Comparative Analysis of Arterial Stiffness and Body Composition in Early and Late Periods After Kidney Transplantation

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ABSTRACT

Introduction. Diseases of the cardiovascular system are the most common cause of death in patients after kidney transplantation (KTx). Pulse wave velocity (PWV) measurement is a simple, noninvasive, and increasingly popular method to assess arterial stiffness, and thus to assess cardiovascular risk. The aim of the study was to compare arterial stiffness and body composition in patients after KTx in the early and late postoperative periods.

Methods. This research was carried out from January to November 2017 at two locations: (1) Department and Clinic of General and Transplant Surgery and (2) Nephrology and Transplantology Clinic Medical University of Warsaw, the Infant Jesus Teaching Hospital, Warsaw, Poland. The study group consisted of 30 patients in the early postoperative period (2–7 postoperative days) and 151 patients in the late period (6 months to 27 years) after KTx. A single blood pressure measurement, PWV, was performed using a Schiller BR-102 plus PWV. Body composition analysis was performed using a Tanita MC-780 device.

Results. The average PWV for patients in the early period after KTx was 8.02 ± 2.21 m/s and in the late period 8.09 ± 1.68 m/s. Positive correlations were found between adipose tissue in the abdominal cavity ($R = 0.444$, $P = .033$) and PWV value. There was no correlation between the values of PWV and time after transplantation ($R = 0.034$, $P = .777$). Upon analyzing patients after transplantation and taking into account the type of dialysis therapy, lower systolic blood pressure (142 ± 21 mm Hg vs 156 ± 24 mm Hg) and diastolic blood pressure (84 ± 13 mm Hg vs 98 ± 11 mm Hg) values were observed in patients treated with hemodialysis compared with those treated with peritoneal dialysis.

Conclusion. Using PWV measurement, we found that arterial stiffness levels were similar for early and late periods after transplantation.

CHRONIC KIDNEY DISEASE (CKD) is a complex syndrome, characterized by a slow, irreversible, progressive deterioration of kidney function. Kidney transplantation (KTx) in clinical terms is the best method for renal replacement therapy as it increases longevity and quality of life, and it should be considered for every patient in end-stage renal disease (ESRD). Cardiovascular disease (CVD) is the main cause of morbidity and mortality in highly developed countries but is also the main cause of death among patients with CKD. KTx reduces the occurrence of cardiovascular risk factors, although it is still the cardiovascular system diseases that are among the main causes of death in the kidney recipients [1,2].

The occurrence of CVDs in patients after KTx is affected not only by the traditional risk factors but also others, such as immunosuppressive therapy, earlier dialysis therapy, proteinuria, inflammation, or anemia. All these factors lead to complications such as hypertension, lipid disorders, diabetes, and increased the artery stiffness [2]. The arteries in the human body have 2 essential functions: supplying blood to

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the tissues and organs and changing the pulsing ejection of blood through the left ventricle to the continuous flow in the organs. While analyzing the parameters of the pulse wave, the flexibility level of the small and large arteries can be defined. Thus, it is possible to obtain information about the early functional and structural changes in arterial walls. Arterial stiffness is described as a reduction in the flexibility properties of the blood vessels. Pulse wave velocity (PWV) measurement is a simple, noninvasive, increasingly popular method used for evaluation of arterial stiffness and thus for the assessment of risk of cardiovascular diseases. PWV can be measured in any artery or between any arterial sites, yet it has been shown that only the measurement between the carotid-femoral artery has major prediction importance [2,3].

A reduction in the number of deaths caused by CVDs could significantly improve the survival rate in patients after KTx. The aim of the study was to compare arterial stiffness as well as hydration and nutrition levels in renal recipients who are in the early and late postoperative periods.

MATERIALS AND METHODS

This research was carried out from January to November 2017 at the Infant Jesus Teaching Hospital, Warsaw, Poland. The study was performed in accordance with ethical principles established by the Declaration of Helsinki and was approved by the bioethics committee of the Medical University of Warsaw (AKBE/179/16), and all patients expressed their voluntary consent to participate in the study. Individuals who qualified for study participation were informed by oral and written instructions about the principles, aims, and benefits resulting from the research. All subjects were $\geq$18 years of age, had stable function of the transplanted organ, and provided informed consent to participate. Time after renal transplant for the early period was $\geq$1 to <8 days and for the late period was >6 months.

