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Original Research Article

Effects of Sensory Neural Hearing Impairment on Balance in Children - A Cross-Sectional Observation Study

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ABSTRACT

Background: Hearing is one of the five major senses. There are many children who have sensorineural hearing impairment. They show vestibular function impairment because cochlea and vestibule share continuous membranous labyrinth of the inner ear and balance impairment because otolith organs contribute to postural control, particularly through the vestibulospinal system. Hence, this study incorporates balance assessment to find out how much they lack when compared with normal children.
Objective: To see the Effects of Sensorineural Hearing Impairment on Balance in Children.
Methodology: This two-group study involved 40 children, i.e., 20 children with sensorineural hearing loss and 20 with normal hearing, aged between 8 to 14 years. Paediatric balance scale (PCB) and Modified Clinical Test of Sensory Interaction in Balance (CTSIB-M) scale on 20 normal and 20 deaf children (sensorineural deafness) were used to assess vestibular function, static and dynamic balance. For data analysis paired t test was used.
Result: The mean value of CTSIB-M score for normal children was 119.6 and that of deaf children was 110.7. Significance difference p value is 0. 008.The mean value of PBS score for normal children was 55.3 and that of deaf children was 54. Significance difference p value is 0.008. That shows p value is < 0.05 indicating significant difference in balance between normal and deaf children.
Conclusion: Children with sensory neural hearing impairment showed lower dynamic balance performance than normal hearing children

Key Words: Sensorineural hearing loss, vestibular function, static and dynamic balance

INTRODUCTION

Hearing is a fundamental sense that plays a crucial role in communication, spatial awareness, and environmental perception. (1) It allows individuals to detect and interpret sound vibrations within the frequency range of 20 Hz to 20,000 Hz. (2) The auditory system is closely linked to the vestibular system, which contributes to balance and postural control.(3) The peripheral vestibular system consists of two key subsystems: the vestibulo-ocular system, which stabilizes gaze during head movements, and the vestibulospinal system, which regulates muscle tone necessary for postural control and early motor development. Studies report a prevalence of vestibular dysfunction in 20-

70% of children with sensorineural hearing loss (SNHL), indicating a strong connection between auditory impairment and balance deficits. [4]

Deafness is defined as "a hearing impairment that is so severe that the child is impaired in processing linguistic information through hearing, with or without amplification." Thus, deafness is viewed as a condition that prevents an individual from receiving sound in all or most of its forms. [5] Types Of Hearing Loss: Conductive, Central, Functional hearing, Mixed hearing, Ototoxic hearing loss, Sensorineural hearing loss

SNHL occurs due to dysfunction within the inner ear, specifically the cochlea or the vestibulocochlear nerve (cranial nerve VIII), leading to impaired auditory signal transmission to the brain. [6]

This type of hearing loss accounts for nearly 90% of all cases and can be congenital or acquired due to various etiologies, including genetic mutations, infections, noise-induced damage, aging (presbycusis), ototoxic medications, and perinatal complications. [7] SNHL is often associated with vestibular dysfunction, leading to symptoms such as dizziness, imbalance, and difficulty maintaining posture. Patients frequently report challenges in distinguishing speech, particularly in noisy environments, and may experience associated conditions like tinnitus. [8,9] Balance, defined as the ability to maintain a stable posture and controlled movement, is classified into static and dynamic balance. [10] Static balance refers to maintaining a steady posture in a stationary position, while dynamic balance involves stability during movement or position changes. [11] Effective balance control requires integration of sensory inputs from the vestibular, visual, and proprioceptive systems. The vestibular system, housed within the inner ear, plays a pivotal role in detecting head motion and orientation in space. Damage to this system, as seen in individuals with SNHL, can result in impaired postural control, increasing the risk of falls and mobility issues. [12] Given the intricate relationship between the auditory and vestibular systems, this study aims to assess the impact of sensorineural hearing loss on balance. Understanding this connection may help develop targeted rehabilitation strategies to improve postural stability and mobility in individuals with SNHL.

MATERIALS & METHODS

Study Design: Cross sectional, observational study

Inclusion criteria

- Age between 8-14 years normal children
- Sensory neural hearing impairment (Not wearing cochlear implant)
- Gender: Both male and female

Exclusion criteria

- Children with known neurological impairments, such as cerebral palsy or learning disabilities
- Any orthopaedic handicaps
- Any visual defect

PROCEDURE

Subjects: Children with sensorineural deafness and normal children

Source of data: Normal school and deaf and dumb school of Surat

Sampling method: Convenient

Sample size: 20 normal and 20 deaf children

Material: Paediatric Balance Scale (PBS) and Modified Clinical Test of Sensory Interaction in Balance (CTSIB-M) scale

- Foam
- Chair
- Measure tape
- Objects

Method

Children met with inclusion criteria were included in the study, one normal children school randomly selected and one deaf and dumb school from Surat.

