Comparative study of cardiovascular autonomic function among blind and normal sighted children – A cross-sectional study

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Received: August 04, 2020; Accepted: August 22, 2020

ABSTRACT

Background: Childhood blindness has a great impact on overall growth and development of the child. The child suffers from stress, reduced physical activity which increases autonomic discharge. Aim and Objective: The present study was done to find for any variation in cardiovascular autonomic functions in blind children which are likely to affect their health later. Materials and Methods: A cross-sectional study was carried out including 60 blind children (cases) and 60 normal sighted children (controls) of age group 10–17 years. Exclusion criteria: Children with a history of any medical illness, parental history of medical illness, and dominant hand deformities. Institutional ethical clearance and informed written consents from the parents/guardians were taken. Isometric handgrip test was used to assess the cardiovascular autonomic function. Results: Z-test was done using SPSS software. Z ≥ 1.96 and P < 0.05 were considered statistically significant. There was increase in diastolic blood pressure (DBP) during isometric handgrip exercise among blind children and particularly in male children compared to their normal sighted counterparts. Female blind children showed increase in the baseline DBP. Conclusion: Our study showed that there was increase in DBP during isometric handgrip exercise among blind children and particularly in male children and the female blind children showed increase in the baseline DBP when compared to normal sighted counterparts which could be suggestive of borderline cardiac autonomic impairment.

KEY WORDS: Blindness; Cardiac Autonomic Functions; Handgrip Test; Plasticity

INTRODUCTION

In India, about 30% of the blind are said to lose their eyesight before they reach the age of 20 years and many more under the age of 5 years.[1] Childhood blindness has a great impact on the development, education, work opportunities, and quality of life thus affecting the life of the child throughout. There is reduced regular exercise, physical activity, mental, and social stress which increases autonomic discharge. These factors induce physiological alterations such as increase in the respiratory rate, heart rate (HR), and diastolic blood pressure (DBP).[2] These autonomic changes in along run can be risk factors for conditions such as cardiovascular diseases, hypertension, and diabetes mellitus.

Blood pressure (BP) response to sustained handgrip is one of the batteries of cardiovascular reflex tests to assess autonomic neuropathy.[3] Sustained handgrip is an isometric exercise. HR increases with the beginning of the isometric muscle contraction which is mostly due to decrease in the vagal tone. Thereafter, the DBP also rises sharply due to increased peripheral resistance (PR) which results from vasoconstriction in the inactive muscles produced by the sympathetic outflow. The rise in the BP will be abnormally small if there is extensive peripheral sympathetic abnormality.[4,5]
Most young normal subjects and hypertensive patients without evidence of cardiac damage had increase BP during sustained handgrip by a rate dependent increase in the cardiac output, while in older subjects and in patients with myocardial dysfunction, there is a raise in the pressure due to increased PR by vasoconstriction.[6]

Studies have shown that blind individuals somehow compensate the loss of vision through more effective use of their remaining senses due to the possibility that neurophysiological changes would manifest themselves within regions of the brain responsible for somatosensory and auditory processing, respectively, forming cross-modal plasticity.[7] Similarly, there can be neuronal plasticity in case of repeated exposure to stress, leading to elevated sympathetic activity.

However, there is a deficiency in the understanding of the association between visually challenged and cardiovascular autonomic functioning as a very limited literature available till date. In this context, the present study was done to find for any variation in cardiovascular autonomic functions (isometric handgrip) among blind children.

Objectives
The objectives of the study were as follows:
1. Determination of the DBP response to the isometric handgrip exercise among blind and normal sighted children.
2. Determination of DBP response to isometric handgrip exercise among both the genders in blind and normal sighted children.

MATERIALS AND METHODS

Study Design
This was a cross-sectional study.

Sample Size
The sample size was 120 subjects.

Age Group
10–17 years.

Inclusion Criteria
Sixty healthy blind children from a blind school in Belgaum (23 females and 37 males) and 60 healthy normal sighted children from primary and high schools in Belgaum (20 females and 40 males) were included as cases and controls, respectively.

Exclusion Criteria
Children with a history of any medical illness, parental history of medical illness, and dominant hand deformities were excluded from the study.

Institutional ethical clearance was taken from the respective medical college and informed written consents were duly signed by the parents/guardians and permission to carry over the study was taken from the schools.

Procedure
Isometric handgrip test is one of the cardiovascular function tests. Handgrip dynamometer with graduations from 0 to 100 kg, manufactured by M.C. Dalal and Co., Chennai, was used for sustained handgrip exercise and to record BP mercury sphygmomanometer of diamond company make was used.

Baseline BP was recorded. The subject was asked to exert maximal handgrip strength on handgrip dynamometer with dominant hand. The maximum voluntary contractions were first determined. Handgrip was then maintained at 30% of that maximum for as long as possible (3–5 min). BP was then recorded 3 times during the handgrip at 1 min interval in the non-dominant hand. The maximum rise in DBP during sustained handgrip was noted.

Maximum rise in DBP was calculated as Highest DBP−Baseline DBP.[8]

Interpretation of the DBP Results
- Normal ≥16 mmHg
- Borderline impairment ≥11–15 mmHg
- Abnormal <10 mmHg.

