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ORIGINAL ARTICLE

Living donor graft versus cadaveric in pediatric liver transplantation. Multicentric study

Injerto de donante vivo versus fallecido en trasplante hepático pediátrico. Estudio multicéntrico

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What do we know about the subject matter of this study?

We present the results of a living donor grafts (LDG) program in Chile which was implemented after successful international reports of liver transplantation (LT) with LDG, considering the mortality rate on the waiting list.

What does this study contribute to what is already known?

This study of patients who underwent LT with LDG vs deceased donor grafts (DDG) allowed us to compare demographic characteristics, complications, and graft and patient survival between both types of LT. Despite presenting a higher percentage of surgical complications, probably determined by the characteristics of LDG recipients who are smaller than DDG recipients, LT with LDG presents similar results in graft and patient survival.

Abstract

Liver transplantation (LT) is the therapy of choice in patients with end-stage chronic liver disease, severe acute liver failure, and metabolic diseases, among other pathologies. Historically, more patients have been on the waiting list than organs for transplantation. In 1999, we started a living-related donor liver transplantation program. **Objective:** to compare surgical results and graft survival in liver transplanted patients with living donor graft (LDG) versus deceased donor graft (DDG). **Patients and Method:** Retrospective observational analytical study of pediatric patients undergoing LT at the Dr. Luis Calvo Mackenna Hospital and Las Condes Clinic between 1999 and 2020 in Santiago, Chile. They were grouped into LDG and DDG and demographic characteristics, complications, and graft and patient survival were compared. **Results:** 276 LT were performed. Of these, 198 were included, of which 81 were LDG and 117 were DDG. The recipients of LDG had a lower average weight ($p < 0.001$), a higher frequency of portal vein thrombosis (13.6% versus 4.3%; $p = 0.006$),

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biliary stricture (38.3% versus 14.5%; $p < 0.001$), and surgical reintervention (76.5% versus 57.3%, $p = 0.006$). Survival of DDG and LDG patients at 1 year and 5 years was 86.1% and 72.3% versus 82.5% and 81.1%, respectively ($p = 0.16$). Graft survival at one year and 5 years was significantly higher in LDG with 80% and 78.6% versus 79% and 62% in DDG, respectively ($p = 0.032$). The recipient's weight between 9-13 kg was significantly correlated with a higher frequency of hepatic artery thrombosis (RR = 1.98) in the multivariate analysis. **Conclusion:** Our study demonstrated comparable long-term results in LDG despite greater postoperative complications, which supports continuing its use as an option in pediatric LT.

Introduction

Liver transplantation (LT) is the therapy of choice in patients with acute or chronic end-stage liver disease, metabolic diseases, and unresectable primary liver tumors[1,2], achieving a survival between 85% and 95%[2-5]. In Chile, pediatric liver transplantation represents approximately 25% of the total number of liver transplants performed annually[6]. The main causes are biliary atresia (BA) in 50%, fulminant hepatic failure (FHF) in 25%, and other cholestatic diseases in 10%[7].

Historically, and similar to what happens in the rest of the world, in Chile, there have been more patients on the waiting list than organs for transplantation. In April 2021, there were 154 patients listed for LT[8]. In the USA, the mortality rate on the LT waiting list for pediatric patients is close to 9% per year[5], while in Chile, the overall mortality of pediatric patients on the waiting list was 25.1%, where the subgroup of children under 2 years of age presented an estimated mortality rate of 38.1% per year[9].

After the reports of the successful LT of Nagasue et al in Japan[10] and Broelsch in Chicago[11], many LT teams started living donor programs. These reports, the experience of the local team in liver surgery, together with the shortage of organs in Chile and the mortality of pediatric recipients, led to the creation of a living-related donor program for LT in 1999 that has been maintained to date.

Theoretically, the living donor graft (LDG) increases the risk of complications because vascular and biliary anastomoses are technically more difficult compared with a deceased donor graft (DDG). Despite the greater presence of serious surgical complications that require surgical reintervention in LDG, most studies agree that the survival rates of both graft and patients remain similar to those of DDG recipients[12,13]. Therefore, it seems essential to evaluate the risk-benefit of this surgical practice, assessing the risk involved for the donor.

