Original Article

Korean J Transplant 2019;33:112-117
https://doi.org/10.4285/jkstn.2019.33.4.112

KJT

Deceased donor liver transplantation under the Korean model for end-stage liver disease score-based liver allocation system: 2-year allocation results at a high-volume transplantation center

Hea-Seon Ha[1], Jung-Ja Hong[1], In-Ok Kim[1], Sae-Rom Lee[1], Ah-Young Lee[1], Tae-Yong Ha[2], Gi-Won Song[2], Dong-Hwan Jung[2], Gil-Chun Park[2], Chul-Soo Ahn[2], Deok-Bog Moon[2], Ki-Hun Kim[2], Sung-Gyu Lee[2], Shin Hwang[1,2]

[1]Organ Transplantation Center, Asan Medical Center, Seoul, Korea;
[2]Department of Surgery, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea

Background: The Korean model for end-stage liver disease (MELD) score-based liver allocation system was started in June 2016 in Korea.

Methods: This study analyzed the detailed allocation results of deceased donor liver transplantation (DDLT) during the first 2 years after the MELD score-based liver allocation system implementation at a high-volume liver transplantation (LT) center in Korea.

Results: This study included 174 patients with age above 12 years. The patient ABO blood groups were A (n=65, 37.4%), B (n=51, 29.3%), O (n=28, 16.1%), and AB (n=30, 17.2%). The LT types were primary LT in 141 patients (81.0%) and retransplantation in 33 (19.0%). The Korean Network for Organ Sharing status categories at LT were as follows: status 1 (n=11, 6.3%), status 2 (n=82, 47.1%), status 3 (n=63, 36.2%), and status 4 (n=18, 10.3%). The mean MELD score at LT and waiting period were 36.6±4.6 and 62.1±98.2 days in blood group A; 37.6±3.6 and 25.7±38.1 days in blood group B; 38.8±2.7 and 26.0±30.5 days in blood group O; and 34.8±5.5 and 68.4±110.5 days in blood group AB ($P<0.001$ and $P=0.012$), respectively. Patients with blood group O and AB had the highest and lowest mean MELD scores at LT allocation, respectively.

Conclusions: Serious deceased organ donor shortage resulted in very high MELD score cutoffs for DDLT allocation. Additionally, a significant inequality was observed in the possibility for DDLT according to blood group compatibility. Nationwide follow-up studies are necessary to precisely determine the allocation status of DDLT.

Keywords: Liver transplantation; Model for end-stage liver disease score; Waiting list; ABO blood group; Deceased donor

INTRODUCTION

Optimized allocation of the deceased donor organs is a matter of concern for waiting list patients for liver transplantation (LT). In Korea, a nationwide allocation system for deceased donor liver grafts was started in February 2000 after the establishment of the Korean Network for Organ Sharing (KONOS) that was modeled after the United Network for Organ Sharing [1,2]. This system utilized a Child-Turcotte-Pugh (CTP) score-based allocation system, similar to what had been used in the United States before the adoption of the model for end-stage liver disease (MELD) score-based allocation

Received September 6, 2019
Revised December 5, 2019
Accepted December 6, 2019

Correspondence to: Shin Hwang
Department of Surgery, Asan Medical Center, University of Ulsan College of Medicine, 88 Olympic-ro 43-gil, Songpa-gu, Seoul 05505, Korea
Tel: +82-2-3010-3930, Fax: +82-2-3010-6701
E-mail: shwang@amc.seoul.kr

HIGHLIGHTS

- This study analyzed the detailed allocation results of deceased donor liver transplantation (DDLT) during the first 2 years after the MELD score-based liver allocation system implementation at Asan Medical Center.
- Serious deceased organ donor shortage resulted in very high MELD score cutoffs for DDLT allocation.
- A significant inequality was observed in the possibility for DDLT according to blood group compatibility.

system. The annual number of deceased organ donors in Korea is much lower than in many Western countries, and a serious deceased donor organ shortage has led to high waiting list mortality rates. As such, the Korean MELD score-based allocation system was adopted in June 2016 to optimize the use of the deceased donor liver organs [3-5].

To date, this new allocation system has been successfully practiced for more than 3 years. However, the number of deceased donors in Korea did not increase over this period. As a result, the majority of the deceased donor liver organs were allocated to patients with very high MELD scores [6]. This study analyzed the detailed allocation outcomes of the deceased donor liver transplantation (DDLT) for the first 2 years after implementation of the Korean MELD score-based liver allocation system at a high-volume LT center in Korea.

