Analysis of Patients with White Coat Hypertension by Ambulatory Blood Pressure Monitoring

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Abstract
Ambulatory blood pressure measurement is the best method of detecting white coat hypertension. We report ambulatory blood pressure measurement findings in 100 individuals during 1 year. All of the referred subjects underwent casual and ambulatory blood pressure measurement. Mean age (± SD) was 36 (± 13) years; 82% male and 18% female; 68% were non-smokers and 32% were smokers. White coat hypertension is found in 68% of individuals who had completely normal blood pressure profile. Among the hypertensive group (32%), blood pressure load was normal in 96% and rose in 4%. Studying of the nocturnal drop had categorized the hypertensive group into reverse diper (1%), non-dipper (3%), extreme dipper (0%), and dipper 96%. No significant correlation between ambulatory blood pressure measurement and socio-demographic characteristics. Thirty-two were hypertensive and 68% were normotensive on ambulatory blood pressure measurement with a statically significant value. Blood pressure load was elevated in 50%. There was a significant association between ambulatory blood pressure measurement results and blood pressure load and blood pressure drop, abnormalities on ambulatory blood pressure measurement are common in individuals with hypertension and are strongly indicated to identify the blood pressure profile. Indeed, ambulatory blood pressure measurement should be strongly indicated in individual with suspected white coat effect to avoid false diagnosis of hypertension and long term costly therapy.

Key words: ABPM; ambulatory blood pressure monitor, BP; blood pressure, WCH; white coat hypertension.
Introduction

In clinical practice, the most well-accepted and established indication to perform an ABPM is to identify untreated patients who have high BP readings in the office but normal or even low readings during usual daily activities outside of this setting, that is, white-coat hypertension, and to identify varying 24-hour BP profile (Di Rienzo M et al, 1983). The old definition of white-coat hypertension is based on an elevated office BP ≥140 mm Hg systolic and/or ≥90 mm Hg diastolic with a normal BP during the awake period, that is, a mean awake ambulatory systolic/diastolic BP <135 and <85 mm Hg respectively in untreated subject (Palatini P et al, 1998). However, it is now recognized that nocturnal BP is superior to daytime BP in predicting cardiovascular risk. Therefore, the recent definitions of white-coat hypertension has included patients with office readings ≥140/90 mm Hg and a mean 24-hour BP <130/80 mm Hg, thereby incorporating nocturnal/sleep BP in the definition (O’Brien E et al, 2013).

Despite that several hypertension guidelines recommend ABPM when white-coat hypertension is suspected; the selecting criteria are somewhat imprecise because there are no characteristics that have a high specificity for diagnosing this condition. Probably the best reason to suspect white-coat hypertension is when patients with high office BP report normal BP readings taken at home or in the community. Indeed, National Institute for Health and Clinical Excellence recommends ABPM for all patients suspected of having hypertension because of a previously elevated office BP measurement (NICE, 2013), whereas the 2013 ESH guidelines recommended ABPM for the detection of white-coat hypertension in low- or moderate-risk patients with elevated office BP (Parati G et al, 2008). With the prevalence of white-coat hypertension in the community being as high as 20% to 25%, it is important to make an accurate diagnosis, which can best be achieved by performing 24-hour ABPM and home BP monitoring before prescribing antihypertensive drug therapy (Pickering TG et al, 1998). The hypertension guidelines also recommend that people with white-coat hypertension should have the diagnosis confirmed in 3 to 6 months and be followed at yearly intervals with ABPM, or home BP monitoring, so as to detect whether and when sustained hypertension occurs (O’Brien E et al, 2005). Lastly it is well-known that the term white coat hypertension should be restricted to people who are not on antihypertensive medication. Because hypertension is a very common topic and the decision to embark upon antihypertensive therapy effectively commits the patient to life-long treatment, we hypothesized that the incidence of white coat hypertension among these patients with newly discovered high blood pressure is also common. We have tried to prove that in this study.

Patients and Methods

In a cohort study, consecutive patients (n=200) suspected of having white coat hypertension were recruited from inpatient ward and out patient internal medicine clinic in AL-Hussein medical city and studied by ABPM during the period from February 2013 to February 2014. Individual who had high BP readings in the office but normal or even low readings during usual daily activities outside of this setting were included. Patients were excluded if they had any of the following:
1. Normotensive or prehypertensive.
2. Patients using anti-hypertensive medicines.
3. Patients with primary indications for anti-hypertensive therapy:
Pregnancy.

