The impact of liver steatosis on the postoperative evolution after right lobe living-donor hepatectomy

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Abstract

Background. Living donor liver transplantation has become a feasible treatment modality for end-stage liver disease. The obesity epidemic worldwide has made it increasingly common to encounter liver steatosis in living donor candidates. The aim of study was to analyze the impact of moderate hepatic steatosis on the postoperative evolutions after right lobe living-donor hepatectomy.

Methods. Living donors who underwent donor hepatectomy during the period 2000 to 2020 in two medical centers were included in this study. We distinguished 3 groups based on the degree of steatosis: Group O - 0%, Group I - 1–10% and Group II >10%.

Results. A total number of 157 living donors underwent surgery, of whom 112 (71.34%) were right lobe liver donors. There were 62 without steatosis, 31 – with steatosis 1-10% and 19 with steatosis >10%. No difference has been found in proportion of men, median of age, body mass index and left lobe/total liver volume ration in compared groups. Total liver volume was significantly higher in the Group I than in the Group O (p=0.028). The moderate hepatic steatosis (HS) group presented significant higher volume of intraoperative hemorrhage than no-HS group (p=0.041). No differences were observed in the postoperative liver function between the groups. The minimal HS group comprised a significantly higher proportion of postoperative complications than no-HS group (67.7% vs 40.3%, p=0.043). The longer postoperative length of hospital stay in ICU was observed in Group I than in Group O (p=0.024).

Conclusion. Moderate HS does not importantly impair living liver donors' safety.

Keywords: hepatic steatosis, right lobe living-donor hepatectomy, outcome

Introduction

With the steady increase in liver transplantation (LT) over the last decades, and the donor pool remaining largely stagnant, the shortage of organs for transplantation has become even more pressing because of the COVID-19 pandemic [1]. Living donor liver transplantation (LDLT) has become a feasible treatment modality for end-stage liver disease (ESLD) to alleviate the shortage of deceased donors and reduce waiting-list mortality. LDLT offers recipients the advantage of a high-quality graft and the possibility of avoiding delisting or death due to a change in clinical status.

LDLT remains a technically demanding procedure. However, since the turn of the millennium the operation has dramatically improved, rendering results on par with those of deceased donor liver transplantation. In these surgeries, donor safety is of paramount importance as are recipient outcomes with preservation of liver graft function. The obesity epidemic worldwide has made it increasingly common to encounter liver steatosis in living donor candidates. The prevalence of nonalcoholic fatty livers has increased as more patients develop a sedentary lifestyle, have high caloric intakes without exercising, and have body mass indexes indicating obesity. Previous studies on

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LDLT have revealed the negative effects of graft steatosis on recipient outcomes, all of which result in decreased graft and patient survival [2-4].

However, with the increasing trend of hepatic steatosis (HS) or fatty change in living donors, different medical centers may want to change their donor selection criteria. The aim of this study was to analyze the influence of moderate hepatic steatosis on the postoperative evolutions after right lobe living-donor hepatectomy and evaluate its safety and feasibility by comparing the outcomes of such donors with those living donors (LDs) with no HS.

Materials and methods

Study population. Participants in this longitudinal study were 157 LDs who underwent donor hepatectomy during the period March 2000 to October 2020 in two medical centers - Fundeni Clinical Institute (Bucharest, Romania) and Republican Clinical Hospital (Chisinau, Republic of Moldova), and have had no less than one year of follow up after surgery (period 2000 to 2014 retrospective evaluation, 2015-2020 - prospective evaluation). A left-lobe hepatectomy was excluded, leaving 112 living donors of right lobe in the study. Approval was granted by the Committee of Ethic in research form State University of Medicine and Pharmacy "Nicolae Testemitanu" (Approval 33, Nb 44). Informed consent was given by the patients.

Data were evaluated and inclusion criteria were applied: age between 18 and 56 years, nondiabetic, compatibility of blood group ABO, absence of major abdominal surgery (except cholecystectomy), abstinence from smoking and discontinuation of contraceptive pills for 6 weeks, the graft-to-recipient weight ratio (GRWR) >0.8% and residual liver volume (RLV) ≥ 30% of total liver volume (TLV) [7]. The endpoint was the comparison of LDs safety including postoperative laboratory findings (peak aspartate transaminase [AST], alanine transaminase [ALT], total bilirubin [TB], prothrombin time [PT] values) and operative morbidity.

