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Living donor versus deceased donor liver transplantation: a surgeon-matched comparison of recipient morbidity and outcomes

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Abstract

Informed consent for living donor liver transplantation (LDLT) requires that patients are provided with accurate information on the relative benefits and risks of this procedure compared with deceased donor liver transplantation (DDLT). There is strong evidence to suggest that LDLT facilitates timely transplantation to patients; however, information on the relative morbidity and death risks after LDLT as compared with DDLT is limited. A matched cohort comparison was performed matching recipients for age, MELD, date of transplant, gender, primary diagnosis, and recipient surgeon. A total of 145 LDLT were matched with 145 DDLT. LDLT had a higher overall rate of perioperative surgical complications ($P = 0.009$). Most of this difference was caused by a higher rate of biliary complications. However, the complications that occurred in the DDLT group tended to be more serious ($P = 0.037$), and these complications were strongly associated with graft loss in multivariate analysis. The 3- and 5-year graft and patient survivals were similar. In conclusion, DDLT and LDLT have different complication profiles, but comparable hospital stays and survival rates. In areas of deceased donor organ shortages, LDLT offers an excellent alternative to DDLT because it facilitates access to a liver transplant without compromising short- or medium-term recipient outcomes.

Introduction

Living donor liver transplantation (LDLT) offers a clear and compelling survival benefit to those patients who undergo transplantation early for end-stage liver disease (ESLD) versus those who remain on the waiting list for a deceased donor (DD), particularly in those communities with low deceased donation rates [1, 2]. However, it is currently not clear if there is a price to be paid postoperatively after LDLT that might be caused by greater technical complexity, delays in graft function associated with the lower graft weight to recipient weight (GWRW) ratios, or other factors.

Previous comparisons of the morbidity and survival after LDLT and deceased donor liver transplantation (DDLT) in North America have been hampered by differences in the study groups. A case-controlled study using the UNOS database showed poorer outcomes for LDLT, but this analysis did not account for center experience [3]. In contrast, single-center and multi-center studies comparing the postoperative outcomes of LDLT versus DDLT have generally reported equivalent outcomes or improved outcomes for live donation, but these reports have been limited by difference in recipient demographics, MELD scores, and length of follow-up [4–6].

To overcome the limitations of previous studies, we undertook a cohort analysis of patients at our experienced, high volume center, and matched LDLT recipients with DDLT recipients based on recipient age, gender, diagnosis, MELD score, and recipient surgeon. Data on perioperative morbidity was collected prospectively and long-term outcomes were compared. We found that LDLT had a slightly higher rate of surgical complications, but this did not

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adversely affect key outcomes such as hospital stay or 5-year survival rates, which were similar in both groups. In addition, the LDLT group had a lower rate of severe, early hepatocellular injury; a factor which strongly correlated with Grade 4 complications in both DDLT and LDLT.

Materials and methods

Patient selection

This study was reviewed and approved by the Research Ethics Board at Toronto General Hospital/University Health Network (REB#09-0082-AE). A prospectively collected LDLT database of 273 consecutive patients from June 2001 to May 2009 was examined. The first 20 cases, which represented the first 15 months (April 2000 to June 2001) following the inception of the adult live donor liver transplant program at Toronto General Hospital, were excluded from the analysis to allow for complications associated with a documented 'learning curve' at our center, which was previously reported [7]. The study group of LDLT recipients (n = 273) was compared with a database of 634 consecutive DDLT recipients from January 2000 to December 2008 to obtain a cohort of matched recipients. Retransplants were excluded from the matching group. Liver transplant recipients were matched 1:1 using the following criteria: age (± 5 years), MELD (± 5 points), date of transplant (± 5 years), gender, primary diagnosis responsible for ESLD, and the recipient operating surgeon. Using these criteria, 145 of the 273 (53%) living donor (LD) recipients could be matched to a group of 145 DD recipients. This match encompassed a wide range of patients transplanted during this period of time; however, patients transplanted for rare causes of liver disease were unable to be matched given the strict criteria. Demographic, perioperative morbidity, and long-term graft and patient survival were compared.

