



Minor laparoscopic liver resection as day-case surgery (without overnight hospitalisation): a pilot study

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Received: 29 March 2018 / Accepted: 18 June 2018 / Published online: 25 June 2018
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Abstract

Background Day-case surgery (DCS) has become increasingly popular over recent years, as has laparoscopic liver resection (LLR) for the treatment of benign or malignant liver tumours. The purpose of this prospective study was to demonstrate the feasibility of minor LLR as DCS.

Methods Prospective, intention-to-treat, non-randomised study of patients undergoing minor LLR between July 2015 and December 2017. Exclusion criteria were resection by laparotomy, major LLR, difficult locations for minor LLR, history of major abdominal surgery, hepatobiliary procedures without liver parenchyma resection, cirrhosis with Child > A and/or portal hypertension, significant medical history and exclusion criteria for DCS. The primary endpoint was the unplanned overnight admission rate. Secondary endpoints were the reason for exclusion, complication data, criteria for DCS evaluation, satisfaction and compliance with the protocol.

Results One hundred sixty-seven patients underwent liver resection during the study period. LLR was performed in 92 patients (55%), as DCS in 23 patients (25%). Reasons for minor LLR were liver metastasis ($n=9$), hepatic adenoma ($n=5$), hepatocellular carcinoma ($n=4$), ciliated hepatic foregut cyst ($n=2$) and other benign tumours ($n=3$). All day-case minor LLR, except two patients, consisted of single wedge resection, while one patient underwent left lateral sectionectomy. There were four unplanned overnight admissions (17.4%), one unscheduled consultation (4.3%), two hospital readmissions (8.6%) and no major complications/mortality. Compliance with the protocol was 69.5%. Satisfaction rate was 91%.

Conclusion In selected patients, day-case minor LLR is feasible with acceptable complication and readmission rates. Day-case minor LLR can therefore be legitimately proposed in selected patients.

Keywords Laparoscopic liver resection · Day-case surgery · Outpatient surgery · Ambulatory surgery

Abbreviations

DCS Day-case surgery
LLR Laparoscopic liver resection

Previous communication: Oral communication (First World Congress of the International Laparoscopic Liver Society 2017).

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Day-case surgery (DCS) does not require an overnight hospital stay. In the field of gastrointestinal surgery, DCS has primarily been validated for inguinal hernia repair and cholecystectomy [1]. Innovative indications have subsequently emerged for more major surgery, such as the treatment of gastro-oesophageal reflux disease [2, 3], sleeve gastrectomy for morbid obesity [4], closure of ileostomy [5] or, more recently, left colectomy [6]. The results of these published series show that more complex surgery can be performed in an outpatient setting with good results and without increased morbidity and mortality, provided patients are rigorously selected for this type of management.

Laparoscopic liver resection (LLR) was first described by Gagner et al. [7] in 1992 and the first series of laparoscopic resections was reported by Cherqui et al. [8] and concerned 30 patients including 12 patients with malignant tumours. Since this time, LLR has become increasingly popular, but remain reserved to specialised centres experienced in liver resection and laparoscopic procedures. The growth of LLR has encountered a number of difficulties: long learning curve, fear of intraoperative bleeding, difficulty of exposure, vascular control, and liver mobilisation. However, recent publications have shown that laparoscopy may present the advantage of better and more accurate vision of the liver parenchyma [9] and could be associated with decreased postoperative morbidity [10] with similar oncological results.

By abandoning certain dogmas, enhanced recovery after liver resection can simplify the management of patients undergoing liver resection and allow more rapid discharge [11]. With the improvement of laparoscopic techniques, some LLR can also be performed with short operating times, suggesting that LLR could be performed as day-case surgery.

Only three series have been published in the field of DCS LLR. A retrospective series demonstrated the feasibility of LLR in the context of minor resection in 20 patients [12]. Most cases of this series presented benign tumours, including 50% of liver cyst removal. A more recent series evaluated the outcomes of minor LLR performed as one-day surgery (with overnight hospitalisation) and showed that short hospitalisation was not associated with increased morbidity and mortality [13]. In another retrospective analysis of 994 patients who underwent LLR in two French expert centres, the authors reported that approximately 7% of patients could benefit from day-case surgery [14].

No prospective studies conducted according to standardised surgical, anaesthetic, and postoperative management protocols have yet been performed in the context of day-case LLR. The objective of this study was therefore to determine the feasibility and outcomes of day-case minor LLR as treatment for liver tumours.

Materials and methods

Population

This was a prospective, intention-to-treat, non-randomised study of a group of consecutive patients undergoing day-case minor laparoscopic liver resection (without overnight hospitalisation) between July 2015 and December 2017. Some of these patients were entered into a prospectively designed registry “Optimization of Health Expenditure in Liver Surgery” (ClinicalTrials.gov identifier: NCT01715402). All patients undergoing LLR during this period were included

in the European Laparoscopic Liver Resections Registry (LapLivEur registry) [15] and take part in a French National Cancer Institute project (No. DGOS/R3/2015/222).

At a preoperative consultation, patients were provided with a study information sheet and a drug prescription for the days after surgery.

Inclusion and exclusion criteria (Fig. 1)

Inclusion criteria were minor LLR (< 3 segments) operated as DCS, absence of significant medical history (cardiovascular and/or pulmonary diseases, no history of major abdominal surgery), treatment-compliant patients aged between 18 and 70 years, living within an hour’s drive from our centre and with an on-site support person available for the night after surgery, access to a telephone and an American Society of Anesthesiologists score of I, II or stabilised III [16].

