ORIGINAL ARTICLE

Longterm Health-Related Quality of Life After Living Liver Donation

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There are little data on longterm outcomes, health-related quality of life (HRQoL), and issues related to living donor right hepatectomy specifically. We studied longterm HRQoL in 127 living liver donors. A donor-specific survey (DSS) was used to evaluate the living liver donor morbidity, and the 36-item short-form health survey (short-form 36 health survey, version 1 [SF-36]) was used to assess generic outcomes. The DSS was completed by 107 (84.3%) donors and the SF-36 by 62 (49%) donors. Median follow-up was 6.9 years. Of the 107 donors, 12 (11.2%) donors reported their health as better, whereas 84 (78.5%) reported their health the same as before donation. Ninety-seven (90.7%) are currently employed. The most common postdonation symptom was incisional discomfort (34%). Twenty-four donors (22.4%) self-reported depression symptoms after donation. Ninety-eight (91.6%) rated their satisfaction with the donation process ≥ 8 (scale of 1-10). Three factors—increased vitality (correlation, 0.44), decreased pain (correlation, 0.34), and a recipient who was living (correlation, 0.44)—were independently related to satisfaction with the donor experience. Vitality showed the strongest association with satisfaction with the donor experience. Mental and physical component summary scale scores for donors were statistically higher compared to the US population norm ($P < 0.001$). Donors reported a high satisfaction rate with the donation process, and almost all donors (n = 104, 97.2%) would donate again independent of experiencing complications. Our study suggests that over a longterm period, liver donors continue to have above average HRQoL compared to the general population. ***Liver Transpl 22:53-62, 2016***. © **2015 AASLD.**

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Liver transplantation remains the only treatment for end-stage liver disease. Sadly, there is a shortage of deceased donors needed to meet the demands. In 2012, there were over 16,000 patients on the waiting list for a liver, 6878 underwent transplantation and 6999 died while waiting.[1] Of those receiving a transplant, 96% received deceased donor transplants and only 4% were living donor liver transplantations (LDLTs).[1] Increasing LDLT represents a possible alternative to help alleviate the organ shortage. However, the safety of the donor must be of paramount consideration, and potential donors should have a broad, clear understanding of the potential short-term and longterm effects of LDLT on the donor. The donor operation has well-documented early risks: (1) mortality rates of 0.4%-0.5% for right lobe and 0.09% for left lobe donation[2,3] and (2) surgical morbidity 38%-47%.[4-7]

LDLT is one of the most selfless and humane acts a person can perform. It is the responsibility of the transplant community to educate the donors on all aspects of the donation process, including early quality of life (QoL) as well as QoL years after donation.

Abbreviations: CI, confidence interval; DSM IV, Diagnostic and Statistical Manual of Mental Disorders, edition 4; DSS, donor-specific survey; HRQoL, health-related quality of life; LDLT, living donor liver transplantation; MCS, mental component summary; PCS, physical component summary; QoL, quality of life; SF-36, short-form 36 health survey, version 1.

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Continued research in this area cannot be over emphasized. For example, living donor kidney transplants have been performed since the 1950s, and all studies until now have shown the short- and longterm safety of donation; however, Muzaale et al.[8] recently published data suggesting that kidney donors have an increased risk of end-stage renal disease when compared to healthy matched nondonors. This only strengthens the argument that continued research in organ donation is of vital importance.

There are little data on longterm outcomes, health-related quality of life (HRQoL), and donor-specific concerns.[9] Ladner et al.[5] recently published a longterm QoL study using the short-form 36 health survey, version 1 (SF-36) but did not include donor-specific aspects. In addition, the length of follow-up in most previous studies has been fairly short. Parikh et al.[10] published a systematic review in 2010 of 19 QoL studies, and median follow-up range was 9-13.7 months. In 2010, Adcock et al.[7] from the University of Toronto published longterm outcomes of 202 donors with mean follow-up time of 33.9 months and concluded that longterm medical and psychiatric complications were relatively rare; but again, they focused on complications and did not assess any HRQoL metrics. Additionally, this study was a retrospective chart review, and for some donors, they relied on the visits with general practitioners who may not inquire about liver donor–specific issues or psychiatric issues.[7] In 2012, Takada et al.[11] published a historical cohort study describing their longterm results using the SF-36 (mean follow-up, 6.8 years). Although the mean follow-up time period is excellent and they did take into account multiple comorbidities (such as hypertension; diabetes; cerebrovascular disease; myocardial infarction; hyperlipidemia; angina pectoris; heart failure; anemia; eye, pulmonary, gastrointestinal, renal, or genitourinary disease; arthritis or rheumatism; dermatological, neurological, psychiatric, endocrine, gynecological, or pancreatic disease; and cancer), it was a HRQoL study without donor-specific issues being assessed.[11]

One aspect missing from other longterm studies was a lack of donor-specific evaluation addressing symptoms and issues related to the right donor hepatectomy specifically experienced by living donors after donation both physically and psychologically.[10-12] Parikh et al.[10] review of the liver donor literature reported between 4% and 26% of donors experience some level of psychological morbidity, and Trotter et al.[13] confirmed that some donors experience severe psychiatric complications. Even more disturbing, Castedal et al.[9] found that only 53% of donors reported being well informed about the potential longterm complications and that 47% stated they had little to no information on the longterm effects of donation. This emphasizes the importance of more longterm studies in living liver donors to allow for a more complete informed consent. In this study, we explore the health status of living liver donors and prevalent longterm morbidity as a result of liver donation focusing on psychosocial outcomes and satisfaction with the donor experience. This was our attempt to combine a QOL study with specific concerns from the right lobe hepatectomy.