Operative technique

Deceased donor transplants were performed using a bicaval anastomosis technique as previously described [8]. For LDLT, donors deemed medically suitable to undergo living donation were further evaluated to define their liver anatomy. Graft and residual liver volumes were calculated. Right lobe grafts were used exclusively during this time period for adult-to-adult LDLT. The contribution of the middle hepatic vein (MHV) to the drainage of the central segments of the liver (segments 5/8 and segments 4a/4b) was carefully examined. In grafts in which segments 5/8 were thought to be highly dependent on the MHV for outflow, the MHV was taken with the graft. Residual liver volume was also taken into account in determining the fate of the MHV. Donors were required to have ≥35% residual liver volume to undergo a right hepatectomy (+MHV) versus ≥30% for a right hepatectomy (−MHV). A GWRW ratio of ≥0.8 (based on preoperative imaging) was also required. LD transplants were performed using a piggyback technique as previously described [7].

A duct-to-duct biliary anastomosis was performed when possible except in patients transplanted for primary sclerosing cholangitis (PSC) in which a bilioenteric anastomosis was performed. When there were two ducts in close proximity on the right lobe graft, the ducts were 'plastied' together to form a single bile duct lumen for anastomosis to the recipient bile duct or Roux loop [9]. When multiple ducts (>2) were present or the donor ducts were widely separated, the individual donor ducts were separately anastomosed to a Roux limb.

Immunosuppression

All patients received steroid induction. In addition, all LDLT recipients received an additional induction agent, either thymoglobulin or basiliximab (Simulect®; Novartis Pharmaceuticals Company, East Hanover, NJ, USA). Basiximab or thymoglobulin was used selectively in patients receiving DD transplants if renal dysfunction or neurologic impairment was present at the time of transplant. Steroids were rapidly tapered to a low dose of prednisone in the first few months and stopped within 3–6 months if there was no evidence of rejection; only a minority of patients continued on low dose maintenance prednisone. Calcineurin inhibitors were also used for maintenance therapy: cyclosporine (Neoral; Novartis Pharmaceuticals Company) for patients with chronic hepatitis C infection and tacrolimus (Prograf; Astellas Pharma US, Inc., Deerfield, IL, USA) for all other patients. Mycophenolate mofetil (Cellcept; Hoffman-La Roche, Inc, Nutley, NJ, USA) was used selectively at the discretion of the attending physician at doses up to 2000 mg/day.

Classification of complications

Complications were categorized as medical (renal, respiratory, infectious, cardiac, hematologic, neurologic, and gastrointestinal) or surgical (arterial, venous, and biliary anastomotic complications). Rates of primary nonfunction, rejection, and retransplantation were recorded and compared. The 5-grade Clavien-Dindo classification system was used to evaluate and compare complications between the two subgroups [10]. Any complications requiring an extended ICU stay (>5 days) was considered a Grade 4 complication.

Statistics

Statistics calculations were performed using SPSS software version 17.0 (SPSS Inc., Chicago, IL, USA). Categorical

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variables were compared using a chi-squared test or Fisher's exact test, when appropriate; continuous variables were compared using a *t*-test. Patient and graft survival were tested using a Cox regression analysis. A bivariate logistical regression analysis was performed to identify factors predictive of significant postoperative morbidity (≥Clavien 4). Factors that had a *P*-value < 0.1 were included in the multivariate analysis. A Cox regression analysis was performed to identify factors predictive of graft loss. Factors that had a *P*-value < 0.1 were included in the multivariate analysis.

Results

LD versus DD cohort characteristics

During the period of analysis, 273 LDLTs and 634 DDLTs were performed at our center. Graft and patient survivals were calculated and compared for both cohorts. The 3- and 5-year graft survival for LD versus DD grafts was 85% vs. 85% and 83% vs. 79% ($P = 0.160$), respectively. The 3- and 5-year patient survival was also calculated for LD versus DD and was 87% vs. 85% and 85% vs. 79% ($P = .051$), respectively. To determine if selection bias occurred between the two groups, a matched, case-controlled comparison was performed. A total of 145 LDLT recipients were matched with 145 recipients of DD liver grafts based on age, gender, MELD score at the time of transplant, date of transplant, and recipient surgeon. As expected, the recipient characteristics, donor characteristics, and postoperative data were similar between the two groups (Table 1). Mean age at the time of transplant (54.2 years vs. 53.9 years, $P = 0.764$), MELD at time of transplant (14.4 and 14, $P = 0.976$), and BMI at the time of transplant (27.1 and 28.2, $P = 0.082$) were all statistically similar when comparing LD versus DD recipients, respectively. The majority of recipients (92 patients in each group) were transplanted for hepatitis C-related cirrhosis (63%). More patients were transplanted with hepatoma (either a known diagnosis or as an incidental finding at the time of explant) in the DD group. Approximately, 5.5% of patients were transplanted with high (≥25) MELD scores (8 LDLTs and 8 DDLTs). There were no ABO incompatible transplants performed.

