The Effects of Crossed Leg on Blood Pressure Measurement

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ABSTRACT.

Background: It is clear that numerous factors influence an individual’s blood pressure measurement. However, guidelines for accurately measuring blood pressure inconsistently specify that the patient should keep feet flat on the floor.

Objective: To determine if the crossing of a leg at the knee during blood pressure measurement has an effect on the patient’s blood pressure reading.

Methods: A convenience sample of 100 hypertensive male subjects was selected from various outpatient clinics in an inner-city acute-care veterans’ hospital. The first 50 subjects positioned their feet flat on the floor while their blood pressure was measured. After 3 minutes, the blood pressure was measured again with the subject’s leg crossed at the knee. The procedure was reversed for the second 50 subjects.

Results: The results indicated that both systolic and diastolic blood pressure increased significantly (p < .0001) with the crossed leg position.

Conclusion: When blood pressure is measured, patients should be instructed to have feet flat on the floor to eliminate a potential source of error.

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Blood pressure monitoring is one of the most commonly used techniques in the diagnosis and treatment of various health care problems. Accurate measurement of blood pressure is especially crucial in the assessment of hypertension. Consequently, all efforts should be made to eliminate errors in measuring blood pressure.

Numerous factors influence an individual’s blood pressure measurement including medications, arm and body position, noise, extreme temperatures, constrictive clothing, faulty equipment, white-coat effect, attitude of the person taking the measurement, anxiety, improper cuff length or width, and talking. Furthermore, an individual’s blood pressure varies from minute to minute, is affected by respiration and heart rate, and is under the influence of the autonomic nervous system. During the course of the day, blood pressure changes according to the degree of mental and physical activity.

Additionally, an overall diurnal variability in blood pressure has been observed. Blood pressure typically falls by approximately 15% during the night in people who are active during the day, although a lesser nocturnal decrease in blood pressure has been noted in some hypertensive subjects. During the early morning hours, some individuals exhibit an abrupt rise in blood pressure, which has been associated with cardiovascular complications (Kaplan, 1998).

Although not an acceptable practice, a single blood pressure measurement often is the basis for clinical decisions such as adjustment of a person’s antihypertensive drug dosage. Thus, it is crucial to eliminate all possible sources of error in measuring a person’s blood pressure (Hill & Grim, 1991).

Some guidelines for accurately measuring blood pressure specify that the patient should keep feet flat on the floor. However, research is lacking on the effect of crossing the leg at the knee during blood pressure measurement. The current study was initiated to determine if blood pressure measurement is affected by the leg crossed at the knee as compared with feet flat on the floor.

Relevant Literature

Cooper (1992), Rudy (1986), and Hill and Grim (1991) recommended that the patient keep both feet resting on the floor during blood pressure measurement. However, others do not address leg position (Anderson & Maloney, 1994; Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure [JNC], 1997). Blood pressure research typically does not control for leg po-

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situation as a measurement variable (Hellmann & Grimm, 1984; Jamieson et al., 1990).

The physiologic mechanism for the rise in blood pressure with leg crossing is a translocation of blood volume from the dependent vascular beds to the thoracic compartment. Case reports have documented the usefulness of leg crossing as a physical maneuver to maintain blood pressure in symptomatic orthostatic hypotension (Takashita, Touma, Kawazoe, Maratani, & Fukiyama, 1991; van Lieshout, ten Harkel, & Wieling, 1992; Wieling, van Lieshout, & van Leeuwen, 1993).

In the Takashita et al. (1991) and van Lieshout et al. (1992) studies, orthostatic hypotensive subjects displayed increased blood pressure when blood pressure was measured with the leg crossed at the knee. These patients experienced an alleviation of many of their symptoms, such as dizziness and lightheadedness, as a result of this increased blood pressure. However, the research findings were inconsistent in the normal comparison study group. Specifically, Takashita et al. (1991) showed no increase in blood pressure taken with the leg crossed at the knee in normal subjects. The study by van Lieshout et al. (1992) demonstrated a significant increase in blood pressure in normal subjects with the leg crossed at the knee.

Methods

Subjects were recruited from the outpatient medical clinics of a midwestern Veterans’ Administration medical center. A convenience sample of 100 male patients, ages 31 to 81 years, participated in this study. All subjects had a medical diagnosis of hypertension and were taking antihypertensive medications. Hypertension was defined as a blood pressure reading of 140/90 or higher sustained for more than 1 year and diagnosed by a physician. Patients were excluded from this study if they had a history of peripheral vascular disease, lower extremity surgery, amputation of any lower extremities, or any condition that would interfere with lower extremity positioning.

