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Research Article

Factors Influencing Survival in the First Year Post Liver Transplantation Among Iraqi Patients

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Abstract

Background: Liver transplantation has transformed medicine, especially for patients with advanced liver disease and hepatocellular carcinoma, improving their lifespan and quality of life. ***Objective***: To assess the one-year survival rate post-liver transplantation and analyze the factors influencing survival. ***Methods***: A retrospective study conducted at Baghdad Gastroenterology Hospital analyzed data from liver transplant referrals over the last 5 years, based on the Model for End-Stage Liver Disease score. 100 Patients were classified as children (≤18 years) and adults (≥19 years) and followed-up for one-year post-transplant. Mortality analysis considered various etiological, clinical, and sociodemographic factors. ***Results***: In adults, males were predominant among both patients (66%) and donors (71.7%). The most frequent cause was cryptogenic cirrhosis (39.62%), then viral and autoimmune hepatitis (20.75 and 18.87%), respectively. Of the 53 adult patients, 5 died (9.43%), and 48 survived (90.57%). The age gap and BMI were significantly different. In pediatrics, biliary atresia was the most common cause (36.17%). Of the 47 pediatric patients, 16 died (34%) and 31 survived (66%). However, there were notable differences in the causes of liver cirrhosis between deceased and surviving patients. BMI and age gap between donors and recipients significantly affect survival in adults, while biliary atresia, Caroli disease, and hyperoxaluria have the highest one-year mortality in pediatric patients. ***Conclusions***: Over 90% of adults and 66% of children survive a year after receiving a liver transplant; in adults, age and BMI differences have a major impact. In contrast, pediatric survival was affected by the etiology of cirrhosis.

Keywords: Liver transplantation; Mortality; Survival rate.

العوامل المؤثرة على البقاء في السنة الأولى بعد زراعة الكبد بين المرضى العراقيين

الخلاصة

الخلفية: غيرت زراعة الكبد الطب، خاصة للمرضى المصابين بأمراض الكبد المتقدمة وسرطان الخلايا الكبدية، مما حسن عمرهم وجودة حياتهم. **الهدف**: تقييم معدل البقاء لمدة عام واحد بعد زراعة الكبد وتحليل العوامل المؤثرة على البقاء. **الطرائق**: أجريت دراسة بأثر رجعي أجريت في مستشفى بغداد لأمراض الجهاز الهضمي حللت بيانات من إحالات زراعة الكبد خلال السنوات الخمس الماضية، استنادا إلى نموذج درجة مرض الكبد في المرحلة النهائية. تم تصنيف 100 مريض كأطفال (≤18 سنة) وبالغين (≥19 سنة) وتمت متابعتهم لمدة عام واحد بعد الزرع. أخذ تحليل الوفيات في الاعتبار عوامل مختلفة من الأسباب والسريرية والاجتماعية الديموغرافية. **النتائج**: بين البالغين، كان الذكور هم الغالب بين المرضى (66٪) والمتبرعين (71.7٪). كان السبب الأكثر شيوعا هو التليف الكبدي السري (39.62٪)، ثم التهاب الكبد الفيروسي والمناعي الذاتي (20.75 و18.87٪) على التوالي. من بين 53 مريضا بالغا، توفي 5 (9.43٪)، ونجا 48 (90.57٪). كان الفارق العمري ومؤشر كتلة الجسم مختلفين بشكل كبير. في طب الأطفال، كان رتسلية الصفراء هي السبب الأكثر شيوعا (36.17٪). من بين 47 مريضا أطفالا، توفي 16 (34٪) ونجا 31 (66٪). ومع ذلك، كانت هناك اختلافات ملحوظة في أسباب تليف الكبد بين المرضى المتوفين والناجين. يؤثر مؤشر كتلة الجسم والفارق العمري بين المتبرعين والمتلقين بشكل كبير على البقاء على قيد الحياة لدى البالغين، بينما تحتوي أمراض ردة الجسم الصفراوي، ومرض كارولي، وفرط الأكسالات على أعلى معدلات وفيات خلال سنة واحدة بين مرضى الأطفال. **الاستنتاجات**: أكثر من 90٪ من البالغين و66٪ من الأطفال ينجون بعد عام من تلقي زراعة الكبد؛ أما بالنسبة للبالغين، فإن فروق العمر ومؤشر كتلة الجسم لها تأثير كبير. على النقيض من ذلك، تأثر بقاء الأطفال على قيد الحياة بأسباب تليف الكبد.

