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ORIGINAL ARTICLE

The Effect of Different Body Positions on Blood Pressure

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ABSTRACT

Background: Blood pressure is one of the fundamental clinical measurements in medicine. It is the basis for the diagnosis, treatment, and epidemiology of hypertension, and for research. Numerous factors affect the result of the measurement of blood pressure which include communication with the individual, attitude of patient, arm circumference, cuff size, arm position, and patient posture.

Objective: to assess the effect of different body positions on blood pressure.

Patients and methods: In this cross sectional study 250 normotensive persons Male represent (N=117 , 46.8%) and female represent (N=133, 53.2%) of study sample , blood pressure has been measured in different positions by using mercury sphygmomanometer at medical wards and consultation unit at al-Sadr medical city/ Najaf city/Iraq to show the effect of position on blood pressure.

Results: Systolic and diastolic blood pressure in supine and supine crossed legs was higher than sitting position. At sitting, the diastolic blood pressure was higher than semi sitting. In supine crossed legs, systolic and diastolic blood pressure was higher than supine blood pressure.

Conclusion: This study showed that blood pressure affected by body positions and there are significant differences in results.

Keywords: *Blood pressure, Hypertension, Body position, Variation*

1. INTRODUCTION

Blood pressure (BP) is one of the fundamental clinical measurements in medicine. It is also the basis for the diagnosis, management, treatment, and epidemiology of hypertension, and for research. Numerous factors affect the result of the measurement of BP, varying from the technique and the selection of an accurate device to intrinsic variability of BP and white-coat hypertension. The procedure itself influences the outcome of the measurement: the communication with the individual, patient education, attitude of observer, attitude of patient, arm circumference, cuff size, arm position, and patient posture (1). The heart supplies the organs and tissues of the body with blood. With every beat, it pumps blood into the large blood vessels of the circulatory system. As the blood moves around the body, it puts pressure on the walls of the vessels. BP readings are made up of two values:

Systolic blood pressure (SBP): is the pressure when the heart beats – while the heart muscle is contracting (squeezing) and pumping oxygen-rich blood into the blood vessels.

Diastolic blood pressure (DBP): is the pressure on the blood vessels when the heart muscle relaxes. The diastolic pressure is always lower than the systolic pressure. BP is measured in units of millimeters of mercury (mmHg). The readings are always given in pairs, with the upper (SBP) value first, followed by the lower (DBP) value (2). Two methods for measuring a BP exist, the direct and indirect method. The direct method is the criterion standard and consists of using an intra-arterial catheter to obtain a measurement The indirect method involves collapsing the artery with an external cuff, providing an inexpensive and easily reproducible way to measure BP. The indirect method can be performed using a manual cuff and sphygmomanometer, a manual cuff and Doppler ultrasound, or with an automated oscillometric device (3). Both observer and methodological errors can occur when BP manually measured. Observer errors include digit preferences, inattention, overly rapid cuff deflation, and hearing deficits, while methodological errors include not accounting for beat-to-beat variations in the pulses (4). The inaccuracy of the oscillometric devices has been criticized, and some concern exists that using these devices in certain populations, such as hypotensive, hypertensive, trauma, or cardiac arrhythmia patients, can lead to inappropriate management (5). Another key component of measuring a manual blood pressure is an

understanding of the Korotkoff sounds, which are pulsatile circulatory sounds heard upon auscultation of the brachial artery (6). Korotkoff sounds are broken down into five phases, heard in sequential order upon deflating the BP cuff (7):

• Phase I: clear tapping sounds heard for at least two consecutive beats, this is SBP.

• Phase II: the softening of the tapping sounds and the addition of a swishing sound

• Phase III: the return of tapping sounds, as heard in phase I, but with an increase in sharpness and intensity

• Phase IV: the abrupt muffling of sounds, exhibiting a soft and blowing quality. The muffling of sounds is explained by increased resistance of the artery to collapse, caused by downstream engorgement of the veins (8).

• Phase V: the complete disappearance of all sounds, this is the DBP.

The second and third Korotkoff sounds have no known clinical significance.

