Modulation of Gait Parameters in Relation to Postural Adjustment in Down's Syndrome

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ABSTRACT

Purpose: *This study was conducted to determine the effect of Biodex training on postural control and selected gait parameters in Down's syndrome children.* ***Subjects:*** *Thirty Down's syndrome children from both sexes, ranging in age from nine to eleven years, participated in this study. They were selected from the out-patient clinic of the Clinical Genetic Department, National Research Center. They were able to stand and walk independently with an abnormal gait pattern. They showed delayed postural reactions.* ***Methods:*** *They were divided randomly into two groups of equal number (A and B). Group A (control) received a designed exercise program to facilitate postural control and balance, while group B (study) received Biodex training to develop postural control in addition to the same exercise program given to group A. Evaluation was conducted for each child of the two groups, via using the Biodex stability system and determination of selected gait parameters, before and after treatment which was conducted three times per week for successive three months.* ***Results:*** *The results of this study after the suggested period of treatment revealed significant improvement in the measuring variables of the two groups (A and B) which was highly significant in favor of group B.* ***Discussion and Conclusion:*** *Significant improvement observed in the study group may be attributed to the effect of Biodex training which improved postural adjustment and in turn gait parameters.*
Key words: *Down's Syndrome, Postural control, Gait Parametens*

INTRODUCTION

Down's syndrome is the trisomy of chromosome 21. This is the most common trisomy among live births. The syndrome was named first mongolism because of the mongoloid facial appearance of patients with the syndrome. Nowadays the term mongolism is obsolete. Advanced maternal age is a major risk factor for Down's syndrome, for mothers aged twinty years or younger the risk is 1-2%, the occurrence is 1 per 2500 births. For mothers aged 45 years or older, the occurrence is 1 per 55 live births[1]. Down's syndrome is a disorder that includes a combination of birth defects, mental retardation, characteristic facial features, heart defects, increased infection, pulmonary problems, visual and auditory problems and other health problems. The severity of all these problems varies greatly among affected individuals[2]

Sedentary behavior and physical impairments commonly associated with the Down's syndrome, such as muscle weakness, circulatory and pulmonary abnormalities have been suggested as reasons for their poor level of physical fitness[3].

Down's syndrome has been recognized as one of the most important cause of disability. It is characterized by delay in development of motor function and mental retardation[4].

Mental retardation, ranging from moderate to severe, is clearly manifested in these patients. However, most Down's syndrome patients are considered trainable rather than educable[5].

Children with Down's syndrome are hypotonic, showing a delay in achieving gross motor milestones, such as sitting, standing and walking, in addition to retarded development of posture reactions[6].

It has been reported that, failure of the Down's syndrome children to achieve normal walking might be a result of their failure to maintain balance freely. Moreover, they lack the sufficient power to maintain their stability[7].

Postural control provides stability, which is exhibited in the form of balance in a variety of body configuration (e.g bipedal stance)[8].

Development of normal postural control is an essential aspect of the development of skilled actions, such as locomotion and manipulation[9].

Balance is a complex motor skill often referred to as postural control which is defined as the ability to maintain equilibrium in a gravitational field by keeping or returning the center of body mass over the base of support. Balance has been viewed as a pre requisite for functional competence because it is vital to the performance of activities of daily living[10].

Balance in standing is frequently used as an indicator of postural control. Both anticipatory and compensatory postural adjustments are required for normal standing balance[11].

An important aspect of postural control is the development of antigravity movement by which the child develops the ability to move against gravity with all body parts. Development of postural control is tightly linked to the acquisition of motor milestones. The development of antigravity movement is strongly associated with the development of higher levels of postural control or balance[12].

In order to walk normally, balance should be maintained, either statically or dynamically during single leg stance. Sufficient power must also be provided to make the necessary limb movements[13].

Postural adjustment occurs in order to maintain postural reactions (righting, equilibrium and protective reactions). These reactions are the intrinsic part of motor skills, carried out by a complex process involving integration of the afferents from the sensory system and afferents being sent from the central nervous system to intact musculoskeletal system. It is a complex process involving co-ordination actions of biomechanical, sensory, motor, and central nervous system components[14]. Anticipatory aspects of postural control prepare the sensory and motor systems for postural demands based on experience and learning[15].

As postural control appears to be an integral part of all motor abilities and improvement of movements, so, high priority should be given to the treatment of patients with postural control problem[9].

Biodex stability system is an important balance assessment and training system. This unique device is designed to stimulate joint mechanoreceptors. It can be used to assess neuromuscular control by quantifying the ability to maintain dynamic posture stability on an unstable surface, as well as, dynamic limits, of stability. This system also acts as a valuable training device to enhance the kinesthetic ability[16].

