Effect of Proprioceptive Training Program on Balance in Patients with Diabetic Neuropathy: A controlled randomized study

Abeer El-Wishy; PTD and Enas Elsayed; PTD
Department of Physical Therapy for Neuromuscular Disorders and its Surgery, Faculty of Physical Therapy, Cairo University, Egypt
Correspondence: Abeer El-Wishy
E-mail: dr.abeerewishy2011@gmail.com

ABSTRACT

Background: *Peripheral neuropathy is a common complication of diabetes mellitus. Peripheral neural damage, in turn, causes balance impairments.* ***Purpose:*** *The aim of the study was to investigate the effects of proprioceptive training program on sway indices and functional balance in diabetic peripheral neuropathy.* ***Participants:*** *Twenty eight diabetic patients were recruited and equally divided into two groups: Proprioceptive training group and control group.* ***Methods:*** *Participants in both groups were examined for balance abilities through Berg balance scale (BBS) and the Biodex Balance System during bipedal stance with closed eyes before and after intervention. Intervention was given twice weekly for 8 weeks. The control group received conventional physiotherapy for 45 minutes while the proprioceptive training group received an additional circuit of 13 stations of balance exercises.* ***Results:*** *No base line differences were found between both groups before treatment. Significant decrease in the balance indices (overall stability index, anterior-posterior stability index and medial–lateral stability index) and significant increase in BBS scores were recorded after treatment in both control and proprioceptive training groups. After treatment, there was significant improvemt in balance indices and BBS score mean values in the proprioceptive training group compared to that of the control group (P > 0.05).* ***Conclusion:*** *Proprioceptive training along with conventional physiotherapy was more effective than conventional physiotherapy alone in improving functional balance and reducing balance indices in diabetic neuropathy.*

Key words: *Balance, Diabetic neuropathy, Proprioceptive training, Berg balance scale, Biodex balance system.*

INTRODUCTION

Polyneuropathy is a common problem for people with diabetes, leading to pain and impaired sensation and movement in the limbs[1]. Diabetic neuropathy plays a significant role in falling as patients often experience balance disorder[2,3]. Postural sway in those patients is increased, especially with the eyes closed[4]. Peripheral neuropathy caused by diabetes significantly causes impairment of feet sensation, reducing patients' ability to control their balance properly during daily activities[5]. Poor balance can be attributed to proprioception impairment, movement-strategy dysfunction, biomechanical structural disorders, and disorientation[6,7]. Consequently, postural instability caused by peripheral neuropathy increases the impact of microtraumas and wounds[8].

Proprioception plays a major role in stabilizing body equilibrium during both quiet stance and unexpected postural perturbations[9,10]. Accordingly, patients with peripheral neuropathy are unstable when standing with eyes closed[11].

Many authors have found that individuals with diabetes and peripheral neuropathy demonstrate impaired postural control in quiet standing compared to healthy control subjects. Boucher and colleagues[12] reported that individuals with diabetes and peripheral neuropathy had greater postural sway in quiet standing and greater difficulty integrating sensory information for balance control than healthy control subjects. They added that postural control was related to the severity of peripheral neuropathy. Additionally, Lafond and co-authors[13] found that postural sway in elders with diabetes and peripheral neuropathy with eyes open was comparable to healthy elders with eyes closed. These studies focused on how diabetic peripheral neuropathy affects postural control. The objective of the current study was to assess the effects of proprioceptive training on balance indices during bipedal stance with eyes closed and functional balance in diabetic neuropathy patients.

METHOD

Design and Participants

In this randomized controlled clinical study, forty two patients, diagnosed as diabetes type II or non- isulin dependent diabetes mellitus, were recruited from the diabetes out -patient clinic, Kasr El-Aini educational hospital, Cairo University (fig. 1). Inclusion criteria: Age ranged from 35 and 50 years, peripheral neuropathy was confirmed by electrodiagnostic tests, duration of polyneuropathy was at least two years, and patients were able to stand on both feet and on one leg. Exclusion criteria: Diabetic ulcers in either foot, uncontrolled blood sugar, inner ear infections, any neurological illness that can affect balance, musculoskeletal problems such as vertebral column and limb deformity, history of repeated ankle sprains in the year before, severe pain influencing balance or visual problems. Absence for two therapy sessions led to exclusion of patients from the research. Twenty eight patients who met the inclusion criteria provided written informed consent and were allocated randomly using a computer- generated random numbers into either control or proprioceptive training program.

