

Laparoscopic liver surgery: 8 years of multicenter Spanish register

Esteve Cugat · Noelia Pérez-Romero · Fernando Rotellar · Miguel A. Suárez ·
Mikel Gastaca · Vicente Artigas · Jorge-Juan Olsina · José Noguera · Sagrario Martínez ·
C. Moreno-Sanz · Joan Figueras · Javier Herrera · Hermógenes Díaz · Jordi Caballé ·
Fernando Pereira

Received: 19 March 2009 / Accepted: 4 August 2009
© Springer 2009

Abstract

Background To present the data of laparoscopy in liver surgery and to assess the real indications and outcomes of this kind of approach.

Methods From February 2000 to March 2008, a prospective study was performed on 182 patients from 15 Spanish surgical centres.

Results A total of 308 lesions was collected. The mean age was 57 years old, and 61.5% were female. Among patients with cystic lesions we found: 45 simple cysts, 19 polycystic diseases, 12 hydatidic cysts and 2 cystoadenomas. Among solid lesions ($n = 104$), we found 34 patients

with benign pathology (12 focal nodular hyperplasia, 10 adenomas, 7 haemangiomas and 5 other lesions) and 70 with malignant pathology (38 metastases, 29 hepatocellular carcinomas, 2 cholangiocarcinomas and 1 lymphoma). The global rate of conversion was 8.8%. The global morbidity rate was 14.8%, and 5 of them required re-intervention.

Conclusions Nowadays there are strong criteria for patients being submitted to laparoscopy procedures based both on type and location features. The postoperative morbidity rate is low, also for hepatocellular carcinoma in cirrhotic liver. In case of malignant pathology, we think the

E. Cugat · N. Pérez-Romero (✉)
Hepato-Bilio-Pancreatic Unit of Hospital Mutua de Terrassa,
C/Plaza Dr Robert no 5, 08221 Terrassa, Barcelona, Spain
e-mail: 35667npr@comb.es

E. Cugat
e-mail: 21202eca@comb.es

F. Rotellar
Hepato-Bilio-Pancreatic Unit of Clinica Universitaria
de Navarra, Navarra, Spain
e-mail: frotellar@unav.es

M. A. Suárez
Hepato-Bilio-Pancreatic Unit of Hospital Carlos Haya,
Málaga, Spain
e-mail: masuarez@nacom.es

M. Gastaca
Hepato-Bilio-Pancreatic Unit of Hospital Cruces,
Barakaldo, Vizcaya, Spain
e-mail: gastacamateo@osakidetza.net

V. Artigas
Hepato-Bilio-Pancreatic Unit of Hospital Santa
Creu i Sant Pau, Barcelona, Spain
e-mail: vartigas@santpau.cat

J.-J. Olsina
Hepato-Bilio-Pancreatic Unit of Hospital Vall d'Hebron,
Barcelona, Spain
e-mail: jjolsina@gmail.com

J. Noguera
Hepato-Bilio-Pancreatic Unit of Hospital Son Llàtzer,
Palma de Mallorca, Spain
e-mail: jnogueras@hsl.es

S. Martínez
Surgery Department of Hospital Nuestra Señora del Prado,
Toledo, Spain
e-mail: smartinez@sescam.org

C. Moreno-Sanz
Surgery Department of Hospital La Mancha Centro,
Ciudad-Real, Spain
e-mail: drmoreno@laparoscopia-online.com

J. Figueras
Hepato-Bilio-Pancreatic Unit of Hospital Joseph Trueta,
Girona, Spain
e-mail: info@jfigueras.net

use of ultrasonography is mandatory to obtain a free margin, which implies a long-term survival rate.

Keywords Laparoscopy · Liver surgery · Multicenter register

Introduction

Minimally invasive surgery has become the first choice for most solid organ resections (spleen [1], kidney [2], adrenal glands [3], pancreas [4] and, more recently, there have been some indications for liver resection [5, 6]). Since the first laparoscopic liver resection [5] in 1992, and the first anatomical liver resection reported by Azagra et al. [7] in 1996, many reports have been published in the literature about this approach. At present, liver resection poses a great challenge for the development of laparoscopy, in terms of both technology and surgical skills. Even though liver surgery is a direct procedure that does not require reconstruction or anastomosis, a significant bleeding risk and other difficulties exist in performing this kind of surgery by the laparoscopy approach. Major technical aspects are related to hepatic mobilization, vascular pedicles control and tumour location by palpation or ultrasonography. For these reasons, all authors agree that this surgical procedure must be performed by surgeons experienced in both hepatic and laparoscopic surgery. In spite of the well-known advantages of the laparoscopy approach, from our point of view recognising the fact that the indications for resections should be the same as for open surgery is mandatory.

