Original Article

Interarm Blood Pressure Difference, Pulse Pressure, and Mean Arterial Pressure as Predictors of Cardiovascular Disease Risk in Young Adults

Manish Kumar Verma, Shambhavi Tripathi[1], Nitin Ashok John, Jyoti E John[2]

Departments of Physiology and [2]Biochemistry, Dr. Ram Manohar Lohia Institute of Medical Sciences, Lucknow, [1]Department of Pathology, Hind Institute of Medical Sciences, Sitapur, Uttar Pradesh, India

Abstract

Background and Aim: Most recommendations on blood pressure (BP) measurement and hypertension have stated that BP should be measured in both arms and that the hand with the highest value should be used for subsequent measurements. It has been suggested that differences in the right and left arm pressures may be caused by undiagnosed peripheral vascular disease affecting the vasculature of upper limbs and may, therefore, predict an increased risk of cardiovascular disease. **Methods:** Simultaneous bilateral brachial BP measurements were taken after 10 min resting period in supine position; three BP measurements were taken simultaneously and automatically using a validated automatic oscillometric device (Microlife WatchBP office) at 1 min interval. **Results:** There were 22, 19, and 9 participants with interarm systolic BP difference of <5 mmHg, 5–9 mmHg, and ≥10 mmHg, respectively. Out of the total 50 participants, 29 (58%) had a positive family history of HTN/diabetes mellitus (DM). There was a positive association ($P < 0.05$) between interarm systolic BP difference ≥10 mmHg and positive family history of HT/DM. A statistically nonsignificant correlation was observed between basal metabolic index ($r = 0.04$), pulse pressure ($r = -0.07$), and mean arterial pressure ($r = 0.23$) with interarm systolic BP difference of both arms. **Conclusion:** The presence of interarm BP difference ≥10 mmHg and positive family history of hypertension and diabetes has a prognostic value in predicting cardiovascular events. Hence, in primary care setting, BP should be measured routinely in both arms using automated oscillometric device.

Keywords: Automatic oscillometric device, cardiovascular disease, interarm systolic blood pressure difference

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Introduction

The interarm difference in blood pressure (IADBP) has received attention globally was discovered by Osler in 1915, who noted first.[1] Most recommendations on BP measurement and hypertension have stated that BP should be measured in both arms and that the hand with the highest value should be used for subsequent measurements.[2] IADBP is recommended by numerous guidelines to be performed at each first visit. This is because significant IADBP may indicate the presence of congenital heart disease, peripheral vascular disease, unilateral neurological, musculoskeletal abnormalities, or aortic dissection. However, even when the IADBP has seemingly no pathological background, relevant IADs (≥10 mmHg) are still important to know, as office measurements consequently performed at the arm with lowest BP can lead to a wrong diagnosis and undertreatment of hypertension.[3] It has been suggested that differences in the right and left arm pressures may be caused by undiagnosed peripheral vascular disease affecting the vasculature of upper limbs and may, therefore, predict an increased risk of cardiovascular disease. In a recent meta-analysis of twenty studies, a systolic BP difference of >15 mmHg between the right and left arm was associated with 2.5-fold greater risk for peripheral vascular disease, a 1.7-fold increase in cardiovascular mortality, and a 1.6-fold

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Address for correspondence: Dr. Manish Kumar Verma, Department of Physiology, Dr. Ram Manohar Lohia Institute of Medical Sciences, Vibhuti Khand, Gomti Nagar, Lucknow - 226 010, Uttar Pradesh, India.
E-mail: drmanish24@gmail.com

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higher risk of all-cause death.[4] BP is also characterized by its pulsatile and steady components. The pulsatile component, estimated by pulse pressure (PP), represents BP variation and is affected by left ventricular ejection fraction, large artery stiffness, early pulse wave reduction, and heart rate. The steady component, estimated by mean arterial pressure (MAP), is a function of left ventricular contractility, heart rate, and vascular resistance and elasticity averaged over time.[5] PP is a major independent predictor of cardiovascular morbidity and mortality in both hypertensive and normotensive populations. Prior studies have shown that PP reflects increased large artery stiffness and is a risk factor for both cardiovascular and cerebrovascular events.[6]

The present study was aimed at a reappraisal of the possible use of an IADBP, PP, and MAP as an indicator of cardiovascular disease risk in young adults with no previous history of cardiovascular disease and events.