Exclusion criteria were liver resection via laparotomy, major LLR (≥ 3 segments), difficult locations for minor LLR (posterior and superior segments), hepatobiliary procedures without liver parenchyma resection (liver radiofrequency ablation, liver cyst removal), cirrhosis with Child > A and/or portal hypertension, repeat liver resection, history of major abdominal surgery via laparotomy, presence of significant medical history (history of myocardial infarction, cardiac arrhythmia, antiplatelet or anticoagulant therapy, poorly controlled diabetes, etc.), BMI ≥ 50 kg/m² and absence of criteria for DCS. Secondary exclusion criteria were intraoperative events for which overnight hospitalisation was preferred, and implementation of abdominal drainage. Hepatic pedicle clamping was not considered to be an exclusion criterion for day-case surgery.

Preoperative management

All patients received a study information sheet and provided their informed consent to participate in the study. During a specific preoperative consultation, patients were informed about the specificity of this type of management. The patient was also provided with the surgeon’s and the emergency department’s telephone numbers and the date of the scheduled postoperative consultation on POD 4 at the preoperative consultation. Patients were also given a drug prescription for the days following surgery at the preoperative consultation. This prescription comprised oral analgesics acetaminophen 1 g qid and tramadol 100 mg tid, an antiemetic (metoclopramide 10 mg po tid) and an anticoagulant (subQ enoxaparin 40 IU qid for 30 days for patients with malignant tumours and for 7 days for patients with benign tumours).

Patients were treated in a dedicated DCS unit. Patients were admitted to the unit at 7:15 am on the day of the operation and entered the operating theatre at 8:00 am. Surgery began at around 9:00 am (Fig. 1).