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INTRODUCTION

Solid organ transplantation has revolutionized medicine, particularly liver transplantation, which has significantly enhanced the longevity and quality of life of millions of patients with end-stage liver disease and hepatocellular carcinoma. Over the past three decades, both graft and patient survival rates have steadily improved owing to advancements in patient selection, surgical techniques, perioperative management, and immunosuppression [1,2]. In contemporary medicine, the graft survival rates following orthotopic liver transplantation are 89.6%, 80.8%, and 72.8% for one, three, and five years, respectively. Correspondingly, the patient survival rates were 91.8%, 83.8%, and 76.1% at one, three, and five years, respectively. These statistics underscore the significant advancements and successes in liver transplantation over the past few decades [3-5]. These criteria for selection for liver transplantation align with the latest practice guidelines outlined by the American Association for the Study of Liver Disease (AASLD) for the indications and contraindications of liver transplantation [6]. The timing of liver transplantation (LT) is critical and

should occur before life-threatening systemic complications develop in patients with end-stage liver disease. However, transplanting patients too early may imbalance the advantages of transplantation against the risks of surgery and lifelong immunosuppression [7]. Since 2002, the Model for End-Stage Liver Disease (MELD) score had been adopted for assessing patients for liver transplantation. The MELD score, based on objective measures such as creatinine, bilirubin, and international normalized ratio (INR), was initially developed to predict short-term prognosis for patients undergoing Transjugular Intrahepatic Portosystemic Shunt (TIPS) after gastrointestinal bleeding. It has since been proposed for predicting 3-month mortality in patients with end-stage liver disease [8,9]. For patients with a MELD score of 14, one-year survival was found to be lower with transplantation than without. Therefore, a MELD score of 15 or higher is recommended for listing patients with end-stage liver disease, although it may not accurately predict mortality following LT, except for patients with very high MELD scores exceeding 35 [10,11]. However, MELD does not fully capture the impact of complications such as refractory ascites and recurrent encephalopathy on mortality risk without transplantation [7]. Exceptions to the MELD include pulmonary complications of cirrhosis, hepatic encephalopathy, amyloidosis, and primary hyperoxaluria. In such cases, additional points may be assigned to prioritize patients for transplantation [12]. Patients with cirrhosis often develop dilutional hyponatremia because of changes in their vascular hemodynamics. This is linked to how high the portal pressure is [13]. Lower sodium levels predict worse outcomes and are independently associated with survival at 3 and 12 months [14]. A modified score incorporating serum sodium, known as the "MELD sodium" score (MELD-Na), was proposed as an alternative to the MELD score [15] and was implemented for liver transplant allocation in 2016, given that hyponatremia is a strong predictor of mortality among patients on the liver transplant waitlist [16]. During the initial three months following liver transplantation, key factors significantly influencing overall survival include preoperative health status (UNOS status), age, weight, and indication for LT. As nearly half of post-LT mortality occurs within this perioperative period, efforts to enhance survival primarily focus on addressing these factors [17]. During the late 1980s, individuals aged > 50 years became eligible for liver transplantation (LT), and this age threshold has progressively increased since then [18]. While some studies suggest a low rejection rate in elderly patients, hinting at a potential positive impact on graft survival [19]. Others argue against LT in the elderly due to the presence of comorbidities and the heightened risk of postoperative complications that could adversely affect their long-term survival [20]. Pre-transplantation, overweight and obesity are prevalent among orthotopic liver transplantation (OLT) recipients, with reported rates of 41% and 28%, respectively [21]. However, the accuracy of pre-transplant body weight measurements can be influenced by the presence of ascites, leading to potential misclassification of overweight or obese status in 11–20% of patients with large-volume ascites [22,23]. Additionally, OLT recipients tend to experience weight gain after transplantation, particularly during the initial year after the procedure. Therefore, post-transplant body weight may provide a more accurate basis for calculating the true Body Mass Index (BMI) [24]. This study aimed to assess one-year survival rates post-liver transplantation and analyze factors influencing survival in both adults and children, including etiology of liver disease, age, BMI, age gap between donor and recipient, and transplant center.

