EVALUATION OF CARDIOVASCULAR AUTONOMIC FUNCTIONS IN DEAF SCHOOL CHILDREN, BELAGAVI- A CASE CONTROL STUDY

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ABSTRACT:

BACKGROUND: A deaf individual has diminished ability to hear sounds like other people do and also cannot speak if he/she has lost ability to hear before age of three. **AIMS AND OBJECTIVES**: To study and compare cardiovascular autonomic functions in deaf children and normal children. **MATERIALS AND METHODS**: We conducted a case control study with a sample size of 120 subjects out of which 60 were children from deaf school as cases and 60 were children with normal hearing as controls. Both the groups had 30 males and 30 females. Cardiovascular autonomic function tests such as Systolic Blood Pressure (SBP) response to immediate standing, Blood Pressure (BP) response to Cold pressor test (CPT), Heart Rate (HR) response to immediate standing expressed as 30:15 ratio, HR response to deep breathing were performed and compared among the two groups. Statistical analysis was done using SPSS software version:22 and results are expressed in percentage and proportions. **RESULTS**: Deaf children showed decrease in SBP on immediate standing, decrease SBP and increase in Diastolic Blood Pressure (DBP) as response to CPT, increase in HR expressed as 30:15 ratio compared to normal children. Depending on response to CPT, 36 subjects were found to be hyperreactors and 84 subjects were normoreactors. **CONCLUSION**: From the statistically significant results obtained in our study it is inconclusive to proclaim that deaf children are more stressed because of loss of hearing. Also CPT serves as a good study tool to evaluate the hyperreactors who can potentially develop hypertension and other co morbid conditions in their later adulthood.

KEYWORDS: Deaf children, Autonomic function tests, Cold pressor test, Hyperreactors, Normoreactors

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Introduction: Deaf-mutism is a devastating disability to affect human beings. For a person with this disability it is like a non-rewritable storage device, which takes in all the data and functions without the ability to express it back in any form. On World Hearing Day 3rd March, 2017, World Health Organization drew attention to the economic impact of unaddressed hearing loss through the theme*;* "Action for hearing loss: make a sound investment".World Hearing Day is an annual advocacy event held on 3rd March. Designated at the First International Conference on Prevention and Rehabilitation of Hearing Impairment in Beijing, China in 2007, the day aims to raise awareness and promote ear and hearing care across the world. Around the world over 5% of the world's population i.e. 360 million people – have disabling hearing loss (328 million adults and 32 million children). Disabling hearing loss refers to hearing loss greater than 40 decibels (dB) in the better hearing ear in adults and a hearing loss greater than 30 dB in the ear hearing better in children. According to WHO disabling hearing loss refers to hearing loss greater than 40 decibels in the better hearing ear in adults and a hearing loss greater than 30 decibels in better hearing ear in children[1].

A congenital deaf child suffers from chronic stress which may increase autonomic discharges. These factors induce physiological alterations in the body, leading to higher rates of breathing, increased heart rate, changes in diastolic blood pressure. These chronic conditions could later on lead to various complications like cardiovascular diseases, hypertension, diabetes mellitus etc. Studies highlight pervasive role of the autonomic nervous system for regulating functionality across organ systems and behavior is often underappreciated in both adult and pediatric medicine [2]. John Newport Langley then redefined the Autonomic Nervous

System (ANS), dividing it into the ortho sympathetic and the parasympathetic system [3]

Autonomic outflow to the heart and blood vessels is controlled on a moment to moment basis by variety of reflexes, which are initiated by arterial baroreceptors and chemoreceptors and by several types of cardiac receptors. Of these reflexes, one of the best studied is the arterial baroreflex, which is a classic negative feedback mechanism`of our body, that buffers fluctuations in the arterial blood pressure and helps maintain homeostasis [4].Baroreflex sensitivity assessment has immense value to a clinician, as impairment may have diagnostic and prognostic value in various disorders[5].The present study was done in an attempt to find out whether there are any variations in the cardiovascular autonomic functions in deaf mute children which is likely to affect the health in their adult life. This may give valuable information in understanding the concept of deaf mutism and the future approach in increasing their physical quality of life in all aspects.There are very few studies done on the parasympathetic parameters and the sympathetic parameters among the deaf children so far and no similar studies done in this region, Hence in our study we have tried to assess these parameters.

