

Effect of Motor Control Program in Improving Gross Motor Function and Postural Control in Children with Sensorineural Hearing Loss-A Pilot Study

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Abstract

Background: Sensorineural hearing loss (SNHL) is the most common type of permanent hearing impairment and results from damage to the inner ear or the nerve pathway. Children with hearing impairment have balance and motor deficits primarily due to concomitant damage to the vestibular structures.

Objective: To study the effect of motor control program on improvement of gross motor function and postural control in children with sensorineural hearing loss.

Methods: A pre-post test trial consisting of 10 participants between the age group of 6 to 12 years with the clinical diagnosis of sensorineural hearing loss. Participants received exercise sessions including 10 min of activities in the following categories: eye hand co-ordination and visual motor training, balance training, activities to improve general co-ordination for 3 days a week for 12 weeks. The outcome was assessed in terms of Pediatric Balance scale (PBS), Test for Gross Motor Development (TGMD-2).

Result: There was highly significant difference seen in scores of both TGMD-2 and PBS ($p < 0.01$).

Conclusion: The findings of the study suggest that motor control program including eye-hand co-ordination, visuo-motor training, balance training and general co-ordination exercises can be useful to maintain gross motor skills and postural control in children with sensorineural hearing loss.

Keywords: Sensorineural hearing loss; Motor control program

Introduction

Hearing is an important sensory ability in psychomotor development of human beings and forms the basis of communication for cognitive, affective and behavioural development to take place [1]. Hearing loss is the diminished ability to detect, recognize, discriminate, perceive and comprehend auditory information [2]. It is usually diagnosed early in life [3].

Sensorineural hearing loss (SHNL) is the most common type of permanent hearing loss which results from the damage to the inner ear or the nerve pathway [4]. Substitutes such as sensorineural deafness, perceptive deafness, nerve deafness are frequently used to describe this condition [5].

According to World Health Organization (WHO) in 2005 about 278 million people suffered from moderate to profound hearing impairment, of which 80% of them live in low and middle income countries [6]. Population-based surveys in year 2003 in India, estimated the prevalence of hearing impairment to be 6.3% approximately 63 million suffering from significant auditory loss [7]. Prevalence of moderate to profound hearing loss in children including SNHL and conductive hearing loss is 1-6 of 1000 children [8]. Incidence of hearing loss in school age population is about 11.3% [9].

The vestibular end organ and cochlea are closely related to each other, both anatomically and functionally. Hence, injury or any kind of trauma may cause damage to one or both the systems which can lead to defective motor development [4]. Vestibular system is an integral part concerned with total body motion and muscle tone. Reduced functioning of vestibular labyrinth, especially of the semi-circular canals can result in balance disturbances [10].

Movement emerges from the interaction of the 3 factors: the individual, the task and the environment [11]. Gross motor skills are very necessary to move, stabilize and control body and objects at an

early age when the child explores the environment. Well-developed gross motor skills helps individuals to function more smoothly in life [12]. Rine et al, reported that children with SNHL as opposed to conductive hearing loss, have progressive developmental delay and is related to concomitant damage to vestibular structure [3]. Postural control and more specifically postural stability is a fundamental prerequisite for the motor development of the child [13]. It involves controlling the body's position in space for dual purposes of stability and orientation. It is composed of the biomechanical motor process and sensory orientation process. The 3 systems of visual, somatosensory and vestibular sources contribute to providing information about postural control [14].

Motor control is the ability to regulate or direct the mechanisms essential to movement [15]. According to Brooks, a neurophysiologist, "Motor control is the study of posture and movement that are controlled by central commands and spinal reflexes and also to the functions of mind and body that govern posture and movement" [16]. The field of motor control is directed at studying the nature of movement and how movement is controlled [15].

Teachers and parents of these children often report incoordination, clumsiness and balance deficits which may hinder the child's optimal

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performance [4]. As hearing impaired children mature, they learn to compensate partially for vestibular damage through the refinement of the visual, proprioceptive, and kinaesthetic senses. When these sensory cues are removed, by shutting both eyes for example, there is a loss of equilibrium until the remaining senses can compensate. However these senses cannot fully compensate for sensory deprivation [17]. This impaired balance may affect the acquisition of other motor skills or interfere with visual-perceptual-motor development and sensory integration [18]. Although there are studies on improving the static and dynamic balance in hearing impaired children there are no studies focusing on the holistic approach to enhance visual motor and somatosensory abilities along with improvement of balance using inexpensive assessment tools. Hence the present study is aimed to find the effect of motor control program for improving gross motor function and postural control in SNHL children.