Patients with active infection, amputation of lower or upper limb/limbs, and active arteriovenous fistulas on both upper limbs were excluded from the study. The final study group consisted of 181 patients in 2 postoperative periods. Among them, 30 (73% men, 27% women) were in the early postoperative period (2–7 postoperative days) and 151 (63% men, 37% women) were in the later period (6 months to 27 years) after KTx. Analysis of medical records was done to determine cause of transplant, time after surgery, time and type of dialysis therapy, and body mass index (BMI). A single blood pressure measurement, PWV, and evaluation of central arterial pressure were performed using using a Schiller BR-102 plus PWA blood pressure monitor, as recommended by the European Society of Hypertension, in the sitting position after an earlier rest. The results of concentration determination of hemoglobin, erythrocytes, creatinine, total cholesterol, low-density lipoprotein (LDL)-cholesterol, high-density lipoprotein (HDL)-cholesterol, triglycerides, C-reactive protein (CRP), and glomerular filtration rate (eGFR), routinely performed on patients after KTx and collected on the same day on an empty stomach, were also used for the analysis. Compared with the renal transplant recipient group, the control group consisted of 20 healthy volunteers, with the following characteirics: mean age 38 years ($P < .001$); 20% male ($P < .001$); mean PWV 6.4 m/s ($P < .001$); mean systolic blood pressure (SBP) 121 mm Hg ($P < .001$); mean central systolic blood pressure (CSBP) 115 mm Hg ($P < .001$); and mean waist circumstance 80 cm ($P < .001$).

PWV measurements were taken between the carotid and femoral artery (aortic PWV) using the Schiller BR-102 plus PWA device. Examinations were performed on an empty stomach between 7:00 and 10:00 AM in a quiet room, in a sitting position after patients' earlier rest. The kit consists of the recorder and a blood pressure cuff. A pressure Holter monitor measures parameters such as CSBP, central diastolic blood pressure (CDBP), PWV, systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), pulse pressure (PP).

Body composition analysis was performed using a Tanita MC-780 segmental body composition scale (Tanita Corp, Tokyo, Japan), which functions based on bioelectrical impedance analysis. Currents of different frequencies flow through the patient's body—frequencies change during measurement, making it possible to obtain the most accurate results and improve the repeatability of results. By using several different frequencies the device allows one to determine the content of the intracellular water (ICW), extracellular water (ECW), total body water (TBW), fat free mass (FFM), fat tissue mass (FATM), fat tissue percentage (FATP), basal metabolic rate (BMR), and visceral fat (VISCFAT).

The results obtained were calculated using statistical analysis methods. Continuous variables are presented as mean $\pm$ standard deviation (SD) and qualitative features are presented as percent. Variables with a normal distribution and a homogeneous variance were verified by parametric tests for unrelated variables and by Student's t test. Pearson's linear correlation coefficient was used to study the relationship between variables. Variables without a normal distribution were subjected to nonparametric tests for unrelated variables by Mann-Whitney U test, Kruskal-Wallis test, or chi-square test. Statistical analysis was done using Statistica version 13.1 (StatSoft, Inc, Tulsa, OK), with $P < .05$ considered statistically significant.

RESULTS

The study included 181 individuals in 2 postoperative periods. The average age in the first group (early postoperative period) was 48 $\pm$ 15 years and 51 $\pm$ 14 years in the second group (late postoperative period). The average PWV value for patients in the early period after KTx was 8.02 $\pm$ 2.218 m/s and in the late period was 8.09 $\pm$ 1.68 m/s. While analyzing patients after transplantation and taking into consideration the type of dialysis therapy, lower SBP (142 $\pm$ 21 mm Hg vs 156 $\pm$ 24 mm Hg) and DBP (84 $\pm$ 13 mm Hg vs 98 $\pm$ 11 mm Hg) values were observed in patients treated with hemodialysis when compared with peritoneal dialysis. Sixty-seven percent of the patients were taking tacrolimus and 34% were taking cyclosporine. A lower PWV value was observed in patients receiving tacrolimus when compared with cyclosporine (7.89 $\pm$ 1.62 m/s vs 8.40 $\pm$ 1.75 m/s, respectively). A lower triglycerides concentration in patients' blood was also detected (144 $\pm$ 54 vs 155 $\pm$ 61 mg/dL, respectively). Estimated glomerular filtration rate (eGFR) was lower for patients taking cyclosporine compared with tacrolimus (42 $\pm$ 18 vs 48 $\pm$ 20 mL/min, respectively).

VISCFAT content, ECW mass, and metabolic age were determined in 80% of the subjects. There was a positive correlation between the VISCFAT ($R = 0.444$, $P < .001$) and PWV. Tables 1 and 2 show the results with regard to