METHODS

Study design and setting

This retrospective cohort study was conducted in the period between January 1, 2019, and February 31, 2023, and data was obtained and analyzed from the gastroenterology hospitals of Iraq. The study population comprised patients who were referred from the liver transplant committee to undergo liver transplantation surgery. Two hundred patients were registered in the hospital's statistics department, and communication with the patients was conducted using their mobile numbers in the files. Only 100 out of the 200 patients who were referred by the liver transplantation committee responded to our request. Follow-up was completed for 100 patients one year after liver transplantation. The participants were divided into two age groups: children ≤ 18 years (47 patients), and adults ≥ 19 years (53 patients). For transplantation, the patients were referred to three main hospitals: Memorial Hospital (Istanbul, Turkey), Ghazi Osman Hospital (Istanbul, Turkey), and BLK Hospital (New Delhi, India).

Inclusion criteria

Patients with decompensated cirrhosis of any etiology and a MELD score ≥15.

Exclusion criteria

Patients with severe cardiopulmonary disease, uncontrolled sepsis, active extrahepatic malignancy, brain death, active alcohol abuse, MELD score < 15, human immunodeficiency virus (HIV) positivity, cholangiocarcinoma, and those who died after liver transplantation due to causes unrelated to liver transplantation.

Interventions and outcome measurements

BMI and MELD scores were calculated for each age group and sent for the following investigations: ABO and Rh blood typing for patients and donors, renal function tests (BUN, S. creatinine), complete blood count including differential, liver function tests (AST, ALT, ALK, bilirubin, albumin), PT, INR, and serologies of hepatitis B and hepatitis C were all done and reviewed. HIV, cytomegalovirus (CMV), Epstein-

Barr virus (EBV), and latent tuberculosis screening: interferon- γ release assay or tuberculin skin testing was performed for patients and donors, and all results were negative. The major focus of the analysis in this study was the one-year survival after OLT.

Ethical considerations

The study protocol was approved by the Ethics Committee of the Arab Scientific Council of Health Specialties for Research and Committee Guidelines, Baghdad, Iraq, and the Basrah College of Medicine Ethical Committee, Basrah, Iraq. All participants provided written informed consent. The study conducted adhered to the Declaration of Helsinki.

Statistical analysis

Statistical Package for Social Sciences (SPSS) software version (24) was used for all statistical analyses. Numerical variables are expressed as means± standard deviation (SD), and binomial variables are expressed as frequencies and percentages. The association of different factors with death was statistically analyzed using the student's t-test for numerical variables and Pearson's chi-square test for binomial variables. The Kaplan-Meier curve was used to determine the survival time for patients. Results were considered statistically significant when *p*-values < 0.05.

RESULTS

The mean age of the adult patients was 37.58 ± 12.06 years compared with 27.53 ± 7.97 years for the adult donors. Thus, the mean age gap between the patients and donors was 14.7±11.69 years. Males were predominant among patients (66%) and donors (71%). Accordingly, the gender compatibility was 60.38%. The mean BMI of the patients and donors was 22.65 ± 3.31 kg/m^2 and 25.41 ± 3.24 kg/m^2, respectively. In approximately 43.4% of patients, the donors were brothers, followed by uncles and daughters (13.21% for each). The most common hospital was Memorial Hospital, where 47.17% of transplantations occurred, followed by BLK-MAX (41.58%). The year 2022 witnessed the most frequent adult liver transplantation (33.96%), as shown in Table 1. The mean MELD score was 19.53 ± 4.8. Cryptogenic cirrhosis was the most common cause of cirrhosis, accounting for 39.62% of patients, followed by viral hepatitis (20.75%) and AIH (18.87%). Less common causes were alcoholic cirrhosis (11.32%), Wilson disease (5.66%), and PSC (3.77%), as shown in Table 2.

