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The Effects of Neurofeedback and Play Therapy on Dynamic Balance in 4-10 Years Old Children with Diplegic Spastic Cerebral Palsy

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Abstract

Background: Dynamic balance is one of the most important challenges for kids who suffer from cerebral palsy especially diplegic spastic ones. Therefore, this study designed to compare the neurofeedback and play therapy training on dynamic balance in 4-10 years old diplegic spastic cerebral palsy kids.

Methods: Quasi-experimental with three groups and pre-posttest design. This study has involved 26 spastic diplegia cerebral palsy children in 1st and 2nd grades, according to the GMFCS protocol. The researcher performed first, initial tests to evaluate the patient's equilibrium level, by using the PBS assessment instruments. To investigate the study goals, the patients were divided into two groups with a two-study method of neurofeedback and play therapy. Each group has done their special exercises during 10 sessions in 2 weeks for the first group and 20 sessions in 4 weeks for the second time and finally, the PBS test was repeated. Primary data were analyzed using descriptive and argumentative statistics by Kolmogorov-Smirnov test, independent t-test, Wilcoxon test, and one-way and two-way ANOVA test. All of these analyzes were done by SPSS software.

Results: The study's results confirm that play therapy has shown a meaningful effect (Pvalue=0.042), while the effect of the neurofeedback method does not represent any legal effect on one's dynamic balance. In the case of the dynamic balance, the play therapy group has shown better operation in post-tests compared with the neurofeedback group.

Conclusions: As results show the play therapy method has shown a meaningful effect on dynamic balance so it has been suggested to improving elderlies balance.

Keywords: Cerebral palsy, Neurofeedback, Play therapy, Statistic equivalent, Dynamic equivalent.
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Introduction

Cerebral palsy is a non-progressive brain injury resulted from abnormal brain growth or brain injuries before, during, and after birth. Some of these children just have movement deficits and don't have other deficits but in other patients, there are other possible symptoms like disorders in learning, hearing, vision, and convulsion. The intelligence rate varies according to the injury position; some of these children are very talent.[1] Cerebral palsy has different forms; the spastic model is the most widespread comprising 70 to 80 percent. The symptoms are very different and they may be minor or severe or include one half or both halves of the body and sometimes hands are more engaged than legs or all of 4 limbs are included. The exact incidence of Cerebral palsy breakout in the world is 3.3 in each 1000 births and this number in premature infants increases to 40 or 100 in every 1000 live births.[2] This breakout number is considerable as it engages the affected person, family, or a great number of communities with its protection cycle. In addition to costing a high amount of time and money, it has many mental and emotional effects on the patients' families and society. Therefore, high costs of treatment and continuous referring of the family to rehabilitation and treatment centers causes more harm to the mental and economic structure of the family. On the other hand, in cerebral palsy, the movement disorder is along with poor balance.[3] Balance is the ability to keep a position in a specified path, which is one of the essential elements of motion and increases the ability in performing skills.[4] Children with Spastic cerebral palsy have manifold problems in terms of motion and balance.[1] There are many dynamic problems for these children and affect their balance, but the worst one is contracted joint.[5] The functional balance is one of the stable elements that allow the child to do all his daily tasks and routine activities, social activities at home, school, and society safely and independently.[6] Poor balance causes a restriction in movement abilities and decreases the ability of the person in discovering the environment, communicating with family members and friends. This issue finally results in a decreasing quality of life.

There are different treatment methods for treating cerebral palsy. Among different treatment methods, the effect of play therapy and neurofeedback on balance has been confirmed. A few studies were conducted about the effect of neurofeedback and play therapy on balance among children with cerebral palsy. Also, the previous studies have confirmed these kinds of practices,[7] so the examination of the effect of treatment methods on balance among children with cerebral palsy is very important. Hence the present study follows the aim of the examination of the effect of training play therapy and neurofeedback focusing on basic skills on balance among children with cerebral palsy.

Materials and Methods

The research methodology is a quasi-experimental research with pre and post-test, and control group design. The research

population was children in the age range of 4-10 with Diplegic spastic cerebral palsy levels 1 and 2 according to SCFMG criteria in rehabilitative clinics of Tehran in 2018. The regular clustering samplings with random distribution in groups were used to select subjects. 30 children were selected based on inclusion and exclusion criteria of research samples from Tehran rehabilitation clinics, where located north-south-east-west and center of the city. Then they were divided randomly into three rehabilitative groups of traditional, neurofeedback, and play therapy. Inclusion criteria were having an age range of 4-10 years, diplegic spastic cerebral palsy level 1 and 2 according to SCFMG criteria based on the pediatrician or neurologist diagnosis, IQ score≥80 (for having the ability to perform required tasks in conducting research),[8] and also having basic skills of standing and keeping balance in standing, ability to communicate and comprehend language concepts. After becoming aware of the participation conditions of research and evaluation, those who were ready to participate in the study, their parents filled out a consent form and included them in the study.