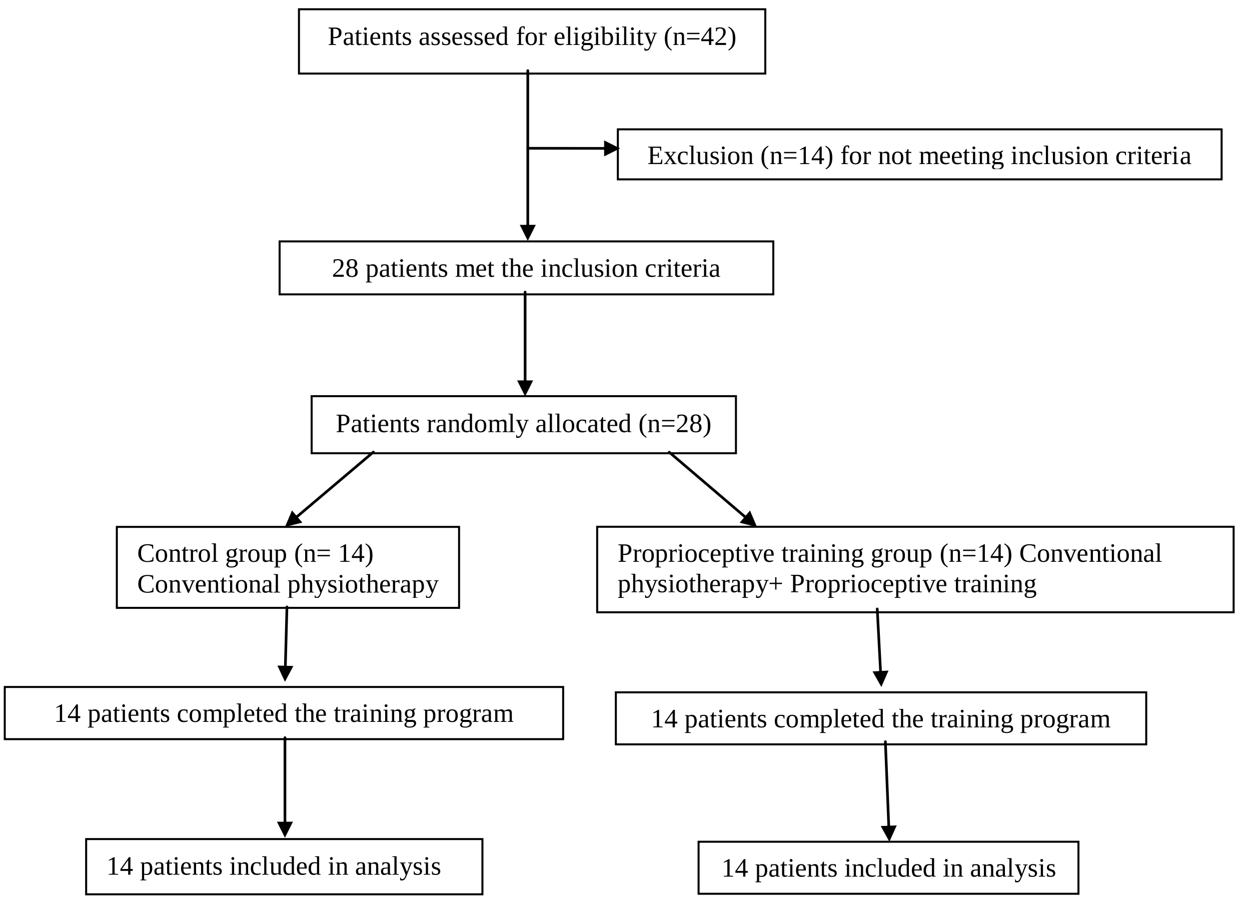

Fig. (1): Flow diagram for randomized patient's assignment.

Assessment

Berg Balance Scale (BBS) was used in order to evaluate functional balance before and after intervention. It is a valid and reliable scale including 14 functional tests, which can quantitatively evaluate balance in community-dwelling adults and patients with balance disorders. Berg Balance Scale completion needs 10-20 min. and its score represents the participant's ability to control postural balance.