The objective of this study was to compare surgical outcomes, graft survival, and survival of pediatric liver transplanted patients with LDG vs DDG in our team.

Patients and Method

Between April 1999 and April 2020, a retrospective observational analytical study was performed which included a historical cohort of patients under 18 years of age who underwent LT at the *Hospital Dr. Luis Calvo Mackenna* and *Clínica las Condes*, both in Santiago, Chile, with post-transplant follow-up of at least one year. This study was approved by the local ethics committee.

Two patients were excluded due to incomplete data in the clinical record and those patients with transplants of more than one organ (n = 10; 10 DDG), retransplants (n = 47; 5 LDG and 42 DDG), and transplants due to oncologic causes (n = 19; 7 LDG and 12 DDG) because they represented a low number of patients and were demographically not comparable for the proposed study.

For LT with LDG, a left lateral sectionectomy (LLS) was performed, initially by conventional open surgery and, since 2015, laparoscopically which was performed with 10mm/30° optics, 10/12mm trocars, and 5mm instruments.

The procedure started with hepatoduodenal ligament dissection, verifying the hepatic arterial anatomy, then the left hepatic hilum was dissected, and the hepatic artery and left portal vein were isolated with vascular silicone ties. The left triangular ligament was sectioned using the Harmonic® HD 1000i Shears, keeping the falciform ligament for liver fixation. With a dissecting hook, the liver transection line was demarcated 1 cm to the right of the falciform ligament for transecting with the Harmonic® and laparoscopic CUSA®. The portal and arterial branches to the caudate lobe were selected, controlled with metallic surgical clips, and then sectioned. The transection reached the vena cava outflow of the left suprahepatic vein which was controlled with mechanical suturing. Vascular control of the hepatic artery and left portal vein was performed with Hem-o-lok® and minor vessels with metallic clips. Subsequently, segments II and III of the biliary duct were identified and controlled with clips. The graft was extracted in a sterile bag through a Pfannenstiel suprapubic incision, and a suction drain was placed in the surgical site. Once extracted from the abdominal cavity, the graft was perfused directly via the arterial and portal routes with the SPS-1® static preservation solution (Organ Recovery Systems).

For transplantation with DDG, the multiple organ procurement technique with aortic and portal perfusion was used. For recipients under 25 kg on average, the extracorporeal liver reduction was performed in a back table, using the left lateral segments and for children under 40 kg, left lobe grafts and complete grafts in older children or pediatric donors.

In the recipient's surgery, hepatectomy was performed with preservation of the vena cava, then, using the triangulation technique, the organ was implanted by anastomosing the cuff of the suprahepatic veins of the graft to the vena cava of the recipient, followed by end-to-end portal anastomosis, using a venous graft due to portal vein hypoplasia. Hepatic reperfusion was performed, with subsequent arterial end-to-end anastomosis, using microsurgical anastomosis since 2015 in cases of graft or recipient hepatic artery diameter less than 3 millimeters or aortic arch in cases of marked difference of graft/recipient artery diameter.

The patients under study were grouped according to the type of graft in LDG and DDG and the demographic and clinical characteristics (sex, age, weight, cause of transplantation, type of donor, type of vascular and biliary anastomosis, and need for contained laparotomy) were compared between them, as well as vascular complications [hepatic artery thrombosis (HAT), portal vein thrombosis (PVT), hepatic artery stenosis, suprahepatic vein stenosis, and portal vein stenosis], and biliary complications [bile duct leak (BDL) and bile duct stricture (BDS)] that required surgical reintervention.

Graft and patient survival with LDG vs DDG at 1 and 5 years were calculated. A sub-analysis of survival was performed by dividing the population into three groups with the same sample size according to the date of transplantation to assess the impact of the learning curve. Calendar years were not used because the number of transplantations varies from year to year.