Design of the study. The study sample was liver donors classified based on hepatic steatosis. All steatotic donors were measured preoperatively with the normal liver function survey. Percutaneous needle biopsy (PCNB) of the liver was selectively performed thereafter in donor candidates with a high body mass index (BMI) (≥30 kg/m^2), elevated AST, ALT, or total bilirubin levels, dyslipidemia, the presence of metabolic risk factors, abnormal findings on computer tomography (CT) or abdominal ultrasonography (US) suggesting HS [6,7].

For all 112 LDs wedge biopsy samples of both hepatic lobes were performed just after laparotomy and sent for frozen section examination. The remaining tissue was formalin-fixed and paraffin-embedded for hematoxylin and eosin staining. After a hepatectomy, a small sample of liver tissue was used to confirm fatty degree by pathology. We distinguished 3 groups based on the following ranges of steatosis: Group O - 0%, Group I - 1–10% and Group II >10%. Finally, 50 LDs with HS (31 - steatosis 1-10%; 19 – steatosis >10%) and 62 LDs with no HS, determined by intraoperative biopsy, were included (Figure 1).

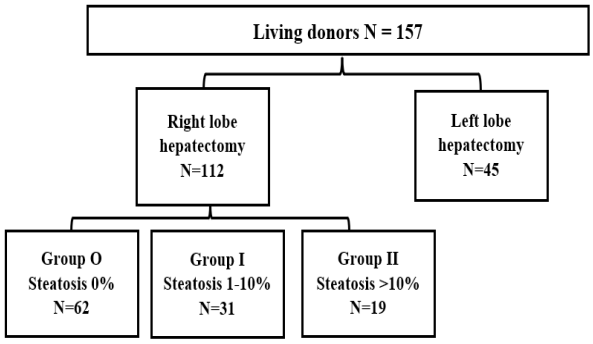

Figure 1. Design of the study.

Preoperative evaluation and selection guidelines for right liver (RL) donation. A detailed multi-stage counselling during the donor work-up with regards to the operation, complications and outcomes, which enabled living donors to have a realistic view of procedure. Healthy voluntary donors underwent a staged evaluation of suitability for donation.

Stage I contained a face-to-face interview with the prospective donor with a detailed discussion of the evaluation process, perioperative period, short- and long-term donor outcomes including the complications. It was followed by a clinical examination of donor, review of the past medical history, basic laboratory tests (complete blood count, liver function test (LFT), renal function test, lipid profile) including viral serology. Initially unsuitable donors were advised to lose weight and offered an exercise and diet plan. They were reviewed following the weight loss and went on to stage II of evaluation if found suitable on review.

Stage II consisted from US and triphasic liver CT, which helped to assess the hepatic volume, vascular anatomy, and steatosis. Liver volumes were estimated on CT scans using 3D reconstruction software (OsiriX MD). An algorithmic approach to graft selection was used, based on the donor functional RLV, expected GRWR, the recipient and donor vascular anatomy.

Suitable donors went onto stage III which included evaluation of the biliary anatomy with magnetic resonance cholangiopancreatography (MRCP) and a multidisciplinary review by the chief surgeon, surgical team, hepatologists, psychiatrist, gynecologists (in female donors), cardiologists and the anesthesiologists. Following this, the transplant papers were put up for approval by a state health authority's legal authorization committee (Committee of Etic Fundeni Clinical Institute, Bucharest, Romania; Independent Committee of Approvals of Transplantation from Republic of Moldova).

Preoperative data. Donor data including age, gender, BMI, preoperative LFT, platelets, bilirubin level, degree of steatosis on biopsy, TLV, RLV based on the volumetry CT were collected (retrospectively - in the period from 2000 to 2014 and prospectively - in the period from 2015 to 2020).

Surgical technique and postoperative management. Incision was usually a reverse L with midline being used for donors with a suitable body habitus. Both teams have used various surgical techniques to ensure LDs safety and graft reconstruction. Right lobe without middle hepatic vein (MHV) is the current standard and to prevent outflow obstruction at the anterior section, sizable (≥5 mm diameter) tributaries of the middle hepatic vein were reconstructed with various kinds of interposition grafts in back-table surgeries. The standard techniques for procurement and implantation were employed. The detailed surgical techniques of donor hepatectomy is described elsewhere [17,18].

