Original Article

J Korean Soc Transplant 2014;28:226-235
http://dx.doi.org/10.4285/jkstn.2014.28.4.226

JKST

Pre-transplant Predictors for 3-Month Mortality after Living Donor Liver Transplantation

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Background: High model for end-stage liver disease (MELD) scores (≥35) is closely associated with poor posttransplantation outcomes in patients who undergo living donor liver transplantation (LDLT). There is little information regarding factors that negatively impact the survival of patients with high MELD scores. The aim of this study was to identify factors associated with 3-month mortality of patients after LDLT.

Methods: We retrospectively analyzed 774 patients who underwent adult LDLT with right lobe grafts between 1996 and 2012. Exclusion criteria were re-transplantation, left graft, auxiliary partial orthotopic liver transplantation, and inadequate medical recording. Preoperative variables were analyzed retrospectively.

Results: The overall 3-month survival rate was 92%. In univariate analysis, acute progression of disease, severity of hepatic encephalopathy, Child-Pugh class C, hepatorenal syndrome, use of continuous renal replacement therapy, use of ventilator, intensive care unit (ICU) care before transplantation, and MELD scores ≥35 were identified as potential risk factors. However, only ICU care before transplantation and MELD scores ≥35 were independent risk factors for 3-month mortality after LDLT. Three-month and 1-year patient survival rates for those with no risk factors were 95.5% and 88.6%, respectively. In contrast, patients with at least one risk factor had 3-month and 1-year patient survival rates of 88.4% and 81.1%, respectively, while patients with two risk factors had 3-month and 1-year patient survival rates of 55.6% and 55.6%, respectively.

Conclusions: Patients with both risk factors (ICU care before LDLT and MELD scores ≥35) should be cautiously considered for treatment with LDLT.

Key Words: Living donor liver transplantation, End stage liver disease, Model for end stage liver disease, Pretransplant, Mortality

중심 단어: 생체 부분 간이식, 말기 간질환, MELD 점수, 이식전, 사망률

INTRODUCTION

Liver transplantation is the best treatment option for patients with end-stage liver diseases and early hepatocellular carcinoma. In Eastern countries, in which deceased donors are scarce, living donor liver transplantation (LDLT) has been considered as an active alternative option for deceased donor liver transplantation (DDLT). In 2013, 2,286 liver transplantations were performed in Korea and 69% of the procedures were LDLTs, while at the end of the year 6,334

Received October 24, 2014
Revised December 8, 2014
Accepted December 16, 2014

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patient were waiting for liver transplants(1).

Living donor hepatectomy is a highly invasive procedure, and the main cause of short term mortality is early graft loss(2). However, the patient survival rate after LDLT has become comparable to the patient survival rate after DDLT because of improvements in surgical techniques such as revascularization, biliary tract reconstruction, and improved postoperative management(3,4).

The model for end-stage liver disease (MELD) score was initially described to predict patient survival rates and complications after transjugular intrahepatic portosystemic shunt procedures(5). The MELD score was adopted by the United Network for Organ Sharing as the standard priority rule for determining who should receive liver transplants(6).

However, there is no simple means of predicting patient survival in LDLT, although such prediction is a critical step to achieving the most favorable patient outcomes. A high MELD score should not be considered an absolute contraindication for LDLT, although it is associated with higher postoperative mortality, higher postoperative complication rates, prolonged intensive care unit (ICU) stays, larger intraoperative blood transfusions, longer hospital stays, and increases in transplant costs(7). Some studies have reported that high MELD scores in LDLT patients are not associated with graft failure or survival rate(8,9). The meaning of MELD scores in LDLT must be reevaluated.

The aim of this study was to determine factors related to 3-month mortality after LDLT using right lobe grafts, and to identify criteria that might be useful for predicting outcomes of LDLT.

MATERIALS AND METHODS

1. Patients

From June 1996 to May 2012, we reviewed the records of 823 patients who underwent primary adult LDLT at Samsung Medical Center, Korea. Patients with ABO incompatible LDLT (n=22), and using a left lobe grafts in older than or equal to 18 years age (n=15), and auxiliary partial orthotopic liver transplantation (n=2) were excluded. Therefore, 774 patients were included in this study.

