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WOBBLE BOARD TRAINING VERSUS GRAVITY FORCE STIMULATION TRAINING IN IMPROVING DYNAMIC BALANCE IN CHILDREN WITH DOWN SYNDROME

Physiotherapy

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ABSTRACT

OBJECTIVE: Very few studies have been done on physical rehabilitation of balance in Down Syndrome (DS) children. Balance is one of the abilities in individuals with DS that has more disorder while most of the physiotherapists fail to work on balance issues of these children. In the present study the comparative effectiveness between two exercise protocols – Wobble Board Training versus Gravity Force Stimulation Training Program on improving dynamic balance in children with DS was evaluated.

METHODS: Thirty-Four individuals were selected and divided into two groups of seventeen each, group A was administered Wobble Board Training with conventional training protocol and group B was administered Gravity Force Stimulation Training with conventional training protocol for four weeks (five days per week). Four Square Step Test and Functional Reach Test were used prior before starting the therapeutic intervention and on last day of the intervention to assess the changes between the baseline and the post intervention. Descriptive statistics including mean, standard deviation were used for comparing means between all the two groups. Based on normality assumption parametric test like Independent t-test& Paired t- test and non-parametric test like Wilcoxon Signed rank test was used to compare the difference within the groups at two time periods – baseline and after 4 weeks. Results were considered to be significant at $p<0.05$ and confidence interval was set at 95 %.

RESULTS: Group A was associated with significant greater improvements in balance than in Group B. In the Four Square Step Test there was significant improvement in post readings between both the groups, whereas in Functional Reach Test there was no significant difference in post readings between both the groups. ($p=0.026$, $p=0.142$ respectively)

CONCLUSION: Wobble Board training is effective as compared to Gravity Force Stimulation training in improving balance in children with Down Syndrome.

KEYWORDS

Down Syndrome, Wobble Board Training, Gravity Force Stimulation Training, Dynamic Balance

INTRODUCTION:

Down syndrome (DS) is a genetic disorder attributed to chromosomal abnormality (Trisomy 21). According to World Health Organization (WHO), Global estimation of the incidence of the condition are 1 in 1,000 to 1 in 1,200 live births. (Bertoti DB., 2008) Down syndrome is characterized by several clinical symptoms which include orthopaedic, cardiovascular, neuromuscular, visual, cognitive and perceptual impairments. It is the most common genetic cause of developmental disability and affects both the gross motor and fine motor skills of children. A striking clinical impression gained from the study of children suffering from DS is their extreme motor clumsiness. (Shumway-Cook A, Woollacott MH., 1985) Mothers past 35 years of age have increased chances of having a child with DS. Its prevalence is highly dependent on maternal age at gestation. (Luz Carvalho R, Vasconcelos DA., 2001)

People with DS suffer various degrees of motor difficulty, they tend to walk later than their peers; they often lack balance and have low muscle tone and poor postural control. People with DS had much diminished optokinetic and vestibular reflexes.

Balance control is the most difficult motor function for individuals with DS to acquire. For example, the number of people with DS who can keep their balance on one foot for a few seconds is very low. And no one almost can maintain their balance with closed eyes. Balance is vital for all the activities of human performance. It refers to the ability to keep the center of gravity within the base of support in various positions. The organs that receive information for balance are the visual, vestibular and somatosensory systems. (Galli M,Mainardi L., 2008, Stratford B, 1980, Shumway-Cook A, Woollacott MH., 1985, Webber A, 2004)

The assessment of postural control in children with DS demonstrates that the status with, open and/or closed eyes did not show any difference, which shows that these children have a serious problem in their balance system.

Recent advances in training balance is through Virtual reality based games (Diarmaid Fitzgerald, 2008), Balance Exercise Assist Robot (BEAR), therapy on unstable platform moving on air cushion, Computer assisted balance training, etc. These devices are too expensive. Treating balance with simple devices like tilt board, wobble board, soft foam, walking on sand, etc are cheaper and easily available tools.

