Review Article

Laparoscopic left lateral sectionectomy for living liver donation: the Ghent University experience

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Abstract: The first laparoscopic living donor liver transplantation (LDLT) was described in 2002, and since then, this procedure has taken to be accepted because of technical difficulties and demanding surgical skills. Left lateral sectionectomy is the graft of choice for pediatric LDLT. Our technique of laparoscopic left lateral sectionectomy for LDLT in herein described. From January 2009 to March 2017, 11 pure laparoscopic left lateral sectionectomies for living donor liver donation have been performed in our institution. The transection line followed the trans-umbilical approach. Warm ischemia was 4 minutes and the total cold ischemia less than 3 hrs. Dietary intake was started from the first post-operative day. Complications have been recorded in 2 (16.6%) donors: 1 necrosis of segment IV needing antibiotic therapy and one fluid collection on the section edge treated conservatively. Analgesics drugs have been administered through a central line during the first 48 hrs. The median length of hospital stay was 4 days. Major indications in recipients were: Biliary atresia (n=8), primary oxaluria, cholestatic syndrome and multifocal HCC on a cirrhotic liver from unknown origin (one case each). One child died because of a fungal sepsis following retransplantation due to graft dysfunction. Biliary complications requiring percutaneous dilations and/or revision of the anastomosis have been recorded in 4 (36%). Laparoscopic left lateral sectionectomy for pediatric LDLT is a safe and feasible procedure having the potential benefit of lowering donor morbidity rates. Its reproducibility should be further validated.

Keywords: Laparoscopy; left lateral sectionectomy; living donor liver transplantation (LDLT)

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Introduction

Minimally invasive liver surgery has been widely adopted for the treatment of different liver diseases. Compared to open liver surgery, this has the advantages of reducing complications, postoperative pain, and recovery (1-3). Further developments have demonstrated its technical feasibility for living donor hepatectomy (4-7). The first laparoscopic living donor liver transplantation (LDLT) was described in 2002, and since then, this has taken some time for acceptance because of technical difficulties and for the skills required to perform it (5). Later, specialized centers have performed minimally invasive donor hepatectomy with either the hybrid or pure technique (6-10).

Different types of graft harvesting, including left lateral sectionectomy, left and right lobes have been reported (11-15). While the left lateral sectionectomy (including hyper reduced segments for infants), is the graft of choice for pediatric LDLT, larger grafts as the full left or full right lobes are considered for adult recipients.

Comparative studies of conventional and minimally invasive techniques for living donor hepatectomy have been reported (16-18). However, because of the small number

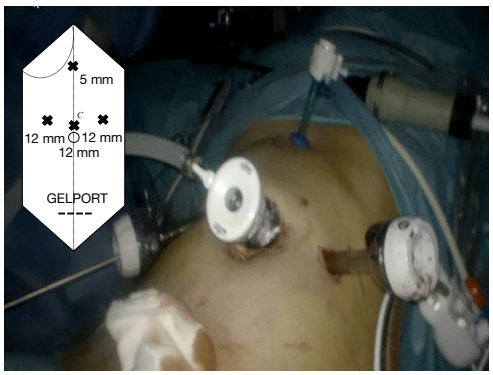

Figure 1 Trocar position.

of reports available and because of the small series, it is still not yet clear what is more beneficial to the donor. According to the 2nd International Consensus Conference on Laparoscopic Liver Surgery, such procedures are classified as Balliol 2b, meaning that institutional oversight is needed and a registry to determine short and long term outcomes in both the donor and the recipient should be provided (19).

Left lateral sectionectomy: surgical technique

The donor work up is standardly performed to assess the anatomy. The modal arterial anatomy (a4 from the left hepatic artery), the replaced left from the gastric artery or the a4 from the right hepatic artery are all considered for graft procurement. Biliary anatomical variations for the left liver are very uncommon: double or multiple biliary ducts could eventually be found if the dissection line is behind the umbilical ligament (trans-umbilical approach-T-U technique). A double separate vein draining segment II into the middle hepatic vein (HV) could be considered as a contraindication for living donor hepatectomy, however, making a separate drainage into one common patch is not a major issue. The CT volumetry of segments II–III including the arterial reconstruction and the cholangio-MRCP are routinely performed.

