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Living Donor Liver Transplant for Alcoholic Liver Disease: Data from the Adult-to-adult Living Donor Liver Transplantation Study

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Abstract

Background.—Alcoholic liver disease (ALD) accounts for 15%–30% of transplants performed in the United States and Europe; however, the data on living donor liver transplantation (LDLT) for ALD remain sparse. The purpose of this study was to examine the outcomes following LDLT for ALD using data from the adult-to-adult living donor liver transplantation (A2ALL) study, which represents the largest Western experience with adult-to-adult LDLT.

Methods.—A retrospective review of A2ALL data collected between 1998 and 2014 was performed. Patients were excluded if they received a deceased donor liver transplant. Demographic data, postoperative outcomes and complications, graft and patient survival, and predictors of graft and patient survival were assessed.

Results.—Of the 1065 patients who underwent LDLT during the study time period, 168 (15.8%) were transplanted for a diagnosis of ALD. Comparing patients who underwent transplant for ALD with those who were transplanted for other etiologies of liver disease, there was no significant difference in graft survival at 1 (88% versus 84%), 5 (76% versus 74%), or 10 years following transplant (55% versus 61%, $P = 0.29$). Similarly, there was no difference in patient survival at 1 (94% versus 91%), 5 (83% versus 79%), or 10 years following transplant (61% versus 66%, $P = 0.32$).

Conclusions.—LDLT for ALD results in excellent 1-, 5-, and 10-year graft and patient survival. Patients with ALD and impaired renal function have a higher risk of graft loss and death. These findings support the notion that early LDLT for patients with ALD may help optimize outcomes.

INTRODUCTION

Alcoholic liver disease (ALD) is a well-recognized indication for liver transplantation (LT); it is currently the second leading cause of liver disease leading to LT in the United States,[1] accounting for approximately 15% of LT,[2] and constitutes 20%–30% of the liver transplants performed throughout Europe.[3] Despite concerns regarding relapse to alcohol consumption

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after transplant, patient survival following LT for ALD is excellent, with 1, 5, and 10-year patient survival rates of 84%–87%, 71%–73%, and 58%, respectively.[3]

Although outcomes are comparable to LT for other etiologies of liver disease,[4–6] transplantation for ALD remains controversial. Approximately 50% of patients transplanted for ALD will return to alcohol consumption at some point following LT, with 5.6% per year returning to any type of use and 2.5% per year returning to heavy use.[7] Accordingly, the transplant community continues to debate many facets of LT for ALD, including the utility of abstinence periods before transplantation, and more recently, whether transplantation might be indicated for treatment of acute alcoholic hepatitis that is refractory to medical management.

The crux of the matter is that LT in the United States and Europe continues to rely heavily on deceased donor organs, and the mismatch between organ demand and supply persists. Living donor liver transplantation (LDLT) has been proposed as a possible solution to this organ disparity; however, the data regarding LDLT for ALD are sparse and consist largely of single-center reports from Asian countries. Our group recently published a review on LDLT for ALD, which demonstrated 1- and 5-year survival rates ranging from 82% to 100% and 78% to 87%, respectively, alcohol relapse rates of 7%–23%, and no effect of pretransplant abstinence periods on posttransplant outcomes.[8] Because these data were dependent on single-center data from Asia, the aim of the present study was to analyze the large, multicenter dataset from the adult-to-adult living donor liver transplantation (A2ALL) study to report outcomes of LDLT for ALD.

MATERIALS AND METHODS

Institutional review board approval was obtained before the initiation of this study.

Study Population

The A2ALL study included 9 North American liver transplant centers. Retrospective data were obtained on study participants who underwent A2ALL between 1998 and 2004, and prospective data were collected between 2004 and 2009, with follow-up data available through 2014. The data collected throughout the study are now housed in the data repository at the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) and available for use by investigators, after a formal application process. Both the retrospective and prospective A2ALL data were obtained from the NIDDK for secondary analyses as outlined below. In this study, our inclusion criteria were as follows: (1) received LDLT, (2) had a date of LDLT, (3) had donor data, and (4) had at least 1 date of follow-up available. As part of a subanalysis comparing LDLT with deceased donor liver transplantation (DDLT) for an indication of ALD, we also included patients in the A2ALL who had undergone DDLT for ALD.

Statistical Analyses

Recipient demographics, postoperative outcomes and complications, and donor characteristics were described with medians (interquartile ranges [IQR]) and frequencies (percentages). Cohort characteristics were stratified by (1) ALD versus other etiologies and

(2) ALD alone versus ALD with hepatitis C (HCV) among those with ALD. Differences by etiology were analyzed using Wilcoxon rank sum, Chi square, and Fisher's exact tests, as appropriate.

The Kaplan-Meier method was used to estimate graft and patient survival after LDLT. For graft survival, graft loss was defined as the first event of retransplant or death. For patient survival, the event was death. Subjects were followed from the date of LDLT to the first event of interest or last follow-up. Subjects without the event of interested were censored at the date of last follow-up.

