ORIGINAL ARTICLE

Organ Quality and Quality of Life After Liver Transplantation

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Not only is there a limited supply of organs for liver transplantation, but the quality of the available organs is not uniform. Risk factors such as donor age and cause of death are known to predict graft failure, but their impact on the recipient's quality of life (QOL) has not been reported. We sent a QOL survey to 299 adults at our institution who had received a liver transplant 1 to 7 years before the study. For the 171 patients (57%) who completed the Medical Outcomes Study Short Form 36 (SF-36), the mean Physical Composite Score (PCS) and the mean Mental Composite Score (MCS) were 61 and 66, respectively; the highest scores were for the Social Functioning subscale, and the lowest scores were for the Role Functioning/Physical and Energy/Fatigue subscales. The mean donor risk index (DRI) of the organs that the subjects received was 1.4 (range = 0.8-2.4). There was no correlation between the SF-36 scores and the DRI [there were changes of −4.8 and −2.8 in the PCS and MCS per unit increase in the DRI ($P = 0.4$ and 0.6, respectively)], even though we controlled for potential confounders such as age, sex, hospitalization before transplantation, the Model for End-Stage Liver Disease score at transplantation, years since transplantation, previous transplantation, and the Charlson comorbidity index. In conclusion, we found no association between organ quality and QOL after liver transplantation. If this finding is confirmed in prospective, multicenter studies, it will be useful in counseling patients about the decision to accept or not accept high-risk organ offers. ***Liver Transpl 17:1443-1447, 2011.*** © **2011 AASLD.**

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Although liver disease ranks 12th overall among causes of death in the United States, the true impact on society is likely much larger because people are affected in the prime of their lives. In fact, liver disease ranks fourth overall among causes of death for people 45 to 54 years old.[1] Furthermore, end-stage liver disease leads to dysfunction in virtually every organ system, and this results in a very poor quality of life (QOL) for those affected.[2] Liver transplantation has become the best treatment for most patients with end-stage liver disease; it prolongs survival[3] and improves QOL.[2] One of its main limitations continues to be the limited supply of organs.

The organ supply is not fixed but rather depends on multiple factors, including the quality of the organs that are accepted for use. Various donor factors are known to be associated with the risk of graft failure after transplantation; these include the donor's age, the anticipated ischemia time, and donation after cardiac death.[4] Whenever an organ offer is made, the physician and the patient must make the difficult decision to accept the organ being offered or to wait and hope that a better organ will be offered.

One limitation to a physician's ability to counsel a patient about this decision is the lack of information on the ways in which donor characteristics affect a recipient's QOL, which is defined by the World Health Organization as "individuals' perceptions of their position in life in the context of the culture and value systems in which they live and in relation to their goals,

Abbreviations: DRI, donor risk index; MCS, Mental Composite Score; MELD, Model for End-Stage Liver Disease; PCS, Physical Composite Score; QOL, quality of life; SF-36, Short Form 36.

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expectations, standards, and concerns."[5] In other words, if a patient accepts a higher risk organ and survives, will he or she experience the same QOL as a recipient of an average quality liver? The answer to this question is particularly important because most high-risk organs are transplanted into patients with low Model for End-Stage Liver Disease (MELD) scores[6]; these patients are predicted to derive little survival benefit from transplantation[7] and thus may be undergoing transplantation predominantly to improve their QOL. Therefore, the aim of this study was to determine whether organ quality is associated with posttransplant QOL in liver transplant recipients.

PATIENTS AND METHODS

Subject Population

A QOL survey was mailed to adults who underwent deceased donor liver transplantation 1 to 7 years before the study. This time period was chosen because previous studies have shown that QOL after liver transplantation continues to rise until approximately 1 year after transplantation, at which time it plateaus.[2] Recipients of combined transplants were excluded. Clinical and demographic characteristics were obtained from medical charts, and the Deyo adaptation of the Charlson comorbidity index was obtained from billing data.[8] Posttransplant variables were obtained through the review of individual charts, and they included the hospital length of stay, renal failure requiring dialysis after the transplant hospitalization, biliary complications requiring a percutaneous transhepatic cholangiogram tube, and biopsy-proven rejection. Informed consent was obtained for participation, and this study was approved by our institutional review board.

