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ORIGINAL ARTICLE

Pure Laparoscopic Left Lateral Sectionectomy in Living Donors

From Innovation to Development in France

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Objective: In this study, we report the results obtained from 70 living donors in France.

Background: Left lateral sectionectomy for pediatric live donor liver transplantation is a well-standardized surgical procedure. Our team introduced the laparoscopic approach to live donation in 2002, and the reproducibility and safety of this method was discussed in 2006.

Methods: Between March 2001 and October 2012, a total of 70 donors underwent a liver procurement. Sixty-seven donors (95.7%) underwent a left lateral sectionectomy, and 3 underwent a left hepatectomy without middle hepatic vein procurement. All data were prospectively recorded in a database.

Results: Of the 70 donors, 66 (94%) liver grafts were procured by laparoscopy, whereas 4 (6%) patients required conversion into an open technique. Seventeen donors experienced complications, leading to an overall complication rate of 24.2%. Eleven donors (16%) had grade 1 complications, according to the Clavien system. Five donors (7.1%) presented grade 2 complications, and 1 donor (1.4%) had a grade 3 complication. No death occurred. Overall, patient and graft survival rates for pediatric recipients were 95% and 92% at 1 year, 95% and 88% at 3 years, and 95% and 84% at 5 years, respectively.

Conclusions: The laparoscopic retrieval of the *left lateral section* for live donor liver transplantation is safe and reproducible and has transitioned from an innovative surgery to a development phase in France.

Keywords: laparoscopic technique, live donor transplantation, organ donation, organ procurement, pediatric liver transplantation

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Left lateral sectionectomy (LLS) for pediatric live donor liver transplantation is a well-standardized procedure that was first described simultaneously in Brazil and Australia in 1989.[1,2] Such living donor liver transplantation in children achieves the best patient survival rates.[3,4]

In an effort to reduce surgical trauma and to minimize risks for donors, the laparoscopic approach of LLS (LLLS) was first proposed by our team in 2002,[5] and its safety and reproducibility were demonstrated in 2006[6] in a comparative study. Live donors are most likely the best theoretical candidates to benefit from the various advantages of laparoscopy. The challenges of laparoscopic organ procurement are to minimize donor morbidity and to ensure a perfect graft quality. This goal has been achieved by live donor kidney procurement. In this view, the left lobe offers optimal conditions for laparoscopic liver procurement, as there are few vascular and biliary anatomical variations. The adequate length of the extrahepatic vessels allows for easy control, and the anterior position gives access with minimal mobilization. Moreover, modern imaging allows an accurate and reliable description of both the vascular and biliary anatomy. Together with these refinements, laparoscopy has gained in popularity not only in liver resection but also in the field of organ procurement in France.

Since our previous reported experience of 16 cases, 2 centers involved in LLLS procurement for pediatric transplantation in France (Paris and Lyon) have used this laparoscopic procedure in a routine fashion. Considered an innovative surgery in 2001, this procedure gradually became more standardized by 2012. This study aims at reporting the results of such laparoscopic procurement in the largest series ever reported of 70 living donors in France. [AQ2]

METHODS

Between March 2001 and March 2012, 70 donors completed a comprehensive evaluation and were considered eligible for either LLLS corresponding to Couinaud's anatomy segments 2 and 3, or laparoscopic left hepatectomy (LH), corresponding to the removal of segments 2, 3, and 4, according to Couinaud's anatomy. These procedures were performed by 2 transplantation teams (O. Soubrane, St Antoine Hospital, Paris, France, for 57 donors and O. Boillot, Edouard Herriot Hospital, Lyon, France, for 13 donors). Senior surgeons with experience in hepatobiliary surgery, laparoscopic liver resections, and transplantation performed all operations. All donors gave their informed consent, according to the French Law called "Loi Bioéthique" (1994, modified in 2004 and 2012), and the Judge of a Civilian Court recorded their consent. All complications, including minor complications, were recorded and classified according to the Clavien-Dindo classification,[7,8] as adapted for live liver donors[9,10] (Table 1). All data were prospectively recorded in a database. All [T1] donors were aware of the innovative nature of the pure laparoscopic technique.