Blood Pressure Measurement

Blood pressure measurements were monitored and recorded by two clinic nurses, who followed a written protocol to ensure identical technique. To exclude observer bias, the blood pressures were measured with the IVAC Vital.Check© Vital Signs Measurement System, Model 4200 (IVAC Corporation, 1989). This model is a microprocessor-based electronic instrument specifically designed to measure and display systolic and diastolic blood pressure. The blood pressure monitor is equipped with a normal adult size (24 x 42 cm) cuff and large adult size cuff (33 x 56 cm). The cuff inflation pressure range is 20–275 mmHg. The monitor was calibrated according to the IVAC Corporation Service Manual procedure for verification of accuracy by a biomedical technician before the study began. This blood pressure monitor was used by the nurse researchers throughout the data collection period.

Procedure

Potential subjects were identified and verbal consent was obtained. The subjects were placed in a room with a temperature of 73°F away from the noise of the clinic to control environmental stress. Each subject was instructed to remove constricting clothing (e.g., coats, sweaters, shirts). The subject was seated and encouraged to relax for a minimum of 5 minutes. After the relaxation period, the subject was instructed to place his feet flat on the floor. The subject’s right arm was positioned comfortably on a table at the heart level, with the palm of the hand upward. The brachial artery was palpated, and the appropriately sized cuff was placed on the subject’s right arm with the arrow directly over the brachial artery. The subject was instructed to refrain from talking or moving during the procedure. The blood pressure was measured and recorded. After a minimum of 3 minutes, the subject was instructed to cross one leg (the leg of comfort) over the knee. Then the blood pressure was measured again and recorded.

In the first 50 subjects, the initial blood pressure was measured with the subject’s feet positioned flat on the floor. In the second 50 subjects, the initial blood pressure was measured with the leg crossed over the knee. For the second blood pressure measurement, the leg position was the reverse of the initial leg position.

Statistical Analysis

The model for this design was repeated measures analysis of variance (ANOVA). The two within-subjects’ factors were blood pressure type (systolic and diastolic) and leg position (crossed and uncrossed leg). Statistical significance was defined as p < .05 for all three effects in the model (two within-subjects’ factors and their interaction).

Results

Because all subjects were assumed to be taking medication for the treatment of hypertension, 16 subjects were excluded because they failed to take their medication on the day of blood pressure measurement. The blood pressure values of these subjects showed greater variability than for the remainder of the sample (Table 1). After excluding these cases, 84 subjects remained.

Examination of the appropriate diagnostic statistics (for distributions and equality of covariance matrices) revealed no violations of model assumptions. The main effect for leg crossing indicated that systolic and diastolic blood pressure, considered together, increased significantly when the leg was crossed (Table 2). The interaction owes much of its strength to the change in systolic over diastolic blood pressure across leg-cross conditions. Diastolic pressure changed by about 3.7 mmHg, from 80.24 to 83.95 mmHg, whereas systolic
pressure changed at more than double that rate, 145.80 to 155.25 mmHg (Table 3).

Table 1
Systolic and Diastolic Blood Pressure Measurement by Medication Status

<table>
<thead>
<tr>
<th>Medication Taken on Day of Measurement</th>
<th>Systolic Leg Uncrossed</th>
<th>Systolic Leg Crossed</th>
<th>Diastolic Leg Uncrossed</th>
<th>Diastolic Leg Crossed</th>
</tr>
</thead>
<tbody>
<tr>
<td>No (n = 16)</td>
<td>M 150.62</td>
<td>157.06</td>
<td>84.38</td>
<td>89.62</td>
</tr>
<tr>
<td>SD</td>
<td>25.67</td>
<td>25.17</td>
<td>12.71</td>
<td>12.98</td>
</tr>
<tr>
<td>Yes (n = 84)</td>
<td>M 145.80</td>
<td>155.25</td>
<td>80.24</td>
<td>83.95</td>
</tr>
<tr>
<td>SD</td>
<td>17.02</td>
<td>18.20</td>
<td>10.61</td>
<td>11.13</td>
</tr>
<tr>
<td>Total</td>
<td>M 146.47</td>
<td>155.54</td>
<td>80.90</td>
<td>84.86</td>
</tr>
<tr>
<td>SD</td>
<td>18.60</td>
<td>19.34</td>
<td>11.19</td>
<td>11.57</td>
</tr>
</tbody>
</table>

M = mean, SD = Standard deviation

Table 2
Repeated Measures Analysis of Variance (ANOVA)

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood pressure type</td>
<td>393,327.43</td>
<td>1</td>
<td>393,327.43</td>
<td>1,759.85</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Error</td>
<td>18,550.57</td>
<td>83</td>
<td>223.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leg crossed versus uncrossed</td>
<td>3,640.58</td>
<td>1</td>
<td>3,640.58</td>
<td>66.78</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Error</td>
<td>4,523.42</td>
<td>83</td>
<td>54.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interaction (BP type x leg crossed)</td>
<td>691.44</td>
<td>1</td>
<td>691.44</td>
<td>21.19</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Error</td>
<td>2,708.56</td>
<td>83</td>
<td>32.63</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3
Cell Statistics

