Predictive Value of Unenhanced Computerized Tomography for Detecting Hepatosteatosis in Living Liver Donors

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ABSTRACT

Objective. Macrovesicular hepatosteatosis is related to post-transplantation complications, so preoperative hepatosteatosis determination plays a critical role in donor selection. The aim of this study was to evaluate the efficacy of unenhanced computerized tomography (CT) in determining hepatosteatosis in liver donor candidates.

Methods. Information about donor candidates was retrospectively reviewed. In this screening, 27 donor candidates who underwent liver biopsy because of suspected hepatosteatosis in routine abdominal CT examination before transplantation, were reviewed. Liver biopsies and CT images were reevaluated by an experienced pathologist and radiologist. Macrovesicular hepatosteatosis was graded according to percentage and divided into 3 groups. Three radiologic liver attenuation indices were used: 1) hepatic attenuation value (CT^{L}); 2) the difference between hepatic attenuation and spleen attenuation (CT^{L-S}); and 3) the ratio of hepatic attenuation to splenic attenuation ($CT^{L/S}$).

Results. CT^{L}, CT^{L-S}, and $CT^{L/S}$ values of donors with hepatosteatosis were significantly higher than the donors without hepatosteatosis. In receiver operating characteristic analysis, the optimal cutoff value of these indices for determining hepatosteatosis were; 42.5, −5, and 0.98, respectively. At these cutoff values, the sensitivity and specificity of these indices were calculated to be 80% and 75%, 93.3% and 83.3%, and 93.3% and 83.3%, respectively. There were no statistical differences between their diagnostic performances. When these 3 indices were used for detect significant hepatosteatosis (>20%) it was observed that hepatosteatosis of only one donor could not be determined whereas it was seen that specificity was decreased markedly.

Conclusions. Despite the high diagnostic yield of unenhanced CT, it is not suitable to use alone for assessment of hepatosteatosis in clinical practice.

THE NUMBER of living-donor liver transplantations (LDLTs) is increasing because there is an increasing number of patients who require transplantation but a limited number of cadaver liver transplant donors [1]. However, donor selection should be performed very carefully before transplantation to minimize complications for both donors and recipients [2]. Macrovesicular hepatosteatosis is the most important donor-related characteristic that needs to be considered. Because macrovesicular steatosis is increased in the donor's liver, risk of complications, such as early graft dysfunction and primary nonfunctional graft, after LDLT may develop [3–5]. Therefore, preoperative hepatosteatosis determination plays a critical role in donor selection, and the majority of transplant centers abstain from liver transplantations with high hepatosteatosis [6,7].

Currently, percutaneous liver biopsy is known as the criterion standard in evaluating hepatosteatosis [8]. Because it is an

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Table 1. Basic Features of Donor Candidates According to Degree of Hepatosteatosis

Variable	All Patients ($n = 27$)	Grade 0 ($n = 12$)	Grade 1 ($n = 6$)	Grade 2 ($n = 9$)	P Value
Age (y)	40.2 ± 9.6	43.2 ± 10.1	36.5 ± 8.4	38.7 ± 9.5	.336
Female	12 (44%)	8 (66.7%)	2 (33.3%)	2 (22.2%)	.105
BMI (kg/m^2)	26.8 ± 2.5	26.2 ± 2.8	27 ± 2.8	27.6 ± 1.8	.838
ALT (U/L)	25.5 ± 12	23.2 ± 11.5	26.5 ± 11.7	27.8 ± 13.5	.712
AST (U/L)	20.5 ± 5.1	20.2 ± 5.5	20.5 ± 5.1	21.1 ± 5.2	.973
ALP (U/L)	78 ± 30	82.9 ± 44.4	69.8 ± 8.5	77.1 ± 12	.876
GGT (U/L)	22.9 ± 11.4	21.5 ± 13.7	21.1 ± 8.1	26 ± 10.4	.387
Total cholesterol (mg/dL)	195.7 ± 45.5	192.1 ± 46.7	177.5 ± 36.9	212.5 ± 47.9	.335
HDL-cholesterol (mg/dL)	40.7 ± 12	44.5 ± 13.9	42.6 ± 12.8	34.3 ± 5.3	.09
LDL-cholesterol (mg/dL)	122 ± 44.5	117.5 ± 44.8	98.6 ± 39.5	145 ± 41	.08
Triglyceride (mg/dL)	166 ± 97.2	141.4 ± 75.5	179 ± 102	190 ± 121	.673
CT^L	40.5 ± 6	44.2 ± 5.3	39.8 ± 4.95	36.1 ± 4.3	.004*
CT^{L-S}	0.94 ± 0.72	1.07 ± 0.16	0.88 ± 0.06	0.81 ± 0.08	.001*
$CT^{L/S}$	−2.48 ± 6.7	2.75 ± 5.95	−4.6 ± 2.7	−8 ± 3.84	.001*
CT^S	43 ± 3.5	41.4 ± 4.54	44.5 ± 2.81	44.1 ± 1.26	.123