When body position is changed from a supine or sitting position to standing, due to gravitational effect, there is pooling of blood in lower extremities, as a result venous return to heart decreases which implies decrease in stroke volume with a fall in SBP. Moreover, the effect of gravity on BP is influenced by the density of the blood, the acceleration of gravity, and the vertical length between the heart and the measured site (9). When individual stand up from lying down or sitting, a small momentary dip in BP occurs in the first few seconds. This occurs because gravity causes about 0.5 to 1.0 liters of blood to pool in lower body (10). The BP should be taken with the patient in a seated position with the back supported and legs uncrossed. The DBP may be higher by 6 mmHg if the back is unsupported, and the SBP may be raised by 5 d 8 mmHg if the legs are crossed (1). Those individual with larger differences in BP as measured in supine or sitting position may be at risk of substantial changes in their therapeutic history according to the position of the measurement (11). Crossing the ankles in the sitting position has no effect on BP, but BP increases when legs are crossed at the knee level. The physiological mechanism responsible for this BP increase is a higher cardiac output but not a higher total peripheral resistance (12). The rise in BP with the legs crossed might be explained by a translocation of blood from dependent vascular beds in the legs to the central thoracic compartment causing a higher stroke volume and cardiac output, and thereby a rise in BP (13). That isometric exercise of the leg muscles increases peripheral vascular resistance

and BP (14). Fowler's position (semi sitting position) is normally used for patients to relax tension in the abdominal muscles, to improve breathing in immobilized patients and to increase comfort during meals and other activities. No information can be found in the literature concerning the influence of Fowler's body position on BP readings in healthy young people (15). An upright upper trunk during Fowler's position allowed maintenance of stroke volume and inhibited tachycardia response compared to an upright whole trunk. regardless of age, an upright upper trunk in Fowler's position might help to reduce orthostatic stress and facilitate routine activities and conversation in frail patients (16).

2. METHODOLOGY

In this cross-sectional study, 250 normotensive persons were included, males (n = 117) represent 46.8% of the study sample, and females (n = 133) represent 53.2% of the study sample. The mean age of study participants was 43.38± (17.16). The older one was 75 years old and the younger one was 18 years old. BP has been measured at Al-Sadr Medical City/Najaf City/Iraq during a period from 1st of November 2022 to 1st of March 2023.

The data was collected during one-to-one interviews with the persons. Clinical and demographical data were obtained; these data include age, gender residency, lifestyle, smoking state, and BMI.

Ethical approval:

The thesis is approved for the Arabic Board for Medical Specializations.

All persons were consented to as per ethical approval.

Inclusion criteria:

Young, adult, and elderly people with normotensive BP.

Exclusion criteria:

1. Hypertensive patient.
2. Person who has taken antihypertensive drugs in their life.
3. Critically ill patient.
4. Morbidly obese person.
5. Diabetic patient.

Blood pressure measurement and technique:

Blood pressure was measured using a stethoscope (Littman type 3) and a mercury sphygmomanometer (Riester) with different cuff arm circumferences.

These arm circumferences are:

• Small adult cuff (12x22 cm) for arm circumferences of 22–26 cm.

• Adult cuff (16x30 cm) for arm circumferences of 27–34 cm .

• Large adult cuff (16x36) cm, for arm circumferences of (35–44) cm .

Verified, calibrated, and well-maintained device was utilized. Also, tight clothing was removed. cuff was put on the left arm, and the brachial artery was palpated, so a stethoscope is put upon it. We inflated the cuff to pressure of 30 mmHg above the level at which the radial pulse is no longer palpable, and then, the cuff deflating slowly (2 mmHg/second). listening to korotkoff phase 1 represents SBP and compete disappearance of korotkoff phase V represents DBP. The readings were recorded.

In all persons, BP was measured subsequently in four positions:

• Sitting position: BP readings were taken from the flexed left arm at the elbow joint, which was placed at heart level on a chair with a back support, with uncrossed legs, and its feet flat on the floor.

• Semi sitting position at 45 degrees (Fowler's position): after two minutes from the supine position, BP readings were taken with the left arm supported at the elbow and the cuff at the heart level without crossing legs.

