



Preoperative work-up for donor main consideration for laparoscopic surgery

Takeshi Takahara¹, Go Wakabayashi², Yasushi Hasegawa¹, Hiroyuki Nitta¹, Hirokatsu Katagiri¹, Shouji Kanno¹, Akira Umemura¹, Akira Sasaki¹

¹Department of Surgery, Iwate Medical University School of Medicine, Iwate, Japan; ²Department of Surgery, Ageo Central General Hospital, Ageo, Saitama, Japan

Contributions: (I) Conception and design: T Takahara, G Wakabayashi; (II) Administrative support: A Sasaki; (III) Provision of study materials or patients: T Takahara, Y Hasegawa, H Nitta; (IV) Collection and assembly of data: T Takahara, Y Hasegawa, H Katagiri, S Kanno, A Umemura; (V) Data analysis and interpretation: T Takahara; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Takeshi Takahara. Department of Surgery, Iwate Medical University School of Medicine, 2-1-1 Idaidori Yahaba, Siwa, 028-3695 Iwate, Japan. Email: takahara@iwate-med.ac.jp.

Abstract: Pure laparoscopic donor hepatectomy (PLDH) has become increasingly accepted in the current era of minimally invasive surgery. However, only skillful surgeons with enough experience in both laparoscopic liver resection (LLR) and living-donor liver transplantation (LDLT) should perform pure laparoscopic donor right hepatectomy (PLDRH). In this paper, we review the evaluation of donors and work up of PLDRH in several high-volume laparoscopic liver surgery centers in Asia. Moreover, we analyzed the frequency of anomalies of the vessels (hepatic artery, portal vein, and hepatic vein) and the bile duct in PLDRH.

Keywords: Living-donor liver transplantation (LDLT); pure laparoscopic donor right hepatectomy (PLDRH); laparoscopic liver resection (LLR)

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Introduction

Living-donor liver transplantation (LDLT) has become a widely accepted therapeutic alternative to deceased donor liver transplantation (DDLTL) with equivalent and promising outcomes. Laparoscopic approaches to liver surgery have evolved over the years and minor resections (segmental and anatomic) are now considered to be a standard practice in selected patients with equivalent and often superior results as compared to open liver resections.

Pure laparoscopic donor hepatectomy (PLDH) has become increasingly accepted in the current era of minimally invasive surgery. After the first successful report of laparoscopic left lateral sectionectomy during adult-to-child LDLT in 2002, the procedure is now recommended in highly specialized centers by international consensus (1). PLDH in adult-to-adult LDLT was first reported in

2013 (2). However, the adoption of laparoscopic liver resection (LLR) to donor hepatectomy has been slow and some concerns have increased regarding donor's safety. The Louisville Consensus Conference in 2008 and the Second International Consensus on Laparoscopic Liver Surgery in 2014 reported that laparoscopic donor major hepatectomy is in the earliest phase of development with an unclear benefit/risk ratio and uncertainty regarding the long-term outcomes of donors and recipients (1). According to an expert panel statement for PLDRH during the 26th World Congress of the International Association of Surgeons, Gastroenterologists and Oncologists (IASGO) in 2016, only skillful surgeons with enough experience in both LLR and LDLT should perform PLDRH (3). In this paper, we review the evaluation of donors and work up of PLDRH in several high-volume laparoscopic liver surgery centers in Asia.

Evaluation of living-donors and work up of PLDRH

<p>Living-donor criteria</p> <ul style="list-style-type: none"> • Age* between 20 and 60 • Medical evaluation Medical history, physical examination Hematology, biochemistry, serology • Ethical evaluation Clinical psychological assessment • Immunological assessment ABO combination, direct crossmatch Donor specific antigen (DSA) 	<p>Graft related evaluation</p> <ul style="list-style-type: none"> • CT • ERCP or DIC-CT • Liver functional reserve (ICG R, etc.) • MRC • Liver biopsy
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*, The upper or lower limit of the age is slightly different in each institution.