RESULTS
Z-test was done using SPSS software to compare the case and control response. Among cases, the baseline DBP and maximum rise in DBP recordings showed statistically significant result in comparison to controls [Table 1]. Cases showed statistically significant variation in maximum DBP during handgrip and maximum rise in DBP compared to females [Table 2]. Comparison of DBP response during sustained handgrip in female children among cases and controls is presented in Figure 1.

DISCUSSION
The study was conducted with the hypothesis that blindness leads to chronic stress, lack of physical activity, and probable
involvement of neuroplasticity, leading to autonomic dysfunction. Hence, a comparative study of cardiovascular autonomic function among blind and normal sighted children was done. The data analysis of our study showed that the baseline DBP was increased among the cases and maximum rise in DBP among the cases was < 16 mmHg. Maximum DBP during handgrip and maximum rise in DBP in males and baseline DBP in females also showed significant variation. The maximum rise in DBP in females among cases and controls showed no significant variation.

There is very limited number of studies regarding the effect of blindness on autonomic functions. Similar to our study, an earlier study has shown that post-isometric exercise BP was maintained above the baseline compared to adults suggesting that children have a more active arterial chemoreflex.[9]

Researches have suggested that there is an increase in cardiac parasympathetic activity compared to sympathetic activity till infancy. This autonomic development seems to continue gradually during early childhood and more gradually still during late childhood. This might be interrupted and early setting of sympathetic activity might take place by constant stress and perceived anxiety and decreased physical fitness.[10,11] The study done on blind children has shown that there can be sympathetic overactivity compared to their normal sighted peers based on cold pressor test.[12]

Cardiac autonomic neuropathy generally starts with parasympathetic denervation followed by sympathetic tone enhancement and then impaired baroreflex sensitivity.[13] Neuroplasticity is one of the factors for autonomic dysfunction. Stress leads to activation of hypothalamic-pituitary-adrenal (HPA) axis which increases cortisol secretion. Acute stress which is a transitory phase can be advantageous for short-term exposure, whereas chronic stress can sensitize the HPA axis, increase the response due to the plasticity of the HPA axis, and can be dysfunctional.[14] Immunohistochemistry studies in animals also are indicative of neuroendocrine plasticity.[15] similar changes in human beings can be a possibility.

Female children among both the cases and controls did not show much variation during handgrip. In spite of the instructions, girls were unable to pull the handles of the dynamometer efficiently. This could be the reason for not much an increase in DBP. Furthermore, in the present study, we could not compare the results between the genders as the participation of female children was less.

The factors such as lower physical fitness and chronic stress which could lead to neuroendocrine plasticity can be attributed to the significant results in our study. Hence, the need to implement training program to improve the fitness levels and to create destressing environment such as yoga, music, and cultural activities is emphasized so as to delay or curb the detrimental consequences in the future.

**Limitations**

- Increase in the sample size
- Including more female children in the study for gender-wise comparison

<table>
<thead>
<tr>
<th>Parameters</th>
<th>DBP values (Mean±SD)</th>
<th>Significance</th>
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<tbody>
<tr>
<td></td>
<td>Cases (n=60)</td>
<td>Controls (n=60)</td>
</tr>
<tr>
<td>Baseline DBP (mmHg)</td>
<td>74.83±7.41</td>
<td>70.5±7.65</td>
</tr>
<tr>
<td>Maximum DBP during handgrip (mmHg)</td>
<td>87.6±7.99</td>
<td>90.3±11.91</td>
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<td>Maximum rise (mmHg)</td>
<td>12.76 ± 5.94</td>
<td>19.53 ± 9.75</td>
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*Z ≥ 1.96; P < 0.05 statistically significant. The results were expressed as mean ± SD. n = Number, DBP: Diastolic blood pressure, SD: Standard deviation

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Cases (n=40)</th>
<th>Controls (n=37)</th>
<th>P value</th>
<th>Z value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline DBP (mmHg)</td>
<td>74.32±8.15</td>
<td>71.15±8.01</td>
<td>&gt;0.05</td>
<td>1.72</td>
</tr>
<tr>
<td>Maximum DBP during handgrip (mmHg)</td>
<td>88.65±8.77</td>
<td>94.00±11.31</td>
<td>&lt;0.05*</td>
<td>2.34*</td>
</tr>
<tr>
<td>Maximum rise (mmHg)</td>
<td>14.32 ± 6.18</td>
<td>22.85 ± 8.79</td>
<td>&lt;0.05*</td>
<td>4.96*</td>
</tr>
</tbody>
</table>

*Z ≥ 1.96; P < 0.05 statistically significant. The results were expressed as mean ± SD. n = Number, DBP: Diastolic blood pressure, SD: Standard deviation
• Correlating the findings with catecholamine levels can be done for better results
• Neuronal imaging or functional magnetic resonance imaging studies can be done for understanding the plasticity changes in autonomic dysfunction.

CONCLUSION

Our study showed that there was increase in DBP during isometric handgrip exercise among blind children and particularly in male children and the female blind children showed increase in the baseline DBP when compared to normal sighted counterparts which could be suggestive of borderline cardiac autonomic impairment.

ACKNOWLEDGMENT

I would like to thank my HOD for guiding me through the study.

REFERENCES


How to cite this article: Doyizode AR, Herlekar SS, Siddanagoudra SP. Comparative study of cardiovascular autonomic function among blind and normal sighted children – A cross-sectional study. Natl J Physiol Pharm Pharmacol 2021;11(01):9-12.

Source of Support: Nil, Conflicts of Interest: None declared.