Donor selection

All but one of the transplantations were performed between first-degree relatives. In one case, a grandmother gave her left lateral section to her granddaughter. All donors completed a preoperative workup that included social status; psychiatric evaluation; cardiovascular, pulmonary, and renal assessment; history of coagulation disorders, including Leiden Factor and factor II mutations; virus screening; and infectious disease screening. Liver morphology and anatomy were assessed by ultrasound, computed tomographic (CT) scanner and magnetic resonance imaging (MRI), which included vascular mapping (portal, arterial, and hepatic vein reconstruction), magnetic resonance cholangiography, and hepatic volumetric measurements. Coeliac trunk angiography, endoscopic retrograde cholangiopancreatography, and liver biopsy were not routinely performed.

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TABLE 1. Clavien System for Classification of Negative Outcomes in General Surgery and Solid Organ Transplantation

Grade 1: Any alteration from ideal postoperative course with complete recovery or which can be easily controlled and which fulfills the general characteristics:
(*a*) Not life-threatening.
(*b*) Not requiring use of drugs other than immunosuppressive agents, analgesics, antipyretic, anti-inflammatory and antiemetic, drugs required for urinary retention or lower urinary tract infection, arterial hypertension, hyperlipidemia or transient hyperglycemia.
(*c*) Requiring only therapeutic procedures that can be performed at the bedside.
(*d*) Postoperative bleeding requiring ≤3 units of blood.
(*e*) Never associated with a prolongation of ICU stay or total hospital stay to more than twice the median stay for the procedure in the population of the study.

Grade 2: Any complication that is *potentially life-threatening* or results in ICU stay ≥5 days, hospital stay ≥4 weeks for the recipient or ≥2 weeks for the donor, *but which does not result in residual disability or persistent diseases.*

Grade 3: Any complication with *residual or lasting functional disability* or development of malignant disease.

Grade 4: Complications that lead to transplantation (grade 4a) or death (grade 4b).

ICU indicates intensive care unit.

Surgical Technique of LLLS and Postoperative Care

The surgical technique was similar to those described previously[3] with few modifications. The donor was placed in a supine position with his legs apart. Two monitors were placed above the left and right shoulders of the patient. A carbon dioxide pneumoperitoneum was created and maintained at 12 mm Hg. Five trocars, 3 of 12-mm diameter and 2 of 5-mm diameter, were inserted (Versastep plus, Tyco Healthcare, Norwalk, CT). The liver was visually assessed using a 30° laparoscope. The left lateral section was mobilized by cutting the round, falciform, and left triangular ligaments using harmonic scalpel (Ultracision, Ethicon Endosurgery, Cincinnati, OH). The left hepatic artery(ies) and left portal vein were dissected free and taped. Arterial and portal branches assigned to the caudate lobe were clipped and divided to increase the length of left hepatic artery and portal vein and to facilitate their control. The liver transection was performed along the right side of the falciform ligament for left lateral sectionectomies and along the Cantlie line for the left hepatectomies. For the latter, the middle hepatic vein was kept within the right liver. The liver capsule was incised using a harmonic scalpel. Parenchymal transections were performed using an ultrasonic dissector (Dissectron, Satelec, Merignac, France). Hemostasis and biliostasis of small elements were performed using a saline-assisted bipolar electrocautery. Vascular elements larger than 2 mm, such as the pedicles in segment 4, were dissected using an ultrasonic dissector, taped, clipped using Hem-o-lock clips, and divided. The laparoscopic control of bleeding included a transient increase in pneumoperitoneum pressure up to 16 mm Hg, bipolar cautery, and vascular stitches. When the liver transection reached the hilar plate, the left bile duct was divided with scissors. *Routine cholangiography was not performed*. However, in cases of unreliable preoperative biliary assessment by MRI or questionable recognition of the left bile duct at the time of hilar dissection, a cholangiography was decided. No cautery was used at this stage to avoid thermal injury to the biliary canal and hilar plate. The distal end was closed with a secured clip (Hem-o-lok nonabsorbable polymer vascular clips, Weck, Teleflex Medical, Limerick, PA). The latter point was modified after we experienced biliary leakage when titanium clips were used. These complications have been previously described and reported in the results section. After completing the transection, the left hepatic vein was dissected freely, controlled and taped, and the graft was ready for recovery. A 7-cm suprapubic incision without muscular section was performed. A 15-mm port was inserted, allowing the introduction of a large specimen bag (Endocatch, Tyco Healthcare). No anticoagulants were given to the donor before the division of the blood vessels during this final step of the procedure. The graft was recovered by clipping and dividing the arterial branch first. The proximal part of the graft was locked in with a bolt clip (Hem-O-Lock, Weck, Research Triangle Park, NC), whereas the distal end was neither closed nor clamped. A unilateral linear stapling device (EndoTA 30, Tyco Healthcare) was used to close the left portal branch and distal part of the left hepatic vein. These structures were then divided using scissors. The graft was rapidly inserted into the bag and extracted. The graft was immediately weighed and flushed with a cold preservation solution through the left portal vein. The bile ducts were also washed out with the same preservation solution. We considered the warm ischemia time to start when the left portal branch was stapled and to end when the graft was flushed with the cold preservation solution on the "back-table."