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SE</th>
<th>t</th>
<th>p</th>
<th>Lower Limit</th>
<th>Upper Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic, leg uncrossed</td>
<td>145.80</td>
<td>1.86</td>
<td>78.51</td>
<td>&lt;.0001</td>
<td>142.10</td>
<td>149.49</td>
</tr>
<tr>
<td>Systolic, leg crossed</td>
<td>155.25</td>
<td>1.99</td>
<td>78.17</td>
<td>&lt;.0001</td>
<td>151.30</td>
<td>159.20</td>
</tr>
<tr>
<td>Diastolic, leg uncrossed</td>
<td>80.24</td>
<td>1.16</td>
<td>69.32</td>
<td>&lt;.0001</td>
<td>77.94</td>
<td>82.54</td>
</tr>
<tr>
<td>Diastolic, leg crossed</td>
<td>83.95</td>
<td>1.22</td>
<td>69.12</td>
<td>&lt;.0001</td>
<td>81.54</td>
<td>86.37</td>
</tr>
</tbody>
</table>

Discussion

Many patient variables affect accurate measurement of blood pressure. Procedure guidelines for blood pressure measurement inconsistently address feet position (Anderson & Maloney, 1994; Cooper, 1992; Hill & Grim, 1991; JNC, 1997; Rudy, 1986). According to the results of this study, crossing the leg during blood pressure measurement in 84 male hypertensive subjects significantly increased both the systolic and diastolic blood pressure readings (p < .0001).

Clinical guidelines state that blood pressure should be measured while patients are seated in a chair with back supported and arms bared and supported at the heart level (JNC, 1997). According to the findings of this study, blood pressure readings may be artificially high if measured while an individual has a leg crossed at the knee. Therefore, patients also should be instructed to keep their legs uncrossed during office and home measurements. Finally, the current authors recommend that this study be replicated on a larger sample that includes female hypertensives because the sample of all-male hypertensive veterans limits the generalizability of this study.

References


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Exercise for Article 11

Factual Questions

1. All subjects had what medical diagnosis?

2. The two clinic nurses followed a written protocol to ensure what?

3. Which group of subjects had the initial blood pressure measured with the leg crossed over the knee?

4. What was the mean systolic blood pressure measurement for those who had taken their medication on the day of measurement and had their legs uncrossed?

5. Did systolic and diastolic blood pressure, considered together, increase significantly when the leg was crossed?
6. For those who had taken their medication, the mean diastolic blood pressure measurement when the leg was crossed was 83.95. We can have 95% confidence that the true mean (allowing for random errors) is between which two values?

**Questions for Discussion**

7. Is this an experimental or nonexperimental study? Explain.

8. The researchers state that they used a “convenience sample.” Does this affect the validity of the study? Explain. (See lines 77–78.)

9. Speculate on why the researchers had half the subjects cross their legs for the first measurement while having the other half cross their legs for the second measurement. That is, why not do the same thing for all subjects such as having them all cross their legs for the first measurement?

10. The researchers state that the characteristics of the sample limits the generalizability of the study. Do you think this is an important caution? Explain. (See lines 175–179.)

11. If you were to conduct another study on the same topic, what changes in the research methodology, if any, would you make?

**Quality Ratings**

Directions: Indicate your level of agreement with each of the following statements by circling a number from 5 for strongly agree (SA) to 1 for strongly disagree (SD). If you believe an item is not applicable to this research article, leave it blank. Be prepared to explain your ratings.

- A. The introduction establishes the importance of the study.
  - SA 5 4 3 2 1 SD

- B. The literature review establishes the context for the study.
  - SA 5 4 3 2 1 SD

- C. The research purpose, question, or hypothesis is clearly stated.
  - SA 5 4 3 2 1 SD

- D. The method of sampling is sound.
  - SA 5 4 3 2 1 SD

- E. Relevant demographics (for example, age, gender, and ethnicity) are described.
  - SA 5 4 3 2 1 SD

- F. Measurement procedures are adequate.
  - SA 5 4 3 2 1 SD

- G. All procedures have been described in sufficient detail to permit a replication of the study.
  - SA 5 4 3 2 1 SD

- H. The participants have been adequately protected from potential harm.
  - SA 5 4 3 2 1 SD

- I. The results are clearly described.
  - SA 5 4 3 2 1 SD

- J. The discussion/conclusion is appropriate.
  - SA 5 4 3 2 1 SD

- K. Despite any flaws, the report is worthy of publication.
  - SA 5 4 3 2 1 SD