Eighty patients received a right lobe graft (−MHV) and 65 recipients were transplanted with a right lobe graft (+MHV). Full grafts were used exclusively in the DD group (Table 1). In the LDLT cohort, 92 patients (63.4%) had a duct-to-duct biliary anastomosis versus 53 patients (36.6%) having a bilio-enteric anastomosis to a roux limb. In contrast, duct-to-duct biliary anastomosis was performed almost exclusively in patients that received a DD graft, except in the cases of patients with PSC. 44.8% of patients that received a LD graft had multiple (≥2) bile ducts requiring anastomosis. The GWRW ratio for the LD group was 1.20 ± 0.29.

Table 1. Demographics – live donor (LD) versus deceased donor (DD) liver transplant recipients.

Recipient characteristics	LD (n = 145)	DD (n = 145)	*P*-value
Age (SD)	54.2 ± 7.5	53.9 ± 7.7	0.764
Gender (M/F)	117/28	117/28	1
MELD at LTx (range)	14.4 (6–29)	14 (6–33)	0.976
MELD ≥25 at LTx (%)	8 (5.5%)	8 (5.5%)	1
BMI	27.1 ± 4.3	28.2 ± 4.8	0.082
Diagnosis			
HCV	92	92	1
EtOH	26	26	
NASH	4	4	
HBV	7	7	
PSC	8	8	
PBC	7	7	
Cryptogenic	1	1	
Autoimmune	1	1	
Hepatoma [Y/N (%)]	55/90 (38)	80/65 (55)	0.003
Surgeon (1/2/3/4)	46/33/37/29	46/33/37/29	1
Graft type			
Full	0	145	<0.001
Right lobe (−MHV)	80	0	
Right lobe (+MHV)	65	0	
GWRW ratio (mean, SD)	NC	1.20 ± 0.29	
Biliary anastomosis			
Duct to duct	92	138	<0.001
Roux	53	7	
Number of bile ducts (1/>1)	80/65	145/0	<0.001
Donor characteristics			
Age	39.6 ± 11.9	46.3 ± 17.8	<0.001
Cold ischemia time, minutes (SD)	91 ± 4	462 ± 15	<0.001
Warm ischemia time, minutes (SD)	55 ± 20	51 ± 12	0.087
Postoperative data			
ICU stay, days (mean, SD)	3.9 ± 1.2	5.45 ± 1.2	0.354
Need for rehab	7	14	0.105
Readmission	43	34	0.231
Length of stay, days (mean, SD)	19.8 ± 27.4	21.8 ± 26.4	0.309

SD, standard deviation; HCV, hepatitis C virus; EtOH, alcohol; NASH, nonalcohol steatohepatitis; HBV, hepatitis B virus; PSC, primary sclerosing cholangitis; PBC, primary biliary cirrhosis; MHV, middle hepatic vein; GWRW, graft weight to recipient weight; NC, not calculated.

Also, as expected, the LDs were younger (36.3 years vs. 46.3 years, $P < 0.001$) and the LD grafts had shorter cold ischemia times (91 min vs. 462 min, $P < 0.001$). Warm ischemia times were similar.

