

Hand-Assisted Laparoscopic Surgery for Liver Tumors

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ABSTRACT: **Background:** The surgical treatment for liver tumors, whether metastatic or hepatic in origin, traditionally used the open approach through large incisions. In recent years the laparoscopic approach became popular but few centers use this method routinely.

Objectives: To assess the results of our initial experience with liver resection using the laparoscopic approach, in terms of patient safety and oncologic surgical outcome.

Methods: Between August 2007 and April 2008 we performed 10 liver resections in 9 patients using the hand-assisted laparoscopic surgery technique.

Results: The main indication for surgery was metastatic colorectal carcinoma in seven patients and hepatocellular carcinoma in two. The mean age was 67 ± 11 years. The tumor was solitary in seven patients. Five patients had neoadjuvant chemotherapy. Altogether, 12 lesions with an average size of 17 ± 9 mm were resected. The mean operative time was 180 ± 52 minutes. Average postoperative stay was 6.5 ± 3.5 days. There was no perioperative mortality. There was one conversion to open surgery due to bleeding from the left hepatic vein. No major perioperative complications were encountered. All resected margins were free of malignancy.

Conclusions: Liver resection using HALS is safe and feasible and should be considered in selected patients.

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KEY WORDS: liver resection, hand-assisted laparoscopic surgery (HALS), metastases from colorectal cancer, hepatocellular carcinoma

requirements, shorter hospital stay, lower morbidity, and improved cosmetic results [1].

The liver is a suitable organ for laparoscopic resection because of its deep location and the fact that there is no need for reconstruction after hepatectomy. Laparoscopic liver surgery has been adopted with gradually increasing frequency but has not entered routine use because of the inability to assess safe margins of resection owing to loss of tactile sense and difficulty with safe parenchymal transaction. Recent technological advances have made laparoscopic liver resection possible. These include laparoscopic ultrasound, introduction of the stapling technique in liver surgery [2], development of parenchymal transaction tools such as the LigaSure and the harmonic scalpel [3], and the addition of the hand assistance port [4].

This study presents our initial experience with hand-assisted laparoscopic liver resection for malignant tumors, with emphasis on patient safety and short-term outcomes.

PATIENTS AND METHODS

Between August 2007 and April 2008 we performed 10 laparoscopic hepatic resections in 9 patients for malignant liver disease using the HALS technique. Patients who were potential candidates for hepatic resection in our department were evaluated at a weekly multidisciplinary round.

Indications for laparoscopic resection were similar to those in traditional surgery. Resection of hepatocellular carcinoma was considered when there were no more than two nodules in well-compensated chronic liver disease (Child-Pugh class A), without signs of portal hypertension and without tumor vascular invasion. Hepatic resection for liver metastases from colorectal carcinoma was considered only in the absence of extrahepatic disease.

The preoperative workup included blood examinations, tumor markers, imaging modalities (computed tomography, positron emission-CT, magnetic resonance imaging, ultrasound), and characteristics of the specific tumor (number, location, size and relation to intrahepatic vascular or biliary structures). Exclusion criteria for laparoscopic resection included gallbladder carcinoma, portal hypertension or decompensated chronic liver disease, and cardiac or respiratory failure.

Over the past three decades liver surgery has undergone significant advances as a result of improvements in anesthesia and surgical techniques, increased knowledge of the surgical anatomy of the liver, and better understanding of underlying liver disease. These developments have led to more aggressive surgery and to a great reduction in morbidity and mortality. In parallel, laparoscopic surgery was further developed, providing several advantages over surgical interventions, such as reduced postoperative pain and analgesia

HALS = hand-assisted laparoscopic surgery

The patients underwent standard evaluation for major surgery by an anesthesiologist. All the patients were informed of the nature and morbidity of the procedure and gave informed consent.

HALS TECHNIQUE

Liver resections were defined according to the International Hepato-Pancreato-Biliary Association terminology derived from the Couinaud classification. Deep segments included segments I, IVa, VII and VIII, while superficial segments included segments II, III, IVb, V and VI. Resection was considered "anatomic" when at least one entire segment was removed; all other resections were defined as non-anatomic or wedge resections. Left lateral lobectomy was defined as resection of segments II and III.

All the operations are performed with the patient under general anesthesia. The patient is placed supine in the "French" position with the primary surgeon positioned between the patient's spread legs and one assistant on the left. The procedure begins with a right subcostal incision far enough from the costal margin. The exact site of the incision is chosen to allow control of both right and left lobes by the surgeon's left hand. The surgeon dissects the adhesions and then inserts the hand port (LapDisc®, Ethicon, Cincinnati, OH, USA). Through the hand port, now with the addition of the surgeon's left hand, a trocar is inserted into the abdominal cavity, the pneumoperitoneum is produced with CO₂ at a pressure of 12–15 mmHg, and visual exploration of the liver and the abdominal cavity is conducted with a 30 degree laparoscope. A 12 mm infraumbilical trocar is then inserted into an adhesion-free area, followed by two to three additional working trocars placed according to the location of the liver lesions, usually along a semicircular line with the concavity facing the right subcostal margin. We use balloon port trocars (Covidien®, Norwalk, CT, USA), which are advantageous since they provide a mechanism to create upward traction on the abdominal wall, thereby enhancing working space for appropriate articulation of the endovascular staplers. The abdominal cavity is explored manually and intraabdominal sonography of the liver is performed. Ultrasound is used to confirm the extension of the tumor, determine the number of lesions, identify potentially hazardous intrahepatic vascular or biliary structures, and demarcate surgical tumor resection margins. The hepatic pedicle is never encircled for the Pringle maneuver.