We analyzed data for the recipients, grafts, donors, and intraoperative variables including gender, age, underlying diseases (hypertension, diabetes mellitus), presence of hepatoencephalopathy, hepatorenal syndrome), history of preoperative ICU management, graft-to-recipient weight ratio (GRWR), and MELD score. The indication of ICU management in end-stage liver disease was following: (1) abnormal pulse rate (<40 or >150/minutes), (2) mean arterial pressure <70 mmHg, (3) septic shock, (4) serum bilirubin >6 mg/dL, (5) severe hepatic encephalopathy, (6) required dialysis in hepatic renal syndrome, (7) respiratory rate > 30/minutes, or (8) severe metabolic acidosis (pH <7.2). The primary endpoint of the present study was to identify factors associated with 3-month mortality of patients after LDLT.

2. The evaluation and selection of living liver donors

Liver donation should be absolutely voluntary. All potential donors underwent a battery of medical evaluations including an initial health screening survey, laboratory examinations including complete blood count, liver and renal biochemistry, coagulation profile, and serologic assays for blood transmittable viruses, electrocardiography, chest radiography, and pulmonary function test. Psychiatric assessments were performed routinely. Doppler ultrasonography was used to evaluate liver quality. Triple-phase abdominal computed tomography (CT) scans were also obtained to calculate liver volume and assess vascular anatomy. The primary selection criteria for a living liver donor were ABO blood group compatibility and adequate size of graft liver and future remnant liver as measured by CT scan. Estimated graft volume (GV) greater than 40% of the recipient's standard liver volume was considered acceptable. Our LDLT program limits donor hepatectomy within 70% of the whole donor liver volume. Absolute exclusion criteria were any underlying medical condition that increases perioperative risk and inoperable hepatic vascular variation. When eligibility was confirmed, magnetic resonance cholangiopancreatography was acquired to verify biliary anatomy(10).

3. Surgical procedures for living donor liver transplantation

Intraoperative ultrasonography for evaluating hepatic venous anatomy was performed to determine adequate resection plane before donor hepatic resection. Parenchymal resection was carried out with a Cavitron ultrasonic surgical

aspirator (Valleylab, Boulder, CO, USA) and by bipolar electrocautery (Codman, Raynham, MA, USA) with the hanging maneuver. After donor hepatectomy, grafts were flushed with 4 L of iced University of Wisconsin solution or histidine tryptophan ketoglutarate solution. Actual graft weights were measured after flushing. Middle hepatic vein (MHV) reconstruction was performed with a cryopreserved iliac artery or iliac vein on the back table when the size of the MHV branch was >5 mm or when a lot of blood gushed out during flushing with perfusion solution. After bench procedure, grafts were transplanted in a piggyback fashion. The orifice of the recipient right hepatic vein was enlarged with a downward incision, and anterior and posterior wall excisions were made to form an oval orifice to obtain sufficient outflow. After right hepatic vein anastomosis, any significant right inferior hepatic vein was anastomosed to the inferior vena cava in an end-to-side fashion. Portal vein anastomosis was performed with 6-0 Prolene (Ethicon, Bridgewater, NJ, USA) continuous sutures with growth factor. After portal vein anastomosis, arterial reconstruction was performed with 8-0 Ethilon (Ethicon) interrupted sutures under a surgical microscope. Bile duct reconstruction was performed by either duct-to-duct anastomosis or Roux-en-Y hepaticojejunostomy(11).

4. Immunosuppression protocol

Tacrolimus, steroids, and mycophenolate mofetil (MMF) were the primary agents used for immunosuppression after liver transplantation. All transplant recipients were given 500 mg of intravenous methylprednisolone during the anhepatic phase until postoperative day 2, tapered to 60 mg per day for a period of 5 days, and received 8 mg, twice per day, for 1 month starting on postoperative day 8. Tacrolimus treatment was started on postoperative day 3, and the optimal blood level was adjusted to maintain a trough plasma concentration of 10～15 ng/mL during the first month and reduced to 5～10 ng/mL thereafter. Starting on postoperative day 1, 750 mg MMF was administered twice a day. MMF was used in combination with tacrolimus and steroids. Cyclosporin (plasma concentration adjusted to 100～200 ng/mL) was used in the event of tacrolimus toxicity or tacrolimus refractory rejection, and was given orally twice a day. Liver biopsies were performed if acute rejection was clinically suspected. Methylprednisolone (500 mg) was administered intravenously every day for 3 days if acute rejection was confirmed by biopsy and tapered to 60 mg per day over a period of 4 days thereafter(12).