Table 1: Demographic characteristics of the adult patients (n=53)

Variables	Values
Age of patients (year)	37.58±12.06 [20-65]
Age of the donors (year)	27.53±7.97 [18-51]
Age gap between patients and donors (year)	14.7±11.69 [1.0-39]
Gender of patients	
Male	35(66.04)
Female	18(33.96)
Gender of donors	
Male	38(71.7)
Female	15(28.3)
Gender compatibility	
Compatible	32(60.38)
Non-compatible	21(39.62)
BMI of patients (kg/m^2)	22.65±3.31 [18-30]
BMI of the donors (kg/m^2)	25.41±3.24 [18.3-31.5]
Relationship with donor	
Brother	23(43.4)
Uncle	7(13.21)
Daughter	7(13.21)
Sister	4(7.55)
Father	3(5.66)
Other	9(16.98)
Hospital of operation	
Memorial	25(47.17)
BLK-MAX	22(41.51)
Gazi Othman	6(11.32)
Date of operation	
2019	11(20.75)
2020	4(7.55)
2021	11(20.75)
2022	18(33.96)
2023	9(16.98)

Values are presented as frequency, percentage, range, and mean±SD.

Table 2: Clinical characteristics of the adult patients (n=53)

Variables	Values
MELD score	19.53±4.8 [13-33]
Causes of liver cirrhosis	
Cryptogenic cirrhosis	21(39.62)
Viral hepatitis	11(20.75)
Autoimmune hepatitis	10(18.87)
Alcoholic	6(11.32)
Wilson disease	3(5.66)
PSC	2(3.77)

Values are presented as frequency, percentage, range, and mean±SD.
PSC: primary sclerosing cholangitis.

In terms of the outcome of liver transplantation, out of the 53 adults, 5 patients died (9.43%), while 48 patients (90.57%) survived. Two demographic factors were significantly associated with the outcomes of adult patients who underwent liver transplantation. The mean age gap between deceased patients and their donors was 24.4±10.87 years, which was higher than that of survived patients (13.1 ± 11.35 years) with a significant difference (*p*= 0.038). Furthermore, the mean BMI of deceased patients was 27.2 ± 3.03 kg/m^2, which was much higher than that of survived patients (22.17 ± 3.0 kg/m^2) with a significant difference (*p*= 0.001) (Table 3).

Table 3: Association of demographic characteristics of adults with outcome

Variables	Died (n=5)	Survived (n=48)	*p*-value
Age of patients (year)	43.6±14.88 [21-60]	36.96±11.74 [20-65]	0.245
Age of donors (year)	22.8±4.76 [18-30]	28.0±8.09 [18-51]	0.165
Age gap (year)	24.4±10.87 [9.0-37]	13.1±11.35 [1.0-39]	0.038
Gender of patients			
Male	3(60)	32(66.67)	0.765
Female	2(40)	16(33.33)	
Gender of donors			
Male	4(80)	34(70.83)	0.665

Female	1(20)	14(29.17)	
Gender compatibility			
Compatible	3(60%)	18(37.5%)	0.328
Non-compatible	2(40%)	30(62.5%)	
BMI of patients (kg/m^2)	27.2±3.03 [23-30]	22.17±3.0 [18-30]	0.001
BMI of donors (kg/m^2)	25.12±4.85 [18.3-30]	25.43±3.1 [19.7-31.5]	0.838
Relationship			
Brother	2(40)	21(43.75)	
Uncle	2(40)	5(10.42)	
Daughter	0(0)	7(14.58)	0.479
Sister	0(0)	4(8.33)	
Father	0(0)	3(6.25)	
Other	1(20)	8(16.67)	
Hospital of operation			
Memorial	3(60)	22(45.83)	0.663
BLK-MAX	2(40)	20(41.67)	
Gazi Othman	0(0)	6(12.5)	
Date of operation			
2019	2(40)	9(18.75)	
2020	0(0)	4(8.33)	0.620
2021	0(0)	11(22.92)	
2022	2(40)	16(33.33)	
2023	1(20)	8(16.67)	

Values are presented as frequency, percentage, range, and mean±SD.