The prevention of deep vein thrombosis by prophylactic doses of low-molecular-weight heparin was systematic for 1 month, as was the gastric ulcer prevention using proton pump inhibitors. No gastric tube was left in place. Oral intake was allowed in the evening of the operation. *Ambulation was encouraged* on postoperative day 1. A routine visit of the donor to the pediatric hospital by ambulance to visit the child was usually possible on the third or fourth postoperative day.

Statistical Analysis

Nonparametric data are presented as medians (range), and categorical data are presented as both frequency and proportion (%). Correlations between CT volumetric assessments and graft weights were assessed by linear regression. Survival analysis was plotted using Kaplan–Meier curves and subsequently compared using the log rank survival. $P < 0.05$ was considered statistically significant. Statistical analyses were performed using the GraphPad 6 Prism Software (La Jolla, CA).

RESULTS

Donor Characteristics

A total of 70 donors, including 39 men (55.7%) and 31 women (44.3%), underwent a liver procurement. Sixty-seven donors underwent a LLLS, and 3 underwent an LH without middle hepatic vein procurement. The characteristics of the donors are presented in Table 2. [T2]

Recipient Characteristics

Three recipients were adults, and 2 underwent auxiliary orthotopic liver transplantation for primary sclerosing cholangitis and alcohol cirrhosis, respectively. The third recipient received a *left lobe* for a retransplantation (chronic rejection).

Sixty-seven recipients were children. Sixty-five LLLSs and 2 laparoscopic LHs were performed. Thirty-two boys and 35 girls were transplanted by 2 teams of pediatric transplantation in 2 different hospitals. Their mean age was 25.7 ± 19.5 months, and their mean body weight was 10.3 ± 3 kg. Indications for transplantation were biliary atresia in 54 children (80.59%), Alagille syndrome in 4 children (5.97%), cirrhosis associated with α-1 antitrypsin deficiency in 3 children (4.47%), mitochondrial cytopathy in 2 children (2.98%), unresectable hepatoblastoma in 2 children (2.98%), chronic rejection in 1 child (1.49%), and a urea cycle deficiency in 1 child (1.49%).

RESULTS OF THE DONORS

Of the 70 donors, 66 (94.3%) were operated upon using pure laparoscopy, whereas 4 (5.7%) required conversion to an open technique. Neither hybrid nor hand-assisted techniques were used. No donor received an intraoperative allogeneic transfusion. The Lyon team used a cell saver system for an autotransfusion in 6 donors. The median operative time was 275 (range: 175–520) minutes, and mean blood loss was 82 ± 79 mL (range: 10–770). The mean graft warm ischemia was 9.0 ± 4.1 minutes. Operative data are presented in [T3] Table 3.

