver tumor, 11 patients (22%) presented with cystic lesions, 3 patients (6%) had Caroli disease, and 1 patient (2%) had intrahepatic lithiasis. Eleven of the 35 patients (31.4%) with solid liver tumor underwent a tumor biopsy (percutaneously in 4 cases, laparoscopically before starting liver resection in 6 cases, percutaneously and laparoscopically in 1 case). In this series, tumor biopsy allowed us to obtain a certain diagnosis in 4 cases (36.4%; 4 of 11 tumor biopsies).

### INDICATIONS

Presence of symptoms and a preoperative uncertain diagnosis were the 2 most common indications (Table 3). Among benign solid tumors, preoperative typical features of hepatic adenoma were found in 4 patients. Three of these patients presented with incidental asymptomatic hepatic lesions and 1 had polycystic disease. Histologic examination confirmed the preoperative diagnosis in all of these patients. Focal nodular hyperplasia (FNH) was diagnosed preoperatively and confirmed after liver resection in 7 cases. The indication for liver resection in these patients was presence of symptoms related to the mass (right upper quadrant pain in 4 cases; palpable mass, discomfort, and early satiety in 3 cases). In 18 patients, imaging characteristics and biopsy features did not exclude hepatocellular adenoma and they underwent liver resection with diagnostic intent. Of these 18 patients, histologic diagnosis after resection confirmed hepatocellular adenoma in 3 patients. The diagnosis in the other 15 patients was FNH.

Two patients with polycystic disease had food intolerance and pain as a result of a cystic disease predominant in the left lobe. Cystadenoma was suspected in 4 patients with symptomatic cystic lesions located on left lateral segments. Symptoms were early satiety and discomfort due to increasing size of lesions. Histologic diagnosis after resection confirmed cystadenoma in 1 patient. Patients with hydatid cysts (5 cases) and hemangioma (2 cases) had right upper quadrant pain. Three patients with localized Caroli disease and 1 patient with intrahepatic lithiasis had recurrent cholangitis and cholestasis (Table 3).

### SURGICAL RESULTS

The laparoscopic procedure was completed in 46 patients. Of these 46 patients, 2 underwent a hand-assisted procedure. In 4 patients (8%), the operation was converted to laparotomy. Conversion was required in the patient with polycystic disease, who had about 20 nodules in the right liver and 1 nodule in segment 4. Cause of conversion in this case was doubt on tumor limits. This patient underwent right hepatectomy extended to segment 4. Conversion to control bleeding occurred in 3 patients (75% of conversions). At the beginning of our experience, 2 of these patients were converted to laparotomy for mild hemorrhage in the area of the left hepatic vein during left hepatectomy and bisegmentectomy of segments 2 and 3, respectively. In these 2 cases, a short midline incision was made, permitting safe completion of the resection. The third patient was converted because of hemorrhage from the middle hepatic vein during right hepatectomy.

Types and details of the liver resections are shown in Table 4 and Table 5. They included 8 major hepatectomies. The patient who underwent right hepatectomy was converted to laparotomy because of bleeding from the middle hepatic vein required intraoperative blood transfusions (3 U) (Table 5). No clinically significant gas embolism occurred.

Mean surgical time was 191 minutes. During the first 5 years of experience in our unit (1996-2000), mean surgical time was not significantly different from that of the second 5-year period (2001-2005): 188 minutes (median, 180 minutes; range, 30-360 minutes) vs 191 minutes (median, 180 minutes; range, 70-480 minutes). However, most major hepatectomies (75%) were performed...
during the second 5-year period. Mean (SD) duration of surgery for minor resection during the first period was 180 (66) minutes (median, 178 minutes; range, 30-330 minutes) and during the second period, 150 (66) minutes (median, 155 minutes; range, 70-240 minutes). The difference was statistically significant \( (P < .05) \).

POSTOPERATIVE RESULTS

There was no mortality in this series. Postoperative complications occurred in 5 patients (10%) (Table 6). Pulmonary complications occurred in 2 patients: 1 patient developed infectious pneumonia and the other patient, who had conversion to laparotomy, developed pleural effusion that required placement of chest tube. One patient developed cardiac arrhythmia. Two incisional hernias occurred on 12-mm port orifices requiring secondary reoperation.

The mean follow-up in this series was 55 months (median, 59 months; range, 3-115 months). All symptomatic patients had complete symptom relief. One patient who underwent bisectionectomy of segments 2 and 3 for polycystic disease had recurrent symptoms at 3 years due to further progression of cysts located in the right lobe. She underwent laparoscopic cyst fenestration with good functional result. Interestingly, there were minimal adhesions at repeat laparoscopy, which was very smooth.