Cox proportional hazards regression estimated hazard ratios (HRs) and 95% confidence intervals (CIs) for risk of graft loss and death by recipient characteristics known at the time of transplant. Characteristics with a univariate $P < 0.1$ were evaluated in the multivariable model. The final multivariable model was built using backward selection ($P > 0.05$ for elimination). ALD, as the primary covariate of interest, was retained in the final model to evaluate if risk of graft loss or death was independently associated with ALD. Interactions between final model covariates and ALD were evaluated. Statistical significance was set at $P < 0.05$. Statistical analyses were completed using SAS version 9.4 (SAS Institute Inc., Cary, NC).

RESULTS

The final study cohort included 1065 patients who underwent LDLT as part of the A2ALL study between 1998 and 2014. Of these patients, 168 (15.8%) underwent LT for a diagnosis of ALD, and the remaining 897 patients (84.2%) were transplanted for other etiologies of liver disease. Baseline demographic characteristics are shown in Table 1. Patients who underwent transplant for ALD were slightly older (median age 53 y [IQR 48–59] versus 52 y [IQR 44–58], $P = 0.02$), with a greater percentage of Caucasian patients (92.7% versus 89.9%, $P = 0.003$), and a greater percentage of patients with a concomitant diagnosis of HCV (44.6% versus 36.6%, $P = 0.047$). Comparing patients with a diagnosis of ALD and those with other diagnoses, there was no statistically significant difference detected in median body mass index (BMI 26.2 [IQR 23.2–29.5] versus 25.8 [IQR 23.0–29.5], $P = 0.36$), the percentage of patients with hepatocellular carcinoma (15.5% versus 15.9%, $P = 0.88$), or the percentage of patients who received a left lobe graft (5.4% versus 7.4%, $P = 0.35$). LDLT recipients with and without ALD had a similar proportion of biologically related donors (70.8% versus 64.6%, $P = 0.12$). However, the proportion of biologically related donors was significantly higher among recipients with ALD compared to those with cholestatic liver disease (PSC, PBC, or autoimmune; 70.8% versus 61.1% [176 of 288], $P = 0.04$).

With regard to complications following transplantation, there were no significant differences detected between ALD and non-ALD for hepatic artery thrombosis (5.8% versus 7.5%, $P = 0.48$), bile leak (28.6% versus 27.8%, $P = 0.85$), biliary stricture (32.5% versus 33.3%, $P = 0.84$), or rejection (8.4% versus 11.1%, $P = 0.33$).

Patients with Concomitant HCV Diagnosis

Because patients with ALD had a significantly greater incidence of concomitant HCV diagnosis and ALD is known to accelerate fibrosis in patients with liver disease,[9] we compared patients with a single diagnosis of ALD versus those with ALD and HCV. Patients with ALD and HCV were younger compared to patients with ALD alone (median age 52 y [IQR 47–57] versus 56 y [IQR 50–61], $P = 0.03$) and consisted of a greater percentage of men (80.0% versus 63.4%, $P = 0.02$). There were otherwise no significant differences in demographics or outcomes between these 2 cohorts (Table 2).

Graft Survival

Graft loss occurred in 61 (36.3%) subjects with ALD (17 retransplants and 44 deaths without retransplant) and 271 (30.2%) subjects with other etiologies of liver disease (93 retransplants and 178 deaths without retransplant). Graft survival is shown in Figure 1. Comparing patients transplanted for ALD and those transplanted for other etiologies of liver disease, there was no significant difference in graft survival at 1 (88% [95% CI, 82%–92%] versus 84% [95% CI, 82%–87%]), 5 (76% [CI, 67%–82%] versus 74% [CI, 71%–77%]), or 10 years following transplant (55% [CI, 45%–64%] versus 61 [CI, 56%–65%], $P = 0.29$). Results of the univariate and multivariable analyses are shown in Table 3. In the multivariable model, risk of graft loss was increased among patients with HCV (HR, 1.51; 95% CI, 1.21–1.87, $P < 0.001$) and elevated pretransplant creatinine (HR, 1.2 per unit increase; 95% CI, 1.10–1.43, $P < 0.001$). No statistically significant association was detected between risk of graft loss and ALD (HR, 1.09; 95% CI, 0.82–1.44, $P = 0.56$). A significant interaction between ALD and creatinine was identified with risk of graft loss per unit increase in creatinine elevated for ALD (HR, 2.21; 95% CI, 1.45–3.34) compared with other etiologies of liver disease (HR, 1.21; 95% CI, 1.04–1.40, interaction $P = 0.008$).

The precise mechanism of graft failure is limited by the coding system available in the A2ALL database. There were no significant differences in mechanism of graft failure among patients transplanted for ALD and those transplanted for other indications (Figure 2, $P = 0.11$). The most common cause of graft failure in ALD patients was recurrent hepatitis (33% versus 15% in non-ALD), whereas the most common cause of graft failure in non-ALD patients was vascular thrombosis (35.5% versus 20% in patients with ALD).