5. Hepatitis B virus prophylaxis

All patients with hepatitis B virus (HBV) infection or recipients without hepatitis B surface antigen who received liver allografts with hepatitis B core antibody were given 10,000 units of hepatitis B immunoglobulin (HBIG, Green Cross Corp., Yongin, Korea) intravenously during the anhepatic phase, followed by a 7-day intravenous course of 10,000 units HBIG per day. Patients received 10,000 units intravenously every month to maintain anti-hepatitis B surface antibody titers at ≥200 IU/mL. Before 2008, patients who were reinfected with HBV received only lamivudine (100 mg/day) for treatment. After January 2008, patients received a combination of entecavir (0.5 mg/day) and HBIG for HBV prophylaxis(12).

6. Statistical analysis

Categorical variables were assessed using the chi-square test or Fisher exact test. Continuous variables were expressed as the median and range and were compared using Mann-Whitney U test. The cutoff values of the continuous variables were evaluated using the receiver operating characteristic (ROC) curve. Factors with $P<0.1$ in the uni-

Table 1. Causes of 3-month mortality after living donor liver transplantation

Variable	Number
Sepsis	19
Primary nonfunction	18
Brain death	5
Hepatic artery complications	5
Acute respiratory distress syndrome	4
Heart failure	3
Bleeding	2
Brain infarction	1
Subarachnoid hemorrhage	1
Pulmonary thromboembolism	1
Portal vein thrombosis	1
Hemothorax	1
Graft-versus-host disease	1
Hepatitis C virus recur	1

Table 2. Comparison of patients with and without 3-month mortality after living donor liver transplantation

Variable	3-month mortality		*P*-value
	No (n=711)	Yes (n=63)	
Gender (male)	561 (79.0)	48 (76.2)	0.630
Recipient age	52 (18～73)	48 (19～69)	0.009
Diagnosis			0.000
Alcoholic	35 (4.9)	3 (4.8)	
HCC	358 (50)	25 (40)	
HBV	238 (33.5)	16 (25.4)	
HCV	13 (1.8)	4 (6.3)	
NBNC	8 (1.1)	0	
Autoimmune	10 (1.4)	0	
HAV	5 (0.7)	2 (3.2)	
HBV+HCV	5 (0.7)	1 (1.6)	
Others	39 (5.5)	12 (19.0)	
Progress			0.003
Acute	33 (4.6)	10 (15.9)	
Acute on chronic	34 (4.8)	7 (11.1)	
Cirrhosis	644 (90.6)	46 (73.0)	
Hypertension	63 (8.9)	10 (15.9)	0.074
Diabetes	136 (19.1)	14 (22.2)	0.511
Child-Pugh class			0.010
A	86 (12.1)	5 (7.9)	
B	249 (35.0)	14 (22.2)	
C	376 (52.9)	44 (69.8)	
MELD ≥35	73 (10.3)	21 (33.3)	0.000
Coexistence of HCC	359 (50.5)	25 (39.7)	0.115
Hepatic encephalopathy			0.008
None	503 (70.8)	34 (54.0)	
Grade 1～2	173 (24.4)	19 (30.2)	
Grade 3～4	34 (4.8)	10 (15.9)	
Varix bleeding	180 (25.3)	12 (19.0)	0.361
Ascites			0.124
None	210 (29.5)	24 (38.1)	
Diuretics controlled	293 (41.2)	25 (39.7)	
Diuretics uncontrolled	208 (29.3)	14 (22.2)	
Hepatorenal syndrome	29 (4.1)	12 (19.0)	0.000
Pretransplant dialysis	10 (1.4)	6 (9.5)	0.001
Pretransplant ventilator care	13 (1.8)	5 (7.9)	0.011
Spontaneous bacterial peritonitis	123 (17.3)	11 (17.5)	0.974
Pretransplant ICU stay	49 (6.9)	24 (38.1)	0.000
GRWR <0.8	60 (8.5)	10 (16.1)	0.061

Data are presented as number (%) or median (range).
Abbreviations: HCC, hepatocellular carcinoma; HBV, hepatitis B virus; HCV, hepatitis C virus; NBNC, non B non C; HAV, hepatitis A virus; MELD, model for end-stage liver disease; ICU, intensive care unit; GRWR, graft-to-recipient weight ratio.

variate analysis were included in the multivariate analyses. Multivariate analyses used binary logistic regression tests. Post-transplant survival was estimated using the Kaplan-Meier method with log-rank test. A value of $P \leq 0.05$ was determined to be statistically significant. Statistical evaluation was carried out using the statistical package SPSS ver. 21.0 (IBM Co., Armonk, NY, USA).