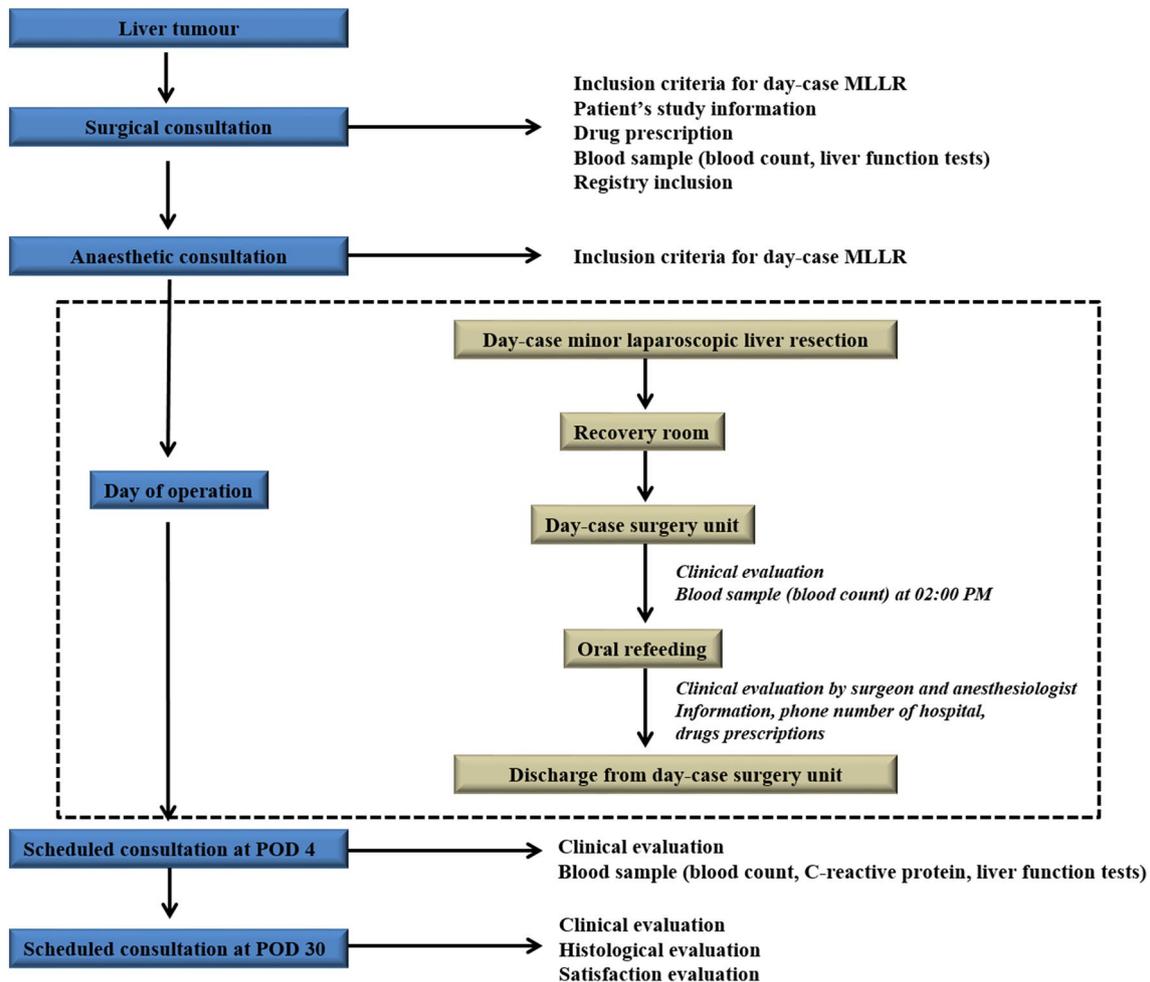


Fig. 1 Protocol for day-case minor LLR

Anaesthesia protocol

The anaesthesia protocol was specifically developed for use in day-case minor LLR and was based on our experience of day-case sleeve gastrectomy [17]. No premedication was administered prior to anaesthesia. In the operating theatre, patients were pretreated with an oxygen fraction of 1 for 5 min. General anaesthesia was induced with propofol (2.5 mg/kg), sufentanil (0.5 µg/kg) and rocuronium (0.6 mg/kg) to facilitate tracheal intubation. Anaesthesia was maintained with 4–6% desflurane and 0.1–0.25 µg kg⁻¹ min⁻¹ remifentanyl. The objective of mechanical ventilation was to maintain the arterial oxygen saturation above 95% and CO₂ between 30 and 35 mmHg with an inhaled oxygen concentration of 50%. Surgery was performed without arterial or central venous catheterization. A low flow rate infusion was maintained to obtain a low central venous pressure (5 mmHg).

Neuromuscular blockade was reversed in every case with neostigmine bromide 40 µg/kg and atropine 1 mg or

sugammadex 2–4 mg/kg when the train-of-four ratio was greater than 2. Postoperative analgesia was ensured by a combination of nefopam 20 mg, tramadol 100 mg and acetaminophen 1 g. To prevent postoperative nausea and vomiting, patients received IV injections of (i) dexamethasone 4 mg and droperidol 0.625 mg on induction of anaesthesia and (ii) ondansetron 4 mg postoperatively. The nasogastric tube, when placed during surgery, was always removed in the operating theatre after surgery.

Standardised surgical procedure

For the LLR procedure, the patient was installed in the supine position with a 15° head-up tilt (French position) with the surgeon placed between the patient's legs. Surgery was performed using a 30° laparoscope and 3–5 trocars and open laparoscopy was routinely performed. Pneumoperitoneum was maintained with an abdominal pressure between 12 and 14 mmHg.

In every case, 20 ml of 7.5 mg/ml ropivacaine was infiltrated under visual control at the trocar sites before trocar insertion. The surgical procedure started with intraoperative liver ultrasound to locate the lesion, determine the vascular relations and guide surgical resection. Cotton tape (Péters Surgical, Bobigny Cedex, France) was systematically placed around the porta hepatis to ensure hilar clamping when necessary. Cotton tape was inserted via a 5-mm trocar placed at the opposite site of liver resection (for example, right flank for a lesion of the left liver lobe).

For lesions of the right lobe, the patient was installed in the same way using a right roll and trocar sites were shifted to the right in order to increase surgical exposure. Hepatic transection was performed using an energy device and irrigated bipolar electrocoagulation was used to control minor bleeding. Vascular structures larger than 3 mm were secured with clips. The resected specimen was removed in a plastic bag and extracted through an enlargement of the umbilical trocar site, previous scar or suprapubic incision depending on the volume of resection. Drainage of the peritoneal cavity was not performed except in the event of intraoperative complications (secondary exclusion criteria for DCS).

Postoperative management

After surgery, patients were initially admitted first to the recovery room and then to the DCS unit for assessment of vital signs, postoperative nausea and pain, and collection of a blood sample for determination of serum haemoglobin. In the absence of any clinical or biochemical contraindications, the surgeon authorised oral refeeding. The patient was deemed suitable for discharge on the same day in the absence of any particular symptoms after food intake in the DCS unit and after examination by the surgeon. When these conditions were not met, the patient was hospitalised overnight. Before leaving the DCS unit, the patients were provided with an information sheet describing symptoms that require emergency consultation (fever, tachycardia and pain not relieved by the prescribed analgesics) and confirmation of the date of the scheduled postoperative consultation on POD 4.

Follow-up procedures

Patients were always contacted by the DCS unit nurse on POD1 and reviewed in the clinic on POD4 with a complete clinical assessment, complete blood count and C-reactive protein (CRP) assay. Patients were reviewed 1 month later, when they were asked about their level of satisfaction with day-case minor LLR.

Classification of postoperative complications

Complications were classified according to the classification of Dindo et al. [18].

Complications specific liver surgery were defined as follows: ascites, defined according to Van den Broeck et al. [19] as abdominal drain output of more than 500 mL of ascitic fluid after POD3 when abdominal drainage have been performed or the need for secondary abdominal drainage; postoperative liver failure, defined according to Balzan et al. [20] as prothrombin time < 50% and serum bilirubin > 2.95 mg/dL on postoperative day five (“50–50” criteria); bile leakage, defined according to Koch et al. [21] as bilirubin level in drain fluid at least 3 times higher than serum bilirubin level on or after postoperative day 3 or as the need for radiological or operative intervention due to bile collections or bile peritonitis; haemorrhage, defined according to Rahbari et al. [22] as a fall in haemoglobin level > 3 g/dL postoperatively compared to the baseline postoperative level and/or any postoperative transfusion of packed red blood cells for falling haemoglobin and/or the need for radiological intervention (such as embolization) and/or re-laparotomy to stop bleeding. Evidence of intra-abdominal bleeding had to be obtained by imaging or blood loss via abdominal drains when present. Abscess was defined by intra-abdominal collection diagnosed by CT scan or ultrasonography performed in patients with postoperative pain, or fever associated with increased white blood cell count.

Study endpoints

The study’s primary endpoint was the unplanned overnight admission rate (i.e. the percentage of intended day-case minor LLR in which the patient was admitted overnight). The secondary endpoints were reasons for exclusion from DCS, intraoperative data and data related to DCS: unscheduled consultation rate, hospital readmission rate, unscheduled reoperation, complications (according to the Clavien classification) [18], major complication rate (with a Clavien score ≥ 3) and levels of patient satisfaction with day-case minor LLR 1 month postoperatively. Compliance with the protocol and the outcomes of patients excluded because of refusal of DCS, significant medical history or for technical reasons were also evaluated.