In our patient the liver parenchyma transaction was performed using the LigaSure™ (LigaSure 5 mm; Valleylab, Boulder, CO, USA). If needed, clips or endoGIA™ staplers (vascular cartridge) (EndoGIA, Covidien, Norwalk, CT, USA) were used for large parenchymal vessels or biliary structure.

For left lateral lobectomy, the round ligament was divided close to the abdominal wall with a harmonic scal-

pel (Ultracision™, Ethicon Endosurgery, Cincinnati, OH, USA). The falciform ligament was divided from the anterior abdominal wall towards the inferior vena cava, and the left triangle ligament was divided to free the left lobe. The lateral wall of the left hepatic vein was exposed and care was taken to avoid injury to the left hepatic and phrenic veins. The posterior surface of segment II-III was exposed and the lesser omentum was checked for the presence of a left hepatic artery. The lesser omentum was divided by 5 mm LigaSure. When a bridge of liver parenchyma covered the round ligament it was divided with the 5 mm LigaSure. The liver was transected on a line just left of the falciform ligament using 5 mm LigaSure until the portal pedicle of segments II-III were exposed. The portal pedicle of segments II-III was divided with EndoGIA staplers (vascular cartridge) applied two or three times. The transaction was continued until the left hepatic vein was reached, after which it was stapled with a small amount of surrounding liver tissue. The specimen was extracted through the LapDisc. The argon beam was used for hemostasis. A single, flat Jackson-Pratt drain was placed in the posterior aspect of the resection bed through a port site. All specimens were sent fresh for pathologic examination to measure the surgical margins.

RESULTS

From August 2007 to April 2008, nine patients with malignant liver tumors were selected for the HALS technique. The main indication for operation was metastatic colorectal carcinoma in seven patients and hepatocellular carcinoma in two. Table 1 presents the indication for resection, medical history and preoperative neoadjuvant chemotherapy. The mean age of the patients – 3 (33%) women and 6 (67%) men – was 67 ± 11 years (range 50–82 years). The tumor was solitary in

Table 1. Characteristics of patients undergoing HALS liver resection

Patient	Age (yrs)	Gender	Diagnosis	Medical history	Location (segment)	Neo-adj treatment
1	70	F	LMCRC	HTN	II-III	Yes
2	51	M	LMCRC		V	Yes
3	64	F	HCC	HTN, COPD	VIII	No
4	82	M	LMCRC	HTN, IHD, CVA	VI	No
5	62	M	LMCRC	Epilepsy	II-III	No
6	77	M	LMCRC	IHD	II-III	Yes
7	71	F	LMCRC	HTN	II-III	Yes
8	77	M	HCC	HTN, DM, IHD, COPD	V	No
9	52	M	LMCRC		II-III, VIII	Yes

LMCRC = liver metastases from colorectal carcinoma, HTN = hypertension, HCC = hepatocellular carcinoma, COPD = chronic obstructive pulmonary disease, IHD = ischemic heart disease, DM = diabetes mellitus

Table 2. Surgical procedure and perioperative data

Patient	Procedure	Lesions	Size (mm)	Margins (mm)	Operative time (min)	Morbidity	Stay (days)
1	LLL+AR	1	35	10	197	Yes	7
2	Seg V	1	25	10	153	No	3
3	Seg VIII	1	30	11	252	No	5
4	Seg VI	2	15, 6	7, 8	165	No	4
5	LLL	1	40	10	135	Yes	8
6	LLL	1	14	14	196	No	5
7	LLL	1	20	15	88	No	5
8	Seg V	1	30	1	248	Yes	15
9	LLL+Seg VIII	3	11, 13, 8	12, 2	180	Yes	7

LLL = left lateral lobectomy, AR = anterior resection, Seg = segment

seven patients, while one patient presented with two nodules and another patient with three nodules. Five patients with colorectal liver metastases had neoadjuvant chemotherapy, usually four to six cycles of Folfox and Avastin[®] (Roche, Israel). One patient had combined surgery, where anterior resection and left lateral lobectomy of the liver were completed using HALS.