**Table 6. Postoperative Course**

| Feature                        | No. of Patients (%)
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Morbidity</td>
<td>5 (10)</td>
</tr>
<tr>
<td>Specific liver resection...</td>
<td>0</td>
</tr>
<tr>
<td>Nonspecific complications...</td>
<td>5 (10)</td>
</tr>
<tr>
<td>Mortality</td>
<td>0</td>
</tr>
<tr>
<td>Hospital stay, d, mean (SD) [range]; median</td>
<td>6 (3) [3-21]; 5</td>
</tr>
</tbody>
</table>

\( ^a \)Bleeding and bile leak.

To our knowledge, this study represents the largest series of laparoscopic liver resections for benign disease performed in a single unit.\(^7,10,12,20,21\) The advantages of laparoscopic liver resections are those of all laparoscopic procedures. The reduction of the abdominal wall damage is associated with decreased postoperative pain, reduced peritoneal adhesions, shorter hospital stay, and an earlier return to previous activity.\(^9,10,22-26\) Furthermore, 2 case-control studies have shown that, despite longer operating times, the laparoscopic procedure is associated with reduced blood loss and reduced morbidity.\(^27,28\) Also, there are cosmetic advantages of the smaller incisions used in the laparoscopic approach.\(^9,22\) For these reasons, the laparoscopic approach should be taken into account, especially in benign liver disease management.

Use of the laparoscopic approach should not modify or widen indications for liver resections, especially in cases of benign liver disease. Biliary cysts and hemangiomas are easily diagnosed and they do not require resection except in rare cases of symptomatic or doubtful lesions.\(^9\) In this series, 3 liver resections were performed for biliary cysts because they were symptomatic cystic lesions with suspicion of cystadenoma on imaging and 2 liver resections were performed for hemangiomas because of presence of symptoms. Our policy in cases of benign hepatocellular tumors includes resection of hepatic adenomas and conservative treatment of FNH when the diagnosis is certain.\(^9,17\) Use of the laparoscopic approach did not change this attitude and did not increase the number of patients with FNH who underwent liver resection. In this series, 22 patients with FNH underwent laparoscopic liver resection. Of these 22 patients, 15 underwent liver resection with diagnostic intent because of suspicion of hepatocellular adenoma and the other 7 patients presented with symptomatic lesions. These patients represent less than 10% of patients with FNH seen at our institution between May 1996 and September 2003.

This series shows the technical feasibility and safety of laparoscopic liver resections for benign disease in select patients. A learning curve effect was noted for limited resections, with a significant reduction in operative time over the 2 consecutive 5-year periods. Mortality was

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\( ^a \)Values in parentheses represent number of conversions.
nil and postoperative complications occurred in 5 patients (10%). Two incisional hernias occurred on 12-mm port orifices in obese patients, requiring minor secondary reoperation. The incisional hernia in the port orifice emphasizes the need for adequate fascia closure of port sites 10 mm and greater, which may be difficult in obese patients. The use of noncutting trocars may be useful. There were no specific postoperative complications, such as postoperative bleeding or bile leak. These results could underline a more precise surgical technique associated with the magnification of the laparoscopic approach. Patient recovery was excellent and most patients were discharged from the hospital in less than 1 week.

Careful selection of patients and liver tumors is essential to perform laparoscopic liver resection with safe results. Location and size of the lesion should be carefully evaluated before choosing the laparoscopic approach. As previously described, our policy is to consider the anterior and lateral segments (segments 2-6) as safe segments for laparoscopic resection. In our series, only 1 patient with hepatocellular adenoma located in segment 7 underwent laparoscopic liver resection. In this case, a laparoscopic, hand-assisted right hepatectomy was performed. In our study, the mean tumor size measured on the surgical specimen was 50 mm and we did not consider large lesions or lesions located near the major vascular structures or in the central and posterior segments for the laparoscopic approach (Table 2). Laparoscopy may have additional advantages in obese patients, but selection for laparoscopic liver resection was based on anticipated feasibility (size and location) and not on body mass index.

Bleeding during laparoscopic transection occurs as in open surgery but may be more difficult to control. Therefore, a very careful technique must be used and the surgeon must be able to control most bleeding episodes laparoscopically. However, bleeding was the cause of 3 of 4 conversions in this series. Two bleeding episodes were mild and occurred early in our experience and would not require conversion today. However, there was 1 episode of significant bleeding from the middle hepatic vein during right hepatectomy. This was the only patient who received transfusions in this series.