Wobble board is an easily available tool. Wobble board training is recommended in patients with balance deficit. It is known that balance training performed on unstable surface, improves the strength of lower extremities and proprioception. (Nahed S. Thabet and Hebatallah M. Kamal, 2011, Ajay Verma, Asir John Samuel and Vencita Priyanka Aranha., 2014) It is reasonable to speculate that the back and forth rocking on the Wobble board device will stress the muscles acting over hip, knee and ankle. It significantly increases lumbar erector spinal activity as compared to walking. Its angle of tilt should be sufficient to destabilize the body but not high enough to injure the ankle joints.(Jose Antonio Merchán-Baeza MG-S, and Antonio Ignacio Cuesta-Vargas., 2014)

Gravity is an absolute environment to which the upright spine and posture of humans must develop and relate. Gravity Force Stimulation (GFS) program is not working on tone or positioning directly, but tone, movement and body posture improve when doing these exercises as, GFS has a strong impact on the child's sensory system helping to normalize the system through exercises that send strong messages to the brain to regulate the tactile, proprioceptive and vestibular components. The GFS is able to trigger immediate, rapid and precisely tailored compensatory muscular contractions reflexively in response to unexpected changes in external or internal forces.

Training with GFS maximizes the functional outcome through central nervous system that produces new antigravity postural control reactions, by providing the less possible external support.

Very few studies in the past, have been conducted on physical rehabilitation of balance in DS children. Balance is one of the abilities in individuals with DS that has more disorder while most of the physiotherapists fail to work on balance issues of these children. The primary purpose of this study was to find out the comparative effectiveness between two exercise protocols – Wobble Board Training versus Gravity Force Stimulation Training Program on

dynamic balance in children with DS.

METHODS:

After getting approval from the Institutional Ethical Committee of The Sarvajanik College of Physiotherapy, 34 students diagnosed with DS were selected on the basis of inclusion criteria like independent walking, able to hear and follow simple instructions and age between 5 to 16. DS children with associated cardiovascular condition, neurological problems, orthopaedic problems, loss of functional vision and hearing that interferes with intervention procedure were excluded.

Children were randomized into 2 groups using sequentially numbered sealed opaque envelope method. Informed consent was taken from the parents of the children included in the study. An informed consent was taken from the parents of the children included in the study.

As a common protocol administered to both the group children, a well-defined conventional therapy protocol was administered to both the groups which included one leg stance with eyes open, tandem stance, walking on line, vertical jumps and horizontal jumps.

Group A was administered Wobble board training while Group B was administered Gravity Force Stimulation Training.

Group A – Wobble Board Training (WBT) (Diarmaid Fitzgerald, 2010): For this Wobble board measuring 50 x 50 cm in diameter and the rounded rocker base was 19 cm in diameter and 6 cm high. The board was made of wooden material to allow friction to develop between the surface and feet of children. Also, the size of the surface on which the children were supposed to stand was considerable big to attain a broader base of support. Children were asked to stand on the Wobble board holding hands of the therapist. The board was stabilized by the therapist with both the feet over it. The child took required support of the hands of the therapist to climb the wobble board. Once the child got stabilized, controlled perturbations were given in different directions by controlling the balance board motions with the feet placed on it by the therapist. Most of the children were afraid when the wobble board was moved back and forth, sideways and as a sign of fear were making the body stiff. The therapist of the school consoled children during panic attacks. Gradually once the child gains confidence support was reduced. After 5 minutes of training on Wobble board the child stepped down carefully. Stepping down from wobble board also required support from the therapist. Rest was given for 5 minutes. 3 times balance training was given on Wobble board and rest in between.

Figure 1: Wobble board training with support from Physiotherapist

Group B – Gravity Force Stimulation Training (GFST) (Nahed S. Thabet and Hebatallah M. Kamal, 2011): The apparatus (Figure 2a, 2b and 2c) was used in three different variant positioning methods to increase the difficulty levels as well as train the balance system of the children by making the arrangement of the parts of the apparatus towards narrower base of support

Figure 2(a): Components Of Box For Gravity Force Stimulation Training

As shown in the figure the two beams are placed horizontally parallel to each other in the grooves provided in the side boxes. This pattern of placement was the first to be practiced with as the base of support was consistently broad enough throughout the way the child was supposed to walk and hence easy to begin with. Also, the apprehension level of the child will be lessened as the two beams are not too far apart.