As children with Down's syndrome have problems in maintaining postural control, so there patients should be evaluated thoroughly and trented according to improve their pastural stability. This study is a trial conducted to determine the effects of balance training on postural control and selected gait parameters in Down's syndrome children.

SUBJECTS, INSTRUMENTATION AND PROCEDURES

Subjects

Thirty Down's syndrome children ranging in age between 9 and 11 years (X` 10.28±0.56years) participated in this study. Their height ranged between 115-130cm. (X`123±0.07cm.). They had a moderate degree of mental retardation, with an average IQ within 50. They had sufficient cognition and were able to understand commands given to them. They were able to stand and walk independently with an abnormal gait pattern. They showed delayed postural reactions as revealed from physical examination.

On basis of medical examination, the children had no other illnesses that might interfere with the treatment program as hearing or vision loss, cardiac anomalies or musculoskeletal disorders as hip dislocation.

The study sample was divided randomly into two groups of equal number (A and B). Group A (control) received a designed exercise program to facilitate postural control and balance, while group B (study) received Biodex training for facilitation of postural mechanism to develop postural control.

Evaluation was conducted for each child of the two groups through the use of Biodex stability system to determine the dynamic balance. Also, selected gait parameters including step length, cadence and velocity were determined.

Instrumentation

I - For evaluation

1- Kalk paper (walking sheet): A straight white kalk paper (10 meters long and 50 cm wide) was used for recording distance (step length) and temporal (cadence and velocity) parameters.
2- Stop watch
3- Ruler
4- Weight and height scale
5- Biodex stability system:

This device was used to assess balance and postural stability. It consists of movable balance platform which provides 20^o of surface tilting in 360^o range and is interfaced with a microprocessor based actuator. The system is interfaced with computer software maintained through the control painel screen and connected with Epson printer to print test results. Biodex stability system was used to evaluate antero-posterior, and medio-leteral stability.

II- For treatment

1- Mat, roller, ball, parallel bars, and tilting board.
2- Biodex stability system: Dynamic bilateral postural stability was used to train the child's ability to control the platform's angle of tilt

Procedures

I - For evaluation

After signing a written consent, all subjects were informed about the whole procedures before testing.

1- Evaluation of dynamic balance

This test was conducted to determine the child's ability to control the platform's angle of tilt. Each child was instructed to stand on the center of the locked platform on both feet while grasping the hand rails, the display screen were adjusted so that the child could look straight at it.

The fallowing parameters were fed to the device:

- Child's weight, height and age.
- Stability level (platform firmness). Stability level (8) was chosen to allow the most stable platform.

He/she was then instructed to achieve a centered position in a slightly unstable platform by shifting his/her feet position until it was easy to keep the cursor (representing the center of the platform) centered on the screen grid while standing in comfortable, upright position.

Once the child was centered and the cursor was in the center of the display target, he/she was asked to maintain his/her feet position till stabilizing the platform.

Recording of feet angles and heels coordinates from the platform was then followed. The child's heels coordinates were measured from the center of the back of the heel, while his/her foot angle was determined by finding a parallel line on the platform to the center line of the foot. After introducing feet angles and heels coordinates into the Biodex system, the test then began.

As the platform advanced to an unstable state, the child was instructed to focus on the visually feedback screen directly in front of him (while standing with both arms at the side of the body without grasping hand rails) and attempt to maintain the cursor in the middle of the bullseye on the screen.

The test duration lasted for 30 seconds for each child. The mean of three repetitions was determined.

At the end of each test trial a print out report was obtained. This report included information as regard overall stability index, antero-posterior stability index, and medio-lateral stability index. High values of these indices represent that the child had balance difficulty.

This test procedure was carried out for each child of the two groups individually before and after three months of treatment.

2- Gait evaluation

The kalk walking sheet was positioned on the floor of the gait evaluation area and fastened on both ends with adhesive tapes, to prevent its slipping. Each child was asked to put his / her bare feet in a bowel filled with water then place them in the colored powder and to walk as normally as he / she used to, from the start to the end of the walkway. Distance (step length) and temporal (cadence and velocity) were recorded by using the stopwatch and ruler as follows:

- Step length (cm.): Vertical distance from the center of the heel of one foot to the center of the heel of the other foot.
- Cadence (step / min): The number of steps divided by the elapsed time for a distance.
- Velocity (m / sec): The total distance between the first and last heel strikes divided by the elapsed time for the distance.

Three successive trials were allowed for testing each parameter and the mean values were obtained, for each child of the two groups, before and after three months of treatment.

II- For treatment

The thirty children representing the sample of the study were divided randomly into two groups of equal number (A and B).

A designed exercise program aiming to facilitate postural control and balance was conducted for each child of the two groups.

