Available online at www.ijmrhs.com

ISSN No: 2319-5886

International Journal of Medical Research & Health Sciences, 2016, 5, 12:65-69

Postural control and balance assessment in children 15 years old with type 1 diabetes

Radwa S. Abdul-Rahman[1], Anees S. Ghait[2], Abdel Aziz Ali Sherief[2] and Amr AboGazy[2]

[1]Faculty of Physical Therapy, Cairo University
[2]Kafrelsheikh University, Egypt.
Corresponding Email: radwakku@gmail.com

ABSTRACT

The purpose of the study was to evaluate the balance and postural control in children 15 years old with type 1 diabetes . all of children participated in this study have ten years chronicity of diabetes. Thirty children shared in this study assumed two equal groups, fifteen were normal children (GI) and fifteen were children with type 1 diabetes (GII), Assessment was done by Biodex balance system via the dynamic balance test which including anteroposterior, mediolatoral and overall stability index.Their age was 15 years. Their body mass index between 14-18 kg/m2. The dynamic balance parameters(Anterior posterior, Mediolateral and Overall stability indices) measured by Biodex Balance System at stability level 7. Comparing between the mean values of participant's stability indices (OA,AP and ML) at stability level-7within the same group (A or B),there was no statistical significant difference (P> 0.05),But there was statistical significant difference between both groups(A&B)(P< 0.05) It could be concluded that there is decrease in balance parameters including (OA , AP and ML indices) at seven levels of stability during the dynamic balance test in children 15 years old with type 1 diabetes group compared with normal children.

Keywords: Balance; type 1 diabetes ; Biodex Balance System.

INTRODUCTION

Diabetes mellitus is the most common endocrine disease in childhood and adolescence. Fifty percent of individuals with type 1 diabetes which known as insulin-dependent diabetes mellitus (IDDM) are diagnosed before the age of 16 years. [1] The World Health Organization (WHO) defines diabetes mellitus as a metabolic disorder of multiple aetiologies characterised by chronic hyperglycaemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both. [2]

Type 1 diabetes is a chronic autoimmune disease in the vast majority and accounts for over 90 percent of childhood and adolescent diabetes in Australia. T-cell mediated destruction of the pancreatic beta cells leads to insulin deficiency. [3]

Susceptibility to autoimmune type 1 diabetes is determined by the interaction of multiple genes, with HLA genes having the strongest known association. Progressive beta cell destruction occurs at a variable rate and the disease becomes clinically symptomatic when approximately 90 percent of the pancreatic beta cells are destroyed. [4]Insulin deficiency then manifests itself clinically as blood glucose levels rise to pathological levels. The onset of the disease is predictable, especially in the relatives of affected individuals, using a combination of auto-antibody measurements, intravenous glucose tolerance testing and genetic typing. [5]

Diabetes in childhood usually presents with severe symptoms, very high blood glucose levels, marked glycosuria, ketonuria and frequently with ketoacidosis. The diagnosis is usually confirmed quickly by measurement of a marked elevation of the blood glucose level. In this situation treatment is urgent. Waiting another day to confirm the hyperglycaemia is neither necessary nor appropriate for diagnosis in such circumstances. [6]

The complications of diabetes affect body systems including the neuromuscular system in the form of sensory, motor and autonomic neuropathies. Motor neuropathy that occurs in diabetes is characterized by muscle atrophy, changes in gait, new pressure points and finally ulceration in foot. Sensory neuropathy is characterized by loss of sensation, bone changes, deformed foot, painless trauma, and finally ulceration in the foot. Autonomic neuropathy is characterized by decrease in prespiration, dry skin cracks fissures, infection, moderate sized areas of gangrane and finally amputation. An individual with diabetes may not experience any pain, even with serious vascular disease, because neuropathy can diminish the feeling or perception of these symptoms. Neuropathy is associated with the lack of senses of touch and pain that provide gait protection. [7]

