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VASCULAR STIFFNESS AND LEFT VENTRICLE REMODELING IN PATIENTS WITH HYPERTENSION RECEIVING RENAL REPLACEMENT THERAPY

Abstract

Objective. The objective of our study was to compare vascular stiffness and left ventricular remodeling in patients with hypertension receiving renal replacement therapy and in patients with essential hypertension.

Materials and methods. The study enrolled 158 patients, divided into 4 comparable in age groups: 32 patients on planned hemodialysis, 37 recipients of renal transplant, 69 patients with essential hypertension and 20 healthy volunteers. All the patients underwent 24-hour blood pressure monitoring with an assessment of VS and central BP. Mean 24-hour, night and daytime SBP, DBP, PBP, SBP_{ao}, PWV_{ao}, RWTT and PTIN, and the decrease degree of SBP and DBP were determined. M- and B-mode echocardiography was performed in all patients.

Results. No significant difference was detected in central and peripheral BP between patients on PH and after KT. Comparing patients on RRT with the group of essential hypertension, the office systolic and diastolic BP values did not differ significantly. However, significantly higher night DBP and SBP_{ao} values were detected in patients on RRT, and in the patients after KT night SBP and PBP levels were also increased. PWV_{ao} increase of more than 10 m/s was detected only in patients on RRT. In the groups of patients with hypertension 24-hour VS differed significantly from the group of healthy volunteers. PTIN showed more obvious difference: in the healthy volunteers, it was in the range of 80–90%, in the patients with essential hypertension — 50–60%, and in the patients on PH and after KT it was 20–40%. In all groups of patients with hypertension, the mean LV posterior wall thickness and the interventricular septum thickness were close to the upper limit of the norm. In these groups, the LV relative wall thickness was also increased. In both groups on RRT, LVMI was increased compared to the norm (≤116 g/m^2 in males and ≤ 96 g/m^2 in females). All patients showed normal LV systolic function and LV dimensions. LVEDD was significantly higher in patients on PH, and LVPWT — in patients after KT, compared to the group of essential hypertension. Furthermore, significantly higher values of LVMI and IVST were detected the group of PH in comparison with after KT. In addition, in all the groups of patients with hypertension, there was a tendency to LV spherification in comparison with healthy volunteers, and in the group of essential hypertension the difference was more significant compared with the group on RRT.

Conclusion. In patients with hypertension, receiving renal replacement therapy, higher mean 24-hour aortic pulse wave velocity, central pressure, and longer period of aortic pulse wave velocity increase are recorded than in patients with essential hypertension with comparable values of office BP.

***Key words:** renal transplantation, planned hemodialysis, vascular stiffness, pulse wave velocity, 24-hour blood pressure monitoring, PTIN*

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Aix — index of augmentation, PTIN — Pulse Time Index of Norm, RWTT — Reflected Wave Transit Time, BP — blood pressure, LVH — left ventricular hypertrophy, (d) — mean daily values, DBP — diastolic blood pressure, RRT — renal replacement therapy, ACEI — angiotensin converting enzyme inhibitors, LVMI — left ventricular mass index, LVEDD — end-diastolic diameter of the left ventricle, LVESD — end systolic diameter of the left ventricle, LV — left ventricle, LVM — left ventricular mass, (n) — mean values, LVRT — relative thickness of left ventricular walls, PBP — pulse blood pressure, PH — planned hemodialysis, (s) — mean 24-hour values, SBP — systolic blood pressure, SBP_{ao} — central blood pressure, VS — vascular stiffness, GFR — glomerular filtration rate, 24-hour BPM — 24-hour blood pressure monitoring, PWV_{ao} — pulse wave velocity in the aorta, CVC — cardiovascular complications, LVPWT — left ventricular posterior wall thickness, IVST — interventricular septum thickness, KT — kidney transplantation, EF — ejection fraction, CKD — chronic kidney disease, Echo — Echocardiography

Introduction

The problem of early and non-invasive diagnosis of target organ damage in hypertension remains extremely topical. Pulse wave velocity in the aorta (PWV_{ao}) is considered one of the methods, which can be used for this purpose [1–3]. In addition to the standard single-step registration of carotid-femoral PWV_{ao}, there is now an opportunity to conduct a 24-hour estimation of vascular stiffness (VS) using the oscillometric method [4–6]. It is important that the study of fluctuations and mean 24-hour PWV_{ao} values enables to provide more complete estimation of the vascular wall state than single measurements. At present, the results of the study of 24-hour VS using single-cuff oscillometry in healthy volunteers and patients with essential hypertension are known [7–9]. In patients on planned hemodialysis (PH) and in patients after kidney transplantation (KT), the features of 24-hour heart rate changes remain poorly understood. However, cardiovascular complications (CVCs) play a leading role among the causes of mortality among these patients [10, 11]. Therefore, timely identification of signs of vascular wall damage is very important in the context of initiation of prevention of CVC progression and measures to increase life expectancy.

