



# History of laparoscopic hepatectomy in donor

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**Abstract:** Laparoscopy in the field of liver resection is slowly gaining ground in recent times, from resection of small tumor's in anterior segments to left lateral sectionectomy for pediatric liver transplant. With the advent of laparoscopy in major hepatic resections, it has now been adopted for adult living donor transplantation. The initial criticism regarding graft patency and donor safety are being countered especially by South Asian centers performing increasing number of laparoscopic donor right hepatectomy with results similar to open procedures. However, due to technical difficulties and donor safety being principal, it is recommended only in centers with expertise in both laparoscopic liver resection (LLR) and open live donor liver transplant. Supervised training under experienced mentors is required in order that the donor is able to benefit from the advantages laparoscopy has to offer.

**Keywords:** Donor hepatectomy; laparoscopic liver resection (LLR); international laparoscopic liver society

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Laparoscopic Surgery has been established as a standard in the surgical specialty. It is adopted in most centers for major surgeries however it has been introduced to liver surgery fairly recently. Even though the first laparoscopic liver resection (LLR) was performed way back in 1992 it is still being used only in select centers with high volumes and by experienced surgeons. This is primarily due to technical difficulties faced in liver surgery.

## History of laparoscopic liver surgery

So far 3 international consensus meetings on LLR have been held. The first International Consensus Conference on Laparoscopic Liver Resection (ICLLR) was held in Louisville, KY, USA (2008). The practicality of performing

LLR was discussed (1) with a special focus on safety. Laparoscopy was recommended for select cases with small tumors in segments 2–6 and left lateral sectionectomy (LLS). Its use in major liver resection was considered unfeasible. Nguyen et al reported 127 series of 3000 cases of LLR worldwide. The operations were considered safe with a morbidity of 10.5% and mortality of 0.3% (2). The second meeting of ICLLR was held in Morioka, Japan in 2014. It recommended 3 actions for patients protection; prospective reporting registry, difficulty scoring system and creation of a formal education structure (3). It focused on comparisons with open technique and demonstrated benefits of laparoscopic approach (4). The International Laparoscopic Liver Society (ILLS) was officially launched at the International Hepato-pancreato-Biliary Association

meeting in Sao Paulo in April 2016 (5).

### **The launch of minimally invasive donor hepatectomy(MIDH) in paediatric patients**

Much before the ICCLLR, the first pure laparoscopic donor hepatectomy in pediatric transplantation was reported in France in 2002 (6). Laparoscopic LLS is a safe procedure as the anatomy of the lateral section is favorable with limited anatomical variations. It is possible to obtain grafts similar to the open technique (7). Laparoscopic LLS for pediatric living donor liver transplant (LDLT) has shown similar short-term outcomes as laparoscopic donor nephrectomy, suggesting that the laparoscopic approach should be considered the new standard practice (8).