Patient Survival

Patient death occurred in 51 subjects (30.4%) with ALD and 218 subjects (24.3%) with other etiologies of liver disease. Patient survival after transplant is shown in Figure 3. Comparing patients undergoing transplant for ALD and those undergoing transplant for other etiologies of liver disease, there was no significant difference in patient survival at 1 (94% [95% CI, 89%–97%] versus 91% [CI, 88%–92%]), 5 (83% [CI, 76%–89%] versus 79% [CI, 76%–82%]), or 10 years following transplant (61% [CI, 51%–70%] versus 66% [CI, 62%–70%], $P = 0.32$). Results of the univariate and multivariable analyses are shown in Table 4. In the multivariable model, risk of death increased with recipient age at transplant (HR, 1.02 per y increase; 95% CI, 1.01–1.03, $P < 0.001$), HCV (HR, 1.43; 95% CI, 1.12–1.83, $P = 0.004$) and pretransplant creatinine (HR, 1.32 per unit increase; 95% CI, 1.16–1.51, $P < 0.001$). Survival was not associated with ALD (HR, 1.06; 95% CI, 0.78–1.44, $P =$

0.71). However, significant interactions between ALD and creatinine and between ALD and age at transplant were identified. Risk of death per unit increase in creatinine was elevated for ALD (HR, 2.48; 95% CI, 1.44–4.29) compared with other etiologies of liver disease (HR, 1.29; 95% CI, 1.11–1.48, interaction $P = 0.02$). Similarly, risk of death per year increase in age was elevated for ALD (HR, 1.07; 95% CI, 1.03–1.11), compared with other etiologies (HR, 1.02; 95% CI, 1.01–1.01, interaction $P = 0.02$).

There were no significant differences in the cause of death among patients transplanted for ALD and those transplanted for other indications (Figure 4, $P = 0.29$). The most common cause of death in ALD patients was coded as “other” (28.9% versus 16.1% in non-ALD patients), whereas the most common cause of death in non-ALD patients was infection (20.0% versus 15.8% in ALD patients). Both cohorts had a relatively high incidence of malignancy as a cause of death (26.3% ALD patients and 18.3% non-ALD).

Assessment of Era Effect

Given that the A2ALL study spanned nearly 15 years and outcomes in LDLT are known to improve with increased center experience, we evaluated transplant year for multivariable associations with patient and graft survival. Although increasing transplant year was associated with a decreased risk of patient death (HRadj, 0.94; 95% CI, 0.91–0.98, $P = 0.001$) and graft loss (HRadj, 0.95; 95% CI, 0.92–0.98, $P < 0.001$), no statistically significant interactions were detected between ALD and transplant year ($P = 0.30$ and 0.34, respectively). This suggests that the effect of transplant year is similar for patients with and without ALD.

Comparison with Deceased Donor Grafts

In the A2ALL cohort, we identified n = 86 DDLT recipients diagnosed with ALD. Among ALD transplant recipients, post-LT patient and graft survival were similar for recipients of live and deceased donor grafts. Five- and 10-year patient survival was 83% (95% CI, 76–88) and 61% (95% CI, 51–70), respectively, for LDLT recipients compared with 78% (95% CI, 67–86) and 61% (95% CI, 48–71) for DDLT recipients ($P = 0.84$). Five- and 10-year graft survival was 76% (95% CI, 68–82) and 55% (95% CI, 45–64), respectively, for LDLT recipients compared with 75% (95% CI, 64–83) and 58% (95% CI, 46–67) for DDLT recipients ($P = 0.64$).

Donor Quality of Life

Donor quality of life was assessed in the subset of donors with available data. Among the 233 donors (22% of N = 1065 study population) with predonation assessments, 36 were for candidates with ALD and 197 for candidates with other liver diseases. No statistically significant differences were identified between donors for patients with ALD and non-ALD diagnoses. Donors for ALD and non-ALD candidates had similar proportions indicating that they knew they wanted to be tested for donation right away (16.7% and 17.4%, $P = 0.91$), felt their decision to donate was voluntary (100.0% and 99.5%, $P = 1.00$), and had no doubts about donating (69.4% and 72.4%, $P = 0.71$). Statistical differences were not detected for responses regarding the donor-candidate relationship: having heated conflicts with the candidate ($P = 0.62$), having a warm relationship with the candidate ($P = 0.43$), and enjoying

the company of the candidate ($P = 0.51$). When asked if the donor saw eye-to-eye with the candidate, the median response for ALD and non-ALD donors was 5 (IQR 4–6) and 5 (IQR 5–7) on a 7-point scale (1 indicates the statement is not at all accurate to 7 indicating very accurate) with responses from donors for ALD candidates shifted toward a lower score although statistical significance was not achieved ($P = 0.08$). Differences in alcohol use between donors for ALD and non-ALD candidates also failed to achieve statistical significance (30.6% and 42.6%; $P = 0.17$).