Conversion

Four conversions (5.7%) were necessary, 3 during left lateral section procurement and 1 during a left liver procurement. The first conversion was undertaken after a left portal branch injury while cutting the left bile duct. The vein was easily repaired, but a systematic conversion was performed to make sure that there was no stenosis of the left portal vein. This injury occurred at the beginning of our experience (case 4 in 2003). Two of the conversions were undertaken because of a poor exposure and slow progression during transection. The last conversion was performed because of doubts regarding the biliary anatomy. This last conversion was performed to check the anatomy of the biliary tree because of a putative biliary duct variation. None of the conversions were associated with acute or uncontrolled bleeding or with the need for perioperative transfusion. All converted donors had an uneventful recovery.

[AQ4]

Postoperative Outcome and Morbidity

No donor died. The median hospital stay was 6 days, ranging from 3 to 18 (Table 4). Seventeen donors experienced complications, [T4] leading to an overall complication rate of 24.2%. Eleven donors (15.7%) had grade 1 complications; 5 donors (7.1%) had grade 2 complications; and 1 donor had a grade 3 complication.

Overall, 4 donors required reoperation: 2 for biliary leakage, 1 for suprapubic hematoma, and 1 for cystoscopy. One donor had a hematoma of the suprapubic incision that required surgical drainage and transfusion of 2 units of packed red blood cells. One donor had a macroscopic hematuria and pelvic pain due to urinary bladder trauma. Cystoscopy revealed a transfixion suture through the urinary bladder

[AQ3]

TABLE 2. Donor and Graft Data (n = 70)

Age, median (range), yrs	32 (19–56)
Gender, n (%)	
Female	31 (44.3)
Male	39 (55.7)
BMI, median (range), kg/m^2	23.5 (16.1–30.7)
ASA score, n (%)	
I	69 (98.6)
II	1 (1.4)
III	0
IV	0
Graft volume evaluation at CT scan, median (range), mL	260 (154–450)
Graft arteries number, n (%)	
1	68 (97.2)
2	2 (2.8)
Graft bile duct(s) number, n (%)	
1	59 (84.3)
2	11 (15.7)
Segment IV drainage type, n (%)	
Left	36 (72)
Right	5 (10)
Independent	9 (18)
Missing data/undetermined	20 (40)

ASA indicates American Society of Anesthesiologists; BMI, body mass index.

TABLE 3. Operative Data in 70 Living Donors

Type of intervention, n (%)	
Left lateral sectionectomy	67 (95.7)
Left Hepatectomy	3 (4.3)
Conversion to laparotomy, n (%)	4 (5.7)
Pedicle clamping, n (%)	1 (1.4)
Transfusion, n (%)	
Autotransfusion	6 (8.6)
Allogeneic transfusion	0 (0)
Graft weight, median (range), g	252 (118–390)
Operative time, median (range), min	275 (175–520)
Blood loss, mean ± SD (range), mL	82 ± 79 (10–770)
Warm ischemia, mean ± SD, min	9 ± 4.1

SD indicates standard deviation.

TABLE 4. Postoperative Outcome in 70 Living Donors

Biological values on POD1	
PT, % (range), min	77 (50–96)
Bilirubin, % (range), μmol/L	17 (7–48)
AST, % (range), UI/mL	211 (56–1469)
ALT, % (range), UI/mL	317 (53–1848)
Postoperative complications, n (%)	
Overall	17 (24.2)
Clavien LD classification	
1	11 (15.7)
2	5 (7.1)
3	1 (1.4)
4	0
Reoperation for complication, n (%)	4 (5.7)
Complication type, n (%)	
Biliary leakage	2 (2.8)
Biliary stenosis	1
Pulmonary complications	2 (2.8)
Pneumothorax (no drainage)	1
Respiratory infection	1
Bladder injury	1
Wound complications	5 (8.6)
Infection	1 (1.4)
Hematoma	4 (5.7)
Gastric ulcer	1
Death, n (%)	0
ICU stay, n (%)	16 (22.9)
Length of ICU stay, median (range), d	1 (1–5)
Length of hospital stay, median (range), d	6 (3–18)

ALT indicates alanine aminotransferase; AST, aspartate aminotransferase; ICU, intensive care unit; LD, living donor, POD1, postoperative day 1; PT, prothrombin time.

wall. After the endoscopic removal of this suture and urinary catheter placement, the donor fully recovered.