Investigator visited school with prior appointment with principal of both schools and explained about the study. Then with prior permission letter taken from principal, investigator performed Paediatric Balance Scale (PBS) and Modified Clinical Test of Sensory Interaction in Balance (CTSIB-M) scale on 20 normal and 20 deaf children (sensorineural deafness).

DATA ANALYSIS

Data analysis was done by using SPSS 20 for both outcome measures PBS and CTSIB-M. Mean difference scores and standard deviation for each variable were done. Paired t-test was used for data analysis. A significance level of 0.05 was set for data analysis.

RESULT

As already stated, 40 children met with inclusion criteria were taken. Children in the study were aged between 8 to 14 years (mean age was 11.47)

Table: 1 Gender (normal children)

Variable	Male	Female
Gender	60%	40%

Table: 2 Gender (deaf children)

Variable	Male	Female
Gender	40%	60%

Table: 3 CTSIB-M Scale

GROUP		N	Mean	Std. Deviation	t	df	Sig.(2-tailed)
CTSIB-M	1.00 (Normal)	20	119.4900	2.02949	2.963	19.924	.008
	2.00 (Deaf)	20	110.7650	13.01183			

The mean value of CTSIB-M score for normal children was 119.4.3 and that of deaf children was 110.7. Significance difference p value is 0.008. That shows p value is < 0.05 indicating significant difference in balance between normal and deaf children.

Table: 4 Pediatric Balance Scale

GROUP		N	Mean	Std. Deviation	T	Df	sig.(2-tailed)
PBS	1.00 (Normal)	20	55.3000	.80131	2.866	25.792	.008
	2.00 (Deaf)	20	54.0000	1.86378			

The mean value of PBS score for normal children was 55.3 and that of deaf children was 54. Significance difference p value is 0.008. That shows p value is < 0.05 indicating significant difference in balance between normal and deaf children.

DISCUSSION

The result of our study was found to be extremely significant for components, standing with one foot in front and standing on one foot in PBS and components- Eyes Open -Foam Surface and Eyes Closed - Foam Surface in CTSIB-M. It was found to be insignificant for components; Sitting to standing, standing to sitting, Transfers, standing unsupported, sitting unsupported, standing with eyes closed, Standing with feet together, Turning 360 degrees, Turning to look behind, Retrieving object from floor and Placing alternate foot on stool in PBS and Eyes Open - Firm Surface and Eyes Closed - Firm Surface components in CTSIB-M.

In one of the cross-sectional study of Amir-Abbas Ebrahimi et al., [13] 145 school children, aged between 7 and 12 years comprising 85 children with congenital or early acquired bilateral profound sensorineural hearing loss (the hearing loss group) and 60 normal hearing aged-matched control counterparts were assessed using the balance subtest of Bruininks-Oseretsky test of Motor Proficiency (BOTMP). The findings suggested that deaf children, specifically those with cochlear implants are at risk for motor and balance deficits. One other study done by Gayle et al., [14] evaluated dynamic balance in 40 children, of which 20 were normal hearing children and 20 were children with sensorineural hearing loss, of both sexes and concluded that children with hearing loss showed lower dynamic balance performance than normal hearing children. Likewise, Jafari et al., [15] evaluated static balance in 60 children, 30 of whom were normal hearing children and 30 were children with sensorineural hearing loss, in the age group of 6 to 9 years, using six balance tests of the Bruininks-Oseretsky Test of Motor Proficiency and found that children with hearing loss had poorer balance than normal hearing children. An et al., [16] analyzed static balance in 114 students, of which 57 were normal hearing children and 57 were children with sensorineural hearing loss, aged 4 to 14 years, using the unipodal support test. They concluded that children with hearing loss presented more static balance instability than normal hearing children. Diego Sarmento de Sousa et al. [17] performed Comparative study of the static balance between deaf and hearing children 8 to 10 years of age using SBT and TEE tests and concluded that deaf children have poor performance on SBT and significantly low performance in TEE when compared to hearing children.

Our result for Standing on one foot component is found to be extremely significant is supported by Thaize C Souza Lima et. al. [18] They performed study on influence of deafness on motor development and balance in children with 9 deaf and 10 non deaf children of age 6 to 10 and concluded that deaf children exhibited a reduction on the time they stayed on the single-limb standing, especially for firm surface.

