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Effectiveness of vestibular stimulation on static balance in mentally retarded children

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Abstract:

Objective: *Mentally retarded children have poor performance in their balance. Therefore, this study examines the effect of vestibular stimulation on static balance in mentally retarded children.*

Materials and Methods: *Twelve mentally retarded girls at Borujerd Eheia School were selected, their age ranging 8 to 11 years old, they were randomly divided into two groups of 6, control and experiment. The experimental group received a 35-min vestibular stimulation, two times a week for 6 weeks. Pre-test and post-test were performed using modified single balance test in four different conditions with eye and surface manipulation. Independent and dependent t-test were used to analyze the data.*

Results: *Results show a significant increase in the static balance under the first and third conditions in the post-test group after the intervention of the vestibular stimulation. The level of significance with dependent t-test was 0.014 in the experimental group under the first condition (eyes-opened soft-surface) and 0.029 in the third condition (eyes-opened soft-surface). Also, the significance level with independent t test was 0.19 in the first condition and 0.037 in the third condition, which is significant (significance level of .05).*

***Conclusion**: The results of this study show that using vestibular stimulations in the static balance of mentally retarded children is effective and can be used with other activities.*

Key words: Vestibular Stimulations, Static Balance, Mentally Retarded Children.

INTRODUCTION

Currently, the number of people in need of special services due to disability is increasing. Factors such as population growth, fall of mortality rates especially in children, and greater longevity of human being have led to an increase in the number of disabled people. (Tavakol, Hojat, & Kohandel, 2013).

Mentally retarded people are a group of disabled people, consisting of about 3% of the world's population. (Contestabile, Benfenati, & Gasparini, 2010).

Several studies have shown that mentally retarded people have a much lower level of muscle strength than their peers and have a weaker balance. (Fernahall & Kenneth, 2000). Children with mild and severe mental retardation performed poorly on balance tests. (Venetsanou & Kambas, 2011).

The ability of individuals to maintain balance is essential for the successful performance on all motions. (Zarerashkooeh, Rahnama, & Movahedi, 2016).

Postural control or balance can be divided into static balance(the ability to maintain a base of support with minimal movement) and dynamic balance (the ability to perform a task while maintaining a stable position). (Yaggie & Campbel, 2006). Some researchers believe that after the age of 11, balance does not improve much and the peak in balance growth is up to this age, but others believe that the growth in balance will continue until the age of 14. (Gholamisultanabadi, 2002).

The postural control system is a complex structure in which the coordination of three balance systems (including the visual, somatosensory and vestibular systems) plays a significant role and the collaboration of these systems will lead to the control of posture and balance in person. (Sadeghi, & Alirezaee, 2006).

The Vestibular system in the body is one of the sensory-motor systems that play a role in maintaining balance of the head and body. Because the Vestibular system is associated with the motor system, proprioception, vision and hearing, therefore, it works with many systems to regulate functions such as inhibiting early reflections and facilitating state (status) patterns. Human vestibular system consists of three components. Peripheral sensory, central processing and motor output. The peripheral part contains a set of sensory receptors that send information to the central nervous system, especially the vestibular cores and the cerebellum (information about the head angular velocity, linear acceleration and head orientation with regard to the gravity axis). The central nervous system processes these signals and combines them to estimate head orientation with other sensory information. The output of the central vestibular system is sent to the ocular muscles and spinal cord to create two important reflections of vestibulo-ocular reflex and vestibulo-spinal reflex. Vestibulo-ocular reflex leads to movements in the eye that result in visual clarity throughout the head movement. The vestibulo-spinal reflex creates compensatory movements of the body to prevent person from falling by maintaining head and postural stability. The central nervous system monitors the performance of these two reflections and the adaptive processor resets them if necessary. (Herdman & Clendaniel, 2014).

Vestibulo-ocular mechanism is healthy and mature until the age of 1.Vestibulo-spinal mechanism or the vestibular apparatus performance continues to grow until the age of 15 to control the body's condition. The sensory integrity capability which is needed to control the body's condition changes and becomes more mature between the ages of 7 and 15. (Lotfi, Zamiriabdollahi, Javanbakht, Delphi, Sheikhzadeh, & Ahmadi, 2015).

Since the vestibular system receptors are of two types, one for angled motion and the other for linear and gravity motions, Vestibular stimulation can also be categorized accordingly. (Zeynalzadeh, 2010).

Since the vestibular system is an underlying factor in a successful balance, the researcher aims to examine its impact on balance by introducing various stimulations to this system. Therefore, this study examines the effect of vestibular stimulations on static balance in mentally retarded children.