AIMS AND OBJECTIVES: The Objectives of the study is to compare the autonomic function tests like heart rate response to standing,blood pressure response to standing, heart rate response to deep breathing and blood pressure response to cold pressor test and to figure out hyperreactors and normoreactors as a response to cold pressor test among deaf and normal children.

MATERIALS AND METHODS: Study design: Case control study **Sample size**: 120 **Cases**: 60 (males-30 & females-30) **Controls**: 60 (males-30 & females-30)**Age group**: 6-18 years **Study period**: January 2016-December 2016 **Institutional Ethical clearance**: Obtained

Cases included 60 deaf children from the Government Deaf School for Girls and Ajay deaf school for boys in Belagavi city.

Control group included 60 normal children from the Sherman primary and high school of Belagavi.

The details such as purpose of the study, nature of the study, methods used, were explained to the parents/guardians in their own understandable language. Informed written consents were duly signed by the parents/guardians and the authorities of the respective schools of both the study group and the control group. The children were tested in the premises of their respective schools in Belagavi. The time chosen for the data collection was from 11am to 1pm and 3pm to 5 pm.

Inclusion criteria:

Healthy deaf children with Sensory Neuronal hearing loss (SNHL) as cases and healthy normal children of either sex aged between 6-18 years as controls were included in the study.

Exclusion criteria:

Children with history of hypertension, diabetes mellitus, asthma, known cardiovascular disease, conductive deafness and who are uncooperative.

Instruments:

The following instruments were used to record the parameters:

Sphygmomanometer: Mercury sphygmomanometer of Diamond make was used to record the blood pressure.

Stethoscope: Pulse Stethoscope Mark IV type was used.

Thermometer: Thermometer with graduations from 0 to 50 degree centigrade was used to record and regulate the temperature of cold water for cold pressor test

Electrocardiogram (ECG) machine: Cardiart 6108T of BPL healthcare was used. This is a portable 12-lead electrocardiograph with a single channel printing system, capable of processing all ECG leads simultaneously.

METHODS:

In the present study four simple, non-invasive cardiovascular reflex tests have been used to assess autonomic function, since one test alone does not distinguish the degree or severity of autonomic damage. These tests provide a useful framework to assess autonomic neuropathy simply, quickly, and noninvasively .

The tests include

Blood pressure response to standing

Cold pressor test

Heart rate response to standing

Heart rate response to deep breathing

PROCEDURE:

Blood pressure response to standing [6]-

Blood pressure of all the subjects was uniformly recorded when the subject relaxes in supine

position quietly for 15 to 20 minutes. After which up suddenly, taking less than 5 seconds; then blood pressure was recorded immediately, then at 30 seconds, 60 seconds and 90 seconds after standing. The difference in SBP was noted.

Cold pressor test[7]-

After the subject had rested supine for 15 to 20 minutes, blood pressure was measured in the right upper arm. The left hand was then immersed to just above the wrist in cold water (3 to 5degree centigrade) for 1 minute, blood pressure were measured at 30 seconds, 60 seconds and 120 seconds after immersion. Maximum increase in SBP and DBP were noted.

Immediate heart rate response to standing [6]-

The test was done with the subject lying quietly while the heart rate was recorded continuously for 30 seconds, on an ECG. The subject then stood suddenly and the point at starting to stand was marked on the ECG. ECG was recorded for 30 seconds after standing. The shortest RR interval at the 15th beat and the longest RR interval at around the 30th beat were measured. The heart rate response was expressed by 30:15 ratio.

two basal readings were taken. The subject stood The ratio of Longest R-R interval at around 30th beat and shortest R-R interval at around 15th beat was calculated.

