Original Article

Outcomes of small-size graft in highly urgent living donor liver transplantation: Korean national data

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Background: The major concern for living donor liver transplantation (LDLT) is the selection of donor graft size because small grafts are often unable to meet metabolic demands or fail to function after implantation in highly urgent LDLT (HU-LDLT). We aim to compare the outcomes between the small graft volume group (graft-to-recipient weight ratio, GRWR <0.8%) and the non-small graft volume group (GRWR ≥0.8%) in the national data of HU-LDLT cases in Korea.

Methods: We conducted a retrospective analysis of Korean Network of Organ Sharing (KONOS) data involving consecutive HU-LDLT patients between 2017 and 2021.

Results: The proportion of the small graft group (GRWR <0.8%) was 7.6% (n=30). The overall survival and graft survival in the small-graft group were inferior to those in the non-small graft group (P=0.03 and P=0.004, respectively) despite there being no significant differences in intensive care unit (ICU) stay in the post-transplant period, postoperative complications, hospitalization, and in-hospital mortality between the groups. Long ICU stays in the post-transplant period and the small graft group were predisposed to mortality and graft failure in multivariate analysis.

Conclusions: The present study suggested that the use of small-size grafts in HU-LDLT patients requires careful living liver donor selection regarding the interaction between GRWR and preoperative patient severity.

Keywords: Living donors; liver failure; donor selection; survival; mechanical ventilator

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Introduction

Patients with acute liver failure (ALF), acute on chronic liver failure (ACLF), or serious cirrhosis who have exhausted all medical treatment options now require highly urgent liver transplantation (LT) (1,2). In such patients, the degradation of liver function can quickly lead to the failure of several organs and a significant death rate within 28 days (3,4). Individuals with cirrhosis and three or more organ failures with timely LT can have a 1-year survival rate above 80% (5). A prior investigation demonstrated that individuals suffering from multiple organ failure have a very limited timeframe for transplantation, with a median time of death ranging from 6 to 10 days (5). It is critical to initiate LT on time, within the ideal window before the onset of sepsis or multi-organ failure (6). Therefore, early LT is associated with better post-transplant outcomes than delayed LT (7-10). Deceased donor liver transplantation (DDLT) is preferred for highly urgent patients, but it is difficult to get DDLT in Korea because there are few deceased donors. Due to the limited availability of deceased donor organs, highly urgent living donor liver transplantation (HU-LDLT) is becoming increasingly important in Asian countries, where LDLT makes up a significant proportion of total liver transplants (2).

One of the primary considerations in LDLT is the careful choice of donor graft size to guarantee the safety of both the donor and recipient. This phenomenon arises due to the inability of small grafts to fulfill the metabolic requirements of patients or to operate properly upon implantation. Reducing the graft size in LDLT increases the likelihood of early allograft failure of the transplant. Historically, experts have regarded a graft-to-recipient weight ratio (GRWR) of 0.8% as the minimum threshold for safe LDLT (11). Many studies have sought to employ small-for-size grafts (SFSG) with GRWR <0.8% in LDLT to increase the potential donor pool. A recent systematic review and meta-analysis showed that switching from large-for-size grafts (GRWR) to SFSG with a GRWR of less than 0.8% can be considered acceptable as long as the long-term overall survival (OS) and graft survival (GS) stay the same, even though there is a chance of vascular problems and small-for-size syndrome (SFSS) (12).

Several previous LDLT investigations have identified the preoperative status of the recipient as a significant factor influencing post-transplant results (11,13,14). Another study found that the preoperative condition of the recipient was an independent predictor of SFSS, rather than the GRWR and portal flow hemodynamics (13). The precise minimum graft size required to maintain patient survival in HU-LDLT with impaired organ function has not been definitively established. Hence, the HU-LDLT study has not yet developed specific criteria for choosing donors and recipients to avoid SFSS in LDLT.

The objective of this study was to analyze and contrast the results of the small graft volume group (GRWR <0.8%) and the non-small graft volume group (GRWR ≥0.8%) in the national data of HU-LDLT cases in Korea. We present this article in accordance with the STROBE reporting checklist (available at https://hbsn.amegroups.com/article/view/10.21037/hbsn-2024-632/rc).

Highlight box

Key findings

- Living liver donors with small-size graft should be selected carefully in highly urgent living donor liver transplantation (LDLT) patients regarding the interaction between graft-to-recipient weight ratio and preoperative patient severity.