Postdonation quality of life responses were available for 243 donors (22.8% of 1065 study subjects), 39 donors for candidates with ALD and 204 for candidates without ALD. Responses were collected at 3, 6, 12, and 24 months postdonation with the most recent response sum-marized. Greater than 75% of responses were at 1 or 2 years postdonation and timing was similar in donors to ALD and non-ALD recipients ($P = 0.83$). Postdonation life satisfaction scores were generally high for donors. Using a response scale of 1 (not true) to 10 (very true), median [IQR] for family gratitude (ALD 9 [7–10] and non-ALD 8 [6–10]; $P = 0.20$), family holds candidate in high esteem (ALD 5 [3–7] and non-ALD 5 [3–8]; $P = 0.26$), and donor feels he/she has helped the recipient significantly (ALD 10 [8–10] and non-ALD 10 [8–10]; $P = 0.61$) were similar by donation to ALD recipient. Family relationships were not deemed more difficult (ALD 1 [1–1] and non-ALD 1 [1–2]; $P = 0.10$) and did not differ significantly by donation for ALD. Furthermore, >50% of donors to ALD and non-ALD recipients indicated their relationship with the recipient was rewarding ($P = 1.00$) and comfortable ($P = 0.09$). Interaction with the recipients remained easy ($P = 0.24$) and positive ($P = 0.62$) with relationships staying the same after transplantation ($P = 0.37$) for donors to ALD and non-ALD recipients. Alcohol use in donors was also similar after donation (ALD 76.9% and non-ALD 71.1%; $P = 0.46$). Finally, on a scale of 1 (very positive) to 7 (very negative), donors for ALD and non-ALD recipients both provided a median score of 1; although responses ranged from 1 (very positive) to 3 (a little positive) for donors for ALD, the donors for non-ALD provided responses ranging from 1 (very positive) to 7 (very negative) ($P = 0.07$).

DISCUSSION

The results presented here describe the outcomes of LDLT for ALD from the A2ALL study, which represents the largest Western experience with LDLT. The significant findings of this study were 2-fold. First, this study con-firmed reports from single centers that excellent short- and long-term graft and patient survival can be achieved with LDLT for ALD and that ALD bears no significant relationship to graft or patient survival. Second, the outcomes after LDLT for ALD versus other etiologies of liver disease were not significantly different. However, we observed significant interactions between ALD and both patient age and pretransplant creatinine, suggesting that older patients with ALD, and patients with ALD and renal dysfunction, are at higher risk for poor outcomes following LDLT.

Before this study, the majority of data on LDLT for ALD was from single centers in Asia. A single, large-volume Korean transplant center published several studies between 2006 and 2014 examining their individual experience with LDLT for ALD.[10–12] The most recent study from 2014 reviewed the outcomes of 126 patients who underwent LDLT for ALD

from 2001 to 2010 and reported 1-year patient survival of 100%, 5-year survival of 87.8%, and 10-year survival of 83.7%,[10] with a relapse rate of 7.9%. Egawa and colleagues conducted 2 multicenter studies of patients undergoing LT for ALD in Japan; although the majority of patients (187 of 195) received a LDLT, all outcome analyses do include a small number of DDLT recipients.[13,14] In this population, the rates of survival at 1, 5, and 10 years posttransplant were 82.5%, 78.4%, and 50.4%, respectively, with a relapse rate of 22.9%. Our group previously examined our experience with LDLT for ALD at our single, high-volume US transplant center (University of California, San Francisco, CA). Between 2003 and 2016, our center performed 136 adult-to-adult LDLT, and 22 of these patients were transplanted for ALD.[8] One- and 5-year survival rates in patients transplanted for ALD were 95% and 79%, respectively, and these were not significantly different from those patients transplanted for other indications. The rate of relapse in this study population was 13.6%. The results of the present study demonstrate similar survival rates at 1, 5, and 10 years posttransplant, which support LDLT as an excellent option for LT in patients with ALD throughout the world.

The relationship between renal dysfunction and poor prognosis in patients with cirrhosis is well known,[15] and epidemiologic studies have shown that patients with either alcohol abuse or tobacco use have twice the baseline risk of developing chronic kidney disease, and 5 times the baseline risk if both behaviors are observed.[16] In the present study, elevated creatinine was associated with both graft failure and death in patients who underwent LDLT. Furthermore, a significant interaction was observed between creatinine and ALD, suggesting that patients with ALD and renal dysfunction at the time of transplant have a worse prognosis compared with patients undergoing transplant for other etiologies of liver disease. One benefit of LDLT is that organ availability and allocation do not rely on the Model for End-stage Liver Disease (MELD) score; as a consequence, patients may undergo transplantation before significant decompensation. The results of this study lend support for early transplantation of patients with ALD, as they appear to be at particular risk for graft loss and patient death as renal function declines.

