case report

First fully laparoscopic donor hepatectomy for pediatric liver transplantation using the indocyanine green near-infrared fluorescence imaging in the Middle East: a case report

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Living donor liver transplantation (LDLT) is a well-established treatment modality for several pediatric end-stage liver diseases owning excellent long-term results. Left lateral sectionectomy (LLS) through an open approach is a well-standardized procedure. This technique has been modified for a fully laparoscopic approach and gaining more and more interest worldwide. We report herein the first fully laparoscopic LLS for pediatric LDLT in the Middle East with the use of indocyanine green dye and near-infrared fluorescence imaging to identify the biliary ducts intraoperatively. The recipient was a 2-year-old. girl affected by glycogen storage disease type IV. The mother, aged 21 years, was her donor. The surgical technique, key-points of this procedure, and outcome are hereby discussed.

Pediatric living donor liver transplantation (LDLT) is the standard treatment for several end-stage liver diseases and a well-established modality treatment with excellent early graft function and long-term results.[1,2] Left lateral sectionectomy (LLS) through the open approach is the gold standard. However, with the increasing experience in laparoscopic liver resection, the question whether this technique could be applied in the living donor has been raised. The first single-center series on laparoscopic donor LLS was published in 2006 showing that the procedure was feasible and safe in pediatric liver transplantation.[3,4] Recently, a comparative analysis between open and laparoscopic LLS for LDLT showed that this technique may significantly shorten the hospital stay as compared to the open procedure and, much more importantly, is reproducible.[5] Based on our long experience with standard open surgery for live donation and split liver transplantation in pediatric and adult patients,[6,7] we implemented fully laparoscopic liver resection in living liver donation to further reduce harm to donors.

CASE

A 2-year-old girl suffering from glycogen storage disease type IV was referred to our center at the King Faisal Specialist Hospital and Research Center in Riyadh in April 2013. The mother, a 21-year-old healthy individual with a body mass index of 15.3, voluntarily offered to donate part of her liver. After an extensive physical evaluation was performed to rule out potential contraindications followed by a multidisciplinary discussion, living donation was unanimously accepted. Predonation workup revealed an estimated graft weight of 234 g with a standard anatomy. The liver graft including segments 2 and 3, a single left hepatic artery, 1 common ostium for the biliary ducts, the left portal vein, and the left hepatic vein were fully harvested by laparoscopic approach on May 5, 2013. The donor was placed in supine and 30° reversed-Trendelenburg position with the surgeon standing between the patient's legs. Intermittent compression device (SCD express, Tyco Healthcare, Mansfield – MA 02048, USA) was utilized to minimize the risk of venous thrombosis. Of the four trocars (5/10/12/12 mm), 2 of 12 mm were

inserted on the upper abdominal quadrants to allow the insertion of both 30° optical device (Karl Storz ICG fluorescent laparoscope, Tuttlingen, Germany) and the linear stapler, 1 of 10 mm for the harmonic scalpel and the surgical aspirator, and the last of 5 mm subxyphoidal for allowing irrigation/aspiration system and/or to hang the liver. The CO_2 pressure was kept around 10 mm Hg to minimize the risk of air embolism. The gallbladder was not removed. After a careful evaluation with a laparoscopic ultrasonography probe (Aloka alpha 7, Tokyo, Japan) to search for anatomical landmarks (i.e., Rex recessus, the confluence of the left [LHV] and the middle hepatic vein [MHV] at the vena cava inferior and venous connections between the LHV and the MHV), the falciform and the left triangular ligaments were divided with the Ligasure device (Covidien, USA). Thereafter, blunt hilum dissection to expose, free, and tape both the artery and the left portal vein was done. Caudate branches were sealed by Ligasure to maximize the length of the left portal vein. Parenchymal dissection was done using ultrasound dissector CUSA (Excel Valleylab, Integra, Ireland) along the right side of the falciform ligament. Hemostasis and biliostasis of small elements were done by bipolar electrocautery and using titanium clips. Once the dissection reached the hilar plate, indocyanine green (ICG, 0.1mg/kg) (Pulsion Medical Systems, Feldkirchen, Germany) was intravenously injected, thus allowing prompt visualization of the left hepatic artery and biliary duct in less than 10 seconds. Following the injection, the biliary duct was cut under the negative fluorescence imaging guidance with straight laparoscopic scissors (**Figure 1**). PDS 5/0 single sutures were put to secure the proximal stump. The left hepatic vein was completely freed and taped at its confluence by cutting collaterals draining into the MHV. A modified hanging maneuver was used during dissection with the CUSA.[8] Following a Pfannenstiel incision, a gelport laparoscopic system (Applied Medical, Rancho Santa Margarita, CA 92688 USA) was inserted to allow atraumatic harvesting of the graft. The left lateral lobe was procured as follows: double Hem-o-lock clips on both hepatic arteries, Endo TA 30 mm (Covidien) on the left portal vein, and Endo-GIATM60 mm Tri-staple Technique Tan-type (Covidien) to secure and cut the left hepatic vein.[9] After taking out the graft through the gelport system with 2 minutes warm ischemia time, the graft (213 g) was flushed on the back table with 2 L of HTK-solution and prepared for sequential engraftment. A silastic drain under suction assured the drainage of the donor operative field. Liver transplantation was carried out with a total of 24 minutes WIT and 182 minutes cold ischemic time, using the standard piggyback technique. The AST/ALT peak was 234 and 543 U/mL,