PBS test is used to evaluate balance. Validity and reliability of the test have been reported (ICC 3.1=0.997)[2] Procomp machine 2 made by Thought Company in Canada was the main instrument for the neurofeedback method. A neurofeedback machine was used for measuring and recording brain waves and presenting feedback for the provision of brain waves.

In this research, the WII fit (WII balance) machine and play techniques were actively used for play therapy. This method of play therapy has been based on computer games using a balance board (WII fit) based on body motion coordination with a monitor screen. This machine has a wireless handle and motion controller it should be placed in front of the subject to control his/her emotions during play. This machine is like a monitor. It can examine different motions in contexts like aerobics, yoga, martial arts, and balance games. This includes other parts like a wheel, WII, the Nunchaku, and the guitar used for various game objectives. The present study uses a DVD game called WII fit plus.[9] Also, the SCFMG criterion was used for detecting disability level1 RAVEN intelligence test is used for detecting the IQ level of children[10] and personal information questionnaire and demography were used for collecting basic data from the subjects.

First, rehabilitation centers with geographic distribution in Tehran were detected, in each geographical position, one center was selected, and official coordination was conducted. Then children with spastic cerebral disability who referred to these centers and after diagnostic confirmation by a neurologist or pediatritioner. Their parents were justified based on their abilities for participating in practices and tests and case of willingness, they filled in the consent form.

After performing initial examinations and acquiring inclusion criteria, a pre-test was performed. Subjects based on disability score were randomly divided into three rehabilitative groups: control, neurofeedback, and play therapy. Then subjects performed specified protocols twice weekly and at least lasted for half an hour each session for 5 weeks. After that tests were repeated at the post-test.

The initial record of brain waves was conducted in the first session. The second record of brain waves was conducted for examining changes in brain wave diagram after 10 sessions. For performing neurofeedback intervention, Hammond protocol (2005) was used as balance protocol (decreasing 4-7 Hz and frequency amplification 15-18 Hz in O_1 and O_2). Then after setting the chair and placing electrodes baseline brain waves (a stage in which any feedback isn't presented) were recorded. In the next stage, i.e. the intervention stage, an animation was presented for children. As the brain waves of children became far from the desired target (i.e. increasing Teta waves and decreasing Beta waves) animation stopped moving. For resuming the animation, the children had to change their brain waves along with detected aim. Selecting animations were based on children's choice. After the intervention period, a post-test was performed. Play therapy group lasted for 20 sessions (4 sessions per week, 15 minutes per session). In a training program, subjects participated in 9 different games with various aims following a common target i.e. increasing the balance level of a child. Each game was used purposefully and periodized that is presented in table 1.

As this study was conducted among patients referred to rehabilitation centers, so ethically it wasn't possible to stop of rehabilitative sessions of visited children hence three rehabilitative pieces of trainings were traditional (training standing up from the ground totally in independent order, gaiting independently, standing on one foot, tandem gait, standing and walking with closed eyes) and the only way to create the similar conditions was the equal number of rehabilitative sessions during the week and implementing rehabilitative program nearly similar for all children in the control group.

Then data comprising demographic information and acquired scores of PBS balance test were included in SPSS software version 20. Homogeneity of variances and normality of data distribution was examined using the Kolmogorov Smirnov test. Also for examining the difference between groups Wilcoxon test and inter-group Kruskal-Wallis test was used.

Table 1. Training program for the play therapy group

Game name	Aim	Week
Scooter heading	Head control	1st week
Sky slalom	Core control	1st week
Driving range	Hands usage and control	2nd week
Bird's-eye bull's-eye	Hands usage and control	2nd week
Sky jump	Legs usage and control	3rd week
Balance bubble	Control and use of ankle and hip mechanism in maintaining balance	3rd week
Hula hoop	Applying weight bearing on legs and trunk rotational movements	4th week
Obstacle course	Head, trunk, hands and legs complex movements	5th week
Snowball fight	Head, trunk, hands and legs complex movements	5th week

Results

Demographic characteristics of subjects, variance homogeneity and related intergroup test have been presented in table 2.

As it is clear from the above table, groups have homogeny distribution in factors like height, weight, gender, and disability level and there is no meaningful difference between groups in terms of the mentioned factors (Pvalue>0.05).

For examining normality of data distribution in groups in pre-test and post-test and general Kolmogorov Smirnov test was performed and the results have been presented in table 3.

Dynamic balance has not normal distribution and we cannot use parametric analyses for it.

As table 4 indicate the results of the Wilcoxon test, the performance of the neurofeedback group in the post-test does not show a meaningful difference with to pre-test (Pvalue=0.131).