Study objective

To carry out a comparative analysis of vascular stiffness and left ventricular remodeling in patients with hypertension receiving renal replacement therapy and with essential hypertension.

Materials and methods

The study enrolled 158 patients. Patients with secondary renal parenchymal hypertension and terminal chronic kidney disease (CKD) (GFR<15 mL/min) comprised two main groups: 32 patients (18 males and 14 females) receiving PH aged 34.4 [25.5; 48] years (mean duration of PH was 24 [9;52] months) and 37 recipients of a kidney transplant (18 males and 19 females) aged 39 [32; 46] years (mean time after surgery was 19 [10; 36] months, and the mean duration of the previous dialysis period was 24 [8; 48] months). The comparison groups were as follows: 69 patients with essential hypertension selected in pairs with patients with nephrogenic hypertension (gender, age, extent and duration of hypertension, office values of BP and antihypertensive therapy were taken into account); and 20 healthy volunteers (16 males and 4 females) composed the control group. The groups of the examined patients were comparable in age, taking into account the fact, proven as far back as 1964 by N.N. Savitsky, that only age has a decisive effect on VS in both healthy and sick persons [12].

Exclusion criteria for all groups of patients were: Body mass index >30 kg/m^2 (due to deterioration of quality of recording of the oscillometric curve with an increase in soft tissue thickness above the brachial artery), unstable clinical status, diabetes mellitus, cardiac arrhythmias (atrial fibrillation and flutter, frequent supraventricular and ventricular extrasystoles), confirmed ischemic heart disease, NYHA II-IV chronic heart failure, severe dyslipidemia, acute inflammatory diseases, exacerbation of chronic diseases, cancer, thyroid disease, connective tissue diseases, history of professional sports, and pregnancy. Additional exclusion criteria for patients with CKD were history of KT, chronic transplant rejection, uncorrected calcium and phosphorus metabolism disorders. Twenty-one patients on PH, 34 kidney transplant recipients and 55 patients with essential hypertension received antihypertensive therapy including angiotensin converting enzyme inhibitors (ACEI), β-blockers, calcium channel blockers and centrally acting drugs (moxonidine). After KT, all subjects also received immunosuppressive therapy. All patients underwent 24-hour monitoring of BP using a portable automatic BPLab monitor with assessment of vascular stiffness and aortic pressure (SBP_{ao}) values using Vasotens technology (Petr Telegin OOO, N. Novgorod). Patients receiving PH were measured within the interdialysis period. BP was recorded by the oscillometric method in automatic mode on the brachial artery for 22–24 hours, against the background of normal physical activity with an interval between measurements of 20 minutes during daytime and 40 minutes at night. Throughout the monitoring period, the patients kept a diary, which reflected the duration and quality of night sleep, levels of physical and emotional activity, eating, taking medications, smoking and changes in well-being. The study was considered informative if the number of successful blood pressure measurements was at least 70% of all planned measurements during the day, or at least 21 measurements in the afternoon and at least 7 measurements during sleep [13]. Parameters of SBP_{ao} and VS were obtained by post-processing the oscillometric curve obtained at the brachial artery using mathematical algorithms incorporated into the Vasotens software (BPLab, N. Novgorod). Mean 24-hour (s), daily (d) and night (n) values of systolic and diastolic pressure (SBP (s), SBP (d), SBP (n), DBP (s), DBP (d), DBP (n)), pulse BP (PBP (s), PBP (d), PBP (n)), central arterial pressure (SBP_{ao}(s), SBP_{ao}(d), SBP_{ao}(n)), pulse wave velocity in the aorta (PWV_{ao}(s), PWV_{ao}(d), PWV_{ao}(n)), reflected wave transit time (RWTT (s), RWTT (d), RWTT (n)), augmentation index (Aix) and pulse time index of norm during 24 hours, daytime and at night (PTIN (s), PTIN (d), PTIN (n)), and the degree of systolic and diastolic BP decrease. The quality control of each BP measurement was carried out based on visual assessment of the oscillometric curves on the clinical report screen. To calculate outpatient PWV_{ao} and associated indices, the distance between the jugular fossa and the superior margin of the pubic symphysis — the jugulum — symphysis distance (projection of the aortic length) — was measured in all patients. Assessment of SBP_{ao} was performed by plotting the curve of the average shape of pulsation in the ascending aorta based on the curve of pressure change in the brachial artery using the forward and backward Fourier transform and the transfer function developed by O'Rourke et al. on the basis of a comparison of direct invasive measurement of BP in the aorta and brachial artery, and using the mathematical algorithms integrated in the Vasotens software [14]. At present, there is no doubt that the value of central BP better correlates with the severity of left ventricular hypertrophy (LVH) and cardiovascular outcomes [7, 15, 16]. Therefore, its determination is preferable in the management of hypertensive patients.