Figure 1 Evaluation of Living-donors and work up of PLDRH. PLDRH, pure laparoscopic donor right hepatectomy; CT, computed tomography; ERCP, endoscopic retrograde cholangiopancreatography; DIC-CT, drip-infusion cholangiography computed tomography; ICG R15, indocyanine green retention rate at 15 minutes; MRC, magnetic resonance cholangiography; DSA, donor specific antigen.

Method

We reviewed the donor evaluation process and work up of laparoscopic donor hepatectomy in Asian high-volume centers that performed laparoscopic liver surgery, with reference to published papers. Specifically, we examined the selection criteria for right lobe grafts, which were frequently utilized in adult-to-adult LDLT. Moreover, we analyzed the weight of the graft and the frequency of anomalies of the vessels (hepatic artery, portal vein, and hepatic vein) and the bile duct in PLDRH.

Results

Preoperative evaluation issues of PLDRH were shown in *Figure 1*. The detailed evaluations of each high-volume center are as follows.

Iwate Medical University School of Medicine (4)

Age of the living donors was adults from 20 to 65 years, and all of the living donors had comprehensive medical evaluations, including cardiovascular, pulmonary, and renal assessments. Donor candidates were routinely counselled by a psychiatrist about their voluntary intention to donate. The transplant coordinator routinely provided precise information about LDLT to donors and confirmed legal relationships between the donors and recipients. Donor candidates with systemic diseases such as diabetes mellitus, hypertension, or psychiatric diseases were strictly excluded. Donor livers were evaluated by four-phase

multidetector computed tomography (MD-CT) and drip-infusion cholangiography computed tomography (DIC-CT) with three-dimensional reconstruction. We had two requirements for hepatic function of the living donor: an indocyanine green retention rate at 15 minutes (ICG R15) of less than 10 as a measurement of hepatic reserve and a liver/spleen (L/S) ratio of greater than 1.1 as an assessment for fatty liver. If the ICG R15 was slightly higher than 10, we performed asialoglycoprotein receptor imaging to examine the functional reserve of the donor liver. If fatty liver was suspected by the L/S ratio, the donor candidate received nutrition support guidance and we arranged to have the liver functional reserve re-assessed after at least 3 months. When the L/S ratio and ICG R15 met our criteria, the donor candidate waited with proper diet and exercise for as long as the recipient's condition allowed. In some cases, liver biopsy was performed to rule out steatohepatitis, non-alcoholic steatohepatitis (NASH), or histological abnormalities (5).

Our criteria for graft selection were a remnant left liver volume of greater than 35% of the donor whole liver and an estimated graft weight of more than 0.7% of the recipient's body weight. In the recipient operation, if the volume of the congested liver was estimated to be greater than 100 mL using a volume analyzer software, we planned to reconstruct the tributaries of the middle hepatic vein in the right lobe graft without using the middle hepatic vein itself. Donor evaluation was based on the criteria approved by the Institutional Review Board of Iwate Medical University School of Medicine.

Table 1 The frequency of anatomical anomalies and graft weight in PLDRH

Asian high-volume centers	PV anomaly (%)		HA anomaly (%)		V5, V8, IRHV reconstruction (%)		Bile duct anomaly (%)		Graft weight (g)	
	Initial	Recent	Initial	Recent	Initial	Recent	Initial	Recent	Initial	Recent
Seoul National University Bundang Hospital (n=33) (11)		NA		20.6		38.2		NA		750
Seoul National University College of Medicine (n=115) (10)	14	5.9		NA		NA	38.1	39.2	700	736.5
Asan Medical Center (n=3) (7)	0	-	0	-	100	-	0	-	556.7	-
Samsung Medical Center (n=100) (14)		5		NA		45		18		712
Iwate Medical University School of Medicine (n=17) (4)		0		17.6		58.8		47.1		668

PLDRH, pure laparoscopic donor right hepatectomy; PV, portal vein; HA, hepatic artery; V5, segment V; V8, segment VIII; IRHV, inferior right hepatic vein; NA, not applicable.

