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Original Article

Comparison of laparoscopic versus open left lateral segmentectomy

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Abstract: Background: Although there are data in the literature about the safety and efficacy of laparoscopic liver resections, there are not many studies comparing laparoscopic versus open approaches in a case-matched design. This study was designed to compare perioperative outcomes of the left lateral segmentectomy via laparoscopic and open approach. Methods: From January 2009 to January 2013, we performed left lateral segmentectomies in 60 patients, those excluded from analysis included previous liver resections, polycystic liver disease and liver cirrhosis. Laparoscopic left lateral segmentectomy was performed in 30 patients and open left lateral segmentectomy was performed in 20 patients. All clinical data were analyzed retrospectively. Results: The mean duration of operation was 120 ± 30.4 min in the LLS and 150 ± 36.8 min in the OLS group, no statistically significant difference was found between the two groups. The median blood loss in LLS group was less than that in OLS group (200 ± 22.1 ml versus 328 ± 36.8 ml, $P < 0.05$). Mean post-operative hospital stay was significantly lower in LLS compared with OLS (5 ± 0.9 vs. 8 ± 1.0; $P < 0.05$). The postoperative morbidity rate was also significantly different between the groups, a tendency towards more severe complications in the OLS group compared with LLS group. Conclusion: Laparoscopic left lateral segmentectomy can decrease complications, shorten hospitalization time, is a minimally invasive, safe and effective way.

Keywords: Laparoscopic liver resection, left lateral segmentectomy, open surgery

Introduction

Since the introduction of laparoscopic cholecystectomy in 1987, the laparoscopic approach has been applied to the full spectrum of abdominal procedures. However, liver resections have remained resistant to the onslaught of laparoscopic surgery, despite a first report as early as 1992 [1]. Recently, as experience in hepatic surgery has grown, alongside improvements in laparoscopic instrumentation, an increasing number of centers are reporting small-volume experience with minimally invasive liver surgery. The first laparoscopic anatomical liver resection was performed in 1996. From its onset, the majority of authors have coincided in defining certain favorable liver segments that are more accessible for a laparoscopic approach, these being the left lateral and right anterior segments [2-5].

The anatomy of the left lateral sector and the configuration of the portal and supra-hepatic pedicles facilitate a feasible and safe laparoscopic approach in this area, with oncological results similar to those achieved using open surgery when performing R0 resections with tumour-free margins [6]. The laparoscopic approach for lesions on the left lateral segment should be considered the method of choice for experienced centers, with superior results in terms of blood losses, operational time, and hospital stay, when compared to the laparotomy approach.

The aim of this study was to undertake a contemporaneous comparison between laparoscopic and open left lateral segmentectomies (OLS). Operating time, blood loss and complications were analyzed.

Methods

We undertook a retrospective cohort study of the left lateral segmentectomies in our institution between January 2009 and January 2013

Figure 1. Use of Harmonic scalpel for division of liver parenchyma.

Figure 3. Division of the left suprahepatic vein with an endostapler.

Figure 2. Division of the portal branches of segments II and III with an endostapler.

(n = 60). Cases were included on an intention to treat basis however, in an attempt to reduce bias, patients having previous liver resections (n = 3), polycystic liver disease (n = 3), liver cirrhosis (n = 4) were excluded. This resulted in 50 left lateral segmentectomies for comparison, 30 in the laparoscopic and 20 in the open group. Selection was based on referral to the individual consultants with all laparoscopic operations performed by a single surgeon and open operations under the care of two surgeons. Data collection included patient characteristics, operative details, morbidity and mortality, postoperative hospital stay, pathology of specimen, and tumour clearance margins.

Laparoscopic technique

Laparoscopic left lateral segmentectomies (LLS) was performed with the patient in supine and 30° anti-Trendelenburg position, with the surgeon standing between the patient's legs. Basically, four trocars (two 5 mm and two 10 mm trocars) were inserted in the upper abdominal quadrant. We used a supraumbilical cut-down in patients to establish pneumoperitoneum, with a 5 mm port and a 10-mm port in the right upper quadrants, a 5 mm port in the left upper quadrants. We find such port placements are ergonomically good and allow adequate exposure.