PTIN was calculated using the formula:

$$PTIN, \% = (\Sigma T_k) / T_m * 100,$$

where ΣT_k is the sum of all periods during which the PWV_{ao} does not exceed the threshold value of 10 m/s, T_m is the total monitoring time. Normally, the value of the PTIN index is close to 100%. During the study, PWV_{ao} values are recorded both above and below the threshold value of 10 m / s. Twenty-four-hour PTIN indicates the percentage of time when the PWV_{ao} curve is below the line drawn through the 10 m/s mark. Obviously, there are differences in the clinical status of patients with PWV_{ao} above the threshold value of 0 or 50 or 100 percent of the study time. Accordingly, it is quite appropriate to use the "time index" for PWV_{ao}. It should be noted that in the process of studying the parameters of 24-hour VS, the authors proposed various experimental indices to improve the diagnostic accuracy of 24-hour VS monitoring. However, currently, only the PTIN index confirms its informative value.

Echocardiography (Echo) was carried out on the DC-7 device, Mindray (China), in patients receiving renal replacement therapy (RRT and on the Vivid 7 Dimension device, GE (USA), in patients with essential hypertension and healthy volunteers in M- and B-regimens within a few days after 24-hour BPM. The measurements were carried out in standard EchoCG positions with the determination of the ejection fraction (EF) of the left ventricle (LV), diastolic thickness of left ventricular walls (posterior wall thickness (LVPWT) and interventricular septum thickness (IVST), mm), end-diastolic and end-systolic LV diameters (EDD, ESD). Calculation of the left ventricular wall relative thickness (LVRT) and left ventricular mass (LVM) using the Devereux R.B formula, and left ventricular mass index (LVMI), as the ratio of LVM to body surface area, was performed. LVMI ≥116 g/m^2 was considered as threshold value for LV hypertrophy for males, and ≥96 g/m^2 — for females [17].

The study was approved by the Ethical Committee of the FSBHI "Volga District Medical Center" of FMBA of Russia. All study participants gave written informed consent.

Statistical analysis was performed using the STATISTICA 10.0 software package (StatSoft, Inc., USA). In order to automatically calculate 24-hour BPM values, aortic pressure and LV parameters, we used the 05.00.04 version of the BPStat program (BPLab, Russia). Non-parametric statistical methods were used in the calculations. For descriptive statistics, median and deviations estimated for the 25th and 75th percentiles (Me ± SD) were calculated. For comparison of two independent groups, the Mann-Whitney U test was used. The Kruskal-Wallis test was used to compare three independent groups. In the calculation of the correlation between the two signs, the Spearman's correlation analysis was used. The level of statistical significance was assumed to be $p < 0.05$.

Results and discussion

Based on 24-hour BPM results, elevated values of mean daily SBP, DBP and aortic pressure were revealed in all groups of hypertensive patients with both renal and essential hypertension (upper limit of the norm for SBP (d) was 135 mm Hg, DBP (d) — 85 mm Hg, SBP_{ao} — 120 mm Hg). Office values of SBP and DBP and mean night SBP and DBP exceeded the norm only in patients receiving RRT (the upper limit of the norm for office SBP was 139 mm Hg, DBP — 89 mmHg, SBP (n) — 120 mm Hg, DBP (n) — 70 mm Hg). The mean values of PBP in any group of hypertensive patients did not exceed the threshold value of 53 mm Hg. The degree of nocturnal decrease of SBP and DBP was reduced only in groups of patients with kidney disease. The results are presented in Table 1.