The analysis of the demographic data was performed according to the total number of patients to be studied, using summary statistics of central tendency (mean, median) and dispersion (standard deviation and interquartile range 25th and 75th percentiles). For the measures of association and magnitude of association, relative risks (RR) were estimated with their respective 95% confidence intervals (95% CI). For the comparison between groups, the Wilcoxon signed-rank test was used for quantitative variables and the Chi-square test for qualitative variables.

The Kaplan-Meier function was used to estimate the probability of graft and subject survival over time, and the Log-Rank test was used to compare between groups. For all tests, a p-value lower than 5% was considered statistically significant. Statistical analyses were performed with the Stata v.14.0 statistical package.

Results

Between April 1999 and April 2020, 276 liver transplants were performed on pediatric patients at the *Hospital Dr. Luis Calvo Mackenna* and *Clínica Las Condes*; 200 patients met the inclusion criteria for this study. The study group included 198 patients, 90 boys (45.5%) and 108 girls (54.5%). Eighty-one patients (41%) received an LDG and 117 (59%) received a DDG.

Demographic data

The most frequent indication for transplantation was BA with 67.9% of cases of LDG and 50.4% of DDG ($p = 0.02$), followed by FHF with 19.8% and 28.2% of LDG and DDG cases, respectively ($p = 0.19$).

Table 1 shows the clinical and demographic characteristics of both groups. LDG recipients presented lower mean weight, 9.3 kg (7.1;13.5) vs 18 kg (11;30), $p < 0.001$ and lower mean age, 19 months (11;30) vs 50 months (24;108), $p < 0.001$, than DDG patients.

Data on the type of arterial anastomosis was available in 165 children (67 LDG and 98 DDG), most of them underwent single end-to-end anastomosis. Microsurgery for arterial anastomosis was performed in 17 patients in the LDG group (21%) and one patient in the DDG group (0.9%), with a statistically significant difference ($p < 0.001$). Regarding portal anastomosis, the data was available in 120 patients (51 LDG and 69 DDG), most of them underwent end-to-end anastomosis (96.1% LDG and 91.3% DDG). Data on biliary anastomosis were available in 190 patients (79 LDG and 111 DDG), most were performed by Roux-en-Y hepaticojejunostomy (76.6% DDG vs 100% LDG). Of the LDG cases, four were double Roux-en-Y, with a statistically significant difference ($p < 0.001$).

There was no statistical difference ($p = 0.71$) in relation to the patients with contained laparotomy, corresponding to 38 patients in total (19.2%), 14 LDG (17.3%), and 24 DDG (20.5%).

Surgical complications (Table 2)

Patients who received LDG had more scheduled or unscheduled re-interventions (76.5%) than those who received DDG (57.3%), representing a statistically significant difference with RR 1.34 (CI 1.09;1.64); $p = 0.01$. The most frequent cause of reoperation was

BDS with 48 cases, 31 LDG (38.3%) and 17 DDG (14.5%), followed by laparotomy closure in 14 LDG (17.3%) and 24 DDG (20.5%), HAT in 12 LDG (14,8%) and 21 DDG (17.9%), BDL in 12 LDG (14.8%) and 17 DDG (14.5%), bleeding in 9 LDG (11.1%) and 9 DDG (7.7%), PVT in 11 LDG (13.6%) and 5 DDG (4.3%), portal vein stenosis in 8 LDG (9.9%) and 7 DDG (6%), intracavity lavage in 7 LDG (8.6%) and 3 DDG (2.6%), intestinal obstruction in 3 LDG (3.7%) and 2 DDG (1.7%), hepatic vein stenosis in 1 LDG (1.23%) and 4 DDG (3.4%), gastrointestinal fistula in 2 LDG (2.5%) and 1 DDG (0.85%), hepatic artery stenosis in 1 LDG (1.23%) and 1 DDG (0.85%), transit reconstitution in 2 LDG (2.5%), surgical wound evisceration in 1 DDG (0.85%), and liver laceration in 1 DDG (0.85%).

