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Original article

Comparison of demographic, clinical, laboratory parameters between patients with sustained normotension, white coat hypertension, masked hypertension, and sustained hypertension

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ABSTRACT

Background: After measurement of office blood pressure (BP) and ambulatory BP monitoring (ABPM), 4 groups of patients were identified namely: (i) sustained normotensive patients (BPs are normal both clinically and by ABPM); (ii) white coat hypertensive patients (clinical BP were above limits, but ABPM were normal); (iii) masked hypertensive patients (clinical BP were normal, but ABPM were high); (iv) sustained hypertensive patients (both office and ABPM were high). The exact pathophysiologic mechanisms of these conditions are not exactly known. Besides in the literature there are only few studies that compare the 4 groups of patients together. Thus the study was carried out to compare patients with sustained normotension (SNT), white coat hypertension (WCHT), masked hypertension (MHT), and sustained hypertension (SHT).

Methods: All patients underwent history taking, physical examination, laboratory analysis, and ABPM. They were referred to the cardiology department for echocardiographic evaluation.

Results: In total 85 patients with SNT, 112 patients with WCHT, 31 patients with MHT, and 81 patients with SHT were included. Going from SNT to SHT, body mass index ($p < 0.0001$), waist circumference ($p < 0.0001$), fasting blood glucose ($p = 0.002$), and uric acid ($p = 0.029$) rose progressively. Presence of metabolic syndrome was also highest in SHT and lowest in SNT ($p < 0.0001$).

Conclusion: Most of the metabolic risk factors were higher in patients with MHT and SHT when compared to SNT and WCHT. Studies are needed to determine whether metabolic risk factors play a causative role for the development of MHT and SHT.

Introduction

Measurements of blood pressure (BP) were initially based on auscultatory method with a mercury or aneroid sphygmomanometer. However, high BP variability with these methods led to development of new methods including ambulatory BP monitoring (ABPM). Accumulating evidence suggests that ABPM predicts cardiovascular mortality and morbidity or end-stage renal disease better than office BP measurements which is probably due to the lower variability of BP measurements by these methods owing to multiple measurements and standardization of the circumstances in which BP is measured. Based on this background, ABPM and office BP were used to identify 4 groups of patients, namely: (i) sustained normotensive patients (BPs were normal both clinically and by ABPM); (ii) white coat hypertensive patients (clinical BPs were above limits, but ABPM were normal); (iii) masked hypertensive patients (clinical BPs were normal, but ABPM were high); (iv) sustained hypertensive patients (both office and ABPM were high) [1].

Although in the literature many studies were performed in patients with white coat, masked, and sustained hypertension, only few studies compared the 4 groups of patients together [2,3]. Despite extensive research, these studies did not certainly tell whether some conditions such as white coat hypertension has prognostic significance [4,5]. Additionally some of these studies were performed in patients who were already taking antihypertensive medication. There is no doubt that more research is needed regarding sustained normotension (SNT), white coat hypertension (WCHT), masked hypertension (MHT), and sustained hypertension (SHT). Thus the present study was conducted to compare demographic, laboratory, and clinical parameters among patients with hitherto treated SNT, WCHT, MHT, and SHT.

Materials and methods

The study had a cross-sectional design. The study was in accordance with the declaration of Helsinki; informed consent was

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obtained from all patients before enrollment. A local ethics committee approved the study. The study included people attending for the first time a nephrology outpatient clinic. Patients with secondary hypertension, liver disease, symptomatic heart failure, neurologic disorders or deficits, and pulmonary, autoimmune, endocrine (including type 1 and type 2 diabetic patients), malignant diseases, and patients with urinary tract infection were not included in the study. Patients with serum creatinine >1.4 mg/dL were not included. None of the patients had a history of acute coronary syndrome, myocardial infarction, angina pectoris, or coronary revascularization procedure. Patients had no history of stroke, carotid revascularization procedure, ischemic leg ulcer, peripheral revascularization, or amputation. On 12-lead electrocardiogram, all patients had normal sinus rhythm and no conduction disturbances.

None of the patients were shift workers and none of them reported alcohol intake. Body mass index (BMI) was calculated as the ratio of dry weight in kilograms to height squared (in square meters).Waist circumference (WC) was measured midway between the lower rib margin and the iliac crest.

Twenty-four-hour urine specimens were collected to determine creatinine clearance after spot urine examination. If the urinary creatinine excretion of the two consecutive specimens differed by more than 10%, another 24-h collection was made to assess the adequacy of collection.

The definition of SNT, WCHT, MHT and SHT were as follows, respectively:

office systolic and diastolic BP <140/90 mmHg and mean daytime ABP <135/85 mmHg;
office systolic and diastolic BP ≥140/90 mmHg and mean daytime ABP <135/85 mmHg;
office systolic and diastolic BP <140/90 mmHg and mean daytime ABP ≥135/85 mmHg; and
office systolic and diastolic BP ≥140/90 mmHg and mean daytime ABP time BP ≥135/85 mmHg [6].