QOL Measurements

We used the Medical Outcomes Study Short Form 36 (SF-36) instrument because it had been previously used in liver transplant recipients and is more sensitive than other instruments to small changes.[9] The 36 items combine to form the Physical Composite Score (PCS) and the Mental Composite Score (MCS), which range from 0 to 100, as well as 8 subscales: Physical Functioning, Role Functioning/Physical, Role Functioning/Emotional, Energy/Fatigue, Emotional Well-Being, Social Functioning, Pain, and General Health.[10] Scores are reported in raw scale units unless otherwise noted.

Organ Quality

The organ quality was measured with the donor risk index (DRI),[4] a continuous measure in which each unit increase over 1 denotes an incremental risk of graft failure with respect to the best quality organs. The individual components of the DRI include the following: the donor's age, race, height, and cause of death; the donation after cardiac death status; the organ type (split versus whole); the share type (regional or national); and the cold ischemia time. Except for the cold ischemia time (which was obtained from our hospital's transplant database), these data were obtained directly from our organ procurement organization. Imputation was performed for 12 of the 171 subjects (7%) with missing cold ischemia times, and an imputation flag was created to ensure that no bias was introduced by this method.[11] When subjects had received multiple liver transplants, the data from the most recent transplant was used.

Statistical Analysis

Bivariate comparisons were performed with the *t* test and Pearson's chi-square statistic for continuous and categorical data, respectively. Multivariate linear regression was used to determine variables independently associated with the raw scores of the SF-36 PCS and MCS as well as the 8 subscales. Although the SF-36 scores were not normally distributed, residual-versus-fitted plots demonstrated no evidence of heteroskedasticity and thus supported the use of parametric methods. Power calculations showed that a sample size of 139 would be sufficient to detect a 10-unit decrease in the SF-36 score caused by the DRI (10% of the overall SF-36 range) if $\beta = 0.8$ and $\alpha = 0.05$ were assumed. Calculations were performed with Stata 11.0 (StataCorp, College Station, TX).

RESULTS

The QOL survey was sent to 299 transplant recipients, and it was completed by 171 (57%). The respondents were less likely to be Hispanic than the nonrespondents (2% versus 11%, $P = 0.03$) but otherwise did not differ from the nonrespondents with respect to age, sex, race/ethnicity, primary diagnosis, or years since transplantation. The demographic characteristics of the survey respondents and the entire population of adult liver transplant recipients at our center during the study period are listed in Table 1.

The mean SF-36 PCS and MCS values for the 171 respondents were 61 and 66, respectively, and they were consistent with the findings of other studies of liver transplant recipients.[12] As shown in Table 2, in comparison with the US population, the transplant recipients appeared to have lower PCS values but similar MCS values.[13] Nineteen percent indicated that their QOL had not improved since transplantation or had gotten worse.

The mean DRI of the organs received by the study subjects was 1.4 ± 0.4, which was consistent with the organ quality in our transplant region.[11] In comparison, the mean DRI for the entire population of adult liver transplant recipients at our center during the study period was also 1.4. The rates of death and graft failure in the entire transplant population during the study period were 27% and 31% for recipients of organs with a DRI ≤ 1.6 (n = 310) and 36% and 38%

TABLE 1. Demographics of the Survey Respondents and All Adult Deceased Donor Liver Transplant Recipients at the Center During the Study Period