The A2ALL cohort included 1065 patients, the majority of whom underwent transplant for cirrhosis secondary to HCV. Only 16% of the A2ALL population underwent transplant for an indication of ALD, although anywhere from 15% to 30% of patients in the United States and Europe undergo LT for ALD. Although this discrepancy may be multifactorial, one possibility is that our current policies and attitudes toward LT for ALD remain conservative. The landscape around transplantation for ALD is a complex tessellation of medicine, ethics, policy, and public opinion. In 2016, Singhvi et al published an article examining the ethics of LT for ALD; the main sociocultural values and assumptions identified as problematic were the “stigma and personal responsibility for health” and “public opinion.”[17] There remains a perception that ALD is “self-inflicted” and that patients with cirrhosis from alcohol misuse and abuse are “not only causally but also morally responsible for liver failure.”[17] Furthermore, the authors explain that because the transplant community relies on continued gifts from deceased or living donors, public opinion plays an important role in transplant policy. LDLT circumvents the need to utilize deceased donor organs and, therefore, may represent an important mechanism of providing early transplant options to patients with ALD, while eliminating the ethical quandary of allocating a limited resource to

this somewhat controversial patient population. Although qualitative data were only available for a small subset of donors in A2ALL, it was encouraging that there were no significant differences in quality of life measures postdonation for donors who donated to patients with ALD and those who donated to patients with other etiologies of liver disease. As is always the case in conversations regarding LDLT, donor safety and informed consent must take priority above all else.

This study had several limitations. First, the data used for analysis were collected as part of the A2ALL study and, as such, it was not collected to specifically examine outcomes for patients with ALD. As a result, we do not have data regarding recidivism and relapse rates for patients within the cohort. However, excellent graft and patient survival rates suggest that relapses to alcohol consumption are likely to be subclinical if they are in fact occurring. Second, although the data were compiled from 9 centers throughout North America, the patients were pre-dominantly Caucasian, with relatively low MELD scores, thus limiting generalizability to populations with a different demographic breakdown or more severe liver disease. Further, there was no consensus of the centers involved in the A2ALL study regarding criteria for transplant and abstinence in patients with ALD undergoing LT. Finally, the data collection began in 1998, which predates the MELD era. We elected to not restrict the data to the post-MELD era in attempt to maintain adequate sample sizes for statistical analysis. Despite these limitations, we believe the data presented here should support and encourage the use of LDLT for patients with ALD.

CONCLUSIONS

LDLT for ALD results in outcomes comparable with LDLT for other etiologies of liver disease, with excellent graft and patient survival at 1, 5, and 10 years posttransplant. In patients with ALD, age and elevated creatinine were associated with worse graft and patient survival, suggesting the importance of early identification and transplantation in these patients. Given its excellent outcomes, elimination of limited resource utilization, and availability independent of MELD score, LDLT appears to be an ideal option for LT in patients with ALD.

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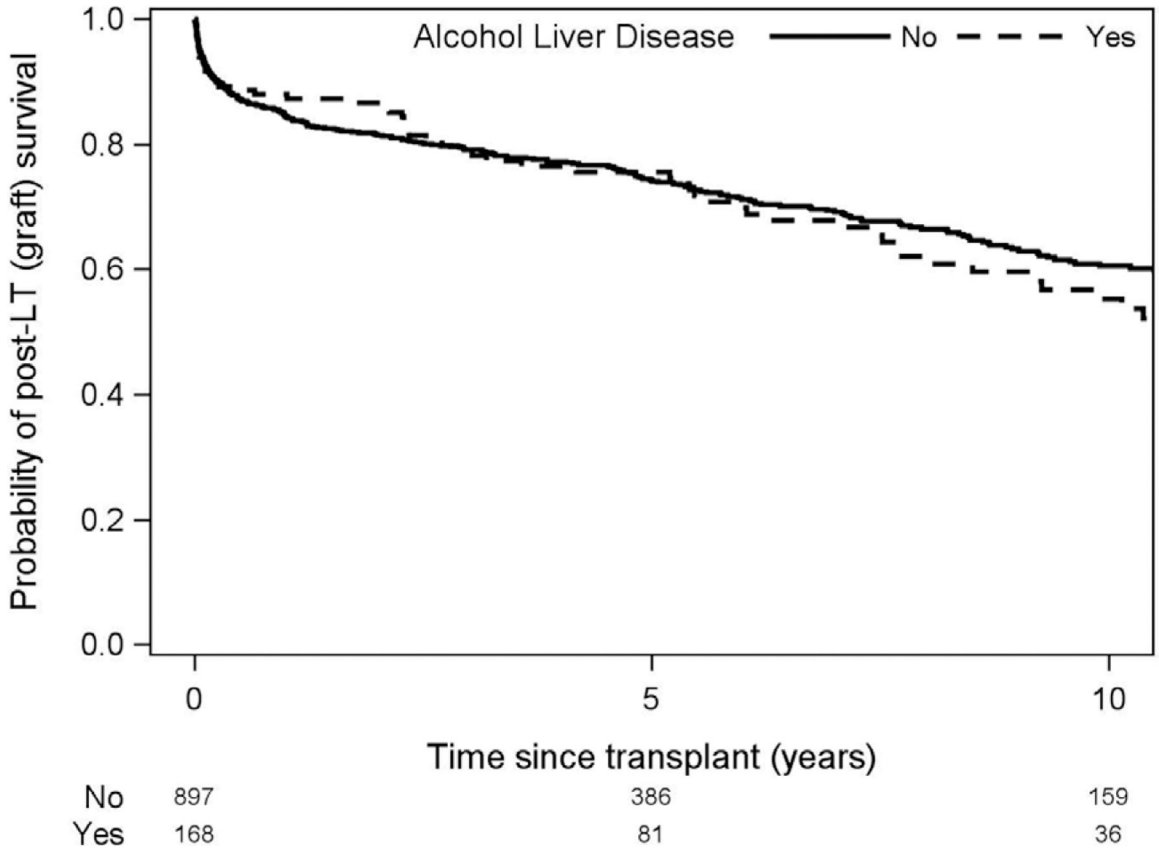

FIGURE 1.

