

# Living Donor Liver Transplantation

## Technical Innovations



Kiara A. Tulla, MD<sup>a</sup>, Hoonbae Jeon, MD<sup>b,\*</sup>

### KEYWORDS

- Living donor liver transplantation
- Portal flow modulation
- Laparoscopic donor hepatectomy

### KEY POINTS

- Selection of a donor and anatomic design of the allograft should be based on various factors of both the donor and the recipient.
- Small-for-size syndrome can be avoided by portal venous flow modulation in combination with careful calculation of required allograft volume.
- Large portosystemic collaterals may need to be obliterated to augment portal venous flow to the graft and to avoid portal venous steal.
- ABO-incompatible living donor liver transplantation can fail due to diffuse intrahepatic biliary strictures even with the use of optimal desensitization protocols.
- Minimally invasive approach for donor hepatectomy more common in high-volume living donor liver transplant programs.

### INTRODUCTION

Liver transplantation has been serving as the best and the ultimate treatment for end-stage liver disease and certain hepatic malignant tumors for the past few decades. Striking developments in surgical technique, rapid acceptance of the procedure as the most sound treatment option, and outbreaks of hepatitis C related cirrhosis in the Western world created a wide gap between availability of livers from deceased donors for the ever-growing patient population that needed liver transplantation in the past 2 decades. For comparison, in 2010, Spain and the United States had the highest rates of deceased-donor liver transplantation (DDLTL): 24.5 and 17.0 procedures per million compared with Taiwan and Korea at 4.0 and 6.0 per million, respectively.

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<sup>a</sup> Department of Surgery, University of Illinois at Chicago, 840 South Wood Street, CSB 401, MC 958, Chicago, IL 60612, USA; <sup>b</sup> Department of Surgery, Tulane University, 1415 Tulane Avenue, #HC-5, New Orleans, LA 70112-2632, USA

\* Corresponding author.

E-mail address: [hjeon@tulane.edu](mailto:hjeon@tulane.edu)

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However, in that same year, Taiwan and Korea had the highest number of living donor liver transplantations (LDLTs) per million people, at 16.0 and 17.0 procedures, respectively, compared with 0.7 and 0.95 events per million in Spain and the United States, respectively.<sup>1</sup> This can be further understood because in Asia the issue with deceased organ donation has always been dire, with late legislation of brain death and lack of dedicated resources for organ recovery.<sup>2</sup> In response to such severe organ shortage, LDLTs between adults were started in a few leading institutions in Japan, Hong Kong, and Korea. Initial reluctance to support LDLT was seen, due to ethical concerns about donor safety and well-being, but was soon tempered by the obvious high demand for liver transplantation. Following by example, by 2000, many institutions in the United States started performing LDLT as well in response to worsening shortage of deceased-donor organs.<sup>3-5</sup>

With regard to the efficacy of living donor transplantation versus deceased-donor transplantation, a 14-year retrospective and prospective study of 1136 living and 464 deceased-donor liver recipients and their respective donors in the Adult-to-Adult Living Donor Liver Transplant Cohort Study in 2002 showed that after 10-year follow-up there is superior recipient survival with LDLT compared with undergoing or waiting for DDLT. This was further supported by data in which those with lower Model for End-Stage Liver Disease (MELD) scores still showed a benefit from having a living donor transplant.<sup>6</sup>

Despite widespread success and acceptance of LDLT, the procedure still has a steep learning curve and unresolved concern about donor safety.<sup>7</sup> A few well-publicized sets of donor mortalities in the early 2000s hampered enthusiasm for LDLT for the next few years.<sup>8,9</sup> Donation of a major portion of the liver is clearly a bigger undertaking for the donor than donating a kidney through a laparoscopic procedure. The transplant community continues to explore procedural endeavors to ensure the safety of the donor. The guidelines regarding donor selection criteria and selection of the surgical procedure are primarily dictated by donor safety; this is done at the potential expense of the transplant recipient. Therefore, careful selection of the recipient based on the best possible partial hepatic allograft provided by any given donor becomes of paramount importance for the successful LDLT.

## **SURGICAL CHALLENGES OF LIVING DONOR LIVER TRANSPLANTATION**

Due to the anatomic nature of the liver being a single organ, partial hepatic allograft would pose some challenges in implantation because of the limited length of vascular pedicles and biliary ducts. Even with successful implantation, the small graft size may leave unmet metabolic demand of the recipient and may result in high morbidity and mortality. In the literature of hepatic resection of malignant tumors, it has been known that removal of healthy liver parenchyma up to 70% of the total volume is possible with traditionally reported mortality rate up to 8%.<sup>10,11</sup> However, that mortality risk in a healthy organ donors would be by no means acceptable. Initial attempts of LDLT used left lobe hepatic allograft, which removes approximately 40% to 45% of total liver volume of the donor to secure safe margins in the donor.<sup>12</sup> Most pioneering groups completing LDLT in Asia soon switched to a right lobe allograft to increase the size as they realized that left lobe allograft often becomes inadequate to meet the metabolic demand of the recipient.<sup>13-15</sup> Thus, all Western centers followed suit and started LDLT with right lobe allografts.

LDLT was conceptualized based on the regenerative capacity of the liver. Both the remnant liver in the donor and the hepatic allograft in the recipient grow bigger after the transplantation.<sup>16</sup> This regenerative process of the hepatic allograft may lead to dynamic changes in the spatial orientation of reconstructed blood vessels, especially

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