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Comparison of Proprioceptive Training Exercises on Gross Motor Coordination between Individuals with and without Sensorineural Hearing Loss

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Abstract

Background: Proprioception lay out a purposive perception of posture, movement and force as proprioceptive preparation focuses on the use of somatosensory signals such as tactile afferents in the absenteeism of information from other modalities like audition in individuals with sensorineural hearing loss. People with deficits of any afferent signal tend to rely significantly on other senses like proprioception, which in turn is an essential sense for executing motor tasks especially gross motor coordination, on that account improving proprioception by training exercises can markedly improve some variables of gross motor coordination in the targeted population.

Methodology: Based on inclusion and exclusion criteria 30 subjects each, including subjects with pre diagnosed sensorineural hearing loss and subjects without sensorineural hearing loss respectively were selected using convenient sampling and informed consent was taken, which were assigned as Group A and Group B respectively. Proprioceptive training exercises were administered to both the groups. The protocol was 04 sessions per week for a period of 08 weeks. Pretest and post test data for gross motor coordination was evaluated for both the groups using gross motor subtests of Bruiniks Oseretsky Test (BOT) of motor proficiency. The data was complied statistically analyzed and compared.

Results: The result showed significant mean difference in Group B in two subtests which are running speed and agility with mean 6.27 ± 2.420 and balance with mean 3.37 ± 1.608 was compared with Group A data of running speed and agility with mean 2.00 ± 2.304 and balance with mean 1.63 ± 1.732 using unpaired 't' test with level of significance set at 0.05 which gave unpaired 't' value of 6.993 and 4.018 respectively using BOT-2 as outcome measure. Also there was no significant mean difference in Group B in two subtests which are bilateral coordination with mean 2.17 ± 1.510 and strength with mean 3.37 ± 1.608 was compared with Group A data of bilateral coordination with mean 1.73 ± 1.112 and strength with mean 5.60 ± 3.450 using unpaired 't' test with level of significance set at 0.05 which gave unpaired 't' value of 1.265 and 1.810 respectively.

Conclusion: The present study concludes that there is significant difference between the effect of proprioceptive training exercises on gross motor coordination between individuals with and without sensorineural hearing loss when compared through four variables of running speed and agility, balance, bilateral coordination and strength.

Keywords: Proprioception; Gross motor coordination; Sensorineural hearing loss; Physiotherapy; Proprioceptive training

Introduction

Zarandi stated that proprioception or joint posture perception is an indispensable part of the somatosensory system and convey information to the central nervous system about movement and the position of the body in latitude [1].

Brown mentioned that the receptors of the proprioceptive perception are detected in the muscles and joints all around the body and they are responsive to stretching and to compression. A standard range of muscle tone is needed for this sensory system to work adroitly and productively [2].

Brown also found that complications with the proprioceptive perception can be made dreadful when there are also troubles with the vestibular sense therefore making it a difficult for individuals with hearing loss which is caused from flaws in the vestibular apparatus [3].

Like the Veiskarami et al. study, Masuda et al. found that deaf children grow up, they face struggle that can affect their physical, emotional, motor and cognitive development. It has been shown that individuals with hearing loss typically have developmental slowdowns compared to their healthy parallel in controlling head and walking independently [4,5]

Aman et al. stated the ultimate goal of proprioceptive training is to improve or restore sensorimotor function; it's an intervention that targets the enhancement of proprioceptive function and focuses on the use of somatosensory signals such as proprioceptive or tactile afferents in the lack of information from other modalities. It has been testified that therapies aiming to reinstate motor function after injury should pivot on training the proprioceptive sense [6].

Kegel et al. mentioned motor coordination is defined as the goal governed execution of a group of muscles in a precise time succession to do a motor activity. Coordination exists in all aspects of motor activity for example visual-motor, two-limb or multi-limb activity etcetera. Gross motor skills coordination, is set back in deaf, for example caliber of running in deaf children is low [7].

Suarez et al. told that children with untimely sensorineural hearing loss and bilateral vestibular dysfunction existing with delayed gross motor development. These children stand and walk later than their coequals with stereotypical development [8].

