Assessment of Arterial Stiffness and Body Composition in Stable Liver Transplant Recipients

U.Z. Szewc[a], Ł. Czyżewski[b,*], J. Wyzgał[b], and Ł. Szarpak[c]

[a]Student Research Circle "NEFRON" at the Department of Nephrology Nursing, Medical University of Warsaw, Warsaw, Poland; [b]Department of Nephrology Nursing, Medical University of Warsaw, Warsaw, Poland; [c]Lazarski University, Warsaw, Poland

ABSTRACT

Introduction. Arterial stiffness and central arterial pressure are important factors in the diagnosis of cardiovascular diseases. The tendency of patients after liver transplantation to reach above-normal BMI values promotes the development of arterial stiffness and lipid disorders.

Methods. The study was conducted on a group of 42 patients after liver transplantation at the Nephrology and Transplantology Outpatient Clinic, Medical University of Warsaw, the Infant Jesus Teaching Hospital, Warsaw 0.5–17 years after surgery. The body composition test was carried out with the Tanita Mc780 device, and the central pressure and pulse wave velocity (PWV) with the Schiller BR-102 PLUS PWA device, using the oscillometric method on the brachial artery. Medical documentation was analyzed and the laboratory parameters values routinely determined during follow-up visits were assessed.

Results. There was a statistically significant correlation between central diastolic pressure and BMI (r = 0.46, $P < .05$), and a lack of correlation between patients' age and PWV value (r = 0.06, $P < .05$), which indicated the age of patients in this study was not associated the stiffness of their arteries. PWV level in patients after liver transplantation whose BMI value is within the normal range was 7.62 m/s, while overweight and obese patients had PVW values of 8.58 m/s ($P < .05$).

Conclusions. In conclusion, our data indicate that 1. the level of central arterial pressure increases with the development of stiffness in the arteries; 2. patients after liver transplantation tend to grow in terms of body weight and body fat content over time after surgery; and 3. the level of bilirubin in the blood is significantly increased among patients with fat content above the upper limit of the normal range.

ACCORDING to the European Cardiac Society, liver transplant surgery carries the highest cardiovascular risk, which is associated with more than a 5% risk of death from cardiac causes or myocardial infarction within 30 days post-surgery. Patients with hepatic insufficiency exhibit a significantly disturbed cardiovascular function, which may lead to the development of hepatopulmonary syndrome [1]. Currently, candidates for liver transplantation (LTx) are getting older and have more diseases accompanying the cardiovascular system than ever before. The ever-growing model of the final stage of liver disease (MELD) at the time of the transplant, resulting from the urgent need for transplantation, reflects the growing risk profiles of patients requiring liver transplantation. In addition to advanced age and the presence of comorbid diseases, there is a specific cardiovascular response to cirrhosis, which may be harmful to this group of patients. Patients diagnosed with cirrhosis and requiring LTx usually show increased cardiac output and disturbed ventricular response to stress, a condition called hepatic cardiomyopathy. Physiological changes of inflammatory mediators, low vascular resistance, and bradycardia contribute to the development of cardiovascular complications, especially with altered hemodynamic

*Address correspondence to Łukasz Czyżewski, Department of Nephrology Nursing, Medical University of Warsaw, Str. Żwirki i Wigury 61, 02-091 Warsaw, Poland. Telephone: +48 22 502 12 57. E-mail: czyzewski_lukasz@wp.pl