PATIENTS AND METHODS

This study was approved by the institutional review board at the University of Minnesota (No. 0301M39762). All living liver donations performed at the University of Minnesota between 1997 and 2011 with a minimum of 2 years or more postdonation follow-up were included in the study. Donor demographic data and postoperative complications were gathered from a clinical transplant database that is prospectively maintained for the program. Donors follow up with the institution immediately after the operation, at 1 year, and at 2 years and are called yearly thereafter. The database of complications includes complications up to 1 year after donation. Early postoperative complications were defined as complications occurring within 1 year after donation and were categorized according to the Clavien classification scheme. The donor survey packet consisted of 2 surveys: (1) a donor-specific survey (DSS) designed to address donor concerns about LDLT (Fig. 1) and (2) the RAND version of the SF-36 to assess HRQoL.[14-16]

Because there was no standardized liver donor survey available for use, we developed a DSS based on a literature review of living liver donation.[2-7,9-13,17-23] The annotated version of the survey shown in Fig. 1 broadens the scope of outcomes assessment to include specific symptoms and complications associated with liver donation in earlier studies. Before use, the DSS was reviewed for face validity, and revisions were made for donor self-administration by mail and telephone interview. Construct validity was evaluated using a multitrait-multimethod matrix that was composed of DSS items and scale scores derived from the SF-36 generic health survey. This analysis was restricted to ongoing symptoms with a prevalence of at least 10%.

Generic health status was measured using SF-36.[14-16] This measure has been shown to have acceptable reliability and to be valid as a measure of HRQoL assessment in a number of patient groups (diseased and healthy) across disparate cultures. Responses from the SF-36 can be used to create 8 health scores: physical functioning, role-physical, bodily pain, general health, social functioning, vitality, role-emotional, and mental health. The scale scores are used to create the component summaries, physical component summary (PCS) and mental component summary (MCS) scores. SF-36 scale scores were normalized to the US population permitting comparison of donor responses to the US population norm.

Before administration of the surveys, donors were called and consent was obtained for study participation. A telephone interview was used for completing the DSS; the SF-36 was dispersed using a mailed self-administered questionnaire. For the telephone interviews, professionally trained student interviewers were employed. All interviews used a standard script.

Living Liver Donor Follow-up Survey

Name_____ Today's Date _____

1. Compared to the time period before donation, how would you rate your health now?

☐ Worse than before donation ☐ Same as before donation ☐ Better than before donation

2. Have you experienced any of the following ongoing since your donation?

(Check one box on each line)	Yes ▼	No ▼
a. GERD/heartburn.	1☐	2☐
b. Persistent nausea	1☐	2☐
c. Vomiting	1☐	2☐
d. Diarrhea	1☐	2☐
e. Flatulence (gas)	1☐	2☐
f. Intolerance to fatty meals	1☐	2☐
g. Change in eating frequency	1☐	2☐
h. Change in eating habits	1☐	2☐
i. Weight loss	1☐	2☐
j. Incisional discomfort	1☐	2☐
k. Rib pain	1☐	2☐
l. Has a doctor ever diagnosed you with keloid scars?	1☐	2☐
m. Has a doctor ever diagnosed you with an enlarged remaining segment of liver causing health issues?	1☐	2☐
n. Depression not treated with medications	1☐	2☐
o. Depression treated with medications	1☐	2☐

3. Since your donation, have you experienced worsening of any medical condition present before the surgery? 1☐ Yes .....2☐ No *If yes, please explain:*

4. Since your donation, have you experienced any other new problems aside from those described above? 1☐ Yes .....2☐ No *If yes, please explain:*

5. On a scale of 1-10, how would you rate your overall satisfaction with your donation experience? Scale range from 1 being extremely unsatisfied to 10 being extremely satisfied.

(Circle one) 1 2 3 4 5 6 7 8 9 10

6. Compared to the time before donation, how would you rate your self-esteem now?

1☐ Worse than before donation

2☐ Same as before donation

3☐ Better than before donation

7. Are you currently employed, either part-time or full-time?

1☐ Yes .....2☐ No

If No, do you feel your unemployment is a direct result of having donated?

1☐ Yes .....2☐ No *If yes, please explain:*_____

8. Is the recipient you donated to still alive?

1☐Yes..... 2☐No.....3☐ Unknown

If Yes, are they currently in good health? 1☐Yes 2☐No… 3☐ Unknown

If No, was their death due to their liver transplant? 1☐Yes…2☐No… 3☐ Unknown

9. Based on your experience, would you do it over and donate again?

1☐ Yes .....2☐ No

10. Please provide any suggestions for improvement to our donation process:

_____

_____

Figure 1. The DSS.

A $10 monetary incentive was provided for completion of the DSS, and a $15 incentive was provided for the SF-36 survey. We specifically paid more for completion of the SF-36 survey because more time is needed to complete the survey compared to the DSS.

Statistical Analyses

Categorical variables were summarized as counts and percentages; continuous variables were summarized as a means and standard error of the mean. A multitrait-multimethod matrix was used to summarize the correlations between outcome variables. The correlations between SF-36 scale scores and morbidities due to donation were used to evaluate construct validity. Reliabilities were summarized along the matrix diagonals. Reliability for the multi-item SF-36 scales expressed a Cronbach's alpha; reliability for single-items were estimated as the lower-bound for reliability, ie, the correlation between the item and the most similar score from the SF-36. For example, it is hypothesized that self-reported depression would be most strongly related to the MCS scores derived from the SF-36.