As table 5 indicates, the performance of play therapy group in post-test was better than pre-test (Pvalue≤0.05).

As table 6 indicates, two groups of play therapy and the control group had better performance in the post-test relative to the pre-test but there was no difference between groups neither in pre-test or post-test. Two-way variance analysis test with gender control confirms this subject that group factor isn't meaningful (Pvalue=0.192) but measuring turn factor is meaningful (Pvalue=0.000).

Table 2. Demographic characteristics of children with diplegic spastic cerebral palsy

Variable	Group	Mean±SD	Pvalue (α≤0.05)	Homogeneity of variances
Age (months)	Neurofeedback	97.5±20.014	0.296	0.464
	Play therapy	80.22±25.738		
	Control	86.78±20.48		
Height (centimeter)	Neurofeedback	115.13±7.82	0.666	0.056
	Play therapy	111.67±10.524		
	Control	112.67±4.444		
Weight (Kg)	Neurofeedback	24.38±4.207	0.543	0.073
	Play therapy	20.11±3.822		
	Control	22.33±2.784		
Level of disability	Neurofeedback	1.5±0.535	0.957	0.970
	Play therapy	1.44±0.527		
	Control	1.44±0.527		

Table 3. Kolmogorov Smirnov test for normality of variable of static balance in all groups

Variable	Set of test	Mean±SD	Kolmogorov-Smirnov	Pvalue
Dynamic balance	Pre-test	23.75±5.14	0.006	2.00
	Post-test	35.5±5.97	0.195	0.018
	Overall	20.88±3.38	0.206	0.006

Table 4. Results of Wilcoxon for analysis of variance of dynamic balance in neurofeedback group

Variable	Set of test	Mean±SD	Pvalue (α≤0.05)
Dynamic balance	Pre-test	22.11±1.53	0.131
	Post-test	22.88±1.82	

Table 5. Results of Wilcoxon test for dynamic balance in play therapy group

Variable	Set of test	Mean±SD	Pvalue (α≤0.05)
Dynamic balance	Pre-test	20.5±4.03	0.042
	Post-test	21.87±2.9	

Table 6. Inter-group and intra group for dynamic balance variable

	Neurofeedback	Play therapy	Control	Intragroup Kruskal Wallis test	Intra group α≤0.05
Pre test	22.11±1.53	20.5±4.03	20±4.06	0.648	0.670
Post test	22.88±1.82	21.87±2.9	20.6±3.87	0.485	
Inter group Wilcoxon	0.131	0.042	0.004		

Discussion

According to obtained results from statistical tests, dynamic balance among children with Spastic brain palsy in the neurofeedback group indicates no meaningful difference relative to pre-test (Pvalue=0.131), while the play therapy group in this factor in post-test indicates meaningful difference relative to pre-test (Pvalue=0.042). In a comparison of the two groups, the dynamic balance of the play therapy group was better relative to the control group in post-test than pre-test. In recent years, various studies have examined neurofeedback and play therapy methods and their effect on balance improvement. Hammond in 2005 and 2007 used balance protocol in balance difficulties of patients with stroke and retarded growth and reported positive results in a positive effect on static balance.[1,18] On the other hand, Wenya et al (2015) examined the effect of neurofeedback training on the physical balance of personal health.[10] They reported no meaningful effect in the physical balance progression of the experiment group relative to the control group that the results are compatible with the results of our study. Hsieh (2020), Rakda et al (2013), Betker et al (2006) in a separate study examined the effect of computer games on dynamic balance.[9,13,17] The results of this study were compatible with the results of our study and indicated considerable improvement in dynamic balance. On the other hand, Blinda Lang et al (2010), Gil-Gomez et al (2011) and Jeon et al (2020) in their studies among adults examined the effect of rehabilitation based on interactive computer games on the dynamic balance using WII machine and reported balance performance improvement.[14-16] The present study examined the effect of the neurofeedback method and play therapy course based on basic skills on dynamic balance of 4-10 years old children. The results indicated that play therapy and experiment groups in post-test had better performance relative to pre-test but the difference between groups has not been reported comparatively. According to the results, it seems that short-term therapy and a low sample size (a total of 30 children in three groups) were among the contributing limits of this study. As we dealt with patients, we needed a long time for treatment to obtain more accurate results that unfortunately time limitation of doing research prevented us from doing this. It is suggested that similar studies were conducted with longer times, longer treatment periods with larger sample sizes. According to the research results, the play therapy group had better performance in implementing dynamic balance and on the other hand, because of variety in play therapy method and effective role in increasing self-confidence spirit and eliminating weariness from traditional methods of rehabilitation, it is suggested that similar studies were conducted based on mental and social effects of play therapy method in rehabilitation and recovering dynamic balance among children with spastic cerebral palsy. It is also recommended that the results of this study be used as a treatment method along with other methods.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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