Office blood pressure measurement

Office BP measurements were performed using a mercury sphygmomanometer. Adequate size cuffs (standard cuff of 23 cm × 12 cm or a large cuff of 34 cm × 15 cm) according to arm circumference were applied round the non-dominant arm. First and fifth phases of Korotkoff sounds were taken as the systolic and diastolic BP, respectively. The measurements were taken after the patients had rested for 10 min in sitting position, with the arm comfortably placed at the heart level. Two measurements were taken at 5-min intervals. Each set of two measurements was averaged to give the office systolic and diastolic BP.

Ambulatory blood pressure measurement

Ambulatory 24-h BP monitoring was performed on each patient's non-dominant arm using a SpaceLabs (Redmond, WA, USA) 90207 oscillometric monitor concomitantly with ultrasonography (within 1 week). The accuracy of the device was checked against the standard auscultatory method to ensure that the difference in BP measurements between methods did not exceed +5 mmHg. The device was set to obtain BP readings at 20-min intervals during the day (07:00 AM–11:00 PM) and at 30-min intervals during the night (11:00 PM–07:00 AM). Each ambulatory BP monitoring dataset was first automatically scanned to remove artifactual readings according to preselected editing criteria. Data were edited by omitting all readings of zero, all heart rate readings <20 or >200, diastolic BP readings >150 and <40 mmHg, systolic BP readings >240 and <70 mmHg, and all readings where the differences between systolic and diastolic BPs was less than 10 mmHg. Readings were evaluated if the percentage of successful readings was above 90%. The following ABPM parameters were evaluated: average ambulatory daytime systolic and diastolic BP levels (awake period), average ambulatory nighttime systolic and diastolic BP levels (asleep period), average ambulatory 24-h systolic and diastolic BP levels, and mean ambulatory daytime, nighttime, and 24-h arterial BPs. Average ambulatory daytime, nighttime, and 24-h heart rates were also determined. All subjects were instructed to rest or sleep between 11:00 PM and 7:00 AM (nighttime) and to continue their usual activities between 7:00 AM and 11:00 PM (daytime). Patients were asked to remain still at the time of measurement and to note in a diary the occurrence of unusual events or poor sleep. "Nocturnal dipping" was defined as a reduction of >10% (when compared with the daytime values) in the systolic and/or diastolic BP levels at night. Left ventricular hypertrophy was evaluated by electrocardiography using Sokolow–Lyon voltage (sum of the amplitude of the S wave in lead V1 and the R wave in lead V5 or V6 >35 mm) [7].

Besides these procedures, patients were referred to measure ecocardiographic parameters.

Echocardiography was performed with a commercially available ultrasound system (Acuson Sequoia C256, Mountain View, CA, USA) using a broadband transducer (3V2c). Two-dimensional, M-mode, color measurements were recorded. Interventricular septum thickness and ejection fraction were measured. The peak velocities of early (E) and late (A) diastolic filling, and their ratio (E/A), were also measured for all patients for the detection of diastolic dysfunction.

Additionally presence of metabolic syndrome (MetS) was diagnosed based on Adult Treatment Panel (ATP) III criteria that defined MetS as a constellation of risk factors of metabolic origin, of which three or more indicate that an individual has MetS. The 5 possible risk factors include abdominal obesity, as evidenced by a waist circumference >102 cm in men and >88 cm in women, triglyceride levels ≥150 mg/dL, high-density lipoprotein cholesterol levels <40 mg/dL in men and <50 mg/dL in women, blood pressure ≥130/85 mmHg, and a fasting glucose level ≥110 mg/dL [8].

Statistics

All values are expressed as mean ± standard deviation or as a percentage (%). Data were analyzed using the program SPSS 15.0 for Windows (SPSS, Inc., Chicago, IL, USA). The normality of data was tested using the Kolmogorov–Smirnov test. Parameter differences among the 4 groups were evaluated using the one-way ANOVA Test for normally distributed variables and Kruskal–Wallis test for non-normally distributed variables. For post hoc analysis of normally distributed variables Tukey's *b* test was used. For post hoc analysis of non-normally distributed variables Benferroni corrected Mann–Whitney *U*-test was used. For the comparison of categorical variables, Chi-square test or Fisher's exact test was used as appropriate. Lastly multiple multivariate logistic regression analyses related with WCHT, MHT and SHT (as dependent variables). A value of $p < 0.05$ was accepted as statistically significant.

Results

Initially 340 patients were included. Four patients were excluded due to atrial fibrillation. One patient with renal artery stenosis, 2 patients with hypothyroidism, and 1 patient with hyperthyroidism, 6 patients with type 2 diabetes, 1 patient with type 1 diabetes, and 4 patients with urinary tract infection were excluded; 12 patients with creatinine >1.4 mg/dL were also excluded. The study was conducted in the remaining 309 patients. Patients were