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RESEARCH PAPER

Changes in blood pressure in the sitting and standing positions in hypertensive patients

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Most guidelines for management of hypertension do not give special preference to a specific position of patient during blood pressure (BP) measurement, suggesting that BP readings taken with patients sitting, supine and standing are equivalent. The objective of this study was to examine whether there was any difference between BP readings with hypertensive participants comfortably sitting on chair and those with participants standing with the arm supported horizontally at the right atrial level. BP was measured twice each for 168 hypertensive patients (medicated and unmedicated) at sitting, standing and sitting positions, respectively, with a mercury-filled column sphygmomanometer. We found significantly lower in systolic and diastolic BP readings in standing position than in sitting position. The present study indicates that the BP readings are related to the posture; thus, BP measured in different positions cannot automatically be regarded as equivalent.

Key words: blood pressure measurement, body position, hypertension, sitting position, standing position.

INTRODUCTION

Measurement of blood pressure (BP) is one of the most common and perhaps one of the most inaccurately procedures performed by health professionals in practice. In a study,[1] revealed that up to 97% of doctors do not adhere to the recommendations of the American Heart Association (AHA) when measuring BP, yet crucial decisions about treatment are made based on these inaccurate measurements.

It has suggested that underestimation of BP by 5 mmHg could result in almost two-thirds of hypertensive individuals being denied treatment.[2] On the other hand, overestimation might involve unnecessary drug treatment and the labelling of a person for life as hypertensive, with its attendant socioeconomic and health implications.

The accuracy of the BP measurement procedure strongly depends on factors including faulty equipment, improper cuff length or width, white-coat effect, anxiety, caffeine consumption and smoking shortly before BP

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monitoring, talking, noise, extreme temperatures, and crossing legs during BP measurement.[3–6] Another potential effect on BP monitoring is patient's body position.

Most guidelines suggest that BP readings with participants sitting, supine and standing might be considered equivalent,[7–9] although previous studies have shown that BP results can be changed according to body position during BP measurement.[10–15]

The large epidemiological and clinical trials, on which therapeutic decisions are based, have used BP readings taken in poorly specified body and arm positions. For example, in the United Kingdom Prospective Diabetes Study (UKPDS), BP was measured in the sitting position,[16] rather than measured in the different positions.

The World Health Organization guidelines recommend that the cubital fossa should be placed at the heart level as approximately by the fourth intercostals space.[17] The British Hypertension Society recommends that the arm should be placed horizontal at the level of mid-sternum.[7] The AHA mentions that right atrium level is the midpoint of the sternum or the fourth intercostals space and recommends that the elbow should be flexed at the heart level.[8] However, in daily practice it is difficult to assess the correct heart level. In this study we examined whether there is any difference between BP readings with hypertensive participants comfortably sitting on chair and those with subjects standing.

METHODS

Participants

We conducted the study at the outpatient hypertension clinic at a university hospital between July 2005 and February 2006. Before the study, we obtained ethical approval according to the Helsinki Declaration. We also obtained informed consent from all participants. Pregnant women, patients with BP differences between two arms > 10 mmHg, and patients whose smoked or consumed caffeine 30–60 min before BP measurement were excluded.

A total of 168 hypertensive patients participated in the study. Of these, 86.9% patients were on antihypertensive drug treatment. Information sample characteristics are summarized in Table 1.

Table 1 Characteristics of the participants

Characteristics	Mean, median, SD, range or %
Age, mean years (SD) (range)	60.40 (12.2) (37–89)
Gender, (% female)	56.5%
BMI, mean kg (SD) (range)	28.4 (3.8) (19.7–40.0)
Mode (median)	32.39 (28.10)
BMI classification, number (%)	
Normal weight	30 (17.9)
Overweight	82 (48.8)
Obese	47 (28.0)
Morbid obese	9 (5.4)
Diagnosed for hypertension, mean years (SD) (range)	8.6 (6.8) (1–28)
Mode (median)	1 (7)
Comorbid disease (% present)	55.4%
Diabetes (% present)	26.2%

BMI, body mass index; SD, standard deviation.

Blood pressure measurement procedure

We performed BP measurement by using a mercury-filled column sphygmomanometer, because we had excellent information about sources of variance.[8] The BP monitor is equipped with a normal adult size cuff (16 × 30 cm) and large adult size cuff (16 × 36 cm).[8] The appropriate cuff size was determined from the mid arm circumference of the participant. Before taking BP readings, the participant was encouraged to empty his or her bladder and during procedure not to talking.

Each patient had his or her BP taken at the right arm in three different positions. Firstly BP was taken while patients sitting on a chair with the arms passively supported horizontally. After at least 3 min of standing, the BP was then taken standing. Finally, the BP was taken again in the sitting position. The right atrium level was located according to the British Hypertension Society recommendations at the level of mid-sternum (precisely determined in each subject at half way between manubrium at fossa jugularis and xyphoid at fossa epigastrica).[7] In all subjects the BP was measured after 5 min of rest. Two BP readings 3–4 min apart were taken in each position.

The BP measurements were done by three nurses who were blinded for research aim. First nurse did two BP readings sitting position, second standing position and third sitting position, respectively.

Statistical analysis

All data analysis was run on SPSS, version 15.0 (SPSS Inc., Chicago, IL, USA) by a statistician. We used paired

Student's *t*-test to compare mean BP readings between sitting and standing positions. The repeated measures for ANOVA were conducted to compare the means at Time 1 (sitting position), Time 2 (standing position) and Time 3 (sitting position). The significance level was $P < 0.05$.