Graft survival for alcohol liver disease compared with other indications for liver transplant.

LT, liver transplantation.

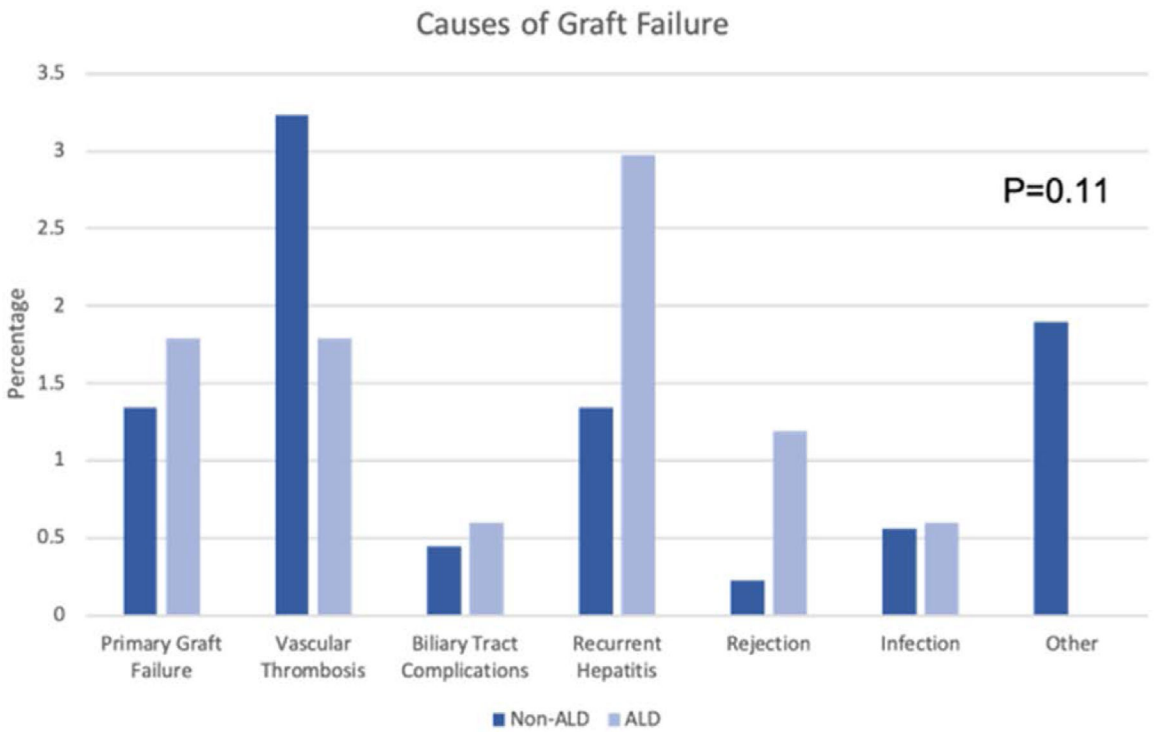

FIGURE 2.

Causes of graft survival, compared among patients with alcoholic liver disease and those with other etiologies of liver disease. ALD, alcoholic liver disease.