Materials and Methods

A cross-sectional study was designed and carried out at the Department of Physiology, Hind Institute of Medical Sciences, Safedabad, Barabanki, UP, India, among 1st-year MBBS students aged between 18 and 30 years. A total of 50 students were randomly selected for the study after approval by the Institutional Ethics Committee. After taking verbal consent and explaining the purpose of the study, anthropometric measurement including height, weight, and basal metabolic index (BMI) was recorded. The family history of diabetes, hypertension, and other chronic diseases also recorded. Simultaneous bilateral brachial BP measurements were taken after 10 min resting period in supine position; three BP measurements were taken simultaneously and automatically using a validated automatic oscillometric device (Microlife WatchBP office)[7] at 1 min interval.

For the purpose of this analysis, the IADBP was calculated as the difference in the average value of all three systolic BP and diastolic BP between the right and the left arm as interarm difference in systolic BP and interarm difference in diastolic BP. PP and MAP values were also recorded automatically from the same device.

Statistical analysis of data

The data were collected on a predesigned schedule and entered into Microsoft excel data sheet for subsequent analysis. Subsequent analysis of the data was performed using Stata 13.0, Stata corp LLC, Texas, USA. The percentage was expressed for categorical variables and mean ± standard deviation was calculated for continuous variables. Correlation between two continuous variables was plotted on scatter plots and subsequently "*r*" was calculated.

Results

A total of fifty healthy participants with mean age of 20.7 years (range: 18–30 years) were included in the study. Systolic BP on the two arms was 126.08 ± 11.20 mmHg and 122.7 ± 12.0 mmHg on the right and left arm, respectively, and diastolic BP was 77.26 ± 8.84 mmHg and 75.70 ± 8.65 mmHg on the right and left arm, respectively [Table 1]. Results significantly showed higher mean systolic BP on the right arm.

There were 22, 19, and 9 participants with interarm systolic BP difference of <5 mmHg, 5–9 mmHg, and ≥10 mmHg, respectively [Table 2]. Out of the total 50 participants, 29 (58%) had a positive family history of HT/diabetes mellitus (DM), while 21 (42%) had no family history of HT/DM. There was a positive association ($P < 0.05$) between interarm systolic BP difference ≥10 mmHg and positive family history of HT/DM [Figure 1].

A statistically nonsignificant correlation ($r = 0.04$) was observed between BMI and interarm systolic BP difference of both arms [Figure 2].

Similarly, statistically nonsignificant correlation was observed between interarm systolic BP difference with PP ($r = -0.07$) [Figure 3] and MAP ($r = 0.23$) [Figure 4].

Discussion

The present study showed that systolic BP is slightly higher in the right arm than in the left arm. This finding was similar to the observation in studies by Kurian[8] and Singer and Hollander.[9] This may be due to right-handedness of majority of participants. The larger muscle mass in the right arm is less easily compressed by BP cuff. The present study showed

Table 1: Association of subjects with blood pressure and inter-arm pressure

Parameters	Values
Mean systolic BP	
Right arm	126.08±11.20 mmHg
Left arm	122.7±12.0 mmHg
Mean diastolic BP	
Right arm	77.26±8.84 mmHg
Left arm	75.70±8.65 mmHg
Interarm systolic BP difference	
<5 mmHg	22 subjects
5-9 mmHg	19 subjects
≥10 mmHg	9 subjects

BP: Blood pressure

Table 2: Association of systolic blood pressure difference ≥10 mmHg and positive family history of hypertension and diabetes mellitus

Systolic BP difference ≥10 mmHg	Family history of HTN/DM (%)		Total
	Yes (29)	No (21)	
No	20 (69.0)	21 (100.0)	41
Yes	9 (31.0)	0	9
Total	29	21	50

Fisher's exact=0.006. HTN: Hypertension, DM: Diabetes mellitus, BP: Blood pressure

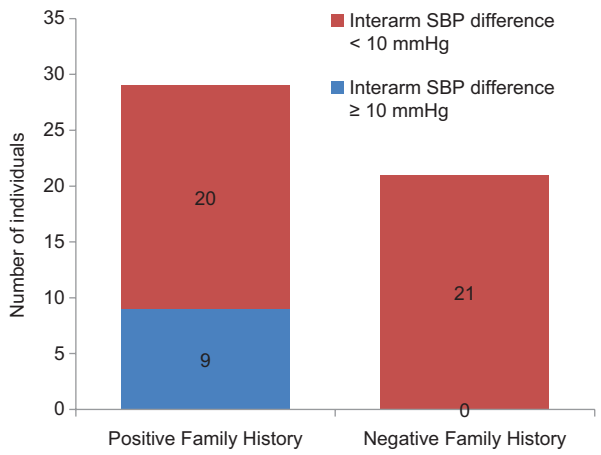

Figure 1: Correlation between positive family of hypertension and diabetes mellitus and SBPD ≥10 mmHg