Multivariate logistic regression was used to evaluate independent risk factors for depression. Evidence for an association between risk factors and the prevalence of depression was evaluated in terms of an adjusted odds ratio. Multivariate regression model fit was evaluated for discrimination using the area under the curve. Calibration of the multivariate logistic model was tested using the Hosmer-Lemeshow chi-square. Satisfaction with the donation experience was evaluated using least-squares linear regression. The results from this driver analysis were expressed as an analysis of variance with independent drivers summarized as unstandardized and standardized coefficients. All analyses were performed using SAS/STAT, version 9.3 (SAS Institute, Chicago, IL).

RESULTS

The study cohort consisted of 127 living liver donors between 2 years and 16 years after donation. Of these, 108 (85.0%) were right lobe adult-to-adult donations, 18 (14.2%) were left lateral segment donors to pediatric recipients, and one was a domino liver donor and excluded from the study. Five donors were lost to follow-up (2 were incarcerated, 1 out of the country, and 2 unknown). Of the 127 donors, 107 donors responded to the DSS (84.3%) and 62 responded (48.8%) to the SF-36. Median follow-up was 6.9 years.

Demographics

Characteristics of responders and nonresponders to the DSS can be seen in Table 1. There were statistical differences between responders and nonresponders by age ($P = 0.03$) and sex ($P = 0.02$). Our responders tended to be older and female. Recipient deaths were more common in the nonresponders ($P < 0.001$). Eighty-six (80.4%) of the donors' recipients were still alive at follow-up, and 21 (19.6%) were deceased (of those that responded). Of the recipients alive, 69 (80.2%) were reported to be in good health, and 17 (19.8%) were in poor health or status unknown.

Reliability and Construct Validity for the DSS and SF-36

The intercorrelation of the SF-36 scale score and DSS items are shown in Table 2. Arranged in the form of a multitrait-multimethod matrix, the estimates of reliability are provided along the diagonal. The SF-36 scale scores were moderately intercorrelated with one another, whereas the single-item symptoms are weakly

TABLE 1. Characteristics of Living Liver Donors Responding and Not Responding to the SF-36 and Living Liver Donor-Specific Follow-up Survey

	Nonresponders (n = 20)	Responders (n = 107)	Total (n = 127)	*P* Value
Donor age group				0.032
19 to 34 years	13 (65.0)	38 (35.5)	51 (40.2)	
35 to 44 years	4 (20.0)	38 (35.5)	42 (33.1)	
45 to 54 years	2 (10.0)	30 (28.0)	32 (25.2)	
55 years or older	1 (5.0)	1 (0.9)	2 (1.6)	
Sex, female, donor	6 (30.0)	65 (60.7)	71 (55.9)	0.023
Race				
White donor	18 (90.0)	100 (95.3)	120 (94.5)	0.338
Hispanic donor	2 (10.0)	7 (6.5)	9 (7.1)	0.580
Years from donation				0.774
2 to 4 years from donation	1 (5.0)	10 (9.3)	11 (8.7)	
5 to 10 years from donation	12 (60.0)	65 (60.7)	77 (60.6)	
More than 10 years from donation	7 (35.0)	32 (29.9)	39 (30.7)	
Donor Relationship				0.072
Living related	17 (85.0)	69 (64.5)	86 (67.7)	
Living unrelated	3 (15.0)	38 (35.5)	41 (32.3)	
Donor relationship				0.125
Parent	6 (30.0)	9 (8.4)	15 (11.8)	
Child	7 (35.0)	29 (27.1)	36 (28.3)	
Sibling	2 (10.0)	18 (16.8)	20 (15.7)	
Other relative	2 (10.0)	13 (12.1)	15 (11.8)	
Not related	3 (15.0)	38 (35.5)	41 (32.3)	
Recipient status				
Recipient deceased	8 (40)	21 (19.6)	29 (23)	<0.001

NOTE: All data are given in n (%).

associated. The Cronbach's coefficient alpha exceed 0.8 for the SF-36 scale scores and the component summary scale scores. The lower-bound reliability for the symptom questions were indirectly estimated using a corresponding component summary from the SF-36. These results suggest that among the single-item questions, self-reported depression, and change in eating habits likely provide the most stable measures. These relatively correlations are not too surprising given the weak associations found between generic and specific patient-reported measures that were reported.

Donor-Specific Survey

The results of the DSS are shown in Table 3. The answers were stratified between those donors reporting depression and those not reporting depression.

In relation to current health, 11 (10.3%) donors reported their health as better, 84 (78.5%) reported their health as the same, and 12 (11.2%) reported their health as worse than before donation (Table 3). Self-esteem compared to before donation was reported better by 33 (30.8%) donors, same by 70 (65.4%), and worse by 4 (3.7%). Of the 107 responders, 97 donors (90.7%) reported being currently employed, and 10 (9.3%) reported being unemployed after donation. None of the donors felt that donation was the cause of their unemployment. Sixty-nine (64.5%) donors reported no new health problems since donation, and 38 (35.5%) reported new health problems since donation (Table 4). One hundred (93.5%) donors reported no worsening of their predonation medical conditions, and 7 (6.5%) reported some worsening. The medical conditions reported to worsen were back/neck pain, insomnia, intolerance to fatty meals, weight gain, worsening of "delicate digestive system," worsening of cognitive abilities (described as brain fog), and arthritis. Twenty-four donors (22.4%) reported current depressive symptoms or clinically diagnosed depression, and 83 (77.6%) reported no issues with depression. Of the 24 reporting depression, 8 (33%) were male and 16 (66%) were female. Eleven (45.8%) donors reporting depression had been diagnosed with depression before donation and 13 (54.2%) had no history of depression before donation.