The exercise program included the following:

-Training the antigravity mechanism, from different positions against gravity.

-Training of righting and equilibrium reactions, on stable surfaces (medical ball, tilting board) from sitting and standing position.

-Training protective saving reactions, through quick, large amplitude of stimulus.

-Training of rising reactions, one of the dynamic components of balance training.
-Counterpoising mechanisms (to maintain balance during motion).
-Gait training activities:
Gait training was important for balance retraining. It was conducted as follows:
*Forward, backward, and side ways walking between the parallel bars (closed environment gait training)
*Obstacles include rolls and wedges with different diameters and hights, were put inside parallel bars.
*Open environment gait training was conducted with the previous obstacles but without parallel bars.
*Up and down stairs
In addition to the exercise program, group B (study) received Biodex training to facilitate dynamic balance as follows:

After obtaining centering step, each child was instructed to focus on the visual feedback screen directly in front of him/her and to attempt to maintain the cursor at the center of the bullseye on the screen while standing on the unstable plateform. The duration of training session was 20 minutes (2 minutes training and one minute rest). With improved balance capacity, the training session was progressed to be divided into 4 minutes training and one minute rest.

The total duration for each session of the two groups lasted about 60 minutes for three times / week for three successive months.

RESULTS

The collected data from this study represent, the statistical analysis of the stability indices including overall stability index, antero-posterior stability index and medio-lateral stability index of the dynamic balance test at the level 8 of stability (more stable platform). Also, the gait parameters including step length, cadence and velocity were measured before and after three months of treatment for the control and study groups. The raw data of the measured variables for the two groups were statistically treated to show the mean and standard deviation. Student t-test was then applied to examine the significance of the treatment procedures applied in each group. No significant difference was observed when comparing the pre-treatment mean values of the two groups. Significant improvement was observed in each group when comparing their pre and post-treatment mean values. After treatment, significant difference was observed when comparing the post-treatment results of the two groups in favor of the study group.

I- Stability indices

- For the control group:

As shown in table (1) and figure (1), the pre and post-treatment mean values of all the stability indices for the control group were as follows:

- Over all stability index:

The pre and post-treatment mean values of over all stability index were 1.38±0.65 and 0.91±0.77 respectively (P<0.001), which was statistically significant.

- Antero-posterior stability index:

Significant improvement was observed when comparing the pre and post-treatment mean values of antero-posterior stability index which were 0.97 ± 0.52 and 0.71 ± 0.46 respectively (P<0.001).

- Medio-lateral stability index:

The pre and post-treatment mean values of medio-lateral stability index were 1.09 ± 0.24 and 0.92 ± 0.31 respectively (P<0.001), which was statistically significant.

Table (1): pre and post-treatment mean values of the stability indices for the control group.

	Stability indices					
	Over all SI		Antero-posterior SI		Medio-lateral SI	
	Pre	Post	Pre	Post	Pre	Post
X`	1.38	0.91	0.97	0.71	1.09	0.92
± SD	± 0.65	± 0.77	± 0.52	± 0.46	± 0.24	± 0.31
t-test	6.85		5.62		6.50	
P-value	0 < 0.001		< 0.001		< 0.001	
Sig.	Significant		Significant		Significant	

X`: Mea SD: Standard deviation P-value: Level of significance Sig.: Significance SI: Stability index

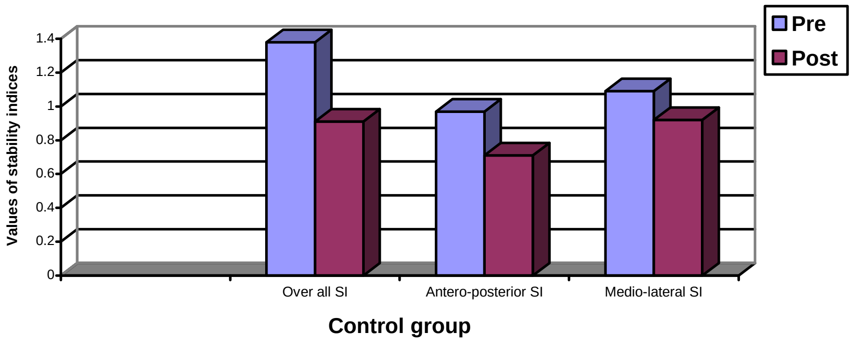

Fig. (1): Illustrating the pre and post-treatment mean values of the stability indices for the control group.

- For the study group:

As shown in table (2) and figure (2), the pre and post-treatment mean values of overall stability index, antero-posterior stability index and medio-lateral stability index at stability level 8 for the study group were as follows:

- Overall stability index:

Highly significant improvement was observed when comparing the pre and post-treatment mean values of over all stability index which were 1.36 ± 0.71 and 0.72 ± 0.63 respectively, (P < 0.0001).