Jha et al. stated that proprioceptive aptness is indispensible for orientation and moving in space and engaging with the environment. So they act like a keystone for goal-directed movements of the limbs [9].

Crowe et al. found that children with hearing impairments tend to exhibit subservient balance and gross motor skills compared with children with standard hearing. In divergence, children with hearing impairments often perform likewise to children without hearing impairments on fine motor coordination and visual-perceptual tasks, which are crucial to manual communication methods [10].

Materials and Methods

The research was carried out in full accordance with the ethical standards of Baba Farid University of health sciences along with the following reference number ASO-MPN-2020/01.

Study design

This is an experimental study which is comparative in nature.

Sampling technique

The sample of the study was selected by convenient sampling.

Source of data

Individuals without Sensorineural Hearing Loss (SNHL) from schools and residents of Ludhiana city and individuals with sensorineural hearing loss from NGO's, special schools and residents of Ludhiana city.

Eligibility

Inclusion criteria

Individuals without and with pre diagnosed sensorineural hearing loss matched as per age (Above 8 years) and Body Mass Index (BMI).

Individuals able to give informed consent

Exclusion criteria

Use of neurological drugs that influence balance

Use of cochlear implant

History of muscular/neural ailments

Postural abnormality in the upper or lower extremities

Surgery or fracture within a year before the study

Diagnosed cerebrovascular disease

Any other disease that interferes with sensory inputs

BMI over 25

Variables

Independent variables

Proprioceptive training

Dependent variables

Gross motor coordination

Procedure

Based on inclusion and exclusion criteria two groups was formulated with 30 subjects each, including subjects without SNHL and subjects with pre diagnosed sensorineural hearing loss respectively, were selected using convenient sampling and informed consent was taken with the assistance of a special educator for the purpose of research process. Pretest data for gross motor coordination was evaluated for both the groups using gross motor subtests of Bruiniks-Oseretsky Test (BOT) of motor proficiency.

Subjects of Group A including 30 subjects without sensorineural hearing loss and subjects of Group B including 30 subjects with pre diagnosed sensorineural hearing loss received proprioceptive training exercises.

Intervention for both groups

The protocol included various exercises that gradationally escalated in the level of adversity during 08 weeks of training. Exercises performed are:

1. The subject performs knee flexion and extension while sitting on a swiss ball between parallel bars.

2. The subject moves a tilt board forward and backward between parallel bars.

3. The subject moves a wobble board sideways while sitting between parallel bars.

4. The subject stands on a tilt board and maintains his balance for 15 seconds between parallel bars.

5. Exercises 2, 3 and 4 are repeated with bent knees.

6. The subject maintains his balance for 15 seconds on a wobble board while standing with the dominant leg.

7. Exercise 6 is repeated with knee bent.

8. The subject moves up hips and back and maintaining balance with assistance of hands while lying down supine with legs on swiss ball.

9. Exercise 8 is repeated with the subject's hands on his stomach.

10. The subject leans against a swiss ball on the wall. With an upright trunk, he bends his knees slightly and returns his back to his initial position.

11. Repetition of exercise 10 with knees bent 90°.

12. Forward walking, heel walking, tandem gait, side walking and toe walking (2 sets of 15 repetitions on a 10 meter smooth path).

13. Repetition of exercise 12 on a rough path.

Time-intended exercises were executed in 2 sets of 20 seconds with 1-2 minutes of rest between each lot. Repetition-intended exercises were executed in 2 sets of 15-20 repetitions with 1-2 minutes of rest between each lot. Subjects used both legs for exercises. Treatment plan was for a total of 32 sittings as 04 sittings in a week for two months. Post test data for gross motor coordination was evaluated for both the groups using gross motor subtests of bruininks-oseretsky test of motor proficiency. The data was complied, statistically analyzed and compared.

Materials

Description of measurement tools

The bruininks-oseretsky test of motor proficiency, second edition (BOT-2) is an independently dispensed test that utilizes resourceful activities to measure a wide spectacle of motor skills in individual ages of 4 to 22 years. The BOT-2 uses a subtest and composite structure that accentuate motor performance in the comprehensive functional areas of coordination, mobility, stability, object manipulation and strength. The eight subscales and four composite scales all had excellent item reliability with all coefficients being >95 for age of 10 years 2 months ± 1 year 4 months. The running speed and agility, balance, bilateral coordination, strength, fine motor precision and manual dexterity subscales exhibited reasonable dimensionality.