The operation started after dissection of eventual adhesions in the upper abdominal quadrant. Division of the round and falciform ligament toward the inferior vena cava was seldom performed and only to allow careful intraoperative ultrasonography guidance for lesions near Rex's recessus or the left hepatic vein to assess surgical margins. The left triangular ligament was freed before parenchymal dissection was started, and the liver was transected on a line just left of the falciform ligament (**Figure 1**). Manipulation of tumoral lesions was systematically avoided in case of malignancy, and no cholecystectomy was required. Once the intrahepatic portal pedicles were visualized, one or two vascular 45-mm linear staplers (EndoGIA Ethicon) were applied (**Figure 2**). The final stage of the hepatectomy was performed without exposure of the left hepatic vein, which was stapled with a slim amount of surrounding parenchyma to avoid unnecessary injury (**Figure 3**). Hemostasis was performed through a combination technique including bipolar cautery and an argon beamer coagulator. The surgical specimen was extracted through a previous laparotomy incision using a plastic sterile

Table 1. Comparison of clinical demographics of patients in LLS group and OLS group

Preoperative clinical variables	LLS (n = 30)	OLS (n = 20)
Age (years)	52 ± 13.5	50 ± 11.5
Sex (F/M)	10/20	5/15
ASA	1.5 ± 1	1.5 ± 1
Child-pugh		
A	30	20
B	0	0

F, female; M: male.

Table 2. Comparison of the operative and post-operative results of patients

	LLS (n = 30)	OLS (n = 20)
Mean operative time (min)	120 ± 30.4	150 ± 36.8
Blood loss (ml)	200 ± 22.1	328 ± 36.8*
post-operative hospital stay (days)	5 ± 0.9	8 ± 1*
Postoperative complications (%)#		
None, grade I	100	60*
Grade II	0	30*
Grade III	0	10*
Resection margin (mm)	20	21.5

*$P < 0.05$ compared to LLS group. #Based on Clavien classification of postoperative surgical complication.

bag. Drainage of the operative field was performed with a silastic drain (removed within 48-72 h) in all cases.

Open technique

A laparotomy was performed via a transverse subcostal incision with a midline extension if required. The left lobe of the liver was transected by a combination of the clamp-crushing maneuver and application of the harmonic scalpel (Harmonic Ace, Ethicon Endo-Surgery Inc., Cincinnati, OH) along the transection line premarked by diathermy. With full mobilisation of the left lobe of the liver, the segment II/III pedicles were ligated and divided. The left hepatic vein was clamped at the end of the parenchymal transection and sutured with 5/0 prolene. Haemostasis was assured with the use of fibrin glue, and a drain was inserted.

Statistical analysis

All values were expressed as the mean ± SD. The chi-squared test was used to evaluate the statistical significance of differences which was set with a P value < 0.05.

Results

Both groups were clinically comparable in terms of age, sex, and ASA scoring. There were no statistical differences in laboratory data between the LLS and OLS groups (**Table 1**). The mean duration of operation was 120 ± 30.4 min in the LLS and 150 ± 36.8 min in the OLS group, no statistically significant difference was found between the two groups (**Table 2**). The median blood loss for the LLS was 200 ± 22.1 ml compared to 328 ± 36.8 ml for the OLS, showing a highly significant difference (**Table 2**). No intra-abdominal or port seeding was encountered in this study. Mean post-operative hospital stay was significantly lower in LLS compared with OLS (5 ± 0.9 vs. 8 ± 1.0; $P < 0.05$) (**Table 2**). The postoperative morbidity rate, as gauged by the Clavien classification model (See **Table 3**), was also significantly different between the groups, with the patients undergoing laparoscopic resection fairing considerable better ($P < 0.01$). A tendency towards more severe complications in the OLS group compared with LLS group. In fact, all patients undergoing laparoscopic LLS (100%) experiencing no or very minimal (grade I) postoperative complications. In contrast, only 60% of the patients undergoing open LLS experienced no or minimal complications postoperatively, 30% patients experienced grade II complications. Two patients had bile leakage needing simple drainage without re-operation (grade IIIa). No patient required blood transfusions during or after surgery. Lastly, there were no deaths, reoperations, or 30-day readmissions in either group.

Histology is shown in **Table 4**. 60% (n = 18) of lesions in the LLS and 55% (n = 11) in the open group were malignant. Resection margins for all malignant lesions were clear. In the LLS the median resection margin was 20 mm (15-30 mm) with the median in the OLS 21.5 mm (15-30 mm) ($P > 0.05$).

The median follow-up in the LLS was 18 months (9-40) and 19 months (10-48) in the OLS. Of the malignant cases, post-LLS recurrence in the liver has occurred in 3/30 of the LLS (median 17 months) and in 2/20 of the OLS (median 19 months). To date no port-site metastases have occurred in these patients.