Data collected

The following parameters were recorded:

- Demographic data: age, gender, body mass index, ASA score, previous abdominal surgery, medical history, rate of patients undergoing minor LLR as DCS, reason for exclusion from DCS.

- Preoperative data: tumour characteristics (type, size, number and site).
- Intraoperative data: type of liver resection, number of trocars, clamping rate and duration, operating time, intraoperative events, conversion rate.
- Postoperative data: mortality rate, complications according to the Dindo classification [18], specific LLR-related complications.
- Day-case surgery data: unplanned overnight admission rate, unscheduled consultation rate, hospital readmission rate, unscheduled reoperation and levels of patient satisfaction with day-case minor LLR 1 month postoperatively.
- Patients excluded because of refusal DCS, significant medical history or for technical reasons: mortality rate, complications according to the Dindo classification [18], length of hospital stay, readmission rate and reasons for readmission.

Statistics

Categorical variables are expressed as number (percentage) and compared by a χ^2 or Fisher's exact test. Quantitative variables are expressed as mean \pm SD (range) and compared by a Student *t* test as applicable. All tests were two-tailed and the limit of statistical significance was set at $p < 0.05$. All statistical analyses were performed with SAS software (version 4.3, SAS Institute Inc., Cary, NC).

Results

Patients managed during the study period

A total of 167 patients underwent liver resection during the study period (30 months). Fifty-seven patients underwent liver resection via laparotomy because of a history of previous liver surgery (complex repeat liver resection or major resection with vascular reconstruction) or because of the specific indication for resection (Klatskin tumour). Ten patients underwent a combined procedure (liver resection associated with colorectal resection or closure of ileostomy). Eight patients underwent laparoscopy-assisted liver resection (beginning of experience of major LLR for most cases). All remaining patients ($n = 92$) underwent complete LLR (55%).

Reasons for exclusion from day-case surgery are described in Fig. 2. Day-case LLR was not proposed in 22 patients (23.9%) because of significant medical history, while day-case LLR was not indicated in 36 patients because of technical reasons, such as major hepatectomy or difficult location for LLR (39.1%). Five patients did not meet the social criteria for day-case surgery (3%) (living more than 1 h drive from our centre or no on-site support person available for the night after surgery). Twenty-nine patients met all of the study criteria for DCS (31.5% of 92 patients). Six patients meeting the criteria for day-case LLR refused to participate in the study (20.7% of all patients meeting the DCS inclusion criteria).

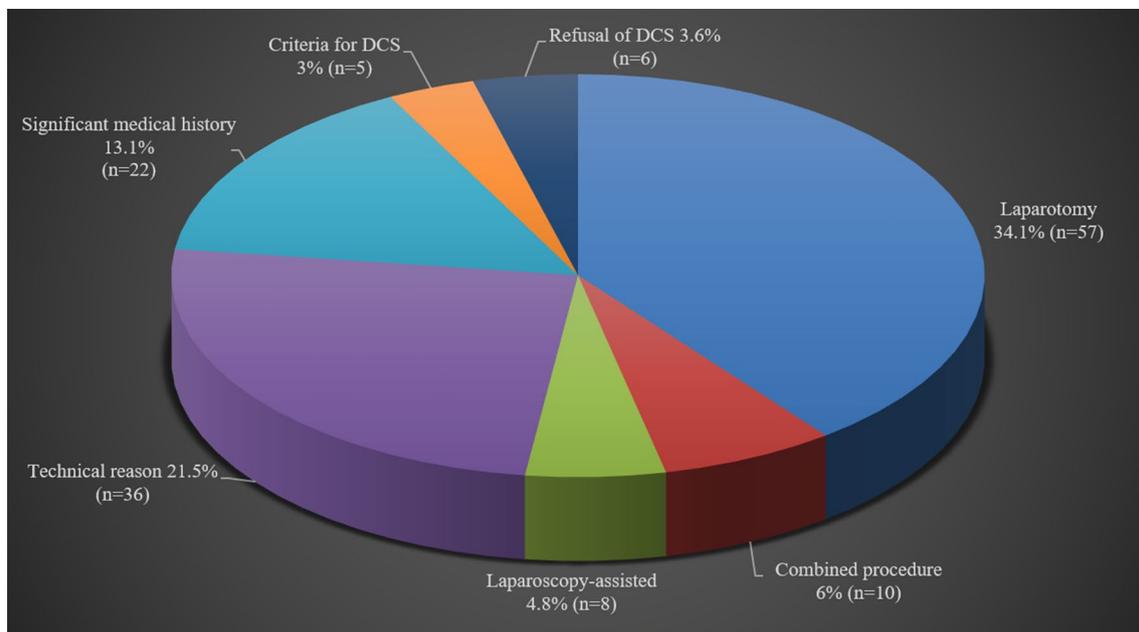


Fig. 2 Reasons for exclusion from day-case LLR

Day-case minor LLR

Preoperative data

The study population consisted of 23 patients, 8 women (34.7%) and 15 men (65.3%) with a median (range) age of 58 years \pm 7 (22–69). Median BMI was 25.9 kg/m² \pm 3.3 (18.2–40.4). Sixteen patients had an ASA score \leq 2 (69.5%).