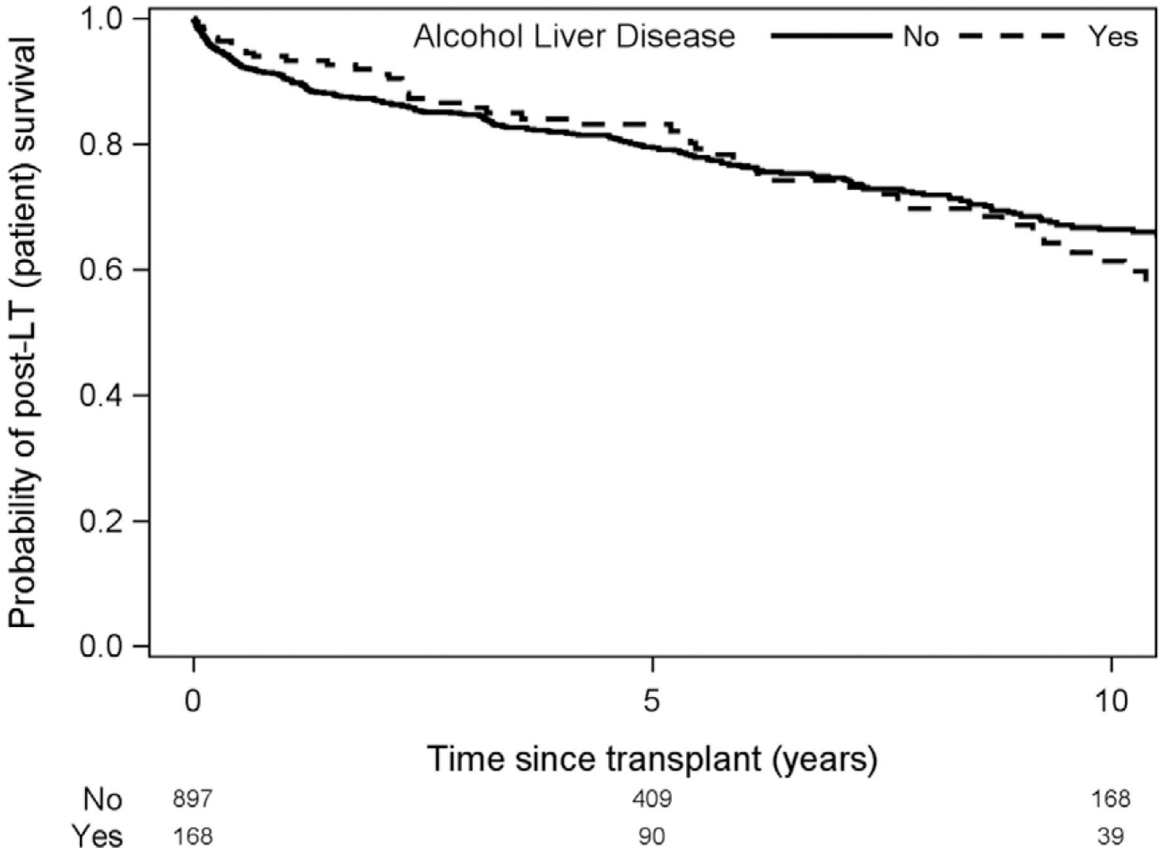

FIGURE 3.

Patient survival for alcohol liver disease compared with other indications for liver transplant.

LT, liver transplantation.

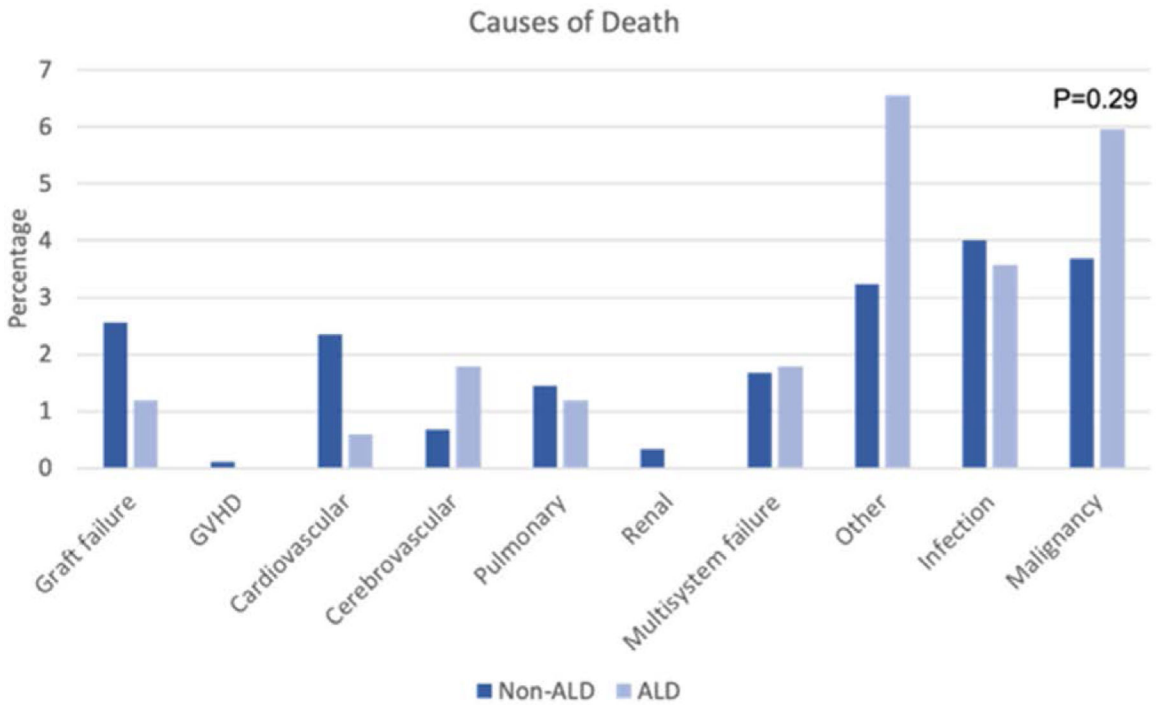

FIGURE 4.