Results

Statistical analysis

The data was analyzed using descriptive statistics, paired't' test and unpaired 't' test.

Data was meaningfully assorted through calculation on mean and Standard Deviation (SD). Later on paired 't' test was applied for comparison within the Group A and Group B respectively. Thereafter unpaired 't' test was applied for comparison between the Group A and Group B respectively. The level of significance was fixed at $p<0.05$.

Table 1 shows unpaired 't' test result of Group A and Group B as per age. The mean ± standard deviation value for Group A was 14.87 ± 4.547 and Group B was 14.87 ± 4.547. The unpaired 't' test value for age comparison between Group A and Group B was 0.000 which was statistically non-significant at $p<0.05$.

Table 2 shows unpaired 't' test result of Group A and Group B as per BMI. The mean ± standard deviation value for Group A was 18.50 ± 2.403 and Group B was 18.50 ± 2.403. The unpaired 't' test value for BMI comparison between Group A and Group B was 0.000 which was statistically non-significant, at $p<0.05$.

Unpaired T test	Comparison	
	Age	
	Group A	Group B
Mean	14.87	14.87
S.D.	4.547	4.547
Number	30	30
Mean difference	0.00	
Unpaired T test	0.000	
P value	1.0000	
Table value at 0.05	2.00	
Result	Not-Significant	

Table 1: Comparison of age between Group A and Group B.

Unpaired T test	Comparison	
	Age	
	Group A	Group B
Mean	14.87	14.87
S.D.	4.547	4.547
Number	30	30
Mean difference	0.00	
Unpaired T test	0.000	
P value	1.0000	
Table value at 0.05	2.00	
Result	Not-Significant	

Table 2: Comparison of BMI between Group A and Group B.

Unpaired T test	Comparison	
	Age	
	Group A	Group B
Mean	14.87	14.87
S.D.	4.547	4.547
Number	30	30
Mean difference	0.00	
Unpaired T test	0.000	
P value	1.0000	
Table value at 0.05	2.00	
Result	Not-Significant	

Table 3: Frequency percentage of gender in Group A and Group B.

Table 4 shows paired 't' test result of running speed and agility subtest for Group A. The mean ± standard deviation value for pre-test of Group A was 46.57 ± 4.797 and post-test value of Group A was 48.57 ± 3.224. The paired 't' test value for pre and post-test comparison of running speed and agility subtest within group was 4.754 which was statistically significant, at $p<0.05$.

Paired T test	Group A	
	Running speed and agility	
Table No 5.4	Pre	Post

Mean	46.57	48.57
S.D.	4.797	3.224
Number	30	30
Mean difference	2.00	
Paired T test	4.754	
P value	0.0001	
Table value at 0.05	2.05	
Result	Significant	

Table 4: Comparison of running speed and agility subtest scores within Group A.

Table 5 shows paired 't' test result of running speed and agility subtest scores for Group B. The mean ± standard deviation value for pre-test of Group B was 35.79 ± 6.085 and post-test value of Group B was 42.03 ± 5.883. The paired 't' test value for pre and post-test comparison of running speed and agility subtest scores within group was 6.24 which was statistically significant, at p<0.05.

Paired T test	**Group A**	
	Running speed and agility	
Table No 5.4	Pre	Post
Mean	46.57	48.57
S.D.	4.797	3.224
Number	30	30
Mean difference	2.00	
Paired T test	4.754	
P value	0.0001	
Table value at 0.05	2.05	
Result	Significant	

Table 5: Comparison of running speed and agility subtest scores within Group B.

Table 6 shows unpaired 't' test result of running speed and agility subtest between Group A and Group B. The mean ± standard deviation value of Group A was 2.00 ± 2.304 and 6.27 ± 2.420 for Group B. The unpaired 't' test value for mean difference comparison between Group A and Group B was 6.993, which was statistically significant, at p<0.05.

