AUTONOMIC REACTIVITY TO COLD PRESSOR TEST IN PREHYPERTENSIVE AND HYPERTENSIVE MEDICAL STUDENTS

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Abstract: Autonomic reactivity to stress has been hypothesized to be a marker for subsequent neurogenic hypertension. Medical training is highly stressful particularly for those who are beginning their medical education. The present study was undertaken to study the autonomic reactivity to cold pressor test in prehypertensive and hypertensive undergraduate medical students. One hundred and seventeen undergraduate medical students between 17-21 years of age got examined for blood pressure and stress level. Twelve Hypertensives and eight prehypertensives selected from the above subjects and twenty normotensives underwent cold pressure test (CPT) to assess autonomic reactivity to laboratory induced stress. 10.25% of the subjects were found to be hypertensive and 6.83% pre hypertensive. On the stress scale 53% had mild stress, 7% showed moderate stress while none had stress as a major problem. There was no correlation between BP and stress score. On CPT, BP increased significantly in all the three groups (hypertensive, prehypertensive and normotensive) but came back to basal levels within 5 minutes indicating normal autonomic response. Rise of BP was higher in hypertensive group as compared to normotensive group. The rise of diastolic and mean BP during CPT was significantly higher in subjects having family history of hypertension. Forty percent of normotensive subjects had more than 20 mm Hg rise in systolic BP on CPT. Adolescents must be routinely screened to detect asymptomatic hypertension. The CPT may identify individuals with an occult physiological abnormality that predisposes them to hypertension in their later life.

Key words: autonomic reactivity blood pressure cold pressor test prehypertensive hypertensive stress

INTRODUCTION

Autonomic reactivity to stress has been hypothesized to be a marker for subsequent neurogenic hypertension (1). Several studies both from west (2-4) and from Asia (5) have...
reported that medical training is highly stressful particularly for those who are beginning their medical education. Also previous studies have shown that repeated pressor episodes may lead to sustained hypertension and hypertensive patients recover very slowly than normotensives after laboratory induced stress (6). Normotensive hyperreactors are more likely to have a positive family history of hypertension (7, 8).

Over activity of sympathetic nervous system also plays an important role in pathogenesis of neurogenic hypertension in young individuals (9). The subject, whose cardiovascular system, is very sensitive to a stressor and recovers slowly after its withdrawal, is at high risk of developing hypertension in future (6).

Early diagnosis is essential to minimize the cardiovascular risk and damage to other target organs. The diagnosed patient can live a healthy life by altering his lifestyle and diet. Hence the present study is planned to find the autonomic reactivity to cold pressor test in prehypertensive and hypertensive medical students.

MATERIAL AND METHODS

The present cross sectional study was conducted in August and September 2008. One hundred and seventeen undergraduate medical students of first and second year from University College of Medical Sciences, Delhi volunteered for this study. They belonged to the age group of 17-21 years. Subjects with history of any chronic illness or drug intake known to influence blood pressure were excluded from the study. Informed written consent was taken from the subjects and institutes ethical committee approved the study.

Each student filled up a questionnaire recording his/her age, sex, address, dietary habits, lifestyle, family history of illness etc. Anthropometric parameters like height and weight of the subjects were measured to calculate their BMI. Height was measured by stadiometer to nearest 1 cm with subject standing without shoes and weight by weighing scale to the nearest 1 kg. A professional life stress proforma was also filled by the students (10). The stress proforma had questions regarding stress because of their academics, peer pressure, the relationship they share with their teachers, time for personal needs etc.

The blood pressure of all the subjects was measured in the right arm by auscultatory method using standard mercury sphygmomanometer in sitting position. Before measuring blood pressure the subjects were made to rest for ten minutes to allay anxiety. The 1st and the 5th Korotkoff sounds were indicative of the systolic and the diastolic blood pressure. Subjects found to be prehypertensive and hypertensive during first recording were checked for their blood pressure three times at weekly intervals. Students with systolic blood pressure ≥ 120 mmHg or diastolic blood pressure ≥ 80 mmHg for all the above three readings were considered as pre hypertensive. While those having systolic ≥ 140 mm Hg or diastolic ≥ 90 mm Hg were considered as hypertensive (11).