Following transplantation, all patients were initially cared for in the intensive care unit (ICU). Once extubated and stabilized, patients were transferred to a transplant step-down unit and finally to the general ward for the remainder of their hospital stay. The median ICU stay for both the LD and DD cohort was 2 days. There was a trend

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for longer ICU stays in the DD group with the mean ICU stay 1.5 days longer (3.9 vs. 5.5 days for LD versus DD, respectively); however, this did not reach statistical significance. The overall length of hospital stay also did not differ between groups. There was a trend for higher readmission rates for the LD group as compared with the DD group (43 vs. 34). Conversely, the need for discharge to a rehabilitation facility was higher in the DD group as compared with the LD group (14 patients vs. 7 patients, respectively). Neither of these differences (readmission rate nor the need for rehabilitation) reached statistical significance.

The initial degree of hepatocellular injury was significantly greater in the DD group as compared with the LD group (Table 2). This was demonstrated by a higher aspartate aminotransferase (AST) level on postoperative day 1 (1423 ± 95 vs. 497 ± 43, $P < 0.001$) and a higher peak AST (1752 ± 113 vs. 497 ± 26, $P < 0.001$). However, this did not result in higher early liver dysfunction as both the DD group and the LD group coagulopathies resolved [normalization of international normalized ratio (INR) to ≤1.2] in an average of less than 7 days (6.6 ± 0.6 vs. 6.8 ± 0.3, $P = 0.79$).

Comparison of complications

Perioperative complications were compared between the two groups. Complications included were ≤30 days from surgery or complications occurring during the initial hospital stay for transplantation. Arterial, venous, and biliary complications were tabulated regardless of when they occurred in the postoperative course. Complications were graded based on their level of severity using the Clavien–Dindo classification system [10].

Complication rates were calculated and presented (Table 3). For some patients, multiple complications were recorded. Overall complication rates were similar between the LD and the DD groups with 46% and 49% patients having no post-transplant complications, respectively (Fig. 1). There was a higher percentage of LD transplant patients having any grade 3 complication (48% vs. 37%), although this did not reach clinical significance ($P = 0.058$). However, there was a higher rate of DD recipients that suffered from grade 4 complications as compared with the LD group (21 patients vs. 8 patients, $P = 0.037$). Grade 5 complications were similar between the two groups. There were no statistical differences in complications rates among the four attending recipient surgeons (data not shown).

Predictors of grade 4 complications were identified (Table 4). Donor age ≥50, DD graft, elevated AST on postoperative day 1 (as a continuous variable) were associated with grade 4 complications in univariate analysis. On multivariate analysis, only DD grafts [hazards ratio (HR) 2.14, confidence interval (CI) (95%) 1.01–4.40, $P = 0.038$] were shown to be associated with these severe complications.

Table 2. Postoperative biochemistry.

Postoperative biochemistry	LDLT	DDLT	*P*-value
AST – day 1	497 ± 43	1423 ± 95	<0.001
AST – day 5	104 ± 15	78 ± 4	0.10
Peak AST	497 ± 26	1752 ± 113	<0.001
Days to normal INR (<1.2)	6.8 ± 0.3	6.6 ± 0.6	0.79

Overall survival and reasons for death/graft loss

Patient survival and graft survival were plotted on a Kaplan–Meier curve comparing LD with DD recipients (Fig. 2a and b). Overall graft and patient survival was similar between the two groups with 5-year survival rates of 78%/83% for the LD group and 84%/84% for the DD group (P = ns). The cause of graft loss and death were also similar between the LD and DD groups. Causes for graft loss and patient death were described and broken down into three categories (graft related, cancer, and medical comorbidities). There were no significant differences in the cause of graft loss/death between LD and DD cohorts (Table 5). Thirty-three deaths occurred in the LD group as compared with 27 deaths in the DD group.

Univariate and multivariate analysis were performed to identify factors associated with graft loss (Table 6). Recipient age, operating surgeon, donor age, postoperative day 1 AST ≥2000, LD graft, and biliary complications all failed to show significance in univariate analysis. A diagnosis of hepatitis C virus (HCV), Clavian 3 complications, and Clavian 4 complications was associated with graft loss in univariate analysis. However, only HCV infection [HR 2.29 CI (95%) 1.24–4.23, $P = 0.008$] and grade 4 complications [HR 3.08 CI (95%) 1.68–5.64] were significant in a multivariate Cox regression analysis.