Regarding hepatic artery complications, those related to hepatic artery anastomosis occurred in 16% of LDG patients and 18.9% of DDG patients; HAT occurred in 12 LDG (14.8%) vs 21 DDG (18%); hepatic artery stenosis occurred in 1 patient of each group (1.2% of LDG and 0.9% of DDG). Both complications did not show a statistically significant difference (p = 0.56 in HAT and p = 0.79 in hepatic artery stenosis).

With respect to portal vein complications, those related to portal vein anastomosis occurred in 27.2% of patients with LDG and 10.3% of DDG; PVT occurred in 11 LDG (13.6%) vs 5 DDG (4.3%) (RR 4.04, p = 0.002); portal vein hypoflow occurred in 3 LDG patients with no cases in DDG, and stenosis occurred in 8 LDG (9.9%) and 7 DDG (6%).

In relation to suprahepatic vein complications, suprahepatic vein stenosis occurred in 1.2% of LDG vs 3.4% of DDG, with no significant difference between groups (RR 0.36, p = 0.33).

Table 1. Clinical and demographic characteristics

Variable	Escala	Injerto donante		P Value
		LDG (n = 81)	DDG (n = 117)	
Age	Months	19 (11; 30)	50 (24; 108)	< 0.001
Weight	kg	9.3 (7.1; 13.5)	18 (11; 30)	< 0.001
Diagnosis	Biliary atresia	55 (67.9%)	59 (50.4%)	0.029
	FHF	16 (19.8%)	33 (28.2%)	
	Alagille Syndrome	2 (2.5%)	9 (7.7%)	
	Neonatal Hepatitis	3 (3.7%)	0	
	PFIC	1 (1.2%)	1 (0.9%)	
	Metabolic Diseases	1 (1.2%)	6 (5.1%)	
	Autoinmune Diseases	0	6 (5.1%)	
	Unknown	2 (2.5%)	2 (1.7%)	
	Other	1 (1.2%)	1 (0.9%)	
		n = 81	n = 116	
Donor	Adult	81 (100%)	76 (65.5%)	< 0.001
	Pediatric	0	40 (34.5%)	
		n = 81	n = 116	
Type of graft	Reduced	81 (100%)	39 (33.6%)	< 0.001
	Whole	0	77 (66.4%)	
Arterial Anastomosis		n = 67	n = 98	
	1 Anastomosis	58 (86.6%)	81 (82.7%)	0.061
	2 Anastomosis	8 (11.9%)	7 (7.1%)	
	Bypass	1 (1.5%)	10 (10.2%)	
Microsurgery	Yes	17 (21%)	1 (0.9%)	< 0.001
Portal Vein Anastomosis		n = 51	n = 69	
	End-to-end	49 (96.1%)	63 (91.3%)	0.416
	Bypass	2 (3.9%)	4 (5.8%)	
	Patch	0	2 (2.9%)	
Biliary Anastomosis		n = 79	n = 111	
	RY	75 (94.9%)	85 (76.6%)	< 0.001
	2 BD RY	4 (5.1%)	0	
	End-to-end	0	26 (23.4%)	
Contained Laparotomy	Yes	11 (13.6%)	24 (20.5%)	0.26

LDG, Living donor grafts; DDG, Deceased donor grafts; FHF, fulminant hepatic failure; PFIC, Progressive familial intrahepatic cholestasis; RY, Roux-en-Y; BD, Bile duct.

Concerning biliary complications, 54.3% of LDG patients presented complications vs 31.6% of DDG patients, and the most frequent was BDS with 31 LDG (38.3%) vs 17 DDG (14.5%), RR 2.63 (CI 1.57;4.23), $p < 0.001$. Also, multiple intrahepatic strictures occurred in 1 LDG patient and 2 DDG patients, and BDL did not represent a difference between the groups (14.8% LDG and 14.5% DDG).

Patient and graft survival

In the group that was transplanted with LDG, patient survival at one year was 82.5% and at 5 years 81.1% compared with the DDG group with 86.1% at one year and 72.3% at five years, without a statistically significant difference (Figure 1a).