Research done by V. Rajendran et. al. [19], W. Martin et. al. [20] and E. Hartman et. al. [21] had shown impairments in motor performances of children with hearing impairment, including balance and dexterity, which support our study. The results of our study are also in alignment with most of the findings in previous literature done by R.M. Rine, et al[22] *and* S.K. Effgen[23] and confirm that balance deficit is a common sensorimotor impairment in children with severe to profound hearing impairment. Other researches also reported that vestibular dysfunction is a frequent finding in otoneurological evaluations of children with sensorineural hearing loss. [24, 25, 26]

On the contrary, Melo et al. [27] compared balance and gait evaluation between deaf and hearing students. The authors did not find significant differences between groups, genders or age groups in balance evaluation.

The findings of our study are consistent with the vestibular deficit theory; one of the predominant theories regarding motor and balance deficits in children with hearing loss. Based on this theory because the cochlea and vestibular end organs are closely related, hearing loss due to inner ear impairment may cause vestibular dysfunction and is likely to result in balance deficits. [28] Also, In children with hearing impairments limited acoustic information cause disruption throughout the system to maintain balance and orientation in space. It is known that the vestibular nerve after leaving the labyrinth alone exceeds the lower part of the road, and then connects to the hearing nerve and travel together to the cortex. After two thirds of the common path of these nerves are separated, so that the vestibular enters the medulla oblongata and the vestibular nucleus and the cochlear nerve in the center of hearing in the cerebral cortex. These two-thirds of the common views of the eighth cranial nerve is substantially determined postural, balance and coordination of every individual. As people with hearing impairments lack adequate sound stimuli, there will be no adequate vestibular stimulation, which leads to awkwardness in coordination and balance disorders. [29, 30, 31] In dynamic balance, both the center of gravity and the base of support are in constant motion, and the center of gravity never aligns itself to the base of support during the stance phase of the movement. To maintain human body balance, anatomical and functional integrity of the vestibular system, located in the inner ear, is essential. The vestibulo-cochlear system has a dual function - the cochlea is responsible for the auditory function, and the vestibular system is responsible for body balance. [12]

We also noticed that children with sensorineural deafness lost their balance almost immediately in Eyes Closed, Foam Surface in CTSIB-M test. This finding is consistent with the test done by Suarez et al. [32]. These authors analyzed deaf children with and without hypo activity of the vestibular system. Children with hypo activity of the vestibular system exhibited an increase in body sway compared to children with normal vestibular response in the condition involving lack of vision combined with the foam surface. According to Suarez et al. [32] and Azevedo et al. [29] the removal of the visual field, represented by the closing of the eyes, further compromises the maintenance of the balance of these individuals, since they already have a vestibular gap. For Castro [33] deaf individuals seem to develop motor performance strategies based on visual cues and proprioceptive information in order to compensate for their problems.

CONCLUSION

From this study it was concluded that there was no significant difference in static balance but significant difference in dynamic balance performance in children with sensorineural hearing impairment when compared to children without hearing impairment.

Declaration by Authors

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REFERENCES

1. Somjen G. Sensory coding in the mammalian nervous system.2013
2. Iyengar S. Development of the human auditory system. Journal of the Indian Institute of Science. 2012 Dec 28;92(4):427-40.
3. Rine RM, Christy JB. Physical therapy management of children with vestibular dysfunction. Philadelphia, PA: FA Davis Company. 2014:457.
4. Cushing SL, Papsin BC, Rutka JA, James AL, Gordon KA. Evidence of vestibular and balance dysfunction in children with profound sensorineural hearing loss using cochlear implants. The Laryngoscope. 2008 Oct;118(10):1814-23.
5. Sheet ND. Deafness and hearing loss. Links. 2010 Jun.
6. Javad-Rashid R, Pirzadeh A, Naderpour M, Mirhaji R. Frequency of Inner Ear Anomalies Among Cochlear Implant Candidates: A Case Study in the Northwest of Iran. Malaysian Journal of Medicine & Health Sciences. 2021 Jul 1(3).
7. Yoshida M, Noguchi A, Uemura T. Functional hearing loss in children. International journal of pediatric otorhinolaryngology. 1989 Jul 1;17(3):287-95.
8. Smith RJ, Bale JF, White KR. Sensorineural hearing loss in children. The Lancet. 2005 Mar 5;365(9462):879-90.
9. Simani L, Oron Y, Handzel O, Eta RA, Warshavsky A, Horowitz G, Muhanna N, Ungar OJ. Evaluation of the quality of online information on sudden sensorineural hearing loss. Otology & Neurotology. 2022 Feb 1;43(2):159-64.
10. Ayanniyi O, Adepoju FA, Mbada CE. Static and dynamic balance in school children with and without hearing impairment. J Exp Integr Med. 2014;4:245-8.
11. O'Sullivan SB, Schmitz TJ. Examination of coordination. In: O'Sullivan SB, Schmitz TJ, editors. *Physical rehabilitation.* 5th ed. Philadelphia: F.A. Davis; 2007. p. 193-226.
12. Woollacott MH, Tang PF. Balance control during walking in the older adult: research and its implications. *Phys Ther.* 1997;77(6):646-60.
13. Ebrahimi AA, Movallali G, Jamshidi AA, Haghgoo HA, Rahgozar M. Balance performance of deaf children with and without cochlear implants. *Acta Med Iran.* 2016;54(11):750-7.
14. Gayle GW, Pohlman RL. Comparative study of the dynamic, static, and rotary balance of deaf and hearing children. *Percept Mot Skills.* 1990;70(3 Pt 1):883-8.
15. Jafari Z, Asad-Malayeri S. The effect of saccular function on static balance ability of

