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Research Article

The Effect of Six Weeks Neuromuscular Training Program on Balance of Congenital Deafness Students

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ABSTRACT

Introduction: According to previous studies, weakness in maintaining balance is one of the main problems in people with congenital deafness; and balance is also an important factor affecting the quality of life. Strengthening and improving balance functions must be emphasized to reduce the problems of this group of people and bring their quality of life closer to normal. Thus, the aim of this study was evaluated the effect of integrative neuromuscular training program on balance of congenital deaf students.

Materials and Methods: This experimental study was conducted with pre/post test design with the control group that performed on 24 congenital deaf students who were randomly divided into two groups of intervention (12) and control (12). The control group performed their routine physical activity three times a week, while the intervention group was performed special integrative neuromuscular training 3×Wek for six weeks. The static balance was measured with the Balance Error Estimate System (BESS) and the dynamic balance was measured with the Star Excursion Balance Test (SEBT). The post-test of BESS and SEBT was done in two groups afterward. ANCOVA test was used to analyse the data via SPSS software at the significance level of $P < 0.05$

Results: The results indicated a significant difference in BESS and SEBT over six weeks in for the TRN group ($P \leq .05$). Also the results indicated significant differences in three excursions (Anterior, postromedial, and postrolateral) for the TRN group ($P \leq .05$). However, no significant reduction was observed in any of the balance occasions in the control group.

Conclusion: Neuromuscular training program may improve the static and dynamic balance and can be used in conjunction with other training programs.

Keywords: Neuromuscular; Postural control; Balance; Congenital deafness

INTRODUCTION

Hearing system is one of the most important factors in communicating with others, and any disturbances in this system cause the deafness and deaf loss person to be separated from the community and as a result of the lack of progress and development of personality and other aspects of his development [1]. The hearing impaired have different motor and social behaviors, of course, some of which are quite evident [2]. These characteristics are more closely related to coordination, movement speed, and balance of the body. Disturbance in the vestibular system, which is very common in congenital deafness individuals, has a negative effect on balance [3]. Also, they have found that the cause of hearing impairment may affect the balance. They observed in their studies that a group of hearing impaired who has been deafness due to known causes performed their activities better than congenital deafness individuals [4]. As a result, it seems that congenital deafness individuals are disturbed in their vestibular system and have a problem in postural control [5].

Balance is an important component of daily activity [6]. The ability of individuals to maintain balance is almost essential for the success in performing daily movements. Control posture is to control the body's position in space in order to maintain stability and body orientation. The condition of the body in space is the result of a complicated operation that occurs between various musculoskeletal, skeletal and neurological systems, and the importance of each system varies according to the purpose of moving and environmental conditions [7]. In many functional tasks, the direction of the body is vertical, and to maintain this state, various sensory stimuli such as gravity (vestibular system), the base of support (somatosensory system), and the relationship of the body to objects in the environment (vision system) are used [8].

Preserving posture and balance requires the interaction between the various sensory information that is derived from different sensory sources, especially Vestibular system, vision and somatosensory come through the nervous system and spinal cord enter the central nervous system. This is the basic information that their combination brings to the standards that are measured consecutively with postural changes and enable the central nervous system to be aware of the state of the body in space and the state of the body segments at any moment [9].

In order to improve the balance, various types of exercises are used that can be used for neuromuscular training using a balance board. The previous studies have shown the role of these training in improving the control posture and preventing injury. In order to study the effect of core stability training on balance, Eric et al. [10] evaluated the effect of four weeks of trunk muscle strengthening program on the balance of healthy subjects and reported a positive and significant effect on balance after performing the training program. Clark and Burden, in their study of the effect of a 4-week wobble board exercise programme for people with functional instability, showed that this program improves the sense of stability [11]. Onigbinde et al. [12] reported on the improvement of static and dynamic balance in assessing the effect of six weeks of wobble board exercises on the static and dynamic balance of stroke patients.

There is experimental evidence from studies that core stabilization exercise has beneficial effects on balance control [13]. In this study, we attempt to investigate the effect of neuromuscular training on balance in people with imbalance problems. Regarding the role of the vestibular system in maintaining balance, ears are taken into account as the sensory-balance limbs. Some studies reported that compared to healthy people, deaf ones have less skills in balance and they rely on sight outputs in balanced tasks [9]. Thus, the aim of this study is to assess the outcome of a six weeks integrative neuromuscular training program on the static and dynamic balance in congenital deafness students.