Paired T test	**Group A**	
	Running speed and agility	
Table No 6	Pre	Post
Mean	46.57	48.57

S.D.	4.797	3.224
Number	30	30
Mean difference	2.00	
Paired T test	4.754	
P value	0.0001	
Table value at 0.05	2.05	
Result	Significant	

Table 6: Comparison of running speed and agility subtest scores between Group A and Group B.

Table 7 shows paired 't' test result of balance subtest scores for Group A. The mean ± standard deviation value for pre-test of Group A was 27.53 ± 3.192 and post-test value of Group A was 29.17 ± 1.913. The paired 't' test value for pre and post-test comparison of balance subtest scores within group was 5.166 which was statistically significant, at $p<0.05$.

Paired T test	**Group A**	
	Balance	
Table No 5.6	Pre	Post
Mean	27.53	29.17
S.D.	3.192	1.913
Number	30	30
Mean difference	1.63	
Paired T test	5.166	
P value	<0.05	
Table value at 0.05	2.05	
Result	Significant	

Table 7: Comparison of balance subtest scores within Group A.

Table 8 shows paired 't' test result of balance subtest scores for Group B. The mean ± standard deviation value for pre-test of Group B was 18.83 ± 5.050 and post-test value of Group B was 22.10 ± 4.981. The paired 't' test value for pre and post-test comparison of balance subtest scores within group was 11.337 which was statistically significant, at $p<0.05$.

Paired T test	**Group B**	
	Balance	
Table No 8	Pre	Post
Mean	18.83	22.1
S.D.	5.05	4.981
Number	29	29

Mean difference	3.28
Paired T test	11.337
P value	<0.05
Table value at 0.05	2.05
Result	Significant

Table 8: Comparison of balance subtest scores within Group B.

Table 9 shows unpaired 't' test result of balance subtest between Group A and Group B. The mean ± standard deviation value of Group A was 1.63 ± 1.732 and 3.37 ± 1.608 for Group B. The unpaired 't' test value for mean difference comparison between Group A and Group B was 4.018, which was statistically significant, at p<0.05.

Unpaired T test	**Comparison**	
	Balance	
	Group A	**Group B**
Mean	1.63	3.37
S.D.	1.732	1.608
Number	30	30
Mean difference	1.73	
Unpaired T test	4.018	
P value	0.0002	
Table value at 0.05	2.00	
Result	Significant	

Table 9: Comparison of balance subtest scores between Group A and Group B.

Table 10 shows paired 't' test result of bilateral coordination subtest scores for Group A. The mean ± standard deviation value for pre-test of Group A was 13.47 ± 1.756 and post-test value of Group A was 15.20 ± 1.827. The paired 't' test value for pre and post-test comparison of bilateral coordination subtest scores within group was 8.537 which was statistically significant, at p<0.05.

Paired T test	**Group A**	
	Bilateral Coordination	
Table No 10	Pre	Post
Mean	13.47	15.2
S.D.	1.756	1.827
Number	30	30
Mean difference	1.73	

Paired T test	8.537
P value	<0.05
Table value at 0.05	2.05
Result	Significant

Table 10: Comparison of bilateral coordination subtest scores within Group A.

Table 11 shows paired 't' test result of bilateral coordination subtest scores for Group B. The mean ± standard deviation value for pre-test of Group B was 8.41 ± 1.570 and post-test value of Group B was 10.66 ± 0.857. The paired 't' test value for pre and post-test comparison of bilateral coordination subtest scores within group was 8.157 which was statistically significant, at $p<0.05$.

Paired T test	**Group B**	
	Bilateral Coordination	
Table No 11	Pre	Post
Mean	8.41	10.66
S.D.	1.57	0.857
Number	29	29
Mean difference	2.24	
Paired T test	8.157	
P value	<0.05	
Table value at 0.05	2.05	
Result	Significant	

Table 11: Comparison of bilateral coordination subtest scores within Group B.

Table 12 shows unpaired 't' test result of bilateral coordination subtest between Group A and Group B. The mean ± standard deviation value of Group A was 1.73 ± 1.112 and 2.17 ± 1.510 for Group B. The unpaired 't' test value for mean difference comparison between Group A and Group B was 1.265, which was statistically not signi icant, at $p>0.05$.