In the literature, most reports of laparoscopic liver surgery concern benign lesions [8–10]. The laparoscopic approach can also be useful in malignant hepatic lesions such as metastases and liver carcinoma in cirrhotic patients

with enough hepatic reserve (Child-Pugh score A). In our opinion there are two things to consider in patients with malignant lesions: on the one hand, achieving the desired objective in oncology, directly related with long-term disease-free survival, and on the other hand, the potential of tumour cell exfoliation and port-site metastases during laparoscopic procedures.

Recently, larger studies with a greater number of patients have shown that the laparoscopic approach had similar survival and recurrence rates for primary and secondary liver tumours [11–15] as in open procedures.

The purpose of this study was to report a large series of laparoscopic liver surgeries performed in a multicentre setting, reflecting an important number of patients and a wide range of disease conditions. The large number of patients facilitated the study of real indications, surgical techniques and outcomes in laparoscopic liver surgery. It also enabled us to compare our results with those of European, American and Asian studies. Here, we describe the patients' features, disease conditions and early post-operative morbidity.

Methods

From February 2000 to March 2008, we registered 182 patients undergoing liver resection for benign and malignant lesions. Fifteen Spanish hospitals took part in this Laparoscopic Liver Surgery Register and sent their data using a form. The data studied were: the presence or not of cirrhosis, histological type of liver lesions, details of the operative procedure (type of resection, time of the surgical resection, different technologies used for the procedure, vascular control, intraoperative complications, use or not of laparoscopic ultrasonography, conversion rate, cause of conversion, use or not of drainage, preoperative and post-operative haemoglobin, and need for transfusion), early postoperative course, including postoperative complications, beginning of oral feeding, analgesia required and length of hospital stay.

Results

During the 8 years of the recruitment, we received 182 patients in the Laparoscopy Liver Surgery Register. The mean age of the patients was 57 ± 15 years, and 61.5% of the patients were female. In these 182 patients, 308 lesions were found and treated. According to Couinaud's classification, there were 78 lesions in segments VII/VIII, 101 in the right peripheral segments (V–VI), and 129 lesions in the left segments (II–III–IV). Thus, 74.6% of the resections were in the peripheral segments (II–III–IV–V–VI).

J. Herrera
Hepato-Bilio-Pancreatic Unit of Hospital Navarra,
Navarra, Spain
e-mail: 948236110@terra.es

H. Díaz
Hepato-Bilio-Pancreatic Unit of Hospital Canarias,
Canarias, Spain
e-mail: kukilo@eresmas.com

J. Caballé
Hepato-Bilio-Pancreatic Unit of "Althaia Xarxa Asistencial de Manresa", Barcelona, Spain
e-mail: 14687jcs@comb.es

F. Pereira
Surgery Department of Hospital de Fuenlabrada, Madrid, Spain
e-mail: fpereira.hflr@salud.madrid.org

One hundred fifty-one (151) patients had a single tumour, and 31 patients had multiple tumours. Laparoscopic liver resection can be categorised into a pure or totally laparoscopic procedure, laparoscopy-assisted or hybrid procedure, and hand-assisted procedure. Of 182 liver surgeries reported, 176 patients underwent a totally laparoscopic procedure, and 6 patients underwent a hand-assisted procedure. There was 1 case of conversion from pure laparoscopic procedure to hand-assisted procedure because of technical difficulties in the resection. Pneumoperitoneum was performed using an open technique or a Veress needle, depending on the different working groups; carbon dioxide was used in all cases to maintain abdominal pressure. The port placement followed a concave curve with respect to the lesion's location. The optical degree was 0° or 30°, depending on the groups. Seventy-eight patients (43%) had cystic lesions, and 104 patients (57%) had solid lesions (Table 1). The cystic lesions included simple cysts in 45 patients, polycystic disease in 19 patients, hydatidic cysts in 12 patients, and 2 patients had cystadenomas. The mean cyst size was 12.75 cm (range 3–25 cm). The type of liver resection (Table 2) in these cases was: 36 unroofings, 7 limited resections, 1 sectionectomy and 1 right hepatectomy for the 45 simple cysts; 17 unroofings and 2 limited resections for the 19 cases of polycystic disease; 12 cystopericystectomies for the 12 hydatidic cysts; and 1 unroofing and 1 limited resection for the 2 cystadenomas (one patient had an initial