Two donors (2.8%) developed a massive bile leakage and underwent reoperations. The primary clinical manifestation of the choleperitoneum due to bile leakage was confusion and abdominal pain. Both reoperations were performed by redo-laparoscopy. In 1 case, the source of the biliary leak was due to titanium clip dislodgement on the left bile duct stump. In the other case, the bile leak originated from the segment I duct. In both cases, Prolene sutures were used to close the biliary leak. After these 2 events, we decided to replace standard titanium clips by the hem-o-lock type or stitches, and no similar events have occurred.

One donor presented a grade 3 complication. On follow-up, this donor presented with cholestasis. Magnetic resonance cholangiography and endoscopic retrograde cholangiopancreatography studies showed a stenosis of the right anterior bile duct. An endoscopic prosthesis was left in place upon the resolution of the cholestasis. However, because this biliary stenosis, the donor required an exhaustive follow-up by MRI. Later, neither cholestatic nor infectious complications occurred, and there was no dilation of the intrahepatic bile ducts at the time of the last follow-up. Finally, 1 donor presented a gastric stress ulcer diagnosed by a gastroscopy under sedation that was treated medically.

[AQ5]

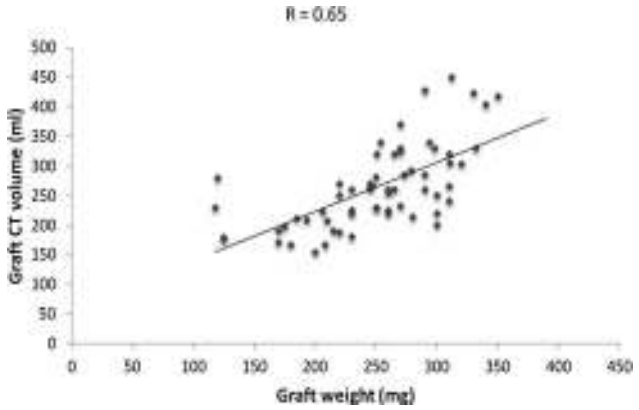
Graft Characteristics

The median graft weight was 252 (range: 118–390] g (Table 2). The correlation between CT volumetric assessment and graft weight [F1] is given in Figure 1.

Eleven grafts had 2 left bile ducts. Two grafts had 2 left arteries. There was no variation in the anatomy of the left portal branch. The hepatic vein anatomy was modal in all cases.

Recipient Outcomes

One recipient experienced a massive esophageal variceal bleeding during surgery and died before graft implantation. Of the 64 LLS transplanted children, 5 recipients (7.8%) had hepatic artery thrombosis (HAT), 3 (4.6%) had portal vein thrombosis, 3 (4.6%) presented acute rejection, and 10 (15.6%) had biliary complications. Three children (4.6%) died in the perioperative period. The reoperation rate for those complications was 12.5% (8 cases). Six children (9.3%) required a retransplantation during the follow up for cholangitis and arterial thrombosis. There was no case of primary graft nonfunction. Overall, patient and graft survival rates for LLLS pediatric transplantation were 95% and 92% at 1 year, 95% and 88% at 3 years, and 95% and 84% at 5 years, respectively (Fig. 2). [AQ6] [F2]



[AQ7]

FIGURE 1. Correlation between CT volumetric assessment and graft weight.

LEARNING CURVE AND PROCEDURE EVOLUTION

The overall complication rate for 70 donors and its evolution over 10 years are presented in Figure 3. Grade II or higher-grade [F3] complications have not occurred since 2009. We decided to focus on the Paris team experience, given that their number of cases was the largest for the longest period of time. The experience from Paris illustrates the evolution of the technique and results.