RESULTS

1. Baseline characteristics

All recipients received right lobe grafts from living donors. The 774 patients included 609 males and 165 females. The median recipient and donor ages were 51 years (range, 18～73) and 30 years (range, 18～64). The median MELD score was 17 (range, 6～54). Six hundred eighty recipients (88%) had MELD scores lower than 35 at the time of transplantation, while 94 patients (12%) had MELD scores above than or equal to 35. Hepatitis B, hepatitis C, alcohol, and hepatocellular carcinoma were the most common causes of LDLT. Seventy-three patients (9.4%) were managed in the ICU prior to liver transplantation and the patients required dialysis (n=16, 2.1%) or mechanical ventilation (n=18, 2.3%). The median follow-up period in our study was 46 months (range, 1～159).

Table 3. Risk factors for hospital mortality after living donor liver transplantation by multivariate analysis

Variable	Odds ratio	95% confidence interval	*P*-value
Pretransplant ICU stay	8.487	4.674～15.408	0.000
MELD ≥35	2.090	1.049～4.164	0.036

Abbreviations: ICU, intensive care unit; MELD, model for end-stage liver disease.

2. Pretransplant risk factors for 3-month mortality

Among the 774 patients, 63 patients (8.1%) died by 3 months after transplantation. Sepsis (n=19) and primary nonfunction (n=18) were main causes for 3-month mortality. Most common causes of sepsis were biliary problem and fungal pneumonia. The causes included brain death (n=5) and hepatic artery complications (n=5) (Table 1).

Univariate analysis showed that age, diagnosis, disease progression, presence of hepatic encephalopathy, Child-Pugh class C, presence of hepatorenal syndrome, history of pretransplant ventilator care or dialysis, pretransplant ICU stay, and high MELD score were associated with 3-month mortality (Table 2).

Among significant risk factors, according to multivariate analysis, pretransplant ICU stay and high MELD score (≥ 35) were predisposing factors for 3-month mortality after LDLT (Table 3). The influences of pretransplant ICU stay and high MELD score are shown in Fig. 1.

We identified risk factors for 3-month mortality in pretransplant ICU and general ward patients. Patients who received ICU management before transplantation, had higher 3-month mortality than patients who did not (*P*=0.021 and *P*=0.038, respectively). Multivariate analysis showed that high MELD score (odds ratio [OR], 3.368; 95% confidence interval [CI], 1.164～9.744; *P*=0.025) was closely associated with 3-month mortality in patients in the pretransplant ICU after LDLT (Tables 4, 5).

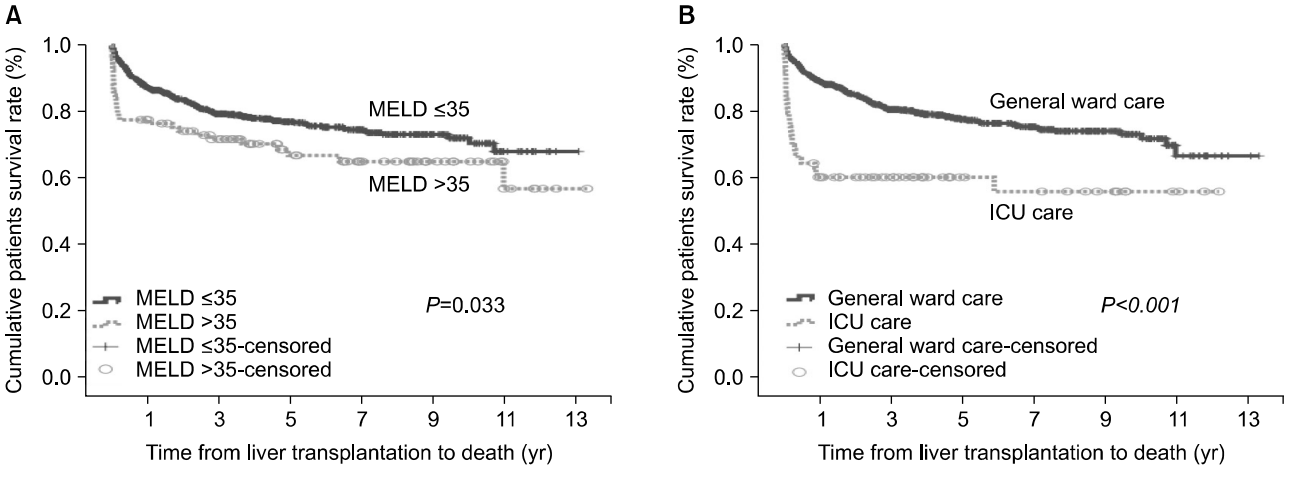

Fig. 1. (A) End-stage liver disease (MELD) scores and (B) patients with pretransplant intensive care unit (ICU) care on patient survival.

