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Relationship Between Within-Visit Blood Pressure Variability and Kidney Function in Patients with Arterial Hypertension

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Abstract

The main purpose of this study was to investigate the features of within-visit blood pressure variability (BPV) in patients with arterial hypertension (AH) and to assess the relationship of those features to impaired renal filtration.

Material and Methods: The study included 120 patients with AH Stages I and II (ESH/ESC, 2013): 58(48.3%) men and 62(51.7%) women aged from 22 to 73 years (mean age 58.7±15 years). Average duration of AH was 15.0±6.7 years. BP was measured three times at 2-minute intervals during one visit. Within-visit BPV was evaluated by the presence of an absolute difference (AD) between any two readings of three SBP measurements of more than 5 mmHg. All patients underwent a comprehensive examination, which included blood and urine tests, kidney ultrasound, assessment of blood levels of creatinine and TnT, and calculation of GFR.

Results: Depending on the response of BP to repeated measurements, three types of BPV were identified. A prognostically unfavorable type of BPV, which is characterized by SBP-AD > 5 mmHg between the third and first measurements, was identified. Patients of this group had the lowest eGFR value that indicates more pronounced renal damage, and, as a consequence, worse prognosis. Also in these patients, there was an increase in TnT level, which is a predictor of the development of adverse cardiovascular complications. **(International Journal of Biomedicine. 2017;7(2):91-95.)**

Key Words: arterial hypertension • blood pressure variability • glomerular filtration rate • chronic kidney disease

Abbreviations

AH, arterial hypertension; **BP**, blood pressure; **BPV**, BP variability; **CKD**, chronic kidney disease; **Cr**, creatinine; **GFR**, glomerular filtration rate; **eGFR**, estimated GFR; **SBP**, systolic BP; **SBP-AD**, absolute difference in SBP; **TnT**, troponin T.

Introduction

AH is an important global health challenge because of its high prevalence and resulting cardiovascular disease and CKD.[1] Epidemiological studies have shown that in Russia AH is observed in 40.8% of the adult population (more than 42 million people).[2] In recent years, researchers have found that cardiovascular (CV) complications of hypertension depend not only on the absolute values of BP, but also on the degree of BPV.[3,4] Short-term BPV within a 24-hour period is increasingly recognized as both a marker and a risk factor for cardiovascular disease.[5-9] However, few studies have examined the importance of BPV measured during a single clinic visit (i.e., very-short-term BPV). Recent studies have demonstrated that within-visit BPV is associated with target organ damage (left ventricular hypertrophy and albuminuria).[10]

CKD, since the earliest stages, has been associated with a high risk of premature CV events.[11-13] Only a few studies have

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explored the relationship between short-term BPV/within-visit BPV and markers of early renal damage, with conflicting results.[10,14-19] It could be hypothesized that an enhanced within-visit BPV in patients with early renal abnormalities may help to explain in part their increased CV risk.

Currently, the most sensitive indicator of myocardial damage is the blood level of troponin. The troponin complex consists of three subunits: troponin T (tropomyosin binding), troponin I (inhibitory), and troponin C (calcium binding). TnT has the highest specificity for myocardial damage.[20] In several studies, it was noted that a stable increase in TnT level is often observed among patients with decreased renal function. Reduced renal clearance is probably not the primary mechanism of persistently elevated troponin levels in patients with CKD, although this issue is controversial.[21-24] Elevated troponin levels in patients with CKD may be explained by cardiac injury associated with chronic structural heart disease (such as coronary artery disease or heart failure) rather than acute ischemia, especially when levels do not change rapidly over time.[25] A recent study showed that an increased TnT level is associated with an increase in signs of heart failure.[26] In this case, even a slight increase in TnT level can be considered a negative sign in predicting adverse CV complications at the subclinical level.

The main purpose of this study was to investigate the features of within-visit BPV in AH patients and to assess the relationship of those features to impaired renal filtration.

Materials and methods

The study included 120 patients with AH Stages I and II. (ESH/ESC, 2013)[4]: 58(48.3%) men and 62(51.7%) women aged from 22 to 73 years (mean age 58.7±15 years). 20(16.67%) people were cigarette smokers. Average duration of AH was 15.0±6.7 years. Type 2 diabetes was identified in 32(26.67%) patients. 58 (48.34%) patients had myocardial infarction in anamnesis.