Heart rate variation during deep breathing [6]-

The subject sits quietly and is instructed to start deep breathing on verbal command as trained earlier (5 seconds deep inspiration and 5 seconds deep expiration) for 30 seconds and the ECG was recorded throughout the period of deep breathing. The maximum and minimum RR interval during each breathing cycle were measured.

The E/I ratio of maximum R-R interval and minimum R-R interval was calculated.

STATISTICAL ANALYSIS:

Analysis of the obtained data from autonomic functions tests was done by using SPSS software version 22. Unpaired student t test was used when data followed normal distribution and Mann whitney U test when data did not follow normal distribution.

Significant values - p value of < 0.05 .

Results: The comparison was done among 60 deaf and 60 normal children.

Table 1: **Comparison of Blood Pressure response to standing among cases and controls**:

Category	**N**	**Parameters**	**SBP values (Mean± SD)**	**CI for mean**	**Significance**	
Cases Control	60 60	Supine SBP	106.40±7.38 106.26±6.17	102.59-106.40 104.67-107.86	t value-1.42	p-0.15
Cases Control	60 60	SBP on standing	106.8±7.37 111.66±6.52	104.9-108.7 109.98-113.35	t value-3.82	p <0.001
Cases Control	60 60	Supine minus standing	4.73±2.80 5.68±2.29	4-5.45 5.09-6.27	Mann Whitney U test-1346	p -0.014

Table 2: Comparison of Systolic Blood Pressure response to cold pressor test among cases and controls

Category	**N**	**Parameters**	**SBP values (Mean ± SD)**	**Significance**	
Cases Control	60 60	Baseline SBP	106.86±6.84 109.10±5.57	t value-1.96	p-0.052
Cases Control	60 60	Max SBP reached	121.13±8.99 126.60±6.24	t value-3.86	P<0.001

Cases Control	60 60	Max rise in SBP	14.26±7.28 17.53±6.28	Mann whitney U test-1286.50	p-0.007

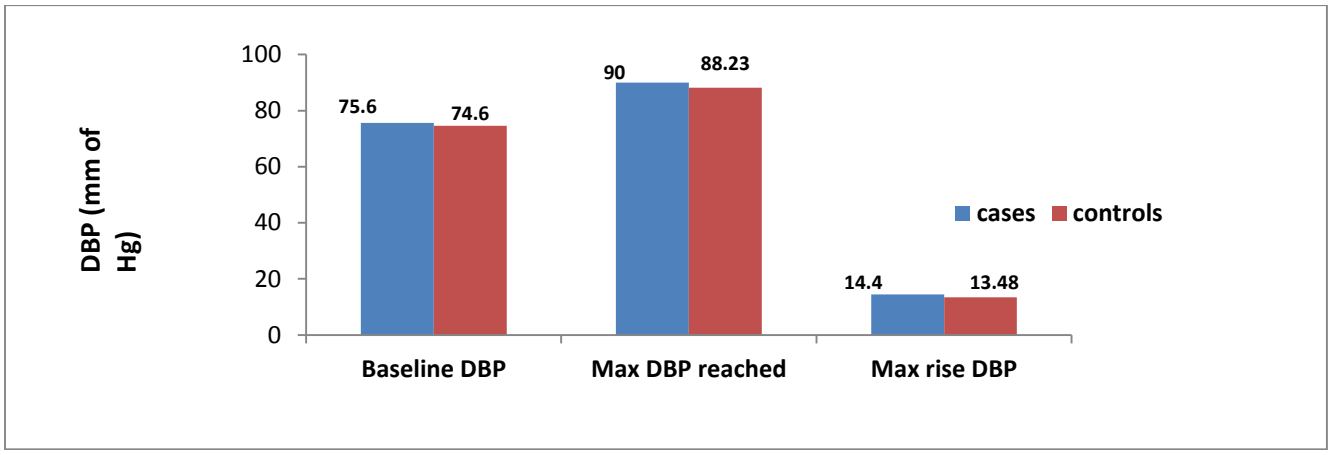

Figure 1: Comparison of Diastolic Blood Pressure response to cold pressor test among cases and controls