The indications for day-case LLR were malignant tumour in 13 cases (54.1%), including 9 cases of liver metastasis (from colon cancer in 5 cases, rectal cancer in three cases and breast cancer in one case) and 4 cases of hepatocellular carcinoma on Child A cirrhosis without portal hypertension. The other 10 patients underwent LLR as day-case surgery for liver adenoma in 5 cases, ciliated hepatic foregut cyst in two cases, focal nodular hyperplasia of the liver in two other cases and one case of hepatic angiomyolipoma.

Tumour sites were as follows: segment III in 7 cases, segment IV in 8 cases, segment V in 4 cases, segment VI in 4 cases and segment VIII in one case. One patient had two tumours (segment IV and VI). The median tumour diameter was 24 mm (15–50).

Nine patients had a history of colonic and rectal surgery (by laparoscopy in 7 cases, by laparotomy in 2 cases) and one case of right partial nephrectomy via a right subcostal incision. Four patients had a history of hypertension, one patients had type 2 diabetes and one patient had haemochromatosis.

Operative data

All procedures were performed laparoscopically. All but two day-case minor LLR procedures consisted of a single wedge resection. One patient underwent left lateral sectionectomy. Median \pm SD (range) operating time was 120 min \pm 35 (50–180). A mean of 4 (3–5) trocars were used. Clamping was performed in three cases (one case due to intraoperative bleeding due to injury of an accessory hepatic vein). Clamping time was 8, 10 and 5 min (only one clamping was performed in each patient). Median blood loss was 50 ml (10–250) (Table 1). Multiple lesions were discovered during laparoscopy in one patient, in whom conversion to conventional hospitalisation was decided although surgery was performed laparoscopically (two wedge resections and one case of radiofrequency ablation of the liver with abdominal drainage). Cholecystectomy was performed during the same procedure in 5 cases and incisional hernia repair was performed during the same procedure in one case. No patients required drainage or intraoperative blood transfusion.

Day of surgery

All patients were admitted to the recovery room after surgery. The median (range) length of stay in the recovery room was 125 min (80–220). Mean (range) values for vital signs and laboratory test values on admission to the DCS unit were as follows: heart rate: 75 bpm (50–100); arterial blood pressure: 135/80 mmHg (80/55–178/90); body temperature: 36.5 °C (36–37.5); haemoglobin level: 13.5 g/dl (10–15.1); white blood cell count: 10,600 (4900–18,000).

Table 1 Indications, intraoperative and postoperative data and data related to DCS criteria of patients undergoing minor LLR as DCS

	Day-case minor LLR
Indications for minor LLR	
Malignant tumour (%)	13 (56.5)
Benign tumour (%)	10 (43.5)
Intraoperative data	
Operating time (minutes), mean (range)	120 (50–180)
Blood loss (millilitres), median (range)	50 (10–250)
Clamping (%)	3 (13)
Postoperative data	
Time to oral refeeding (minutes), mean (range)	465 (405–585)
Length of stay in the DCS unit (minutes), mean (range)	645 (585–705)
Overall complications (%)	6 (26)
Major complications (%)	0 (0)
Data related to DCS criteria	
Unplanned overnight admission (%)	4 (17.4)
Unplanned consultation (%)	1 (4.3)
Unplanned readmission (%)	2 (8.6)
Unplanned reoperation (%)	0 (0)

LLR laparoscopic liver resection, DCS day-case surgery

Oral feeding was resumed an average of 480 min \pm 45 (450–585) after admission to the DCS unit. Nineteen patients were discharged on the evening of the day of surgery, after a mean length of stay in the DCS unit of 645 min \pm 37 (585–705) (Fig. 3).

Criteria related to day-case surgery

No postoperative deaths were observed. Four unplanned overnight admissions (17.4%) were required due to acute urinary retention ($n=1$), pain on incisional hernia repair ($n=1$), postoperative hypotension ($n=1$) and an unplanned procedure in the patient in whom multiple tumours were discovered during laparoscopy ($n=1$). Two of these 4 patients were discharged on POD 1, one patient was discharged on POD 2 and the last patient was discharged on POD 4.

One patient attended an unscheduled consultation for wound pain, not requiring hospitalisation. Two patients were hospitalised after a scheduled consultation (8.6%) for pain at trocar sites in two cases (length of hospital stay of 2 days). No unscheduled surgical procedures were performed for postoperative complications.

Postoperative day 4 consultation

All patients except for the patient in whom multiple tumours were discovered were reviewed on POD4. The patient who required an unplanned procedure was discharged on POD 4. Twenty patients (86.9%) therefore did not have any specific somatic complaints. Two patients reported postoperative pain requiring hospitalisation to adjust analgesic

management. No patients underwent abdominal CT scan for suspicion of postoperative complications at the scheduled consultation.