When the demographic characteristics had been studied in association with the outcome, it had been found that the clinical characteristics were comparable between deceased and surviving patients, with no significant differences (Table 4).

Table 4: Association of clinical characteristics of adults with the outcome

Variables	Died (n=5)	Survived (n=48)	*p*-value
MELD score	20.8±5.54 [15-27]	19.4±4.77 [13-33]	0.541
Causes of liver cirrhosis			
Cryptogenic cirrhosis	2(40)	19(39.58)	
Viral hepatitis	2(40)	9(18.75)	
Autoimmune hepatitis	0(0)	10(20.83)	0.432
Alcoholic	0(0)	6(12.5)	
Wilson disease	1(20)	2(4.17)	
PSC	0(0)	2(4.17)	

Values are presented as frequency, percentage, range, and mean±SD.

The mean age of the pediatric patients was 7.86 ± 6.44 years, compared with 32.89 ± 10.6 years for the donors. Thus, the mean age gap between the patients and donors was 25.0 ±11.9 years. Males were predominant among patients (61.7%) and donors (57.45%). Accordingly, the gender compatibility was 57.45%. The mean BMI of the donors was 24.74 ± 3.53 kg/m². In approximately 45% of the patients, the donors were mothers, followed by fathers (29.79%) and brothers (12.77%). Memorial Hospital was the commonest hospital at which 46.81% of transplantations occurred, followed by Ghazi Othman (27.66%) and finally BLK-MAX (25.53%). The year 2019 revealed the most frequent pediatric liver transplantation (34.04%), followed by 2021 (23.4%), as shown in Table 5. In terms of outcome, out of 47 pediatrics, 16 patients have died (34%), while 31 patients (66%) survived. The mean PELD score was 17.7±4.47. Biliary atresia was the most common cause of liver cirrhosis, accounting for 36.17% of the patients, followed by glycogen storage disease (17.02%), cryptogenic cirrhosis, and Wilson disease (each with 14.89%). Less common causes were PFIC (8.51%), AIH (4.26%), Caroli disease (2.13%), and hyperoxaluria (2.13%), as shown in Table 6.

Table 5: Demographic characteristics of the pediatric patients (n=47)

Variables	Values
Age of patients (year)	7.86±6.44 [0.25-18]
Age of donors (year)	32.89±10.6 [18-58]
Age gap (year)	25.0±11.9 [1.0-51]
Gender (patients)	
Male	29(61.7)
Female	18(38.3)
Gender (donors)	
Male	25(57.45)
Female	22(46.81)
Gender compatibility	
Compatible	27(57.45)
Non-compatible	20(42.55)
BMI (donors) (kg/m^2)	24.74±3.53 [20-32]
Relationship with donor	
Mother	21(44.68)
Father	14(29.79)
Brother	6(12.77)
Others	8(17.02)
Hospital of operation	
Memorial	22(46.81)
Gazi Othman	13(27.66)
BLK-MAX	12(25.53)
Operative date	
2019	16(34.04)
2020	3(6.38)
2021	11(23.4)
2022	8(17.02)
2023	9(19.15)

Values are presented as frequency, percentage, range, and mean±SD.

Table 6: Clinical characteristics of pediatric patients (n=47)

Variables	Values
PELD score	17.7±4.47 [15-40]
Causes of liver cirrhosis	
Biliary atresia	17(36.17)
Glycogen storage disease	8(17.02)
Cryptogenic cirrhosis	7(14.89)
Wilson disease	7(14.89)
PFIC	4(8.51)
Autoimmune hepatitis	2(4.26)
Caroli disease	1(2.13)
Hyperoxaluria	1(2.13)

Values are presented as frequency, percentage, range, and mean±SD.
PFIC: Progressive familial intrahepatic cholestasis.

Generally, none of the included demographic characteristics had a significant association with mortality. Although survived patients were older than deceased (8.74 ± 6.3 years vs. 6.16±6.57 years), the difference was not significant (Table 7).