Table 4. Risk factor for 3-month mortality after living donor liver transplantation in patients requiring pretransplant intensive care

Variable	3-month mortality		*P*-value
	No (n=49)	Yes (n=24)	
Gender (male)	27 (55.1)	20 (83.3)	0.021
Recipient age	48 (19～67)	45 (18～69)	0.087
Diagnosis			0.615
Alcoholic	5 (10.2)	2 (8.3)	
HCC	6 (12.2)	4 (16.6)	
HBV	19 (38.8)	10 (41.7)	
HCV	0	1 (4.2)	
Autoimmune	2 (4.1)	0	
HAV	4 (8.2)	2 (8.3)	
Others	13 (26.5)	5 (20.8)	
Progress			0.432
Acute	18 (36.7)	7 (29.2)	
Acute on chronic	13 (26.5)	6 (25.0)	
Cirrhosis	18 (36.7)	11 (45.8)	
Hypertension	4 (8.2)	2 (8.3)	0.980
Diabetes	7 (14.3)	2 (8.3)	0.708
Child-Pugh class			0.152
A	1 (2.0)	0	
B	1 (2.0)	0	
C	47 (95.9)	24 (100)	
MELD ≥35	20 (40.8)	16 (66.7)	0.038
Coexistence of HCC	6 (12.2)	4 (16.7)	0.720
Hepatic encephalopathy			0.862
None	11 (22.4)	7 (29.2)	
Grade 1～2	22 (44.9)	7 (29.2)	
Grade 3～4	16 (32.7)	10 (41.7)	
Varix bleeding	12 (24.5)	5 (20.8)	0.728
Ascites			0.164
None	20 (40.8)	11 (45.8)	
Diuretic controlled	11 (22.4)	10 (41.7)	
Diuretics uncontrolled	18 (36.7)	3 (12.5)	
Hepatorenal syndrome	15 (30.6)	9 (37.5)	0.602
Pretransplant dialysis	9 (18.4)	6 (25.0)	0.547
Pretransplant ventilator care	9 (18.4)	5 (20.8)	0.802
Spontaneous bacterial peritonitis	9 (18.4)	2 (8.3)	0.320
Pretransplant ICU stay (day)	2 (1～15)	3 (1～16)	0.052
GRWR <0.8	3 (6.4)	5 (21.7)	0.104

Data are presented as number (%) or median (range).
Abbreviations: HCC, hepatocellular carcinoma; HBV, hepatitis B virus; HCV, hepatitis C virus; HAV, hepatitis A virus; MELD, model for end-stage liver disease; ICU, intensive care unit; GRWR, graft-to-recipient weight ratio.

In patients in general ward, the presence of hypertension in patients who died before 3 months after transplantation was higher than survived patients. However, multivariate analysis showed that cirrhosis in disease progression (OR, 0.165; 95% CI, 0.040～0.681; *P*=0.013) was an independent factor predicting 3-month mortality after LDLT.

3. Outcomes for patients with pretransplant ICU care and high MELD score

Ninety-five patients (12.3%) had at least one risk factor of those two risk factors analyzed in multivariate analysis. and 36 patients (4.7%) had two risk factors, pretransplant ICU stay and high MELD score (≥35) both. Most patients (n=643, 83.1%) did not have any risk factors. Those with

Table 5. Risk factors for 3-month mortality after living donor liver transplantation in patients treated in the general ward pretransplant