- Antero-posterior stability index:

The pre and post-treatment mean values of antero-posterior stability index were 0.96 ± 0.43 and 0.64 ± 0.48 respectively, which was statistically highly significant, (P < 0.0001).

- Medio-lateral stability index:

Comparing the pre and post-treatment mean values of the medio-lateral stability index, there was highly significant improvement. The pre treatment mean value was 1.03 ± 0.24, while the post-treatment mean value was 0.74 ± 0.40 (P< 0.0001).

Table (2): Pre and post-treatment mean values of the stability indices for the study group

	Stability indices					
	Overall SI		Antero-posterior SI		Medio-lateral SI	
	Pre	Post	Pre	Post	Pre	Post
X	1.36	0.72	0.96	0.64	1.03	0.74
± SD	± 0.71	± 0.63	± 0.43	± 0.48	± 0.24	± 0.40
t-test	10.113		7.45		9.33	
P value	0 < 0.0001		< 0.0001		< 0.0001	
Sig	Highly Significant		Highly Significant		Highly Significant	

X`: Mean SD: Standard deviation P-value: Level of significance Sig.: Significance SI: Stability index

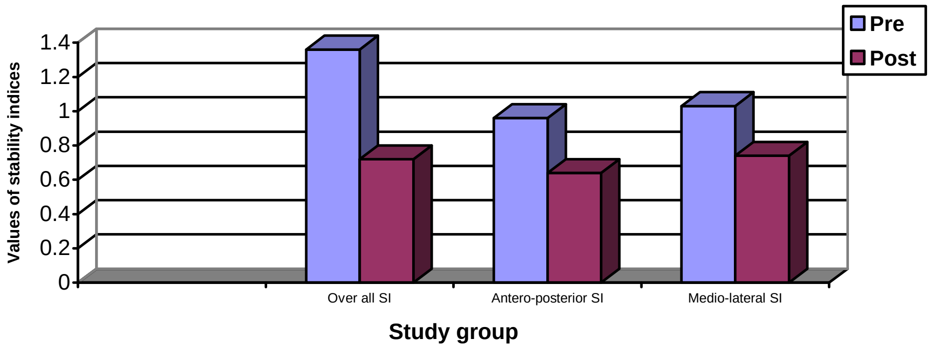

Fig. (2): Demonstrating the pre and post-treatment mean values of the stability indices for the study group.

Significant improvement was also observed when comparing the post-treatment mean values of the stability indices of the two groups in favor of group B, (P< 0.05), as shown in figure (3).

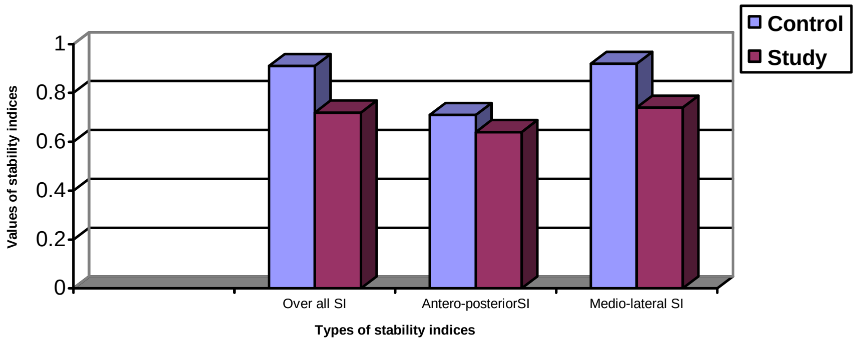

Fig. (3): Representing the post-treatment mean values of the stability indices for the control and study groups.

I- Gait parameters

1-step length

As shown in table (3) and figure (4), pre and post-treatment mean values of step length of the control group were 26.4±3.95cm. and 29.5±3.78cm., respectively (P<0.0001), which was statistically significant. Also, highly significant improvement was observed when comparing the pre and post-treatment mean values of step length of the study group which were 25.9±3.63cm. and 32.2±3.81cm. respectively (P<0.0001).

Table (3): Pre and post-treatment mean values of the step length (cm.) for the control and study groups.