What is known and what is new?

- The overall survival and graft survival in the small-graft volume were inferior to those in the non-small graft volume, despite there being no significant differences in intensive care unit (ICU) stay in the post-transplant period, postoperative complications, hospitalization, and in-hospital mortality between the groups.
- Long ICU stays in the post-transplant period and the small graft group were predisposed to mortality and graft failure in multivariate analysis.

What is the implication, and what should change now?

- The careful choice of donor and recipient is crucial for achieving successful LDLT with small grafts.

Methods

Study design

We performed a retrospective analysis on KONOS data, which included consecutive HU-LDLT patients from 2017 to 2021. We obtained KONOS' patient list, demographic information, and dates of death or life termination and combined them with individual test results from each hospital. This study was conducted in accordance with the Declaration of Helsinki and its subsequent amendments. The Samsung Medical Center Institutional Review Board (SMC-2022-11-057-002) granted ethical approval for this investigation. We omitted the requirement for informed consent due to the retrospective nature of this analysis of

de-identified data.

Administrative LDLT approval process in Korea

To obtain LDLT approval, the transplantation institution is required to provide documentation such as a statement of purpose, consultation report, and identification for both the donor and recipient states. Following receipt and examination of these documents, KONOS typically requires around 14 days to grant or deny approval.

The practical considerations for the immediate implementation of LDLT are complex, and determining the justification solely from test findings or medical records is extremely difficult. Under the existing liver transplant application system in Korea, each patient must submit a note for approval by a government agency. This approval is based on individual audits conducted by at least two independent liver transplant surgeons and/or hepatologists. We assessed and classified the causes of HU-LDLT by examining each applicant's medical records.

Data collection

For each patient, we gathered the following data: gender, age, body mass index (BMI), presence of underlying liver disease [hepatitis B virus (HBV), hepatitis C virus (HCV), and alcohol-related liver disorder], and additional concomitant conditions (hypertension, diabetes mellitus, and chronic kidney disease). We obtained data on Model for End-Stage Liver Disease (MELD) scores, GRWR, postoperative complications, graft failure, and mortality from the KONOS database. We assessed the clinical severity of postoperative problems using the Clavien-Dindo grading system (15).

We evaluated categorical variables that indicate the severity of the patient: the use of a ventilator, continuous renal replacement therapy (CRRT), or admission to the intensive care unit (ICU), and the existence of hepatorenal syndrome (HRS) or the existence of hepatic encephalopathy (HE). Also assessed were the ABO-incompatibility between the blood types of the recipient and donor, as well as the time elapsed between the receipt of the HU-LDLT application by KONOS and the day of transplantation.

Definition

We classified highly urgent patients as those with ALF, acute-on-chronic liver failure (ACLF), and serious cirrhosis, who are anticipated to succumb without a liver transplant within one to two weeks, according to the multidisciplinary team's assessment. This operation requires obtaining accelerated clearance from KONOS. As a result, KONOS grants approval for LDLT instances within 2–3 days of processing, classifying them as highly urgent. The small graft group was characterized by a GRWR of less than 0.8%, whereas the non-small graft group had a GRWR of over 0.8%. People with ALF didn't have any previous liver disease, but they did have liver damage shown by abnormal liver tests, coagulopathy shown by an INR greater than 1.5, and HE (16). The EASL-CLIF collaboration defines ACLF as the sudden worsening of chronic liver disease in patients, characterized by decompensations such as ascites, hepatic hemorrhage, infection, gastrointestinal bleeding, and bacterial infection. It also includes liver dysfunction indicated by serum bilirubin levels of ≥3 mg/dL (4,17). HRS was specifically defined in accordance with the International Club of Ascites (ICA) guidelines (18). HCV was co-defined as having positive levels of both anti-HCV antibodies and HCV RNA expression (19). HBV was characterized as having a positive HBsAg or HBV DNA test result or being HBeAg-positive for a duration exceeding 6 months prior to transplantation (20). Chronic kidney disease was defined as the presence of an estimated glomerular filtration rate (eGFR) below 60 mL/min/1.73 m^2 one year prior to LDLT application in the KONOS study. Alcohol-related liver disease was characterized based on the clinical guidelines of the Korean Association for the Study of the Liver (KASL) (21). HE is a neuropsychiatric disorder resulting from liver malfunction, presenting with a range of neurological and mental disorders (22). The West-Haven criteria determine the severity of HE classification (22). Critical cirrhosis was defined as patients with severe cirrhosis complications such as HRS and HE, who were likely to die within 1 week from cirrhosis complications without a liver transplant. These patients were also selected for HU-LDLT by a multidisciplinary team.