Discussion

Liver transplantation is life-saving for patients with ESLD. In regions with low deceased donation rates, LDLT reduces wait list mortality [1, 2]. However, previous reports have suggested that technical complications are much higher after LDLT (especially when performed at inexperienced centers) potentially resulting in graft failure [11]. Accurate information on the relative morbidity and death risks after LDLT and DDLT has been difficult to obtain because of the confounding effects of differences in the LDLT population who tend to be younger, have lower MELD scores, and have shorter follow-up.

This study was undertaken with the aim of reducing potential biases in prior DDLT and LDLT comparisons

Table 3. Postoperative complications after live donor (LDLT) or deceased donor (DDLT) liver transplantation.

Complication*	LDLT (n = 145)	DDLT (n = 145)	P-value
Any medical complication (%)	40	49	0.252
Postoperative dialysis	5	2	
Respiratory	2	4	
Acute respiratory distress syndrome	–	1	
Pulmonary edema	2	3	
Pneumothorax	–	1	
Infection	39	42	0.667
Pneumonia	6	18	
Clostridium difficile colitis	2	3	
Intraabdominal infection/abscess	21	8	
Cellulitis	1	1	
Urinary tract infection	3	11	
Bacteremia	8	2	
Herpes simplex virus	1	2	
Cytomegalovirus	–	1	
Cardiac	3	13	
Arrhythmia	2	7	
Myocardial infarct	1	4	
Congestive heart failure exacerbation	–	1	
Other	2	3	
Hematologic	4	5	
Deep venous thrombosis	2	1	
Pulmonary embolus	2	2	
Thrombotic thrombocytopenic purpura	–	1	
Neurologic	1	0	
Calcineurin inhibitor toxicity	1	–	
Gastrointestinal	2	1	
Gastric ulcer	–	1	
Small bowel obstruction	1	–	
Pancreatitis	1	–	
Any surgical complication (%)	71	49	0.009
Reoperation	33	22	0.099
Bleeding requiring reoperation	4	12	
Retroperitoneal hematoma	0	1	
Bowel perforation	1	1	
Incarcerated hernia	–	2	
Arterial	8	3	
Hepatic arterial thrombosis	6	2	
Hepatic artery stenosis requiring intervention	1		
Mycotic pseudoaneurysm	1		
Femoral pseudoaneurysm	–	1	
Venous	9	5	
Veno-obliterative disease	1	–	
Hepatic vein stenosis/thrombosis	4	1	
Portal vein stenosis/thrombosis	4	3	
Splenic vein thrombosis	–	1	
Biliary complication	50 (34%)	25 (17%)	0.001
Stricture	26	16	
Cut surface bile leak	7	–	
Bile leak	15	5	
Bile leak and stricture	4	2	
Ischemic biliopathy	1	1	
Bile duct stone	–	1	
Wound complications	8	7	
Wound hematoma	–	1	
Wound infection	4	5	
Fascial dehiscence	4	1	
Primary nonfunction	–	1	
Retransplantation	3	2	
Rejection	30	53	0.003

*Multiple complications are recorded in the same patient.

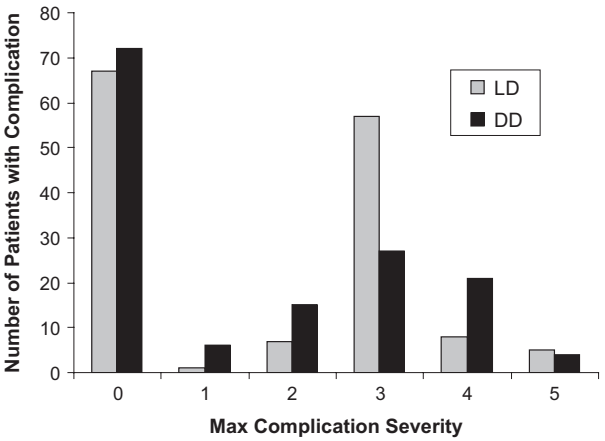

Figure 1 Maximum complication score. Graphic depiction of the greatest complication score for patients who underwent live donor (LD) or deceased donor (DD) liver transplant.

Table 4. Predictors of grade 4 complications.