Limited joint mobility is a complication affecting about 30% of those with type 1 diabetes in childhood and adolescence the limited joint mobility is associated with microvascular complications in children and adolescents as well as in adults. Limited joint mobility in the feet may lead to secondary foot problems associated with abnormal pressure areas. Contractures are seen more often in patients with poor long-term diabetic control. [8]

Balance is defined as the process of maintaining the center of gravity within the body's base of support. To maintain upright stance, the central and peripheral components of the nervous system are constantly interacting to control body alignment and the center of gravity over the base of support .Peripheral components in balance include the somatosensory, visual, and vestibular systems. The CNS incorporates the peripheral inputs from these systems and selects the most appropriate muscular responses to control body position and posture over the base of support. [9]
Balance is controlled on the basis of afferent information from the somatosensory, visual and vestibular systems. The first two systems are often affected in the presence of diabetes and also participate in increasing the risk of falling among this population. [10]

The somatosenory system is the biggest contributor of feedback for postural control. This sensory system is composed of several different muscle, joint, and cutaneous mechanoreceptors. The information from these receptors is integrated in the centeral nervous system to produce sensation of joint position and movement. The different receptors do not be seen to equally contribute to kinesthesia. For control of upright posture in individual without pathologic conditions the importance of muscle spindles particularly of the lower leg has been established in numerous studies. [9]

Diabetic neuropathy impairs muscle spindle function. As the neuropathic process progresses, its effect on the muscle spindle function increases. This could mean loss of either afferent or gamma efferent nerve to muscle spindle in the lower leg. Diabetes damages the spindle receptors themselves. [11]

Children with diabetes can develop nerve problems at any time, but significant clinical neuropathy can develop within the first ten years after receiving diabetes diagnosis so about 60% of people with diabetes have some form of neuropathy . [12]

The purpose of the study was to evaluate the balance and postural control parameters in children 15 years old with type 1 diabetes . all of children participated in this study have ten years chronicity of diabetes .

MATERIALS AND METHODS

Patients population:
Thirty children shared in this study assumed two equal groups, fifteen were normal children (GI) and fifteen were children with type 1 diabetes (GII), Assessment was done by Biodex balance system via the dynamic balance test which including anteroposterior, mediolatoral and overall stability index.

Their age was 15 years. Their body mass index between 14-18 kg/m2. The dynamic balance parameters(Anterior posterior, Mediolateral and Overall stability indices) measured by Biodex Balance System at stability level 7.The chronicity of diabetes was at least 10 years.

Inclusive criteria:
1- All selected patents were diabetic type 1.
2- All their ages were 15 years old .

Exculsive criteria:
1- No previous neuorological disease or syndrome.
2- No previous orthopedic disease or syndrome.

Equipment:

Biodex balance system

Is a balance screening and training tool. It consists of a movable balance platform, which provides up to 20 degree of surface tilt in a 360 degree range. (Biodex medical system Inc, Shirley New York, U.S.A. The stability levels available by the system range from a completely firm surface (stability level 8) to a very unstable surface (stability level 1)[9]**.** The computer analyzes the patient movements and determines in which directions the patient desire to move or is having difficulty moving. The study was done in biomechanics lab. At faculty of physical education, kafrelsheikh university and patient consent was taken for ethical standards.

The dynamic balance test parameters include

a- Anterior posterior stability index: represent the patient’s ability to control their balance in front to back directions. High values represent less stability in all indices of the system.
b- Mediolateral stability index: represent the patient’s ability to control their balance from side to side.
c- Overall stability index: represent the patient’s ability to control their balance in all direction.

Balance assessment:

The Biodex Balance assessment was performed in standing position as well as testing. The subject was instructed to focus on the visually feedback screen directly in front of him and attempt to maintain the cursor at the center of the screen while standing on the unstable platform (stability level seven) .