Graft failure is defined as loss of liver function requiring re-transplantation. In our study, graft failure is death-censored graft failure.

Statistical analysis

For continuous data, we display the patient characteristics using the median and range, and for categorical categories, we express the frequency in percentage terms. We assessed and contrasted the OS and GS rates in the small graft group with those in the non-small graft group. The survival study

Table 1 Comparison of highly urgent adult LDLT between small graft (GRWR <0.8%) and non-small graft (GRWR ≥0.8%) groups

Characteristics	Non-small graft group (n=365)	Small graft group (n=30)	P value
Sex (male)	203 (55.6)	18 (60.0)	0.71
Age (years)	51 (20–77)	50 (27–77)	0.70
BMI (kg/m^2)	22.5 (18.1–39.9)	25.7 (18.4–38.1)	0.01
Liver disease progression			0.27
Acute liver failure	136 (37.3)	7 (23.3)	
Acute on chronic liver failure	147 (40.3)	16 (53.3)	
Critically ill cirrhotic	82 (22.5)	7 (23.3)	
Hepatitis B	97 (26.6)	8 (26.7)	0.99
Hepatitis C	9 (2.5)	2 (6.7)	0.15
Alcohol-related liver disease	117 (32.1)	16 (53.3)	0.03
Chronic kidney disease	6 (1.6)	0 (0)	0.48
Hepatic encephalopathy			0.15
None	139 (38.1)	16 (53.3)	
Grade I or II	145 (39.7)	9 (30.0)	
Grade III or IV	81 (22.2)	5 (16.7)	
Hepatorenal syndrome	102 (27.9)	11 (36.7)	0.30
ICU care in pre-transplant	181 (49.6)	12 (40.0)	0.35
ICU stay in pre-transplant (days)	2 (1–61)	1 (1–14)	0.09
Ventilator support in pre-transplant	96 (26.3)	6 (20.0)	0.52
CRRT in pre-transplant	85 (23.3)	6 (20.0)	0.82
Ascites	234 (64.1)	21 (70.0)	0.69
MELD score	28 (10–40)	30 (8–40)	0.18
Wait time (days)	1 (0–28)	2 (0–29)	0.41
GRWR (%)	1.20 (0.89–1.99)	0.77 (0.63–0.80)	<0.001
ABO-incompatibility	38 (10.4)	2 (6.7)	0.76

Data are presented as n (%) or median (interquartile range). BMI, body mass index; CRRT, continuous renal replacement therapy; GRWR, graft-to-recipient weight ratio; ICU, intensive care unit; LDLT, living donor liver transplantation; MELD, Model for End-Stage Liver Disease.

utilized the Cox proportional hazard model to compute the hazard ratio (HR) and 95% confidence interval (CI). We estimated the survival rates using log-rank tests under the Kaplan-Meier approach. Statistical significance was set at two-sided P<0.05. Statistical analyses were performed using SPSS software version 22.0 (IBM, Armonk, NY, USA).

Results

Baseline characteristics

Table 1 summarizes the baseline characteristics. In the HU-LDLT studies conducted in Korea, the small graft group (GRWR <0.8%) accounted for 7.6% (n=30). We observed a statistically significant difference in the median BMI and incidence of alcohol-related liver disease between the small graft group and the non-small graft group (P=0.01 and P=0.03, respectively). Differences in terms of sex, age, liver disease progression, chronic kidney disease, HE, HRS, pre-transplantation ICU care, pre-transplant ventilator care, MELD score, wait time, and ABO-incompatibility were not statistically significant between the two groups. Some patients had low MELD score cases, which LDLT was

Table 2 Comparison of living liver donors between small graft (GRWR <0.8%) and non-small graft (GRWR ≥0.8%) groups in highly urgent adult LDLT patients