METHODS

The present study was experimental with pre/post test design. The statistical population of this study was all students of the deafness boys of Qazvin town. Among them, 24 eligible subjects that all of them were congenital deafness were selected by non-randomized targeting method and divided into equal groups of control and intervention. The participant's dominant leg was noted and measured, as determined as the leg that would normally be used to kick a soccer ball [14]. Degree of hearing loss was obtained from records of audiometric testing. All of the subjects had either severe or profound hearing losses, greater than 75 dB [13]. Subjects signed an informed consent form and answered a demographic/injury history questionnaire, which was used to obtain background information from each subject. They were free of lower and upper extremity pathology, neurological and visual disorders, and none of them used medication and did not perform any core stabilization, strengthening and balance program within the past six months and they were matched in age and physical activity level.

ETHICAL CONSIDERATIONS

The College's Ethics Council reviewed this study for ethics. The Physical Education Department of the Imam Khomeini International University approved the study. Before starting the research, the College's Ethics Council fully evaluated the whole research process (research objectives, how measurement of variables was going to be performed, and duration of the research period).

Training procedures

The integrative neuromuscular training program used in this study was specifically designed for primary school children and was based on earlier reports on resistance training and neuromuscular conditioning for school-age youth [15-17]. The intervention group performed the integrative neuromuscular training program three times a week (Saturday, Monday, and Wednesday) and the control group did not conduct a special integrative neuromuscular program during the research period (six weeks) but performed their routine physical activity three times a week. Of course, after the completion of the study, the training program and its movements were taught to the control group and were used by the physical education teacher for use.

The integrative neuromuscular program consisted of a five min dynamic warm-up (e.g., marching in place and multidirectional chops) followed by five primary exercises that focused on enhancing muscular power, lower body strength, and core strength (e.g., abdominals, trunk and hip), and secondary exercises that aimed at improving FMS (e.g., primarily object control and stability skills). The secondary exercises progressed from simple to complex over the six week training period. Table 1 outlines the structure and content of the integrative neuromuscular program. Participants performed two sets on all primary exercises and during the six week training period they progressed from 7 to 10 repetitions on the dynamic exercises and from 10 to 30s on the plank exercises. Secondary exercises were performed in 15-30s and the exercises progressed every two to three weeks.

Test star excursion balance

This test is a valid and reliable instrument for quantifying the dynamic balance [18]. The SEBT involved a taped star pattern with eight excursions each at 45 degrees from each other, on an even floor surface. Due to the similarity of the Test Star Excursion Balance results from the Y balance test, we used the Y balance test [19]. Subjects placed their non-dominant foot on the middle of the star pattern, while their dominant foot reached as far as possible to each of the three excursions (anterior excursion, posteromedial excursion, poster lateral excursion) while maintaining a single leg stance while reaching with the opposite leg to touch as far as possible along a chosen excursion. They touched the furthest point possible, and as light as possible, along a chosen excursion with the most distal part of their reach foot. Subjects were then instructed to return to a bilateral stance while maintaining their balance. A practice session of six times in each excursion followed by a one-minute rest and subsequently the measured average of three trials for each excursion was recorded as the subject's dynamic balance scores (Figure 1).

Balance error scoring system

In this test, which is used to measure static, six different situations have been considered, including three positions standing on the hard surface and three standing positions on the soft surface. Hard surfaces include carpet or flooring and a soft surface, including a padded foam cushion with a size of 41 x 50 x 6 centimeters. Standing positions also include standing on both legs in pairs, standing together on both legs, one way back and standing on the same. In all situations, the eyes of the subjects are closed and the hands stick to the sides. The subject performs each situation for 20 seconds and calculates the total number of errors that occur in these six states as his grade. Errors include: detaching the hands from the waist, opening the eyes, lifting the heel or toes, relying on the ground, attaching or abducting more than 30 degrees of thumb, a collision of the foot with the ground, or a disturbance of balance for any reason. Before performing the test, each subject has performed three tests to getting known with the test (Figure 2) [20].

Table 1: Structure of integrative neuromuscular program with 5 primary exercises and progressive secondary exercises.