The influence of the learning curve on patient survival was evaluated by comparing 3 groups with the same number of individuals (n = 66) (Figure 1b), which showed an improvement in survival in the last group at 1 and 5 years with 87.7% and 86.2%, respectively (group 3) vs 81.3% and 70.3%, respectively, at the beginning of the program (group 1).

In relation to graft survival, this was significantly higher in the LDG group (p = 0.032) with a rate at one year of 80% (CI 69.5; 87.2) and at 5 years 78.6% (CI 67.8; 86.1) (Figure 1a).

Retransplantation was necessary for 10 patients in the LDG group (12.4%) and 25 in the DDG group (21.4%). The most frequent cause of retransplantation was vascular complications with 15 patients (n = 7, 70% LDG vs n = 8, 32% DDG), followed by chronic rejection with 9 patients (n = 1, 10% LDG vs n = 8, 32% DDG). (Table 3).

The effect of the learning curve on graft survival was also evaluated, demonstrating a statistically significant difference (p = 0.011) between the groups with survival reaching at 1 year 84.6% in group 3 vs 71.8% in group 1 and at 5 years 83.1% in group 3 vs 52.4% in group 1 (Figure 1b).

Mortality

During the study period, 61 patients died [19 LDG (23.5%) vs 42 DDG (35.9%)], without statistical significance (p = 0.062). The most frequent cause was sepsis, occurring in 29 patients [10 LDG (52.7%) vs 19 DDG (45.3%)]; hypovolemic shock [2 LDG (10.5%) vs 7 DDG (16.7%)], liver failure [1 LDG (5.3%) vs 7 DDG (16.7%)], corresponding to 2 cases of primary graft dysfunction and 6 cases of vascular cause; intracranial complication [2 LDG (10.5%) vs 4 DDG (9.5%)], corresponding to 1 case of intracranial hemorrhage, 1 of ischemic stroke, 1 of ruptured aneurysm, and 3 cases of hypertensive aneurysm; respiratory failure [2 LDG (10.5%) vs 2 DDG (4.8%)]; intraoperative causes [2 LDG (10.5%) vs 1 DDG (2.4%)] corresponding to 1 case of heart failure, 1 of massive hemorrhage, and 1 case of primary graft dysfunction; lymphoproliferative syndrome [1 DDG (2.4%)], and drug toxicity [1 DDG (2.4%)].

Multivariate analysis

Multivariate analysis included the following variables: sex, type of donor, cause of transplantation, technique (complete vs segmented), microsurgery, type of arterial anastomosis, type of portal anastomosis, and type of bile duct anastomosis, as well as the categorized

Table 2. Surgical complications

Complication		LDG (n = 81)	DDG (n = 117)	RR (IC95%)	P Value
Re-intervention		62 (76.5%)	67 (57.3%)	1.34 (1.09;1.64)	0.010
Hepatic Artery					
	Thrombosis	12 (14.8%)	21 (18%)	0.82 (0.43;1.58)	0.561
	Stenosis	1 (1.2%)	1 (0.9%)	1.44 (0.09;22.76)	0.793
Portal Vein					
	Thrombosis	11 (13.6%)	5 (4.3%)	4.04 (1.52;10.79)	0.006
	Hypoflow	3 (3.7%)	0		
	Stenosis	8 (9.9%)	7 (6%)	1.65 (0.62;4.37)	0.309
Suprahepatic Vein					
	Stenosis	1 (1.2%)	4 (3.4%)	0.36 (0.04;3.17)	0.335
Bile duct					
	Leak	12 (14.8%)	17 (14.5%)	1.02 (0.52;2.02)	0.956
	Stricture	31 (38.3%)	17 (14.5%)	2.63 (1.57;4.23)	< 0.001
	Multiple intrahepatic strictures	1 (1.2%)	2 (2.6%)	0.48 (0.05;4.55)	0.513

LDG, Living donor grafts; DDG, Deceased donor grafts.

variables of age and weight [less than 9 kg (n = 53), between 9 kg and 13 kg (n = 50), between 14 kg and 20 kg (n = 48), and greater than or equal to 21 kg (n = 47)]. The weight variable between 9 kg and 13 kg was significantly correlated with a higher frequency of HAT (RR 1.98).