Characteristics	Non-small graft group (n=365)	Small graft group (n=30)	P value
Sex (male)	213 (58.4)	15 (50.0)	0.44
Age (years)	33 (18–63)	30 (18–67)	0.68
BMI (kg/m^2)	23.4 (18.7–39.0)	23.2 (19.2–30.1)	0.86
HTN	15 (4.1)	1 (3.3)	0.84
DM	4 (1.1)	1 (3.3)	0.33
Psychological disorder	3 (0.8)	0 (0)	0.62
Donor and recipient relationship			0.056
Offspring	172 (47.1)	14 (46.7)	
Parents	65 (17.8)	2 (6.7)	
Sibling	58 (15.9)	4 (13.3)	
Relatives	27 (7.4)	7 (23.3)	
Spouse	35 (9.6)	3 (10.0)	
Non-family	8 (2.2)	0 (0)	
Donor operation			0.52
Open	268 (73.4)	22 (73.3)	
Laparoscopic	60 (16.4)	7 (23.3)	
Robotic	37 (10.1)	1 (3.3)	
Postoperative complications	26 (7.1)	4 (13.3)	0.27
Clavien-Dindo grade III	11 (3.0)	0 (0)	0.74
Hospitalization (days)	8 (4–98)	9 (5–28)	0.29
Follow-up duration (days)	372 (7–2,024)	347 (7–1,753)	0.51

Data are presented as n (%) or median (interquartile range). BMI, body mass index; DM, diabetes mellitus; GRWR, graft-to-recipient weight ratio; HTN, hypertension; LDLT, living donor liver transplantation.

urgently requested due to recurrent varix bleeding.

Living liver donors (LLDs)

Table 2 presents the distinctive features of LLDs. In the small graft group, the variables of sex, age, BMI, history of hypertension, diabetes, or psychological illnesses, and the donor-recipient connection were similar to those in the non-small graft control group. Furthermore, the two groups did not exhibit any notable disparities in terms of the donation procedure type, postoperative problems, or hospitalization.

Perioperative characteristics and outcomes

We observed no statistically significant differences in the duration of ICU stay, postoperative complications and severity, or hospitalization between the groups. Follow-up duration, acute cellular rejection, antibody-mediated rejection, and mortality rates were similar in the small graft group compared to the non-small graft group (*Table 3*). Within the small graft group, graft failure emerged as the primary cause of mortality. The OS and GS in the small-graft volume were lower compared to the non-small graft volume (P=0.03 and P=0.004, respectively) (*Figure 1*). For the non-small graft volume, the cumulative OS and GS rates at 1-year, 2-year, and 3-year were 87.7%, 84.3%, and 83.4% and 95.9%, 95.4%, and 93.8%, respectively. In the small graft volume, the rates were 78.6%, 78.6%, and 66.3%, as well as 85.1%, 85.1%, and 80.7%.

Table 3 Recipient outcomes after highly urgent adult LDLT between small graft (GRWR <0.8%) and non-small graft (GRWR ≥0.8%) groups

Characteristics	Non-small graft group (n=365)	Small graft group (n=30)	P value
ICU stay in post-transplant (days)	6 (1–224)	6 (2–40)	0.14
Post-operative complications	240 (65.8)	20 (66.7)	0.92
Clavien-Dindo grade			0.76
None	125 (34.2)	10 (33.3)	
I or II	54 (14.8)	3 (10.0)	
III or IV	149 (40.8)	12 (40.0)	
V	37 (10.1)	5 (16.7)	
Post-transplant infectious complications	173 (47.4)	14 (46.7)	0.94
Viral infection	72 (19.7)	7 (23.3)	0.64
Bacterial infection	127 (34.8)	10 (33.3)	0.87
Fungal infection	60 (16.4)	5 (66.7)	0.61
Hospitalization (days)	25 (2–491)	32 (1–168)	0.13
Acute cellular rejection	35 (9.6)	3 (10.0)	0.96
Antibody-mediated rejection	1 (0.3)	0 (0)	0.99
Death	68 (18.6)	10 (33.3)	0.059
Cause of death			0.01
Postoperative complications	16 (4.4)	0 (0)	
Graft failure	5 (1.4)	4 (13.3)	
Infection	22 (6.0)	0 (0)	
Malignancy	5 (1.4)	2 (6.7)	
Others	20 (5.5)	4 (13.3)	
Follow-up duration (months)	28.6 (0.1–69.3)	18.2 (0.1–63.4)	0.71

Data are presented as n (%) or median (interquartile range). GRWR, graft-to-recipient weight ratio; ICU, intensive care unit; LDLT, living donor liver transplantation.