### **Laparoscopic major hepatectomy in living donors**

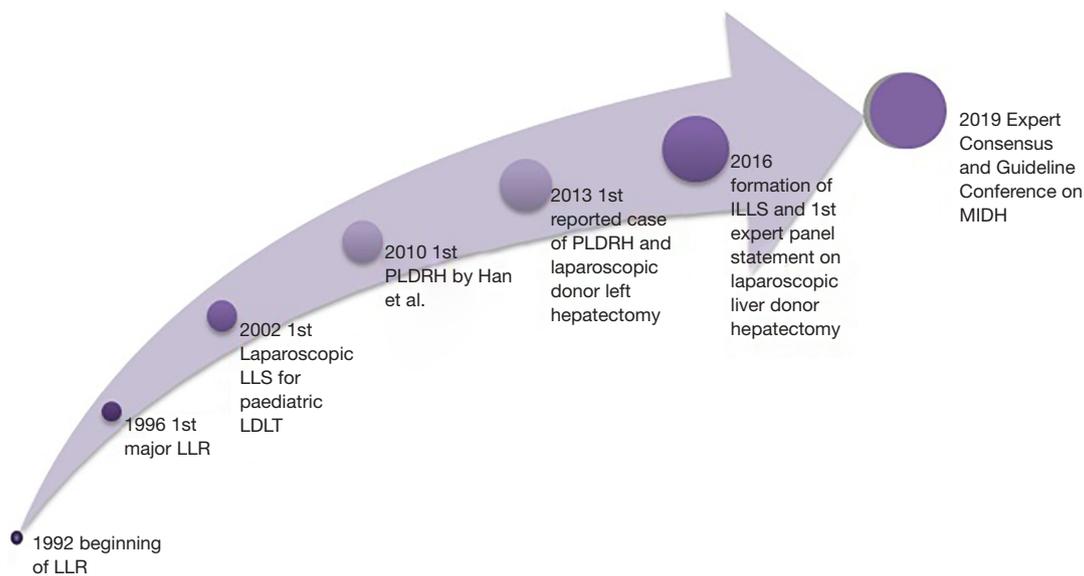
Laparoscopic surgery for major hepatic resections was being considered dangerous due to the complex anatomy of the liver. However Koffron *et al.* (9) performed the first laparoscopic assisted right hepatectomy in 2006 which was later followed by pure laparoscopic donor right hepatectomy (PLDRH) by Han *et al.* in 2010 but reported in 2015 (10). Since then, laparoscopic surgery for major hepatectomy started being adopted at many centers. A report of 9 donors undergoing either pure laparoscopic or hand assisted laparoscopic right hepatectomy safely, preserving branches of the middle hepatic vein was published in 2009 further proving the feasibility of the procedure. Another systematic review in Sao Paulo focused on outcomes of hybrid versus open and hybrid versus pure laparoscopic surgery. Twenty-one studies were included. The hybrid procedure has less blood loss, shorter hospital stay and lower morbidity compared to open. There was no difference when compared to the pure laparoscopic technique. They concluded that hybrid donor hepatectomy should be considered as a minimal invasive approach (11). Giulianotti *et al.* reported the first robotic assisted donor right hepatectomy in 2012 (12). The results of robotic hepatectomy were similar to that of PLDRH; operation time was longer but required less analgesics and had a quicker recovery compared to open surgery. The 3D vision allows depth perception and improves pure surgical performance (13). The first reported cases of PLDRH were in 2013 by Soubrane *et al.* (14) and Rotellar *et al.* (15) Laparoscopic donor hepatectomy aims to provide equal donor safety and faster rehabilitation

compared to the open technique for living donors. The risk of mortality and morbidity depends on three factors: the physiological status, the proportion of liver excised, and, the amount of intraoperative blood loss and need for transfusion. Thus, to reduce morbidity in living liver donors, transplant teams must focus on the best technique of surgery in the donor, leaving adequate liver remnant with the lowest blood loss (14). Around the same time 2 case reports of pure laparoscopic donor left hepatectomy were published by Samstein *et al.* (16) and Troisi *et al.* (17).

The first expert panel statement on laparoscopic living donor hepatectomy was prepared during the third ICCLLR at the 26th World Congress of the International Association of Surgeons, Gastroenterologists and Oncologists (IASGO 2016) in Seoul (18). A 24 question survey was sent via email to 17 surgeons. The panel included surgeons who already perform laparoscopic donor hepatectomy, surgeons who perform LLR without laparoscopic donor hepatectomy, and surgeons who perform LDLT without laparoscopic surgery. The panel concluded that laparoscopic donor right hepatectomy is still innovative and in the developmental stage, and can only be recommended for performance by surgeons experienced in both LLR and LDLT. Some experts recommended that the donor indications for laparoscopic right hepatectomy should be a graft-to-recipient weight ratio >1.0, a remnant liver volume >35%, and a normal bile duct anatomy and portal vein (19) (*Figure 1*).