The most commonly reported postdonation symptoms are shown in Fig. 2. Incisional discomfort was the most frequently reported. We further evaluated the number of symptoms reported by our donors and 37 (34.6%) reported no current symptoms, 48 (44.9%) reported 1 to 2 symptoms, 16 (15.0%) reported 3 to 4 symptoms, and 6 (5.6%) reported 5 or more symptoms.

We looked at the early postoperative complications incurred by donors in our series. Fifty-four of the 127 donors had complications (complication rate of 42.5%). Subdivided into left and right lobe donation,

TABLE 2. Multitrait-Multimethod Matrix for SF-36 Scale Scores and the DSS

	Physical Functioning	Role-Physical	Bodily Pain	Social Functioning	Health Perception	Vitality	Role-Emotional	Mental Health	PCS	MCS	Health Transition	Heartburn	Diarrhea	Flatulence	Intolerance to Fatty Meals	Change in Eating Habits	Weight Loss	Incisional Discomfort	Depression	Number of Symptoms	Worsening Health Condition	New Health Problems
Physical Functioning	0.91																					
Role-Physical	0.09	0.83																				
Bodily Pain	0.51*	0.22	0.86																			
Social Functioning	0.44*	0.41*	0.34*	0.82																		
Health Perception	0.21	0.28*	0.31*	0.49*	0.82																	
Vitality	0.18	0.24	0.29*	0.60*	0.42*	0.84																
Role-Emotional	0.29*	0.16	0.29*	0.66*	0.27*	0.41*	0.82															
Mental Health	0.32*	0.23	0.19	0.62*	0.21*	0.65*	0.55*	0.92														
PCS	0.50*	0.42*	0.75*	0.27*	0.62*	0.19*	–0.06	–0.10	0.91													
MCS	0.24	0.22	0.18	0.80*	0.34*	0.75*	0.82*	0.87*	–0.11	0.88												
Health Transition	0.12	–0.06	0.10	0.08	0.40*	0.19	0.11	0.15	0.19	0.15	0.40											
Heartburn	0.06	–0.06	0.05	–0.04	–0.11	–0.03	–0.13	0.12	–0.02	–0.03	–0.17	0.11										
Diarrhea	0.04	–0.01	0.10	0.19	–0.09	0.09	0.00	0.24	–0.04	0.15	–0.15	0.27*	0.09									
Flatulence	0.11	–0.01	–0.08	0.04	–0.25	–0.08	–0.20	0.02	–0.07	–0.09	–0.12	0.14	0.33*	0.25								
Intolerance to Fatty Meals	0.02	0.14	0.03	–0.03	–0.16	0.02	–0.07	0.12	–0.02	0.00	–0.08	0.40*	0.30*	0.46*	0.16							
Change in Eating Habits	–0.12	0.09	–0.26*	–0.16	–0.52*	–0.15	–0.17	0.00	–0.34	–0.11	–0.12	0.19	0.21*	0.05	0.47*	0.52						
Weight Loss	–0.11	0.05	–0.05	–0.12	–0.21	–0.12	0.07	0.08	–0.19	0.01	0.22*	–0.08	0.04	–0.07	0.01	0.23*	0.23					
Incisional Discomfort	–0.05	0.05	–0.13	–0.20	–0.18	–0.25	–0.36*	–0.30*	0.03	–0.35*	–0.20*	–0.04	–0.01	0.25*	–0.12	0.04	–0.04	0.13				
Depression	–0.31*	0.05	–0.27*	–0.25	–0.01	–0.11	–0.46*	–0.38*	0.03	–0.39*	–0.04	0.12	0.06	0.16	0.23*	0.28*	0.01	–0.01	0.39			
Number of Symptoms	–0.08	0.03	–0.17	–0.21	–0.47*	–0.23	–0.33*	–0.06	–0.21	–0.24	–0.23*	0.46*	0.56*	0.48*	0.60*	0.62*	0.22*	0.41*	0.24*	0.47		
Worsening Health Condition	–0.43*	–0.04	–0.28*	–0.35*	–0.26*	–0.24	–0.36*	–0.26*	–0.22	–0.32*	–0.16	0.00	0.08	0.02	0.11	0.13	0.15	–0.03	0.22*	0.16	0.26	
New Health Problems	–0.23	0.09	–0.28*	–0.23	–0.31*	–0.10	–0.39*	–0.16	–0.18	–0.24	–0.20*	0.15	0.19	0.17	0.31*	0.26*	0.06	0.13	0.30*	0.37	0.20*	0.31

*P values < 0.05.

TABLE 3. Donor Employment Status, Self-esteem, Recipient Status, Donor Health Status, Donor Symptoms, and Satisfaction with Donation as Reported in the DSS

	Total (n = 107)
Self-esteem	
Worse than before donation	4 (3.7)
Same as before donation	70 (65.4)
Better than before donation	33 (30.8)
Currently employed	97 (90.7)
Unemployed because of donation	0 (0.0)
Recipient outcome	
Alive	86 (80.4)
Deceased	21 (19.6)
Recipient in good health	
Yes	69 (80.2)
No or unknown	17 (19.8)
Yes	3 (14.3)
No or unknown	17 (81.0)
Postdonation outcome	
Worse than before donation	12 (11.2)
Same as before donation	84 (78.5)
Better than before donation	11 (10.3)
Symptoms	
Heartburn	15 (14.2)
Nausea	5 (4.7)
Vomiting	0 (0.0)
Diarrhea	18 (17.0)
Flatulence	12 (11.4)
Intolerance to fatty meals	25 (23.4)
Change in eating frequency	8 (7.5)
Change in eating habits	13 (12.3)
Weight loss	4 (3.8)
Incisional discomfort	36 (34.0)
Rib pain	8 (7.5)
Keloid scars	4 (3.8)
Enlarged liver	0 (0.0)
Number of symptoms	
0	37 (34.6)
1 to 2	48 (44.9)
3 to 4	16 (15.0)
5 or more	6 (5.6)
Worsening of medical condition since donation	7 (6.5)
New health problems since donation	38 (35.5)

NOTE: All data are given in n (%).

