CIRUGÍA ESPAÑOLA

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Original article

Laparoscopic resection of the left segments of the liver: the "ideal technique" in experienced centres?

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ARTICLE INFORMATION

Article history:
Received September 17, 2008
Accepted November 11, 2008
On-line March 24, 2009

Keywords:
Liver surgery
Primary liver tumours
Liver metastases
Laparoscopic surgery

A B S T R A C T

Introduction: The resection of tumours of the anatomical left lobe is normally straightforward using either left lateral sectionectomy (LLSEC) or segmentectomy II or III. Our objective is to present the results of the laparoscopic approach and to consider whether this could be the "*ideal technique*" in liver surgery units where the surgeons have experience of laparoscopic liver surgery (LLSURG).

Patients and methods: We have studied patients with resected solid tumours of the anatomical left lobe using LLSURG (n=18): ten cases with LLSEC and 8 cases with segmentectomy II or III. We carried out a comparative study with a control group of 18 patients operated on using the same surgical technique using open surgery (OS).

Results: There were no cases of mortality in either of the 2 groups (n=36). Morbidity was similar (5.5% per group). For LLSEC, the LLSURG group (n=10) had a shorter hospital stay (*P*=.005) and less surgical time (141 vs 159 min) (differences not significant), than the OS group. For segmentary resections II or III, in the LLSURG group (n=8) there was greater use of the Pringle manoeuvre (*P*=.05), greater surgical time (*P*=.05) and a shorter hospital stay (4.8 vs 5.6 days) (differences not significant), than in the OS group.

Conclusions: LLSEC should be carried out by laparoscopy in centres where they have considerable experience. The patients may have a shorter hospital stay and spend less time in surgery than when OS is performed, with the same morbidity and mortality rates. Segmentectomy resections II or III carried out by laparoscopy involve a shorter hospital stay but longer surgery time and therefore the advantages are not as evident as they are for LLSEC.

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La resección laparoscópica de los segmentos del lóbulo hepático izquierdo debe ser el abordaje inicial en centros con experiencia

Palabras clave:
Cirugía hepática
Tumores hepáticos primarios
Metástasis hepáticas
Cirugía laparoscópica

RESUMEN

Introducción: La resección de tumores hepáticos del lóbulo izquierdo anatómico suele ser una técnica sencilla, tanto la seccionectomía lateral izquierda (SLI) como la segmentectomía II ó III. Nuestro objetivo es presentar los resultados del abordaje laparoscópico y plantear si podría ser el *"técnica ideal"* en las unidades de cirugía hepática con experiencia en cirugía hepática laparoscópica (CHL).

Pacientes y método: Presentamos 18 pacientes con resección de tumores sólidos del lóbulo izquierdo anatómico por CHL: 10 casos con SLI y 8 casos con segmentectomía II ó III. Realizamos un estudio comparativo con un grupo control de 18 pacientes intervenidos con la misma técnica quirúrgica por cirugía abierta.

Resultados: No hubo mortalidad en ninguno de los 2 grupos (n = 36). La morbilidad fue similar (5.5% por grupo). Para la SLI, el grupo CHL (n = 10) presentó menor estancia hospitalaria (p = 0.005) y menor tiempo quirúrgico (141 vs 159 min) (diferencias no e.s), que el grupo de CA. Para las resecciones segmentarias II ó III, el grupo CHL (n = 8) presentó mayor empleo de la maniobra de Pringle (p = 0.05), mayor tiempo quirúrgico (p = 0.05) y una estancia hospitalaria inferior (4.8 vs 5.6 días) (diferencias no e.s), que el grupo de CA.

Conclusiones: La SLI debe realizarse por laparoscopia en centros que tengan experiencia debido a una menor estancia hospitalaria y un menor tiempo quirúrgico que la realizada por CA, con la misma morbimortalidad. Las resecciones segmentarias II ó III realizadas por laparoscopia, aunque tienen menor estancia hospitalaria, presentan un mayor tiempo quirúrgico, por lo que las ventajas no son tan evidentes como para la SLI.