diagnosis of simple cyst, but due to doubts and the intraoperative pathologic results, the patient was operated upon a second time to complete the surgery, and a limited resection was performed).

For solid lesions, there were 104 patients with 119 lesions. The classifications according to the type of histological diagnosis were 34 cases of benign lesions [nodular focal hyperplasia (12), adenoma (10), haemangioma (7), angiomyolipoma (1), sclerosing cholangitis (1) and unspecific lesions (3)]. In 70 cases, there were malignant solid lesions, and of these, 38 cases were metastases

Table 1 Histological diagnosis in 182 laparoscopic liver resections

Type of lesion	n (%)
Cystic lesions	78 (43%)
Simple cystic	45
Polycystic disease	19
Hydatidic cyst	12
Cystadenoma	2
Solid lesions	104 (57%)
Benign lesions	34
Focal nodular hyperplasia	12
Adenoma	10
Haemangioma	7
Others ^a	5
Malignant lesions	70
Metastases ^b	38
Hepatocellular carcinoma	29
Cholangiocarcinoma	2
Lymphoma	1

^a 1 Angiomyolipoma, 1 sclerosant colangitis, 3 unspecific lesions

^b 28 colorectal cancer metastases, 4 breast metastases, 2 lung metastases, 2 pancreatic metastases, 1 gastric metastasis, 1 melanoma metastasis

Table 2 Type of laparoscopic resection in 182 patients with liver lesions

Type of resection	n
Cystic lesions	78 (43%), 189 lesions
Simple cystic	36 unroofings 7 limited resections 1 sectionectomy 1 right-hepatectomy
Polycystic disease	17 unroofings 2 limited resections
Hydatidic cyst	12 cystopericystectomy
Cystadenoma	1 unroofing 1 limited resection
Solid lesions	104 (57%), 119 lesions
Benign lesions	34
Focal nodular hyperplasia	10 limited resection 2 bisectionectomies
Adenoma	7 limited resection 1 sectionectomy 2 bisectionectomies
Haemangioma	4 limited resection 3 bisectionectomies
Others ^a	4 limited resection 1 bisectionectomy
Malignant lesions	70
Metastases ^b	13 limited resection 9 sectionectomies 16 bisectionectomies
Hepatocellular carcinoma	17 limited resection 3 sectionectomies 8 bisectionectomies 1 left-hepatectomy
Cholangiocarcinoma	1 sectionectomy 1 limited resection
Lymphoma	1 limited resection

^a 1 Angiomyolipoma, 1 sclerosant colangitis, 3 unspecific lesions

^b 28 colorectal cancer metastases, 4 breast metastases, 2 lung metastases, 2 pancreatic metastases, 1 gastric metastasis, 1 melanoma metastasis

[colorectal cancer metastases (28), breast cancer metastases (4), lung cancer metastases (2), pancreas cancer metastases (2), gastric cancer metastasis (1) and melanoma cancer metastasis (1)]. Other malignant lesions were hepatocellular carcinoma (29), cholangiocarcinoma (2) and primary liver lymphoma (1). The mean size of solid lesions was 4 cm (range 1–20). The types of resection in these solid lesions consisted of limited resections (56), bisectionectomy (32), sectionectomy (15) and left hepatectomy (1). Among 29 patients with hepatocellular carcinoma, 25 had cirrhosis, all of them Child-Pugh A, as a criterion for the laparoscopic liver resection. There were 4 cases of hepatocellular carcinoma in a non-pathological liver parenchyma.