Table 3. Clavien classification of surgical complications

Complication grade	Definition
I	Any deviation from the normal postoperative course without the need for pharmacologic treatment, surgical, endoscopic or radiological intervention. Allowed therapeutic regimens include drugs such as antiemetics, antipyretics, analgesics, diuretics, electrolytes, and physiotherapy. This grade also includes wound infections opened at the bedside
II	Any condition requiring pharmacological treatment with drugs other than such allowed for grade I complications. Blood transfusions and total parenteral nutrition are also included
III	Any condition requiring surgical, endoscopic or radiological intervention
III a	Intervention not under general anesthesia
III b	Intervention under general anesthesia
IV	Any life-threatening complication [including central nervous system (CNS) complications] requiring intermediate care or intensive care unit management
IV a	Single-organ dysfunction (including dialysis)
IV b	Multiorgan dysfunction
V	Death of a patient

Table 4. Types of malignant and benign lesions in both groups

	LLS (30)	OLS (20)
Benign	12	9
FNH	1	1
Hemangioma	7	6
Adenoma	1	0
Cystadenoma	3	2
Malignant	18	11
HCC	18	11

Discussion

Recently a number of case series have been published detailing the feasibility and safety of the laparoscopic approach for liver resection [7, 8]. LLS has been considered the most suitable anatomical resection for the laparoscopic approach and as an entry procedure to laparoscopic liver surgery [9]. As surgical skill develops, left lateral segmentectomy will shift from being a traditionally open procedure to a laparoscopic one. This in turn may benefit an increasing number of patients for whom open surgery could be considered high risk.

Driving the adoption of laparoscopic hepatectomy is increasing evidence that this approach is not only safe and feasible but also confers patients with meaningful clinical benefits which may not be equaled by open hepatectomy. In fact, Koffron et al. showed that patients undergoing laparoscopic resection had decreased operative times (99 versus 182 min), blood loss (102 versus 325 ml), transfusion requirement (2 of 300 versus 8 of 100), length of stay (1.9 versus 5.4 days), overall operative complications (9.3 versus 22%), and local malignancy recurrence rate (2% versus 3%) [9]. In other studies looking specifically at LLS, the vast majority of these aforementioned clinical benefits were replicated [10, 11]. For example, Lesurtel et al. undertook a case-control study comparing laparoscopic LLS with matched open LLS [12]. They found that, despite longer operative times, the laparoscopic cohort benefited from decreased blood loss and no noticeable increase in postoperative morbidity, thus demonstrating that laparoscopic LLS was at least as safe as open resection.

The results of this study are consistent with other published series showing laparoscopic liver surgery to be feasible and safe [13, 14]. No significant difference was found in the operating time between the two groups, consistent with both Mala et al [15] and Mamada et al [16]. Other groups have shown longer operating times in the laparoscopic group [12, 17]. We highlight the importance of laparoscopic training operation and its impact on improving our laparoscopic experience and operating time. A previous case-control study found that, compared with open resection, laparoscopic left lateral sectionectomy was associated with decreased blood loss [12]. In the present study mean operative blood loss was significantly less in the LLS than OLS. We considered that this is attributable to the pneumoperitoneum which is advantageous in reducing venous and backflow bleeding.

In laparoscopic liver surgery there are long standing concerns regarding gas emboli with laparoscopic surgeons opting for abdominal wall lifting (gasless laparoscopy) or using low CO_2 pressures to maintain pneumoperitoneum, to minimise any potential risk. We find it best to work with a low CO_2 pressure in the pneumoperitoneum, around 10-12 mm Hg, in order to minimize the possibility of gas entering the veins in the case of damage to a suprahepatic vein. Also, in contrast to the standard procedures used for open surgery, i.e. a central venous pressure close to 0 mm Hg in order to minimize haemorrhage, it is preferable to maintain this pressure close to 6 mm Hg in order to decrease the gradient between the intraabdominal pressure and CVP, thus reducing the risk of gas embolism [18, 19].

When treating malignant cases, it is very important to adhere to oncological principles. In our series, 18 patients with malignant liver lesions underwent LLS. The surgical margins obtained laparoscopically were equivalent to those of the open resections and there were no instances of portsite metastases in follow-up.

In conclusion, laparoscopic LLS is a feasible and reproducible technique. The anatomical positioning of segments II and III and their portal and suprahepatic pedicles facilitates a laparoscopic approach. Finally, standardizing this procedure could facilitate widespread acceptance of this method for the majority of liver surgeons with laparoscopic experience.

Disclosure of conflict of interest

None.

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