Introduction

The development of technological devices and the experience of surgical teams in laparoscopic hepatic surgery (LHS) has enabled the realisation of right and left[1-3] hepatic segment resections in solid hepatic tumours (SHT). It has even permitted certain groups to carry out hepatectomies for liver transplants in live donors.[4-6]

Due to the anatomical disposition of the portal pedicles of the 2nd and 3rd segments and of the left upper hepatic vein (LUHV), the left lateral sectionectomy (LLS) was the first arranged resection that was carried out by laparoscopy,[7] as it is a simple open surgery (OS) technique. The technique has been improved with the incorporation of endostaplers to section vascular elements.[8-11]

Although some authors propagate the performance of LLS in all cases of tumours in these segments,[12] there are situations where it is necessary to carry out only a segmentectomy II or III, to treat benign tumours or to save hepatic parenchyma (resection of hepatic metastases—HM—to conserve parenchyma for future resections, resection of the HM of the left lobe as the first stage in a 2 stage resection, etc).

At that moment, given the simplicity of carrying out the LHS of SHT of the left lobe, we consider that the laparoscopic technique could be the "ideal technique" in hepatic surgery units that have experience with LHS. To confirm this, we present patients with LLS and segment II and III resections carried out by LHS and we compare the results with a control patient group that have been operated on with the same surgical technique in OS.

Patients and methods

Between January 1996 and July 2008 we have performed 515 hepatic resections (HR). In January 2003, we began a prospective evaluation of patients for LHS, having carried out 57 HR, of which 18 had SHT in the left lobe (Couinaud's segments II and III): in *10 cases we performed a LLS* (segments II and III) and in *8 we performed laparoscopic segment resections* (5 of segment III and 3 of segment II). Two of these 8 cases of laparoscopic segment resection were carried out as the first stage of the HR in 2 surgical stages of HM of colorectal carcinoma (HMCRC). The average age was 62 years (range, 38-78) and 12 were males (66%). Eleven percent (2 cases) were benign tumours (1 adenoma of 5 cm in segment II and 1 haemangioma of 6 cm in segment III), and 16 were malignant (89%), the majority (14 cases) were HMCRC, 1 patient had a hepatocarcinoma of 8 cm close to the LUHV, and the rest were a primary leiomyosarcoma of 7 cm located in segment III, close to the portal branches of segment IV (tumour size greater than 5 cm was not a limitation to indicate laparoscopic resection). The

average number of lesions was 2 (range, 1-4) and the average tumour size was 4 cm (range, 2-8 cm).

Surgical technique

Hand-assisted laparoscopic surgery (HALS) was used with the 16 patients with malignant tumours as they were large tumours located near large blood vessels and the TLS was used for the hepatic adenoma and the haemangioma. The TLS and HALS[1,13,14] surgical techniques are briefly presented.

1. *Position of the patient and placement of trocars:* TLS was used in 2 cases to perform a segment resection: the patient was placed in the supine position and the surgeon was between the patients legs. The first assistant was located at the left side of the patient, and the second assistant at the right side of the patient, using a second monitor. Five trocars were used, 4 of them following a concave line with the lesion, and 1 in the epigastric region (Figure 1). After creating a pneumoperitoneum (12 mm Hg of CO_2), a trocar of 10 mm is placed at the navel level to introduce the optic, a second trocar of 10 mm to the left of the naval trocar and a third one of 12 mm to the right. The 4th trocar was placed in the left side, in the mid axillary line, to introduce the clamp to perform the Pringle manoeuvre; and the rest were placed in the subxiphoid area to introduce hepatic separation forceps. Next, an intraoperative laparoscopic sonography is performed, introduced by a trocar of 12 mm. After the necessary mobilisation of the left lobe, a section of the minor epiploon is performed to control the hepatic pedicle and posterior occlusion of the hepatic hilum where necessary.
   The HALS described in our Unit[14] was used in 16 cases: the positioning of the patient and the assistants is identical to that in the TLS. The intervention is started by making a transverse incision in the right side from the mid axillary line to the anterior axillary line. Adherences are liberated from previous surgeries and the hand-port is introduced. With the surgeon's left hand inside of the abdomen, a 10 mm trocar is inserted in an area free of adherences, and a pneumoperitoneum is created to then place the 4 remaining trocars, with the same placement and function as in the TLS (Figures 2 and 3). Following this, a sonography is performed with an abdominal catheter (Entos®, CT8, Phillips) introduced by the hand-port®.
2. *Surgical technique of the segmentectomy II and III:* in the case of the segmentectomy II, no anchor ligaments are sectioned. In the segmentectomy II, the movement of said ligaments is necessary. The section of the parenchyma is performed with a harmonic scalpel (Ethicon®) or with Ligasure® of 10 mm (Tyco©). In the segmentectomy II, the sectioning of the upper left hepatic vein is done with an endostapler. Once the hepatectomy is completed, the clamp that occludes the hepatic pedicle is removed and, if necessary, haemostasis is carried out with Tissuelink® (Primm©), possible existing biliary leaks are sutured and Tachosil® (Nycomed©) is applied in the surgical bed. The placement of the drain is performed selectively. In the TLS, as there are no adherences, the surgical piece is extracted using a Pfannestiel incision; and in the case of patients that have been operated on for HMCRC, the extraction of the piece is performed without fragmenting it through the incision on the right side with the hand-port.
3. *LLS technique:* the round ligament is sectioned as high as possible to avoid interfering with vision, and next the falciform ligament is sectioned. Following this, the triangular and left coronary ligaments are sectioned until the LUHV is identified, without surrounding it. The parenchyma is then