METHODS

Study Design

This study was a retrospective analysis using single-institution DDLT data from Asan Medical Center. The study period for patient selection included the 2 years from June 2016 to May 2018, during which a total of 174 DDLT cases were performed in patients older than 12 years. The study parameters were KONOS status, MELD score, waiting period until organ allocation, admission status at organ allocation, and ABO blood group. This study was approved by the institutional review board of Asan Medical Center.

Korean MELD Score-Based Allocation System

The Korean MELD score-based liver allocation system is based on the following original calculation formula: [9.57 × loge (creatinine, mg/dL) + 3.78 × loge (total bilirubin, mg/dL) + 11.2 × loge (international normalized ratio) + 6.43]. Moreover, there are five MELD score status categories as follows: status 1 (acute liver failure and early graft failure), status 2 (MELD score 38-40, equivalent to KONOS status 2A), status 3 (MELD score 31-37), status 4 (MELD score 21-30), and status 5 (MELD score ≤20). Patients with hepatocellular carcinoma within the Milan criteria receive additional 4 to 5 points if their MELD score is less than or equal to 20 [6]. The pediatric end-stage liver disease (PELD) scoring is used for patients up to 12 years of age, but not included in this study.

Status 1 can be extended to a total period of 14 days. The renewal interval periods for MELD score update are the following: 7 days for KONOS statuses 2 and 3, 3 months for status 4, and 6 months for status 5. If the MELD score is not updated within the interval period, the score automatically decreases to 6. In addition to MELD score, identical blood groups and same country regions of the donors were assigned a priority, whereas a no priority was given to donor management institution.

Table 1. Primary diagnoses of patients undergoing deceased donor liver transplantation

Primary diagnosis	Case
Status 1	
Fulminant hepatic failure	8 (4.6)
Early retransplantation	3 (1.7)
Status 2-4	
Hepatitis B virus-associated liver cirrhosis	54 (31.0)
Hepatitis C virus-associated liver cirrhosis	3 (1.7)
Alcoholic liver cirrhosis	53 (30.5)
Cryptogenic liver cirrhosis	16 (9.2)
Primary biliary cirrhosis	3 (1.7)
Budd-Chiari syndrome	2 (1.1)
Primary sclerosing cholangitis	1 (0.6)
Autoimmune hepatitis	1 (0.6)
Late retransplantation	30 (17.2)

Values are presented as number (%).

Statistical Analysis

Continuous variables were presented with mean and standard deviation, and were compared using the Student t-test. Statistical analyses were performed using the IBM SPSS ver. 22.0 (IBM Corp., Armonk, NY, USA).

RESULTS

Recipient Demographics

The total of 174 recipients included 129 (74.1%) male and 45 (25.9%) female patients. The mean and median age of the recipients was 52.3±12.0 years (range, 17 to 74 years) and 53 years, respectively. The recipient age at DDLT was less than 40 years in 27 patients (15.5%), 41 to 50 years in 40 patients (23.0%), 51 to 60 years in 62 patients (35.6%), and over 60 years in 45 patients (25.9%). The primary diagnoses of these patients were summarized in Table 1, with hepatitis B virus-associated liver cirrhosis (n=54, 31.0%), alcoholic liver cirrhosis (n=53, 30.5%), cryptogenic liver cirrhosis (n=16, 9.2%), and late retransplantation (n=30, 17.2%) being the most common liver diseases diagnosed in patients at KONOS statuses 2 to 4.

The recipient ABO blood groups were group A in 65 (37.4%), group B in 51 (29.3%), group O in 28 (16.1%), and group AB in 30 (17.2%) patients. No patient carried Rh-negative blood group. The types of DDLT operation were primary LT in 141 (81.0%) and retransplantation in 33 (19.0%). The numbers of patient with in-hospital admission status at DDLT allocation were as follows: 24 (89.2%), 38 (95.0%), 60 (96.8%), and 41 (91.1%) in blood groups A, B, O, and AB, respectively.

KONOS Status Categories at DDLT

The KONOS status categories at LT allocation were status 1 in 11 patients (6.3%), status 2 in 82 patients (47.1%), status 3 in 63 patients (36.2%), and status 4 in 18 patients (10.3%) (Fig. 1). In status 1 patients, the LT types were primary LT in eight cases (72.7%) and retransplantation in three cases (27.3%) with the mean waiting period to LT of 4.7±3.8 days. The MELD score ranged from 28 to 40.

