



24-hour Arterial Stiffness Monitoring in Kidney Transplant Recipients in the Early Postoperative Period

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ABSTRACT

Introduction. Laboratory tests and anthropometric assessments are essential in determining the risk for cardiovascular disease in patients after kidney transplantation (KTx). Patients with hypertension and elevated pulse wave velocity (PWV) are at a higher risk of cardiovascular mortality. The purpose of this study was to determine the role of blood pressure, arterial stiffness, and selected laboratory and anthropometric parameters in estimating the risk of cardiovascular disease in KTx patients.

Methods. A total of 17 KTx patients of the Clinical Department of Gastroenterological Surgery and Transplantation at Central Clinical Hospital of Ministry of the Interior and Administration (MSWiA Hospital) in Warsaw, Poland, were enrolled in this study between 3 to 7 days after undergoing kidney transplantation. Medical records of these patients were reviewed for the selected laboratory parameters. The patients' blood pressure and PWV values were monitored for 24 hours and their body mass index (BMI) values were calculated (BMI \geq 25.0 is considered overweight).

Results. Hemoglobin concentration showed a negative correlation with PWV ($r = -0.6$), whereas red blood cell distribution width (RDW) showed a positive correlation with the PWV value ($r = 0.29$). There was a significant correlation ($r = 0.21$) between overweight measured via BMI and the PWV values. For results of kidney function blood tests, the estimated glomerular filtration rate (GFR) and creatinine levels showed no significant correlation with 24-hour PWV values (GFR $r = -0.03$; creatinine $r = 0.03$).

Conclusions. The following were shown to be important indices of cardiovascular risk in the evaluated population of KTx patients: age, BMI, blood pressure, PWV, hemoglobin levels, red blood cells, and RDW%.

KIDNEY transplantation (KTx), besides dialysis and hemodialysis, is a treatment method for end-stage renal disease (ESRD). Currently, the leading cause of mortality among KTx patients is cardiovascular disease (CVD) [1]. During the period of 15 years following KTx, approximately 23%, 15%, and 15% of patients are affected by coronary artery disease, cerebral vascular disease, and peripheral vascular disease, respectively. Accurate identification of CVD risk factors can help increase survival in KTx patients. These patients are particularly prone to developing hypertension. The main factors contributing to the development of CVD in KTx patients are pre-existing diabetes mellitus, history of cardiovascular events, the estimated glomerular filtration rate (eGFR), age, sex, race, and ESRD

duration [2,3]. Primary and secondary CVD prevention strategies in KTx patients do not differ from those for the general population. Thus, eliminating modifiable risk factors for CVD (including smoking cessation, blood pressure reduction, dyslipidemia control, physical activity, weight loss, and healthy diet) plays a key role, with medical treatment, adequate control of calcium and phosphorus metabolism, and management of anemia also playing an

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important part in achieving a long-term positive outcome following KTx [1,2,4]. The blood ejected by the left ventricle of the heart ensures blood flow and stretches aortic walls as the pressure wave generated by each heartbeat propagates peripherally, a phenomenon known as the pulse wave. Reduced arterial wall elasticity (or increased arterial stiffness) associated with certain conditions and old age causes the pulse wave to propagate more rapidly. Arterial stiffness, or arteriosclerosis, which is observed already in patients with early-stage chronic kidney disease, tends to aggravate as the disease progresses. The most common way of assessing arterial stiffness is to measure pulse wave velocity (PWV), which involves recording the pulse wave with sensors placed along the carotid and femoral arteries. The 2007 guidelines of the European Society of Hypertension declared a PWV of >12 m/s to be an indicator of subclinical organ injury. Lower eGFR values are associated with higher PWV. These values are also affected by age, arterial blood pressure, diabetes mellitus, high cholesterol levels, and vascular calcification. One population of interest are diabetic patients, who exhibit particularly high markers of arterial stiffness. Patients on hemodialysis and peritoneal dialysis show considerably elevated PWV of >10 m/s, which is associated with a higher mortality risk. The PWV value in predialysis patients is also noticeably lower than that in hemodialyzed patients. The factors determining an elevated PWV in KTx recipients also include the excretory graft function, immunosuppressive therapy, donor's age, and cold ischemia time. Elevated markers of arterial stiffness were also observed in patients with ESRD, irrespective of the treatment used. The noninvasive PWV measurement allows early detection of any signs and the management of the modifiable aspects of this condition [5–8]. The objectives of this study were 1. to analyze the 24-hour blood pressure profile, PWV, and factors affecting these parameters in KTx recipients during the early postoperative period; 2. to establish the role of selected laboratory tests and anthropometric assessments in diagnosing cardiovascular complications in KTx patients; and 3. to determine any correlations between laboratory test results on one side and blood pressure values and arterial stiffness and anthropometric parameters on the other.