In the second phase of examination, Cold pressure test (CPT) was performed on twelve
subjects diagnosed as hypertensives and eight prehypertensives from the above subjects. Twenty randomly selected normotensive subjects also underwent CPT. Before the cold pressor test a baseline blood pressure was recorded by taping the cuff on the right arm. Then the subject was directed to dip his left hand up to his wrist in a water kettle having water at 4 degrees Celsius for 5 minutes. If the subject was not able to bear cold water the hand was taken out. The second recording of blood pressure was taken during the CPT. The hand was then wrapped in a towel for 5 minutes and the third reading of BP was taken after this. Before performing CPT the procedure was explained to the subjects. The same person took all the measurements. The instruments were calibrated on the day of the examination.

**Statistical analysis**

Statistical analysis was performed using SPSS 17.0 version. Anthropometric measurements, heart rate, mean BP and stress scores were compared in the three groups by One way ANOVA with Tukey Kramer test at 5% level of significance.

**RESULTS**

Of all the hundred and seventeen subjects studied 10.25% were found to be hypertensives while 6.83% were prehypertensive. On the stress scale 53% subjects had mild stress, 7% had moderate stress and none had stress as a major problem. There was no correlation between BP and stress score. The comparison between normotensive, prehypertensive and hypertensive subjects is shown in Table I. There is no difference between the three groups in age, height, weight BMI and stress score. The BP is significantly different between the hypertensive and normotensive groups.

The BP variation with CPT is shown in Table II. The systolic, diastolic and mean BP increased significantly after the CPT but subjects diagnosed as hypertensives and eight prehypertensives from the above subjects. Twenty randomly selected normotensive subjects also underwent CPT. Before the cold pressor test a baseline blood pressure was recorded by taping the cuff on the right arm. Then the subject was directed to dip his left hand up to his wrist in a water kettle having water at 4 degrees Celsius for 5 minutes. If the subject was not able to bear cold water the hand was taken out. The second recording of blood pressure was taken during the CPT. The hand was then wrapped in a towel for 5 minutes and the third reading of BP was taken after this. Before performing CPT the procedure was explained to the subjects. The same person took all the measurements. The instruments were calibrated on the day of the examination.

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The BP variation with CPT is shown in Table II. The systolic, diastolic and mean BP increased significantly after the CPT but

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Normotensive (n=20)</th>
<th>Prehypertensive (n=8)</th>
<th>Hypertensive (n=12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>18.70±1.17</td>
<td>18.38±1.30</td>
<td>18.20±1.28</td>
</tr>
<tr>
<td>Height (cms)</td>
<td>174.28±7.01</td>
<td>176.25±6.54</td>
<td>173.60±5.40</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>66.85±11.44</td>
<td>66.88±18.44</td>
<td>69.45±10.87</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>21.93±3.10</td>
<td>21.47±3.82</td>
<td>23.07±3.40</td>
</tr>
<tr>
<td>Stress score</td>
<td>17.00±8.05</td>
<td>19.63±4.83</td>
<td>20.30±4.99</td>
</tr>
<tr>
<td>Mean BP (mm Hg)</td>
<td>90.9±5.5</td>
<td>100.16±2.43</td>
<td>108±8.15*</td>
</tr>
<tr>
<td>Heart Rate</td>
<td>82.20±2.41</td>
<td>88±8.55</td>
<td>83.33±5.06</td>
</tr>
</tbody>
</table>