Variable	3-month mortality		*P*-value
	No (n=662)	Yes (n=39)	
Gender (male)	534 (80.8)	28 (71.8)	0.211
Recipient age	52 (18～73)	50 (31～68)	0.420
Diagnosis			0.000
Alcoholic	30 (4.5)	1 (2.6)	
HCC	352 (53.2)	21 (53.8)	
HBV	219 (33.1)	6 (15.4)	
HCV	13 (2.0)	3 (7.7)	
NBNC	8 (1.2)	0	
Autoimmune	8 (1.2)	0	
HAV	1 (0.2)	0	
HBV+HCV	5 (0.8)	1 (2.6)	
Others	26 (3.9)	7 (12.9)	
Progress			0.324
Acute	15 (2.3)	3 (7.7)	
Acute on chronic	21 (3.2)	1 (2.6)	
Cirrhosis	626 (94.6)	35 (89.7)	
Hypertension	59 (8.9)	8 (20.5)	0.025
Diabetes	129 (19.5)	12 (30.8)	0.088
Child-Pugh class			0.872
A	85 (12.8)	5 (12.8)	
B	248 (37.5)	14 (35.9)	
C	329 (49.7)	20 (51.3)	
MELD≥35	53 (8.0)	5 (12.8)	0.361
Coexistence of HCC	353 (53.3)	21 (53.8)	0.949
Hepatic encephalopathy			0.557
None	492 (74.4)	27 (69.2)	
Grade 1～2	151 (22.8)	12 (30.8)	
Grade 2～3	18 (2.7)	0	
Varix bleeding	168 (25.4)	7 (17.9)	0.346
Ascites			0.690
None	190 (28.7)	13 (33.3)	
Diuretic controlled	282 (42.6)	15 (38.5)	
Diuretics uncontrolled	190 (28.7)	11 (28.2)	
Hepatorenal syndrome	14 (2.1)	3 (7.7)	0.063
Spontaneous bacterial peritonitis	114 (17.2)	9 (23.1)	0.384
GRWR <0.8	57 (8.6)	5 (12.8)	0.379

Data are presented as number (%) or median (range).
Abbreviations: HCC, hepatocellular carcinoma; HBV, hepatitis B virus; HCV, hepatitis C virus; NBNC, non B non C; HAV, hepatitis A virus; MELD, model for end-stage liver disease; GRWR, graft-to-recipient weight ratio.

no risk factors had 95.5% 3-month patient survival rate respectively. In contrast, patients with at least one risk factor had 88.4% 3-month patient survival rates respectively, while patients with two risk factors had 55.6% 3-month patient survival respectively (Fig. 2). These differences in patient survival rates were statistically significant ($P<0.001$).

DISCUSSION

In the present study, we aimed to determine characteristics of transplant recipients that might be useful for predicting 3-month mortality after LDLT and that would impact the selection of patients for LDLT. Our results suggest that MELD scores can predict postoperative survival in pa-

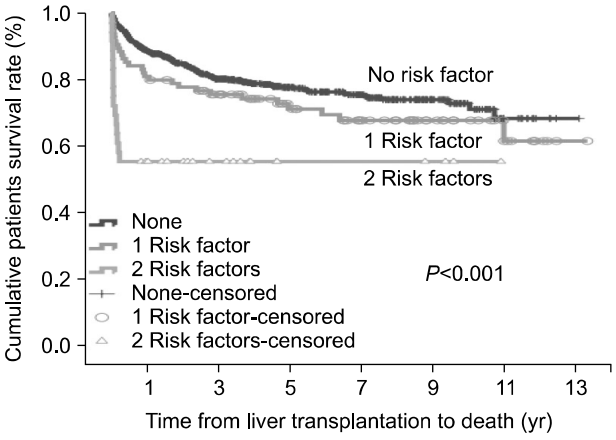

Fig. 2. Patient survival with two risk factors which were high End-stage liver disease score (≥35) and pretransplant intensive care unit care when compared with those who had at least one risk factor or no risk factor.

tients with pretransplant ICU stays. Patients with two risk factors, such as ICU care before LDLT and MELD scores ≥35, had extremely poor 3-month survival. However, MELD scores were not associated with poor outcomes in patients who were in the general ward before LDLT.

Using preoperative MELD scores to predict posttransplant outcomes after LDLT is controversial. Some studies have suggested that high MELD scores are associated with poor outcomes, whereas others reported that MELD scores had no prognostic value(8,13). While it is unclear if MELD scores are useful for predicting liver transplantation outcomes, the MELD score relies on objective laboratory data that reflects severity of illness in patients with liver disease. It is generally accepted that live liver donation should be prohibited in recipients with MELD scores over 25(8,14). However, some studies have raised questions about the impact of MELD scores on short-term outcomes after right lobe LDLT(8,13,15).