Follow-up at the first postoperative month

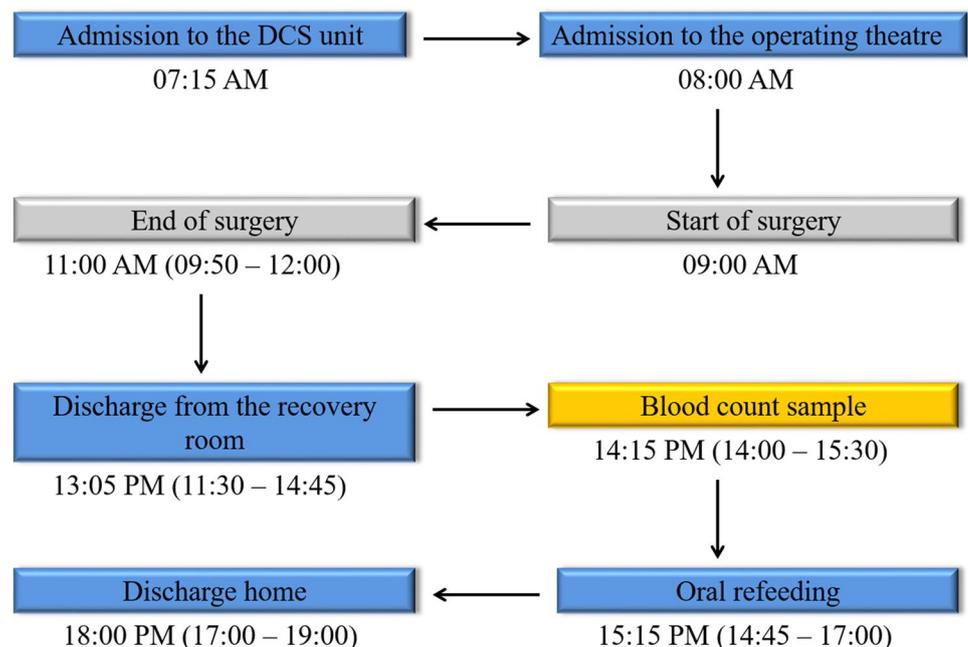
No major complications (Clavien score ≥ 3) or deaths were observed. Six cases of minor complications with a Clavien score of 1 were observed, corresponding to four patients with pain (requiring unplanned overnight admission in one patient, two patients were rehospitalised and one patient attended an unscheduled consultation without rehospitalisation), one patient with acute urinary retention not requiring a bladder catheter and one patient with postoperative hypotension. No complications specifically related to liver surgery were observed.

The patient satisfaction rate after day-case LLR at the scheduled consultation on POD30 was 91% (20 of 22 patients). The only dissatisfied patients were patients with postoperative pain, who required rehospitalisation. Compliance with the protocol was 69.5% (Fig. 4).

Conventional LLR during the study period

During the study period, 33 patients were excluded from day-case management despite the fact that resection as day-case surgery was technically feasible. Thirty-six patients were excluded from day-case management for technical reasons; 22 patients were excluded because of significant medical history, and 5 patients were excluded on the basis

Fig. 3 Operating schedule for day-case minor LLR



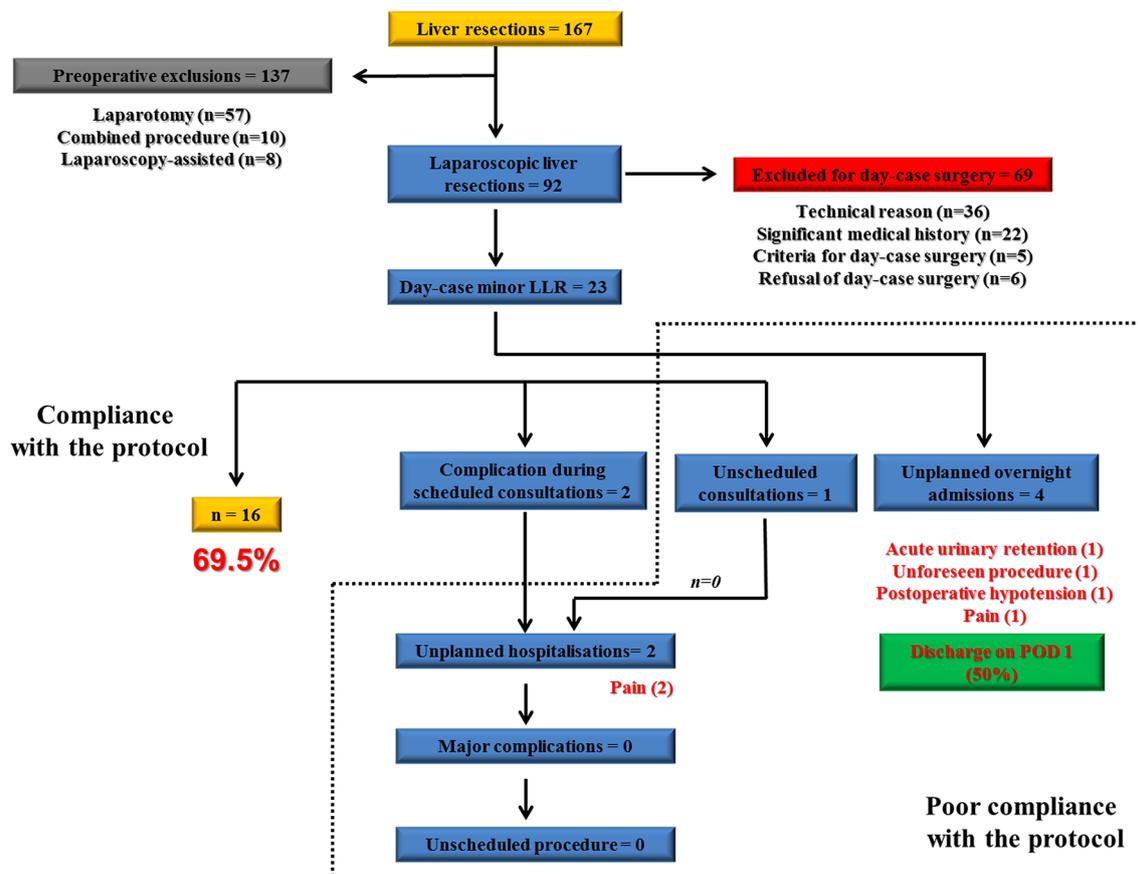


Fig. 4 Study synopsis

of DCS criteria. The remaining 6 patients refused LLR as day-case surgery,

Surgery was performed laparoscopically in the 36 patients excluded for technical reasons. Median time to discharge from hospital was 6 days (1–30). The postoperative complication rate was 25.7%, including six major complications (16.6%) but no deaths. The readmission rate was 8.3% (Table 2).