Data presented are mean±SD. Analysis of data was done by one-way ANOVA and post-hoc by Tukey Kramer test. The * depicts comparison with normotensive group, *P<0.05.
### TABLE II: Blood pressure variation with the Cold pressor test in normotensive, prehypertensive and hypertensive subjects.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Readings</th>
<th>Normotensive (n=20)</th>
<th>Prehypertensive (n=8)</th>
<th>Hypertensive (n=12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic BP</td>
<td>1st</td>
<td>117.60±7.06</td>
<td>129±6.92</td>
<td>142±14.54*</td>
</tr>
<tr>
<td>(mm Hg)</td>
<td>2nd</td>
<td>134.10±12.13</td>
<td>138.75±10.89</td>
<td>153.3±14.70*</td>
</tr>
<tr>
<td></td>
<td>3rd</td>
<td>115.50±7.59</td>
<td>126.75±9.37</td>
<td>136.8±13.35*</td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>1st</td>
<td>77.60±5.78*</td>
<td>85.75±3.28</td>
<td>91±9</td>
</tr>
<tr>
<td>(mmHg)</td>
<td>2nd</td>
<td>93.70±10.64</td>
<td>94±11.26</td>
<td>94.3±16.55</td>
</tr>
<tr>
<td></td>
<td>3rd</td>
<td>81.00±5.78</td>
<td>85±8.21</td>
<td>87.2±7.55</td>
</tr>
<tr>
<td>Mean BP</td>
<td>1st</td>
<td>90.9±5.0</td>
<td>100.16±2.43</td>
<td>108±8.15*</td>
</tr>
<tr>
<td>(mmHg)</td>
<td>2nd</td>
<td>107.2±10.3</td>
<td>108.92±9.49</td>
<td>114±12.43</td>
</tr>
<tr>
<td></td>
<td>3rd</td>
<td>91.83±5.6</td>
<td>100.25±5.23</td>
<td>103.83±8.18*</td>
</tr>
</tbody>
</table>

Data presented are mean±SD. Analysis of data was done by repeated measure ANOVA and post-hoc by Tuky-Krammer test. The * depicts comparison with normotensive group and the # depicts comparison with Prehypertensive and hypertensive group. *P<0.05; #P<0.05.

1st Reading – Base line blood pressure, 2nd Reading – During cold pressor test, 3rd Reading – 5 min after cold pressor test.

Intra group significance is also observed in systolic, diastolic and mean BP in all the three groups (2nd readings are significantly higher than 1st and 3rd readings).

### TABLE III: Blood pressure variation with respect to family history of hypertension.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Family history present</th>
<th>Family history absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic BP</td>
<td>1st 129.88±15.70</td>
<td>125.22±13.39</td>
</tr>
<tr>
<td>(mmHg)</td>
<td>2nd 144.47±17.09</td>
<td>138.09±13.05</td>
</tr>
<tr>
<td></td>
<td>3rd 125.53±115.35</td>
<td>123.13±12.40</td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>1st 85.88±10.59</td>
<td>81.30±6.78</td>
</tr>
<tr>
<td>(mmHg)</td>
<td>2nd 99.88±11.21</td>
<td>89.57±11.69*</td>
</tr>
<tr>
<td></td>
<td>3rd 85.76±8.42</td>
<td>82.87±6.34</td>
</tr>
<tr>
<td>Mean BP</td>
<td>1st 100.54±11.66</td>
<td>95.94±7.04</td>
</tr>
<tr>
<td>(mmHg)</td>
<td>2nd 114.75±12.63</td>
<td>105.74±7.90*</td>
</tr>
<tr>
<td></td>
<td>3rd 99±9.79</td>
<td>95.71±6.96</td>
</tr>
</tbody>
</table>

Data presented are mean±SD. Analysis of data was done by repeated measure ANOVA and post-hoc by Tuky-Krammer test. The * depicts comparison with group having family history of hypertension *P<0.05.

1st Reading – Base line blood pressure, 2nd Reading – During cold pressor test, 3rd Reading – 5 min after cold pressor test.

Intra group significance is also observed i.e: 2nd readings are significantly different from 1st and 3rd readings in all the three systolic, diastolic and mean BP of both the groups.

came back to baseline values within 5 minutes in all the three groups. Forty percent of normotensive subjects had more than 20 mm Hg rise in systolic BP.