In all patients, the mean MELD scores' distributions at initial enrollment and DDLT allocation and mean waiting period until DDLT according to the recipient ABO blood groups were the following: 30.6±7.7, 36.6±4.6, and 62.1±98.2 days in blood group A; 32.7±7.4, 37.6±3.6, and 25.7±38.1 days in blood group B; 32.1±7.1, 38.8±2.7, and 26.0±30.5 days in blood group O; and 28.5±8.5, 34.8±5.5, and 68.4±110.5 days in blood group AB, respectively. The mean MELD scores' com-

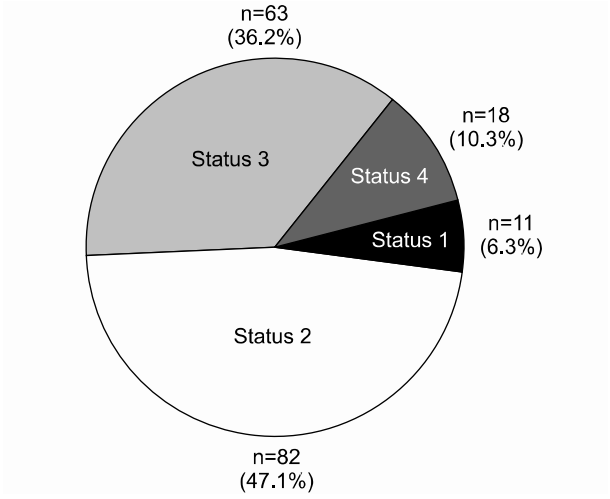

Fig. 1. Distribution of deceased donor liver transplantation recipients according to the Korean model for end-stage liver disease score-based allocation system.

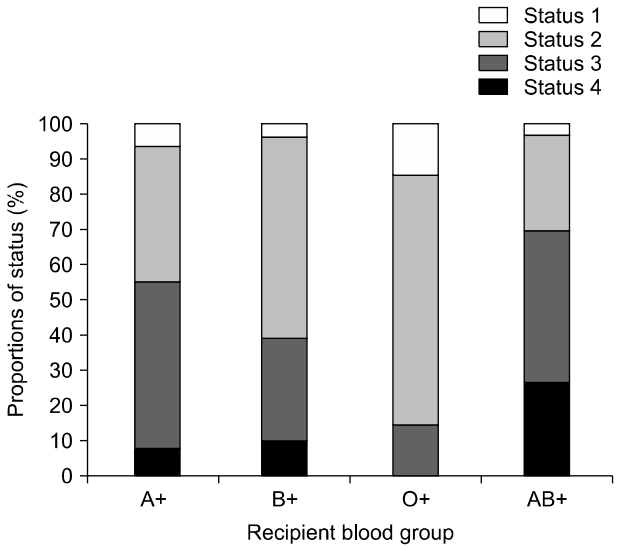

Fig. 2. Comparison of patient proportions of the Korean Network for Organ Sharing status categories according to the ABO blood group.

parison revealed significant statistical differences ($P<0.001$). Patients with blood groups O and AB carried the highest and lowest mean MELD scores at DDLT allocation, respectively. Furthermore, the comparison of the mean waiting periods revealed significant statistical differences ($P=0.012$). Patients with blood group AB and blood groups B and O carried the longest and shortest mean waiting period until DDLT allocation, respectively. The KONOS status distribution according to the ABO blood groups is presented in Fig. 2, indicating that the recipients with blood group O accounted for the greatest proportion in KONOS statuses 1 and 2.

DISCUSSION

The high demand for LT in Korea is attributed to the high prevalence of hepatitis B virus-associated liver cirrhosis and subsequent high incidence of hepatocellular carcinoma [4-6]. Recently, alcoholic liver disease became one of the major LT indications in Korea [7]. The yearly number of deceased organ donors temporarily exceeded 10 per million individuals in the year 2016 [3]; however, it prospectively declined because of certain medical and social issues, including the Life Insurance Decision Act regulating termination of life-sustaining treatment. The annual numbers of deceased organ donors and those undergoing DDLT in Korea were 573 and 508, 515 and 450, and 449 and 369, in the years 2016, 2017, and 2018, respectively.

In recent years, the total annual number of LT cases in Korea remained largely unchanged, suggesting a reciprocal relationship between the case numbers of DDLT and the living donor LT [4,5,8]. Currently, critically ill patients, defined as those with very high MELD scores, are more likely to receive DDLT than before; thus, they have usually waited for significantly long time periods after enrollment in the KONOS waiting list. However, it is not possible to estimate the waiting period because DDLT allocation happens unpredictably. Thus, urgent living donor LT is also performed, particularly in critically ill patients with progressive hepatic encephalopathy [5,9].