Unpaired T test	**Comparison**	
	Bilateral Coordination	
	Group A	**Group B**
Mean	1.73	2.17
S.D.	1.112	1.51
Number	30	30
Mean difference	0.43	
Unpaired T test	1.265	

P value	0.2108
Table value at 0.05	2
Result	Not-Significant

Table 12: Comparison of bilateral coordination subtest scores between Group A and Group B.

Table 13 shows paired 't' test result of strength subtest scores for Group A. The mean ± standard deviation value for pre-test of Group A was 23.20 ± 3.316 and post-test value of Group A was 28.80 ± 4.788. The paired 't' test value for pre and post-test comparison of bilateral coordination subtest scores within group was 8.890 which was statistically signi icant, at $p<0.05$.

Paired T test	**Group A**	
	Strength	
Table No 13	PRE	POST
Mean	23.2	28.8
S.D.	3.316	4.788
Number	30	30
Mean difference	5.60	
Paired T test	8.890	
P value	<0.05	
Table value at 0.05	2.05	
Result	Significant	

Table 13: Comparison of strength subtest scores within Group A.

Table 14 shows paired 't' test result of strength subtest scores for Group A. The mean ± standard deviation value for pre-test of Group A was 21.14 ± 2.133 and post-test value of Group A was 25.48 ± 2.011. The paired 't' test value for pre and post-test comparison of bilateral coordination subtest scores within group was 16.180 which was statistically signi icant, at $p<0.05$.

Paired T test	**Group B**	
	Strength	
Table No 14	PRE	POST
Mean	21.14	25.48
S.D.	2.133	2.011
Number	29	29
Mean difference	4.34	
Paired T test	16.180	
P value	<0.05	
Table value at 0.05	2.05	
Result	Significant	

Table 14: Comparison of strength subtest scores within Group B.

Table 15 shows unpaired 't' test result of strength subtest between Group A and Group B. The mean ± standard deviation value of Group A was 5.60 ± 3.450 and 4.37 ± 1.426 for Group B. The unpaired 't' test value for mean difference comparison between Group A and Group B was 1.810, which was statistically not significant, at p>0.05.

Unpaired T test	**Comparison**	
	Strength	
	Group A	**Group B**
Mean	5.60	4.37
S.D.	3.45	1.426
Number	30	30
Mean difference	1.23	
Unpaired T test	1.810	
P value	0.0756	
Table value at 0.05	2.00	
Result	Not-Significant	

Table 15: Comparison of strength subtest scores between Group A and Group B.

Discussion

The current study aimed to compare the effect of proprioceptive training exercises on gross motor coordination between individuals with and without sensorineural hearing loss using 4 subtests of BOT as outcome measure. The data was analyzed by using paired and unpaired 't' test.

The result showed significant mean difference in Group B in two subtests which are running speed and agility with mean 6.27 ± 2.420 and balance with mean 3.37 ± 1.608 was compared with Group A data of running speed and agility with mean 2.00 ± 2.304 and balance with mean 1.63 ± 1.732 using unpaired 't' test with level of significance set at 0.05 which gave unpaired 't' value of 6.993 and 4.018 respectively using BOT-2 as outcome measure.

The result showed no significant mean difference in Group B in two subtests which are bilateral coordination with mean 2.17± 1.510 and strength with mean 3.37 ± 1.608 was compared with Group A data of bilateral coordination with mean 1.73 ± 1.112 and strength with mean 5.60 ± 3.450 using unpaired 't' test with level of significance set at 0.05 which gave unpaired 't' value of 1.265 and 1.810 respectively using BOT-2 as outcome measure.

In this study the proprioception training exercises were executed in a Closed Kinetic Chain (CKC), which bring about muscle contractions and entitles the mechanoreceptors in the skin, joints and capsules to function more constructively. Thus, the competence of the proprioceptive receptors is advocated. From this perspective the results of improvement in the post test data with mean 48.57 ± 3.224 in running speed and agility subtest of Group A with pretest data with mean 46.57 ± 4.797 was compared using paired 't' test with level of significance set at 0.05 that gave paired 't' value of 4.754 which is in agreement with findings of study. [11] who confirmed that agility is remarkably correlated with speed in both sexes, with power in females and with balance in males. Balance furtherance after proprioceptive training can further influence complex motions and could result in improved agility, as the agility training contains stops, changes of direction and accelerations. When stopping, the improved balance ensures a finer stability of the body, opposing the inertia and averting the body segments to carry on moving in the previous direction. This precipitates both a more economic change of direction and a more efficient acceleration [12].