• Supine position: after two minutes of semi-sitting position, Bp was measured with the left arm supported at heart level without crossed legs.

• Supine crossed legs at knees position: after two minutes, Bp was measured with the left arm supported at heart level with crossed legs.

Data Analysis

Statistical analysis was carried out by using SPSS version 27. Categorical variables were presented as frequencies and percentages. Continuous variables were presented as means and standard deviations. A paired t-test was used to compare the means of two paired readings. A P-value of less than 0.05 was considered significant.

3. RESULTS

A total of 250 persons enrolled in this study with normotensive BP. Distribution of the baseline socio-demographic characteristics and body mass index of the studied group are shown in (**Table 1**). The mean differences of SBP and DBP (mmHg) according to position of measurement, including sitting position and supine position are shown in (**Table 2**). There were significant differences between the means of SBP and DBP (mmHg) according to the position of measurement, supine BP higher than sitting BP in both SBP and DBP. So the change in mean differences was 3.28 mmHg for SBP and 1.86 mmHg for DBP. The mean differences of SBP and DBP (mmHg) according to position of measurement, including sitting position and supine crossed leg, are shown in (**Table 3**). There were significant differences between the means of SBP and DBP (mmHg) according to the position of measurement, supine crossed legs BP higher than sitting BP in both SBP and DBP. So the change in mean differences was 5.5 mmHg for SBP and 2.72 mmHg for DBP. The mean differences of SBP and DBP (mmHg) according to position of measurement, including sitting position and semi-sitting 45 degree There were significant differences between means of diastolic blood pressure (mmHg) according to position of measurement, are shown in (**Table 4**). Sitting DBP higher than semi sitting DBP. But no significant changes in SBP. So the change in mean differences is 1.16 mmHg for DBP. The mean differences of SBP and DBP (mmHg) according to position of measurement, including (Supine position and Supine crossed leg), are shown in (**Table 5**). There were significant differences between means of SBP and DBP (mmHg) according to position of measurement. Supine crossed legs BP higher than supine Bp both SBP and DBP. So the change in mean differences is 2.22 mmHg for SBP and 0.86 mmHg for DBP.

Table 1. socio-demographic characteristics of the studied group (N=250)

Study variables		No.	%
Age (years)	< 20	15	6.0
	20 - 39	91	36.4
	40 - 60	81	32.4
	> 60	63	25.2
Gender	Male	117	46.8
	Female	133	53.2
Residence	Urban	125	50.0
	Rural	125	50.0
Lifestyle	Active	222	88.8
	Sedentary	28	11.2
Smoking	Smoker	60	24.0
	Passive smoker	28	11.2
	Ex-smoker	21	8.4
	Non smoker	141	56.4
Body mass index	Underweight	7	2.8
	Normal	165	66.0
	Overweight	54	21.6
	Obese	24	9.6

Table 2. Comparison of mean values of SBP and DBP between sitting and Supine positions (N=250)

Study variable	Position	Mean ± SD	Paired t-test	P-value
SBP (mmHg)	Sitting	120.10 ± 7.54	-8.099	<0.001*
	Supine	123.38 ± 9.27		
DBP (mmHg)	Sitting	75.68 ± 7.04	-5.409	<0.001*
	Supine	77.54 ± 7.88		

Table 3. Comparison of mean values of SBP and DBP between sitting and Supine crossed leg positions (N=250)

Study variable	Position	Mean ± SD	Paired t-test	P-value
SBP (mmHg)	Sitting	120.10 ± 7.54	-11.916	<0.001*
	Supine crossed leg	125.60 ± 9.40		
DBP (mmHg)	Sitting	75.68 ± 7.04	-7.134	<0.001*
	Supine crossed leg	78.40 ± 7.38		

Table 4. Comparison of mean values of SBP and DBP between sitting and Semi sitting 45 degree positions (N=250)