As is seen from Table 1, the groups of patients on PH and after KT did not differ significantly in terms of values of central and peripheral blood pressure. Comparison of groups of patients receiving RRT with the essential hypertension group revealed no significant differences in the office SBP and DBP values; but significantly higher values of DBP (n) and SBP_{ao} (n) were detected in patients on RRT, and in patients after KT, SBP (n) and PBP (n) were also increased. Thus, both peripheral and central blood pressure values differed in the groups, which is significant for the development of target organ damage. A significantly lower nocturnal SBP and DBP decrease was observed in patients on PH and after KT (i.e., change in 24-hour BP profile of a non-dipper type). In all groups with hypertension, all 24-hour BPM values significantly differed in comparison with the healthy group.

When considering 24-hour VS parameters, an increase in PWV_{ao} more than 10 m/s was detected only in groups of patients with CKD. Other vascular stiffness indices (Aix and RWTT) also showed a tendency to VS increase in patients receiving RRT,

Table 1. *The results of 24-hour BP monitoring in patients with hypertension of various origin and in healthy volunteers (Me[25p;75p])*

Parameters	Patients with renal hypertension receiving PH (n = 32)	Patients after KT (n = 37)	Patients with essential hypertension (control group) (n = 69)	Healthy persons (n = 20)
Age, years	34.5 [25.5; 48]	39 [32; 46]	39 [29; 48]	32 [27; 40.5]
HR, bpm	74 [64; 83]	69 [61; 80]	65 [59; 78]	69 [63; 80]
office SBP, mm Hg	144 [127; 160][1]	143 [130; 148][1]	138 [127; 144][1]	122 [115; 127]
office DBP, mm Hg	92 [81; 100][1]	91 [82; 98][1]	88 [80; 94][1]	79 [73; 82]
SBP (s), mm Hg	139 [123; 155][1]	138 [125; 143][1]	133 [122; 139][1]	117.5 [108; 122]
SBP (d), mm Hg	140.5 [126.5; 156][1]	137.5 [127; 143][1]	137 [126; 144][1]	119 [109.5; 123.5]
SBP (n), mm Hg	122 [111; 144][1]	129.5 [121; 143][1,2]	117 [110; 123][1]	107 [98; 110.5]
DBP (s), mm Hg	87 [76; 95.5][1]	86 [78; 92][1]	83 [76; 88][1]	74.0 [68; 76]
DBP (d), mm Hg	90 [78; 97][1]	86 [80; 94][1]	87 [79; 93][1]	74.5 [69; 77.5]
DBP (n), mm Hg	76.5 [69; 86][1,2]	79.5 [77; 87][1,2]	71 [65; 76][1]	62.0 [57.5; 68.5]
PBP (s), mm Hg	48 [41; 57.5][1]	51 [42; 56][1]	48 [44; 54][1]	44.0 [40.5; 48]
PBP (d), mm Hg	49.5 [41; 59.5][1]	51 [43; 57][1]	48 [45; 55][1]	44.0 [40.5; 48]
PBP (n), mm Hg	45.5 [42; 55][1]	48.5 [43; 57][1,2]	45 [41; 49][1]	40.5 [39.5; 45.5]
Nocturnal SBP decrease, %	9 [3; 16][1,2]	8 [2; 14][1,2]	12 [9; 19][1]	17 [12; 20]
Nocturnal DBP decrease, %	6 [1; 11][1,2]	8 [1; 12][1,2]	13 [11; 17][1]	18 [13; 19]
Mean 24-hour SBP_{ao}, mm Hg	127.5 [113; 143.5][1]	127 [119; 132][1]	122 [113; 128][1]	105.5 [99; 110]
Mean daily SBP_{ao}, mm Hg	129.5 [116; 145.5][1]	126 [120; 132][1]	126 [117; 133][1]	106.5 [101; 111.5]
Mean night SBP_{ao}, mm Hg	115.5 [100; 135.5][1,2]	119.5 [114; 134][1,2]	109 [102; 114][1]	95 [88; 100]

Note: [1] — significant differences (p <0.05) with a group of healthy persons, [2] — significant differences (p <0.05) with the group of essential hypertension

although they did not exceed the standard values in any of the studied groups. The results are presented in Table 2.

