Incidence and Predictors of Increased Coronary Calcium Scores in Liver Transplant Recipients

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ABSTRACT

Background.   Cardiovascular complications in liver transplant recipients are common. A coronary calcium score >400 determined by coronary computed tomographic angiography (coronary CT) provides useful information for predicting postoperative cardiovascular complications in liver transplant recipients. However, little is known about the association between risk factors and increased coronary calcium scores in coronary CT preformed as a preoperative cardiovascular evaluation before liver transplantation. We evaluated the incidence and cardiovascular risk factors of a coronary calcium score >400 in liver transplant recipients.

Methods.   Between 2013 and 2014, 548 liver transplant recipients were analyzed retrospectively. Preoperative cardiovascular assessments and laboratory data were collected with coronary calcium scores. Univariate and multivariate logistic regression analyses were performed to evaluate cardiovascular risk factors of a coronary calcium score >400 in coronary CT.

Results.   The total mean coronary calcium score was 103 ± 358. Of the 548 recipients, 41 (7.5%) had a coronary calcium score >400. The mean coronary calcium score in patients with a coronary calcium score >400 was 999.7 ± 892.1, and the mean coronary calcium score in patients with a coronary calcium score ≤ 400 was 30.1 ± 70.9. In multivariate logistic regression analysis, predictors of a coronary calcium score >400 in liver transplant recipients were age (odds ratio [OR] = 1.05, $P = .029$), male sex (OR = 14.42, $P = .009$), and diabetes mellitus (OR = 2.04, $P = .040$).

Conclusions.   We found that old age, male sex, and diabetes mellitus were predictors of a coronary calcium score >400, which is associated with cardiovascular complications after liver transplantation. This study can provide useful information for preoperative cardiovascular evaluation in liver transplant recipients.

L IVER transplantation is a curative therapy for patients with fulminant hepatic failure and advanced liver disease [1]. The incidence of cardiovascular complications after liver transplantation ranges from 25% to 70%, and these complications are regarded as the most common cause of morbidity and mortality after liver transplantation [2–4]. Furthermore, the prevalence of coronary artery disease increases in liver transplant recipients with cardiac risk factors such as obesity, diabetes mellitus, hypertension, smoking, and hyperlipidemia [4]. Therefore, accurate preoperative cardiovascular evaluations should be performed before liver

transplantation to prevent postoperative cardiovascular complications.

Preoperative cardiovascular assessments include electrocardiography (ECG), echocardiography, coronary angiography,

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and coronary computed tomographic angiography (coronary CT). However, the optimal method to assess cardiovascular risks in liver transplant recipients remains controversial [5,6]. Interestingly, the coronary calcium score obtained from coronary CT scans is considered as a more sensitive indicator of cardiovascular complications than the Framingham risk score in patients undergoing liver transplantation [7]. Furthermore, our previous study reported that coronary CT provides useful information for predicting early postoperative cardiovascular complications in liver transplant recipients [8]. Particularly, a coronary calcium score >400 in coronary CT is a significant predictive factor for cardiovascular complications that occur during a period of 1 month after liver transplantation [8]. However, the association between risk factors and increased coronary calcium scores in liver transplant recipients remains largely unexplored.

We therefore evaluated the incidence and cardiovascular risk factors of a coronary calcium score >400 in liver transplant recipients. To this end, coronary calcium scores in coronary CT scans were calculated using an Agatston scoring method [9]. Recipients were categorized into 2 groups: patients with a coronary calcium score >400, and patients with a coronary calcium score ≤400 [8].

METHODS

This was a single-center, retrospective observational study of 548 patients who underwent liver transplantation at Asan Medical Center, Seoul, South Korea, from January 2013 to December 2014. The study protocol was approved by the Institutional Review Board of Asan Medical Center (Number 2014-0843). The following groups of patients were excluded from the study: (1) patients under 20 years of age, (2) patients who did not undergo coronary CT before liver transplantation, and (3) patients who had incomplete preoperative cardiac evaluation data.