BDL had a statistically significant relationship with recipient weight between 14 kg and 20 kg (RR 7.33) and with arterial arch anastomosis (RR 3.09). On the other hand, BDS was associated with the use of LDG (RR 3.67).

In portal anastomosis complications, portal stenosis was associated with portal anastomosis with venous bypass (RR 1.67), and PVT was associated with the use of LDG (RR 4.67).

A sub-analysis of complications according to the most frequent etiologies was performed, comparing vascular complications in patients with chronic liver disease (CLD) vs FHF, finding a statistically significant difference in the presence of PVT in the CLD group (22% LDG and 5% DDG) vs the FHF group (0 LDG and 3% DDG) ($p = 0.013$).

In addition, the results of laparoscopic vs open LDG were analyzed, finding a statistically significant decrease in the presentation of HAT, with 4% vs 20%, respectively ($p = 0.003$), with no variation in other complications.

Discussion

In Chile, pediatric liver transplantation represents approximately 25% of the total number of liver transplants, with an average of 76 surgeries performed per year[6] and, as of April 2021, 154 patients remained on the waiting list for a liver[8]. This shows a shortage of organs for transplants from deceased donors so that related-living donors constitute an opportunity to reduce mortality and time on the waiting list.

Despite being a source of graft susceptible to improving the survival of patients who require a transplant, its use showed more general complications in the recipients, similar to what was found in the literature[4]. The LDG group presented more complications that required surgical reintervention than the DDG group (76.5% vs 57.3%, respectively), however, they are not demographically similar groups; compared with the DDG group, the patients transplanted with LDG are smaller and younger with an average weight of 9.3 kg (7.1:13.5) vs 18 kg (11:30), $p < 0.001$, and younger average age with 19 months (11:30) vs 50 months (24:108), $p < 0.001$, than patients with DDG. The most frequent complications in LDG recipients and that represented a statistically significant difference with those who received a DDG were biliary complications and PVT ($p = 0.006$).