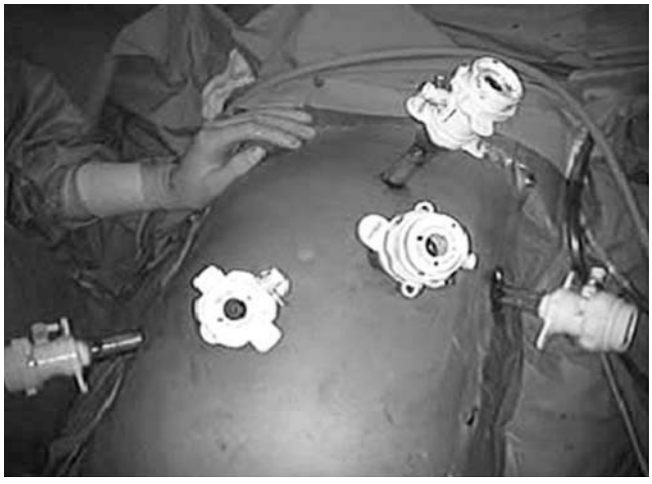

Figure 1 – Position of the trocars.

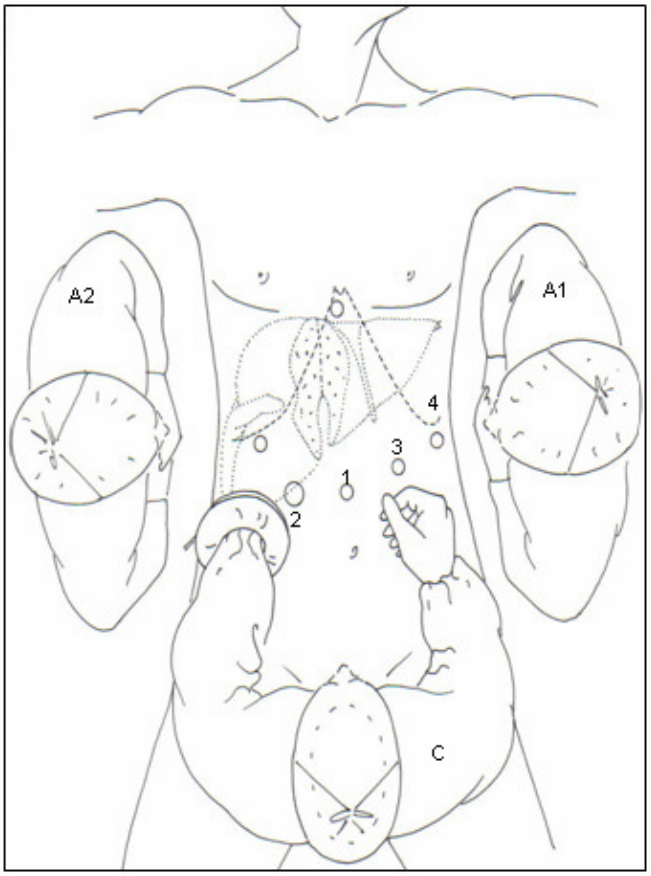

Figure 2 – Position of the patient, assistants and trocars (numbered from 1 to 4), with our original hand-assisted technique.

Figure 3 – Intra-operatory image of the hand-assisted laparoscopic surgery, originally from our unit.

sectioned, with Ligasure® of 10 mm, on the left side of the round ligament until the pedicle of segment II is identified, which is sectioned using the endostapler. The sectioning of the parenchyma is continued with Ligasure until the portal branch of segment III is identified, that is also sectioned with endo-GIA. The sectioning of the remaining parenchyma, to the LUHV is done with Ligasure of 10 mm, until finally, the LUHV is sectioned using the endostapler. Haemostasis is completed and the intervention is finished as described with the segmentectomies.