The number of complications, median hospital stay, and blood loss evaluated over the 10 years of procedural experience in the Parisian team (57 donors) are presented in Figure 4. In 2006, a maxi- [F4] mum number of donors operated on per year was achieved. After that date, the allocation system changed in France, moving to a national prioritization of any donor younger than 30 years to child candidates. This may explain the sharp decrease in the number of cases since 2007. The median hospital stay decreased from 7 to 5 days, whereas the median blood loss ranged from 10 to 108 mL until 2006 and then stabilized around 50 mL from 2006 to 2011 [10–72].

The median operative time varied from 2001 to 2011. A trend to decrease was observed from 2001 to 2006, with a median operative time during these 5 first years extending from 253 to 520 minutes. After 2006, we observed stabilization in the median operative times, ranging from 175 to 310 minutes.

Overall, 2006 was a key year that was associated with stable operating time, minimal blood loss and shorter hospital stay. Since 2009, no severe morbidity has occurred. Then, accordingly, a minimal number of 20 donors was posited as adequate for the Paris team to achieve a stable and reproducible, that is, standardized, technique.

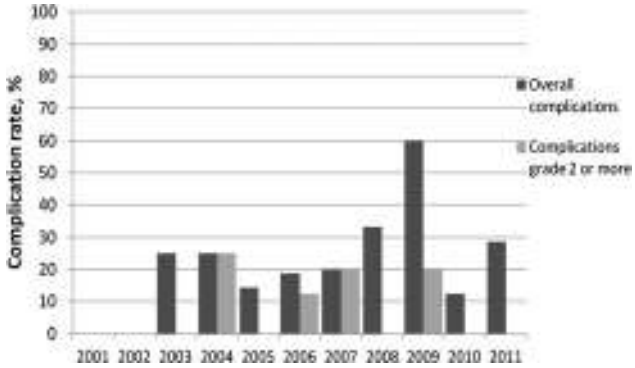


FIGURE 2. Overall patient and graft survival rates for LLLS pediatric transplantation (64 patients).

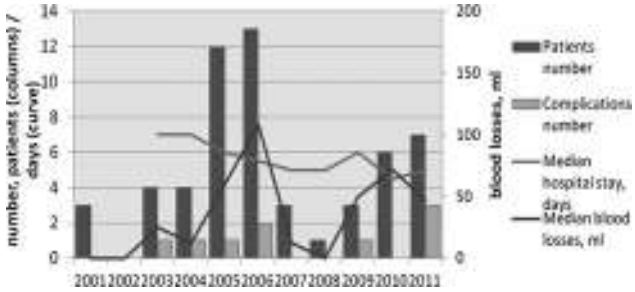


FIGURE 3. Overall and grade II or greater complication rates for 70 donors: evolution over 10 years.

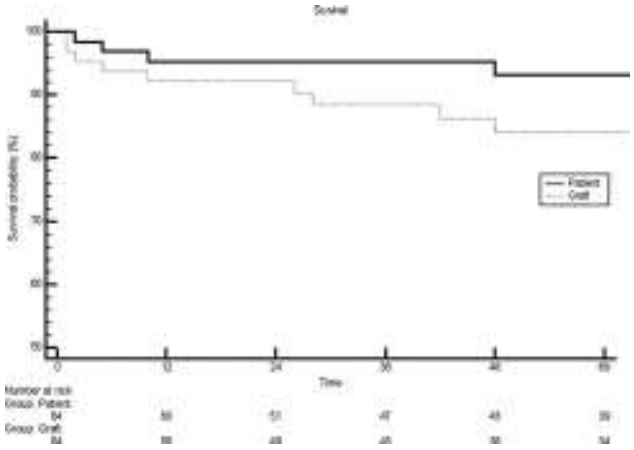


FIGURE 4. Number of complications, median hospital stay, and blood loss: evolution over 10 years of procedural experience in the Parisian team (57 donors).

DISCUSSION

Laparoscopic left lateral section procurement started in 2001 as an innovative procedure and, 10 years later, has become a more standardized approach in France. This series confirmed the safety and reproducibility of this technique but also highlighted the existence of a learning curve and the need for a close interaction between 2 experienced surgeons when performing this procedure. Living donor transplant surgeons carefully balance donor safety and the procurement of a graft of optimal quality for the recipient. Although not comparative, this experience confirmed the absence of a deleterious impact on liver graft function.