	Control group		Study group	
	Pre	Post	Pre	Post
X`	26.4	29.5	25.9	32.2
± SD	± 3.95	± 3.78	± 3.63	± 3.81
t-test	8.51		17.96	
P value	0 < 0.0001		< 0.0001	
Sig.	Significant		Highly Significant	

X`: Mean SD: Standard deviation P-value: Level of significance Sig.: Significance

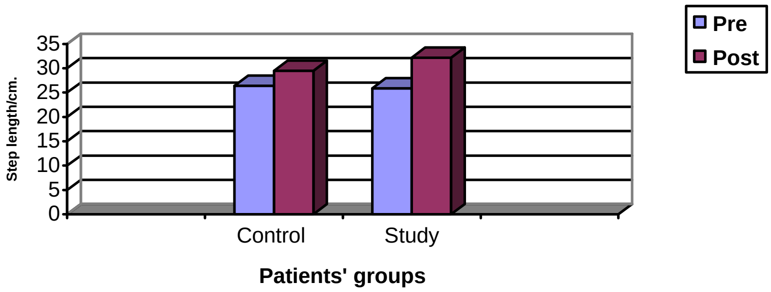

Fig. (4): Illustrating the pre and post-treatment mean values of the step length (cm.) for the control and study groups.

2-Cadence

As shown in table (4) and figure (5), pre and post-treatment mean values of cadence of the control group were 72.4±3.2 step/min. and 74.92±3.24 step/min., respectively (P<0.05) which was statistically significant. Also, significant improvement was observed when comparing the pre and post-treatment mean values of cadence of the study group which were 71.15±3.16 step/min. and 79.86±3.13 step/min. respectively (P<0.001).

Table (4): Pre and post-treatment mean values of cadence (step/min) for the control and study groups.

	Control group		Study group	
	Pre	Post	Pre	Post
X`	72.4	74.92	71.15	79.86
± SD	± 3.2	± 3.24	± 3.16	± 3.13
t-test	2.511		5.39	
P value	0 < 0.05		< 0.001	
Sig.	Significant		Significant	

X`: Mean SD: Standard deviation P-value: Level of significance Sig.: Significance

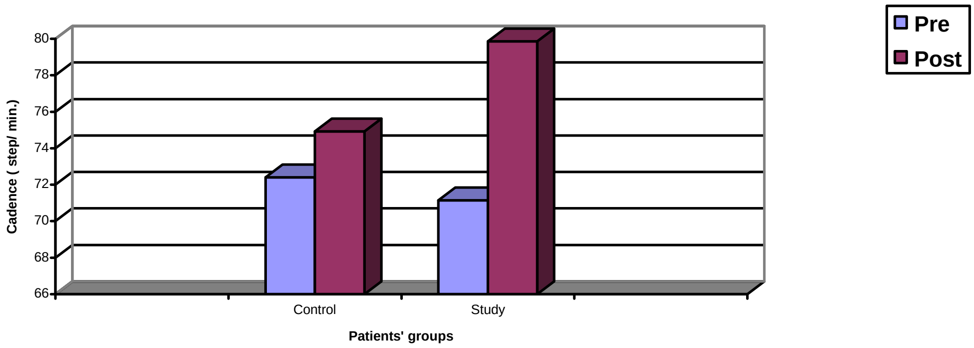

Fig. (5): Showing the pre and post-treatment mean values of cadence (step/min) for the control and study groups.

3-Velocity

As shown in table (5) and figure (6), pre and post-treatment mean values of velocity of the control group were 35.23±3.16cm./sec. and 37.34±3.51cm./sec., respectively (P<0.001), which was statistically significant. Also, significant improvement was observed when comparing the pre and post-treatment mean values of velocity of the study group which were 36.01±3.14cm./sec. and 40.02±3.45 cm./sec. respectively (P<0.0001).

Table (5): Pre and post-treatment mean values of the velocity (cm./sec) for the control and study groups.

	Control group		Study group	
	Pre	Post	Pre	Post
X`	35.23	37.34	36.01	40.02
± SD	± 3.16	± 3.51	± 3.14	± 3.45
t-test	6.70		12.89	
P value	0 < 0.001		< 0.0001	
Sig.	Significant		Highly Significant	

X`: Mean SD: Standard deviation P-value: Level of significance Sig.: Significance

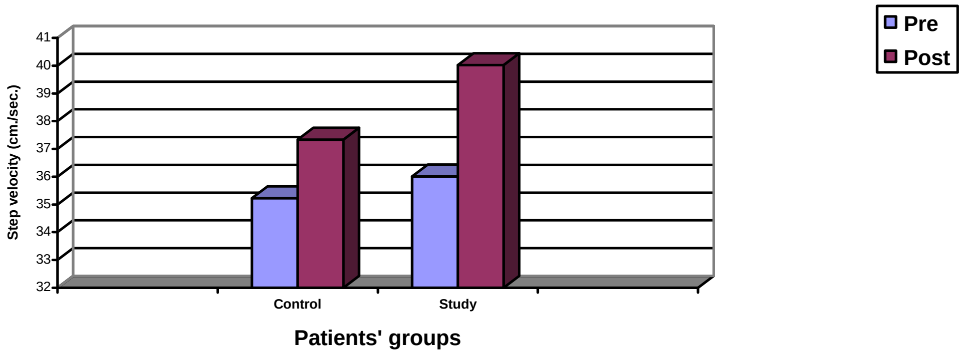

Fig. (6): Demonstrating the pre and post-treatment mean values of the velocity (cm./sec) for the control and study groups.