Donor was usually extubated in the operation room and monitored in the intensive care unit (ICU). All LDs were closely monitored during the first 1 or 2 days after donation, especially for the timely detection of bleeding. Oxygenation, nutritional support with early feeding, and early ambulation were emphasized. Intravenous patient-controlled analgesia was routinely used for 2 to 3 days after the operation. Discharge from the hospital was aimed for the 6th post-operative day after a satisfactory ultrasound of the abdomen, chest X-ray and liver function tests. Outpatient follow-up was once weekly for 1 month, following discharge from hospital. Donors were followed up on a long-term basis in outpatient department or by local physicians with standard blood investigations at 3, 6, 12 months and then annually.

Intraoperative and postoperative data. Details of the GRWR, duration of operation, volume of hemorrhage and blood transfusions were analyzed for all groups. Postoperative variables including serum bilirubin, AST, ALT, international normalized ratio (INR), on post operative day (POD) 1 and POD7 were analyzed in order to assess post operative recovery in liver function in the donor. Cut off value of AST was established as 28 U/L, ALT – 31 U/L, total bilirubin - 1 mg/dL.

Complications. The Dindo-Clavien score was used to determine severity of complications [8, 9], major complications were defined as Dindo-Clavien grade >3b. In case of more than one complication the most serious was used for gradation. Bile leak was defined according to the international study group of liver surgery (ISGLS) as bilirubin concentration in the drain fluid at least three times the serum bilirubin concentration on or after POD 3 or as the need for radiologic or operative intervention resulting from biliary collections or bile peritonitis [10]. Post-hepatectomy liver failure (PHLF) was defined using the '50–50' criteria for defining PHLF (serum bilirubin >2.9 mg/dL and prothrombin time <50% of normal (INR >1.9) on POD 5) [11]. Readmission to the hospital within the first 3 months was defined as early readmission.

Outcome measurement. Donor surgical primary outcomes were evaluated by length of hospital stay, morbidity of living donors (postoperative complications within the first 30 days) and mortality in first 90 days after surgery. Secondary outcomes were included duration of surgery, intraoperative hemorrhage, and volume of transfusion.

Statistical analysis. Continuous variables are presented as mean ± standard deviation (SD) in case of normal distributed data, if distribution of data was non-normal - as median and range. Nonparametric data are presented as relative frequency (percentage). The Pearson chi-square test and one-way ANOVA test were used to examine differences in demographic and clinical characteristics within the 3 groups, if distribution of data was normal. Kruskal -Wallis and Mann-Whitney U test was used for analysis of continuous variable with non-normal distribution and chi-square test – for categorical variables. The outcomes between the groups were compared using least-squares means, the linear mixed model after log transformation, and cumulative logistic regression with generalized estimating equations.

P-values lower than 0.05 were considered to indicate statistically significant differences. All statistical analyses were performed using IBM SPSS Statistics, version 26.0.

Results

A total number of 157 living donors underwent donations, of whom 112 (71.34%) and 45 were right lobe and left lobe donations, respectively. Median of age of LDs was 34±9.3 years (19-56 years), proportions of men - 52.7% (59/112), BMI – 24.46±3.28 kg/m^2 (17.5-34.0 kg/m^2). Median of TLV was 1433±304 m^3 (955-3030 m^3) and LL/TLV rates - 34±5% (25-49%) There were 62 without steatosis (Group 0), 31 – with steatosis 1-10% (Group I) and 19 with steatosis >10% (Group II).

Donor baseline characteristics. Table I shows the differences in the demographic and clinical features between the groups with no HS, minimal and moderate HS. The no-HS group comprised a significantly higher proportion of donors with biological relation with recipients than moderate- HS group (85.5% vs 52.6%, p=0.009). TLV was also significantly higher in the minimal HS group than in the no-HS group (1510.0±270.7 m^3 vs. 1374.5±253.6 m^3, p=0.028). No difference was found in proportion of men, median of age, BMI and LL/TLV ration in compared groups.

Comparison of intraoperative characteristics. The moderate HS group presented significant higher median of volume of intraoperative hemorrhage than no-HS group (800.4±392.3 ml vs. 500.0±367.7 ml, p=0.041) (Figure 2). Median of duration of surgery and graft weight were not differed significant between the group from the study (Table II).

Table I. Comparison of demographic and clinical characteristics between right lobe donors with different degree of steatosis (G0, GI, GII).

