Journal of the American Society of Hypertension 3(6) (2009) 416–423

Research Article

White coat hypertension in children: not rare and not benign?

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Manuscript received August 13, 2009 and accepted October 15, 2009

Abstract

The clinical significance of white coat hypertension (WCH) remains uncertain. We aimed to evaluate the target organ damage (TOD) in children with essential hypertension (HTN) and WCH. We retrospectively analyzed the body mass index (BMI) and ambulatory blood pressure monitoring (ABPM) in 183 untreated children aged 5 to 19 years who were referred for assessment of hypertension and had secondary hypertension ruled out. Left ventricular mass index (LVMi) and carotid intima media thickness (CIMT) were analyzed in a subset of 106 children. WCH was found in 54/183 children (29.5%) who had normal mean arterial pressure (MAP), MAP load, and MAP day/night ratio. However, the mean ± SD LVMi ($g/m^{2.7}$) was identical in HTN and WCH patients (38.2 ± 10.9 vs. 37.0 ± 11.3, $P = .59$); it exceeded the 95th percentile in 40% HTN and 36% WCH patients (NS). The mean CIMT was significantly higher compared with normal, but not different between HTN and WCH; it exceeded the 95th percentile in 26% HTN and 29% WCH patients. WCH was found in up to 30% of children referred for HTN. Patients with WCH have TOD comparable to that found in HTN patients despite similar BMI, significantly lower average BP and BP load and a well-preserved BP dipping pattern. J Am Soc Hypertens 2009;3(6):416–423.

Keywords: Hypertension; white coat hypertension; children; left ventricular hypertrophy; carotid intima-media thickness.

Introduction

White coat hypertension (WCH) has been defined by elevated blood pressure (BP) readings in the office, but normal BP on ambulatory blood pressure monitoring (ABPM).[1,2] Its prevalence in pediatric studies ranges from 10% to 60% depending on the methods and the threshold limits used for office and ABPM and the characteristics of the study population.[3]

Clinical significance of WCH in children is a matter of debate.[3] Because several earlier studies did not show significant target organ damage (TOD) associated with WCH,[4–6] it has been believed that WCH represents a rather benign condition in children that does not require therapeutic intervention and monitoring.[7,8] Even in adults, the clinical significance remains uncertain[9] and most studies indicate that the incidence of cardiovascular events is not significantly different between WCH and true normotension.[10]

The availability of normative values for ABPM in children[11] has improved the classification and detection of WCH. In addition, increased availability of echocardiography for the assessment of the left ventricular mass index (LVMi) and pediatric reference values for ultrasound assessment of carotid intima media thickness (CIMT)[12] have allowed for a more specific evaluation of presence of HTN-related TOD. Indeed, three recent studies in children and adolescents with WCH showed impaired arterial elasticity[13] and increased LVMi,[14,15] suggesting that WCH is not a benign condition.

Our study had two major goals: to analyze the prevalence of WCH in children with office hypertension (HTN) and to compare the prevalence of hypertrophy of the left ventricle and carotid intima media thickness in children with WCH and true HTN.

Conflicts of interest: None

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1933-1711/09/$ – see front matter
doi:10.1016/j.jash.2009.10.002

Methods

Subjects

Our study population consisted of consecutively referred children to two tertiary university centers (Warsaw and Ottawa) for evaluation of HTN based on the elevated office BP readings between January 2004 and December 2007. HTN was confirmed by an elevated BP above the 95th percentile for age and gender on three separate occasions per current guidelines.[16] According to these guidelines, all patients underwent the same workup for secondary causes of HTN, which included determination of the body mass index (BMI), serum thyroid hormone, glucose, cholesterol, urea and creatinine levels, heart echocardiography, renal ultrasound with Doppler, and urinalysis.[16] Patients with secondary forms of HTN were subsequently excluded from the analysis. Patients with no identifiable causes of HTN were labeled as essential HTN. All patients included in the study underwent ABPM before starting antihypertensive therapy. Based on the results of the ABPM, patients were divided into true essential HTN (n = 129) or WCH (n = 54); these data were used for the calculation of the prevalence of WCH. The number of patients with WCH was 47/149 (31%) in Warsaw and 7/34 (20%) in Ottawa (Fisher's exact test $P = .29$, NS). We therefore pooled the data from both centers for the calculation of the prevalence of WCH.

