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Complications of right lobe living donor liver transplantation☆

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***Background/Aims*: Right lobar living donor liver transplantation (LDLT) has been controversial because of donor deaths and widely variable reports of recipient and donor morbidity. Our aims were to ensure full disclosure to donors and recipients of the risks and benefits of this procedure in a large University center and to help explain reporting inconsistencies.**

***Methods*: The Clavien 5-tier grading system was applied retrospectively in 121 consecutive adult right lobe recipients and their donors. The incidence was determined of potentially (Grade III), actually (Grade IV), or ultimately fatal (Grade V) complications during the first post-transplant year. When patients had more than one complication, only the seminal one was counted, or the most serious one if complications occurred contemporaneously.**

***Results*: One year recipient/graft survival was 91%/84%. Within the year, 80 (66%) of the 121 recipients had Grade III ($n = 54$) Grade IV ($n = 16$), or Grade V ($n = 10$) complications. The complications involved the graft's biliary tract (42% incidence), graft vasculature (15%), or non-graft locations (9%). Complications during the first year did not decline with increased team experience, and adversely affected survival out to 5 years. All 121 donors survive. However, 13 donors (10.7%) had Grade III ($n = 9$) or IV ($n = 4$) complications of which five were graft-related.**

***Conclusions*: Despite the satisfactory recipient and graft survival at our and selected other institutions, and although we have not had a donor mortality to date, the role of right lobar LDLT is not clear because of the recipient morbidity and risk to the donors.**

***Keywords*: Liver transplantation; Complications; Biliary tract; Hepatic artery; Living donation; Right lobe**

1. Introduction

Successful transplantation to pediatric recipients of small portions of the left hepatic lobe of living adult donors was first reported in 1990 [1,2]. By the mid 1990s, removal began of larger hepatic fragments for adult-to-adult transplantation [3–6]. It was soon recognized that the risk of donor death with living donor liver transplantation (LDLT) exceeded that of live kidney donation and that the highest mortality was with right lobar LDLT [7,8]. Because of concern about the donor deaths, and uncertainty about recipient outcomes, a group of stakeholders agreed in 2005 that all LDLT cases should be entered into an international registry [9].

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Abbreviations: LDLT, living donor liver transplantation; UPMC, University of Pittsburgh Medical Center; UNOS, United Network for Organ Sharing; MELD, model for end-stage liver disease; IRB, Institutional Review Board; SFSS, small for size syndrome; NASH, non-alcoholic steatohepatitis; NIH, National Institute of Health; A2ALL, NIH-funded 9-center adult to adult living donor liver transplant consortium.

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It was further agreed that the rate and severity of recipient and donor complications would be determined with the multi-tier grading system developed by Clavien et al. [10,11] (Table 1). One of the high priorities was definitive assessment of the right lobar LDLT that had become the most commonly used living donor procedure for adult recipients in Western (non-Asian) countries. Instead, there have been striking disparities in the reported incidence and severity of complications in both right lobar donors and their recipients [12].

To help explain these inconsistencies and allow full disclosure to all interested parties of the risks and benefits of right lobar LDLT, we analyzed our nearly 4-year experience with 121 consecutive cases. The parallel purpose of this quality assurance study was to identify factors that potentially could be modified to improve results.

2. Patients and methods

2.1. Patient population(s), procedures, and immunosuppression

We retrospectively identified and analyzed the complications during the first post-transplant year of 121 right liver lobe recipients whose operations and follow-up were carried out at the Montefiore Hospital of the University of Pittsburgh Medical Center (UPMC) between March 2003 and November 2006. Recipient disease severity scores (model for end-stage liver disease, MELD) were calculated as of the time of transplantation with a UNOS formula based on the individual's bilirubin, creatinine, and a coagulation index. Data sets were compiled that included, but were not limited to, the donor and recipient demographic, anatomic, operative, and survival parameters shown in Fig. 1 and Table 2. Although the formal recipient complication analysis was limited to the first year, 2–5 year survival data also were obtained.

The donor work-up included liver function tests, liver biopsy, ultrasound examination, and psychological assessment [13]. Because of the medical insurance-driven policy mandating prompt donor return to primary healthcare providers, there often was a paucity of donor post-transplant information in our records after discharge from the primary hospitalization. Consequently, there may have been late donor complications or long-term disability of which we are unaware.

The donor operation [14] consisted of removal of 36–81% ($63 \pm 6.9\%$) of the CT-estimated liver volume. After complete removal of the recipient's diseased liver, the donor right lobe was transplanted to the vacated hepatic fossa, with technical variations that were dictated largely by anatomic variations in both the recipient and donor [14,15]. In addition to the hepatic allograft, 10 recipients during the last third of the experience (October 2005–October 2006) also were given an infusion of unmodified mononuclear cells obtained from the donor by leukopheresis [16].

Individualized immunosuppression for recipients was guided by the generic algorithm that has empowered the field of organ transplantation: i.e. sufficient initial treatment to prevent non-reversible acute rejection with subsequent reduction of immunosuppression to maintenance levels [17]. Baseline treatment was with tacrolimus to which prednisone, lymphoid depleting agents, or other drugs were added as described in the Section 3.

2.2. Clavien classification of complications

Clavien's modified 5-tier scoring system [11] was used for both recipients and donors (Table 1) in preference to his original version [10] which had only four grades [10]. When patients had more than one complication, only the seminal one was counted, or the most serious one if complications occurred contemporaneously. The onset of the complication was defined as the time when the resulting organ dysfunction began or the corrective treatment was started.

Because most of the Clavien I scores were trivial, these were grouped with those that had no Clavien grades. Some of the Clavien II complications that were not related to the allograft were potentially serious (e.g. atelectasis or pneumonia). If they were managed solely with antibiotics or other non-procedural means, however, they did not qualify for a grade higher than II. The same rules applied to graft-related complications: e.g. 11 bile leaks that ceased with external drainage under antibiotic coverage, but without corrective interventional procedures, were given Clavien II scores.

The interventional therapeutic procedures that mandated $\geqslant$Clavien III scores included operative biliary or vascular reconstructions as well as radiologic procedures such as bile duct or blood vessel dilatation or stenting. Distinctions of Clavien IIIa and b were not used for analysis because patients are given sedation under anesthesiologist supervision for essentially all radioendoscopic and other invasive procedures at our center.

Table 1
Clavien classification of surgical complications.

Grades	Definitions
I	Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions. Allowed therapeutic regimens are: drugs as antiemetics, antipyretics, analgetics, diuretics, electrolytes, and physiotherapy. This grade also includes wound infections opened at the bedside
II	Requiring pharmacological treatment with drugs other than such allowed for grade I complications; blood transfusions and total parenteral nutrition are also included
III	Requiring surgical, endoscopic or radiological intervention a. Intervention not under general anesthesia b. Intervention under general anesthesia
IV	Life-threatening complication (including CNS complications)[a] requiring IC/ICU management a. Single organ dysfunction (including dialysis) b. Multiorgan dysfunction
V	Death of a patient

CNS, central nervous system; IC, intermediate care; ICU, intensive care unit.
[a] Brain hemorrhage, ischemic stroke, subarrachnoidal bleeding, but excluding transient ischemic attacks.