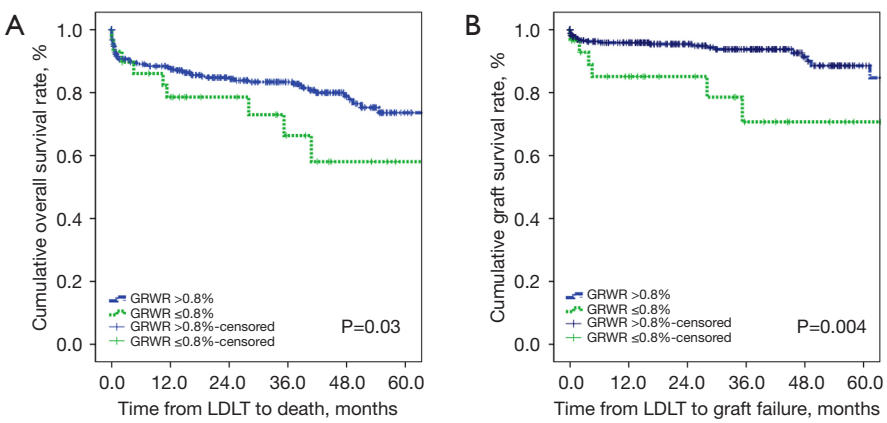

Figure 1 Kaplan-Meier curves comparing (A) overall survival and (B) graft survival between the small graft (GRWR <0.8%) and non-small graft (GRWR ≥0.8%) groups. GRWR, graft-to-recipient weight ratio; LDLT, living donor liver transplantation.

Risk factors for mortality and graft failure

The univariate analysis showed a strong link between adult HU-LDLT patients' deaths and having chronic kidney disease, using a ventilator before the transplant, having HRS, staying in the ICU for a long time after the transplant, having a small graft (GRWR <0.8%), and being an old LLD (≥55 years). Prolonged stays in the ICU after transplantation, small graft group (GRWR <0.8%), and advanced age of the LLD (≥55 years) increased the risk of death after adult HU-LDLT.

In univariate modeling, the variables pre-transplant CRRT, HRS, prolonged ICU stay after transplant, and small graft group (GRWR <0.8%) are strongly linked to graft failure. A study using multivariate analysis found that having a long stay in the ICU after transplantation and having a graft that is too small (GRWR <0.8%) both raise the risk of graft failure in HU-LDLT (*Table 4*).

Discussion

OS and GS were both lower in HU-LDLT patients who either didn't get enough graft volume (GRWR <0.8%) or who stayed longer in the ICU after the transplant. There was no difference in the recipient's Clavien-Dindo grade between the two groups. During the follow-up period, the small graft group had a higher rate of graft failure or and other unspecified causes of mortality; however, these other causes could not be precisely identified due to data limitations.

Our study included ALF, ACLF, or critical cirrhotic patients who needed urgent or immediate LDLT to preserve their lives. Patients with poorer preoperative conditions, such as rapid decline of liver function, HE, HRS, ICU care, CRRT, or ventilator care in the pre-transplant period, should avoid using a small graft volume (GRWR <0.8%) when choosing LLDs. The existing LDLT application method in Korea mandates a medical certificate for HU-LDLT, originally intended for the treatment of ALF, ACLF, and severely ill cirrhotic patients. Given the severe shortage of deceased liver donors, LDLT is a viable option for treating patients with ACLF, ALF, and critically sick cirrhosis. In an emergency scenario, the HU-LDLT procedure is the most effective treatment within the therapeutic range for advanced extrahepatic organ failure resulting from liver failure (23). The practical decision-making process about the necessity of HU-LDLT is highly intricate due to the medical condition of patients, the accessibility of available LLDs, and the correlation between prospective LLDs and patients.

The implanted liver graft's dimensions may not be compatible with the recipient's physical or metabolic needs, which is an inherent limitation of LDLT (24). The task of determining an appropriate graft size that accommodates the recipient's anticipated liver volume in order to fulfill metabolic requirements and future liver regeneration demands has attracted significant interest among liver transplant physicians and surgeons. Published literature has documented extensive research on this subject (8,11,12,25,26). The GRWR is a continuous variable that does not have a specific or absolute threshold below which results rapidly deteriorate. A GRWR of 0.8% is now considered the global standard lower limit; however, several teams with high-volume LDLT cases have documented safe use of grafts with GRWR values below 0.8%. Recent comprehensive analysis suggests that we can consider increasing the number of potential LLDs in LDLT to SFSG with a GRWR of less than 0.8% to achieve similar short- and long-term results, as long as we carefully avoid vascular problems and SFSS (12).