Methods

Participants: This study is a quasi-experimental design including baseline, pre-test evaluation, intervention, post-test evaluation. Ten participants who participated in the intervention were from Sangram Mukbadhir Vidyalaya, Sangamner, Dist-Ahmednagar, Maharashtra state, India 413736. Study received an ethical clearance from the Institutional Ethical Committee (PIMS/CPT/2012/1242/14). The participants were screened to ensure that they met the following inclusion criteria for the study: Both boys and girls within the age group of 6-11 years with clinical diagnosis of sensorineural hearing loss of unilateral or bilateral ear, with or without cochlear implants and those willing to participate in the study were included in the study [3,12]. Participants who were mentally challenged, or with any cognitive problems like attention deficit hyperactive disorder (ADHD), any neurological problem like cerebral palsy, downs syndrome, with visual disabilities like blindness, low vision, and with any musculoskeletal disability were excluded from the study [3]. Informed consent form was obtained from their parents and the participants were enrolled in the intervention.

Motor control training programme was developed and administered thrice a week for the period of 12 weeks [3]. The training programme was based on the literature available to enhance motor skills and balance. Intervention consisted of total duration of 45 minutes session with adequate rest intervals included. Motor control program was designed to enhance visual-motor and somatosensory abilities. Exercise included activities under the following categories: eye-hand co-ordination and visual motor training [19,20], balance training [20,21] and activities to improve general co-ordination [22]. Each activity was pre-determined and was demonstrated to every participant until it was clear. For adequate communication, help from teachers of the respective classes was taken. Participants were also given positive re-enforcement during their respective exercise session. The outcome measures used in this study were Test of Gross Motor Development-2 (TGMD-2) [23], which was used to measure motorskills performance and Pediatric Balance Scale (PBS) which was used to measure postural control in participants. It was assessed prior to and after 12 weeks of an interventions.

Results

Statistical analysis was done by GraphPadInStat (v 3.10) software. The data was entered into an excel spreadsheet, tabulated and subjected to statistical analysis (Tables 1 and 2). Various statistical measures such as a mean, standard deviation (SD) and test of significance such as Paired 't' test were utilized to analyzed the data. The results were concluded to be statistically significant with $p > 0.05$ and highly significant with $p < 0.01$.

Demographic Profile	Interventional Group
Age (years)	7.62 ± 1.053
Gender (Boys/Girls)	6/4
BMI (kg/cm ²)	18.79 ± 2.569

Table 1: Showing demographic profile.

	Pre-intervention	Post-intervention	't' value	'p' value
Total TGMD-2 score	10.6 ± 2.011	13.8 ± 1.989	16.0	<0.01
PBS score	35.5 ± 2.593	49.4 ± 2.171	18.857	<0.01

Table 2: Comparison of TGMD-2 and PBS pre intervention and post-intervention.

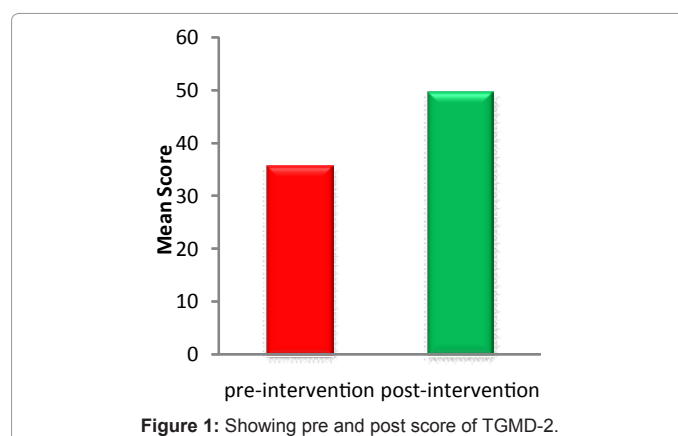


Figure 1: Showing pre and post score of TGMD-2.