RESULTS

As seen in Table 2, both the systolic blood pressure (SBP) and the diastolic blood pressure (DBP) were significantly lower in the standing position than sitting position ($P < 0.001$ for both). There was no difference between diabetics and nondiabetic patients (Table 3).

DISCUSSION

In the present study, we have investigated the influence of sitting and standing positions on the indirect BP measurement in hypertensive participants. The BP readings in the correct reference standing position with the arm supported horizontally at the right atrial level were significantly lower than those taken in sitting position. Our findings confirm the conclusions of previous reports.[10,13,15]

In a study conducted by Mariotti *et al.*,[10] involved 181 participants including normotensives, treated hypertensives and untreated hypertensives. They compared BP measurements taken at supine and standing positions with the patient's arm supported horizontally at heart level. They found lower BP readings in three groups at the standing position. In the same study, a postural fall of SBP $\geq$ 20 mmHg was detected in 31 patients (26 treated hypertensive, five untreated hypertensive) and DBP fell the same extent in 12 patients (nine treated hypertensive, three untreated hypertensive). Singer *et al.*[13] found that significant lower BP in standing position than sitting position among 19 healthy volunteers. Mourad *et al.*[15] compared sitting and standing BP, measured at patient's arm supported at heart level horizontally among 51 participants, 26 of them were hypertensive. They showed that at standing position oscillometric SBP fell ≈6 mmHg, DBP 2 mmHg in hypertensive group, there was no significant BP differences in normotensive group.

In a survey study, conducted by Altun *et al.*,[18] 4910 participants were screened for hypertension. It was reported that 3333 people had their BP measured beforehand. They found 1804 participants had hypertension, among them, 1070 participants (59.8%) were not aware of their hypertension. For this reason, it can be thought

Table 2 SBP and DBP in sitting and standing positions

Body positions	SBP	Mean differences	*t*	*P*	DBP	Mean differences	*t*	*P*
Sitting	144.09 ± 14.50				88.34 ± 9.83			
		−8.05 ± 5.18	20.139	< 0.001		−6.35 ± 4.11	20.038	< 0.001
Standing	136.54 ± 14.87				81.97 ± 9.11			
		7.55 ± 5.04	19.390	< 0.001		6.36 ± 3.96	20.786	< 0.001
Sitting	144.59 ± 14.70				88.33 ± 9.52			
Wilks' Lambda	0.28				0.26			
F(2,17)	210.00				239.00			
Multivariate eta squared	0.72				0.74			
P	< 0.001				< 0.001			

DBP, diastolic blood pressure; SBP, systolic blood pressure.

Table 3 SBP and DBP in sitting and standing positions in diabetics and nondiabetics

Blood pressures in different body positions	Diabetics (N = 44)	Nondiabetics (N = 124)	Mean differences	*t*
SBP				
Sitting	145.13 ± 18.81	143.72 ± 12.70	1.41	0.58*
Standing	134.86 ± 18.67	137.13 ± 13.31	−2.27	0.38*
Sitting	145.22 ± 19.45	144.37 ± 12.68	0.86	0.74*
DBP				
Sitting	89.09 ± 11.65	88.08 ± 9.13	1.01	0.56*
Standing	81.12 ± 10.89	82.28 ± 8.42	−1.16	0.47*
Sitting	88.59 ± 11.36	88.24 ± 8.83	0.35	0.83*

* $P > 0.05$. DBP, diastolic blood pressure; SBP, systolic blood pressure.

that there are people whose BP was found to be low although they had high BP beforehand.

Singer *et al*.[13] mentioned that 'assuming the upright posture is accompanied by a vertical displacement of blood below heart level. When humans stand up from the supine position, it is estimated that 300–800 mL of blood is shifted from the chest to the venous capacitance bed within seconds. In addition, slow transcapillary fluid shifts from vessels below the hydrostatic indifference level in the surrounding tissues reduce plasma volume over several minutes by ≈10%. These changes result in a decline in venous return and stroke volume'.

There is currently no standardized method of measuring the BP response to orthostasis. In different studies, BP is measured after various intervals ranging from seconds to 3–4 min after standing up from either sitting or supine positions.[10,13,15] It has been previously found that after a first drop in BP with a maximum between 30 s and 1 min of standing, the BP returns towards the original level. Thus, it has been suggested that BP measurement after at least 2 min of standing would estimate more accurately the evidence of orthostatic hypotension.

CONCLUSION

In conclusion, the present results once more indicate that the BP readings are related to the posture; thus, the body posture plays an important role in terms of diagnosis and treatment of hypertension. The importance of the present findings for clinical practice can be better appreciated if one considers that initiation and modification of antihypertensive therapy are based on BP levels in categories of 5–10 mmHg. Changes in BP as low as 10 mmHg can consistently modify the risk of cerebral and cardiovascular complications of hypertension.[9] As the AHA recommended,[8] it seems important to note the participant's posture in which the BP is measured on every occasion.

Compared with previous studies, the present study has a number of advantages including the largest sample study, performing multiple BP readings at each position and using different BP cuff size. Moreover, the nurses were unaware of the purpose of the research and the statistician was blinded to which set of data (sitting position or standing position) was being analysed. There was one limitation of this study: it was not randomized in terms of BP assessments in the sitting position and standing position. We see this as a worthwhile goal for subsequent study.

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