Laparoscopic surgery has gained global acceptance over the last 20 years. The advantages of laparoscopic surgery in terms of surgical stress, abdominal wall trauma, respiratory complications, hospital stay, immunologic status, and overall surgical act-related morbidity[11] have been studied and demonstrated.[12] Today, laparoscopic minor liver resections are considered to be safe and reproducible techniques that were even superior to the open approach in recent meta-analyses gathering the results of retrospective comparisons.[13,14] Our purpose was to provide the healthy donors with the advantages of this modern minimal invasive approach and, at the same time, to assure maximal safety of the procedure and the procurement of grafts of optimal quality. In our experience, the laparoscopic approach of the left lateral sectionectomy is able to fulfill these objectives.[15] Since our experience was reported in 2006, the technique has progressed in Asia. Kim et al published a series of 22 patients (11 open vs 11 laparoscopy) and compared open surgery to laparoscopic left lateral section procurement. The conclusion was in accordance with the results of our initial experience and confirmed that live donor LLLS is a safe, reproducible procedure that has been associated with a reduced hospital stay.[16] Recently, this Korean team, in a cohort of more than 15 donors, reappraised the safety and reproducibility of the procedure.[17] The preoccupation with donor safety is most likely maximal, compared with other types of indications. To enhance donor safety, 2 senior surgeons systematically performed this procedure (O.S. and O.S., mainly). From the very beginning of our experience, we decided that any incident that might compromise donor safety or graft integrity should lead to prompt conversion. We then defined these events, or criteria of conversion, as follows: significant bleeding, failure to accurately recognize bile duct anatomy, any vessel injury, and poor exposure, leading to failure or slow progression during parenchymal transection. Accordingly, 4 donors were converted to an open approach without any emergency. This clear definition may partially explain the low bleeding rate and the absence of intraoperative allogeneic transfusions. Indeed, the main result of this study was the very low amount of blood loss. This is an overall advantage of laparoscopic liver resection that has been recently confirmed in several reviews and meta-analyses.[18] Laparoscopy is significantly associated with reduced blood loss in both normal and diseased livers.[19] This point is obviously crucial in the setting of living donation. This advantage is most likely due to the cut surface effect of the pneumoperitoneum and to the meticulous parenchymal transection. Indeed, the main source of bleeding occurs from venous backflow. We do not hesitate to increase transiently the pneumoperitoneum to 14 or 16 mm Hg to minimize bleeding. This last refinement may also explain why the bleeding did not exceed 50 mL in most donors and the absence of intraoperative homologous transfusion in all donors. Finally, according to the learning curve exhibited by the Paris Team, we believe that preliminary experience with at least 20 donors may also improve these results. However, defining this cutoff seems very difficult and would most likely vary among teams. Although we found that 20 cases were associated with less conversion (not significant) and stable operative times, we also performed more than 300 laparoscopic liver resections, including major resections, during the same period of time. This parallel experience certainly had an impact on our donor technique and feasibility. Consequently, we are aware that the relevance of the cutoff appears important to our team, but this cutoff could be different for other teams with different learning curves.