One of the primary reasons underlying the change in the liver allocation system from the old CTP to the new MELD score-based system was that relisting was not allowed after the 2-week priority allocation in patients classified under the old KONOS status 1 or 2A. In this CTP score-based allocation system, patients who did not receive DDLT within 2 weeks could not be indicated for priority allocation again, implying that if they did not receive LT during that time, most patients, except those who received living donor LT, died [2,6]. Paradoxically, this system was implemented to restrict the pool size of critically ill patients on the waiting list. With the new MELD score-based allocation, the pool size was gradually expanded because patients were allowed to wait for prolonged periods until DDLT or death without LT. Since the number of deceased organ donors cannot meet the demand for DDLT in critically ill patients, a priority allocation was made only for patients with the highest KONOS status.

In this study, organ shortage significantly affected patients belonging to the blood group O, which was reflected to LT in this study. The LT candidates with blood group O were initially enrolled at a mean MELD score of 32.1 ± 7.1 and allocated to DDLT at a mean MELD score of 38.8 ± 2.7 after a mean waiting period of 26.0 ± 30.5 days. Their MELD score at DDLT allocation was the highest, compared with other blood groups. Conversely, LT candidates with blood group AB had the lowest MELD score, compared with those with other blood groups.

Several studies have summarized the results following the introduction of MELD scoring in deceased donor liver organ allocation. Freeman et al. [10] reported that the MELD/PELD score-based system in the United States has been associated with reduced registrations and improved LT rates without increasing the mortality rates for individual groups of waiting candidates or changes in early transplant survival rates [10]. In addition, Ben-Haim et al. [11] concluded that MELD score was valid in Israel and superior to the CTP score for predicting waiting list mortality. Although longer waiting time due to organ scarcity is a key factor, death rates in the mid-range MELD groups indicate that further audit of the care of patients with end-stage liver disease is indispensable [11]. Moreover, Castro et al. [12] found that

patient survival on the waiting list for LT remained unchanged for 1 year after the introduction of MELD scoring in Brazil. The collective review by Chaib et al. [13] indicated that MELD scoring significantly improved short-term survival of the sickest patients on the waiting list for LT.

In addition, the results of this study indicate that the Korean MELD score-based liver allocation system was greatly influenced by a serious shortage of deceased donors [3]. The mean MELD score of DDLT recipients exceeded 36, suggesting that only patients with very high MELD scores were allocated to DDLT due to the severe organ shortage in Korea. Before the MELD score-based allocation system adoption, the new KONOS statuses 2 and 3 had been expected to cover approximately a half of the DDLT cases, with a considerable proportion of liver grafts allocated to status 4 patients carrying MELD scores between 21 and 30. However, in reality, the proportion of the statuses 2 and 3 patients was much greater than anticipated. Recent decreases in the number of deceased donors resulted in the expansion of the waiting list pool of patients with very high MELD scores. We presume that this deleterious outcome was responsible for the current rise in the MELD score cutoff enabling liver allocation. Unless the number of the deceased organ donors is significantly increased, the mean cutoff score for DDLT allocation will not be lowered.

This study has several notable limitations. First, it was a single-center study, which may potentially introduce a selection bias. Hence, nationwide follow-up studies are needed to validate our results. Second, the waiting list mortality and posttransplant outcomes were not assessed in this study.

In conclusion, the new Korean MELD score-based liver allocation system was successfully established at a high-volume LT center during the first 2 years. Serious deceased organ donor shortage resulted in very high MELD score cutoffs for DDLT allocation. Furthermore, there was a significant inequality in the possibility for DDLT according to blood group compatibility. Unless the number of the deceased organ donors significantly increases, the mean cutoff for DDLT allocation will not be lowered. Large-scale nationwide follow-up studies are needed to precisely delineate the allocation status of DDLT.

ACKNOWLEDGMENTS

Conflict of Interest

Shin Hwang is an editorial board member of the journal but did not involve in the peer reviewer selection, evaluation, or decision process of this article. No other potential conflicts of interest relevant to this article were reported.

Funding/Support

This study was supported by the Research Fund of Asan Medical Center Organ Transplantation Center.

This study was supported by research grant from the Korean Society for Transplantation (2019-04-01003-006).