RESEARCH METHODOLOGY:

The present research is applied in terms of purpose and it is quasi-experimental in terms of the nature of implementation. The research plan was implemented through pre-test and post-test in both control and experimental groups. The study population includes the girls at Eheia special school of mentally retarded children in Borujerd, 12 of which were selected. Inclusion criteria: students with intellectual disabilities studying "with an IQ of 50 to 70" using the Wechsler Intelligence Test previously performed by the tester of school of intelligence at school. The age range of 8 to 11 years, complete physical and mental health, lack of skeletal anomalies, lack of flat feet and early orthopedic injuries and lesions (fracture, Joint dislocation and subluxation) in the lower limbs, lack of genetic problems such as Down syndrome and the lack of behavioral disorders such as hyperactivity. Exclusion criteria: Lack of cooperation during the test or vestibular stimulation intervening time, Non-attendance in medical sessions, in 2 consecutive sessions and 3 sessions in total number of meetings, parents'/teacher' discontent. Place of research was Occupational Therapy of the Eheia School (researcher's work place) and time of the research was April and May 2017).

Research process started with gathering information on height, weight and age of the students and 12 children were selected randomly and were divided into 2 groups of 6 control and experimental. After providing necessary explanations about the method of doing the test, required pre-tests were carried out. The experimental group received a 35-min vestibular stimulation, two times a week for 6 weeks using existing equipment at the department of occupational therapy school in common practices in occupational therapy clinics and in accordance with the configured protocol. Then, the post-test was performed from both groups. To carry out these stimulations, the rotational and linear motions (anterior-posterior, lateral, ascending and descending motions) in different positions (Standing, kneeling, sitting) were used. These stimulations began with linear motions and ended with rotational motions that were performed using tools such as trampoline, occupational therapy swing, C.P (cerebral palsy) ball, twist board and tilt board. Stimulations in each position were repeated several times in short periods, the duration of each stimulus in linear motions was at least 1 minute and maximum 2 or 3 minutes, in rotational motions of at least 10 rounds (20 seconds), and the maximum in the case of endurance,15 rotations to one side and after a 10-second stop, the same number of rotations turned opposite.

To evaluate static balance on one leg, modified single balance test (r=0.87) was used. The method of doing the test was that the subject stood on flat surface with one leg and the free leg was raised to the level of the ankle and both hands beside the body were free. The examiner measured the maximum time that the subject was standing on his feet, this test was performed 2 times in both legs, and the best time was recorded (as a record). (Oja & Tuxworth, 1995).

Of course, this test was carried out in four conditions by manipulating the eyes and surface using a blinder and a 10 cm foam. First condition: eyes-opened soft-surface - second position: eyes-closed hard surface - third position: eyes-open soft surface - fourth condition: eyes-closed soft surface.

The Kolmogorov-Smirnov test was used to examining the normality distribution of data dependent and independent t-test were used to analyze the data using SPSS16 software at a significant level of 0.05.

Also, Excel 2007 software is used to draw the chart.

RESULTS:

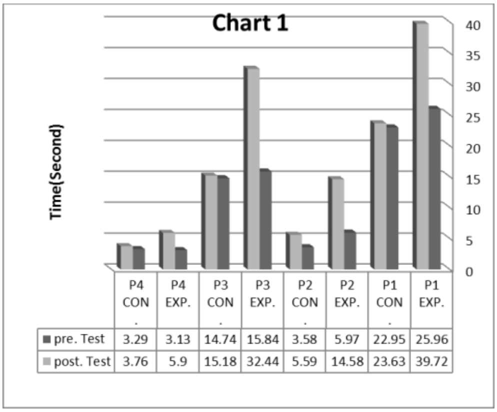
The average and the standard deviation of subjects' demographic characteristics including height, weight and age in both control and experiment groups are represented in table 1.

Table 1. General characteristics of subjects

Groups	N	Age (year)	Height(cm)	Weight (kg)
1. Experimental M±SD	6	9.75±.98	134±7.96	29.50±10.70
2. Control M±SD	6	9.58±.82	129±9.95	31.83±8.75

M±SD : mean ± standard deviation

Initially, it was found that the variables of the present research were normal using the Kolmogorov-Smirnov test. Also, the assumption of equality of variances for variables in the pre-test and post-test of four conditions is observed. Therefore, parametric statistics were used to test the research hypotheses.
The data of the pre-test and post-test and the modified single balance test in the two groups in four different conditions are shown in Fig. 1. Also, the results of dependent and independent T-tests are summarized in Tables 2 and 3. The significance level was considered as 5%.