Because of the retrospective nature of the study, some patients did not have the TOD assessment done at the time of the ABPM measurement or results were not available. To correct for this bias, only those patients, in whom all the results (ABPM and TOD) were available (n = 70 for HTN, n = 36 for WCH), were included in further analysis of ABPM and TOD. All these patients came from the Warsaw center.

Office BP Measurement

In both centers, office BP measurements were performed using oscillometric device Dinamap (Dinamap 1846 SX, Criticon Inc., Tampa, FL, USA). Office BP was obtained using current guidelines.[16] Patients were considered hypertensive if the office BP was above the 95th percentile according to age and height on three separate occasions measured in the university centers. For the descriptive statistics of office BP, we used an average value of all available office BP values obtained during three consecutive clinic visits in a given patient. Classification of patients into stage 1 and stage 2 HTN was based on current guidelines.[16]

Ambulatory BP Monitoring

SpaceLabs 92007 device (Spacelabs Healthcare, Washington, USA) was used for the ABPM in both centers. The ABPM device was programmed to measure BP every 20 minutes during the day and every 30 minutes during the night. The nighttime period was set from midnight to 6:00 AM to comply with current reference values.[11] Raw data from the SpaceLabs device were subsequently exported into and analyzed in Chronos-Fit software v.1.05 (P. Zuther and B. Lemmer, Chronos-Fit, http://www.abpm-fit.de). The obtained absolute average BP values (systolic, diastolic, and mean arterial pressure [MAP]) were converted into standard deviation scores (SDS) values using the most recent European reference values[11] to compare the BP measured in children of various ages and heights. Patients were considered to have ambulatory HTN when the MAP or systolic (SYS) or diastolic (DIA) BP exceeded the 95th percentile[11] during either the 24-hour period, or daytime (D) or nighttime (N). Consequently, patients were labeled as WCH when the MAP, SYS, and DIA were below the 95th percentile in all time periods. MAP, SYS, and DIA loads were calculated as the number of BP values exceeding the 95th percentile for the whole 24-hour, D, and N periods. The diurnal BP rhythm was assessed by the ratio between the D and N MAP; patients were considered as dippers when the MAP D/N ratio >1.1 (ie, 10% difference between D and N BP). The ambulatory arterial stiffness index was computed from 24-hour ABPM recordings according to formula and methodology described by Li et al.[17] The variability of BP was assessed by the standard deviation (SD) of the 24-hour SYS BP using a weighted approach (ie, the means of day and night SD values were corrected for the number of hours included in each of these subperiods).[18]

Target Organ Damage Assessment

Left Ventricular Mass Measurement

Left ventricular mass (LVM) was assessed by echocardiography. All echocardiographic examinations were performed by one examiner in each center who did not know the final diagnosis (HTN or WCH) and was not aware of the severity of HTN. Echocardiographic measurements were performed according to the American Society of Echocardiography guidelines. To standardize left ventricular mass to height, LVM index (LVMi) was calculated according to the deSimone formula.[19] Left ventricular hypertrophy (LVH) was then defined as LVMi >38.6 g/m$^{2.7}$ (95th percentile). Patients with LVMi >51 g/m$^{2.7}$ were considered having significant LVH.[19–21]

To account for a potential effect of height on the estimation of the LVMi, we applied the novel method of expressing LVM relative to body size in children.[22] This method allows the calculation of LVM Z scores based on lambda-mu-sigma method, where the Z score = $[(\text{LV mass/M})^{L} - 1]/(L \times S)$.