Other studies found that the MELD score, inpatient status, prior organ failure, and preoperative renal impairment were significant predictors of postoperative SFSS (11,26). Studies have shown the preoperative MELD score as a risk factor for SFSS, although not all studies have confirmed this correlation (24,27). The MELD threshold of 19 appears to indicate a recipient with high acuity and a greater risk for SFSS (26). In our study, the non-small graft group experienced a 28-point increase in the median MELD score, while the small graft group experienced a 30-point increase. Thus, our analysis revealed patients with high acuity as indicated by their MELD score. Furthermore, our patients exhibited a poor condition, as around 40–50% of them displayed the presence of HE and required pre-transplant treatment in the ICU. Hence, the level of pre-transplant ventilator assistance in each group ranged from 20% to 26%. We recognize sepsis and systemic inflammatory response syndrome as risk factors for SFSS in ALF, ACLF, or critical cirrhosis (11). Insufficient evidence suggests that neither ALF nor ACLF is a risk factor for SFSS when the graft volume is sufficient (28). SFSG may heighten the risk of SFSS due to its increased metabolic demand, particularly when sepsis and systemic inflammatory response syndrome are present (17).

Preoperative renal impairment can have a variety of effects on outcomes. These individuals exhibit elevated

Table 4 Risk factors for mortality and graft failure in adult highly urgent LDLT

Variables	Patient mortality (n=395, events =78)				Graft failure (n=395, events =32)			
	Univariate		Multivariate		Univariate		Multivariate	
	HR (95% CI)	P value	HR (95% CI)	P value	HR (95% CI)	P value	HR (95% CI)	P value
Male sex	1.076 (0.697–1.661)	0.74			1.068 (0.530–2.152)	0.85		
Age	1.01 (0.997–1.023)	0.12			0.994 (0.977–1.012)	0.99		
BMI	1.026 (0.981–1.073)	0.26			1.006 (0.932–1.087)	0.87		
HBV	1.216 (0.763–1.935)	0.41			0.802 (0.359–1.793)	0.80		
Alcohol-related liver disease	0.864 (0.539–1.383)	0.54			1.009 (0.474–2.151)	0.98		
Chronic kidney disease	6.205 (2.249–17.124)	<0.001			0.049 (0.010–30.685)	0.74		
Ascites	0.882 (0.568–1.371)	0.58			0.818 (0.405–1.650)	0.58		
Reason for emergent LDLT								
Acute liver failure	1	0.92			1	0.43		
Acute-on-chronic liver failure	0.945 (0.590–1.515)	0.82			0.657 (0.307–1.405)	0.28		
Critical ill cirrhotic	0.876 (0.460–1.666)	0.69			0.565 (0.188–1.698)	0.31		
Pre-transplant ICU care	1.235 (0.802–1.902)	0.34			1.093 (0.546–2.189)	0.80		
Pre-transplant ventilator care	1.756 (1.113–2.771)	0.02			1.186 (0.531–2.647)	0.68		
CRRT in pre-transplant	1.651 (1.036–2.631)	0.04			2.351 (1.119–4.941)	0.02		
Hepatorenal syndrome	1.666 (1.066–2.604)	0.03			2.274 (1.091–4.739)	0.03		
MELD score	1.008 (0.981–1.036)	0.58			1.015 (0.968–1.064)	0.53		
ABO-incompatibility	0.946 (0.473–1.892)	0.87			1.638 (0.669–4.010)	0.28		
ICU stay post-transplant	1.010 (1.004–1.015)	<0.001	1.008 (1.001–1.015)	0.03	1.015 (1.008–1.022)	<0.001	1.016 (1.008–1.023)	<0.001
GRWR <0.8 %	2.025 (1.037–3.955)	0.04	1.930 (1.120–4.300)	0.02	3.514 (1.422–8.686)	0.006	5.411 (2.041–14.347)	0.001
Donor age ≥55 years	2.342 (1.075–5.102)	0.03	2.582 (1.019–6.539)	0.045	0.047 (0.015–36.007)	0.50		