Significant improvement was also observed when comparing the post-treatment mean values of the gait parameters (step length, cadence, and velocity) of the two groups in favor of group B, (P< 0.05).

DISCUSSION

Down's syndrome is manifested by a delay in gross motor development as sitting, standing and walking. Failure of such development may be a result of their inability in maintaining balance due to lack of sufficient power. It has been reported that children with Down's syndrome between 7 and 14 years show defect in agility and balance tasks[17].

Development of normal postural control is an essential aspect of development of skilled actions as locomotion and manipulation, particularly in developmentally delayed children[9].

The aim of this study was to determine the effects of balance training on postural control and selected gait parameters in Down's syndrome children.

The aim of the study support the findings of Fishman et al.,[18] who believed that, communication between sensory system inputs and motor system outputs is required for normal standing balance. They stated that normal standing balance is the ability to maintain the body's center of gravity over its base of support with limited postural sway.

Shumway Cook and Woollacott[15] revealed that stance postural control is usually associated with the maintenance of vertical orientation to control a stable standing position. They added that, a number of factors contribute to postural control during quiet stance, including : a) body alignment which minimize the effect of gravitational force; b) muscle tone, and c) postural tone, which keeps the body from collapsing in response to the pull of gravity.

In the present study, the dynamic balance has been evaluated via using Biodex stability system among Down's syndrome children. Furthermore, deviations in some selected gait parameters were also evaluated. They were chosen to be a main representative parameters for delayed postural control and gross motor development and to determine the effect of treatment programs on them.

Jones and Barker[14] and Revel et al.,[19] reported that balance assessment should attempt to stimulate dynamic condition in order to stress the postural control system fully and reveal the presence of balance disorders.

This also agree with Fishman et al.,[18] who found that, in an attempt to measure standing balance, a large number of evaluation tools have been developed. They added that, tools that assess an individual's ability to maintain balance during external perturbation are thought to be more useful because control of the body during movement is the essence of practical standing balance.

Choosing gait as a parameter for evaluation come in agreement with Sutherland and Davis[13] and Whittle[7] who established that Down's syndrome children show a delay in achievement of normal gait as a result of lack of sufficient muscle power and balance to maintain stability.

The results of this study after the suggested period of treatment revealed significant improvement in the measuring variables of the two groups when comparing their pre and post-treatment mean values. Highly significant improvement was observed when comparing the post-treatment results of the two groups in the favor of group II. However, no significant difference was observed when comparing the pre- treatment mean values of the two groups.

The pre-treatment mean values revealed significant increase in the over all stability index, antero-posterior stability index, and medio-lateral stability index of the dynamic balance test which indicated that those children had a significant balance problems. Also, there was a decrease in the mean values of gait parameters including step length, cadence and velocity.

The pre-treatment results of the present study come in agreement with Testerman and Griend[20] who emphasized that the larger the numerical value of the stability index (represents the variance of platform displacement in degree from level), the greater the degree of difficulty or instability in balancing the platform. This also agree with Rozzi et al.,[16] who concluded that, compared to low stability indices, high stability indices indicate greater platform motion during stance and therefore denoting less stability.

As children with motor dysfunction suffer from problems in maintaining postural stability, so, the use of early intervention programs was directed to focus on the stimulation of developmental skills.

The post-treatment results indicated that the Biodex stability system has a great role in training of dynamic balance in children with Down's syndrome which was reflected also on improvement of the selected gait parameters.

In the present study, postural reactions (righting, equilibrium and protective reactions) have been considered to be related to motor events[21].

Facilitation of postural reactions aiming for improvement of dynamic balance and gait patterns in developmentally delayed children come in agreement with De Weerdt and Spaepen[22] who reported that postural adjustments are necessary for all motor tasks and need to be integrated within voluntary movements. These postural adjustments support the head and body against gravity and other external forces, and maintain the center of body mass aligned and balanced over the base of support. They added that, postural adjustments are achieved by means of anticipatory (feed forward) and compensatory (feed back) mechanisms.

The results of the study also agree with the results of Amin et al.,[23] who conducted a balance training program and reported significant improvement in balance and gait in Down's syndrome children.

Howle[21] stated that righting reactions are orienting reactions that bring the head and body into normal alignment when assuming an upright posture or when changing position. She added that, righting reactions can be initiated either by proprioceptive or tactile input as a result of changes in the body in relation to the support surface or through activation of the vestibular system as the head is moved in space.