According to the Table 2, almost all VS parameters in groups on RRT during daytime and at night, except for the augmentation index, significantly differed from the group of patients with essential hypertension, which indicates more pronounced changes in the vascular wall in patients with kidney disease. In all groups with hypertension, all 24-hour VS parameters significantly differed in comparison with the healthy group. PWV_{ao} in the healthy group was significantly lower than the upper limit of the norm (10 m/s) (mean 24-hour PWV_{ao} was 6.6 [6.3; 6.9] m/s); in patients with essential hypertension PWV_{ao} was at the upper limit of the norm (mean 24-hour PWV_{ao} was 9.9 [9.2; 10.4] m/s); and in patients with hypertension receiving renal replacement therapy it exceeded 10 m/s by several tenths (mean 24-hour PWV_{ao} in patients on PH was 10.7 [9.5; 11.2] m/s, and in patients after KT — 10.3 [9.7; 11] m/s). PTIN in the study groups differed more clearly: in healthy volunteers, it was in the range of 80–90%; in patients with essential hypertension, it was 50–60%, and in patients on PH and after KT — 20–40%. The augmentation index was within normal limits, but there were differences in this parameter in the groups of patients with hypertension and healthy volunteers.

In all groups of patients with hypertension, the mean IVST and PWT were close to the upper limit of the normal value. In the groups of patients with hypertension, there was also an increase in the relative thickness of the LV walls. In both groups of patients receiving RRT, an increase in LVMI was observed compared to the normal value (≤116 g/m² in males and ≤96 g/m² in females). LV systolic function and LV cavity dimensions were recorded within normal values in all of the examined groups. The results are presented in Table 3.

As is seen from Table 3, in all groups of patients with hypertension compared with healthy volunteers, significantly higher values of the LV wall thickness, LVRT, LVMI, and EDD were observed. When comparing patients with hypertension receiving renal replacement therapy and patients with essential hypertension, significantly higher LVMI values were obtained. In addition, significantly higher

Table 2. *The results of 24-hour VS monitoring in patients with hypertension of various origin and in healthy volunteers (Me[25p;75p])*

Parameters	Patients with renal hypertension receiving PH (n = 32)	Patients after KT (n = 37)	Patients with essential hypertension (control group) (n = 69)	Healthy persons (n = 20)
Aix, %	–28 [–42; 5][1]	–29 [–47; 6][1]	–39[1][–52; –27.5]	–52 [–63; –44.5]
RWTT (s), ms	133 [127.5; 140.5][1,2]	135 [129; 143][1,2]	143 [133; 154][1]	156.0 [148, 159.5]
RWTT (d), ms	132.5 [124; 139][1,2]	134.5 [127; 142][1]	141 [131; 153][1]	154.0 [146; 159]
RWTT (n), ms	139 [130.5; 151][1,2]	140 [131; 153][1,2]	149 [138; 162]	163.0 [160; 169]
PWV_{ao} (s), m / s	10.7 [9.5; 11.2][1,2]	10.3 [9.7; 11][1,2]	9.9 [9.2; 10.4][1]	6.6 [6.3; 6.9]
PWV_{ao} (d), m / s	10.8 [9.9; 11.4][1,2]	10.4 [10; 11.3][1,2]	10 [9.3; 10.7][1]	6.6 [6.4; 7]
PWV_{ao} (n), m / s	10.2 [8.6; 11][1,2]	10.2 [8.9; 11][1,2]	9.2 [8.6; 10][1]	6.1 [5.9, 6.8]
PTIN (s), %	27 [9; 69.5][1,2]	22 [1; 50][1,2]	61 [15; 85][1]	89 [47; 99]
PTIN (d), %	17.5 [1.5; 58.5][1,2]	19 [0; 37][1,2]	50 [10; 71][1]	80 [46; 90]
PTIN (n), %	36.5 [6; 99.5][1,2]	17 [0; 75][1,2]	48 [15; 75][1]	78 [57; 100]

Note: [1] — significant differences (p <0.05) with a group of healthy persons, [2] — significant differences (p <0.05) with the group of essential hypertension

Table 3. *The results of echocardiography in patients with hypertension of various origin and in healthy volunteers (Me [25p; 75p])*

Parameters	Patients with renal hypertension receiving PH (n = 32)	Patients after KT (n = 37)	Patients with essential hypertension (control group) (n = 69)	Healthy persons (n = 20)
Age, years	34.5 [25.5; 48]	39 [32; 46]	39 [29; 48]	32 [27; 40.5]
IVST, mm	12.5 [10; 13.5][1,2,3]	11.7 [9; 12.5][1]	11 [10.4; 13][1]	8 [7.8; 9.1]
LVPWT, mm	11 [10; 12.3][1]	12 [11; 12.8][1,2]	10.5 [9.2; 11][1]	8 [7.2; 8.1]
LVRT	0.45 [0.38; 0.46][1]	0.46 [0.44; 0.56][1]	0.47 [0.43; 0.52][1]	0.35 [0.32; 0.38]
LVMI, g / m²	129 [102; 137][1,2,3]	119 [104; 131][1,2]	95 [83; 105][1]	65 [59; 73]
EDD, mm	51.8 [49; 56.4][1,2]	50 [43; 53][1]	47.4 [43.5; 51.2][1]	45.4 [43.7; 48]
ESD, mm	33 [28; 40.6][1,3]	30.3 [25.2; 32.2]	30.7 [29.6; 32.5][1]	29.4 [28.1; 30.5]
EF, %	59 [58; 74]	61 [52; 76]	64.5 [62; 66]	67 [64; 70]

