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Arm Position as a Source of Error in Blood Pressure Measurement

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Summary: The present study was designed to assess the value of correct positioning of a patient's arm when measuring blood pressure (BP). A total of 181 subjects were examined, 141 hypertensives on treatment, 25 untreated hypertensives, 15 normotensives. All the subjects underwent three BP measurements after a 5-min resting period in supine position. Then two BP readings were recorded in standing position with the arm either positioned by the patient's side or supported passively at patient's heart level. Average systolic BP (SBP) in standing position were 144.6 ± 20.2 mmHg with the arm at the side and 136.4 ± 21.1 mmHg with the arm at the heart level ($p < 0.001$); average diastolic pressures were 99.0 ± 12.0 mmHg and 90.2 ± 12.3 mmHg ($p < 0.001$), respectively. A fall in SBP $\geq$ 20 mmHg from the supine to the upright position was detected in 18.2% of cases when measurement was performed at heart level; such a reduction was inapparent in two-thirds of cases when the arm was placed at the patient's body side. Incorrect positioning of a patient's arm during BP measurements in standing position leads to overestimation of BP values and masks the presence of postural hypotension.

Key words: blood pressure, blood pressure measurement, arm position

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Introduction

In clinical practice the diagnosis of hypertension is usually based upon isolated recordings of blood pressure, often obtained from unstandardized techniques of measurement.

Several factors may affect the measurement of blood pressure: emotional stress, cigarette smoking, environmental temperature, time of day, type of instrument utilized, size of the cuff, technique of measurement, intraobserver and interobserver variability.[1] Correct positioning of a patient's arm is often neglected, even though many authors have stressed the importance of such a methodological issue.[2-4]

The aim of the present study was to evaluate the influence of incorrect positioning of the arm on the measurement of blood pressure.

Material and Methods

A total of 181 outpatients were examined (103 males, 78 females, mean age 44.7 ± 12.5 years): 141 were hypertensives on treatment (TH), 25 were untreated hypertensives (UH), 15 were normotensive (N).

Blood pressure determinations were performed in a quiet room, with comfortable temperature; cigarette smoking and physical exertion had been avoided during the preceding 30 minutes. Three readings were taken after a resting period of 5 minutes in the supine position; two more readings were recorded in standing position with the arm either maintained by the patient's side or supported by the observer at the patient's heart level (IVth intercostal space).

The readings in the standing position were performed in randomized order; all the determinations were made by the same physician using a mercury sphygmomanometer (Accoson Freestyle) with a properly sized cuff (12×35 cm or 12×23 cm depending on the patient's arm circumference). First and fifth Korotkoff sounds were taken as systolic (SBP) and diastolic (DBP) pressures,

respectively. Values were approximated to the nearest 2 mmHg.

Statistical Analysis

Student's *t*-test for paired data was used for assessing differences between mean values; differences between proportions were assessed by the chi-square test. Linear regression analysis was also utilized.

Results

Average values of SBP and DBP in both supine and standing position are summarized in Table I. Data refer to the overall population and to the three subgroups examined: treated hypertensives (TH), untreated hypertensives (UH), normotensives (N). Mean difference of BP between the two measurements in standing position was 8.2±7.3 for SBP and 8.8±6.7 for DBP, the higher values being those obtained with the arm positioned by the patient's side. No significant differences were observed among the three groups.

The elevation of BP recorded when the measurement was performed with the arm by the patient's side was nearly systematic, affecting in 88.4% of cases both systolic and diastolic pressures; in a few cases (6.1% for systolic, 4.4% for diastolic BP) the elevation exceeded 20 mmHg. In some patients (31 for SBP, 13 for DBP), however, BP measured with the arm by the side was equal or lower than the one obtained with the arm supported at the heart level.

In our study, a postural fall of SBP ≥ 20 mmHg was detected in 31 patients (18.2%), 26 TH (17.7% of total TH) and 5 UT (20%); DBP fell to the same extent in 12 subjects (6.6%), 9 TH (6.3% of the whole) and 3 UH (12%).

The variability of BP response to postural changes was not significantly associated with any of the following parameters: sex, age, presence and kind of antihypertensive treatment, clinostatic values of SBP, DBP, and HR. No sequence effect of measurements was observed.

Discussion

Arm position is one of the several variables which are known to affect the measurement of blood pressure. A correct arm position is valuable for both clinical and experimental purposes.

During the measurement of BP, the arm must be passively supported at the heart level. When these conditions are lacking, an overestimation of BP values is likely to occur. Moreover, in case of an unsupported arm the patient undergoes a sort of isometric exercise causing an increase in peripheral resistance and therefore in BP values, particularly in hypertensive patients.

In our study an increase both in systolic and diastolic pressures was observed in most cases (88.4%) when the arm was dependent by the side. In the remaining subjects (12.6%) no change or even an opposite response was observed when the arm was displaced by the side, probably due to a paradoxical reflex. These data are consistent with the observations of Webster *et al.*,[4] who found a mean

TABLE I Mean values (±SD) of SBP and DBP in supine and upright position[a]

	Supine		Upright →		Upright ↓	
	SBP	DBP	SBP	DBP	SBP	DBP
Overall population (n=181)	147.9±18.2	92.1±11.2	136.4±21.0	90.2±12.3	144.6±20.2[b]	99.0±12.0[b]
N (n=15)	142.0±9.6	76.6±7.7	131.6±10.5	74.9±10.0	140.8±11.4[b]	85.8±9.1[b]
UH (n=25)	157.8±15.3	102.3±9.6	146.7±16.8	98.5±11.6	153.7±19.8[b]	106.4±13.4[b]
TH (n=141)	146.7±18.8	92.0±9.7	135.2±21.9	90.3±11.1	143.5±20.6[b]	98.9±10.9[b]

[a]Data refer to overall study population and the three subgroups.
[b]$p<0.001$ between upright → and upright ↓.
Abbreviations: SBP=systolic blood pressure; DBP=diastolic blood pressure; N=normotensives; UH=untreated hypertensives; TH=treated hypertensives; Upright →=measurement performed with the patient's arm at the heart level; Upright ↓=measurement performed with patient's arm dependent by the side.

difference of 11/12 mmHg between the two different arm positions.

Such a BP elevation seems to be caused mainly by a hydrostatic effect: Mitchell *et al.*[5] did not find any significant difference between the values recorded with indirect measurements and those predicted by the formula for calculating the hydrostatic pressure in a column of blood.

Overestimation of BP values, which is frequently observed when measurements are performed with the arm in the wrong position, has important clinical implications. In fact it may lead to the false diagnosis of hypertension and the decision to start a course of treatment; in already treated hypertensives, it may lead to adjustments in posology (increments in dosages or addition of another drug) which are unnecessary and possibly dangerous. Moreover, overestimation of BP values can mask the existence of an orthostatic hypotension; in our study a postural reduction of BP $\geq$ 20 mmHg was present in 18.2% of patients and would have gone unrecognized in two-thirds of them if BP had been measured with the arm positioned by the patient's side.

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