Table 7: Association of demographic characteristics with the outcome of pediatric patients

Variables	Died (n=16)	Survived (n=31)	*p*-value
Age of patients (year)	6.16±6.57 [0.25-18]	8.74±6.3 [0.5-18]	0.196
Age of donors (year)	31.5±7.7 [18-44]	33.61±11.87 [18-58]	0.523
Age gap (year)	25.34±10.93 [1.0-39.5]	24.87±12.54 [2.0-51]	0.899
Gender (patient)			
Male	8(50)	21(67.74)	0.236
Female	8(50)	10(32.26)	
Gender (donor)			
Male	8(50)	17(54.84)	0.753
Female	8(50)	14(45.16)	
Gender compatibility			
Compatible	10(62.5)	17(54.84)	0.615
Non-compatible	6(37.5)	14(45.16)	
BMI of donors (kg/m^2)	26.14±4.28 [18.1-32]	25.4±3.73 [20-34]	0.537
Relationship			
Mother	8(50)	13(41.94)	0.609
Father	4(25)	10(32.26)	
Brother	3(18.75)	3(9.68)	
Others	1(6.25)	5(16.13)	
Hospital of operation			
Memorial	8(50)	14(45.16)	0.284
Gazi Othman	6(37.5)	7(22.58)	
BLK-MAX	2(12.5)	10(32.26)	
Operation date			
2019	5(31.25)	11(35.48)	0.912
2020	1(6.25)	2(6.45)	
2021	5(31.25)	6(19.35)	
2022	2(12.5)	6(19.35)	
2023	3(18.75)	6(19.35)	

Values are presented as frequency, percentage, range, and mean±SD.

The mean PELD score of deceased patients was 19.28 ± 5.88, which was higher than that of survived patients (16.88 ± 3.36), although the difference was not significant (p= 0.082). On the other hand, patients who died had higher rates of biliary atresia, Caroli disease, and hyperoxalurea (62.5%, 6.25%, and 6.25%, respectively), while those who lived had lower rates of these conditions (22.58%, 0%, and 0%, respectively), showing a significant difference (Table 8).

Table 8: Association of clinical characteristics of pediatrics with outcome

Variables	Died (n=16)	Survived (n=31)	*p*-value
PELD score	19.28±5.88 [15-40]	16.88±3.36 [15-28]	0.082
Causes of liver cirrhosis			
Biliary atresia	10(62.5)	7(22.58)	0.019
Glycogen storage disease	0(0)	8(25.81)	
Cryptogenic cirrhosis	0(0)	7(22.58)	
Wilson disease	2(12.5)	5(16.13)	
PFIC	1(6.25)	3(9.68)	
Autoimmune hepatitis	1(6.25)	1(3.23)	
Caroli disease	1(6.25)	0(0%)	
Hyperoxaluria	1(6.25)	0(0%)	

Values are presented as frequency, percentage, range, and mean±SD.
PFIC: Progressive familial intrahepatic cholestasis.

Regarding early death post liver transplantation, it is reported in three adult patients, two of whom were from Memorial Hospital and one from BLK-Max. Statistically, there was no significant association between the hospitals and early death, while in pediatric patients, early death (within the first 3 months after liver transplantation) occurred in 5 patients, 2 of whom were in Memorial Hospital, 2 in Ghazi Othman, and 1.0 in BLK-Max. Statistically, there was no significant association between the hospital and early death. The survival time was 10.66 ± 0.35 months, 95% CI= 9.98-11.34, as shown in Figure 1.

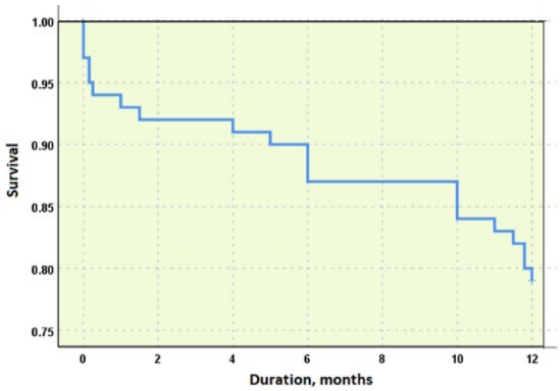

Figure 1: Kaplan Meier curve for survival of patients with transplant liver.