Patient medical records were reviewed to evaluate the cardiovascular risk factors. All data were collected <2 weeks before and 2 weeks after performing the coronary CT. Potential cardiovascular risk factors associated with a coronary calcium score >400 were collected from patient medical records. These included age, sex, body mass index, diabetes mellitus (DM), hypertension, Model for End-Stage Liver Disease score, smoking history, preoperative laboratory data, and echocardiographic findings. DM and hypertension were defined by a history of a physician's diagnosis of these factors, use of hypoglycemic agents or insulin treatment for DM, and treatment for hypertension. Smoking history was categorized as active, former, or never smokers [10]. The active smokers were defined as patients who had smoked at least once within the 2-year period before coronary CT. Patients who had a history of cigarette smoking and had quit for more than 2 years were defined as former smokers. Finally, patients who did not have a past history of smoking were categorized as never smokers.

Preoperative laboratory data about the levels of hemoglobin, platelet, prothrombin time, activated partial thromboplastin time, fibrinogen, D-dimer, total cholesterol, triglycerides, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol, glucose, albumin, sodium, potassium, total bilirubin, creatinine, aspartate transaminase, alanine transaminase, C-reactive protein, B-type natriuretic peptide, ammonia, magnesium, and

troponin-I were collected. Preoperative echocardiographic findings included left atrium diameter, left ventricle ejection fraction, and left ventricle mass index. The corrected QT interval on ECG was evaluated. Coronary CT scans using dual-source CTs (Somatom Definition Flash or Somatom Definition, Siemens Medical Solutions, Forchheim, Germany) were performed, and coronary calcium scores were calculated with an automated, computerized software program using an Agatston scoring method [9].

Categorical data are presented as a number (percentage) and were compared using the χ^2test or Fisher exact test as appropriate. Continuous data are expressed as the mean ± SD and were compared using a t test and Mann-Whitney U test. Factors were input as independent variables into univariate logistic regression analysis. Variables with a value of $P < .15$ on the univariate logistic regression analysis were included in a stepwise multivariate logistic regression analysis to evaluate cardiovascular risk factors that were associated with a coronary calcium score >400 in liver transplant recipients. A value of $P < .05$ was considered statistically significant. All statistical analyses were performed using SPSS for Windows, version 18.0 (SPSS, Inc., Chicago, IL).

RESULTS

Of the 647 patients who underwent liver transplantation during the study period, 548 patients were included in the study. The underlying etiologies of liver disease were as follows: hepatitis B virus−related liver cirrhosis (n = 340, 62.1%), hepatitis C virus−related liver cirrhosis (n = 45, 8.2%), alcoholic liver cirrhosis (n = 92, 16.8%), non-B non-C hepatitis (n = 28, 5.1%), biliary cirrhosis (n = 22, 4%), and others (n = 21, 3.8%).

Coronary CT was performed on all 548 patients with no complications, and the total mean coronary calcium score was 103 ± 358. Of the 548 patients, 41 (7.5%) had a coronary calcium score of >400. The mean coronary calcium score in patients with a coronary calcium score >400 was 999.7 ± 892.1, and the mean coronary calcium score in patients with a coronary calcium score ≤400 was 30.1 ± 70.9.

Baseline characteristic data including those of preoperative cardiovascular evaluations are listed in Table 1. The mean age of the 548 recipients was 54 ± 8.5 years. Of the 548 recipients, 406 (74%) were male and 142 (26%) were female; 139 (25%) recipients had DM and 79 (14%) had hypertension. Significant differences were found for age, sex, DM, a smoking history, Child-Turcotte-Pugh sore, and corrected QT interval between patients with a coronary calcium score >400 and those with a coronary calcium score ≤400 (Table 1). All patients underwent ECG and echocardiography before liver transplantation. A comparison of the preoperative laboratory data of liver transplant recipients listed according to the coronary calcium score is shown in Table 2. Significant differences were found for D-dimer, glucose, total bilirubin, B-type natriuretic peptide, and troponin-I levels between 2 groups (Table 2).

In the univariate logistic regression analysis, the following factors were significantly associated with a coronary calcium score >400 ($P < .15$): age, male sex, DM, a smoking history,