**Casual Blood Pressure**

Three casual BP measurements were taken after the patient had been seated comfortably for at least 5 minutes, the back supported, and the arm bare and at the heart level. The readings were then averaged for each arm and the highest reading was chosen (Verdecchia P et al, 2001). Tobacco and caffeine were avoided for 30 minutes. Each participant’s casual BP was classified according to the Seventh Report of the Joint National Committee on the Prevention, Evaluation, and Treatment of High Blood Pressure: normotensive (≤ 120/80 mmHg), prehypertensive (120–139 / 80–89 mmHg), and hypertensive (≥ 140/90 mmHg) (Chobanian AV et al, 2003).

**Ambulatory BP Monitoring**

ABPM was used to subjects with an elevated office BP ≥140 mm Hg systolic and/or ≥90 mm Hg diastolic. Using of the commercially available ContecTM device (Fig. 1-1), ABPM is performed with the patient wearing a portable BP measuring device, on the non-dominant arm or the arm with the highest blood pressure, for continuous 24 hours period so that it gives information on BP during daily activities and at night during sleep (O’Brien E et al, 2003).

At the time of fitting of the portable device, the difference between the initial values and those from casual BP measurements were not greater than 5 mmHg. In the event of a larger BP difference the ABPM cuff was removed and fitted again.

The patient was instructed to engage in normal activities but to refrain from strenuous exercise and, at the time of cuff inflation, to stop moving and talking when possible and to keep the arm still with the cuff at the heart level. Each participant was given a diary and was asked to provide information on symptoms and events that may influence BP, in addition to the time of any drug ingestion, meals, and going to- and rising from the bed. Measurements were made at 15 minutes intervals during the day and every 30 minutes overnight (Parati G, 2008).

**Other Variables**

Pregnancy test was requested for fertile women.

**Definitions**

Quality of the ABPM studies was defined by the length of time that the monitor was actually worn and the number of successful BP recordings. Monitors worn for ≥ 21 hours with ≥18 hours with ≥ 1 valid BP measured per hour were acceptable for analysis. As additional criteria to ensure adequate representation of both wake and sleep periods, each ABPM had to have ≥1 successful BP recording in ≥75% of wake
hours and ≥75% in sleep hours. The monitory was repeated in case that less than 75% of BP during day time and night time periods was not satisfactory (O’Brien E, 2011).

Analysis of ABPM was undertaken according the standardized protocol of blood pressure profile (average 24-hours, average day-time, and average night time), maximum values, blood pressure load, and circadian rhythm.

ABP profile was interpreted in relation to dairy information taking into account the following normal values (Mancia G, et al 2007):

- Average ABP over 24-hours period < 130 / 80 mmHg
- Average day-time ABP < 135 / 85 mmHg
- Average night-time ABP < 120 / 75 mmHg

Wake and sleep BP loads were calculated as the percentage of readings ≥ 95th percentile which in adults corresponds to < 20% above normal values. For 24-hour load calculation, a weighted sum of wake and sleep loads was used (Soergel M, et al 1997).

Mean day time and night time (sleep) ABP measurements were considered normal when differ by 10 – 20%. Based on that, participants were classified into reverse dpper < 0, non-dipper < 10, dipper 10 – 20, and extreme dipper > 20 (Hermida RC, et al 1998).

Results

The range of patients' age underwent ABPM was 18 – 74 years with a mean age (± SD) of 36 ± 13 years (Table 1).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean ± SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>36 ± 13</td>
<td>18 – 74</td>
</tr>
</tbody>
</table>

The majority of the studied patients were males and represented 82% while the remaining were females and represented 18% (Figure 2).

Non-smoking patients represented 68% of the studied patients while smoking patients represented 32% (Figure 3).

All the studied patients had high clinic blood pressure i.e. SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg. They had normal or even low readings during usual daily activities outside of this setting, that is, white-coat hypertension.
The study had shown 32% of the studied patients were hypertensive on ABPM with a significant statistical value. On the other hand, the remaining 68% were discovered to be normotensive on ABPM with a significant value (Figure 4). The latter represented the real white coat hypertension.

Analysis of ABPM parameters had shown blood pressure load was normal in 96% and rose in 4% of the studied patients (Figure 5).