The primary idea behind performing this exercise training mode was to allow pertubating forces to create multidirectional disturbances in the posture of the child made to stand on the board.

Figure 2(b): Box With Single Beam And Broad Base Of Support

As shown in the figure a single beam is placed horizontally connecting the two boxes by linking the respective grooves made for the single beam arrangement. After the previous activity is done by the child, the progression would be done towards increasing the challenge of the balance by making the walking base narrower by having just one beam to walk on, hence the medio lateral stability would be challenged more.

Figure 2©: Box With Double Beam And Narrow Base Of Support

As shown in fig c the two beams are placed vertically and parallel to each other in the grooves provided in the boxes. As the challenge on balance was further increased, the two beams would be arranged as, in the third arrangement, placed in vertical position as shown in the figure above.

Figure 3: Sequence Of Training On Gravity Force Stimulation

This therapy protocol was given thrice a week to each individual for 4 weeks. Record was kept regarding no of days each child performed the exercise protocol from the respective groups i.e. group A and group B.

OUTCOME MEASURES

Their dynamic balance was assessed using valid and reliable outcomes i.e. Four Square Step Test and Functional Reach Test.

Four Square Step Test (FSST) (Whitney SL, 2007, Jannette M., 2008): This is a clinical test of dynamic standing balance that measures the time taken to step over four walking sticks, which are placed in a cross-configuration on the ground by using a set movement sequence. The combination of cognitive and physical demands is a key attribute of this test.

It requires minimal space, equipment and time. Test performed is recorded in seconds. Mean of last two readings is considered as final score. The FSST is easy to score and quick to administer. The Four Square Step Test (FSST) measures rapid stepping in different directions and over low obstacles.

Most equipment used for measuring balance is costly, highly technical and not portable. FSST is easy to score and quick to administer. It is a tool to estimate dynamic balance in children with Down syndrome.

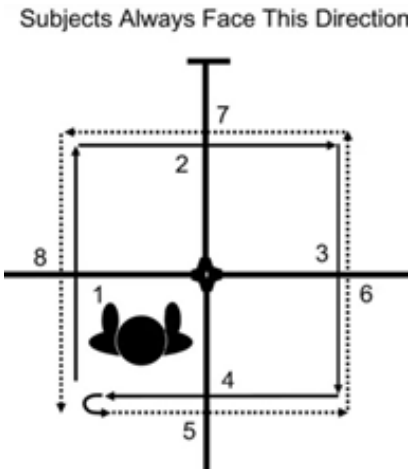

Figure 4: Four Square Step Test Blocks And Direction

After completing this clockwise movement in all the 4 quadrants, the child was asked to perform the same in the anti-clockwise direction. For this the child has to start from 1st quadrant, move to 4th quadrant, followed by 3rd, 2nd and again back to starting position, i.e. 1st quadrant. This complete series of clockwise and anti-clockwise movements complete the test.

The time taken to complete the test was recorded with the stop watch. The trial was considered a failure and repeated if the test not completed correctly, that is, if a child loses his or her balance, or a foot touched a stick. Each one of them performed 3 trials with 1 minute rest between trials to avoid fatigue. Time taken to complete the test was noted and mean of last 2 trials was used as a final score.