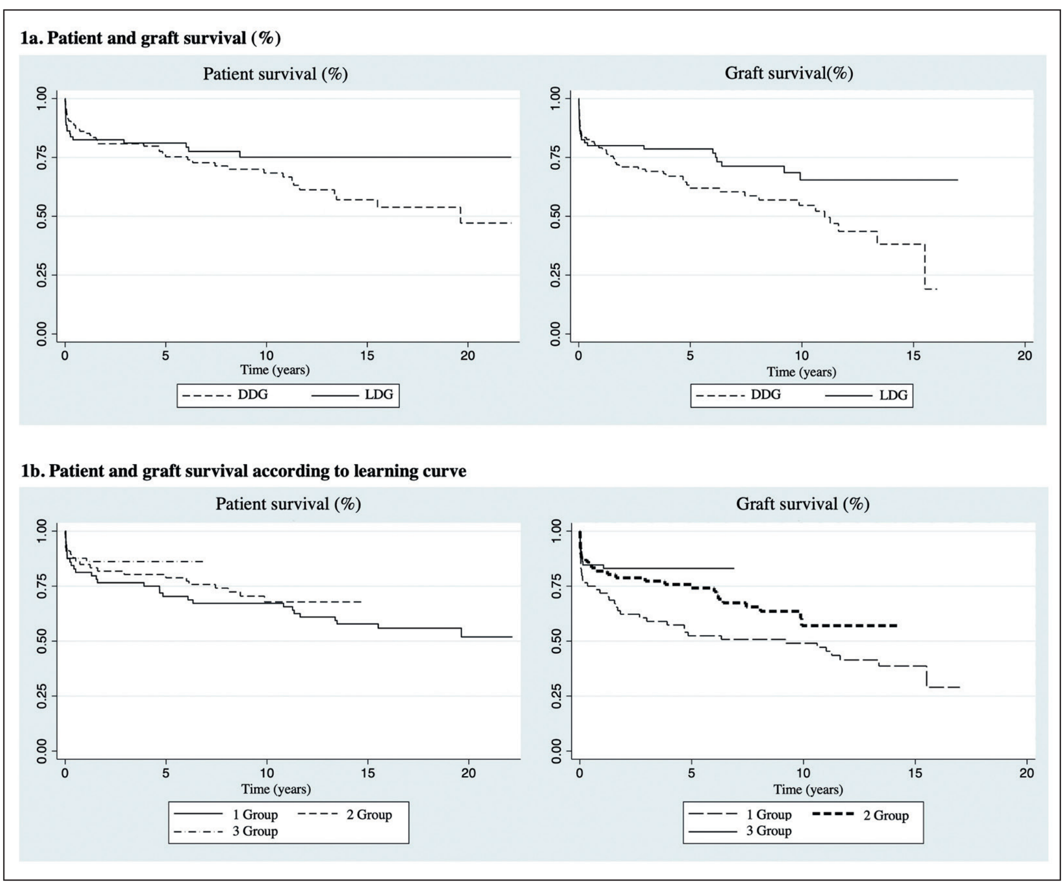

Figure 1.

Table 3. Cause of Retrasplantation

		LDG (n = 81)	DDG (n = 117)	P Value
Retrasplantation	Yes	10 (12.4%)	25 (21.4%)	0.102
Cause	Vascular complication	7 (70%)	8 (32%)	0.167
	Primary graft dysfunction	0	4 (16%)	
	Bile duct stricture	2 (20%)	3 (12%)	
	Chronic rejection	1 (10%)	8 (32%)	
	ABO I	0	2 (8%)	

LDG, Living donor grafts; DDG, Deceased donor grafts; ABO I, ABO incompatibility.

Table 4. Multivariate analysis

Variable		TAH	TVP	Filtración biliar	Estenosis biliar	Estenosis portal
Sex	Male					1,64 (0,53; 5,08)
Donor	Living		4.67 (1.43; 15.22)		3.67 (1.84; 7.21)	
Age	< 17 months					
	17 and 31 months					
	32 and 69 months			0.14 (0.02; 0.84)		
	≥ 70					
Weight	< 9 kg					
	9 kg - 13 kg	1.98 (0.89; 4.39)				
	14 kg - 20 kg			7.33 (1.83; 29.45)		
	≥ 21 kg					
Arterial anastomosis (n = 165)	1 anastomosis					
	2 anastomosis					
	Bypass			3.09 (0.52; 18.26)		
Portal vein anastomosis (n = 120)	Bypass					1.67 (0.18; 15.72)

HAT, hepatic artery thrombosis; PVT, portal vein thrombosis.

PVT occurred in 13.6% of LDG vs 4.3% of DDG, being similar to the 2%-13.7% of PVT reported in the literature[4,12,14]. LDG was the only variable that presented an association in our study, however, the lower weight of the recipients, with smaller portal veins, could also be a factor. In addition, BA is the etiology significantly more frequent in this group of patients, which is related to hypoplastic portal veins and chronic thrombosis that cause a PVT increase in the postoperative period due to size difference and endothelial alteration and the presence of collaterals effects that cause relative portal vein hypoflow. Fulminant hepatic failure is an etiology with greater relative weight in the group of patients transplanted with DDG, with the flow and portal anatomy showing no alterations before transplantation[15].

Regarding biliary complications, BDS was more frequent in LDG, occurring in 38.3% vs 14.5% in DDG, representing a high percentage compared with the international literature, where it is reported in 6.8% and 21.3% of cases, respectively[4,5,16,17]. We did not find a cause for the high rate of BDS, except that the study group consists of low-weight patients and a high rate of BA, which are known risks for the occurrence of biliary complications[18]. Other associated factors, HAT, and cold and warm ischemia times (mean 236 min and mean 42 min, respectively) are similar to the literature, and preservation solutions have varied during the period, so we analyzed the percentage of BDS over time, with no variation between groups.