Abbreviations: BMI, body mass index; ALT, alanine aminotransferase; AST, aspartate aminotransferase; ALP, alkaline phosphatase; GGT, gamma glutamyltransferase; HDL, high-density lipoprotein; LDL, low-density lipoprotein; CT^L, liver attenuation; CT^{L-S}, difference between liver and spleen attenuation; $CT^{L/S}$, ratio of hepatic attenuation to splenic attenuation; CT^S, splenic attenuation.
*$P < .01$.

invasive method, it may cause severe complications which may end up with mortality. Other disadvantages of this method are the small sample size (sample ratio 1/50,000) and discrepancies between evaluations by pathologists [9]. Therefore, noninvasive methods have been investigated recently in evaluation of hepatosteatosis. Different results have been reported for the role of abdominal unenhanced computerized tomography (CT) in determining the hepatosteatosis in donor candidates [10–13].

The aim of the present study was to evaluate the efficacy of unenhanced CT in determining hepatosteatosis in LDLT donor candidates, and to analyze factors related to hepatosteatosis.

MATERIALS AND METHODS

Information about donor candidates who applied from January 2007 to December 2013 for LDLT was retrospectively reviewed. Abdominal CT was performed during pre-transplantation evaluation, and percutaneous hepatic biopsy was performed in cases that were suspected to have hepatosteatosis in abdominal CT examinations. In this screening, 27 donor candidates were found that underwent percutaneous liver biopsy. Liver biopsies and unenhanced CT images of these donors were reevaluated by an experienced pathologist and radiologist.

Laboratory Parameters and Demographic Characteristics

Body mass indexes (BMIs) and biochemical parameters of donor candidates were recorded at the time of application. BMI was defined as the donor weight (kg) divided by the square of height (m^2). Laboratory parameters and their normal ranges were as follows: alanine aminotransferase (ALT; <33 U/L), aspartate aminotransferase (AST; <33 U/L), alkaline phosphatase (ALP; 33–105 U/L), gamma glutamyltransferase (GGT; 5–36 U/L), total cholesterol (<200 mg/dL), high-density lipoprotein cholesterol (40–60 mg/dL), low-density lipoprotein cholesterol (LDL; <130 mg/dL), and triglyceride (TG) (<150 mg/dL).

CT Images

Images were obtained in all donor candidates with the use of multidetector CT (Lightspeed 16; GE Medical Systems, Milwaukee, Wisconsin). Examination was performed first without any contrast material, and then with the contrast for angiographic imaging. In CT examination without contrast, attenuation values of liver and spleen were calculated by taking mean Hounsfield units (HU) of regions of interest (ROIs). Three ROIs were selected in the right hepatic lobes of all donor candidates, and each ROI was an approximately 1 cm × 1 cm area.

In our clinical practice, hepatosteatosis in routine abdominal CT examination is determined by calculating the difference (CT^{L-S}) between hepatic attenuation value (CT^L) and spleen attenuation value (CT^S) in CT images without the contrast material. If this difference is <5, then the case is accepted as being "suspicious for hepatosteatosis" [11].

When CT examinations of all donor candidates were reevaluated, the efficacies of 2 different methods in determining hepatosteatosis were also evaluated and compared with CT^{L-S}. These methods included CT^L and the ratio of hepatic attenuation to splenic attenuation ($CT^{L/S}$) [14].

Histopathologic Evaluation

All hepatic biopsies were performed within 1 month after hepatosteatosis was suspected in the CT exam. Hepatic samples were obtained percutaneously with the use of C17-gauge biopsy needle under ultrasound guidance and were fixed in 10% formalin and embedded in paraffin. The cross-sections were stained with hematoxylin-eosin, Masson trichrome, and reticulin dyes. Samples were accepted as sufficient for examination if they were >1 cm in length and contained >10 portal areas. Macrovesicular hepatosteatosis was graded according to the percentage and divided into 3 groups as grade 0 (0–5%), grade 1 (6%–20%), and grade 2 (>20%) [15,16]. Fibrosis was examined with the use of Masson trichrome stain.

Statistical Analyses

Statistical analysis was performed with the use of SPSS 18.0 (SPSS, Chicago, Illinois) software program. Descriptive analyses for normally