

Relationship between 24-hour mean pulse pressure and the cardiac function in the elderly with isolated systolic hypertension

Jianjun Mu¹, Fuqiang Liu², Baoli Wang³

ABSTRACT

Objective: To investigate the effect of mean pulse pressure during 24 hours on cardiac function in the elderly with isolated systolic hypertension.

Methodology: One hundred seventy two elderly patients with isolated systolic hypertension were enrolled to determine mean pulse pressure by monitoring 24-hour ambulatory blood pressure and to analyze the cardiac function by nuclide cardiac blood pool imaging.

Results: Twenty four hours mean pulse pressure negatively correlated with left ventricular ejection fraction (LVEF) ($r = -0.46$, $P < 0.01$), and also with peak filling rate (RFR) ($r = -0.41$, $P < 0.05$). The greater the mean pulse pressure, the worse the cardiac function ($P < 0.01$).

Conclusion: The 24-hours mean pulse pressure was an important factor predicting risk for cardiac disfunction in the elderly with isolated systolic hypertension.

KEY WORDS: Hypertension; Pulse pressure; Cardiac disfunction; Single-photon emission computed tomography.

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INTRODUCTION

Elevation of systolic blood pressure (BP) has been recognized as an independent risk factor that far exceeds the risk associated with an elevated diastolic blood pressure in older patients with hypertension.¹ Isolated systolic hypertension (ISH) was a disorder typically defined when the systolic blood pressure

(SBP) was greater than 140 mmHg but with diastolic blood pressure (DBP) below 90 mmHg. Pulse pressure (PP, the difference between systolic and diastolic pressure) has recently become an active area of discussion in the literature as an independent factor of cardiovascular risk.^{2,3} An increased pulse pressure nearly always indicated reduced vascular compliance of large arteries and, by definition, was always increased in patients with isolated systolic hypertension.

We designed this study to monitor ambulatory blood pressure in the elderly with isolated systolic hypertension and measured left ventricular systolic and diastolic function by nuclide cardiac blood pool imaging to analyze the relationship between 24-hours mean pulse pressure and cardiac function.

METHODOLOGY

Elderly patients with ISH who were hospitalized in our hospital from January 2003 to June 2005 were enrolled in this study. Inclusion criteria were as follows: All patients, according to the ISH diagnosed

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standard made by WHO, had systolic BP greater than or equal to 140 mmHg with diastolic BP below 90 mmHg. No current or previous diagnosis of coronary heart disease, cardiomyopathy, heart valvular defects, diabetes and atrial fibrillation. One hundred seventy two elderly patients with ISH whose data were complete were included in the study.

There were 89 men and 83 women, their age varying from 65 to 79 years (70.8 ± 5.3 years). All subjects had not received any antihypertensive drug treatment and any other kind of drug that might have affected their cardiac function for at least two weeks before entering the study. The protocol was approved from the ethics committee of our university hospital. To assure the ethical aspects of this research, before each test we clearly explained the program and protocol, every patients was asked to sign a informed consent under their guardians' agreements.

Casual Blood Pressure Measurement: A mercury sphygmomanometer with several choices for size of cuff was used. After selecting the appropriately sized cuff, which can completely encircle the arm without overlapping, the cuff was applied snugly around the arm with the lower edge above the cubital space and was inflated to about 30 mmHg above the points at which the radial pulse disappeared. The pressure within the cuff was then released at a rate of about 2 to 3 mmHg/sec while auscultation was performed over the brachial artery. The first sound of Korotkoff was taken as the systolic pressure, and the fifth phase as diastolic pressure. Three measurements were usually performed for calculating the mean values, each of the measurements was performed every other minute.

Ambulatory Blood Pressure Monitoring: All 172 subjects underwent 24-hours ambulatory BP monitoring on a usual day. They were instructed to act as usual. The SpaceLabs 90202 ABP monitor (SpaceLabs inc, Redmond, WA) was used to monitor each subjects 24-hours blood pressure. After the cuff was bound to the left upper arm, the system was set to obtain systolic and diastolic BP measurements every 20 minutes in the daytime and 30 minutes at night. No subjects who had fewer than two readings per hour in any of the 24-hours was included in this study. Average systolic BP and diastolic BP levels for 24 hours, daytime (7 am to 10 pm) mean pulse pressure (mean PP), nighttime (10 pm to 7 am) mean PP and the 24 hours mean PP values were analyzed after recording was over and all the valid data was obtained.

Cardiac Function Measurement: The SPOPHY DS7 single-photon emission computed tomography

(SPECT) was used to measure the patients cardiac function. Tracing with ^{99m}Tc -RBC, the left ventricular gating nuclide cardiac blood pool imaging was obtained by gating electrocircuit which is triggered by R wave of ECG, 16 frames were shot in each R-R interval. All of these were about 400 to 600 cardiac cycle. By using PRAN KFURT gating handling programs, automatically produce ventricular function index, including left ventricular general ejection fraction (GEF), left ventricular end-diastolic volume (EDV), peak ejection rate (PER) and peak filling rate (PFR).

Statistical Analysis: All the parameters were indicated by mean \pm standard deviation ($X \pm SD$). We used SPSS 13.0 software to make ANOVA and correlation analysis.