In Group B the statistical analysis showed significant difference in running speed and agility subtest when pre data with mean 35.79 ± 6.085 and post data with mean 42.03 ± 5.883 was compared using paired 't' test with level of significance set at 0.05 which gave paired 't' value of 13.668 because proprioception provides cues solely on the stature of the internal body, with the expertise of proprioception individual can master new motor skills. proprioceptive capabilities are essential for orientation and moving in space and undertaking with the environment [9].

Vestibular receptors portray a principal role in basic movement reactions, as they receive cues admissible to the position of the head in space and spawn reflexes this suggests use of substitute pathways like that of proprioception in individuals with sensorineural hearing loss for adapting to varying speed, direction and movement pattern [13].

In comparison between the groups, Group A and Group B, for running speed and agility subtest scores group B showed comparative improvement statistically at values with unpaired ‘t’ test value of 6.993 with level of significance set at 0.05. Proprioception physiology in all likelihood is detailed in three ways as described in the literature. First, the information from the proprioception helps to cushion the joint from excessive and injurious motion *via* reflex mechanism. Second, it gives information about joint stabilization during static posture. Third, it will help in conducting coordination of the motion or complex motion in a precise manner. Also, person who does not receive audio signs or other kinesics from environment may perform motor tasks in different manner. Hearing disturbances cause the infirmity of proper motions production as stated therefore it is believed that proprioceptive training improves more motor output in Group B leading to a significant mean difference between the two groups [14].

In Group A the statistical analysis showed significant difference in balance subtest when pre data with mean 27.53 ± 3.192 and post data with mean 29.17 ± 1.913 was compared using paired ‘t’ test with level of significance set at 0.05 which gave paired ‘t’ value of 5.166 attributed to the fact that during movements proprioception has importance for: Feedback (responsive) control, feed forward (precursory) control and the regulation of muscle stiffness, to achieve specific roles for movement acuity, joint stability, co-ordination and balance [15].

In Group B the statistical analysis showed significant difference in balance subtest when pre data with mean 18.83 ± 5.050 and post data with mean 22.10 ± 4.981 was compared using paired ‘t’ test with level of significance set at 0.05 which gave paired ‘t’ value of 11.337. Studies have shown that proprioceptive feedback accord significantly to controlling opposite muscle torque, scheduling multi-joint movements, planning movement and providing internal models of body exposure that are essential for generating and endorse proficient movements [1]. This is the mechanism of improvement in balance subtest scores of individuals with sensorineural hearing loss.

In comparison between the groups, Group A and Group B, for balance subtest scores group B showed comparative improvement statistically at values with unpaired ‘t’ test value of 4.018 with level of significance set at 0.05. Proprioception is the most essential system for sensory balance control and helps the joints and body stability through feedback and feed-forward mechanisms [16]. The protocol included various exercises that challenged static as well as dynamic balance along with weekly progression this led to a marked increase in scores of balance subtest in group B than group A as group B relied more on other pathways like that of proprioception thereby giving them an edge over group A.

In Group A the statistical analysis showed significant difference in bilateral coordination subtest when pre data with mean 13.47 ± 1.756 and post data with mean 15.20 ± 1.827 was compared using paired ‘t’ test with level of significance set at 0.05 which gave paired ‘t’ value of 8.537 as the role of proprioception in sensorimotor control is multifold. To plan appropriate motor commands, the central nervous system needs an updated body architecture of the biomechanical and spatial properties of the body parts, supplied substantially by proprioceptors [17]

In Group B the statistical analysis showed significant difference in bilateral coordination subtest when pre data with mean 8.41 ± 1.570 and post data with mean 10.66 ± 0.857 was compared using paired ‘t’ test with level of significance set at 0.05 which gave paired ‘t’ value of 8.157 because proprioceptive deficits cause postural control or balance problems, difficulties and apprehension in many activities of daily living therefore proprioceptive abilities are essential for orientation and moving in space and engaging with the environment. Their functions are performance of motion sequences, controlling of aiming accuracy, control and correction of ceaseless movements, reaching and tracking movements like grasping and manipulating objects [18].