TABLE 4. Prevalent Health Problems Reported by 38 Donors Since the Time of Donation

Health Problem	n
Scar tissue causing abdominal pain	4
Incisional hernias requiring surgical repairs	4
Headaches	1
Weak core strength in multiple patients	3
Neck/low back pain	3
Bowel obstruction	2
Fatigue	2
Intolerance/decreased tolerance to alcohol	2
Syncopal episode	1
Diabetes	1
Herniated disk	1
"Liver congestion"	1
Breech pregnancies	1
Low platelets	1
Sinus issues resolved by septoplasty	1
Abdominal pain related to digestion issues	1
Shingles	1
Eczema	1
Cutaneous sensitivity at scar	1
Lung nodules	1
Hashimoto's thyroiditis	1
Hypertension	1
Short-term memory loss	1
Nodule on the "throat"	1
Depression	1
Glaucoma	1
Fecal urgency after eating	1
Torn meniscus	1
Brain tumor on chemotherapy	1

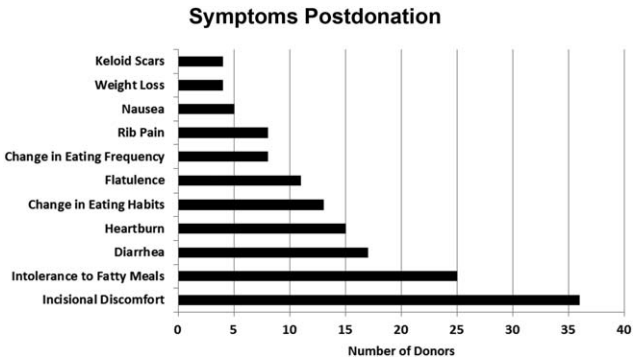

Figure 2. Symptoms reported after donation.

5 (27.8%) of the 18 left lobe donations had complications and 49 (45.4%) of the 108 right lobe donations had complications. There were significantly more complications in the right lobe group than the left lobe group ($P < 0.001$). Forty-five of 54 donors with complications completed the survey. Thirty-seven (82%) donors had Clavien class I or II complications, 1 (2.2%) Clavien class IIIa (bile leak drained percutaneously), and 7 (15.6%) Clavien class IIIb (5 hernias and 2 re-exploration for bleeding). The nonresponders were also evaluated. Nine (16.7%) of the 54 patients who had early postoperative complications did not respond. Complications did not seem to affect donors' willingness to complete the survey ($P = 0.65$). Thirty-nine of the 45 responders (86.7%) who had postoperative complications still rated their satisfaction score at an 8 to 10. Six of the 9 donors reporting low satisfaction scores had early postoperative complications. This consisted of 3 Clavien I complications and 3 Clavien II complications. There was no association with low satisfaction

TABLE 5. Living Liver Donor Open-Ended Comments and Suggestions for Improvement in the Donation Process at University of Minnesota

Living Donor Liver Open-Ended Responses
Excellent job, no suggestions for improvement, n = 59
Suggestions for improvement, n = 48
Nursing Issues
Increase nurse to patient ratio
Improve nurse discharge teaching
Improve professionalism from nurses
Quicker response to call button
Provide education regarding the following:
Details about scar
GB removal
Postcholecystectomy digestive symptoms
Recovery times
Obtaining insurance after donation
Pain during recovery
Diet during recovery
Postoperative depression
Side effects of pain medications (constipation)
Facilities
Extra bed for guest to stay over night
Physical therapy
Donor Evaluation
Reduce time it takes to work up a donor
Raise minimum age for donation
More rigorous evaluation about decision to donate
Depression screening
Schedule workup at local hospital for nonlocal donors
More follow-up after donation by transplant center
Start support groups for donors
More public awareness about liver donation

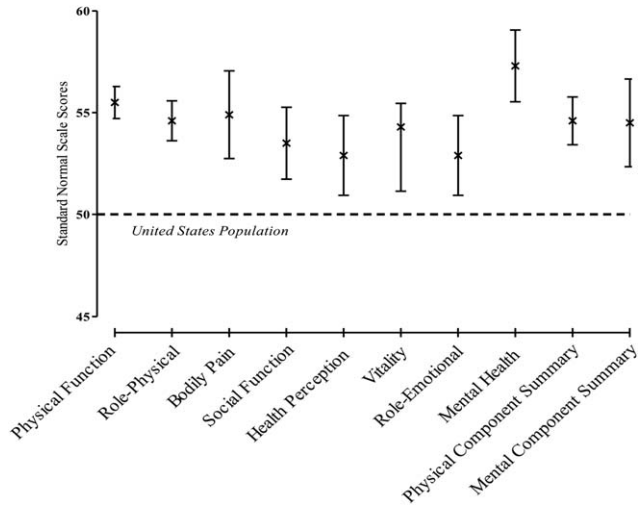

Figure 3. Mean standard normal SF-36 scale scores and 95% CIs for LDLT donors compared to a US population.