	Survey Respondents (n = 171)	All Adult Liver Transplant Recipients (n = 464)
Age at transplantation (years)	53 (18-70)	53 (18-71)
Male sex [n (%)]	105 (61)	280 (60)
Race/ethnicity [n (%)]		
White	144 (84)	376 (81)
Black	13 (8)	41 (9)
Hispanic	3 (2)	18 (4)
Other	11 (6)	29 (6)
Primary diagnosis [n (%)]		
Viral	38 (22)	115 (25)
Alcohol	20 (12)	59 (13)
Cryptogenic/fatty liver	21 (12)	56 (12)
Hepatocellular carcinoma	34 (20)	101 (22)
Cholestatic	28 (16)	64 (14)
Other	30 (18)	69 (15)
Laboratory MELD score at transplantation [median (range)]	19 (6-40)	18 (6-40)
Previous liver transplantation [n (%)]	13 (8)	39 (8)

TABLE 2. SF-36 Scores of the Survey Respondents (n = 171)

	Raw Score	Norm-Based Score
PCS	61 ± 25	43
MCS	66 ± 22	49
Physical Functioning	67 ± 26	43
Role Functioning/Physical	51 ± 44	42
Role Functioning/Emotional	68 ± 41	45
Energy/Fatigue	51 ± 24	47
Emotional Well-Being	73 ± 18	49
Social Functioning	75 ± 26	46
Pain	62 ± 30	47
General Health	56 ± 24	43

NOTE: Raw scores are expressed as means and standard deviations on a 0 to 100 scale, whereas norm-based scores are compared to 1998 US population data with a mean of 50 and a standard deviation of 10.

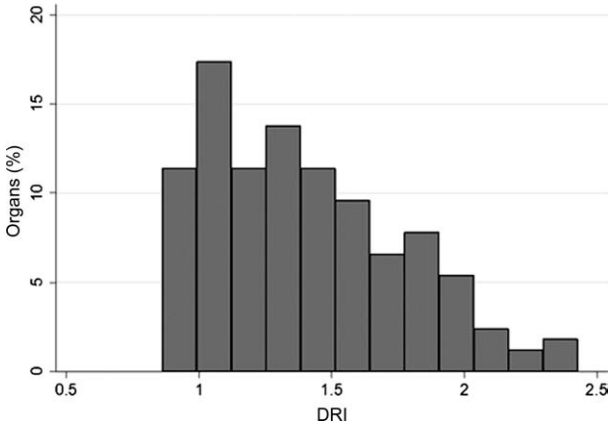

Figure 1. DRI distribution for the organs received by the study subjects.

for recipients of organs with a DRI > 1.6 (n = 154; $P = 0.04$ and $P = 0.1$, respectively).

The DRI distribution for the survey respondents is shown in Fig. 1. Subjects who received a transplant in more recent years tended to have higher DRI organs, and so did those with lower laboratory MELD scores at transplantation ($P < 0.05$ for both comparisons). However, there was no association between the DRI and posttransplant QOL by the PCS, the MCS, or any individual subscale. When the organs were categorized into high-risk organs (DRI > 1.6) and standard-risk organs, the PCS and MCS were 61 and 66, respectively, in the standard risk group and 60 and 66, respectively, in the high-risk group (P = not significant). As shown in Table 3, this lack of an association persisted even after we controlled for multiple potential confounders, including the recipient's age and sex, the years since transplantation, the MELD score at transplantation, the history of previous transplantation, the comorbidity index, and the hospitalization status immediately before transplantation. Subjects who reported that their QOL had not improved with transplantation were distributed equally according to the quality of the organs that they had received: 18% in the standard-risk group and 24% in the high-risk (DRI > 1.6) group ($P = 0.4$).