The mean number of ports used was 4 (range 3–6). The tumour location was explored visually in all patients and also by laparoscopic ultrasonography in 96 patients (52.7%). In case of malignant lesions, laparoscopic ultrasonography was used in 57 patients (84.3%). Vascular control was obtained by the Pringle manoeuvre in 40 patients (22%); the mean time of vascular occlusion was 42 min (range 5–135 min). This manoeuvre was used in 19 limited resections, 15 bisectionectomies (13 II–III bisectionectomies, 1 V–II bisectionectomy and 1 VI–VII bisectionectomy), 4 sectionectomies, 1 right hepatectomy and 1 left hepatectomy. Haemostasis of the transected liver surface was achieved using monopolar cautery, harmonic shears, argon beam coagulator, and sutures. Haemostatic swabs were used in 25 patients and fibrin glue in 45 patients. The extraction of the surgical specimen was always performed using an endo-bag, to avoid crushing the specimen in order to allow subsequent pathological study of margins. The extraction was performed through an enlarged port site in 107 patients (58.8%), through an accessory incision in 53 patients (29.1%), 7 (3.8%) patients through the hand-assistant incision (1 patient was a conversion from a totally laparoscopic procedure) and in 15 (8.2%) patients through a laparotomy (they were the conversion cases). Peritoneal drainage was used in 125 patients (68.7%).

The conversion rate was 8.8% (16 patients): 7 patients due to uncontrollable bleeding, 8 due to poor laparoscopic vision or technical difficulties and 1 due to an uncertainty in the diagnosis. Three patients experienced bleeding due to parenchyma transection. There was also 1 case of bleeding from the gallbladder bed, 1 case of portal vein bleeding and another 2 cases of bleeding caused by a left hepatic vein lesion. Ten patients (5.5%) received blood transfusions. The mean haemoglobin concentration preoperatively was 13.4 mg/dl and postoperatively was 11.8 mg/dl. There was 1 case of gas embolism in a patient with a hepatic carcinoma in segment II who underwent a bisectionectomy. The diagnosis was made by the anaesthetist, who noted haemodynamic instability. It was transitory and

rapidly corrected. The argon beam coagulator was not used in this patient. One left hepatic vein lesion occurred and caused a conversion. The patient recovered satisfactorily, without either complications or sequels during the postoperative period.

The median operation time was 150 min (range 20–390 min). Oral nutrition started an average of 26 h after surgery. One hundred forty-six (146) patients (80%) started oral intake less than 24 h after surgery. The median duration of analgesia was 3 days (range 1–15 days). The median length of hospital stay was 6 days (range 1–20 days).

Twenty-seven patients (14.8%) had postoperative complications (Table 3). These were divided into minor complications: wound infections (2), phlebitis (2), paralytic

Table 3 Rate of conversion, postoperative complications and reoperation rate in 182 laparoscopic liver resections

Conversions	16 (8.8%)	7 uncontrollable bleeding 3 transection parenchymal bleeding 1 gallbladder bed bleeding 1 portal vein bleeding 2 left hepatic vein lesion 8 bad laparoscopic visions or technical difficulties 1 diagnosis doubt
Postoperative complications	27 (14.8%)	13 minor complications 2 wound infections 2 phlebitis 2 hepatic decompensation 2 cardiac decompensation 2 urinary infection 1 paralytic ileum 1 auricular fibrillation 1 allergic drug reaction 14 major complications 1 wound evisceration ^a 1 epiplon ischaemia ^a 1 haemoperitoneum ^a 1 pneumoniae 1 right hemotorax 2 TEP ^b 3 abdominal abscess ^c 4 biliar leak ^{a,d}
Rate of redo	5 (2.7%)	
Mortality	0	

^a Patients who underwent a reintervention

^b One patient had a gas embolism during the surgical procedure

^c Percutaneous drainage

^d Percutaneous drainage + ERCP

ileus (1), urinary tract infection (2), ascites decompensation (2), cardiac decompensation (2), auricular fibrillation (1), and allergic drug reaction (1); and major complications: wound evisceration (1), omental ischemia (1), hemoperitoneum (1), pneumonia (1), pulmonary thromboembolism (2, 1 being gas embolism during surgery), abdominal abscess (3), biliary leak (4) and right pneumothorax (1). Five patients (2.7%) required a reoperative procedure by laparotomy due to wound evisceration (1), biliary leak (1), omental ischaemia (1), hemoperitoneum (1) and a mistaken diagnosis, which was a cystoadenoma. The 3 abdominal abscesses were treated by percutaneous drainage; 3 cases of biliary leak were also treated with percutaneous drainage followed by an endoscopic retrograde cholangiography. There was no mortality in this series. The anatomopathological study of malignant lesions showed a correct margin in all liver specimens; none of them had margins in contact with the lesion. One patient with a previous surgical diagnosis of simple cyst had a cystoadenoma and underwent a new surgical procedure, limited resection by laparotomy.