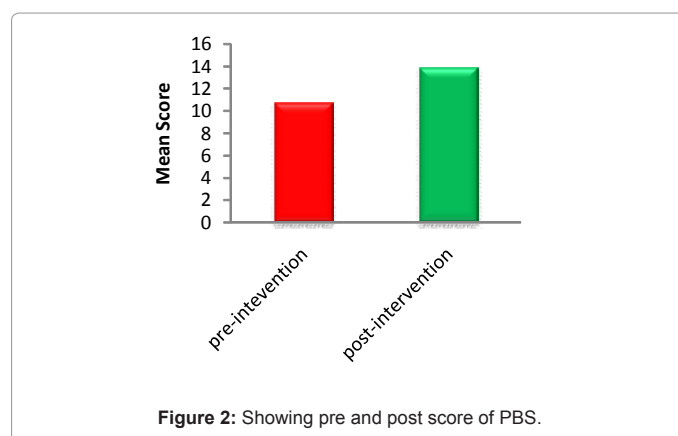


Figure 2: Showing pre and post score of PBS.

Paired 't' test was used to compare the differences of scores on pre-intervention and at 12th week (Figures 1 and 2).

Discussion

The results of this study showed highly significant improvement in Test of Gross Motor Development-2 Score. The pre-interventional average score for TGMD-2 was 10.6 ± 2.011 and post-interventional average score was 13.8 ± 1.989. The average difference in the pre and post-interventional score was 3.2 ± 0.02. There was highly significant improvement in Pediatric balance scale scores. The pre-interventional average score for PBS was 35.5 ± 2.593 and post-interventional average score was 49.4 ± 2.171. The average difference in the pre and post-interventional score was 13.9 ± 0.422.

Auditory deprivation from birth brings about functional plastic changes in the central nervous system (CNS). One of the changes is the activation of the "meaning brain areas" by activating different

sensory sources by the role of visual input. The disturbances are corrected through the process of compensation whereby input from proprioception, visual and other sensory systems substitute for the absent peripheral vestibular input. The observed recovery could potentially be substituted by a network of other brainstem, cerebellar or cortical pathways [17].

Research conducted so far point out the fact that lack of hearing may affect the motor development at least at 2 levels-

1. The nature of hearing loss relates to the CNS and the semi-circular canals integrity. The effect of hearing on CNS will consequently refer to many common motor abilities. As stated by Myklebust simultaneous motions, general and dynamic balance and movement speed are impaired in hearing impaired children.

2. Deafness itself is the second layer by which motor abilities are affected. When an individual doesn't receive sounds, signs and signals from the surrounding, individual may perform the motor task in a very different manner [24].

Theoretically, the stability improvements could have been due to various factors such as-enhanced use of the residual vestibular function, enhanced use or substitution of visual and somatosensory inputs for the lost vestibular function or some combinations of such factors [20].

Sensory organization problems can manifest as an inflexible weighing of sensory information for orientation i.e person may depend heavily on one particular sense for postural control, that may be vision-dependent or somato-sensory system dependent. When given such a situation where sense is either not available or not working efficiently, the person will still continue to rely on the preferred sense even if instability is the known consequence [25]. Also found by Lee and Lishman, when individual is learning a new task there is an increased reliance on visual inputs. As the task becomes more known and automatic there appears to be decrease in relatively importance of visual inputs for postural control and increased reliance on somatosensory inputs [26]. This explains the improvement in participants when motor control program was administered.

The results in this study are in agreement with the previous study done by Rine et al, in which they have suggested that exercise intervention helps to improve sensory organization for gain in motor development status of children with hearing loss [3]. Alexandra De Kegel in their study showed that hearing impaired children shows a trend to perform weaker on both manual dexterity and ball skills abilities of MABC-2. Explanation of these findings can be given by the fact that adequate postural control is a necessary condition for acceptable motor control [27].

Results are very conflicting to the research done by S.K. Effgan who has stated, lack of improvement in the motor abilities in children with hearing loss following exercise intervention for ten days [28]. The intervention in this study focused on encouraging substitution and development of somatosensory and visual abilities as done by Rine et al.

In the present study, assessment of the variable was assessed only before and after intervention. Further analysis has to be made the sustained effect of the exercise program over the period of time in a larger population.

Conclusion

Motor control program including eye-hand co-ordination and visuo-motor training, balance training and general co-ordination

exercises can be useful to maintain gross motor skills and postural control in children with sensorineural hearing loss.

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