OPERATIVE RESULTS

Altogether, 12 lesions with an average size of 17 ± 9 mm were resected. Ten liver resections were performed; types and details of the liver resection are shown in Table 2. When we first began using this approach we had one conversion (11%) due to mild bleeding from the left hepatic vein during left lateral lobectomy. This patient required one transfusion of packed blood cells; he was included in our statistical analysis. There was no perioperative mortality. The mean operative time was 180 ± 52 minutes. Average postoperative stay was 6.5 ± 3.5 days. Four patients had a postoperative complication: wound infection, pneumonia, urinary tract infection, and an abscess that was drained percutaneously, respectively.

PATHOLOGIC RESULTS

Ten metastatic colorectal lesions were resected from 7 patients. One colorectal metastatic mass after chemotherapy was resected but revealed no malignancy in the final pathology. All lesions were resected with tumor-free margins of 9 ± 5 mm.

DISCUSSION

Since the introduction of laparoscopic cholecystectomy in 1987, laparoscopic techniques have been applied for solid organ surgery. The first non-anatomic liver resection for focal nodular hyperplasia was described by Gagner et al. [5] and the first left lateral lobectomy by Azagra et al. [6]. Despite

the widening of indications and improved surgical equipment for hepatic surgery, the endoscopic approach remains underutilized for liver surgery as compared to other surgical modalities. Due to specific difficulties associated with this procedure it is not commonly used by hepatobiliary surgeons worldwide. Loss of manual palpation of the liver during laparoscopy may compromise the oncologic resection. A long learning curve is required to reduce the risk for intraoperative complications such as uncontrolled bleeding biliary injury and laparoscopy-specific complications.

The current literature contains accounts of both pure laparoscopic resections and hand-assisted laparoscopic resections, with firm support for both [7-13]. Our center uses the hand-assisted approach for reasons of patient safety and safe practice of oncologic surgery. Left lateral lobectomy is the most frequently performed laparoscopic procedure due to excellent exposure of the whole operation field and safe vascular control [8,11,14,15]. In most of our patients (55%) a left lateral lobectomy was performed, using a simple stapling technique without inflow or outflow control. Resection of other segments can be more problematic; lesions in easily accessible lower liver segments (IVb, V, and VI) with minimal parenchymal transaction are still considered the best indication for a laparoscopic approach [1]. Lesions of the posterior and superior liver segments (IVa, VII, and VIII) are technically demanding, especially in terms of choosing the right transaction plane and controlling bleeding [7,8]. In our initial experience we performed resections for tumors that were confined to segments II-VI (the laparoscopic segments), which were relatively easy to manipulate, were far from large hepatic veins and porta hepatis, and bleeding could be visualized and controlled laparoscopically with LigaSure, stitches, endoGIA or clips. We performed non-anatomic resection of segment VIII and resection of deep segment V; the operative time in these cases was significantly longer than in resection of the other laparoscopic segments. Intraoperative ultrasound is mandatory; it allows correct staging of the tumor, precise evaluation of its extension and its relationship with major surrounding structures, and oncologic free margins.

The size of the tumor is important when selecting patients for laparoscopic resection, in which an acceptable diameter for nodular and pedunculated tumor should be smaller than 40 mm and 60 mm respectively [1]. In our series, the mean tumor size was 17 mm (range 6-40 mm).

The main concern during liver resection is bleeding. Parenchymal bleeding is usually limited and can be controlled either with the full laparoscopic approach or HALS. Hepatic veins or arterial bleeding put the patient at immediate risk. This major bleeding can be efficiently controlled by the surgeon's hand, which is inside the patient's abdominal cavity throughout the HALS procedure. Hemorrhage is the main reason for conversion to open surgery, with rates

ranging from 0% to 55%. In our series one procedure (11%) was converted to open surgery due to bleeding from the left hepatic vein. This occurred at the start of our experience; we prefer to convert to open surgery for patient safety.

There was no perioperative mortality in our experience. In general, acceptable perioperative mortality in liver surgery is $\leq 5\%$. HALS or full laparoscopy series have demonstrated very low mortality rates (1.2% and 1% in two series and zero in all other reports). These low rates can be explained by patient selection, i.e., patients with tumors located in less risky segments.

All resected tumors in our series were excised with healthy margins. The largest lesion measured 40 mm, but much larger lesions can be resected using HALS since most incisions are 7.5 cm in length. Long-term follow-up is required to ascertain that port site or peritoneal spread did not occur. This was reported in other series of laparoscopic abdominal operations for malignancy of the gastrointestinal tract; the rates of recurrence were low and the procedure was considered practically safe.

In our series the average postoperative in-hospital stay was 6.5 days, which reflects a prompt recovery due to small incisions and early mobilization, which are seen less when laparotomy is used.

In conclusion, we found that the HALS technique approach for the treatment of solid tumors in the liver for highly selected patients is safe, feasible and easily tolerated by patients; it has a good cosmetic result and does not compromise the oncologic and pathologic standards of care. Long-term follow-up is still needed to establish the surgical superiority of the HALS technique over traditional laparotomy in terms of a disease-free outcome, incisional complications and patient satisfaction.

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