Few series reported resection of 3 or more segments. Although most resections in this series were fewer than 3 segments, 8 major hepatectomies were performed for benign disease (16%). Three of the 4 conversions occurred during major resection, for a 37% conversion rate in major resections (2 were for bleeding and 1, for doubt on tumor limits in a patient with multiple adenomas). By contrast, there was only 1 conversion among 42 minor resections at the beginning of our experience. This difference shows that, in our hands, laparoscopic limited resection for peripheral lesions has become standardized, while major hepatectomy remains challenging and requires further improvements. We have found hand assistance helpful in reducing operative time and the conversion rate in laparoscopic right hepatectomy.

According to our results, we believe that laparoscopic liver resection for benign disease can be recommended in patients with left-sided and right-overflowing lesions requiring limited resection. By contrast, laparoscopic major resections require further evaluation. Laparoscopic liver resections should be performed in units with a combined expertise in hepatic surgery and advanced laparoscopic procedures. Indications for resection of benign liver disease should not be widened by the availability of the laparoscopic approach but must be the same as those of open surgery. Reduction of abdominal wall damage and cosmetic advantages of the laparoscopic approach represent a clear benefit in patients with benign liver disease.

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Author Contributions: Study concept and design: Cherqui. Acquisition of data: Ardito, Tayar, Laurent, Karoui, and Loriau. Analysis and interpretation of data: Ardito. Drafting of the manuscript: Ardito. Critical revision of the manuscript for important intellectual content: Tayar, Laurent, Karoui, Loriau, and Cherqui. Study supervision: Cherqui.

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REFERENCES


S
urgeons do not have the luxury of becoming too
set in their ways lest they be left behind by in-
sidious and ever present changes in surgical prac-
tice and technology. Those who trained in surgical resi-
dency programs before the revolution of laparoscopic cholecystectomy were forced to jump on the laparo-
scopic bandwagon or risk being left behind. While it is
human nature to bemoan the passing of the “good old
days,” I do not know of any surgeon who would admit
that he or she is unwilling or unable to learn new tech-
niques and to provide state-of-the-art patient care.

In this issue of the Archives, Ardito and colleagues re-
port their results with laparoscopic resection for benign
liver lesions. The key component of this report is that
laparoscopic resection was used to treat patients with
symptomatic benign tumors. Laparoscopic techniques and
equipment have not yet progressed to a point where rou-
tine use for resection of malignant disease should be un-
der taken. It is possible to perform laparoscopic ultraso-
nography of the liver, but this technique is not as accurate
or as complete as intraoperative ultrasonography per-
formed as part of an open liver operation. Furthermore,
the issue of adequate tumor-free margins is generally not
a significant concern with benign lesions but is a major
focus for resection of malignant liver tumors. A failure to
perform a margin-negative liver resection for malig-
nant disease is tantamount to a failure in the planning and
completion of an appropriate oncologic operation.

It is a minority of patients who are found to have a
benign hepatic tumor who will require resection of the
lesion or lesions. However, in patients who do have symp-
tomatic disease, or who have a preneoplastic lesion like
a biliary cystadenoma or a suspicious hepatic adenoma,
resection is indicated. The article by Ardito and his group
indicates that laparoscopic resection is feasible in pa-
tients with benign liver tumors. The mean surgical time
required to complete a resection was 191 minutes. Ar-
dito et al performed minor liver resections in 42 of the
50 patients. Resection of bisegment 2 and 3 was the most
common operation. Ardito et al also report that all symp-
tomatic patients had complete relief of symptoms. How-
ever, they provide no information on any other poten-
tial advantages of a laparoscopic approach. Specifically,
there is no information on how quickly their patients re-
turned to a normal quality of life, activities of daily liv-
ing, and work. The average time in the hospital was al-
most a week, which is similar to the length of stay after
an open minor liver resection. Furthermore, an open re-
section of 1 or 2 segments of the liver can generally be
performed with modern surgical techniques in a signifi-
cantly shorter time than that reported by Ardito et al for
a laparoscopic approach. Thus, it is hard to detect an ob-
vious benefit for this approach based on the data pro-
vided in their article. It is unfortunate that most surgical
investigators do not include a routine and validated qual-
ity-of-life survey as part of their clinical research data.
This information would make it possible to better as-
se ss the effects of a surgical procedure and the ultimate
outcome of patients undergoing a particular operation.

Ardito and his group are very honest in their assess-
ment that major liver resections are difficult to perform
given current laparoscopic instrumentation. Oftentimes,
a hand-assist device must be included as part of the op-
eration to complete a major liver resection safely. Given
the excellent outcomes and low morbidity and mortality
rates of patients who undergo open liver resection in high-
volume centers, laparoscopic liver resection may still be
considered an operation in search of an indication.

Steven A. Curley, MD

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