The diagnosis of AH was based on 2013 ESH/ESC Guidelines for the management of AH.[13] All patients were checked on office BP using Korotkov's method after a 5-min rest in the seated position with back support. BP was measured three times on the left arm at 2-minute intervals with the use of a validated semi-automated electronic device (UA-787). All measurements were carried out on the same time between 9:00 and 10:00. All patients underwent a comprehensive examination, which included blood and urine tests, kidney ultrasound, and assessment of blood levels of creatinine (Cr) and TnT. Blood samples were collected within 4-48 hours after admission.

Determination of serum TnT was performed on the Elecsys-2010 automatic analyzer Roche Diagnostics GmbH, Germany) using Elecsys Troponin T Stat Assay. The limit of detection (LOD) for this assay is 0.01 ng/ml. A cut-off of 0.1 ng/ml was used in assessing the prognostic significance of TnT.

GFR was estimated using the CKD-EPI (eGFR(CKD-EPI)) equation according to the recommendations of the National Kidney Foundation.[27,28] The CKD-EPI equation reclassifies people at lower risk of CKD and death into higher eGFR categories, suggesting more accurate categorization. [29]

The study was approved by the local ethics committee. Written informed consent was obtained from each patient. Statistical processing of data was carried out using the program SPSS 10.0 software. Correlation analysis was carried out using the non-parametric Spearmen criterion. A probability value of $P<0.05$ was considered statistically significant.

Results and Discussion

Within-visit BPV was evaluated by the presence of an absolute difference (AD) between any two readings of three SBP measurements of more than 5 mmHg. According to this criterion, we have identified several options for BPV. In 37(30.84%) patients, there was a systematic increase in BP by more than 5 mmHg in successive measurement (Response A). Reduction of BP during repeated measurements >5 mmHg was noted in 23(19.17%) patients (Response B). No difference > 5 mmHg between the measurements was observed in 24(20%) patients (Response C). In 36(30%) patients, multidirectional BP fluctuations were noted between the measurements (Response D) (Fig.1).

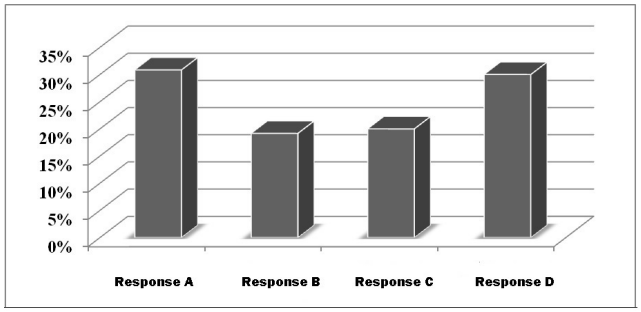

Fig. 1. *Frequency of the different BP responses during repeated measurements.*

Depending on the response of BP to repeated measurements, we identified three types of BPV. Type 1: SBP-AD is > 5 mmHg between the third and the first measurements; Type 2: SBP-AD is > 5 mmHg between the first and the third measurements. Type 3: SBP-AD is < 5 mmHg during repeated measurements. Analysis of BPV types allowed us to better analyze the body's response to repeated measurements and to evaluate the relationship with other indicators.

Different authors distinguished several types of short-term BPV;[3,30,31] however, we have not previously encountered in the literature an approach such as ours to the evaluation of the types of BP response to repeated measurements, which indicates the relevance and insufficient knowledge of this problem.

After GFR calculation, we determined CKD stages in our patients. Most frequent (46.7%) was Stage 2, next was Stage 3A (22.5%), then 3B (20%), Stage 1 (10%), and finally Stage 4 (0.83%) (Fig.2).

We also analyzed the distribution of CKD stages depending on the BPV type (Fig.3). CKD Stages 3A and 3B were more often observed in patients with BPV Type 1 (25%

and 33.34% of cases, respectively). Stage 2 had almost the same frequency distribution by BPV type. Stage 1 did not exceed 5 cases in each type; Stage 4 was registered in one patient with BPV Type 1.

