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

Manish Kumar Verma, Shambhavi Tripathi, Nitin Ashok John, Jyoti E John

Departments of Physiology and Biochemistry, Dr. Ram Manohar Lohia Institute of Medical Sciences, Lucknow, 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

Received: 18th January, 2018; Revised: 10th March, 2018; Accepted: 16th March, 2018

INTRODUCTION

The interarm difference in blood pressure (IADBP) has received attention globally was discovered by Osler in 1915, who noted first. 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. 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
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) 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/DM 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[9] and Singer and Hollander.[10] 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**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean systolic BP</td>
<td></td>
</tr>
<tr>
<td>Right arm</td>
<td>126.08±11.20 mmHg</td>
</tr>
<tr>
<td>Left arm</td>
<td>122.7±12.0 mmHg</td>
</tr>
<tr>
<td>Mean diastolic BP</td>
<td></td>
</tr>
<tr>
<td>Right arm</td>
<td>77.26±8.84 mmHg</td>
</tr>
<tr>
<td>Left arm</td>
<td>75.70±8.65 mmHg</td>
</tr>
<tr>
<td>Interarm systolic BP difference</td>
<td></td>
</tr>
<tr>
<td>&lt;5 mmHg</td>
<td>22 subjects</td>
</tr>
<tr>
<td>5-9 mmHg</td>
<td>19 subjects</td>
</tr>
<tr>
<td>≥10 mmHg</td>
<td>9 subjects</td>
</tr>
</tbody>
</table>

BP: Blood pressure

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

<table>
<thead>
<tr>
<th>Systolic BP difference ≥10 mmHg</th>
<th>Family history of HTN/DM (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes (29)</td>
<td>No (21)</td>
</tr>
<tr>
<td>No</td>
<td>20 (69.0)</td>
<td>21 (100.0)</td>
</tr>
<tr>
<td>Yes</td>
<td>9 (31.0)</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>21</td>
</tr>
</tbody>
</table>

Fisher’s exact=0.006. HTN: Hypertension, DM: Diabetes mellitus, BP: Blood 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, Kuriam\(^8\) 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 IADBPP and both all-cause and cardiovascular mortality.\(^2,11-13\) The presence of IADBPP ≥10 mmHg is a significant and independent predictor of future cardiovascular events according to longitudinal analysis. In a number of previous studies, IADBPPs were determined by measuring BP in each arm sequentially, not simultaneously, as unilateral cuff inflation to measure BP increases the BP 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 IADBPP ≥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 IADBPP 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.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**REFERENCES**