Taking into consideration the family history of hypertension, there was a significant rise in systolic, diastolic and mean BP during CPT in both the groups. The baseline values of BP were not different in the two groups (Table III). The rise of diastolic and mean BP was significantly higher in subjects having family history of hypertension. Family history of hypertension was present in 46.66% of hypertensives, 40% of prehypertensives as against 35% of normotensives.

**DISCUSSION**

**Hypertension**

Prevalence of hypertension according to JNC criterion (11) was observed to be 10.25%
and that of pre hypertension 6.83%. Out of which two students were aware of their hypertensive status while the rest were not. Other studies of blood pressure of adolescents in our country have reported 0.46% to 11.9% prevalence (12-15). This wide difference may be due to different standards used for the diagnosis of hypertension and also due to regional variation. Some studies have adopted fourth phase of Korotkoff sound to define the diastolic blood pressure (16).

There is higher incidence of hypertension in Southern India (17) probably because of influencing factors, genetic inheritance, dietary habits and lifestyle factors. The difference in ethnicity may also be one of the factors.

Higher prevalence of hypertension in the present study could be due to majority of students belonging to middle or upper middle socioeconomic status. The changing diet and lifestyle are contributing to the rise in blood pressure. More over the present study is done on medical students who are under stress due to academic demands and are having more sedentary lifestyle as compared to general population. This may be contributing to higher incidence of blood pressure in them.

**Stress**

In the present study 53% subjects had moderate stress on the stress scale and in 7% stress was clearly a problem. This is in agreement with previous reports where academic demands of medical training during the first year are a significant source of stress (2, 3, 5). The increased level of stress in our subjects did not have a significant correlation with hypertension.

**Autonomic reactivity**

Autonomic reactivity to stress has been hypothesized to be a marker for subsequent neurogenic hypertension. Cold pressor test assesses the discriminative or prognostic value of excessive reactivity to a standardized cold stimulus. It is observed that hypertensive persons show greater lability of BP under various forms of stress than do normotensive persons (18). The normotensive hyper reactors to CPT are more likely to have a positive family history of hypertension than normotensive persons who are less reactive (7, 8). The hyper reactors to CPT with slower rate of recovery may be predisposed to the development of essential hypertension at a later point of time (19). In the present study all the subjects had complete recovery within 5 minutes indicating that their autonomic control system is competent enough to bring down the BP to baseline. Since 40% of normotensive subjects in our study had more than 20 mmHg rise in systolic BP on CPT, they are more prone to develop hypertension in future and were advised to modulate their lifestyle.

**Lifestyle**

We studied the subjects on the basis of lifestyle but could not get any significant difference. This may be because most of our subjects had a sedentary lifestyle and even though a few were in a practice of doing exercise, it was of very mild category.

Since most of our subjects were unaware of their hypertensive status, they were advised to modulate their diet and lifestyle. One of the subjects diagnosed as
hypertensive on further investigation was found to be having left ventricular hypertrophy and is on antihypertensive drugs now.

**Family History**

Family history of hypertension was present in 45% of hypertensives, 40% of prehypertensives as against 35% of normotensives. The baseline values of BP were not significantly different in the two groups. The rise of diastolic and mean BP on Cold pressor test was significantly higher in subjects having family history of hypertension. Family history of hypertension is a well established risk factor (20, 21). Young subjects who show greater and prolonged responsiveness to diastolic BP due to sympathetic stimulation through CPT are reported to be more prone to develop hypertension (6). Once stimulated by a stressor, sympathetic system causes rise in heart rate and BP but usually these parameters return to normal level within 5 min after withdrawal of the stressor. The

**Limitations of the study**

1. Small sample size
2. BP is also influenced by other factors like ambience, fasting Vs non fasting state, psychological stress which could not be controlled by our study.

**Conclusion**

Adolescents must be routinely screened to detect asymptomatic hypertension. The CPT may identify individuals with an occult physiological abnormality that predisposes them to hypertension in their later life.

**REFERENCES**

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