Table 3: Comparison of Heart rate response to standing 30:15 ratio among cases and controls

Category	N	Parameters	30:15ratio (Mean ± SD)	Significance	
Cases Control	60 60	Heart rate 30:15 ratio	1.28±0.102 1.22±0.083	Mann whitney U test-1276.50	p-0.006

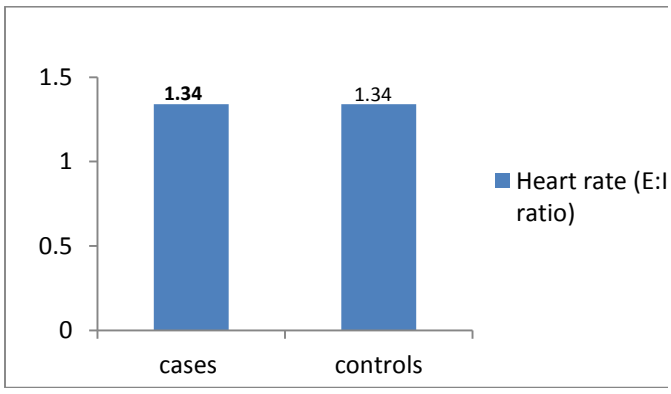

Figure 2: Comparison of Deep Breathing E:I ratio among cases and controls

Discussion: In our study deaf children showed decrease in SBP on immediate standing, decrease SBP and increase in DBP as response to CPT, increase in HR expressed as 30:15 ratio compared to normal children. Depending on response to CPT, 36 subjects were found to be hyperreactors and 84 subjects were normoreactors.

The cardiovascular system has proved suitable for an analysis of the principles used in testing for autonomic dysfunction[8]. For the neurologist, tests of peripheral sudomotor function may form the organizing nucleus of autonomic evaluation; for the cardiologist it may be tests of blood pressure and heart rate; for the endocrinologist it may be circulating catecholamines and renin; for the ophthalmologist it may be pupillary tests; and for the pharmacologist, it may be drug tests for evidence of suitable autonomic function or hypersensitivity.For a physiologist autonomic nervous system can be studied by assessing the cardiovascular autonomic function tests [9].

Sympathetic function parameters:

Blood pressure response to standing:

With change of posture that is on immediate standing from supine position the cardiovascular reflexes that are involved in the short term nervous regulation of the circulation are immediately activated in order to offset the fall in central venous pressure, stroke volume cardiac output and arterial pressure[10, 11,12]. Postural stress reduces intra thoracic volume and shifts to legs where it forms a pool, thereby producing fall of blood pressure and reduction in the circulating blood volume [13]. Compensation to this is brought about by reflex tachycardia, arteriolar constriction which is aimed at maintaining the arterial blood pressure, vasoconstriction which helps to limit expansion of blood pool in legs, keeps up the preload and is helped by the increased activity of abdomino-thoracic respiratory pump, the pumping action of calf muscles and the venous valves [14,15].

In our study baseline BP of cases and controls showed no significant difference (Table:1). This is not in accordance with study by Hooft et al[16]which showed that the resting mean SBP and DBP were significantly higher in normally hearing subjects with parental history of hypertension. On immediate standing, that is when there is a change in the posture from supine to standing, there is pooling of blood in the lower part of the body which results in a temporary decrease of venous return to the heart [17]. Hence there is reduction in systolic blood pressure but is immediately corrected by the baroreceptor mechanism. But in our study on immediate standing SBP values noted among cases and controls show significant difference with normal subjects showing rise in SBP (Table:1). The rise in SBP on standing could be attributed to the anxiousness which students had inspite of explaining the nature of study to them with the help of teachers. Chinagudi et al[18]studied that the mean reduction in the systolic blood pressure (mmHg) in the deaf children was 7.32±2.28 and that in normal children was 7.84±1.86 and hence the difference between the two groups was not statistically significant.