Characteristic	UV P-value	MV P-value	HR (CI)
MELD >25	0.491	–	
Age	0.557	–	
Surgeon	0.606	–	
Donor age	0.037	NS	
Cold time >6 h	0.227	–	
Deceased donor graft	0.037	0.038	2.14 (1.01–4.40)
AST day 1	0.028	NS	

using a matched cohort design to examine surgeon-specific rates of perioperative complications and long-term survival. Short-term and long-term graft and recipient survival rates were comparable following LDLT versus DDLT. Grade 4 complications requiring extended ICU stays were more frequent in the DD group. Surgical complications were higher in the LD group, especially biliary

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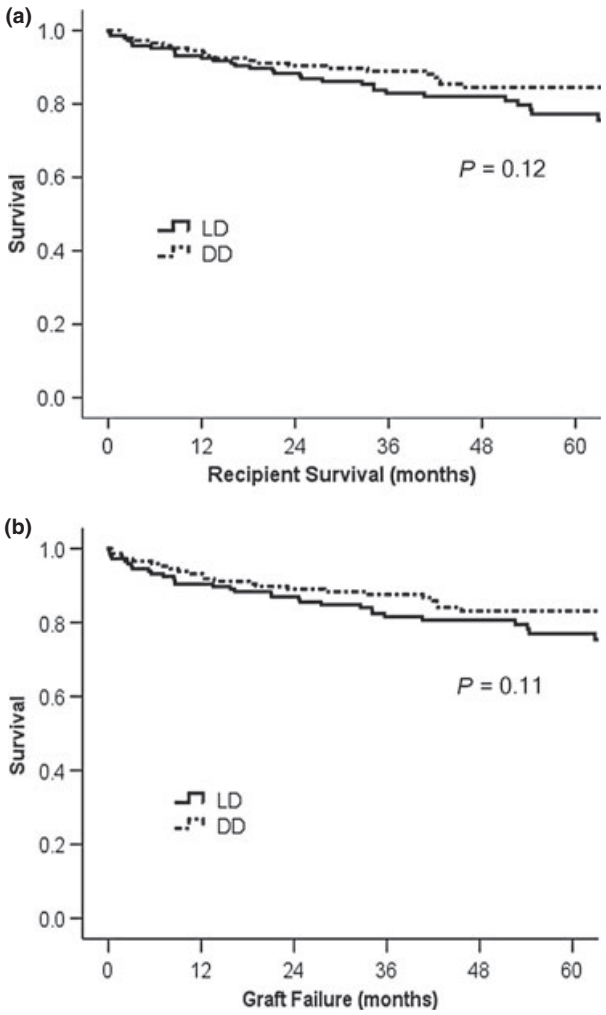

Figure 2 Long-term recipient and graft survival. Kaplan–meier curves depicting graft (a) and recipient (b) survival stratified by live donor (LD) or deceased donor (DD) liver transplant.

Table 5. Reason for graft loss/death.

	LDLT	DDLT	*P*-value
Reason for graft loss/death	*n* = 33	*n* = 27	0.252
Graft related	17	9	
Veno-occlusive disease	1*	–	
Primary nonfunction	–	1	
Graft failure secondary to HAT	3†	1	
Secondary biliary cirrhosis	1	–	
Ischemic cholangiopathy	1	1	
Chronic rejection	–	1	
Recurrent hepatitis C	11	5	
Cancer	10	11	
Recurrent hepatocellular cancer	6*	5	
Metastatic breast cancer	1	–	
Metastatic head and neck cancer	1	2	
Metastatic lung cancer	2	1	
Mesothelioma	–	1	
Myelodysplastic syndrome	–	1	
Post-transplant lymphoproliferative disorder	–	1	
Medical comorbidities	8	9	
Pneumonia	1		
Sepsis	5	3	
Rupture of mycotic aneurysm	1		
Cerebral vascular accident	1†	1	
Cardiac arrest	–	3	
Severe hemolytic anemia	–	1	
Accident	–	1	

*In one patient, reason for graft loss differed from reason for death.
†Reason for graft loss and death were different.
HAT, hepatic artery thrombosis.

Table 6. Risk factors for graft loss/death.