Causes of death, compared among patients with alcoholic liver disease and those with other etiologies of liver disease. ALD, alcoholic liver disease.

TABLE 1.

Demographic and outcome data for patients transplanted for ALD vs other indications of liver disease

Variable	ALD (N = 168)	Non-ALD (N = 897)	*P*
Male, n (%)	119 (70.8)	501 (55.9)	<0.001
Caucasian	153 (92.7)	800 (89.9)	0.26
Age at transplant, median (IQR), y	53 (48–59)	52 (44–58)	0.02
HCC, n (%)	26 (15.5)	143 (15.9)	0.88
HCV, n (%)	75 (44.6)	328 (36.6)	0.048
BMI, median (IQR)	26.2 (23.2–29.5)	25.8 (23–29.5)	0.36
MELD, median (IQR)	15 (13–19)	15 (11–19)	0.15
Left lobe, n (%)	9 (5.4)	66 (7.4)	0.35
Related donor, n (%)	119 (70.8)	579 (64.6)	0.12
Hepatic artery thrombosis, n (%)	9 (5.8)	57 (7.5)	0.48
Bile leak, n (%)	44 (28.6)	213 (27.8)	0.85
Biliary stricture, n (%)	50 (32.5)	255 (33.3)	0.84
Rejection, n (%)	13 (8.4)	85 (11.1)	0.33

ALD, alcoholic liver disease; BMI, body mass index; HCC, hepatocellular carcinoma; HCV, hepatitis C virus; IQR, interquartile range; MELD, Model for End-stage Liver Disease.

TABLE 2.

Demographic and outcome data for patients transplanted for ALD vs those with ALD and concomitant HCV

Variable	ALD (N = 93)	ALD + HCV (N = 75)	*P*
Male, n (%)	59 (63.4)	60 (80)	0.02
Caucasian, n (%)	86 (93.5)	67 (91.8)	0.68
Age at transplant, median (IQR)	56 (50–61)	52 (47–57)	0.03
HCC, n (%)	11 (11.8)	15 (20.0)	0.14
BMI, median (IQR)	25.4 (23.1–29.3)	26.5 (23.9–30.6)	0.18
MELD, median (IQR)	15 (12–19)	16 (13–19)	0.48
Left lobe, n (%)	5 (5.4)	4 (5.3)	0.99
Related donor, n (%)	66 (71.0)	53 (70.7)	0.97
Hepatic artery thrombosis, n (%)	7 (8.4)	2 (2.8)	0.14
Bile leak, n (%)	23 (27.7)	21 (29.6)	0.80
Biliary stricture, n (%)	29 (34.9)	21 (29.6)	0.48
Rejection, n (%)	9 (10.8)	4 (5.6)	0.25
Retransplant, n (%)	7 (7.5)	10 (13.3)	0.21
Death, n (%)	25 (26.9)	26 (34.7)	0.28

ALD, alcoholic liver disease; BMI, body mass index; HCC, hepatocellular carcinoma; HCV, hepatitis C virus; IQR, interquartile range; MELD, Model for End-stage Liver Disease.

TABLE 3.

Univariate and multivariable models for graft survival

Variable	Univariate		Multivariable	
	HR (95% CI)	*P*	HR (95% CI)	*P*
Recipient age (tx)	1.01 (1.00–1.022)	0.02	–	
MELD (tx)	1.02 (1.01–1.04)	0.01	–	
Creatinine (tx)	1.27 (1.12–1.45)	<0.001	1.25 (1.10–1.43)	<0.001
Length of stay	1.02 (1.01–1.02)	<0.001	–	
ALD	1.16 (0.88–1.54)	0.29	1.09 (0.82–1.44)	0.56
HCV	1.60 (1.29–1.98)	<0.001	1.51 (1.21–1.87)	<0.001
Sex, female	0.77 (0.62–0.96)	0.02	–	

ALD, alcoholic liver disease; CI, confidence interval; HCV, hepatitis C virus; HR, hazard ratio; MELD, Model for End-stage Liver Disease.

TABLE 4.

Univariate and multivariable models for patient survival

Variable	Univariate		Multivariable	
	HR (95% CI)	*P*	HR (95% CI)	*P*
Recipient age (tx)	1.03 (1.01–1.04)	<0.001	1.02 (1.01–1.04)	<0.001
Recipient weight (tx)	1.01 (0.999–1.01)	0.08	–	
MELD (tx)	1.02 (1.00–1.04)	0.02	–	
Creatinine (tx)	1.36 (1.19–1.55)	<0.001	1.32 (1.16–1.51)	<0.001
Length of stay	1.02 (1.01–1.02)	<0.001	–	
ALD	1.17 (0.86–1.58)	0.32	1.06 (0.78–1.44)	0.71
HCV	1.60 (1.26–2.03)	<0.001	1.43 (1.12–1.82)	0.004
Female gender	0.77 (0.60–0.99)	0.04	–	

ALD, alcoholic liver disease; CI, confidence interval; HCV, hepatitis C virus; HR, hazard ratio; MELD, Model for End-stage Liver Disease.