	Right lobe liver donors N=112			p value
	Steatosis 0% N=62	Steatosis 1-10% N=31	Steatosis >10% N=19	
Preoperative variables				
Age (years), median ± SD (range)	32.5±9.2 (19-54)	34.0±9.1 (21-56)	38.0±9.8 (23-56)	0.312
Age > 50 years, (n%)	3(3.3)	1(2.3)	2(8.7)	0.400
Age (years) < 35, (n, %)	40(64.2)	17(54.8)	8(42.1)	0.204
Gender (male, n, %)	41 (45.6)	22 (50)	11(47.8)	0.887
Biologic relation with recipient (n%)	**53(85.5)**	**19 (61.3)**	**10(52.6)**	**0.009**
Height (m, median ± SD)	1.72±001	1.72±0.11	1.71±0.08	0.089
Weight (kg, median ± SD)	70.5±10.0	73.7±12.3	75.5± 11.7	0.379
BMI (kg/m^2, median ± SD)	23.9±2.8	24.8±3.8	25.6± 3.6	0.101
Body surface (m^2, median ± SD)	1.8±1.2	1.9±1.9	1.9±1.7	0.299
TLV (m^3, median ± SD)	**1374.5±253.6**	**1510.0±270.7**	**1493.0±436.3**	**0.028**
LL/TLV ratio (%)	35.28±4.42	32.93±4.50	34.55±55	0.09

SD, standard deviation; BMI, body mass index; TLV, total liver volume; LL, left lobe; Bold indicates the significant variables.

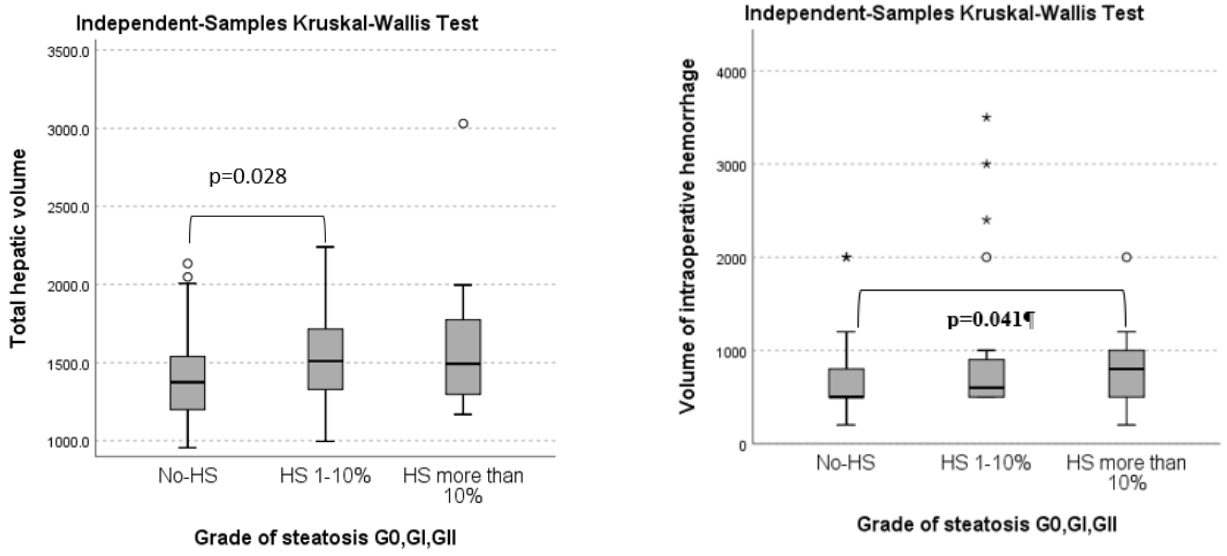

Figure 2. Pairwise comparisons of median of total hepatic volume and volume of intraoperative between right lobe donors with different grade of steatosis (G0, GI, GII)

Table II. Comparison of intraoperative characteristics of donor right hepatectomy between donors with minimal (1-10%), moderate (> 10% steatosis) and no hepatic steatosis.

	Right lobe liver donors N=112			p value
	Steatosis 0% N=62	Steatosis 1-10% N=31	Steatosis >10% N=19	
Intraoperative variables				
Duration of surgery (min, median ± SD)	260.0±87.2	275.0±76.1	290±60.8	0.947
Volume of intraoperative hemorrhage (ml, median ± SD)	**500.0±367.7**	**600.0±754.9**	**800.0± 392.3**	**0.041**
Graft weight (g, median ± SD	747.5±172.1	800.0±137.2	790.0±142.7	0.111

Bold indicates the significant variables.