### **Data on the safety and feasibility of laparoscopic donor hepatectomy**

In a study conducted including 72 donors in each group, the safety of PLDRH compared to open was assessed. Major complications were 15.4% in laparoscopic group and 6.6% in open group. However, after propensity score matching the results in both groups were similar. They also found that a right hepatic duct <1 cm on preoperative Magnetic Resonance Cholangiopancreatography was independently associated with complications in PLDRH (20). Another review of 100 initial cases of PLDRH compared its feasibility with open surgery. Their results showed longer operation time but lower blood loss in the laparoscopic group. Clavien dindo Grade III3b complications and above were higher in the laparoscopic group however the results were significant only in the first 25 cases. Grade IIIb complications were comparable when type 1 bile duct donors were selected. They thus concluded that laparoscopic living donor hepatectomy can cause



**Figure 1** History of laparoscopy in donor hepatectomy (original figure).

significant complications initially hence donor selection must be carefully done (21). Similar results were shown in a center in Seoul where 115 donors were assessed. They reported higher grade IIIb complications in the initial period however no complications in the recent period. The difference in hemoglobin and AST in preoperative and postoperative period were also lower in the recent period. They considered performance of about 60 PLDRHs over 1 year to be sufficient to standardize the procedure (22).

In a 13-year experience study in France, when assessing cases of donor laparoscopic LLS, laparoscopic donor left hepatectomy and laparoscopic donor right hepatectomy, the authors concluded that the laparoscopic procedures require expertise in both open LDLT and LLR. The learning curve for LLR was considered to be 15–60 cases while mastery of open technique was considered mandatory. For beginners in laparoscopic LDLT, left lobe should be mastered first due to fewer vascular and biliary anatomical variations (23). A comparative study of laparoscopic versus open donor right hepatectomy after completion of learning curve showed no significant differences in terms of mean operative time, blood loss, graft weight, hospital stay thus showing PLDRH can be performed as safely as the open technique without increasing the risk of complications once sufficient experience has been obtained (24). A meta-Analysis in China evaluated 9 studies with 318 donors who underwent laparoscopic living donor hepatectomy. It demonstrated less

post-operative blood loss, shorter hospital stay but longer operative time in the laparoscopic group. No significant differences were found in overall complications including bile leakage, postoperative bleeding, wound complications and time to dietary intake (25).

At the 24<sup>th</sup> annual congress of the International liver transplant society in 2018, laparoscopic donor hepatectomy in living donors was discussed. It was reported that results from centers routinely performing PLDRH indicate that donor complications and operative times decrease significantly with increasing experience, in particular when the learning curve (of around 60 cases) has been met. The use of advanced visualization techniques, such as 3-dimensional laparoscopy and indocyanine green (ICG) near-infrared fluorescence cholangiography, can also improve the safety of PLDRH in donors with complex portal vein anatomy. Biliary complications remain a significant concern with minimally invasive donor procedures (26). Laparoscopic MIDH is currently considered to be in the exploratory phase (IIb) under the Balliol classification scheme of the IDEAL model (27). It is now being widely performed at centers with the maximum cases being concentrated in Seoul, South Korea. This has established that pure laparoscopic MIDH can be performed extensively without damage to the donor and preserving graft outcomes. (Daniel Cherqui, Kyung-Suk Suh, Expert Consensus and Clinical Guidelines Conference

in Minimally Invasive Donor Hepatectomy (MIDH), APHPBA, unpublished data).

There are no clear guidelines or recommendations to perform Laparoscopic MIDH hence in an attempt to develop guidelines an Expert Consensus and Guideline Conference on MIDH was held at the Asian-Pacific Hepato-Pancreato-Biliary Association meeting at Seoul on 7<sup>th</sup> September 2019. A team of experts after performing extensive research and reviewing existing literature formulated 18 questions covering Rationale of MIDH, Donor safety and outcomes, Recipient outcomes, technical issues and training and certification. The questions were voted upon by the surgeons present and the final guidelines are awaited.

Laparoscopic donor LLS is now considered standard practice. Adult laparoscopic donor liver transplant is recommended in high volume centers. The advances in imaging and technology, 3-dimensional surgical imaging, use of ICG fluorescence imaging have made laparoscopic major hepatectomy more widespread and safer than what was earlier assumed. Strict selection criteria, standardization of the procedure, supervised training under experienced mentors will help in reducing the learning curve and thus spread the use of LLR and later laparoscopic MIDH to more centers making it easily accessible to the donor.

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