Discussion

The introduction of the laparoscopic approach in hepatic resection has been slower than in other fields of surgery because of technical difficulties and a high bleeding risk. Although many reports in the literature have shown that this kind of procedure is safe and feasible, the indications are still restricted.

In this study, we present a multicentre nationwide register of the laparoscopic treatment of liver lesions. This kind of register provides certain advantages, such as a large number of patients, a wide range of disease types and complexity, and the possibility of comparing this series with other national or international series. However, some shortcomings may arise, for example: the learning curve of each centre, problems in data collection and hospitals that decide not to participate. These aspects could affect the validity of the data, or raise the question of whether or not they are representative. To avoid such situations, we designed a data collection form that was accepted by the national section for liver disease. Also, prior to starting the register, we assured participation of the country's leading and most representative centres.

We want to emphasise that about 25% of the lesions treated were located in non-favourable segments (VII and VIII). The majority of them were benign lesions, such as simple cysts, polycystic disease and hydatidic cysts. In spite of that, if we observe the complications and conversion rate between these two groups (lesions located in favourable segments and ones located in non-favourable

segments), a lower complication rate in the non-favourable segments is found (7.5 vs. 17.8%), and similar conversion rates (7.5 vs. 9.3%). We accept that these two groups have different features, but the results may suggest that in selected patients with lesions in posterior segments (VII and VIII), the use of the laparoscopic approach can be as safe as in favourable segments (II, III, IV, V, VI).

Benign lesions were more common than malignant (112 vs. 70) in our series, but there were also more solid lesions than cysts (104 vs. 78). The indications for resection for these benign lesions were the same as in open surgery: positive symptoms, involvement of other structures due to its location or bleeding risk. We report 2 patients with cystoadenoma who underwent a limited resection. In one case, an unroofing was initially performed, but after receiving the definitive pathology data, a resection was performed. That shows the possibility that a cystic lesion could be a cystoadenoma. However, this aspect does not represent a contraindication for the laparoscopic approach. It would be interesting to have the pathology results available during the procedure in order to enable changes in the surgical strategy if necessary.

In our opinion, the indications for solid malignant lesions constitute an important issue, which is still the subject of controversy. Despite the functional postoperative advantages, two important aspects may affect the role of laparoscopy in solid lesions: margin-free lesions and anatomical resection, involving sectionectomies and major resections. In terms of oncologic aspects, the follow-up and subsequently the overall survival rate were not an objective for the present work. However, no cases of margin affected after surgery were reported.

On the one hand, a margin-free lesion influences the survival rate and should become the goal of any laparoscopic procedure for the resection of liver malignancies. The same rules should be applied as in open therapy, including the "no touch" tumour technique, radical R0 resection and a free surgical margin. In the laparoscopic approach, there is no digital palpation, which makes it more difficult to assure a safety margin in the resection. This aspect is clearly related to the routine use of ultrasonography, which provides a precise determination of the lesion's limits. In the present work 84.3% of the malignant lesions were also studied by intraoperative ultrasonography. We believe that the intraoperative use of ultrasonography is necessary, not only for the margin-free lesion, but also in order to discard new lesions.

On the other hand, the laparoscopic approach to solid lesions is only widely accepted when they are located in the left lateral or right peripheral segments. Since Azagra made the first anatomical resection [7], this procedure has become standardised and is currently the first choice for lesions located in segments II and III. Large tumours sited

deeply or posteriorly in the right hepatic lobe, or lesions close to the portal bifurcation or the suprahepatic junction should be considered for laparoscopic resection, even though it implies increased complexity. However, some recent articles have reported on major hepatic resections (left hepatectomy or right hepatectomy) [16–20]. Such major hepatic resections require high surgical expertise and advanced technology. In our multicentre register, out of 182 liver surgeries we only reported two major hepatectomies (one left and one right). Although we do not consider a major liver resection to be a contraindication for laparoscopy, we prefer to do it only in selected patients. For us, the paramount criterion for this kind of procedure is the maintenance of a safe margin. Intraoperative ultrasonography can be very helpful. We also consider that this type of resection still requires development in some technical aspects, such as vascular control, patient position, etc.