Figure 5(a) Starting Position

Figure 5(b) Child moving to 2nd Quadrant

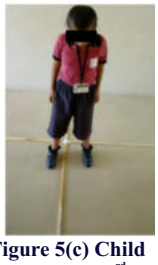

Figure 5(c) Child moving to 3rd Quadrant

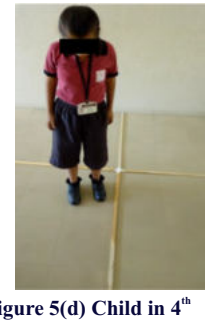

Figure 5(d) Child in 4th Quadrant

Figure 5(e) Child moving back to 1st Quadrant

Functional Reach Test (FRT) (Pamela W Duncan., 1992): FRT was performed by using a measuring tape placed on the wall, parallel to the floor, at the height of acromion process of the selected children. Changes were made if height of the children varied. The dominant arm was aligned closer to the wall with 90 of shoulder flexion with a closed fist. Children were asked to stand with feet apart. Then they were asked to make a fist and bend forward as much as possible without taking a step or touching the wall. In total, three trials were recorded. Mean of last 2 measurements was taken as final score. Appropriate rest time was provided whenever needed to avoid fatigue.

Descriptive statistics including mean, standard deviation were used for comparing means between the two groups. Shapiro-Wilk test (Table 1) performed for both outcome measures showed FRT data normally distributed while FSST data was not normally distributed. Based on this normality testing, Paired t- test was used in FRT group and Wilcoxon Signed rank test was used in FSST to compare the difference within the groups at two time periods – baseline and after 4 weeks. Independent t test was used to compare the difference between the groups pre and post intervention. Results were considered to be significant at $p<0.05$ and confidence interval was set at 95 %.

All statistical analysis was performed using SPSS version 20.

RESULTS

Table 1: Shapiro-wilk Test For Normality Of Data

Outcome	Statistics	df	p
FSST	.850	34	.000
FRT	.952	34	.146

Table 2: Within group Comparison for Four Square Step Test (FSST) in Group A using Wilcoxon Signed Rank test

	Mean	SD	Mean difference	p
Pre	19.35	1.45	3.35	0.000
Post	16.00	4.28		

Table 3: Within group Comparison for Four Square Step Test (FSST) in Group B using Wilcoxon Signed Rank test

	Mean	SD	Mean difference	p
Pre	19.65	1.22	1.12	0.001
Post	18.53	1.32		

Table 4: Within group Comparison for Functional Reach Test (FRT) in Group A using Paired t test

	Mean	SD	Mean difference	t	p
Pre	5.24	1.66	1.18	-2.01	0.03
Post	6.42	2.15			

Table 5: Within group Comparison for Functional Reach Test (FRT) in Group B using Paired t test

	Mean	SD	Mean difference	t	p
Pre	5.08	1.12	0.27	-4.24	0.001
Post	5.35	1.16			

Table 6: Between group Comparison of Four Square Step Test (FSST)

Group A		Group B		Mean difference	p
Mean	SD	Mean	SD	2.23	0.026
3.35	3.83	1.11	0.92		

Table 7: Between group Comparison of Functional Reach Test (FRT)

Group A		Group B		Mean difference	p
Mean	SD	Mean	SD	0.9	0.142
1.17	2.41	0.27	0.26		

DISCUSSION

The main purpose of the study was to compare the effectiveness of two different balance training programs on children with DS.

The result of present study concluded that there is a significant difference between Wobble Board Training and Gravity Force Stimulation Training program with conventional therapy in both the groups to improve dynamic balance. As per results obtained it is seen that Wobble Board Training improves dynamic balance in children with DS better as compared to Gravity Force Stimulation Training. The outcome measures FSST shows significant improvements between groups while FRT does not.

WY Wang et al (Wai-YI Wang and Chang JJ, 1997) performed a study on balance training in children with and without Down Syndrome. Balance was assessed using BOTMP scale. Analysis of covariance showed the pre- and posttest differences on scores for floor walk, beam stand, and horizontal and vertical jumping by subjects with Down syndrome were significantly greater than those for the typical children.

In the present study the pre readings of the outcome measures FSST and FRT correlates with the above mentioned study. The results prove that children with DS have problems with balance.