One study reported that high MELD scores (≥25) were associated with prolonged postoperative ICU stays and increased hospital costs but not with postoperative mortality(13). Another showed that recipients of liver donor liver grafts with high MELD scores (≥25) had excellent outcomes. They had increased rates of postoperative pulmonary infections, but similar rates of graft function, postoperative graft injury, overall postoperative complications, length of hospital stay, short-term and long-term graft survival, and patient survival(8).

Most of these studies divide the patient population into two groups according to MELD score (< or >25), and suggest that MELD scores lack predictive power for short-term outcomes after LDLT(8,13). We also found that MELD scores ≥25 had no impact on 3-month mortality in patients who underwent right lobe LDLT. In the present study, the cutoff point on ROC curve was move to 35 from 25.

We found that MELD scores ≥35 were useful for predicting the 3-month mortality following LDLT. However, high MELD scores above than or equal to 35 alone should not be an absolute contraindication of LDLT. Another previous study reported that patients with high MELD scores had significantly more early postoperative complications, but comparable hospital mortality, graft survival, and overall survival compared to patients with low MELD scores(16). A recent study reported that high MELD scores and advanced donor age were associated with graft survival. In addition, these variables had the highest sensitivity for predicting in-hospital mortality(17). However, our results did not support an association between 3-month mortality and donor age.

High MELD score patients may not be suitable candidates for LDLT because of the need for greater liver mass and low tolerance to postoperative complications(18). DDLT may be indicated for recipients in very poor condition, eliminating concerns about risk to the donor. LDLT for sicker patients is controversial due to ethical issues, and DDLT with whole liver graft transplantation is recommended as the best option for sicker patients compared with split or LDLT(19). Nevertheless, LDLT should be considered for patients with high MELD scores or those requiring intensive care to survival in situations when the use of liver grafts from deceased donor is limited. The decision to undertake LDLT can be difficult when available living-donor grafts are marginal and the recipient is judged to be at high risk of complications. LDLT should be performed only if the risk to the donor is justified by the expectation of an acceptable outcome for the recipient(17,20). The balance of ethical issues needs to be considered in LDLT.

Preoperative renal dysfunction in patients with end-stage cirrhosisis common and ranges from 10%～20% among patients who undergo liver transplantation(21). Previous studies suggested that preoperative renal dysfunction was asso-

ciated with a high incidence of infection, long ICU stay, and long hospital stay(22). However, in the present study, hepatorenal syndrome or dialysis in the pretransplant patient was associated with 3-month mortality, but not with 3-month mortality according to multivariate analysis.

Small-for-size grafts was not a risk factor for 3-month mortality in the present study. All institutions at which LDLT is performed have lower limits for donated GV that include the following safety margin: GRWR >0.6 to 0.8 for transplanted GV(11). However, patients with small-for-size grafts may have poor outcomes in patients when they have high MELD scores(23).

This study includes the largest series of adult LDLT recipients with high MELD scores ever examined, and our results suggest that the optimal cutoff point on ROC curve for MELD scores should move to 35 from 25. We identified high MELD scores (≥35) and preoperative ICU care as risk factors. High MELD scores should not be an absolute contraindication for LDLT, but when patients with MELD scores above than or equal to 35 required ICU care, DDLT should be considered prior to LDLT as a treatment strategy.

The preoperative ICU management is one of the major risk factors in this study; however, other several risk factors as hepatic encephalopathy, hepatorenal syndrome, dialysis, and ventilator care have associated with pretransplant condition which demand on ICU management. Therefore, our study should be considered of these issues. Further studies are needed to reevaluate the risk factors associated with serious patient condition after divide into two subgroups for MELD scores above than or equal to 35, and lower than 35.

In addition, in this study we analyzed 3-month mortality as a single end-point; however, further studies are needed to collect data on multiple end point. For example, the mortality related to pretransplant condition (sepsis and brain death), to procedure (presence of hepatic artery thrombosis, portal vein thrombosis, and bleeding), and to extrahepatic causes (heart failure, cerebrovascular event).

CONCLUSION

In conclusion, high MELD score alone is not an absolute contraindication for LDLT. We identified MELD score greater than or equal to 35 and preoperative ICU stay as clinical risk factors for short-term mortality within 90 days after LDLT. We found that patients with both risk factors have extremely poor 3-month survival and should therefore be cautiously considered as candidates for LDLT.

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