RESULTS

Basic Characteristics of the Patients: One hundred seventy two patients were enrolled and completed the protocol. The main demographic characteristics were summarized in Table-I.

Pulse Pressure and Cardiac Function: Table-II shows that the patient's cardiac functional parameters based on 24 hour mean pulse pressure (MPP). The subjects were divided into 3 groups on the basis of their 24 hour mean pulse pressure value, mean pulse pressure (MPP) of group A was lower than or equal to 60 mmHg, MPP of group B was greater than 60 mmHg while lower than or equal to 100 mmHg, MPP of group C was greater than 100mmHg.

The correlation analysis between Casual PP, 24 hour mean PP and parameters of cardiac function

Table-I: Characteristics of the patients.

	Variable
Sample size	172
Mean age(yr)	70.8 ± 5.3
Sex(% , males)	51.2
BMI(kg/ m ²)	24.7 ± 2.3
Hypertension duration(yr)	9.5 ± 5.8
Casual SBP/DBP(mmHg)	$168.5 \pm 14.3 / 80.5 \pm 7.3$
Casual PP(mmHg)	82.0 ± 17.2
24 Hours SBP/DBP(mmHg)	$150.7 \pm 13.35 / 75.8 \pm 10.35$
Daytime SBP/DBP(mmHg)	$158.5 \pm 11.8 / 78.3 \pm 9.0$
Nighttime SBP/DBP(mmHg)	$138.0 \pm 12.6 / 72.5 \pm 8.8$
Pulse rate (beats/min)	74.5 ± 13.8

Table-II: Comparison of the cardiac functional parameter among three groups (X±SD).

Group	N	Age(years)	BMI (kg/m ²)	LVEF (%)	LVEDF (ML)	PER (l/s)	PFR (l/s)
A	60	69.3±6.2	24.9±2.2	0.70±0.11	161.62±54.71	3.19±0.64	2.36±0.66
B	58	70.5±5.4	24.6±2.4	0.56±0.13*	183.35±61.26	2.94±0.66	2.11±0.49*
C	54	71.4±5.1	24.5±2.3	0.50±0.12	197.47±62.14	2.94±0.66	1.98±0.51

* Group C compared with group A and group B, respectively, P < 0.05

were showed in Table-III. The casual PP and 24 hour mean PP measured by ambulatory blood pressure monitoring negatively correlated with some parameters of systolic or diastolic function which was determined by the nuclide cardiac blood pool imaging. Moreover, the correlation between the 24 hour mean PP and the parameter of cardiac function was more stronger than that of casual PP.

DISCUSSION

Recently, the study of hypertension has transferred focus from the resistance vessels to the large arteries, which is an important cause for the development of hypertension and it's many complications because of low compliance.^{4,6} Pulse pressure level can indirectly reflect the change of arterial compliance. An increased pulse pressure nearly always indicates reduced vascular compliance of large arteries. Some clinical researches has proved that increase of the casual pulse pressure is related with the left ventricle disfunction, while the study about the relationship between 24 hour mean pulse pressure and cardiac function by the method of ambulatory blood pressure monitoring was seldom reported.

We have reported the relationship between 24 hour systolic or diastolic blood pressure overload and the changes of cardiac function: increase of systolic blood pressure (SBP) or diastolic blood pressure (DBP) load degree can affect the diastolic function of mild to moderate hypertensive patients, the later was more prominent. Meanwhile, DBP load degree correlated significantly with ventricular diastolic function, and it can be used as a sensitive marker to predict patients' cardiac function.⁷ According to this study,

we found ISH in the elderly can influence the cardiac systolic and diastolic function. Change of the cardiac function is correlate closely with 24 hour mean PP, which is an important risk predictor of cardiac disfunction. Our data also showed that the parameters of left ventricular systolic function were normal or high when the PP was increased slightly. These indicated that the systolic hyperfunction, high output and overloading of left ventricle displayed as hemodynamic change in the early period of ISH.⁸

There are about half of the elderly over 60 years old who have hypertension, of which more than 50% are ISH.³ Many prospective study have showed that high systolic blood pressure correlate with coronary heart disease, stroke, renal failure independently and continuously, among which the most risk factor is ISH, then the IDH, the last one is IDH, and these phenomenon are more common in the male patient.⁹ The large arterial stiffness is the main reason of ISH in the elderly. Reduced arterial distensibility and compliance contributes to an increase in pulse wave and pulse wave velocity, which increases systolic and pulse pressures and decreases diastolic pressure. All of these can lead to functional disorder between heart and vessel and the increase in the end-systolic stress of left ventricle with the result that the target organ such as heart and brain are damaged because of the thickening of the cardiac wall, cardiac remodeling and decreased perfusion of coronary artery.^{10,11} Since the evidence that a widened pulse pressure is an independent marker of cardiovascular risk is quite well established, the main therapeutic target is to find out how to reverse arteriosclerosis, change wave

Table-III: The correlation coefficient between the casual PP,24 h mean PP and the parameter of cardiac function (r).

The PP type	LVEF	LVEDF	PER	PFR
Casual PP	-0.29	-0.17	-0.20	-0.31
24 h mean PP	-0.46**	-0.20	-0.24*	-0.41*

Compared with the casual PP, * P < 0.05, **P < 0.01

reflex, reduce the PP and decrease the functional damage of cardiac and cerebral vascular system.

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