In comparison between the groups, Group A and Group B, for bilateral coordination subtest scores, Group B didn’t show comparative improvement statistically at values with unpaired ‘t’ test value of 1.265 with level of significance set at 0.05. The probable reason for this outcome could be the measurement tool; in essence the bilateral coordination subtest of BOT-2 examines coordination of upper extremities whereas the proprioceptive training exercise protocol focused primarily on lower extremities as it involved all weight bearing exercises. Moreover due to sensorineural hearing loss Group B wasn’t able to fully comprehend the tasks which assessed bilateral coordination in BOT-2.

In Group A the statistical analysis showed significant difference in strength subtest when pre data with mean 23.20 ± 3.316 and post data with mean 28.80 ± 4.788 was compared using paired ‘t’ test with level of significance set at 0.05 which gave paired ‘t’ value of 8.890 because proprioception is vital also after movement for comparison of actual movement with intended movement, as well as the predicted movement supplied by the efferent copy. This is suggested to have importance for motor learning by upgrading of the internal forward model of the motor command [19].

In Group B the statistical analysis showed significant difference in strength subtest when pre data with mean 21.14 ± 2.133 and post data with mean 25.48 ± 2.011 was compared using paired ‘t’ test with level of significance set at 0.05 which gave paired ‘t’ value of 16.180. This is because of activation of proprioceptive connections in absence of vestibular system integrity, increased proprioception paved way for increased enthusiasm for undergoing the protocol [20].

In comparison between the groups, Group A and Group B, for strength subtest scores, Group B didn't show comparative improvement statistically at values with unpaired 't' test value of 1.810 with level of significance set at 0.05. The probable reason for this is the non-uniformity of baseline in the pretest data [21]. Group A already had more strength when compared to their counterparts in Group B, but the protocol was totally identical including the number or repetitions and progression plan. Moreover the protocol didn't involve extensive strengthening exercise which might have aided in a significant increase in strength of Group B when compared with Group A. On top of that the strength subtest of BOT-2 included only standing broad jump, sit ups and knee pushups which in themselves aren't enough to measure complete strength [22].

Brown 2005 insinuated that excessively high or low muscle tone is usually correlated with poorly tempered tactile and proprioceptive senses in deaf children, tactile defensiveness may be present and awareness of touch, pain and temperature may be fluctuating.

Conclusion

The present study concludes that there was significant difference between the effect of proprioceptive training exercises on gross motor coordination between individuals with and without sensorineural hearing loss. Therefore, alternate hypothesis was accepted and null hypothesis was rejected. Moreover the protocol didn't involve extensive strengthening exercise which might have aided in a significant increase in strength. The probable reason for this outcome could be the measurement tool; in essence the bilateral coordination subtest of BOT-2 examines coordination of upper extremities whereas the proprioceptive training exercise protocol focused primarily on lower extremities as it involved all weight bearing exercises

Limitations

Sample size of the groups was small

Outcome measure didn't cover all domains of GMC

Future scope of the study

Other parameters besides age, gender and BMI can be considered

Tools other than BOT-2 could be of implicative value

Further components of motor coordination apart from GMC can be explored

Long term effects of the techniques can also be compared.

Bigger sample of the individual can be used for comparison.

Declaration of Funding

No funding was received.

Disclosure of Interest

There was no conflict of interest between the authors.

Data Availability

The data that support the findings of this study are available from the corresponding author, Kapoor A., upon reasonable request.

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All four authors confirm that they fulfill the following criteria:

Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work;

Drafting the work or revising it critically for important intellectual content;

Final approval of the version to be published; and

Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

as per ICMJE recommendations for authorship.

Ethical Approval Statement

The faculty of physiotherapy of Baba Farid University of health sciences has approved the plan of this research project with ethical approval number stated as ASP-MPN-2020/01. All the subjects signed written consent before enrolling for the research project.

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