Tae Jin Park (Tae Jin Park, 2014) performed a study on static balance on children with Down Syndrome after wobble board training. The

author here made a comparison between Centre of Pressure of children during quiet standing with eyes open and children with eyes closed after receiving wobble board training. Aim of the study was to examine the influence of Wobble Board Training on static balance, with and without vision, of adolescents with DS. The results shows $p<0.01$ for eyes open condition and $p<0.05$ for eyes closed condition. The author concluded that there was a significant improvement in static balance post Wobble Board Training. The author also commented that the Wobble Board Training enhances the proprioceptive function that compensates for interrupted vision, improving the balance ability of adolescents with DS.

In the present study aim was to improve dynamic balance in children with DS using wobble board as one of the balance training program. Here the outcomes used were FSST and FRT. The result of the study shows that there is a significant difference between pre readings and post readings of both the outcomes among group of children receiving wobble board training. Hence the study favours the results of the previously mentioned study.

N S Thabet and H M Kamal (Nahed S. Thabet and Hebatallah M. Kamal, 2011) performed a study on balance training children with DS. For balance training intervention the authors used Gravity Force Stimulation Training Program. The theory behind using this technique was providing a sensory feedback to improve balance. The results of the study showed significant improvements in dynamic balance and gait in experimental group. For evaluation Biodex Balance System was used. The obtained $p<0.05$ showed a significant difference between pre training readings and post training readings. The author commented that the improvement in the post treatment mean values of study group may be attributed to the increase of the activity of antigravity muscles which counteract the force of gravity and leads to modulation of postural control and maintenance of good alignment with least expenditure of energy.

The present study shows an improvement between pre and post readings of FSST after administering Gravity Force Stimulation Training. There was no significant improvement observed in FRT after balance training. In the present study all the children with DS were given conventional training that included horizontal jumps, vertical jumps, one leg stance, tandem standing, walking on line. In addition to this WBT and GFST was administered. Hence all the children were provide basic balance training. The main finding of the study is that following 4 weeks of intervention program there was a significant improvement observed in pre and post readings of FSST while very less difference between pre and post readings of FRT.

The reason for this difference could be difference in components of the outcome measures used. Both the outcomes measures the dynamic balance but the mechanism of performing the test varies. It is known that children with DS have hypotonia and ligamentous laxity. They very well make compensations and are able to walk. FSST measures dynamic balance by moving over the obstacles in a limited period of time. May be this task could be achieved using compensatory mechanisms.

In case of FRT, dynamic balance is measured with maintaining a static base of support and moving the torso over it. The child tries to make the maximum compensation in order to maintain balance but once COG moves further, stepping reaction occur. In FSST the whole body moves once COG is shifted. May be this could be a possible reason for difference in outcomes.

Secondly, the treatment techniques used varied in their mechanism of stressing the postural control system of the children. Exercise on a wobble board was a challenging task for children. Maintaining balance over the dynamic surface requires good amount of concentration and strength. On the other hand maintaining balance and moving over the two beams of the GFS was easier. However walking over a single beam was the difficult one but not as difficult as in Wobble Board training. Fear while standing on wobble board was a confounding factor. During wobble board training, therapist had to provide double hand support throughout the protocol.

Similarly walking over the edge of the two vertically placed wooden beams was difficult for children. This required double hand support from the therapist throughout the training protocol.

CONCLUSION

The result of present study concluded that there is a significant difference between Wobble Board Training and Gravity Force Stimulation Training program with conventional therapy in both the groups to improve dynamic balance. As per results obtained it is seen that Wobble Board Training improves dynamic balance in children with DS better as compared to Gravity Force Stimulation Training. In addition, Wobble Board is an easily available tool and easy to administer. In Gravity Force Stimulation Training few steps were extremely difficult for children to perform. The outcome measures FSST between group shows significant improvements between groups while FRT does not. Hence Wobble Board Training will be more effective in improving dynamic balance in children with DS as compared to Gravity Force Stimulation Technique.

CONFLICT OF INTEREST: Author agree that there was no source of Conflict of Interest.

SOURCE OF FUNDING: There was no source of funding from anyone for the present study.

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