Asan Medical Center (6,7)

In Korea, each donation was approved by the ethics committee of the local authority and by the Korean Network for Organ Sharing (KNOS), which is affiliated with the Korean Ministry of Health. In addition to the preoperative evaluation necessary for general anesthesia, the pretransplantation evaluation of the living donors included standard liver function tests, doppler ultrasonography, triphasic liver CT, magnetic resonance cholangiopancreatography (MRCP), liver biopsy, and ICG R15. In the initial period, donors who had single and relatively long segments in the right hepatic artery, right portal vein, and a single right hepatic duct were selected for PLDRH.

Seoul National University College of Medicine (8-10)

Magnetic resonance spectroscopy (MRS) was preoperatively performed for the evaluation of the donor fatty liver. Liver biopsies were routinely performed for potential donors with fat fraction >8–10% as determined by MRS and other factors including older age, and elevated body mass index (BMI). If necessary, these potential donors were enrolled in a short-term weight reduction program. It was an absolute requirement to procure a right lobe graft only if the estimated remnant liver volume was over 30% of the whole liver.

All donors had undergone preoperative MRCP, which has replaced intraoperative cholangiography in this center since 2009. More recently, an ICG near-infrared fluorescence camera system for real-time cholangiography

was introduced in March 2016. Initially, PLDRH was only performed in selected donors who had no anomalies of the portal vein or bile duct. However, since March 2016, no special selection criteria were applied once the technique had become sufficiently established.

Seoul National University Bundang Hospital (11)

The donor selection criteria for PLDRH in the initial phase included an expected graft weight of more than 1.0% of the recipient weight, a remnant left liver volume of greater than 35% of the donor whole liver, no unsuitable vascular or biliary variation for resection and anastomosis, normal laboratory test results, and the recipient being medically stable.

Samsung Medical Center (12-14)

All donors were required to have an expected remnant liver volume of more than 30% after right lobe grafts. At the beginning of PLDRH adoption, only patients under 60 years with an expected remnant liver volume of greater than 35% of the whole liver were selected. Additionally, any anatomical variations that might have required sophisticated techniques for the laparoscopic procedure were excluded, and only type 1 portal veins and type 1 bile ducts were included.

The anomaly frequency of the vessels and the bile duct, and the graft weight in each institution were shown in *Table 1*. Regarding the graft weight, the largest grafts were procured by pure laparoscopy in the most highly

experienced institutions. The surgical skill to mobilize the large right lobe without damaging the right lobe graft may have depended on the number of PLDRH procedures previously carried out in the center. In the introductory phase of PLDRH, only donors with no anatomical variation were selected in even these high-volume centers.

Postoperative biliary complications were associated with difficulties assessing bile duct anatomy during PLDRH. To prevent biliary complications such as leakage and/or stenosis, it is important to close the stump securely. The laparoscopic suturing technique is necessary for closing the stump of the bile duct definitively while avoiding bile leakage and stenosis of the residual bile duct. On the other hand, the bile duct was cut with a safe distance from the residual bile duct to prevent stenosis. As a result of this, Suh *et al.* reported that the percentage of surgeries with multiple bile duct openings was significantly higher in PLDRH than in open donor right hepatectomy (9).

Careful attention must be given to perform PLDRH safely for living donors who have portal vein anomalies, as well as to perform open donor right hepatectomy. Lee *et al.* reported a subgroup analysis of donor who underwent PLDRH in which the rate of major complications was 4.7% in the initial group but 0% in the most recent group (10). The completion of about 60 PLDRHs per medical center is sufficient to standardize the procedure. Suh *et al.* also reported that modern technical developments such as three-dimensional laparoscopes and real-time, ICG, near-infrared fluorescence cameras have brought about substantial benefits (9). In Korea, the use of flexible three-dimensional laparoscopy and ICG near-infrared fluorescence cholangiography might improve the safety and outcome of PLDRH in donors with anatomical, vascular, and biliary variants.

Summary

Meticulous and vigilant donor evaluation is the most important and necessary aspect of LDLT. Therefore, there should not be any compromise in the process of evaluating and selecting a living donor. Extensive experience in LLR and LDLT is necessary to introduce PLDRH in medical centers, and precise evaluations of anatomical variants and hepatic reserve are essential to perform PLDRH safely.

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Footnote

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