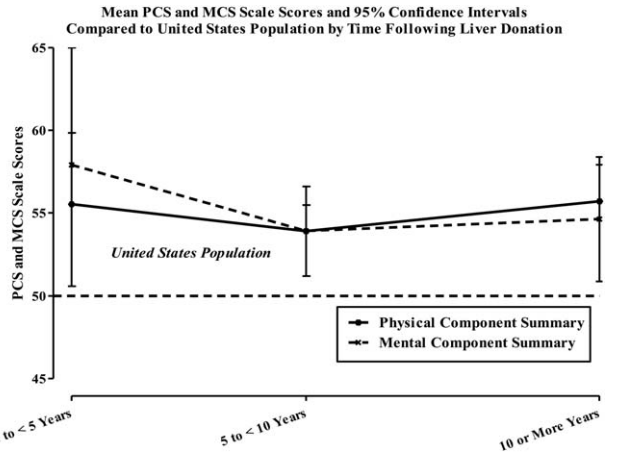

Figure 4. Mean PCS and MCS scores and 95% CIs compared to US population by time following LDLT.

scores and early postoperative complications. Of the 24 patients self-reporting depression, 13 (54.2%) had early postoperative complications. Finally, we queried our donors about aspects of the donor experience that could be improved. Fifty-nine of our donors felt we did an excellent job and/or had no suggestions for improvement. Comments made by 48 donors are listed in Table 5. Donors liked that we checked on them yearly with surveys and a phone call. They stressed the importance of showing compassion for the donor from the entire team. Several donors expressed concerns and frustrations with the amount of time it took for the workup and scheduling of the donation.

SF-36

Sixty-two (48.8%) of the 127 donors completed the SF-36. Figure 3 shows the SF-36 scale score means and 95% confidence intervals (CIs) compared to a representative sample drawn from the United States. Among those responding, HRQoL for living liver donors as measured by the SF-36 is significantly greater than standard normal US population. This is found for each of the 8 SF-36 subscales and the 2 component summary scale scores, and PCS and MCS scores.

This health status pattern was found for each time interval following living liver donation. The MCS and PCS scores for intervals after donation of 2 to 5 years, 5 years to 10 years, and >10 years are shown in Fig. 4. For each interval of time, both the MCS and PCS scores were statistically higher ($P < 0.001$) than the US population norm.

Satisfaction With the Donor Process

Donors rated their satisfaction with the donation process on a scale of 1 to 10. A Fisher's exact test was used to determine the break point for a statistically low satisfaction score. Results from our analysis suggest a satisfaction rating of less than 8 meets this criteria. Ninety-eight (91.6%) donors scored their experience between 8 and 10. Nine donors (8.4%) reported a satisfaction score between 1 and 7. Of

these 9 donors reporting low satisfaction scores, 6 had early postoperative complications. The status of the recipient was evaluated in the 9 donors that gave lower satisfaction scores, and 7 of the 9 donors' recipients were still alive. There was no correlation between lower satisfaction scores and death of the recipient.

A least squares linear regression for satisfaction with the donor experience was performed. Three factors—increased vitality (correlation, 0.44), decreased pain (correlation, 0.34), and a recipient who was living (correlation, 0.44)—were independently related to satisfaction with the donor experience. Vitality showed the strongest association with satisfaction with the donor experience. These 3 factors accounted for 30% of the variability between satisfaction scores (r^2, 0.30; adjusted r^2, 0.27).

As an alternate measure of donor satisfaction, we asked our donors if they would be willing to donate again; 104 (97.2%) patients reported they would, 0 (0.0%) said they would not, and 3 (2.8%) were unsure if they would donate again.

DISCUSSION

The aim of our study was to describe the longterm effects of liver donation, including health problems and perception of the donation process. Our study is unique in that we combined a DSS addressing donor issues along with a standardized survey, the SF-36. The latter generic HRQoL measure enabled us to compare donors to the population norm. One aspect missing from other longterm studies was a lack of a DSS addressing symptoms and issues specifically experienced by living liver donors.[10-12] This was our attempt to combine a QOL study with specific concerns after a right hepatectomy.

The response to our DSS was excellent (84.3%), and median postdonation follow-up was 6.9 years (mean, 7.7 ± 3.4 years; range, 2-15.7 years). To our knowledge, this is one of the longest follow-up studies published. It had been suggested in other studies that death of a recipient may make a donor less likely to participate in follow-up surveys.[10,17,18] Miyagi et al.[17] reported only 40% response rate for donors whose recipients had died, and Takada et al.[11] also reported attenuated responses from this group of donors. Similarly, we found that 40% of the nonresponders' recipients were deceased and that only 19.6% of the responders' recipients were deceased, which reached significance. One may postulate that responses may differ from donors whose recipient is deceased and may decrease the QOL scores, increase depression rates, and decrease satisfaction scores.

The reliability for the surveys was weakest for incisional discomfort. This may be due to the cross-sectional design of our study and querying donors at differing points after donation. We may also see a difference due to the amount of education provided to the donor before donation. Some donors may have expected incisional discomfort because it was emphasized more during the predonation education than others.

Financial stress is extremely important to the donors; therefore, return to work after donation is an important aspect to investigate. Most of our donors had returned to work, with 90.7% reporting current employment. There were 10 unemployed donors; however, they did not feel as though the donation was the cause of their unemployment. In hindsight, it would have been advantageous to inquire if they had returned to the same type of work or if they changed careers as a result of the donation and to determine time to return to employment. Previous studies indicate a return to employment for 84% by 6 months and that a change in employment was not due to donation.[19] Our study reaffirms the previous data suggesting that donation does not affect employment.