Ninety six percent of the studied patients were dipper i.e. normal physiological fell of blood pressure during sleep, 3% were non-dipper i.e. the blood pressure fall during
sleep to a little extent than it should and only 1% was reverse dipper i.e. the blood pressure inversely raised at night.

![Figure 6 Distribution of patients according to the smoking habit.](image)

The study had shown that there was no significant difference in the mean of patients' age when ABPM is used to prove or refute white coat hypertension (Table 2).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Results</th>
<th>N</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>Hypertensive</td>
<td>32</td>
<td>38.96±16.31</td>
</tr>
<tr>
<td></td>
<td>Normotensive</td>
<td>68</td>
<td>35.91±12.25</td>
</tr>
</tbody>
</table>

*P value 0.351*

The study had shown no significant association between socio-demographic characteristics and the results of ABPM when the physician intended to perform ABPM (Table 3).

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Results</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>29 (90%)</td>
<td>53 (77.9%)</td>
</tr>
<tr>
<td>Female</td>
<td>3 (9.4%)</td>
<td>15 (22.1%)</td>
</tr>
<tr>
<td>Smoking habit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoker</td>
<td>12 (37.5%)</td>
<td>20 (29.4%)</td>
</tr>
<tr>
<td>Non-smoker</td>
<td>20 (62.5%)</td>
<td>48 (70.6%)</td>
</tr>
</tbody>
</table>
Lastly, the study had shown a significant association between ABPM results on one hand and blood pressure load as well as circadian rhythm on the other hand (Table 4).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Results</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circadian rhythm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse</td>
<td>1 (3.1%)</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td>Non-dipper</td>
<td>3 (9.4%)</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td>Dipper</td>
<td>28 (87.5%)</td>
<td>68 (100%)</td>
</tr>
<tr>
<td>Extreme dipper</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td>BP load</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elevated</td>
<td>4 (12.5%)</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td>Normal</td>
<td>28 (87.5%)</td>
<td>68 (100%)</td>
</tr>
</tbody>
</table>

### Discussion

White coat hypertension is a common finding in patients with elevated office blood pressure measurements. The cardinal component of the diagnosis is an elevated clinic BP above accepted normal levels, in association with a normal ambulatory BP profile.

This study had shown a great proportion of patients (68%) met the criteria of white coat hypertension. This finding was consistent with (O’Brien et al., 2013) who demonstrated the phenomenon of WCH. The physiological, psychological, and behavioral factors involved in the white-coat phenomenon are still controversial to give an acceptable explanation for this phenomenon (Siegel WC et al. 1990).

A significant proportion (32%) of the studied patients had high blood pressure on ABPM despite the presumption of having WCH. Many literatures had suggested that ABPM is not entirely free from the white coat effect. Specifically, the first or final measurements may be elevated above the mean value for the day. (Prasad N et al.,1995) had demonstrated elevation of blood pressure during the first two hours of ambulatory blood pressure monitoring in a study comparing consecutive twenty-four-hour monitoring periods. This raises the question of whether these parameters may be useful as markers for the presence of the white coat phenomenon, and, indeed, whether they might identify a separate substratum of patients.

The study had shown that the mean age of patients would not alter the decision of performing ABPM for patients i.e. WCH can be diagnosed in any given age of the studied range. This was inconsistent with (Vasan et al.,2001 and Zhang et al.,2006) who assessed the frequency of progression to hypertension in non-hypertensive participants in the Framingham Heart Study.

The study had shown that gender and smoking habit add no clinical superiority to perform ABPM. This partly was consistent with de la (Sierra et al.,2011) in a population study of the clinical features of patients with resistant hypertension classified on the basis of ambulatory blood pressure monitoring.

The study had shown a significant association between ABPM results on one hand and blood pressure load as well as circadian rhythm on the other hand. This was consistent with (Verdecchia et al.,2011) in a study of independent predictors of isolated clinic ("white-coat") hypertension. The study was also consistent with (O’Brien et al.,1988) in a study of dippers and non-dippers patients and (Pickering et al.,1990) in a study of the clinical significance of diurnal blood pressure variations.
Recommendations
1. Every patient with suspected white coat hypertension should be referred to ABPM.
2. Age is not important when white coat hypertension is suspected and ABPM is indicated.
3. Irrespective to the gender or smoking habit, patients with suspected white coat hypertension should undergo ABPM.
4. Whole ABPM parameters are vital and the physician should analyze them on every opportunity.

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