Characteristic	UV *P*-value	MV *P*-value	HR (CI)
Recipient age	0.407	–	
Surgeon	0.588	–	
Diagnosis of HCV	0.016	0.008	2.29 (1.24–4.23)
Donor age	0.277	–	
AST day 1 (≥2000)	0.059	NS	
Living donor graft	0.123	–	
Clavian 4 complications	<0.001	<0.001	3.08 (1.68–5.64)
Biliary complications	0.358	–	

complications, but these complications were treatable and were not associated with higher rates of graft loss in the short or long term. Rates of cellular rejection were slightly lower in the live donor recipients who had routinely received either anti-lymphocyte globulin (thymoglobulin) or an IL-2 antagonist during the early postoperative period.

Potential advantages of LDLT include: (i) the ability to optimize the recipient's health prior to transplant; (ii) provision of a high-quality donor graft; and (iii) brief cold storage times [2]. At our center, these advantages translated into a lower rate of hepatocellular injury in the early postoperative period as measured by the peak AST and ALT levels. These advantages of LDLT at our center were off-set by a higher rate of technical complications as compared with DDLT, as previously reported by others [4, 6, 11]. Fortunately, when performed at an experienced center, these complications can usually be mitigated [11] and thus the short- and long-term graft and patient survival rates were similar with DDLT and LDLT at our center.

Several studies have previously compared both perioperative outcomes and long-term outcomes of LDLT and DDLT [3–6, 11]. One of the largest North American series examining perioperative outcomes was published by the Adult-to-Adult LDLT (A2ALL) cohort and compared the outcomes of 384 LDLTs with 216 DDLT. Unlike our experience, this multi-institutional study found a higher rate of

complications leading to retransplantation in the LDLT group (15.9% vs. 9.3%). However, the risk of graft loss was significantly reduced after 20 LDLTs were performed (11% vs. 9%). Biliary complications were also higher in the LDLT group; however, this appeared to decrease with center experience [11]. In contrast, a matched, case-controlled comparison by Thuluvath *et al.* demonstrated lower graft survival rates for the LDLT group. Although patients were matched, this study utilized the UNOS database and was unable to control for surgical experience and center-specific differences [3]. Furthermore, perioperative complications were not examined in the latter study [3].

Biliary complications continue to be a challenge in LDLT. In this well-matched cohort study at a large case volume center, biliary complications occurred in 34% of the LDLT cohort versus 17% of the DDLT cohort. Several other groups have also reported persistently high rates of biliary strictures that do not change with increased center experience. [11, 12]. The majority of these strictures can be successfully treated with conservative, nonoperative measures, although repeated interventions are often required [13–19]. In patients who fail nonoperative treatment, surgical revision of the anastomosis has reasonable success rates in carefully selected patients [20, 21].

This study also demonstrated an increased rate of rejection in the DD group. As a program policy at Toronto General Hospital, LDLT routinely received an induction agent (either thymoglobulin or basiliximab) because of the concern of the ability of the partial graft to tolerate rejection in the early postoperative period [22]. However, the use of other immunosuppressive agents (mainly cellcept) is not completely uniform and clouds further analysis. These findings, however, do cohobate previous finding by Maluf *et al.* who also found increased acute cellular rejection in the DD group [5].

There are several potential weaknesses in this article. This is a retrospective review of a database, but the data were collected prospectively as part of our ongoing measures to monitor the quality of care. We were unable to control for donor variables, but none of the donor grafts had obvious technical complications during recovery. Finally, although this case series is large in comparison with many of the previous reports, the cohorts may not have been large enough to detect small differences between the two groups.

In summary, this case–control comparison of the outcome of deceased and LDLT reinforces the notion that the principle reasons to recommend or offer live donor liver transplantation are (i) to time the transplant when the recipient can obtain the maximum recovery and survival benefit; and (ii) to reduce the risk of death or disqualification while waiting for the liver transplant. Post-transplantation, these two procedures have different complication profiles, but with expert management, the overall outcomes are similar. With LDLT, the advantage of a higher quality donor organ is counterbalanced by greater technical complexity and a higher rate of largely treatable surgical complications.

Authorship

TWR, DRG, IDM, AG, and GL: designed the study. TWR, HK, TT, and MS: data collection and analysis. TWR, ELR, GL, and DRG: wrote paper. MSC, PDG, IDM, AG, MS: critical revision.

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