The donor is placed in a supine position. Usually, four trocars are placed on the upper abdominal quadrants, and an 8–10 cm suprapubic incision is performed in order to place a Gelport device (Applied Medical, USA) (*Figure 1*).

Middle and left HV confluence is identified by intraoperative ultrasonography, dissection of the hilum to expose the left hepatic artery and the left portal vein is performed with scissors and bipolar forceps. The left triangular ligament is divided with a high-energy instrument (Thunderbeat, Olympus), the Arantius ligament is dissected and cut with the exposure of the groove of the middle and left HV. An umbilical tape can be placed between the left and the middle HV. Further, the hilum is gently dissected skeletonizing the left artery eventually preserving the branch for segment IV. In case of small arterial size and a modal arterial anatomy (a4 originating from the left artery) the decision to include a4 into the graft should be considered.

Parenchymal dissection is performed with the ultrasonic dissector and without Pringle maneuver (20). The transection line could be at the level of the round ligament (T-U approach) or 1-cm on the medial side of this (trans-hilar approach). The difference is that in the first case it is possible to preserve, in most of the cases, the a4 and the segmental biliary duct (b4). However, the risk to have multiple ducts for biliary anastomosis is higher (21).

Non-resorbable clips (Hem-o-Lock, TFX Medical Ltd., Durham, USA) are placed on intra-hepatic vessels. Alternatively, sealing of small vessels (up to 5–7 mm) could also be done by means of high-energy instruments.

The site of transection of the left hepatic duct is close to the rex recessus and does not require a real-time cholangiography because of the distance from the biliary confluence so that, even in case of a b6–7 duct (right posterolateral) draining into the left duct, there is no risk of biliary injury. The left hepatic bile duct is secured with a couple of titanium clips or with sutures. Afterwards, we divide and cut the portal vein branches to the caudate lobe from the left portal branch, and the bile duct tributaries sealing them with high-energy instruments. Usually we avoid clips in this area to facilitate the position of the stapler on the left portal branch. Preservation of the portal branches to the caudate lobe is possible however a shorter left portal vein branch should be anticipated.

After administration of systemic heparin (5,000 units), the left hepatic artery is clipped on the remnant side and divided. Then, a stapler division of the left portal vein (Endo TA 30 mm, Covidien, Mansfield, USA) and the left HV after exposing the confluence of middle HV (Endo GIA 60 mm curved, Covidien) is performed. The manual graft extraction through the suprapubic incision is usually done by putting the graft into a plastic bag previously introduced through the Gelport system.

The graft is flushed on the back table with 1–2 L of

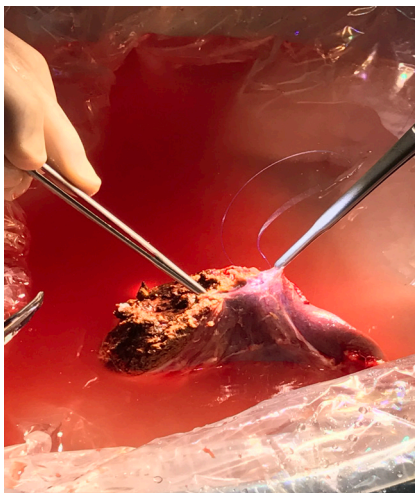

Figure 2 Back-table graft preparation.

Figure 3 Left lateral LD Hamburg technique (22).
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HTK solution (UW or IGL-1 are also currently used) (*Figure 2*). No heparin antagonist is given to the donor to avoid the risk of possible pro-thrombotic effects (*Figure 3*).