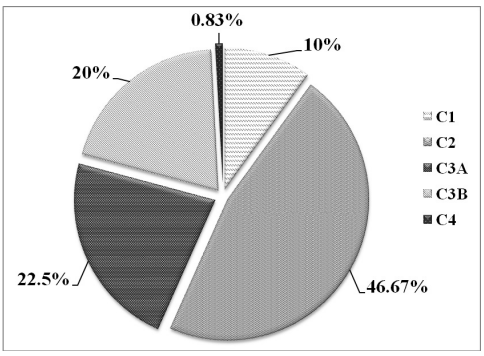

Fig. 2. *CKD stages in studied patients.*

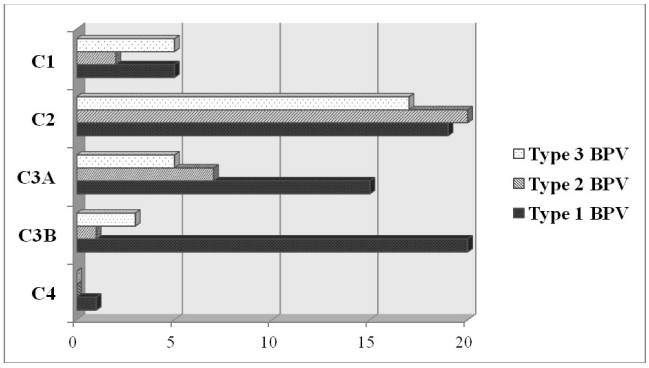

Fig. 3. *Distribution of CKD stages depending on the BPV type*

To establish the relationship between BPV and a number of parameters, we conducted a correlation analysis (Table 1). According to the data obtained, the greatest prognostic value belonged to BPV Type 1. This type was associated with decreased eGFR - up to Stage 3B.

Table 1.

Correlations between BPV types and clinical characteristics of patients.

BPV Type	Gender	Age	BMI	Cr	eGFR	Diabetes	TnT
1	-0.015 P=0.12	-0.09 P=0.21	0.36 P=0.03	0.62 P=0.001	-0.58 P=0.001	-0.14 P=0.27	0.48 P=0.0021
2	-0.019 P=0.21	-0.078 P=0.31	0.096 P=0.27	0.22 P=0.012	-0.19 P=0.021	-0.23 P=0.17	0.21 P=0.07
3	-0.024 P=0.28	-0.1 P=0.18	0.16 P=0.11	0.2 P=0.025	-0.14 P=0.023	-0.1 P=0.24	0.09 P=0.15

In the literature, there are few reports on the connection between the decrease in eGFR and BPV. One opinion is that this phenomenon can be associated with dysfunction of the endothelium.[32] As GFR decreases, the blood accumulates the inflammatory cytokines, lipid peroxidation products, and other vasoactive metabolites.[33,34] According to M. Zwolinska, in this condition, the synthesis of VCAM-1 is enhanced, triggering several reactions that cause endothelial dysfunction.[35]

When measuring serum TnT, we found that in patients with BPV Type 1, TnT level ranged between 0.1 ng/ml and 0.3 ng/ml (0.23±0.12 ng/ml), whereas in patients with other types of BPV, TnT level did not exceed the upper reference limit. This fact indicates a more significant lesion of the myocardium as a target organ in AH patients with BPV Type 1, which is associated with an unfavorable cardiovascular prognosis. During analysis, we found correlations between the increase in SBP during the first and third measurements, a decrease in eGFR, and an increase in TnT level in AH patients.

Conclusion

Thus, our results show that within-visit BPV may be one of the important criteria for assessing cardiovascular complications in hypertension. We have identified a prognostically unfavorable type of BPV, which is characterized by SBP-AD > 5 mmHg between the third and first measurements. Patients of this group had the lowest eGFR value that indicates more pronounced renal damage, and, as a consequence, worse prognosis. Also in these patients, there was an increase in TnT level, which is a predictor of the development of adverse cardiovascular complications.

Competing interests

The authors declare that they have no competing interests.

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