The results of this study confirm the findings of Nicholes[12] who reported that, reactive or compensatory reactions are used to respond to external disturbances. It includes equilibrium and protective reactions. He found that postural control involves the programming of postural muscle activation in association with voluntary movement. This activation occurs in a feed forward manner. He stated that, feed forward is the anticipatory strategies that are observed in postural adjustments that the individual makes before voluntary movements.

The results of the study also come in agreement with Shumway Cook and Woollacott[15] who established that, when quiet stance is perturbed, the recovery of stability requires movement strategies that are effective in controlling the center of mass relative to the base of support. These motor strategies and underlying muscle synergies help in recovering stability when balance is threatened in response to brief displacements of the supporting surface. They classified these movement strategies into: a) antero-posterior stability which includes; ankle strategy, hip strategy and stepping strategy. B) medio-lateral control of balance, which is controlled predominantly by the hip abductors and adductors and to a lesser extent, by the ankle invertors and evertors.

Improvement fulfilled in the control and study groups might be attributed to the effect of the designed postural control exercises program, which included a group of exercise representing the integral components of the postural control, including antigravity mechanism, and postural reactions components.

Improvement in balance control come in agreement with Nashner[11] who revealed that, compensatory adjustments that accompany the disturbances of equilibrium relay on, visual, somatosensory and vestibular feed back mechanisms.

Improvement observed in balance and gait parameters may be attributed to the effects of improvement of postural reactions which required input from the visual somatosensory, vestibular system, ability to organize muscle activity in response to normal background postural sway to perturbation of balance sway, caused by reactive force during movement, Hozak and Shupert[24].

Improvement of the measured parameters may be attributed to the findings of Nichols[12] who described three sensory systems associated with postural control that contributes to the child's awareness of orientation in space:

a) Visual system, which provides a representation of the vertical plane that is dependent on the objects in the visual field.
b) Somatosensory system; that provides input from proprioceptors, mechanoreceptors and cutaneous receptors, which supply information about limb position and supporting surface characteristics.
c) Vestibular system; that provides a constant gravitational reference from postural orientation, with which the child compares visual and somatosensory inputs.

Improvement observed in group two receiving Biodex training may be attributed to the findings of Ragnarsdottir[10] who reported that, new theories about balance or postural control are derived from three major findings:
1) Postural adjustments that occur as a result of both sensory feedback and feed forward in anticipation or preparation.
2) Visual information from the environment has a powerful effect upon postural adjustments.
3) Muscle activation patterns which are task and context specific.

Improvement observed in the measuring variables may be due to the role of facilitatory program which lead to improvement of postural mechanisms which in turn might improve muscle tone, muscle strength and endurance. The treatment program may also lead to modulation of sensory discharges to neural connections of the motor cortex leading to improved coordination and automatic reactions.

Conclusion

It may be concluded that Biodex training may be added to the program of treatment of Down's syndrome children as it denoted significant effect on postural control and gait parameters.