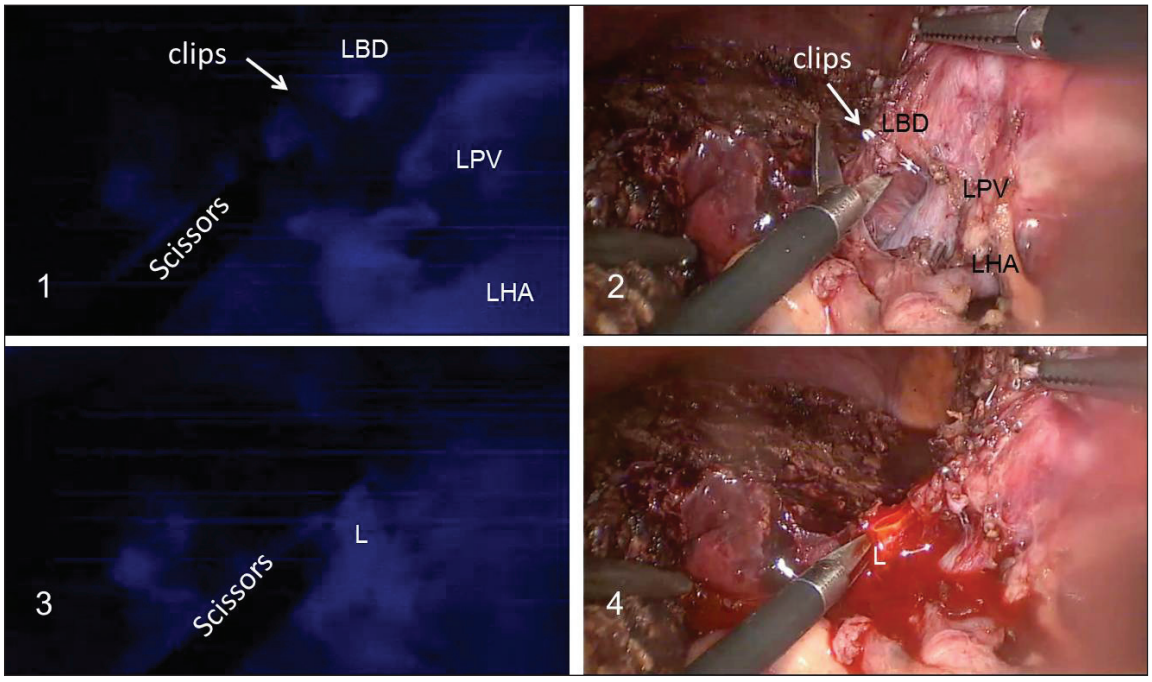

Figure 1. ICG near-infrared fluoroscence imaging. 1) ICG view before cutting (LBD=left biliary duct; LPV=left portal vein; LHA=left hepatic artery. 2) Standard view. 3) ICG view after cut; L=bile leak. 4) Standard view after cut.

respectively. Postoperatively, no complications were observed, and the donor was discharged on the fourth postoperative day. The recipient hospital stay lasted for 15 days. Nine months later, both donor and recipient were in excellent clinical conditions.

DISCUSSION

Fully laparoscopic living donor hepatectomy is a very challenging operation and an important technical innovation, which can only be considered by highly skilled and experienced surgical teams in performing minimally invasive liver surgery and liver transplantation using segmental grafts. These advanced prerequisites and the issue of the living donor safety are probably the main reasons for its slow development.[4]

Nowadays, laparoscopic surgeons have a broad spectrum of instruments and devices allowing safe dissection of the liver parenchyma. Anatomical dissection can be done very accurately and under magnification, allowing careful hemostasis and biliostasis with limited manipulation. Although published experiences in fully laparoscopic living donor hepatectomy are scarce, we noticed that the reproducibility is possible in different countries suggesting the potential of this technique.[3-5] Probably, the most difficult phase is the hilar dissection, which is exposed to vascular injury potentially compromising the perfusion of the graft while doing hemostasis. Additionally, the careful identification of the hilar plate should be done, avoiding any vascular injury either by electrocautery or by CUSA. Cutting the left hepatic duct at the right side is a challenge and more difficult as compared to open procedures. We introduced for the first time the ICG dye with the near-infrared (NIR) fluorescence imaging to better identify the donor ductal anatomy in laparoscopic donor hepatectomy. NIR with intravenous ICG injection can immediately visualize the sheet where the biliary ducts are located in the hilar plate confirming an important anatomical landmark.[10,11] However, only subsequent experiences will confirm the usefulness of this technique to identify small biliary ducts (i.e., segment IV ducts), both with direct injection of dye into the bile ducts (most likely needing a cholecystectomy) or by intravenous injection in advance to the time required to get to the hilar plate while dissecting the liver parenchyma (i.e., 30, 60, 90 minutes), as suggested by others.[12]

Some theoretical advantages could be credited to the laparoscopic donor hepatectomy. The most important is the preservation of the abdominal wall in young and healthy donors, which is quite attractive.[3] Laparoscopic liver resection results in a Pfannenstiel incision rather than an upper abdominal incision with a shorter hospital stay and quick return to physical activity as recently shown in a comparative analysis.[5] Although the safety and feasibility of the fully laparoscopic LLS for pediatric living liver donation has been shown with only 1 favorable comparative experience available, additional advantages of this technique such as reduced pain and worldwide reproducibility in a standard fashion have yet to be proven.

Our first experience with the fully laparoscopic LLS for pediatric living liver donation confirms the feasibility and the potential of this procedure in Saudi Arabia. More experiences are needed to validate the usefulness of the ICG dye injection for enhanced and prompt recognition of important biliary anatomical landmarks in full laparoscopic donor hepatectomy as well as improved donor outcome.

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