DISCUSSION

To our knowledge, this is the first study to discuss post-liver transplantation survival among adult and pediatric Iraqi patients. In our study, we divided the population into two age groups: adults and pediatrics. Among the adults, 12-month survival rates for liver transplant patients were observed to be 48 out of 53 patients, equating to 90.57%. Our findings indicated no significant correlation between patient age and mortality following liver transplantation. This result aligns with that of Lai *et al*. [25], who reported similar conclusions. However, this finding contrasts with that of Weismüller *et al*. [26], who demonstrated a negative

correlation between patient age and survival rates. This discrepancy might be attributed to the fact that the majority of our patient population was under 55 years of age. Regarding the age gap between recipients and donors, our study found a significant negative correlation with survival rates. This result is consistent with the findings of Snyder *et al*. [27], who categorized young recipients into four groups based on donor age: younger than the recipient, 0–9 years older, 10–19 years older, and ≥ 20 years older. Their study demonstrated the influence of age on long-term survival, with survival rates of 6,114 (40.3%), 3,315 (21.9%), 2,970 (19.6%), and 2,771 (18.3%) for groups 1–4, respectively. Additionally, Zhang *et al*. [28] reported a similar correlation between age gap and liver transplant survival, further supporting our findings. Regarding the sex of the recipients and donors as well as sex compatibility, our study found no significant correlation with survival. This result is in line with the findings of Lehner *et al*. [29], who reported no significant differences in patient survival in gender-incompatible orthotopic liver transplants (OLT). However, our results differ from those of Lai *et al*. [25] and Germani *et al*. [30], who reported a significant decrease in graft survival among patients with sex incompatibility, particularly in female-to-male transplants. This discrepancy may be due to the fact that most donors in our study were male. In this study, the BMI of deceased recipients was significantly higher than that of surviving recipients (p= 0.001). This finding aligns with that of van Son *et al*. [31], who demonstrated that obese recipients had a significantly increased mortality risk compared to normal-weight recipients (p= 0.027). Conversely, Saab *et al*. [22] suggested that BMI does not specifically affect patient survival. The discrepancy in results may be attributed to differences in the duration of survival follow-up, with the latter study having a follow-up period exceeding five years. We also examined the correlation between donor BMI and recipient survival and found no significant relationship. This result is consistent with the study by Takagi *et al*. [32], which showed that donor BMI was not associated with graft or patient survival. Similarly, Molina Raya *et al*. [33] found that while there was a significant difference in the pre-extraction ICU stay of the donors (p= 0.006), there was no significant difference in post-transplantation complications or recipient survival (p> 0.05), further supporting our findings. All donors in this study were living relatives of the recipients, and there were no significant differences between them. Additionally, no studies are available for comparison in this context. The patients enrolled in this study were treated at three different hospitals. Analysis revealed no significant differences in early mortality or survival rates among the hospitals. Given that most previous studies on liver transplantation have been conducted at a single center, no comparative studies are available. Furthermore, our investigation into early mortality rates (within three months) at each hospital showed no statistically significant difference. Regarding the impact of clinical characteristics on adult patient survival, we examined the MELD score and cause of liver cirrhosis. In our study, the MELD score was not significantly correlated with patient survival. This finding aligns with that of Nagler *et al*. [34], who revealed that higher MELD scores did not negatively impact patient and graft survival following orthotopic liver transplantation (OLT). Conversely, Saab *et al*. [35] found that MELD scores of 24 or higher were highly suggestive of worse 1-year post-transplantation survival than scores below 24. This discrepancy may be due to the fact that most patients in our study had MELD scores less than 24. Cryptogenic cirrhosis was the most common cause of cirrhosis in our study, accounting for 39.62% of cases, followed by viral hepatitis (20.75%), autoimmune hepatitis (AIH) (18.87%), and alcoholic cirrhosis (12.5%). The best 1-year survival rates were observed in patients with AIH and alcoholic cirrhosis. This finding is similar to the results reported by Vogt *et al*. [36], who found no statistically significant correlation between the cause of liver cirrhosis and 1-year survival rates. Meanwhile, Jain *et al*. [37] reported that the early survival rate (0–5 years post-transplant) was better for alcoholic cirrhosis compared to other indications. In the present study, of the 47 cases, 16 patients (34%) died, whereas 31 patients (66%) survived. There was no significant correlation between patient age, age gap, and 1-year survival. This finding is consistent with that of Ryckman *et al*. [38]. However, Keeling *et al*. [39] suggested that long-term survival is inversely correlated with recipient age following a pediatric liver transplantation. The variability in the findings could stem from variations in the sample sizes across studies, as well as disparities in the environmental and genetic factors. The survival rate showed no correlation with the sex of either the donor or recipient or with sex compatibility, aligning with the findings of Takagi *et al*. [34], who revealed no significant difference in patient survival in sex-incompatible orthotopic liver transplantation (OLT). In contrast, Zhang [40] reported results that differed from those of our study. This discrepancy may be attributed to the fact that we followed patients for only one year, while the latter study followed patients for a duration exceeding five years. In our study, the BMI of the donors showed no correlation with survival outcomes, similar to the findings of Perito *et al*. [41] in pediatric donors. However, the same study indicated an increased risk of graft loss in adult donors with a BMI ≥ 35. This difference can largely be attributed to the fact that in our study, all donors had a BMI of less than 35. Regarding recipient-donor relationships, most donors were mothers, followed by fathers and brothers, with no statistically significant effect on survival. However, no similar studies are available for comparison. In our pediatric cohort, the recipients were treated at the same three hospitals as the adult recipients. We found no statistically significant correlation between the different hospitals regarding early mortality and survival rates. This is noteworthy because available studies typically focus on liver transplantation performed at a single center. In our analysis, there was no statistically significant correlation between the PELD score and post-liver transplant mortality, consistent with the findings of Oya *et al*. [42]. However, Barshes *et al*. [43] reported that PELD correlates with post-transplant survival. This