Selection of patients for laparoscopy

For laparoscopic LLS, patients were selected with tumours located in segments II, III, or central that, although they were greater than 5 cm, had no vascular invasion with the vascular pedicles free. For laparoscopic segmentectomies II and III, patients with peripheral tumours in segments II and III that were smaller than 5 cm were chosen. In our Unit,[14] we indicate HALS in cases of HMCRC for a better staging (14 cases), in large tumours and in those that are close to large blood vessels (2 cases).

Control group (Table 1)

The control group consisted of 18 patients that had undergone open surgery (OS) with the same surgical technique (10 sectionectomies II-III and 8 segmentectomies of S. II and III), selected randomly among 36 patients that had been operated on between 2000 and 2008. Although data was collected in a prospective manner according to the database of hepatic tumours, the study was not randomized given that the learning curve of the LHS is very difficult. Sixteen patients had malignant pathology and 2 had benign tumours. In OS we always realise a bilateral sub-costal incision and as a section method of the parenchyma, we use an ultrasonic scalpel and an argon scalpel to section the parenchyma and vascular endostaplers to section the vascular pedicles.

Statistical method

The data were tabulated in the SPSS 15.0 statistical program for Windows. The statistical analysis of the double-entry tables was done using the χ^2 and the exact Fisher test, and for the analysis of age, number of tumour nodules, size of the nodules, number of resectioned segments, hospital stay and surgical time, non-parametric tests were used (Kruskal–Wallis and the Mann–Whitney test). Data was considered statistically significant at $P<.05$.

Results

1. *Results of the 36 patients* (Table 1). There was no mortality in any of the groups. The morbidity was similar: in the LHS group, 1 patient of 18 (5.5%) presented an intraabdominal collection that was resolved with a radiologic drain and in the OS group, 1 patient of 18 presented a biliary fistula from the drain, that needed surgery for its definitive resolution. There were no differences between both groups concerning age, comorbidity, surgical indication, number of resectioned lesions, size of the lesions, transfusion needs, surgical margin of the resection, morbidity, and surgical time employed. The laparoscopic group presented a greater age (63 years old) than the OS group (52 years old) (P=.03), greater use of the Pringle manoeuvre (7 vs 2 cases) (P=.06) and a shorter hospital stay (4.9 vs 7 days) (P=.003).
2. *Results of the LLS* (Table 2). When we compare the LLS group using LHS, with the OS group, there were only s.s. differences concerning a greater age (65 vs 51 years old) (P=.043) and a shorter hospital stay (4.9 vs 8.4 days) (.005), in the LHS group. Surgical time was not less with LHS (141 vs 159 min), although the differences were not s.s.
3. *Results of the isolated segmentectomies II and III* (Table 3). When we compare the group of segment resections of the left lobe using LHS, with the OS group, there were differences regarding a greater use of the Pringle manoeuvre (6 vs 2 cases) (P=.05) and a greater surgical time (166 vs 127 min), in the laparoscopic group (P=.05). Hospital stay was less with LHS (4.8 vs 5.6 days), although the differences were not s.s.

Discussion

LHS has not been generally accepted among hepatic surgeons due to the technical difficulties that it presents.[1,12,14-22] Related

Table 1 – Resection of solid hepatic tumours located in the left hepatic lobe by laparoscopic surgery (n=18) and by open surgery (n=18)