ORCID

Hea-Seon Ha	https://orcid.org/0000-0003-1923-7481
Jung-Ja Hong	https://orcid.org/0000-0002-8219-3170
In-Ok Kim	https://orcid.org/0000-0001-8615-9191
Sae-Rom Lee	https://orcid.org/0000-0001-9289-7190
Ah-Young Lee	https://orcid.org/0000-0002-7203-2381
Tae-Yong Ha	https://orcid.org/0000-0001-9932-0212
Gi-Won Song	https://orcid.org/0000-0002-4235-0434
Dong-Hwan Jung	https://orcid.org/0000-0001-5984-023X
Gil-Chun Park	https://orcid.org/0000-0003-1631-3258
Chul-Soo Ahn	https://orcid.org/0000-0002-3844-3646
Deok-Bog Moon	https://orcid.org/0000-0002-8209-3540
Ki-Hun Kim	https://orcid.org/0000-0002-4016-0995
Sung-Gyu Lee	https://orcid.org/0000-0001-9161-3491
Shin Hwang	https://orcid.org/0000-0002-9045-2531

Author Contributions

Conceptualization: HSH, SH. Data curation: HSH, JJH, IOK, SRL, AYL, TYH, GWS, DHJ, GCP, CSA, DBM, KHK. Formal analysis: HSH, SH. Funding acquisition: HSH, SH. Methodology: HSH, SH. Project administration: SGL. Visualization: HSH, SH. Writing - original draft: HSH, SH. Writing - review & editing: HSH, SH.

REFERENCES

1. Bollinger RR, Cho WH. Organ allocation for transplantation in the USA and Korea: the changing roles of equity and utility. Yonsei Med J 2004;45:1035-42.
2. Hwang S, Ahn CS, Kim KH, Moon DB, Ha TY, Song GW, et al. Survival rates among patients awaiting deceased donor liver transplants at a single high-volume Korean center. Transplant Proc 2013;45:2995-6.
3. Min SI, Ahn C, Han DJ, Kim SI, Chung SY, Lee SK, et al. To achieve national self-sufficiency: recent progresses in deceased donation in Korea. Transplantation 2015;99:765-70.
4. Lee SG, Moon DB, Hwang S, Ahn CS, Kim KH, Song GW, et al. Liver transplantation in Korea: past, present, and future. Transplant Proc 2015;47:705-8.
5. Jung BH, Hwang S, Song GW, Jung DH, Ha TY, Park GC, et al. Updated status of deceased-donor liver graft allocation for high-urgency adult patients in a Korean high-volume liver transplantation center. Transplant Proc 2015;47:580-3.
6. Ha SM, Hwang S, Song GW, Ahn CS, Moon DB, Ha TY, et al. Successful introduction of Model for End-stage Liver Disease scoring in deceased donor liver transplantation in Korea: analysis of first 1 year experience at a high-volume transplantation center. Ann Hepatobiliary Pancreat Surg 2017;21:199-204.
7. Ahn CS, Hwang S, Kim KH, Moon DB, Ha TY, Song GW, et al. Long-term outcome of living donor liver transplantation for patients with alcoholic liver disease. Transplant Proc 2014;46:761-6.
8. Moon DB, Lee SG, Hwang S, Kim KH, Ahn CS, Ha TY, et al. Toward more than 400 liver transplantations a year at a single center. Transplant Proc 2013;45:1937-41.
9. Hwang S, Lee SG, Ahn CS, Kim KH, Moon DB, Ha TY, et al. An increase in deceased donor incidence alleviated the need for urgent adult living donor liver transplantation in a Korean high-volume center. Transplant Proc 2010;42:1497-501.
10. Freeman RB, Wiesner RH, Edwards E, Harper A, Merion R, Wolfe R, et al. Results of the first year of the new liver allocation plan. Liver Transpl 2004;10:7-15.
11. Ben-Haim M, Carmiel M, Katz P, Shabtai E, Oren R, Nakache R. Is the model of end-stage liver disease (MELD) valid in Israel? A critical analysis of liver transplant waiting list mortality. Isr Med Assoc J 2006;8:605-9.
12. Castro RS, Deisanti D, Seva-Pereira T, Almeida JR, Yamanaka A, Boin IF, et al. Survival before and after model for end-stage liver disease score introduction on the Brazilian liver transplant waiting list. Transplant Proc 2010;42:412-6.
13. Chaib E, Figueira ER, Brunheroto A, Gatti AP, Fernandes DV, D'Albuquerque LA. Does the patient selection with MELD score improve short-term survival in liver transplantation? Arq Bras Cir Dig 2013;26:324-7.