difference may be attributed to the fact that, in our study, few patients had a PELD score higher than 24. Regarding the cause of transplantation, biliary atresia, Caroli disease, and hyperoxalurea were more frequent in deceased patients than in surviving patients, with a significant difference. This finding is similar to the studies by Alex *et al*. [44] and Jain *et al*. [45], which also showed biliary atresia as the most common cause of pediatric liver transplant. However, no significant correlation was reported between the cause of transplantation and survival, while Jain *et al*. revealed that patients with biliary atresia, metabolic liver diseases, and autoimmune liver diseases had better survival rates than other patients [45]. This difference with our results may be due to differences in the number of patients studied and the duration of follow-up. The survival time in our cohort averaged 10.66 ± 0.35 months, with approximately 79% of the patients surviving for more than 1 year. This ratio is comparable to the findings of Stey *et al*. [46], who reported a 76% survival rate. However, Roberts *et al*. [47] demonstrated a 1-year survival rate of > 85%. This discrepancy may be attributed to several factors, including patient population composition. Stey *et al*. [46] and Roberts *et al*. [47] focused exclusively on adult patients, whereas our study included both adults and pediatric patients. Additionally, differences in sample sizes could also contribute to variations in survival rates owing to the high variation in the number of patients enrolled in those studies [46,47], whereas our study included 100 patients. In summary, in our study, the factors affecting survival in pediatric liver transplantation were the etiology of liver cirrhosis, with hyperoxaluria, biliary atresia, and Caroli disease carrying the worst prognosis post-LT.

Study limitations

This study focused only on the one-year follow-up post-liver transplantation; although this is an acceptable follow-up protocol, a five-year follow-up can be more representative of survival post-transplantation. The other limitation was the success in contacting only one hundred of the 200 patients referred for liver transplantation.

Conclusion

In this study, we found that the survival rate one year after LT was excellent, at over 90% in adults and 66% in children. The BMI and age gap between the donors and recipients significantly affected adult survival. Biliary atresia, Caroli disease, and hyperoxaluria had the highest 1-year mortality rate in pediatric patients.

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Conflict of interests

The authors declared no conflict of interest.

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Data sharing statement

Supplementary data can be shared with the corresponding author upon reasonable request.

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