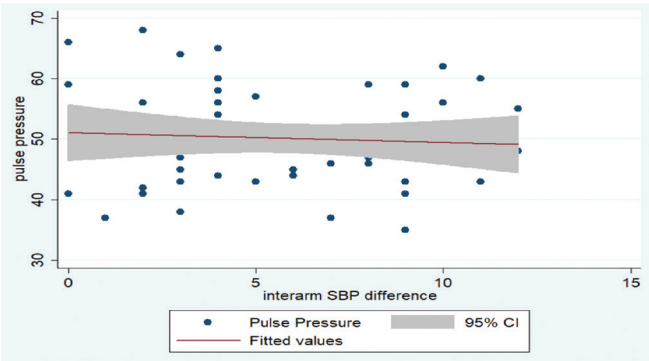

Figure 3: Correlation between interarm systolic blood pressure difference and pulse pressure

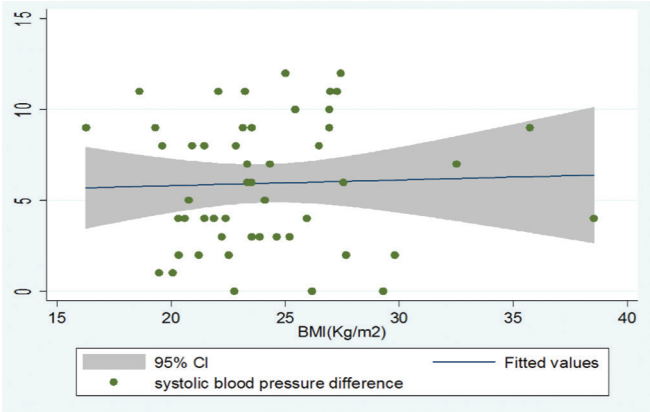

Figure 2: Correlation between interarm systolic blood pressure difference and basal metabolic index

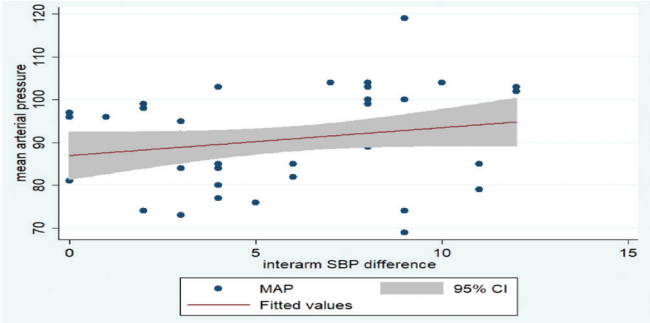

Figure 4: Correlation between interarm systolic blood pressure difference and mean arterial pressure

the prevalence of raised interarm systolic BP 18%. Interarm BP differences have been evaluated by several investigators. However, the prevalence rate varied considerably between studies. For example, Singer and Hollander[9] and Agarwal *et al.*[10] found systolic BP difference that exceeds 10 mmHg in 40% and 30% of patients, respectively. In contrast, Kurian[8] had found the prevalence rate for raised interarm systolic BP difference in 16.5% of participants, which is similar to our report. In this study, nine participants have found interarm BP difference ≥10 mmHg with having a positive family history of hypertension and diabetes. Similarly, several small and large prospective studies in cohorts of selected participants previously described an association between IADBP and both all-cause and cardiovascular mortality.[2,11-13] The presence of IADBP ≥10 mmHg is a significant and independent predictor of future cardiovascular events according to longitudinal analysis. In a number of previous studies, IADBPs were determined by measuring BP in each arm sequentially, not simultaneously, as unilateral cuff inflation to measure BP increases the B*P* values in contralateral arm. In this study, we used automatic device with two identical cuffs, which gives the opportunity of performing the most accurate simultaneous double arm measurements of BP. In this study, we found that BMI and interarm BP difference nonsignificantly associated, whereas Tokitsu *et al.*,[14] Zhang *et al.*,[15] and Maeda *et al.*[16] observed that BMI is significantly associated and an independent predictor of IADBP ≥10 mmHg. Similarly, statistically nonsignificant correlation was observed between interarm systolic BP difference with PP and MAP. A cohort study by Clark *et al.*[17] found that magnitude of IADBP is positively associated with PP.

Conclusion

The presence of interarm BP difference ≥10 mmHg has a prognostic value in predicting cardiovascular events. Hence, in primary care setting, BP should be measured routinely in both arms using automated oscillometric device.

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Conflicts of interest

There are no conflicts of interest.

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