P : Postion EXP. : Experimental CON. : Control
1: open eyes - Hard surface 2: Closed eyes - Hard surface
3: open eyes - Soft surface 4: Closed eyes - Soft surface

The above diagram shows that the experimental group performed better in the post-test each of the four conditions than the control group.

Table 2. Paired Samples T Test

Position	**N**	**Pre-test M±SD**	**Post-test M±SD**	**Mean Difference**	**T**	**Sig**
One(open eyes-Hard surface)						
Group 1. Exp.	6	25.96 ±21.16	39.72 ±24.15	-13.75	-3.734	**0.014***
Group 2. Con.	6	22.95±17.33	23.63±17.17	-0.67	-0.238	0.821
Two (Closed eyes-Hard surface)						
Group 1. Exp.	6	5.97 ±5.60	14.58±16.85	-8.60	-1.775	0.136
Group 2. Con.	6	3.58±.98	5.59±4.97	-2.01	-0.946	0.388
Three (open eyes-soft surface)						
Group 1. Exp.	6	15.84±13.47	32.44±21.52	-16.60	-3.032	**0.029***
Group 2. Con.	6	14.74±12.04	15.18±17.86	-0.44	-0.114	0.914
Four(Closed eyes-soft surface)						
Group 1. Exp.	6	3.13±2.20	5.90±4.25	-2.77	-1.523	0.188
Group 2. Con.	6	3.29±3.20	3.76±2.27	-0.47	-0.421	0.691

$p<.05$, 1. Experimental 2. Control M±SD : mean ± standard deviation

The results of the Paired t-test in Table 2 show that in the first and third conditions, the level of significance in the experimental group was 0.014 and (0.029) respectively and these results indicate that Vestibular stimulations are statistically significant in these two conditions.

Table 3. Independent Samples T Test

Position	DF	Mean Difference Pre-post Test ±SD	T	Sig
One(open eyes-Hard surface)				
Group 1. Exp.	10	-13.75±9.25	-2.807	**0.019***
Group 2. Con.	10	-0.67±6.98		
Two (Closed eyes-Hard surface)				
Group 1. Exp.	10	-8.60±11.86	-1.157	0.274
Group 2. Con.	10	-2.01±5.20		
Three (open eyes-soft surface)				
Group 1. Exp.	10	-16.60±13.41	-2.409	**0.037***
Group 2. Con.	10	-0.44±9.49		
Four(Closed eyes-soft surface)				
Group 1. Exp.	10	-2.77±4.46	-1.075	0.308
Group 2. Con.	10	-0.47±2.75		

$p<.05$, SD: standard deviation

Also, in Table 3, by comparing the difference between the pre-test and post-test means of both groups with independent t-test, the level of significance was (0.019) in the first conditions and (0.037) the third conditions, which is statistically significant.

Discussion and conclusion:

Based on the results obtained by comparing the pre-test and post-tests of the two groups shown in Figure 1,

In the experimental group, the post-test results showed a significant increase in pre-test in the four conditions after 6 weeks of vestibular stimulation and the differences are all negative. This indicates improved post-test results compared to pre-tests, but in the control group, results are not significant. One of the reasons that can be named for the improvement of the balance of both groups, given the average age of the participants in the study, is the natural growth of the balance of these ages. However, the improvement in the balance in the control group was not significant and the meaningfulness of the results in the test group could be attributed to the intervention of Vestibular stimulations. It can be said that the use of vestibular stimulations, the vestibular apparatus and its communication involve a two-way process which causes the growth and myelination of new neural network (Salamat, 2012).

But, in order to determine whether these differences were statistically significant, dependent and independent t-test were used.

According to the information provided by the dependent t-test, in the first conditions (eyes-opened hard surfaces) and the third (eyes-Opened soft surfaces) The mean of pre and post test changes in the experimental group is (0.014) and (0.029), respectively, with regard to significance level of 0.05.

Also, by comparing the mean difference between the pre and post-tests between the two groups using independent t-test in Table 3, these differences were significant at the first condition (eyes-opened hard surfaces) and the third (eyes-opened soft surfaces), which are respectively (0.019) and (0.037).

In the present study the effectiveness of vestibular stimulation on balance in children with intellectual disability was assessed. The results showed that vestibular stimulations were effective on static balance and a significant progress was observed in the experimental group. Therefore, the results of this study confirmed the use of vestibular stimulations in mentally retarded children. Therefore, it is suggested that these stimulations, along with other activities, be used to improve balance. For researchers interested in the subject, it is also suggested to investigate the use of these stimulations in the opposite sex As well as with other motor activities and other sensory stimulations.

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