REFERENCES

1- Natalio, J.I.: "Down Syndrome" American Academy of Ophthalmology J. April 8, 2005.
2- Leshin L.: "Down Syndrome": Health Issuses" www.ds.health.com, 2005.
3- Karen J.: "A systematic review of the outcomes of cardiovascular exercise program for people with Down Syndrome" Arch. of Phys. Med. and Rehab. Vol. 86, Oct., 2005.
4- Luigi M. and Diego M.: "The general movement in children with Down Syndrome" Early human development J., Vol. 79, Sept., 2004.
5- Robinson N.M. and Robinson H. B.: The mentally retarded child: A psychological approach, New York, Mc Graw Hill, 1976.
6- Haley S. M.: Postural reactions in infants with Down Syndrome Phys. Ther. 66 (1): 17-22, 1986.
7- Whittle, M.: Gait analysis: An introduction. Oxford: ButterWorth. Heinemann. 52-119, 1993.
8- Wade, M.G. and Jones, G.: The role of vision and spatial orientation in the maintenance of posture. Phys. Ther. 77(6): 619-628, 1997.
9- Shumway–Cook A. and McCollum, G.: Assessment and treatment of balance disorders in the neurologic patient. In Montgomery T., Connolly B., (eds), Motor control and physical therapy: Theoretical frame work and practial applications. Chattanooga, TN: Chattanooga Corp, 123-138, 1990.
10- Ragnarsdottir M.: The concept of balance. Physiotherapy, 82(6), 368-375, 1996.
11- Nashnar, L.M.: Practical biomechanics and physiology of balance. In: Jacobson, G.B., Newman, C.W. and Kartush, J. M. (eds), Hand book of balance function testing. Mo: Mosby-Year Book Inc., St. louis, 261-279, 1993.
12- Nichols, D.S.: The development of postural control. In: Case Smith, J., and Robertson, J. (eds), Occupational therapy for children.4th ed., Mosby, london, 266-288, 2001.
13- Sutherland, D.H. and Davis J.R.: Common abnormalities of the knee in cerebral palsy. Clin. Orthoped. and Related research 288:139-147, 1993.
14- Jones, K. and Barker, K.: Human movement explained, Butter Worth, Heineman Oxford, 1996.
15- Shumway-Cook, A. and Wollacott M. H.: Postural control. In: Shumway-Cook A., and Woollacott M. H (eds), Motor control theory and practical applications. 2nd ed., Lippincott Williams and Wilkins, Philadelphia, PP.: 163-217, 2001.
16- Rozzi S.L., Lephart S. M., Sterner R., and kuligowski. L.: Balance training for persons with functionally unstable ankles. JOSPT, 29 (8): 478-486., 1999.
17- Henderson S.E.; Morris J and Frith U.: The motor deficit in Down syndrome children: A problem of timing, J. Child psychology and Psychiatry, 22: 233-244, 1981.
18- Fishman M.N., Colby L. A., Sachs L.A., and Nichols D.S.: Comparison of upper extremity balance tasks and force platform testing in persons with hemiparesis, Phys. Ther. 77 (10): 1052-1062, 1997.
19- Revel M., Mingvet G., and Ergoy P.: Changes in cervicocephalic Kinesthesia after a proprioceptive rehabilitation program in patients with neck pain. Arch. Phys. Med. Rehab., 72: 288-291, 1999.
20- Testerman C., and Griend RV.: Evaluation of ankle instability using the Biodex stability system. Foot and Ankle Int, 20 (5) : 317-321, 1999.
21- Howle J.: Cerebral Palsy. In campbell, S.k. (ed.), Decision making in pediatric neurologic physical therapy. Churchill livingstone, New York, PP.: 23-83, 1999.
22- DeWeerdt W. and Spaepen A: Balance In: Durward, B R., Baer, G. D., Rowe, P. J. (eds)., Functional Human Movement: measurement and analysis. ButterWorth Heineman, Oxford, 204-218, 1999.
23- Amin H. M., shoukry K. E., Salem A. H. and. Mamdouh K. A: Role of postural reaction facilitation techniques on walking pattern in Down syndrome children. An M.sc. thesis,

Faculty of Physical Therapy, Cairo University, 1997.

24- Horak F. and Shupert C.: The Role of the vestibular system in Postural control. In: Herdman, S. (ed), Vestibular rehabilitation, FA Davis, Philadelphia, PP.: 22-72, 1994.

الملخّص العربي

تحوير قياسات المشي نتيجة علاقتها بتعديل القوام في متلازمة داون

تهدف هذه الدراسةِ الي تحديد تأثيرِ التدريب علي جهازعلاج الأتزان على التحكمِ في القوام من وضع الوقوف وايضا علي بعض قياسات المشي عند الأطفال المصابين بمتلازمة داون. اشتمل البحث علي ثلاثين طفلا من الجنسين ممن تَرَاوُحت أعمارهم بينْ تسعة إلى إحدى عشْر سنةِ، . وقد تم إختيارهم مِنْ العيادة الخارجيةِ لقسمِ الوراثة بالمركز القومي للبحوث طبقا لبعض المعايير الأساسية، وتلا ذلك تقسيمهم عشوائيا الي مجموعتين متساويتين (مجموعة ضابطة ومجموعة اجراء موضوع البحث). وقد تم قياس مؤشرات الثبات (الأجمالي – الأمامي الخلفي – الجانبي) علي مستوي الصعوبة الثامن وهو اسهل مستوي بجهاز الأتزان ، بالأضافة الي تحديد قياسات المشي (طول الخطوة ، عدد الخطوات في الدقيقة ،وسرعة المشي) عند جميع الأطفال قبل وبعد ثلاثة شهور من العلاج. وقد تلقت المجموعة الضابطة برنامج من التمرينات العلاجية للتحكم في ضبط القوام والتدريب علي المشي. بينما تلقت مجموعة اجراء موضوع البحث التدريب علي جهاز الأتزان بالأضافة الي تطبيق نفس برنامج التمرينات العلاجية المستخدم في المجموعة الضابطة. وقد أظهرت النتائج وجود فروق ذات دلالة احصائية في جميع القياسات عند مقارنة نتائج ماقبل العلاج بنتائج ما بعد العلاج للمجموعتين وأيضا عند مقارنة نتائج ما بعد العلاج للمجموعتين لصالح مجموعة اجراء موضوع البحث. وطبقا لهذه النتائج يوصي باستخدام التدريب علي جهاز الأتزان في علاج الأطفال المصابين بمتلازمة داون.