profound hearing-impaired children. *Int J Pediatr Otorhinolaryngol.* 2011;75(7):919-24.

16. An MH, Yi CH, Jeon HS, Park SY. Age-related changes of single-limb standing balance in children with and without deafness. *Int J Pediatr Otorhinolaryngol.* 2009;73(11):1539-44.
17. Sousa DS, Gama IMC, Silva JS, Sequeira MEA, Pinto RF. Comparative study of the static balance between deaf and hearing children 8 to 10 years of age. *Revista Digital – Buenos Aires.* 2010;15(144).
18. Souza Lima TC, da Cunha Pereira MC, de Moraes R. Influência da surdez no desenvolvimento motor e do equilíbrio em crianças. *Braz J Mot Behav.* 2011;6(1):16-23.
19. Rajendran V, Roy FG. An overview of motor skill performance and balance in hearing-impaired children. *Ital J Pediatr.* 2011; 37:33.
20. Martin W, Jelsma J, Rogers C. Motor proficiency and dynamic visual acuity in children with bilateral sensorineural hearing loss. *Int J Pediatr Otorhinolaryngol.* 2012;76(10):1520-5.
21. Hartman E, Houwen S, Visscher C. Motor skill performance and sports participation in deaf elementary school children. *Adapt Phys Activ Q.* 2011;28(2):132-45.
22. Rine RM, Wiener-Vacher S, Ghulyan A, Emond F, Dumas G, Lopes C, et al. Balance and motor skills in young children with sensorineural hearing impairment: a preliminary study. *Pediatr Phys Ther.* 1996;8(2):55-61.
23. Effgen SK. Effect of an exercise program on the static balance of deaf children. *Phys Ther.* 1981;61(6):873-7.
24. Lisboa TR, Jurkiewicz AL, Zeigelboim BS, Martins-Bassetto J, Klagenberg KF. Vestibular findings in children with hearing loss. *Int Arch Otorhinolaryngol.* 2005;9(4):271-9.
25. Schwab B, Kontorinis G. Influencing factors on the vestibular function of deaf children and adolescents - evaluation by means of dynamic posturography. *Open Otorhinolaryngol J.* 2011; 5:1-9.
26. Jerome A, Kannan L, Lakhani H, Palekar TJ. Prevalence of vestibular dysfunction in hearing-impaired children. *Int J Pharm Sci Health Care.* 2013;3(2):1-6.
27. Melo RS, Silva PW, Tassitano RM, Macky CF, Silva LV. D Balance and gait evaluation: comparative study between deaf and hearing students, Rev Paul Pediatr. 2012;30(3):385-91.
28. Livingstone N, McPhillips M. Motor skill deficits in children with partial hearing. *Dev Med Child Neurol.* 2011;53(9):836-42.
29. Azevedo MG, Samelli AG. Comparative study of balance on deaf and hearing children. *Rev CEFAC.* 2009;11(Suppl 1):85-91.
30. Kaga K, Shinjo Y, Jin Y, Takegoshi H. Vestibular failure in children with congenital deafness. *Int J Audiol.* 2008;47(10):590-9.
31. Angeli S. Value of vestibular testing in young children with sensorineural hearing loss. *Arch Otolaryngology Head Neck Surg.* 2003;129(5):478-82.
32. Suarez, H., Angeli, S., Suarez, A., Rosales, B., Carrera, X., & Alonso, R. (2007). Balance sensory organization in children with profound hearing loss and cochlear implants. International Journal of Pediatric Otorhinolaryngology, 71, 629-637.
33. CASTRO, EM Development of Locomotion for Deaf Children: A Qualitative Analysis of Walking and Running. Rev. SOBAMA, V.5, n.1, p.09-18. 2000.

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