METHODS

This single-center observational case-control cohort study was conducted from February 2016 to February 2017. The study evaluated 17 consecutive patients admitted to the Clinical Department of Gastroenterological Surgery and Transplantation at Central Clinical Hospital of Ministry of the Interior and Administration (MSWiA Hospital) in Warsaw, Poland. All patients who qualified to take part in the study were informed orally and via written instructions as to the nature, purpose, and benefits of the study and provided their written informed consent. The inclusion criteria were age ≥ 18 years, time after kidney transplantation ≥ 3 and ≤ 8 days, stable graft function, and informed consent to undergo assessments. The exclusion criteria were presence of an active infection, lack of informed consent, age under 18 years or over 80 years, and patent

arteriovenous fistulas in both upper limbs. The study protocol had been approved by the Institutional Review Board of the MSWiA Hospital (approval no. 34/2016). The PWV measurements and ambulatory blood pressure monitoring (ABPM) were conducted during the patients' hospital stay. All measurements were conducted by one trained investigator. Twenty-four-hour blood pressure was monitored with a Schiller BR-102 Plus PWA system (Schiller, Baar, Switzerland), recommended by the European Society of Hypertension. The system includes a recorder and a cuff, with the recording spanning a 24-hour period. The individual measurements were conducted in 20-minute intervals during the day and in 30-minute intervals at night, with the cuff placed on the upper limb with no patent arteriovenous fistulas. All patients underwent anthropometric measurements, such as body weight, height, and waist circumference, and body mass index (BMI) for each patient was calculated based on the gathered data. Medical records were reviewed for the following laboratory test results: hemoglobin, red blood cell (RBC) count, RBC distribution width (RDW%), creatinine, and eGFR, as well as for details on the time after KTx, duration and type of the preceding dialysis treatment, and the patient's age.

The obtained findings were analyzed statistically, with continuous variables expressed as the mean \pm standard deviation (SD), and categorical variables expressed as proportions (percentage values). Variables with normal distribution and equal (ie, homogeneous) variances were verified with Student's *t* test. Pearson's correlation coefficient was used to measure the linear correlation between variables. Variables with non-normal distribution were analyzed with nonparametric tests for independent variables: Mann–Whitney *U* test, Kruskal–Wallis test, or χ^2 test. The Spearman rank correlation coefficient was used to measure dependence between the analyzed variables. Statistical analyses were conducted with Statistica 13.1 software (StatSoft, Palo Alto, Calif, United States) with the significance threshold set at $P < .05$.

RESULTS

A total of 17 KTx patients, aged from 22 to 71 years, took part in the 24-hour-monitoring study. The mean age of kidney transplant recipients was 48 years. Prior to their transplantation procedure, all patients had received ESRD treatment in the form of hemodialysis for a mean period of 2.4 ± 1.4 years. Laboratory test results in 47% of patients showed a hemoglobin level of <10 g/dL. The mean hemoglobin value was $9.8 \text{ g/dL} \pm 0.8 \text{ g/dL}$. All patients had a low RBC count with the mean value of $3.2 \text{ mil}/\mu\text{L}$. All patients had RDW values within normal limits with a mean value of 13.3%. All patients exhibited elevated creatinine levels with the mean creatinine level of $4.6 \text{ mg/dL} \pm 2.9 \text{ mg/dL}$. Low eGFR values were observed in all patients, with eGFR $<15 \text{ mL/min}/1.73 \text{ m}^2$ in 41%, $15\text{--}30 \text{ mL/min}/1.73 \text{ m}^2$ in 29%, and $>30 \text{ mL/min}/1.73 \text{ m}^2$ in 30% of patients, and the mean eGFR of the study population was $20.6 \pm 14 \text{ mL/min}/1.73 \text{ m}^2$. Twenty-four-hour blood pressure monitoring yielded normal blood pressure in 23.5% of patients, above normal in 17.6%, grade 1 hypertension in 35%, and grade 2 hypertension in 23.9%. The 24-hour mean systolic blood pressure (SBP) was 141 mm Hg and mean diastolic blood pressure (DBP) 85 mm Hg. Mean arterial pressure (MAP) was 109 mm Hg. Pulse pressure (PP) was elevated in 58% of patients, with a mean value of 56 mm Hg. Central SBP

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