230 Park Avenue, New York, NY 10169

0041-1345/18
https://doi.org/10.1016/j.transproceed.2018.05.004

stresses, which affect patients with a transplanted liver in the immediate postoperative period. Reperfusion after transplantation can lead to cardiac death due to many reasons, including arrhythmia, acute heart failure, and myocardial infarction. The diagnosis of hemodynamic changes in perioperative liver transplant patients and how these reactions may become more severe as a result of cardiac pathology is important in developing recommendations for pre-operative risk assessment and management of these patients [2]. Pulse wave velocity (PWV) is a measure of the speed of the pulse wave. The test is simple and noninvasive and its results provide information about the stiffness of the examined part of the arterial system, including aorta values and peripheral arterial vascular segments [3,4]. According to the European Society of Hypertension/European Society of Cardiology's (ESH/ESC) latest guidelines from 2013, while evaluating cardiovascular risk to patients with increased blood pressure, it is necessary to evaluate the physical parameters of the artery walls, because it determines the interactions between the heart and large arteries. Arterial stiffness depends on genetic factors, age, and environmental factors. Genetic factors have a direct and indirect influence on arterial stiffness, because vascular stiffness can change modify depending on genetic influences in blood pressure, lipedema, glycemia, and other classic risk factors. Previous research about inheritance of the arterial stiffness highlights the renin−angiotensin−aldosterone system (RAA), which is responsible for cell proliferation and synthesis of extracellular matrix [5]. The latest research shows the crucial influence of the sex hormones, especially estrogen and progesterone, on the structure and function of arterial vessels in women [6]. Arterial stiffness in young patients with non-alcoholic fatty liver disease (NAFLD) is dependent on the presence of an unfavorable metabolic profile. Studies show that patients with NAFLD have a high risk of cardiovascular disease, including risk factors such as a larger waist circumference, increased levels of triglycerides and insulin, high systolic blood pressure, and lower HDL cholesterol level. These are important determinants of cardiac complications, which is associated with elevated PWV values [7]. Portal-pulmonary hypertension (PPH) affects 4.5−8.5% of patients with advanced liver cirrhosis [1]. Body weight and body composition disorders are a serious problem in most developed countries. Being overweight and obese are risk factors for many diseases such as hypertension, ischemic heart disease, Type 2 diabetes, hyperlipidemia, or most malignant tumors. Liver transplant patients in particular tend to be overweight or obese. Increased body mass index (BMI), an concentration of LDL cholesterol, and lack of physical activity promote the deposition of atherosclerotic plaques in the arterial endothelium, which affects the arterial stiffness. Bioelectrical impedance analysis (BIA) is a fast, cheap, noninvasive and repeatable measure of body composition. It is possible to use this method with healthy people, children, and people with chronic metabolic disorders. BIA is based on measuring impedance, that is electrical resistance, of the resistance and reactance of the soft tissues through which low electric current is passed [8]. An important element in the assessment of nutritional status is the measurement of muscle exhaustion or protein loss. Protein is a key structural and functional component of the body, and its loss is associated with the inferior functioning of the body. Protein-energy malnutrition (PEM) is common in chronic liver disease due to various factors, including inadequate nutrition, malabsorption, increased loss of proteins in the intestines, reduced hepatic protein synthesis, abnormal substrate use, and hypermetabolism. In patients with liver disease, PEM is associated with an increased risk of complications, including bleeding from varicose veins, encephalopathy, and hepatorenal syndrome, which affects the survival of the patient [9,10]. The main goal of this work was: 1. the assessment of arterial stiffness and the central pressure in a group of patients after liver transplantation, and 2. determining the association between central pressure, arterial stiffness, and body composition among liver transplant patients in terms of cardiovascular risk.

METHODS

The study was carried out between March and April 2017 at the Nephrology and Transplantology Outpatient Clinic, Medical University of Warsaw, the Infant Jesus Teaching Hospital, Warsaw, Poland. The study involved 42 patients after liver transplantation. The study was carried out in accordance with the principles of ethics (Declaration of Helsinki) and has been approved by the Bioethical Committee of the Medical University of Warsaw (no. AKBE/178/16). Patients under 18 years old were not included in the study. Informed consent was obtained from every patient participating in the study. Anthropometric measurements, like weight (with accuracy to 0.1 kg), height (with accuracy to 1 cm), and waist size (with accuracy to 1 cm) were obtained for all participants. Body composition measurements were made with the TaniTAMc 780 device. Based on the collected data, BMI, basal metabolic rate (BMR), kilogram fat content (FATM), percentage fat content (FATP), total body water (TBW), and indicator of visceral fat (VISCFAT) were calculated for every patient. The central pressure was also measured. Arterial stiffness was measured by the SCHILLER BR-102 PLUS PWA device using the oscillometric method on the shoulder artery. The measurement was made on the supported upper limb and located at the heart level while patients were sitting using the standard 12 cm width and 35 cm length cuff. Compared to liver transplant recipients, the control group consisted of 20 healthy volunteers, mean age was 38 years ($P < .001$), 20% male ($P < .001$), mean PWV of 6.4 m/s ($P < .001$), mean SBP of 121 mm Hg ($P < .001$), mean CSBP of 115 mm Hg ($P < .001$), and mean waist circumstance of 80 cm ($P < .001$).

For the statistical analysis results, continuous variables were presented in the form of a mean ± standard deviation (SD), and the qualitative features presented as a percentage distribution. Variables of a normal distribution and homogeneous variances were verified by parametric tests for unrelated variables (Student *t* test). Pearson's linear correlation coefficient was used to study the relationship between variables. Variables that do not have a normal distribution were subjected to the non−parametric tests for unrelated variables: Mann−Whitney U test, Kruskall−Wallis test or $\chi 2$. Statistical analysis was performed using Statistica 13.1 software (StatSoft Inc., Tulsa, OK), assuming $P < .05$ as a threshold of significance.