The psychiatric stability of the donor before donation is rigorously assessed but after donation is not routinely evaluated. Parikh et al.[10] review of the liver donor literature reported between 4% and 26% of donors experience some level of psychological morbidity, and Trotter et al.[13] confirmed that some donors experience severe psychiatric complications. Others have suggested there are positive psychological benefits to living organ donation.[20] In our series, a surprise finding was 24 (22.4%) donors reported depression symptoms, either treated or untreated with medications. This was self-reported depression. This self-reported depression was rather an unexpected finding in our series. We clearly intend to further evaluate this finding in our future studies with criteria that meet clinically diagnosed depression according to the Diagnostic and Statistical Manual of Mental Disorders, edition 4 (DSM IV). Overall, our donors were satisfied with their donation experience with 91.6% rating their experience between an 8 and 10 on a 10-point numerical rating scale regardless of complications or death of the recipient. Satisfaction with the experience did not correlate with death of the recipient or complications as was observed in other follow-up studies.[4,9,11,21-23] There were 3 factors that were found to be independent related to higher satisfaction scores. These were increased vitality as determined by the SF-36, decreased pain as determined by the SF-36, and whether the recipient is living as determined by the DSS. Vitality, which is a measure of energy level, was the strongest association with satisfaction. Our short-term complication rate was 42.5%, which is in line with current reported literature.[4,7,24] Although there is high early morbidity associated with LDLT, donors' longterm satisfaction was not affected by experiencing early complications. This may reflect the fact that the complications had resolved and had been forgotten about or the informed consent had prepared them for the complications to come. Furthermore, the primary purpose of helping their recipient may be important enough to keep the satisfaction scores higher despite complications.

The SF-36 response rate was much lower than our DSS, which may be due to the mode of administration. The SF-36 was mailed and self-administered. In addition, the length of the survey and its perceived lack of specificity to donation might have obviated donor motivation to complete the measure. The SF-36 response rate was 48.8%, which is similar to Takada et al.[11] (58%). The most common postoperative symptoms reported were incisional discomfort, intolerance to fatty meals, diarrhea, heartburn, change in eating habits, and flatulence. In relation to the gastrointestinal symptoms, it is possible these are related to the cholecystectomy portion of the donor operation. Postcholecystectomy syndrome is characterized by pain, nausea, vomiting, dyspepsia, and diarrhea and occurs in 5% to 20% of patients undergoing cholecystectomy.[25] It can occur months to years after the surgery.[25] Several mechanisms for this phenomenon have been proposed, some of which pertain to our operation. Scar tissue can form between the duodenum and pylorus or from the duodenum to the liver causing an acute angle of the common bile duct impairing emptying.[25] The patient may experience sphincter of Oddi dysfunction causing distention of the bile duct, which has been shown to cause nausea and vomiting in humans.[26] During the cholecystectomy portion and portal dissection, there is disruption of the parasympathetic and sympathetic pathways to the bile duct, which may impair appropriate emptying.[25] Diarrhea can be caused by bile acid malabsorption, a well-known postcholecystectomy phenomenon that can be treated with bile acid salts such as cholestyramine.[27] The cholecystectomy portion of the operation is usually minimized, and 1 of our patients commented that they were never told they would have their gallbladder removed. More attention to describing all aspects of the operation, including the complications and/or side effects of gallbladder removal should be a part of the consent process. Patients reported certain medical conditions worsening after donation that have not been previously described as complications of a partial hepatectomy. Some of these conditions included neck and back pain, insomnia, weight gain, and "brain fog." It is unclear if the donors reported these symptoms and were associating them with donation or if they were just reporting any medical issues that were worse since donation. The question was not phrased to ask in relation to donation. In the future, we plan to continue this query of our donors and will make changes to the survey to better reflect the information we are trying to extract.

Our study has limitations. Comparing the postdonation SF-36 results to the general population may not be indicative of maintenance of QOL because the donors likely have higher scores at baseline.[10] In addition, the comparison of donors to the general population may be flawed because it was not age matched, and donors tend to be younger than the general population. Future work will include a comparison of the same donors' before and after SF-36 to ascertain maintenance of QOL after donation as well as comparison to age-matched general population.

The term depression in our study was not defined as clinical diagnosis by a physician or by DSM IV criteria. The depression was self-reported and some donors may have depression symptoms without having a diagnosis of depression. Therefore, the depression rate in our donors after donation might be unreliable.

Evaluating our demographics, it is obvious that our donor population consisted of mostly Caucasian donors with only a few Hispanic donors. The lack of cultural variance in our donor population can also be cited as a weakness of our study.

In summary, our study suggests that over a longterm period, liver donors continue to have above average HRQoL compared to the general population. Donors report a high satisfaction rate with the donation process, and almost all donors would donate again independent of experiencing complications. It is important to note the positive aspects of donation to the donor validated by this study, which include satisfaction with donation and a reported higher self-esteem. Although we cannot definitely determine the risk for postdonation depression from this cross-sectional study, we feel that further studies are needed. We recommend more aggressive education about the longterm aspects of donation.