Primary	Secondary		
Weeks1-8	**Weeks 1-2**	**Weeks 3-5**	**Weeks 6-8**
Font squat	SL balance	SL balance & OH press	SL balance & CP
Squat jump	OH press & catch	SL OH press & catch	Get up and Catch*
90° jump	Knee tap & catch	ALT knee tap & catch	Knee tap, turn & catch
Plank	Hip twister	OH chop	Diagonal chop
Balance drop & catch¥			

INT= Integrative Neuromuscular Training; SL= Single Leg; OH= Overhead Press; CP= Chest Press; ALT alternate right and left knee *From a sitting position on the floor eighth a balloon in front of the chest, children tossed the balloon into the air and stood up as quickly as possible to catch the balloon in an athletic stance.
¥Exercise was performed with eyes open weeks 1-4 and eyes closed weeks 5-8

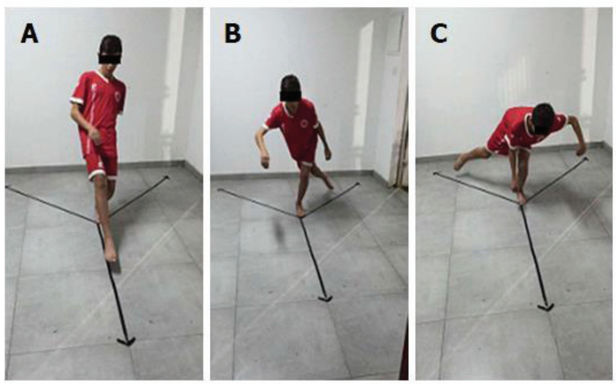

Figure 1: Subject performing Y excursion balance test

Statistical analysis

In this study, Schapiro-Wilk's statistical test was used to assess the normality of the data and then, a series of 2×2 ANCOVA (group × intervention) analyses were computed for each dependent variable, using pre-test as covariates. Statistical analyses were conducted in SPSS Version 23. Statistical significance was established a priori at $p < 0.05$.

RESULTS

Table 2 shows Mean and Standard deviation of the general characteristics of subjects in intervention and control groups.

The mixed ANCOVA test 2×2 method that Y balance test and Balance Error Score System (BESS) test include two levels of pre/post test and group variable include two levels of control and intervention group was used for analysis. To analyze homogeneity of variance in two groups, Levin's variance analysis was used. As shown in table 3, Levine's test was not statistically significant for any of the variables studied.

The ANCOVA analysis was used to compare the mean scores of post-test, dynamic balance and, static balance after controlling the pre-test effect in the two groups, its results are presented in tables 4 and 5.

As shown in table 4, there is a significant difference between the mean scores of post-test dynamic balance in the anterior excursion after the elimination of the pre-test effect]($p = 0.02$) and (F = 12.56)]. Also, there is a significant difference between the post-test scores for the Posteromedial excursion after the elimination of pre-test effect]($p = 0.02$) and (F = 12.34)], and post-test scores for Posterolateral excursion after the elimination of the pre-test effect were significant] ($p = 0.00$) and (F = 25.36)]; therefore, the mean scores of post-test the intervention group was significantly higher in the Y balance test than in the control group.

As shown in table 5, here is a significant difference between the mean scores of post-test static balance after the elimination of the pre-test effect] ($p = 0.001$) and (F = 16.08)].

Figure 2: Balance Error Test (BESS) in six different situations.

Table 2: General characteristics of subjects (mean ± SD).

Variable	Group	Number	Mean ± SD	t	sig
Age (year)	CON	12	16.91 ± 1.83	0.192	0.850
	INT	12	1.04 ±17.00		
Height (cm)	CON	12	169.16 ± 2.82	1.80	0.85
	INT	12	172.58 ± 5.10		
Weight (kg)	CON	12	54.83 ± 4.67	0.631	0.535
	INT	12	56.08 ± 5.01		

*Significance level is P ≤ 0.05

Table 3: Test of homogeneity of variances.

Excursion	Variable	Levene Statistic	df1	df2	Sig
Anterior	Pre	0.37	1	22	0.54
	Pos	0.41	1	22	0.52
Posteromedial	Pre	2.30	1	22	0.14
	Pos	3.65	1	22	0.06
Posterolatera	Pre	0.69	1	22	0.41
	Pos	1.85	1	22	0.18
BESS Balance	Pre	0.00	1	22	1.00
	Pos	0.35	1	22	0.57

Table 4: Results of Ancona analysis for comparing post-test dynamic balance in two groups.