Table III. Comparison of postoperative laboratory findings after donor right hepatectomy between donors with minimal (1-10%), moderate (> 10% steatosis) and no hepatic steatosis.

	Right lobe liver donors N=112			p value
	Steatosis 0% N=62	Steatosis 1-10% N=31	Steatosis >10% N=19	
Postoperative variables				
On posthepatectomy day 1				
ALT, (IU/L, median ± SD)	215.95±115.68	234.71±163.34	256.27±151.49	0.505
Total bilirubin, (mg/dL, median ± SD)	1.8±0.7	1.5±1.6	1.9±1.1	0.860
INR (median ± SD)	1.4±0.26	1.4±0.3	1.5±0.4	0.594
On posthepatectomy day 3				
ALT, (IU/L, median ± SD)	149.19±59.83	203.26±219.06	199.03±181.90	0.163
Total bilirubin, (mg/dL, median ± SD)	1.4±0.9	1.3±0.7	1.9±1.0	0.313
INR (median ± SD)	1.3±0.4	1.4±0.3	1.4±0.3	0.849
On posthepatectomy day 7				
ALT, (IU/L, median ± SD)	102.29±30.22	119.93±82.90	108.67±39.18	0.406
Total bilirubin, (mg/dL, median ± SD)	1.0±0.6	0.9±0.5	0.9±1.15	0.845
INR (median ± SD)	1.1±0.2	1.1±0.2	1.2±0.2	0.821
Posthepatectomy peak value				
Peak ALT (IU/L, median ± SD)	216.10±112.57	280.48±233.99	286.61±272.23	0.168
Peak AST (IU/L, median ± SD)	164.90±91.45	290.48±218.22	230.45±199.37	0.192
Peak total bilirubin (mg/dL, median ± SD)	1.9±1.0	1.8±1.7	2.0±1.3	0.795
Peak INR (median ± SD)	1.6±0.8	1.6±0.3	1.5±0.4	0.996
Duration of normalization after hepatectomy (days)				
ALT, (days, median ± SD)	19.45±8.86	21.07±10.59	19.16±7.88	0.685
Total bilirubin, (days, median ± SD)	3.0±3.9	7.0±6.2	7.0±3.8	0.060

ALT, alanin aminotransferase; AST, aspartate aminotransferase; INR, international normalization ratio.

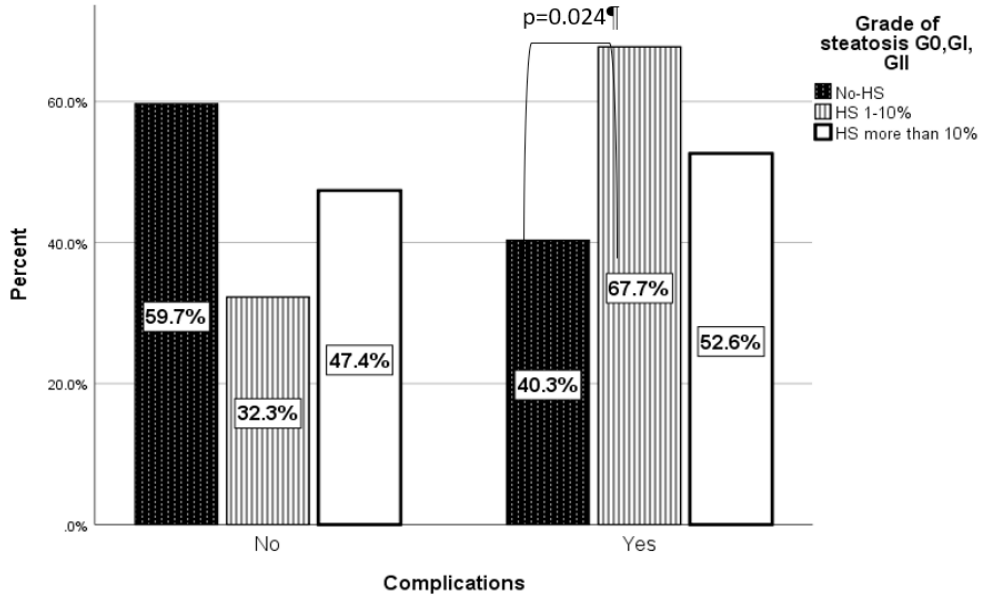

Figure 3. Comparison of proportion of postoperative complications after donor right hepatectomy between donors with minimal (1-10%), moderate (> 10% steatosis) and no hepatic steatosis.