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REFERENCES

1. OPTN. Organ Procurement and Transplantation Network database. http://optn.transplant.hrsa.gov. Accessed October 19, 2015.
2. Renz JF, Kin CJ, Saggi BH, Emond JC. Outcomes of living donor liver transplantation. In: Busuttil RW, Longmire WP. Transplantation of the Liver. 3rd ed. Philadelphia, PA: Elsevier; 2005:713.
3. Otte JB. Donor complications and outcomes in liver-liver transplantation. Transplantation 2003;75:1625-1626.
4. Azoulay D, Bhangui P, Andreani P, Salloum C, Karam V, Hoti E, et al. Short- and longterm donor morbidity in right lobe living donor liver transplantation: 91 consecutive cases in a European Center. Am J Transplant 2011; 11:101-110.
5. Ladner DP, Dew MA, Forney S, Gillespie BW, Brown RS Jr, Merion RM, et al. Long-term quality of life after liver donation in the adult to adult living donor liver transplantation cohort study (A2ALL). J Hepatol 2015;62:346-353.
6. Ghobrial RM, Freise CE, Trotter JF, Tong L, Ojo AO, Fair JH, et al. Donor morbidity after living donation for liver transplantation. Gastroenterology 2008;135:468-476.
7. Adcock L, Macleod C, Dubay D, Greig PD, Cattral MS, McGilvray I, et al. Adult living liver donors have excellent longterm medical outcomes: The University of Toronto liver transplant experience. Am J Transplant 2010;10: 364-371.

8. Muzaale AD, Massie AB, Wang MC, Montgomery RA, McBride MA, Wainright JL, Segev DL. Risk of end-stage renal disease following live kidney donation. JAMA 2014; 311:579-586.
9. Castedal M, Andersson M, Polanska-Tamborek D, Friman S, Olausson M, Fehrman-Ekholm I. Long-term follow-up of living liver donors. Transplant Proc 2010;42: 4449-4454.
10. Parikh ND, Ladner D, Abecassis M, Butt Z. Quality of life for donors after living donor liver transplantation: a review of the literature. Liver Transpl 2010;16:1352-1358.
11. Takada Y, Suzukamo Y, Oike F, Egawa H, Morita S, Fukuhara S, et al. Long-term quality of life of donors after living donor liver transplantation. Liver Transpl 2012;18:1343-1352.
12. DuBay DA, Holtzman S, Adcock L, Abbey S, Greenwood S, Macleod C, et al. Adult right-lobe living liver donors: quality of life attitudes and predictors of donor outcomes. Am J Transplant 2009;9:1169-1178.
13. Trotter JF, Hill-Callahan MM, Gillespie BW, Nielsen CA, Saab S, Shrestha R, et al.; for A2ALL Study Group. Severe psychiatric problems in right hepatic lobe donors for living donor liver transplantation. Transplantation 2007;83:1506-1508.
14. Ware JE Jr, Gandek B. Overview of the SF-36 health survey and the International Quality of Life Assessment (IQOLA) project. J Clin Epidemiol 1998;51:903-912.
15. Keller SD, Ware JE Jr, Bentler PM, Aaronson NK, Alonso J, Apolone G, et al. Use of structural equation modeling to test the construct validity of SF-36 health survey in 10 countries: results from the IQOLA project. International quality of life assessment. J Clin Epidemiol 1998;51: 1179-1188.
16. Ware JE Jr, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. Med Care 1992;30:473-483.
17. Miyagi S, Kawagishi N, Fujimori K, Sekiguchi S, Fukumori T, Akamatsu Y, Satomi S. Risks of donation and quality of donors' life after living donor liver transplantation. Transpl Int 2005;18:47-51.
18. Humar A, Carolan E, Ibrahim H, Horn K, Larson E, Glessing B, et al. A comparison of surgical outcomes and quality of life surveys in right lobe vs. left lateral segment liver donors. Am J Transplant 2005;5(pt 1): 805-809.
19. Diaz GC, Renz JF, Mudge C, Roberts JP, Ascher NL, Emond JC, Rosenthal P. Donor health assessment after living-donor liver transplantation. Ann Surg 2002;236: 120-126.
20. Nadalin S, Malagò M, Radtke A, Erim Y, Saner F, Valentin-Gamazo C, et al. Current trends in live liver donation. Transpl Int 2007;20:312-330.
21. Sotiropoulos GC, Radtke A, Molmenti EP, Schroeder T, Baba HA, Frilling A, et al. Long-term follow-up after right hepatectomy for adult living donation and attitudes toward the procedure. Ann Surg 2011;254:694-700.
22. Crowley-Matoka M, Siegler M, Cronin DC 2nd. Long-term quality of life issues among adult-to-pediatric living liver donors: a qualitative exploration. Am J Transplant 2004;4:744-750.
23. Trotter JF, Talamantes M, McClure M, Wachs M, Bak T, Trouillot T, et al. Right hepatic lobe donation for living donor liver transplantation: impact on donor quality of life. Liver Transpl 2001;7:485-493.
24. Abecassis MM, Fisher RA, Olthoff KM, Freise CE, Rodrigo DR, Samstein B, et al.; for A2ALL Study Group. Complications of living donor hepatic lobectomy- A comprehensive report. Am J Transplant 2012;12:1208-1217.
25. Womack NA, Crider RL. The persistence of symptoms following cholecystectomy. Ann Surg 1947;126:31-55.
26. Zollinger, R. Observations following distention of the gallbladder and common duct in man. Proc Soc Exper Biol Med 1933;30:1260-1261.
27. Sciarretta G, Furno A, Mazzoni M, Malaguti P. Post-cholecystectomy diarrhea: evidence of bile acid malabsorption assessed by SeHCAT test. Am J Gastroenterol 1992; 87:1852-1854.