The frequency of HAT reported in the literature in

LDG was between 3-18% and in DDG 1-12%[4, 5,12,19]. In our study, it was similar between the groups with 18% in LDG and 14.8% in DDG, being the recipient's weight between 9 kg and 13 kg as the only associated factor in the multivariate analysis, presenting HAT in 24%. In the analysis, it was remarkable that the group under 9 kg presented 17% of HAT, however, in this group, microsurgery was used in 22% vs 10% in the group from 9 kg to 13 kg.

Due to the historical high percentage of HAT in the series, we incorporated changes in the LDG arterial anastomosis technique since 2015, with the introduction of microvascular suture for the hepatic arteries, decreasing our percentage of HAT to 0% in LDG as described in a paper previously presented at the national congress of the Chilean Society of Pediatric Surgery in 2020, which influences this result.

In both groups, the most frequent cause of retransplantation was vascular complications, but the statistical weight of this etiology was greater in LDG (70%) than in DDG (32%) ($p < 0.001$). The analysis groups are demographically different, patients receiving LDG weigh less, requiring a transplantable liver mass that should not be less than 10% of the recipient's weight, which makes these patients smaller in age and weight, and therefore their more frequent etiology is BA ($p = 0,02$). This is related to a higher frequency of portal vein hypoplasia, small hepatic arteries, and greater preoperative deterioration with higher Pediatric End-stage Liver Disease (PELD) score (median 21; range 1-42), which in the literature is related to a higher frequency of vascular complications[15].

Although complications were more frequent in the LDG group, patients who received DDG had greater graft loss and a higher rate of retransplantation (21.4% DDG vs 12.4% LDG), which is similar to that reported by Mogul et al who found an association of LDG with a lower risk of graft failure[20]. Graft survival was longer in LDG recipients at 1 and 5 years than in DDG (80% and 78.6% vs 79.1% and 62%, respectively), similar to other study groups[4,21]. The effect of the learning curve on graft survival showed a statistically significant improvement ($p = 0.011$).

Patient survival reported in the literature ranges from 85% to 95%[2-5]. Yankol et al.[5] reported a similar survival in both groups as in our study (DDG 86.1% vs DDG 82.5% at one year), this supports the use of LDG for patients on the waiting list, although the donor takes a risk when undergoing surgery. Uribe et al performed an analysis of the causes for not performing transplantation with a related-living donor, finding that the main cause was parental fear of the surgical procedure (36.4%)[22], however, the morbidity reported internationally for the procedure varies between 3.7-17%[22,23], generally requiring conservative management and the risk of death for a left lateral segment donor has been estimated at 0.1%[24].

With laparoscopic surgery on the donor, a decrease in bleeding, shorter hospitalization time, and less intraoperative and postoperative morbidity have been demonstrated[25]. Since laparoscopic LLS was initiated in 2015, our group presented 3% postoperative complications (one patient with BDL successfully managed with endoscopic retrograde cholangiopancreatography), similar to that reported by another study in our country which presented morbidity, according to the Clavien-Dindo classification, in 5 patients (33.3%) with only one grade III that required percutaneous bilioma drainage[26].

For this reason, it is very important to clarify doubts with the relatives regarding the donation and promote from the beginning the use of living donor livers in order to reduce mortality on the waiting list, since, despite the complications of LDG, this has better graft survival and similar patient survival, which could be related to the shorter time of cold ischemia time. In addition, the living donor allows us to plan the procedure and the recipients tend to be in better clinical conditions[5,27] since it has been demonstrated that the PELD score does not correlate adequately with the severity and worsening in the waiting list of pediatric patients[9].

In conclusion, the study population represents more than 80% of the pediatric LT performed in our country and includes the only pediatric LT program with LDG in the public health system in Chile. Although LDG recipients presented a lower weight at transplantation, which implies a higher rate of complications per se, we demonstrated comparable long-term results with the use of LDG and a low rate of complications in the donor, which supports its continued use.

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

Rights to privacy and informed consent: The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the correspondence author.

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

Financial Disclosure

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