Δ (change rate) = (day of application – 3 days before application)/3 days before application × 100%. BMI, body mass index; CI, confidence interval; CRRT, continuous renal replacement therapy; GRWR, graft-versus-weight ratio; HBV, hepatitis B virus; HR, hazard ratio; ICU, intensive care unit; LDLT, living donor liver transplantation; MELD, Model for End-Stage Liver Disease.

metabolic demands and may encounter difficulties with a smaller graft. The incidence of HRS and pre-transplant CRRT varied in each group from 27.9% to 36.7% and from 20% to 23.3%, respectively. A literature study conducted recently revealed a strong association between the patient group with GRWR <0.8% and postoperative renal impairment [30]. Researchers recognized preoperative renal impairment and the need for renal replacement therapy as additional risk factors for postoperative acute kidney injury (AKI) in patients with SFSS (29). Preoperative renal impairment and the requirement for renal replacement therapy were recognized as further risk factors for postoperative AKI in patients with SFSS (29). If a candidate for LDLT experiences HRS, they should receive intensive treatment, especially for patients who are at risk of SFSS. Furthermore, our investigation revealed that the incidence of ascites in each group ranged from 60% to 70%. Elevated ascites output parallels renal dysfunction, and when combined with the elevated ascites production associated with small grafts, it can complicate fluid control, escalate treatment requirements, and lengthen hospital stays, thereby increasing complication rates. A multivariate analysis revealed that a longer duration in the ICU was indicative of lower OS.

Given the rapid deterioration of the patient's medical condition, HU-LDLT can proceed without sufficient evaluations of both the recipient and the donor. Concerns about LLDs typically center on issues around the acquisition of informed consent in a time-sensitive and emotionally intense scenario, as well as the safety of the LLDs. The age of the LLDs is a well-established predictor for recipient morbidity and mortality in adult-to-adult LDLT (26). It is more likely for grafts from donors older than 45 years old to have SFSS and a shorter survival rate. This is especially true if the graft is steatotic, the GRWR is low, the recipient is very sick, the intraoperative portal venous pressure (PVP) is higher than 19 mmHg, and the donors' ABO type is not compatible (8,27,30). Recent Korean multicenter research demonstrated that sexagenarian liver transplants were both viable and safe (31). A previous Japanese study reported that a GRWR <0.7 with an aged graft (donor ≥50 years old) had a worse outcome after LDLT than those with a young graft (32). A multicenter study in Korea found that grafts with a GRWR less than 0.8% had lower GS compared to controls (85.2% *vs.* 90.1%), especially when at least two risk factors for graft loss were present (e.g., being 60 years or older, having a MELD score of 15 or more, or being a male donor) (33). However, our study also demonstrated that more than 55 years of LLD was an important factor for death in HU-LDLT patients, but old LLDs were not associated with graft failure.

The present investigation is subject to many constraints. First, we conducted a retrospective analysis of the HU-LDLT cases using KONOS data, which resulted in the introduction of selection bias. We also didn't have specific information about the portal vein modulation technique, biliary problems, bleeding after surgery, hepatic vein or inferior vena cava thrombosis, early allograft malfunction, or small-for-size syndrome. In addition, we have data regarding the transplant type, blood loss, blood transfusion quantities, the exact cause of death, and immunosuppressants. Second, the inadequate format made it challenging to precisely determine the cause of HU-LDLT. Since it is a rough dataset of the entire country of Korea, it is disappointing that it is difficult to obtain detailed information like in a single-center study.

Conclusions

In conclusion, our study suggests that the use of small-size grafts in HU-LDLT patients requires careful LLD selection using Korean national data. Patients with elevated MELD scores or prior organ dysfunction have increased metabolic demands, and the metabolic capability of a small graft may not be enough for these patients until the graft undergoes regeneration. Furthermore, our study supports the use of substantial grafts in patients with HU-LDLT. The current investigation should take into account the connections between GRWR and the severity of preoperative conditions in patients. Thus, the careful choice of donor and recipient is crucial for achieving successful LDLT with small grafts.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://hbsn.amegroups.com/article/view/10.21037/hbsn-2024-632/rc

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://hbsn.amegroups.com/article/view/10.21037/hbsn-2024-632/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. This study was approved by the Samsung Medical Center Ethics Committee (SMC-2022-11-057-002) and complied with the Declaration of Helsinki and its subsequent amendments. The Institutional Review Board waived the need for patient consent because this observational study was retrospective, and all data came from patient medical records.

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