Table IV. Comparison of postoperative morbidity after donor right hepatectomy between donors with minimal (1-10%), moderate (> 10% steatosis) and no hepatic steatosis.

	Right lobe liver donors N=112			p value
	Steatosis 0% N=62	Steatosis 1-10% N=31	Steatosis >10% N=19	
Morbidity of the donors				
Postoperative complications (n, %)	**25(40.3)***	**21(67.7)***	**10(52.6)**	**0.043**
Minor complications (less 3 C-D)				
Acute pancreatitis	4(6.4)	4(12.9)	3(15.8)	0.388
Fluid collection	7(11.3)	6(19.4)	2(10.5)	0.279
Pneumonia	2(3.2)	4(12.9)	2(10.5)	0.159
Pleurisies	3(4.8)	4(12.9)	5(26.3)	0.264
Major complications (3b and more C-D)				
Bile leakage	5(8.1)	2(6.4)	2(10.5)	0.876
Subphrenic abscess	**4(6.4)**	**1(3.2)**	**1(5.3)**	**0.036**
ICU stay (days)	**3.19±1.4**	**4.16±1.8**	**3.74±2.0**	**0.024**
Postoperative hospital stay (days)	13.3±7.3	14.2±5.1	14.74± 11.3	0.720

C–D, Clavien–Dindo classification; SD, standard deviation; ICU, intensive care unit. Bold indicates the significant variables.

Comparison of postoperative laboratory findings of donors. No significant difference in the peak serum AST, ALT, INR and serum TB values were observed. Laboratory parameters showed comparable results on posthepatectomy day 1, 3 and 7. Among LDs, no significant difference in duration of normalization after hepatectomy of ALT (p=0.685) and serum TB (p=0.060) were observed (Table III).

Comparison of postoperative morbidity of donors. One hundred twelve right lobe LDs experienced a total of 56 complications (41 minor complications and 15 major complications) which were diagnosed in 26 (23.2%) patients. The minimal HS group comprised a significantly higher proportion of postoperative complications than no-HS group (67.7% vs 40.3%, p=0.043) (Figure 3). The two most common major complications being bile leakage (n = 9) and subphrenic access (n = 6). During the comparison of different types of minimal complications after donor right hepatectomy between donors from group O, I and II no significant difference was observed.

The longer postoperative length of hospital stay in ICU was observed in minimal HS group than in no-HS group (4.16±1.8 days vs 3.19±1.4 days, p=0.024). No significant differences in the total postoperative length of hospital stay were observed in LDs (p = 0.720). (Table IV) Post-hepatectomy liver failure was not been diagnosticated in the LDs included in this study. None of the one hundred twelve LDs was readmitted in the hospital within the first tree month.

Discussion

The operative risk for LDs is associated with multiple factors such as LDs age, the type of hepatectomy, remnant liver volume, degree of HS, the surgeon's skill, and experience of the center. Among these factors, the remnant liver volume, LDs age, and HS are considered major determinants. In right lobe donation, the donor is also exposed to the risk of post hepatectomy failure as right hepatectomy leads to a loss of half to two-thirds of the normally functioning liver mass. In the presence of steatosis, contralateral lobe hypertrophy may further be compromised and delayed, thus raising concerns about donor safety. Aging and liver steatosis, both common problems in contemporary society, have a negative impact on liver regeneration [16]. HS is the most common medical cause of donor rejection, not only due to concerns regarding donor safety but also due to poor outcomes in recipients. In terms of recipient outcomes, the estimated graft volume (GV) was corrected by assuming that each percentage of either macrovezicular or macrovezicular fatty change decreased the functional GV by 1% [11]. Therefore, the primary concern related to HS in LDLT is LDs safety. The impact of HS on the operative risk after major hepatectomy remains controversial. Patients with HS that undergo liver surgery suffer more complications, such as postoperative hemorrhage and infection but not liver-specific complications (biliary leakage and post-hepatectomy liver failure) [14]. Our series of LDs have had the similar result – higher volume of intraoperative hemorrhage in LDs with moderate HS, but without difference in liver specific complications (ex. biliary leakage). In contrast, HS < 30% neither increased postoperative complication and mortality rates nor impaired long-term regeneration in LDs [15].