We view hepatocellular carcinoma to be a special case. Some studies have reported the advantages of the laparoscopic approach in this kind of tumour [21–23]. The less exposure of abdominal organs, remarkable reduction of abdominal wall trauma by laparoscopy itself and the lesser degree of hepatic mobilization performed using this approach seem to benefit vein drainage, causing less hepatic decompensation in the postoperative period. In our series, of 28 patients with resection of hepatocellular carcinoma, we have only reported 2 hepatic decompensations. Furthermore, recently it has been reported that laparoscopic liver resection in patients who could be potential transplant candidates facilitates posterior liver transplantation procedures as compared with open liver resection [24].

In spite of the difficulties of using this approach in this kind of surgery, when a surgical team experienced in both liver and laparoscopic surgery performs it, using state-of-the-art technology provided by specialised units, it appears to be safe and is associated with an acceptable morbidity rate, as others have reported [25]. Our series had good results compared with other series (Table 4). This is an

important issue due to the fact that the data of the present work are from many centres in different phases of the laparoscopic learning curve. It is noted that the conversion and morbidity rates in Sasaki et al.'s series are the lowest, achieving very good operative results as a single institution. Furthermore, the risk of gas embolism when using this approach can be avoided with gasless laparoscopy and caution in the use of the argon beam coagulator [26].

In conclusion, laparoscopic resection of liver malignancies is feasible, with an acceptable complication rate. We think that multicentre series that gather the limited number of patients who are candidates for this technique for each centre will provide real data in terms of indications, type of resections, morbidity and mortality rates.

Acknowledgments We express our thanks to the different Chiefs of Surgical Units of the centres who participated in the Spanish Register. We want to give special mention to: Constancio Marco MD, Fernando Pardo, MD, José A. Bondía Navarro, MD, Jorge Ortiz de Urbina, MD, Manel Trias i Folch, MD, Ramón Charco Torra, MD, Jesús Timón Peralta, MD, José Miguel Leras Tricas, MD, and Fernando González Hermoso MD. We also want to note that this work has been made under the sponsorship of the Endoscopic Diversion and Hepato-Bilio-Pancreatic Diversion of the Spanish Society of Surgery (AEC).

References

- Gigot GF, de Goyet J, van Beers BE, Reding R, Etienne J, Jadoul P, et al. Laparoscopic splenectomy in adults and children: experience with 31 patients. *Surgery*. 1996;119:384–9.
- Clayman RV, Kavoussi LR, Soper NJ. Laparoscopic nephrectomy. *N Engl J Med*. 1991;324:1370–1.
- Gagner M, Pomp A, Heniford BT, Pharand D, Lacroix A. Laparoscopic adrenalectomy: lessons learned from 100 consecutive procedures. *Ann Surg*. 1997;226:238–46.
- Gagner M, Pomp A. Laparoscopic pancreatic resection: is it a worthwhile? *J Gastroenterol Surg*. 1997;1:20–6.
- Gagner M, Rheault M, Dubuc J. Laparoscopic partial hepatectomy for liver tumor. *Surg Endosc*. 1992;6:99.
- Gugenheim J, Mazza D, Katkhouda N, Goubaux B, Mouiel J. Laparoscopic resection of solid liver tumours. *Br J Surg*. 1996; 83:334–5.
- Azagra JS, Goergen M, Gilbert E, Jacobs D. Laparoscopic anatomical (hepatic) left lateral segmentectomy: technical aspects. *Surg Endosc*. 1996;10:758–61.
- Descottes B, Lachachi F, Sodji M, Valleix D, Durand-Fontanier S, Pech de Laclause B, et al. Early experience with laparoscopic approach for solid liver tumours: initial 16 cases. *Ann Surg*. 2000;232:641–5.
- Cherqui D, Husson E, Hammoud R, Malassagne B, Stéphan F, Bensaid S, et al. Laparoscopic liver resections: a feasibility study in 30 patients. *Ann Surg*. 2000;232:753–62.
- Katkhouda N, Mavor E, Gugenheim J, Mouiel J. Laparoscopic management of benign cystic lesions of the liver. *J Hepatobiliary Pancreat Surg*. 2000;7:212–7.
- Descottes B, Glineur D, Lachachi F, Valleix D, Paineau J, Hamy A, et al. Laparoscopic liver resection of benign liver tumors. *Surg Endosc*. 2003;17:23–30.
- Lesurtel M, Cherqui D, Laurent A, Tayar C, Fagniez PL. Laparoscopic versus open left lateral hepatic lobectomy: a case-control study. *J Am Coll Surg*. 2003;196:236–42.