Surgery was performed laparoscopically in all 22 patients excluded because of significant medical history. Median time to discharge from hospital was 4 days (2–18). The postoperative complication rate was 13.6%, including two major complications (9%) with one death (4.5%). Complications were septic shock secondary to pneumonia, acute renal failure (Clavien grade of 5) and acute prostatitis in a cirrhotic patient. One patient was readmitted on POD 18 (patient with acute renal failure who was discharged on POD 6) (Table 2).

Among the 5 patients who were excluded on the basis of DCS criteria, surgery was performed for resection of a metastasis from colon cancer ($n=2$), hepatocellular carcinoma on Child A cirrhosis without portal hypertension ($n=2$) and liver adenoma ($n=1$) consisting of wedge resection of segments V, VI and III in 3 cases. Three patients were discharged from

hospital on POD 1, while two patients were discharged on POD 2 (one patient with HCC) and POD 3 (liver adenoma). An uneventful outcome without rehospitalisation was observed on POD 30.

Among the 6 patients who refused LLR as day-case surgery, surgery was performed for resection of a metastasis from colon cancer in two cases, a metastasis from breast cancer, focal nodular hyperplasia of the liver, liver adenoma and ciliated hepatic foregut cyst and consisted of wedge resection of segment III (two patients with metastasis from colon cancer), wedge resection of segment V, left lateral sectionectomy and wedge resection of segment IV (liver adenoma and ciliated hepatic foregut cyst), respectively. Four patients were discharged from hospital on POD 1, while one patient was discharged on POD 2 and the remaining patient was discharged on POD 5. An uneventful outcomes without readmission was observed on POD 30.

Discussion

This is the first prospective study to evaluate day-case minor LLR. This study shows that, with strict inclusion criteria, a well-organised clinical pathway and a dedicated protocol

Table 2 Comparison of demographic data, tumour characteristics, operative and postoperative data between day-case minor LLR and patients excluded for medical and technical reasons

	Day-case minor LLR (<i>n</i> = 23)	Exclusion for medical reasons (<i>n</i> = 22)	Exclusion for technical reasons (<i>n</i> = 36)
Demographic data			
Median age (range)	58 (22–69)	66 (45–79) ^a	60 (35–75)
ASA score ≤ 2 (%)	16 (69.5)	4 (18.1) ^a	15 (41.6)
Cirrhosis, <i>n</i> (%)	4 (17.4)	8 (36.3) ^a	7 (19.4)
Previous abdominal surgery by laparoscopy, <i>n</i> (%)	7 (30.4)	5 (22.7)	16 (44.4)
Previous abdominal surgery by laparotomy, <i>n</i> (%)	3 (13)	4 (18.1)	12 (33.3)
Indications for LLR			
Malignant tumour, <i>n</i> (%)	13 (56.5)	20 (91) ^a	33 (91.7) ^b
Single tumour, <i>n</i> (%)	22 (95.6)	18 (81.8)	17 (47.2) ^b
Operative data			
Operating time (minutes), median (range)	120 (50–180)	120 (60–360)	180 (90–420) ^b
Single wedge resection, <i>n</i> (%)	21 (91.3)	17 (77.2)	15 (41.6) ^b
Two or more wedge resections, <i>n</i> (%)	2 (8.6)	5 (22.7)	11 (30.5) ^b
Left lateral sectionectomy, <i>n</i> (%)	1 (4.3)	1 (4.5)	4 (11.1)
Right posterior sectionectomy, <i>n</i> (%)	0 (0)	0 (0)	3 (8.3)
Right hepatectomy, <i>n</i> (%)	0 (0)	0 (0)	3 (8.3)
Associated radiofrequency ablation, <i>n</i> (%)	1 (4.3)	3 (13.6)	8 (22.2)
Blood loss (millilitres), median (range)	50 (10–250)	100 (0–600)	280 (0–2850) ^b
Clamping, <i>n</i> (%)	3 (13)	8 (36.3)	26 (72.2) ^b
Median clamping time, min (range)	8 (5–10)	20 (3–58)	30 (9–61) ^b
Postoperative data			
Mortality, <i>n</i> (%)	0 (0)	1 (4.5)	0 (0)
Overall complications, <i>n</i> (%)	6 (26)	3 (13.6)	9 (25)
Major complications, <i>n</i> (%)	0 (0)	2 (9)	6 (16.6)
Unplanned reoperation, <i>n</i> (%)	0 (0)	0 (0)	4 (11.1)
Unplanned readmission, <i>n</i> (%)	2 (8.6)	1 (4.5)	3 (8.3)

^aSignificant difference between the day-case minor LLR and exclusion for medical reason groups

^bSignificant difference between the day-case minor LLR and exclusion for technical reason groups

(surgical and anaesthetic), minor LLR for benign or malignant tumours are feasible with no increased risk of morbidity or mortality and with a high level of patient satisfaction. The potential day-case LLR rate according to our protocol was relatively high, as 23 out of a total of 92 LLR procedures were performed as DCS (25%), similar to our experience of laparoscopic sleeve gastrectomy, in which the DCS inclusion rate was 24% [4] despite the fact that the LLR population was older than the bariatric surgery population. The compliance rate with the protocol was acceptable (69.5%), bearing in mind that this was a pilot study and that no prospective series have been previously published on this topic. Most cases of non-compliance in the present series also corresponded to minor deviations and were not due to major morbidity.