Parameters analysed	Laparoscopy (n=18)	Open surgery (n=18)	P
Age, mean (SD) (range)	62 (11) (38–78)	52 (12) (26–71)	.03
Sex ratio M:F	12:6	8:10	n.s.
Comorbidity (ASA II-III)	9 (50%)	5 (27%)	n.s.
Benign pathology	2 (11%) cases	2 (11%) cases	n.s.
• HFN	0	1	
• Adenoma	1	0	
• IHL	0	1	
• Haemangioma	1	0	
Malignant tumours	16 (89%) cases	16 (89%) cases	
• HMCRC	14	12	
• Hepatocarcinoma	1	2	
• HM oesophageal cancer	0	2	
• Leiomyosarcoma 1°	1	0	
Pringle manoeuvre	7 (38%)	2 (11%)	.06
No. lesions (range)	2 (1.2) (1–4)	1.8 (1.4) (1–5)	n.s.
Size, cm	4 (2) (2–8)	4.5 (2)	n.s.
Surgical time, min	152 (130) (90–240)	145 (160) (60–240)	n.s.
Blood loss	150 (100–500)	200 (100–800)	n.s.
Tranfusioned patients	0	1	n.s.
Transfusion average, mL	25 (0–300)	50 (0–600)	n.s.
Surgical margin in malignants			n.s.
>1 cm	12	14	
<1 cm	6	4	
Invaded	0	0	
Morbidity	1 (5.5%)	1 (5.5%)	n.s.
Hospital stay	4.9 (2) (3–8)	7 (3) (3–20)	.003

HFN indicates hyperplasic focal nodule; HMCRC, hepatic metastases from colorectal cancer; IHL, intrahepatic lithiasis; M/F, male/female.

to a lack of experience, there are no randomized prospective studies that compare the laparoscopic and open LLS. There is only one control study comparing 18 LLS with TLS with 20 performed with OS.[23] The results of this retrospective study do not show obvious advantages of the LHS compared with OS (the Pringle manoeuvre employed and hospital stay were similar, due to blood losses that were smaller in the LHS group but with greater surgical time).

From a technical point of view, the LLS is a technique that is easy to perform due to the special location of the hilar elements of segments II and III, the thinness of the hepatic parenchyma at the venous ligament level, and the transversal position of the left hepatic vein, making the dissection of the principal trunk unnecessary for its section.

Linden et al[8] report that the sectioning of the vascular pedicles with an endostapler has simplified the surgical technique. With a minimal dissection to the left of the round ligament, the instrument is introduces with a vascular load of 6cm and it sections the elements of segments II and III. The thickness of the parenchyma at said level must be checked to make sure that it is not greater than 3 cm (measured by CT and intra-operatory sonography). With another similar vascular load, the LUHV is then sectioned. According to our experience, we have modified this technique, as on the left side of the round ligament, the thickness of the parenchyma is always greater than 3 cm, and thus we first section with Ligasure 10 mm, until we can identify that the hilar elements of segments II and III are coming out, sectioning them with 2

Table 2 – Patients with left lateral sectionectomy by laparoscopy (n=10) and by open surgery (n=10))

Parameters analysed	Laparoscopy (n=10)	Open surgery (n=10)	P
Age, mean, (SD) (range)	65 (10) (49–78)	51 (13) (26–64)	.043
Sex ratio M:F	7:3	5:5	n.s.
Comorbidity	5	3	n.s.
Benign pathology	0 cases	2 cases	n.s.
• HFN	0	1	
• IHL	0	1	
Malignant tumours	10 cases	8 cases	
• HMCRC	8	6	
• Hepatocarcinoma	1	1	
• Leiomyosarcoma 1°	1	0	
• HM oesophageal cancer	1	0	
Pringle manoeuvre	1	0	n.s.
No. lesions (range)	1.9 (1.2) (1–4)	1.5 (0.9) (1–3)	n.s.
Size, cm	4.1 (1.7) (2–8)	4.4 (1.7) (2–8)	n.s.
Surgical time, min	141 (120) (90–240)	159 (120) (60–240)	n.s.
Blood loss	180 (100–500)	150 (100–400)	n.s.
Tranfusioned patients	0	0	n.s.
Transfusion average, mL	45 (0–300)	30 (0–300)	n.s.
Surgical margin in malignants			n.s.
>1 cm	10	10	
<1 cm	0	0	
Invaded	0	0	
Hospital stay	4.9 (1.5) (3–7)	8.4 (4.3) (3–20)	.03

HFN indicates hyperplasic focal nodule; HMCRC, hepatic metastases from colorectal cancer; IHL, intrahepatic lithiasis; M/F, male/female.

separate charges. At this point, after shooting, it is necessary to check for bleeding and the possibility of the existence of an unstapled biliary conduct, as we found in 2 of our patients that had undergone laparoscopic suturing. The sectioning with Ligasure is continued to the LUHV, applying a third charge of vascular endoGIA of 6 cm to said vein.