Table 4 Laparoscopic liver surgery. Results of different studies

References	<i>n</i>	Benign/ malignant	Conversion rate (%)	Morbidity rate (%)	Mortality rate (%)
Cherqui et al. [9]	30	18/12	6.6	20	0
Gigot et al. [13]	37	0/37	13.5	22	0
Descottes et al. [11]	87	87/0	10	5	0
Sasaki et al. [15]	82	6/76	1.2	4	0
Cugat et al. 2009 (this study)	182	112/70	8.8	14.8	0

13. Gigot J, Glineur D, Azagra JS, Georgen M, Ceuterick M, Morino M, et al. Laparoscopic liver resection for malignant liver tumors. Preliminary results of a multicenter European study. *Ann Surg.* 2002;236:90–7.
14. Laurent A, Cherqui D, Lesurtel M, Brunetti F, Taver C, Fragniez PL. Laparoscopic liver resection for subcapsular hepatocellular carcinoma complicating chronic liver disease. *Arch Surg.* 2003;138:763–9.
15. Sasaki A, Nitta H, Otsuka K, Takahara T, Nishizuka S, Wakabayashi G. Ten-year experience of totally laparoscopic liver resection in a single institution. *Br J Surg.* 2009;96:274–9.
16. Dagher I, Proske JM, Carloni A, Richa H, Tranchart H, Franco D. Laparoscopic liver resection: results for 70 patients. *Surg Endos.* 2007;21:619–24.
17. Gumb AA, Bar-Zakai B, Gayet B. Totally laparoscopic extended left hepatectomy. *J Gastrointest Surg.* 2008;12(7):1152.
18. Vibert E, Kouider A, Gayet B. Laparoscopic anatomic liver resection. *HPB (Oxford).* 2004;6(4):222–9.
19. Gagher I, Caillard C, Proske JM, Carloni A, Lainas P, Franco D. Laparoscopic right hepatectomy: original technique and results. *J Am Coll Surg.* 2008;206(4):756–60.
20. Andoh H, Sato T, Yasui O, Shibata S, Kurokawa T. Laparoscopic right hemihepatectomy for a case of polycystic liver disease with right predominance. *J Hepatobiliary Pancreat Surg.* 2004;11:116–8.
21. Abdel-Atty MY, Farges O, Jagot P, et al. Laparoscopy extend the indications for liver resection in patients with cirrhosis. *Br J Surg.* 1999;86:1397–400.
22. Belli G, Fantini C, D’Agostino A, Belli A, Russolillo N. Laparoscopic liver resections for hepatocellular carcinoma (HCC) in cirrhotic patients. *HPB (Oxford).* 2004;6(4):236–46.
23. Mizoe A, Tomioka T, Inoue K, Azuma T, Fujioka H, Furui J, et al. Systematic laparoscopic left lateral segmentectomy of the liver for hepatocellular carcinoma. *J Hepatobiliary Pancreat Surg.* 1998;5:173–8.
24. Laurent A, Tayar C, Andréoletti M, Lauzet JY, Merle JC, Cherqui D. Laparoscopic liver resection facilitates salvage liver transplantation for hepatocellular carcinoma. *J Hepatobiliary Pancreat Surg.* 2009;16:310–4.
25. Inagaki H, Kurokawa T, Yokohama T, Ito N, Yokohama Y, Nonami T. Results of laparoscopic liver resection: retrospective study of 68 patients. *J Hepatobiliary Pancreat Surg.* 2009;16:64–8.
26. Intra M, Viania MP, Ballarini C, Pisani Ceretti A, Ongari B, Croce AM, et al. Gasless laparoscopic resection of hepatocellular carcinoma (HCC) in cirrhosis. *J Laparoendosc Surg.* 1996;6:263–70.