RESULTS

Comparing between the mean values of participant’s stability indices (OA,AP and ML) at stability level-7within the same group (A or B),there was no statistical significant difference (P> 0.05),But there was statistical significant difference between both groups(A&B)(P< 0.05)

Table 1: Stability indices for the normal control group at stability level seven.

Stability index (SI)	Level seven $\overline{X}$ **± SD**
Overall stability	3.35 ± 1.12
Anteroposterior stability	2.82 ± 1.11
Mediolateral stability	2.14 ± 0.732

1-Overall stability index: The mean value of OA index of the control group at stability level seven was 3.35 ± 1.12 .

2-Anteroposterior stability index: The mean value of AP stability of the control group at stability level seven was 2.82 ± 1.11 .

3-Mediolateral stability index: The mean value of ML stability of the control group at stability level seven was 2.14±0.732 .

Table 2: Stability indices for the study group at stability level seven.

Stability index (SI)	Level seven $\overline{X}$ **± SD**
Overall stability	11.406 ± 1.44
Anteroposterior stability	9.39 ± 1.25
Mediolateral stability	8.39 ± 1.14

Table 3 : Comparison between stability indices for the study group and the control group at stability level seven .

Stability Index (SI)		$\overline{X}$ ±SD	t value	Sign.
Overall	Study group	11.4± 1.44	0.00	P<0.05
	Control group	3.35±1.12		
Anteroposterior	Study group	9.39±1.25	0.00	P<0.05
	Control group	2.82±1.11		
Mediolateral	Study group	8.39± 1.14	0.00	P<0.05
	Control group	2.14 0.73		

1-Overall stability: Mean values of OA index pre treatment for study group and control group were 11.4± 1.44 and 3.35±1.12 respectively showed high significant differences.

2-Anteroposterior Stability: Mean values of AP stability pre treatment for the study group and the control group were 9.39±1.25 and 2.82±1.11 respectively showed high significant differences.

3-Mediolateral Stability: Mean values of ML stability pre treatment for the study group and the control group were 8.39± 1.14 and 2.14 ±0.73 respectively, showed high significant differences.

DISCUSSION

No literature exposed to the evaluation of the balance and postural control in children 15 years old with type 1 diabetes using the Biodex balance system so from this point the need of our study has been derived and established. The elevated stability indices of the dynamic balance test at stability level seven in the study group could be attributed to muscles weakness especially the foot and ankle. In addition to limited joint mobility. [13]

Deficits in the standing postural control of children with type one diabetes could be attributed also to severe muscle weakness specially of the foot and ankle muscles. As diabetes affect muscle strength and decrease power required to produce joint stability and adequate reactions. [13]

The elevated stability indices of the dynamic balance test at stability level seven in the study group proved that balance was disrupted on this level of stability level four. This could be attributed to inability of of children with type 1 diabetes to activate distal muscles (ankle synergy) quickly enough to recover stability at the maximum disturbance produced at level seven due to timing problem.

In general, diabetes affects muscle strength or the amount of force the muscle produce. The lower extremity strength can be reduced by as much as 40% between age 30 and 80 years. [14] . Endurance which is the capacity of the muscle to contract continuously at sub maximal level decrease by diabetes and aging process which lead to smaller size of muscles and this reduction in muscle mass is greater in the lower extremity than the upper extremity. The muscle cell die and they are replaced by connective tissue and fat. [15]

So that deficits related to standing balance in the children with type 1 diabetes of the present study might be due to reduced sensation, distorted proprioception of the lower limb, decline in the muscle strength of the lower limb specially foot and ankle, decline in the muscle endurance that may affect their ability to maintain balance in addition to limited joint mobility.