Note: [1] — significant differences (p <0.05) with a group of healthy persons, [2] — significant differences (p <0.05) with the group of essential hypertensions, [3] — significant differences (p <0.05) with the group of patients after KT

Table 4. *Correlation between LV wall thickness, LVMI, and 24-hour VS monitoring parameters (mean 24-hour PWVao and PTIN)*

Analyzed parameters	Patients on PH (n = 32)		Patients after KT (n = 37)	
	SpearmanR	p	SpearmanR	p
Age & PTIN	–0.72 *	0.02	–0.64 *	0.01
Age & PWV_{ao}	0.53	0.05	0.58 *	0.02
IVST & PTIN	–0.23	0.52	–0.57 *	0.03
IVST & PWV_{ao}	0.60 *	0.04	0.41	0.13
LVPWT & PTIN	–0.19	0.59	–0.58 *	0.03
LVPWT & PWV_{ao}	0.58 *	0.05	0.43	0.11
LVMI & PTIN	–0.67	0.22	–0.66 *	0.01
LVMI & PWV_{ao}	0.60	0.28	0.61 *	0.02

* — significant correlation (p <0.05)

EDD was recorded in patients on PH in comparison with essential hypertension patients, and in patients after KT there was higher LVPWT. Significant differences were found in LVMI, IVST and LV ESD between the groups of patients on PH and after KT.

Thus, the results of Echo in the examined groups revealed an increase in LVMI in the following series: healthy volunteers < patients with essential hypertension < recipients of kidney transplant < patients on planned hemodialysis. Concomitant LV hypertrophy was detected in patients receiving RRT, and concentric remodeling was observed in patients with essential hypertension. Analysis of linear parameters in all groups of patients with hypertension showed a tendency of LV spherification as compared to the control group; and in the group of essential hypertension, it was more significant compared to the renal hypertension group.

In the groups of patients receiving RRT, the correlation of LV wall thickness, LVMI, and 24-hour VS monitoring parameters (mean 24-hour PWV_{ao} and PTIN) was analyzed. The results are presented in Table 4.

According to the Table 4, in the group of patients receiving PH, significant correlation was found only for mean 24-hour PWV_{ao} and thickness of LV walls. Significant correlation coefficients were found for kidney transplant recipients for PTIN and IVST, LVPWT and LVMI ($r = -0.66$; $p = 0.01$). Correlation was found for LVMI and PWV_{ao} ($r = 0.61$; $p = 0.02$), although it was slightly lower than the similar correlation with the PTIN index. This means that with decreasing PTIN, IVST, LVPWT and LVMI increase.

Thus, a decrease in the PTIN index, which reflects a more frequent or longer 24-hour increase of PWV_{ao}, correlates with an increase of hypertensive LV remodeling in patients after KT, whereas in patients on PH, the thickness of LV walls is associated with the mean 24-hour PWV_{ao}.

Conclusion

In patients with hypertension, receiving renal replacement therapy, higher mean 24-hour aortic pulse wave velocity, central pressure, and longer period of aortic pulse wave velocity increase are recorded than in patients with essential hypertension with comparable values of office BP. The best indicator of these differences is PTIN with its significantly lower value in patients with CKD than in patients with essential hypertension.

Higher vascular stiffness, systolic and diastolic night BP values, as well as the frequency of non-dipper and night-picker 24-hour profiles are obtained in patients with hypertension, receiving renal replacement therapy, in comparison with patients with essential hypertension.

In patients with hypertension associated with CKD, higher LVMI values and less pronounced left ventricle spherification are recorded than in patients with hypertension of the same grade. In kidney transplant recipients, LVMI is significantly lower than in patients receiving planned hemodialysis, which may indicate a positive effect of kidney transplantation on the improvement of cardiac remodeling associated with hypertension.

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