The Pringle manoeuvre is used systematically by some authors,[15] other use it in 66% of the LLS[23,24] and Duluq et al,[20] with similar criteria, uses it in 50% of the cases. In some series,[23,24] the occlusion time was extremely long (average, 39 min; range, 23-62 min). With other authors,[8,25,26] we consider that the use of the Pringle manoeuvre in LLS should be selective. Consequently, Belli et al[26] never use it in the 8 patients that they present (7 were hepatocarcinoma with cirrhosis) and they consider that this way they avoid hepatic ischaemia that could worsen hepatic insufficiency in these patients and a lower rate of ascitis as many of these patients have portal hypertension. Linden et al[8] never use it in their 5 patients that they present and we never use it in patients by OS, and only in the case of LHS, due to excessive bleeding (continuous occlusion during 10 min).

It has been reported[23] that the morbidity-mortality of the LLS was similar to the LHS as well as to OS, similar to the results obtained in our series and by other authors.[8,13,25] Blood loss was similar in LHS and OS in our series, as well as in results reproduced by other authors.

The surgical time of the LLS by laparoscopy is greater than that of OS in the majority of series.[8,23,24] Our study is the first to report a lower surgical time with LHS compared to OS, possibly due to the fact that in OS we use a bilateral sub-costal incision and in laparoscopy we use HALS. Belli et al[26] report a similar time to our series (an average of 142 min in 8 patients).

The principal advantage of laparoscopic surgery to perform LLS resides in a shorter hospital stay. It was 4.9 days for LHS

Table 3 – Resection of segments II and III by laparoscopy (n=8) and by open surgery (n=8)

Parameters analysed	Laparoscopy (n=8)	Open surgery (n=8)	P
Age, mean (SD) (range]	59 (11) (38–71)	55 (11) (42–71)	n.s.
Sex ratio M:F	5:3	3:5	n.s.
Comorbidity	4 (50%)	2 (25%)	n.s.
Benign pathology	2 (25%) cases	0 cases	n.s.
• Adenoma	1	0	
• Haemangioma	1	0	
Malignant tumours	6 (75%) cases	8 cases	
• HMCRC	6	6	
• Hepatocarcinoma	0	1	
• HM oesophageal cancer	0	1	
Pringle manoeuvre	6 (75%)	2 (25%)	0.05
No. lesions (range)	2.25 (1.2) (1–4)	3 (2.5) (1–5)	n.s.
Size, cm	4 (1.1) (3–6)	4.7 (2.3) (2–6)	n.s.
Surgical time, min	166 (48) (100–240)	127 (120) (120–180)	.05
Blood loss	120 (100–200)	220 (100–800)	n.s.
Tranfusioned patients	0	1	n.s.
Transfusion average, mL	0	75 (0–600)	n.s.
Surgical margin in malignants			n.s.
>1 cm	2 (25%)	4 (50%)	
<1 cm	6 (75%)	4 (50%)	
Invaded	0	0	
Hospital stay	4.8 (1.3) (4–8)	5.6 (1.3) (4–7)	n.s.

HM indicates hepatic metastases; HMCRC, hepatic metastases from colorectal cancer; M/F, male/female.

compared to 8.2 for OS in our series. Others report a stay shorter than 2.2 days,[24] and other somewhat longer (5.75 days).[26] In the study carried out by Lesurtel et al,[23] the stay was similar in both groups: 8 days with LHS and 10 days with OS.

Furthermore, in our opinion, there are tumours found in the left lobe where it is convenient to carry out a segment II and III resection, as it is indicated in benign tumours and when hepatic parenchyma needs to be conserved for future resections (HMCRC that may require future re-resections and in the first stage of two-stage liver resection). Concerning LLS, these segmentectomies presented a longer surgical time (due to the fact that they present a greater level of technical difficulty) and the Pringle manoeuvre was used with more frequency (in 9 of the 16 patients compared to the LLS that was used in 1 out of 20 patients). Concerning OS, a greater use of the Pringle manoeuvre (75% vs 25% in the OS group) was needed in the laparoscopic group as well as a longer surgical time. However, in spite of the greater technical difficulty, the hospital stay was shorter with HLS, although the differences were not s.s.

To conclude, LLS, in the hepatic surgery units with experience in LHS should initially carry out said intervention by laparoscopy due to a shorter hospital stay than that carried out by OS, with the same level of morbidity. Segmentary resections (II and III) done by laparoscopy present a longer surgical time than OS and, if the surgeon has experience with LHS, they should also carry out said intervention with laparoscopy as the hospital stay is shorter, although the differences were not s.s.

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