Our team has recently published the first prospective series of day-case laparoscopic sleeve gastrectomy based on a standardised surgical and anaesthetic protocol [4]. We

also have an extensive experience of liver resection (for benign and malignant tumours) with currently more than 1000 liver resections, including more than 20% of laparoscopic resections [23] and all patients undergoing liver resection are managed according to an enhanced recovery programme. Based on our experience of laparoscopic sleeve gastrectomy [4], we therefore adopted a similar type of protocol, but adapted to liver surgery criteria. Very simple DCS exclusion criteria were applied. Patients with previous liver resection were excluded, as secondary liver resection could be more challenging with longer operating times and a higher risk of complications [24]. Patients with a history of major abdominal surgery via laparotomy were also excluded for the same reason (longer operating time). Patients with BMI ≥ 50 kg/m² were excluded because liver resection in the presence of steatosis (fatty liver) is even more difficult with increased morbidity due to specific liver complications [25]. In contrast, patients

with Child A liver cirrhosis were included in the absence of portal hypertension based on our experience of minor LLR for HCC on cirrhosis [23], in which a laparoscopic approach can eliminate the excess morbidity associated with cirrhotic liver with an acceptable complication rate. Clearly defined criteria for DCS are necessary to avoid increased morbidity and to guide surgeons, as not all patients are eligible for day-case surgery.

In this prospective study, 16% of patients satisfied the criteria for DCS. In a recent retrospective two-centre study based on a large population of 994 patients, Tranchart et al. [14] analysed their DCS eligibility criteria and found that 7% of patients could potentially benefit from day-case management. We fully agree with these criteria and most patients in the present series satisfied these criteria with the exception of liver cyst unroofing, which was routinely performed as DCS, but which were excluded from the present analysis (absence of liver resection). We agree that some left lateral sectionectomies can be performed as DCS (as demonstrated in our study) according to a standardised procedure [26] with a low risk of bleeding and complications. We have performed one case of left lateral sectionectomy as DCS after progressively introducing short-stay hospitalisation (1 day surgery) for this procedure (Table 2).

However, day-case management has a number of limitations. Patients undergoing liver resection are older than those undergoing sleeve gastrectomy, resulting in more limited eligibility for DCS (increased risk of significant medical history). Most of the 13.1% of patients excluded from DCS for medical reasons would have been technically eligible for DCS as the operative data were similar. Patients requiring LLR in zones of difficult access, such as posterior and superior segments were also excluded for technical reasons. However, although these resections are more difficult and time-consuming [27] and probably constitute poor candidates for day-case management, with more extensive experience of LLR, single lesions, even located in superior segments, could progressively also be managed by DCS. In the present series, one patient with a lesion located in segment VIII (last patient of our series) was operated by DCS.

Few intraoperative events were observed in this series, with no case of conversion and only three cases of intraoperative clamping. No drainage was necessary. In our experience, clamping does not constitute an exclusion criterion for day-case management, provided clamping is only intermittent and we prefer clamping to blood transfusion [28]. However, this study illustrates the difficulty of LLR, particularly in the context of liver metastases. Despite complete preoperative screening, multiple lesions were discovered during laparoscopy in one patient in this series. The inclusion criteria for minor LLR as DCS are therefore probably more complex than for other types of surgery. On the basis of the operative findings and our protocol, this patient was hospitalised (discharged on

POD 4) to ensure a secure patient pathway, with an uneventful outcome.

The unplanned overnight admissions rate in this first prospective study was low (17.4%), and were mostly due to benign causes, such as postoperative pain (Fig. 4; Table 2), allowing rapid discharge with 75% of patients discharged on POD 2. No complications directly related to liver surgery were observed, as most resections consisted of “easy” liver resections. Our results are similar to those of the series reported by de Angelis et al. [13] analysing outcomes of patients undergoing LLR as a 1 day hospitalisation. The readmission rate for patients undergoing anterior wedge resection was 8.3%, similar to our readmission rate of 8.6% with a low rate of complications directly related to LLR.

Patients who refused DCS presented uneventful outcomes, reflecting the quality of our selection criteria. The same applies to patients excluded on the basis of DCS criteria, in view of the short length of stay without complications. One death was observed among the patients excluded because of significant medical history, not directly related to surgery but possibly potentiated by surgery. Eligibility for outpatient surgery must therefore not only be based on technical criteria, but should also take all of the patient’s history into account.

This study presents a number of obvious limitations. First, this single-centre study was based on a small sample size. This study was not randomised, due to the limited data currently available on this topic and a randomised study would have reduced the number of inclusions. Secondly, only minor liver resections were included and only one left lateral sectionectomy was performed in this preliminary study. As laparoscopic left lateral sectionectomy is currently becoming the gold standard, this procedure could probably be performed as DCS over the next year and could also become a classical procedure in experienced centres in view of its reasonable operating time [29] with a low postoperative complication rate [30].

Conclusion

Day-case minor LLR is feasible in selected patients. Postoperative complication and readmission rates were acceptable and patient satisfaction was high. This preliminary study shows that day-case minor LLR can be legitimately performed in selected patients and that this type of management can be an alternative to conventional hospitalisation for highly selected patients.

Compliance with ethical standards

Disclosure Lionel Rebibo, Pauline Leourier, Rachid Badaoui, Fabien Le Roux, Emmanuel Lorne and Jean-Marc Regimbeau have no conflicts of interest or financial ties to disclose.

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