Study variable	Position	Mean ± SD	Paired t-test	P-value
SBP (mmHg)	Sitting	120.10 ± 7.54	1.157	0.248
	Semi sitting 45 degree	119.66 ± 8.02		
DBP (mmHg)	Sitting	75.68 ± 7.04	2.982	0.003
	Semi sitting 45 degree	74.52 ± 7.66		

Table 5. Comparison of mean values of SBP and DBP between Supine and Supine crossed leg positions (N=250)

Study variable	Position	Mean ± SD	Paired t-test	P-value
SBP (mmHg)	Supine	123.38 ± 9.27	-5.924	<0.001
	Supine crossed leg	125.60 ± 9.40		
DBP (mmHg)	Supine	77.54 ± 7.88	-2.40	0.017
	Supine crossed leg	78.40 ± 7.38		

4. DISCUSSION

Regarding the supine position, the results found a significant increment in both SBP and DBP when compared with sitting position. In comparison with Netea et al (17) and Sala et al (18), same results were found. But all these studies were done on hypertensive patients. In another study, Ismet Eser et al (19), found both SBP and DBP higher in supine position but only SBP was statistically significant. The study involved 157 healthy young Turkish students for both genders by using one cuff size of 28*12.5 cm. In other study, MN Islam et al (9), found both SBP and DBP were higher in supine than sitting but statistically not significant. The volunteers number was 100 healthy adults with age >18 years and by using an aneroid sphygmomanometer at Khulna Medical College & Hospital, Bangladesh. In contrast to this study, Ernest Privsek et al (20) study, found seated BP was significantly higher than supine BP. Regarding supine with crossed leg, the results showed a significant increment in both SBP and DBP in comparison with standard sitting position. Same results were found at Ismet Eser

et al (19). A lot of studies tried to show the effect of crossing legs on BP measurement they found significant increases in both SBP and DBP whith crossing legs such as Lucie Foster-Fitzpatric's et al (21), Michelle H.M.M.T et al (22) and Rukiye Pinar et al (23). But all these studies were performed with sitting crossed legs. Ahmet Adiyaman's et al (24) study showed the effect of crossing legs on BP. This study included 111 persons (60 women, mean age 52–17, 28 normotensives, and the others have hypertension and diabetes), and by oscillometric device and at sitting position, found significant increments in both SBP and DBP in crossing legs in hypertensive and diabetic patients, but in normotensive patients, significant increment was found only in SBP. The results of semi sitting showed a significant increment in DBP in sitting more than in semi sitting. In comparison with Giancarlo Cicolini et al, found both SBP and DBP were higher in sitting than semi sitting, their sample was 225 healthy young people with one cuff size (12 *26 cm) (25). From the three positions above, the semi sitting position may be a good alternative position for the standard sitting position for BP measurement, such as in an emergency unit where some patients find the sitting position unsuitable. The BP readings taken when Fowler's position are in-between those taken while seated and those taken while lying flat (26). In supine and supine crossed legs, the results showed a significant increment in SBP and DBP in supine crossed legs than in supine. At Ismet Es er 2005, they found no difference between the two positions. (19)In two studies, Lucie Foster-Fitzpatrick (1999) and Michelle H.M.M.T. van Velthoven (2010), these studies tried to show the effect of crossing legs on BP measurement. These studies found increments in both SBP and DBP, but these studies were in the sitting position (21,22).

5. CONCLUSIONS

This study showed that BP readings are affected by body position, and the presumption that BP in different body positions can be believed to be the same is not accurate. So it's important to take body position into account during measurement before starting or alternating antihypertensive drugs. So in many patients, if we can't measure their BP in the sitting position, we can measure it in the semi-sitting position. Crossing legs at knee may elevate BP in hypotensive patients. Hence we recommend, Knowing the effect of position on BP before a diagnosis of hypertension, measurement of BP in a standard sitting position and

in situations where measuring BP in a sitting or supine positions are unsuitable, we can measure BP in a semi sitting position.

Ethical Approval:

All ethical issues were approved by the author. Data collection and patients' enrollment were in accordance with Declaration of Helsinki of World Medical Association, 2013 for the ethical principles of researches involving human. Signed informed consent was obtained from each participant and data were kept confidentially.

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