Results

From January 2009 to March 2017, 11 pediatric LDLT with a pure laparoscopic approach for donor hepatectomy have been performed in our institution. Neither conversions nor surgical revisions have been recorded so far. Donor characteristics are depicted in *Table 1*. The transection line followed the T-U approach. The first warm ischemia was around 4 minutes and the total cold ischemia less than 3 hrs. An ERAS protocol haw been implemented even in case of laparoscopic donor hepatectomy. Dietary intake has been allowed from the first post-operative day. Complications have been recorded in 2 (16.6%) donors: 1 necrosis of segment IV needing antibiotic therapy and one fluid collection on the section edge treated conservatively. Analgesics drugs have been administered through a central line during the first 48 hrs.

The median length of hospital stay was 4 days. Major indications in children were: Biliary atresia (n=8), primary oxaluria, cholestatic syndrome and multifocal HCC on a cirrhotic liver from unknown origin (one case each).

One child died because of a fungal sepsis following retransplantation due to graft dysfunction. Most likely the subjacent infection has been the reason of the dysfunction of both grafts leading to patient's death. Biliary complications requiring percutaneous dilations and/or revision of the anastomosis have been recorded in 4 (36%).

Discussion

According to our experience, laparoscopic donor hepatectomy for pediatric LDLT is safe and feasible allowing few complications and an earlier return to daily activity. To date there are only two comparative single center studies showing the feasibility and safety of laparoscopic left lateral sectionectomy for pediatric LDLT (23,24). Recently, a comparative study between laparoscopic living liver and kidney donor surgeries showed, interestingly, a significant lower number of minor complications in liver donors compared to the others; major complications were, however, identical. A comparable CCI was observed between liver and kidney donors with complicated postoperative outcome (25). This study is the first validation of laparoscopic donor hepatectomy, and suggests that the laparoscopic approach along the open could become a standard of care in the hands of experts, as for donor nephrectomy.

Donor morbidity is intensely evaluated in the Western countries where living donor is considered not as first-choice. This is why the split grafts are proposed to children with end-stage liver diseases, although this can vary according to center's policy.

Laparoscopic living donor hepatectomy must be considered as the ultimate evolution of the minimally invasive approach to the liver. The concept of applying the laparoscopic technique to a living donor is attractive because it can further reduce donor complications ensuring the best grafts to diseased children in a timely fashion. Unfortunately, two main disadvantages should be considered: learning curve of laparoscopy and the specific

Table 1 Donor characteristics

Characteristics	Mean age (y ± SD)	Parental	Graft volume (mL^3 ± SD)	Peak AST (U/L ± SD)	Peak ALT (U/L ± SD)	OP time (min. ± SD)	Blood losses (ML ± SD)	Real GW (g ± SD)
Outcome	29.2±6.9	6 father, 2 uncles, 2 aunts, 1 mother	208.9±67.5	318±182	273.4±156.4	237±99	70±41	210.8±52.3

SD, standard deviation; AST, aspartate aminotransferase; ALT, alanine aminotransferase; OP, operative time; GW, graft weight.

experience of partial liver transplants from living donors. The learning curve is mainly depending on the background in advanced laparoscopic surgery that facilitates laparoscopic hepatobiliary procedures (provided one has already gained experience in open hepatobiliary surgery and liver transplantation). To date, more than 600 pure laparoscopic hepatectomy have been done at the Ghent University Hospital including major resections and resections in the posterosuperior segments. In our opinion there are two major critical points in the laparoscopic procurement of segment 2–3 grafts: the small size of the left hepatic artery (if the a4 patch is not considered) including the risk of intima damage during laparoscopic dissection of the hilum and the possibility to have two or more biliary ducts for the anastomosis with the consequent higher risk of late stenosis in the recipients (especially in case of the T-U approach).

In conclusion, our experience proves the feasibility of laparoscopic left lateral sectionectomy for pediatric LDLT. Although seems that laparoscopic LLS could be considered as standard practice in highly specialized centers, the potential of this technique in lowering donor morbidity rates and, especially, its reproducibility should be further validated.

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Footnote

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