Cold pressor test:

The total number of subjects were again divided into hyperreactors and normoreactors based on the reactivity during cold pressor test. The subjects who showed a rise in SBP of 22 mm of Hg and more and DBP of 18 mm of Hg and more were grouped as hyperreactors and the subjects who did not show that much of a rise were grouped as normoreactors. 36 subjects were found to be hyperreactors and 84 subjects were found to be normoreactors. In our study the baseline SBP recorded was higher in controls compared to cases . The maximum SBP reached on exposure to cold pressor test was also statistically significantly higher in control group compared to cases group (Table:2). But maximum DBP reached when cases and controls were compared is higher in cases (Fig:1). Allen et al[19]studyhave shown thatthere is an increase in systolic pressure of 22 mm Hg and 18.2 mm Hg of diastolic blood pressures on exposure to cold water. This is in accordance with study done by Victor RG et al [20] which correlated the increase in muscle sympathetic activity during the cold pressor test with the increase in mean arterial pressure. Increased cardiovascular reactivity to the cold pressor test (CPT), a knownsympathoexcitatory stimulus , predicts the future development of hypertension[21] and may represent a preclinical manifestation of hypertension before elevations in peripheral arterial blood pressure are detected says a study**.** Investigators also hypothesized that the pressor reaction to a cold stimulus was mediated through a neurogenic reflex arc and that repeated pressor episodes led to fixed hypertension[22]. Barnett and associates studied a group of Hines's original cohort and found a small incidence ofhypertension among patients who had been hyperreactors at the time of the initial cold pressor test, whereas none of the normoreactors had become hypertensive after 25 years of follow-up [23].

From the above results, it is clear that this particular group of hyperreactors with increased sympathetic response are very likely to develop hypertension if they continue to be hyperreactors till adult age . But yet another study showed that the correlation between Anxiety state scores/sympathetic over activity and cold pressor test response was not significant statistically. The correlation between Anxiety trait scores and cold pressor test response was also not significant statistically **[24]**. Further follow up studies is required to test the same.

Parasympathetic function parameters:

Heart rate response to standing:

Baroreflex control of the heart rate is predominantly mediated through vagal modulation of the sinus node[25]. The change of posture (lying down to standing) displaces about 600 ml of blood from thorax to the legs [26].

This deactivates baroreceptors to produce a reflex tachycardia which is mediated mostly by vagal tone withdrawal [27].Displacement of blood produces slight fall in systolic blood pressure and a slight increase in diastolic blood pressure. The heart rate response there is an increase in the heart rate on immediate standing at about 15th beat and later settles down and steadies at about 30th beat.

The magnitude of the initial heart rate changes after standing can be used to evaluate diabetic and other patients for parasympathetic activity [9].

Measurement of HRV has been particularly useful in assessing parasympathetic activity [28]. In our study the heart rate measured by RR interval expressed as HR in 30th and 15th beat ratio among cases and controls showed significant difference with cases showing higher range (Table: 3). Another study also conducted AFT in deaf and normal children and found heart rate response to standing was significantly higher in cases than controls [29].

Heart rate variation to deep breathing:

Estimation of heart rate response to deep breathing expressed as E/I ratio among cases and controls in our study showed no significant difference (Fig:2). Study done by Veena et al also concluded similar results [29].

Small sample size taken in our study is a limitation hence the results may not apply on wider range of population. Autonomic function tests carried out in our study is a manual mode of assessment due to limited resources and logistic issues. Performing the tests using tilt table in properly set autonomic function lab will definitely yield more accurate and reproducible results which will form definite evidence to design similar studies in future generation

Conclusion: Our study findings conclude that it is inconclusive if deaf children are more stressed expressed in terms of autonomic dysfunction in contrast to what was hypothesized before the study. Deaf children showed decrease in SBP on immediate standing, decrease SBP and increase in Diastolic Blood Pressure(DBP) as response to CPT, increase in HR expressed as 30:15 ratio compared to normal children. Also cold pressor test serves as a tool to diagnose hyperreactors who are potential candidates to develop hypertension in future. Future studies with high end equipments which will reproduce more specific results is recommended

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