Posttransplant complications are shown in Table 4 for subjects who received standard-risk organs and subjects who received high-risk organs. In this population of study patients who survived for at least 1 year after transplantation, the recipients of high-risk organs had similar lengths of stay in comparison with the recipients of standard-risk organs, and they were

TABLE 3. Multivariate Analysis of Pretransplant Factors Associated With the SF-36 PCS and MCS

	PCS		MCS	
Factor	Coefficient	*P* Value	Coefficient	*P* Value
DRI	−4.8	0.4	−2.8	0.6
Sex	0.8	0.8	4.7	0.2
Current age (years)	−0.3	0.3	0.2	0.3
MELD score at transplantation	−0.2	0.5	−.06	0.8
Years since transplantation	0.3	0.8	0.6	0.5
Previous transplantation	11.5	0.2	10.9	0.1
Charlson comorbidity index	0.1	0.9	0.5	0.4
Hospitalized at transplantation	−2.7	0.7	−4.7	0.4

NOTE: Coefficients should be interpreted as changes in the SF-36 score per unit increase in the DRI.

TABLE 4. Posttransplant Complications According to the Quality of the Organ

Complication	High-Risk Organ (DRI > 1.6) Recipients (n = 52)	Standard-Risk Organ Recipients (n = 119)	*P* Value
Length of stay [days; median (range)]	10 (5-69)	10 (4-101)	0.2
Dialysis beyond transplant hospitalization [n (%)]	2 (4)	14 (12)	0.1
Biliary complications requiring percutaneous transhepatic cholangiography [n (%)]	7 (13)	14 (12)	0.8
Biopsy-proven rejection [n (%)]	3 (6)	26 (22)	0.01

no more likely to require dialysis or a percutaneous transhepatic cholangiogram tube. The recipients of high-risk organs had lower rates of biopsy-proven rejection than recipients of standard-risk organs ($P = 0.01$).

DISCUSSION

This study has found that organ quality, as measured by the DRI, does not appear to affect posttransplant QOL. The SF-36 PCS and MCS values were virtually identical for subjects who received standard-risk organs and subjects who received high-risk organs (DRI > 1.6). This lack of a clinically or statistically significant association persisted despite adjustments for multiple potential confounders, such as age, medical comorbidities, and the pretransplant severity of liver disease.

It is important to reiterate that subjects in this study had to survive for at least 1 year after transplantation to be included, and the time since transplantation was 4 years on average. Because the DRI is known to be a strong predictor of graft failure within the first 1 to 3 years, the QOL implications of these findings are contingent upon the survival of patients for these first years. This survival bias likely explains the lack of an association between organ quality and posttransplant complications. Additionally, not all patients experienced improvements in QOL: 19% felt that they were no better or were even worse since transplantation. Therefore, patients can be counseled as follows: if they accept a high-risk organ and do not die from graft failure, their QOL may be no worse than it would have been if they had received a standard-risk organ. Indeed, their QOL would be much better than it would have been if they had died on the waiting list, and this could be the outcome for patients with high MELD scores who decline a high-risk organ.

The first limitation of this study is the relatively small proportion of very high-risk organs (DRI > 2). Further studies are needed to determine whether such organs, which are less than 10% of liver transplants nationwide,[11] are associated with worse QOL after transplantation. Second, the sample size was powered to detect a 10-unit change in the SF-36 score. A less than 10-unit impact of organ quality on QOL could be clinically significant and could have been missed. Third, this was a single-center study. Variations in surgical techniques at different centers could theoretically interact with organ quality and thus influence posttransplant QOL via biliary complications or other complications. Furthermore, variations between centers in organ utilization and recipient/graft matching might limit the generalizability of these findings. A final limitation of this study is its cross-sectional design, which may be less sensitive than a longitudinal design for the detection of minor changes in QOL and also fails to account for pretransplant QOL. It is possible that patients with worse pretransplant QOL tended to receive better quality organs, even after we controlled for variables such as the MELD score.

In summary, organ quality does not appear to affect QOL after liver transplantation, at least among recipients of low- to moderate-risk organs and among patients who survive at least 1 year after transplantation. If these findings are confirmed in multicenter,

prospective studies, they can be used to counsel patients when they are making difficult decisions about organ acceptance.

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