Variable	Source	Sum of Squares	df	Mean square	F	Sig
	Pretest	410.2	1	410.2	45.38	*0.00
Anterior	Group	113.59	1	113.59	12.56	*0.02
	Error	189.795	21	9.03	-	-
	Pretest	1460.58	1	1460.58	43.69	*0.00
Posteromedial	Group	412.6	1	412.42	12.34	*0.02
	Error	701.9	21	33.42	-	-
	Pretest	1549.41	1	1549.41	163.21	*0.00
Posterolateral	Group	256.48	1	256.48	25.36	*0.00
	Error	21.36	21	10.11	-	-

*Significance level is *P* ≤ 0.05

Table 5: Results of Ancona analysis for comparing post-test static balance in two groups.

Variable	Source	Sum of Squares	df	Mean square	F	sig
	Pretest	26.61	1	26.61	22.09	*0.000
BESS Balance	Group	19.73	1	19.73	16.08	*0.001
	Error	25.298	21	1.2	-	-

*Significance level is *P* ≤ 0.05

DISCUSSION

The primary finding from this study was that participation in an integrative neuromuscular program was found to be an effective, safe and worthwhile method of conditioning for congenital deaf students. Specifically, the intervention group who performed integrative neuromuscular with balloons during the training program made significantly greater gains in muscle strength/endurance, lower body power, static and dynamic balance as compared with age-matched control group who participated in routine physical education activities without integrative neuromuscular training. The improvements in static and dynamic balance measures are evidence of this treatment's efficacy. No injuries occurred all over the training period and our observations suggest that the training program was well-received by the intervention group. This information demonstrates the potential value of the integrative neuromuscular program for the primary school congenital deaf students.

The results of this study showed that performing the integrative neuromuscular training can improve the control posture of congenital deaf students. First, before evaluating the effect of integrative neuromuscular training on balance and control posture of the intervention group, it was necessary to evaluate the relationship between deafness and balance, which the results of some researchers conducted showed a significant relationship between these two issues. Rajendran et al. [21] stated that deafness people have a similar physical, emotional and movement needs compared with normal hearing, but the fact that deaf people are naturally deprived of the auditory system, In many cases, they limit their activities, especially in childhood (e.g, games), and slow down their physical movement development.

Fear of injury because of the incomplete understanding of the environment in deaf children that inspired by their parents during childhood, can reduce the natural interest of deaf children in heavy muscular activities such as running, climbing and jumping during this period, and ultimately affect in muscle growth and build muscle coordination. But a continuous participate in physical activity can compensate for the delay in movement growth in the deaf people. The researchers have argued that the effectiveness of the exercise on balance requires a response at three levels of motion. At the level of the spinal cord, its main role is to regulate muscle reflexes. The sensory information obtained from joint mechanical receptors resulting in balances reflexes, in the form of reflex, causes a contraction around the joint and prevents excessive pressure on the limiting joint movement limiting factors. At the level of the brain stem, the development of equilibrium reflexes helps control body balance, and at the level of the higher nervous system (the cerebral cortex and cerebellum), the individual concentrates and consciously tries to control his joint and balance. Control at any of these levels requires the sensory information collected from vision, vestibular and the somatosensory system. As a result, with the difficulty of practicing conditions (through closing eyes, keeping balance on a single foot and using a multi-table balance board), the overload increases on these senses and proprioception [22]. Taylor et al. [23] concluded that somatosensory plays an important role in balancing control. One aspect of the role of the somatosensory of movement control and postural control is the design and modification of the movement commands before and during the implementation of a movement. The movement control system should consider the current and changing state of the joints to estimate the mechanical balance resulting from its implementation. In this context, the somatosensory has the best conditions for supplying information and transmitting it to the central nervous system; because it is a complex process that can only be carried out by the somatosensory system. Somatosensory information plays a crucial role both in the overall stability of the body and in maintaining the stability of the local areas (joint functional stability). Given that integrative neuromuscular training can reduce body swings and the displacement of the center of gravity.

In the present study, this training program probably improves the somatosensory and changes in the utilizing of motor unit patterns, which increases postural stability and maintains the center of gravity at the base of support and improves balance in these children. The results showed that students in the intervention group who performed the integrative neuromuscular training for six weeks had better results in balancing tests than control group who were routinely physically active.

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