A main drawback that might be attributed to laparoscopy was the occurrence of 2 biliary leaks. Two donors presented with an early massive biliary leakage and required emergency redo-laparoscopy. The origin of this complication was found in each case, and the decision to modify the technique was made accordingly using locked clips. Since then, this complication has not occurred. Using biliary reconstruction by MRI has accurately and reliably defined the biliary tree anatomy; however, misunderstanding the biliary anatomy lead could to intraoperative cholangiography. Biliary complications are a major concern in live donor liver surgery, independent of the laparoscopic or open approach. A comprehensive study from Asia that included 605 left lateral sectionectomies reported a complication rate of 9.3% with a bile leak rate of 5.5%.[20] Another large single center retrospective review from Japan reported a complication rate of 18.8% and 4.9% bile leaks in a series of 762 "left grafts" (LLS, extended left and monosegmental).[21] Steinbrück et al[22] reported 60 open LLS and 3 open LHs with an overall morbidity of 25.39% and 3.33% bile leaks. In our series, we report similar results, with a 24% overall complication rate including 4.3% bile leaks. Although the overall complication rate in our series might seem high, only 5 donors (7.1%) presented with grade 2 complications; 1 donor (1.4%) presented a grade 3 complication. The risk of death in live donation is most likely lower for the left section procurement, ranging from 0.05% to 0.1%, but it can reach as high as 0.5% for the right liver donation. According to the European Liver Transplant Registry, 3622 procedures were performed in 74 centers from October 1991 to December 2009. Donor mortality was 0.16%, with an overall donor morbidity rate of 20%.[23] The reported mortality risk of living donor liver surgery is estimated to be 0.2% worldwide.[24] To date, there have been 2 donor deaths reported that were directly associated with open left lateral sectionectomy.[25,26] In our series, there was no mortality.

There was no incident that might have compromised graft quality in terms of vascular and biliary structure integrity. The overall patient and graft survival rates were satisfactory. At the beginning of this experience in France, living donation was dedicated to emergent situations, especially acute necrosis in biliary atresia recipient

or retransplantation for acute liver graft failure. These clinical conditions might partially explain the arterial complication rate, which may seem higher compared to values reported in the literature. In Lyon, where liver transplantation is mainly performed in elective situations, the arterial thrombosis rate was nil. There were 5 cases of HAT in the Paris series. Among these 5 cases of HAT, 4 of the recipients weighed less than 10 kg, and 3 of them were transplanted in the urgent setting. The fifth child presented HAT in the context of posttransplant lymphoproliferative disorder. However, it should be noted that no anticoagulants were given to the donor at the time of vessels division. Given these results, we will most likely change our practice to introduce a *systematic protocol for anticoagulation* before retrieval. The warm ischemic time was less than 10 minutes for all these grafts.

An interesting question raised by this series is the progression that leads this type of procedure from an innovative surgery to a more standardized technique. Evaluating a surgical innovation remains challenging. In 2008, the Society of University Surgeons[27] and the Balliol group proposed a definition of a surgical innovation. Accordingly, LLLS may be considered as an innovative procedure because this technique is new and differs from currently accepted practices. In 2006, we published the results of our early experience, comparing 16 living donors who underwent a laparoscopic resection to 14 historical controls who had open surgery.[6] Considering that our results showed a significantly decreased blood loss in the laparoscopic group and comparable morbidity, we decided to adopt the laparoscopic technique in live donors during a development phase that now corresponds to the stage 2a of the "IDEAL" recommendations of the Balliol group. The development of LLLS is especially slow due to the very low number of live donors operated on (average 10 per year in France), even though we take care of most living donors in France (88 of the 98 Live donors in France between 2001 and 2011, Agence de Biomedicine data). This may explain why a consistent control group is lacking to make comparisons between open and laparoscopic surgeries. Although the Asan medical center adopted the same process, the transition to a stage 3-assessment process may be difficult. Although a randomized study is the best-designed way to achieve this step, its feasibility seems unlikely in the setting of living donation, especially for the recruitment reasons mentioned earlier. Another aspect is the good acceptance of the technique by the donors. Even informed of the innovative nature of this procedure, former operated donors fully advised other parent candidates to request a laparoscopic approach. Creating an international registry might allow us to evaluate the relevance and risk of the technique. A significant advantage of the laparoscopic approach is difficult to demonstrate in the context of live donor liver surgery, mainly due to the small series published. However, there are adequate data that analyzed laparoscopic versus open left lateral sectionectomies for other indications and showed the superiority of the laparoscopic approach in terms of blood loss, postoperative pain, hospital stay and cost, with no significant difference in overall morbidity.[28–32]

CONCLUSIONS

LLLS is a safe and reproducible technique for living donor graft procurement that has transitioned from an innovative phase to a developmental phase in our department. However, these results also stress the need for expert teams, ideally including 2 senior surgeons, to construct a specific learning curve before starting such a laparoscopic living donation program.

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Queries to Author

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