Our study was based on the degree of biopsy proven steatosis in a cohort of right lobe living donors, and its effect on donor outcomes. Intraoperative protocol biopsy was

used to quantify the degree of steatosis. Grafts with mild to moderate steatosis are acceptable in the LDLT setting. The surgery is always performed by a dedicated teams of surgeons with experience in both LT and hepatopancreatobiliary surgical oncology. The results of the present study showed that the outcomes of right lobe living-donor hepatectomy with moderate HS (10-30%) were comparable to those in LDs without HS, with an acceptable biochemical profile. We achieved comparable and acceptable outcomes in terms of LDs safety with a relatively large sample size and long-term follow-up period. We did not find a delay in recovery of transaminases in the moderate HS group after LDLT. In fact, the POD 7 AST and INR were comparable in the moderate HS donors compared to the minimal HS donors, although the values were normal even in the latter group. *Young-In Yoon et al.* [5] concluded that, though the careful selection of case, functional recovering of the remnant liver in LDs was not impaired by moderate HS. Right lobe donation by LDs with moderate HS in ALDLT can be performed safely in strictly selected patients with sufficient remnant liver volume in younger LDs.

Most of the protocol for LD evaluation is not approved for RL donation LDs candidates with HS > 30% in total or with macrovezicular HS > 15%. In such cases, LDs are re-evaluated after dietary modifications and weight reduction. In a recent systemic review and metanalysis Trakroo et al. [12] concluded that the use of appropriate short term weight loss interventions in living liver donors is an effective tool in turning marginal donors in low-risk donors. Although transplant surgeons should select more ideal donor candidates such as those without HS and with sufficient remnant liver volume to maximize LDs safety, occasionally, it is necessary to adjust the acceptability level of these factors, within an acceptable range, to reduce waiting-list mortality in end stage liver disease patients. We may come across LD candidates with moderate HS on preoperative liver biopsy not amenable to weight reduction because of reasons such as urgency of LT in the recipient owing to high MELD scores along with deteriorating portal hypertension or advanced hepatocellular carcinoma (HCC) in progress.

Thus, with increasing experience, we have started accepting more donors with 10-20% steatosis for right lobe donation. Consensus on the upper limit of graft macrovesicular steatosis in the LDLT setting is lacking. Of course, this is difficult because multiple factors including GRWR, RLV, hepatic venous outflow, and recipient status play a role not only in donor selection, but also donor and recipient outcomes. In addition, Kim et al. [13] attested that living donor right hepatectomy under extended criteria (1. old donor - age >40 years, with remnant liver volume of < 35%, 2) young donor, age ≤40 years, with remnant liver volume < 29% and minimal fatty change (<15%); 3. young donor with mild hepatosteatosis (15%-30%) and remnant liver volume of < 35%) could be performed to expand donor pools without adverse effects on donor safety. Indeed, most surgeons have encountered cases involving recipients requiring urgent LTs in which there is no time to wait for the LDs to lose weight or find several LDs. In such cases, we can consider immediate adult-to adult LDLT (ALDLT) utilizing the RL without LDs weight reduction to modify HS if the LDs is young and has a sufficient remnant liver volume. Bangui et al. conclude that prospective donors with 10-20% steatosis can be safely included in the living donor pool to meet the ever-increasing demand of organs. It is essential to take the degree of steatosis into consideration when determining adequate GRWR for the recipient, and future liver remnant for the donor.

The rate of complications after living donation varies widely in the literature. Reports have shown complication rates between 9 and 40%. Our experience (23%) is therefore comparable with others. We have not experienced any donor death or any major long-term sequelae. Most of the previously reported series of living donation have also shown no deaths [19 – 21].

The present study was limited because of its hybrid (retrospective period 2000 - 2014 and prospective from 2015-2020) observational study design, and with inherent risks of confounding factors (favoring good outcomes in patients with steatotic donors) and bias. However, as LDs safety in LDLT is unconditional, the results of this study are meaningful in that they suggest the safety of RL donation in carefully selected LDs with moderate HS. Furthermore, this study suggested the indications for RL donation in LDs with moderate HS, and this will enable the expansion of the donor pool for LDLT.

In conclusion, moderate HS does not markedly impair living liver donors' safety. It therefore has the potential to expand the donor pool and, consequently, decrease the number of waiting list candidates. Comprehensive donor evaluation, surgical experience, surgical technique, and close postoperative follow-up should allow for better outcomes.

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