Also, the increased blood glucose level increases non enzymatic glycosylation of collagen which cause abnormal cross linking and subsequent stiffness of the soft tissue which leads to limited ankle dorsiflexion and decrease the mobility of the first ray. In addition chronic edema of the lower limb can lead to fibrosis of the soft tissue, which compounds the local stiffness. It has been speculated that contracture of tendon Achilles in uncontrolled blood sugar is by product of the glycosylation. [16]

The present study is consistent with that of who found that diabetic peripheral neuropathy lead to problems throughout the body. [17] One of these problem is neuropathy linked with loss of balance. Clinical neuropathy can develop within the first ten years after receiving diabetes diagnosis. About 60% of people with diabetes have some form of neuropathy. The exact causes of neuropathy are unknown, several factors may contribute to the disorders, including high blood glucose which cause chemical changes in the nerves impairs the nerve ability to transmit signals. It also damage blood vessels that carry oxygen and nutrients to the nerves.

It could be concluded that there is decrease in balance parameters including (OA , AP and ML indices) at seven level of stability during the dynamic balance test in children 15 years old with type 1 diabetes group compared with normal children .

REFERENCES

[1] Aaron L,Braraslon D,and Roy F: Diabetic autonomic neuropathy. Diabetes Care, 2003, 26 (2): 1553-1579,.
[2]-Dellon A: Diabetic Neuropathy: Review of a Surgical Approach to Restore Sensation, Relieve Pain, and Prevent Ulceration and Amputation: J foot and ankle International, 2004, 25 , (10) : 749-755,.
[3]Rubenstein L,Kenny R, and Koval K:Guidelines for prevention of falls in older persons .J AM Geriat SOC, 2004, 4 (49) 664-672 ,.
[4]Shumway-Cook A and Wollacott M : Postural control in normal human. Physiother, 2001, 11 (4), 32-33, .

[5**]**Sacks DS, Bruns DE, Goldstein DE, Maclaren NK, Mcdonald GM, and Parroll MA: Guide lines and recommendations for laboratory analysis and in the diagnosis and management of Diabetes Mellitus.Clin Chem , 2002, 48:436-472,.
[6]Paolo P: Autoimmune Diabetes Not requiring Insulin at diagnosis (Latent Auto immune Diabetes of the Adult). Diabetes Care, 2001, 24: 1460-1467,.
[7]Gardener T: Practical implementation of an exercise in elderly diabetic persons. Aging, 2001, 30(1): 77-89,.
[8]Nichols D.S.:The development of postural control .4th "ed",Philadelphia, F.A.,Davis Co, 2001, PP 266-288.
[9**]**Rozzi S,lephart S,sterner R, and kuligowski I :Balance training for persons with functionally unstable ankles.JOSPT, 1999, 29(8):478-486 .
[10**]**Hess J,Woollacott M and Shivitz N :Aging process. Clin-Exp-Res. 2006,18(2):107-115.
[11**]**Khan k , Ambroset B, Donalson M, and Mckay H:Physical activity to prevent falls in older people :time to intervene in high risk groups using falls as an outcome .Br J Sports Med. 2001, 23 (4): 144-145.
[12**]**Nakamura H ,Tsuchida T and Mano Y :The assessment of postural control in the elderly using the displacement of the center of pressure after forward platform translation. J Electromyogr Kinesiol, 2001,11 :395-403.
[13**]**Gutierrez E, Helber M, Dealva D, and Richardson J: Diabetes mellitus .Clin Biomech 2001, 16(6):522-528.
[14**]**Opara E: Oxidative stress, micronutrients, diabetes mellitus and its complications. JR Soc Health , 2002, 122(1): 28 34.
[15**]**Osullivan F: Strategies to improve motor control and motor learning. J Electromyogr Kinesiol, 2002, 15 :195-203.
[16**]**Skeleton D and Beyer N :Exercise and injuiry prevention in older people . J Med Sci Sports,2003 , (13)1 :77-85 .
[17**]**Zheng Y, Choi Y, Wong K, and Chan S :Biomechanical assessment of planter foot tissue in diabetic patient using an ultrasound identation system. Ultrasound Med. Biol. 2000, 26 (5) : 451-456 .