Each test is scored 0-4 (0 – inability to complete the task; 4 – independent task fulfillment). The overall score is the sum of the obtained scores for each test. Thus, the maximal overall score is 56, and the minimal is zero. The higher score indicates a better functional balance[14,15]. Various studies have shown that BBS has high Intra-rater, Inter-rater and test retest reliability[16,17,18].

The Biodex balance system (Biodex Crop. Shirley, Ny, USA) includes a circular platform that is free to move about the anterior-posterior (AP) and medial-lateral (ML) directions simultaneously. Also, one can change the stability of the platform by varying the resistance force applied to the platform by underside springs. The springs' forces are adjustable to preset resistance levels that determine the difficulty levels of the system. The device measures the degree of tilt about each axis of ML and AP during dynamic conditions by two under-platform potentiometers that record tilting. Its movable balance platform provides up to 20° of surface tilt in a 360° range of motion. The platform is connected to computer software (Biodex, Version 3.1; Biodex Medical Systems) that enables the device to be used objectively for assessing balance. Balance tests in the control and proprioceptive training group were performed before and after treatment. Overall stability index (OSI), an index of deviation in any direction from the horizontal plane on the Biodex balance system plate; anterior-posterior stability index (APSI), an index of deviation on the Biodex balance system plate in the sagittal plane; and medial–lateral stability index (MLSI), a deviation on the Biodex balance system plate on the frontal plane, were measured. A high score in the indexes indicates poor balance[19].

The subject was instructed to assume a bipedal stance on the platform with eyes closed while it was locked in a level position. This foot placement was maintained throughout all three trials. This position was used as the reference point level from which the degree of displacement was measured. The test period was started by unlocking the platform, and the subject then attempted to maintain his or her balance for thirty seconds. Each subject was allowed three practice attempts for familiarization purposes, and this was followed by three test trials at stability level one (the least stable platform). The mean displacement from the referenced level position during the thirty-second trial was calculated for each trial. The mean and standard deviation of the three trials was calculated by the Biodex balance system. A higher stability index from the reference point indicates a greater difficulty of the subject to maintain the platform in a stable position. This indicates less postural stability demonstrated by the subject. In the study by Schmitz and Arnold[20], they reported an intratester reliability of 0.80 for the APSI, 0.43 for the MLSI, and 0.82 for the OSI.

Assessment was conducted by two blinded evaluators not involved in the treatment before and after the eight weeks training program.

Intervention

Intervention was provided twice weekly for 8 weeks.

Control group: Conventional physiotherapy treatment[21] was given for 45 minutes with one minute rest for every five minutes of exercises. The program included the following exercises: Relaxed deep breathing exercise (3 min.), range of motion exercises for bilateral ankle joints (5 min.), functional balance training (15 min.) involving sit to stand (5 times); standing weight shift (5 times each); functional reach-sideway and anterior for touching targets set by the therapist (5 times each); bipedal heel rise for 20 seconds (5 times); unipedal standing for 15 seconds (5 times each) and unipedal standing with knee bending for 15 second (5 times each). Other exercises were practiced as wobble board training (6 min.) and gait training including tandem walking (5 min.) and spot marching (5 min.).

Proprioceptive training group: The same conventional physiotherapy of the control group was practiced with an additional 26 minu. of proprioceptive training (one min. rest for every six min. of exercises). The protocol, as described by Santos et al.[22] included a circuit with different floor textures composed of 13 stations of exercises with the objective of stimulating the sole of the foot where participants had to coordinate gait by stepping

with alternate feet on markers placed on the ground and the progression was manipulated through modifications of speed and direction.
The activity time at each station was two min. and the rhythm of the exercises was determined by alternating slow-paced and fast-paced music. Materials used to build the circuit were used in the following sequence: 10 cm-thick foam, a wood box with beans, a two-cm thick mat with a density lower than the foam, a wood box with cotton, and again a similar two-cm thick mat. A balance board was then used to train the lateral balance reactions. At the seventh station, volunteers sat on a bench and trained feet flexors by grasping with the toes a towel put on the floor. At the eighth station, there was again a ten-cm thick foam. Two proprioception balls with an eight-cm diameter with external projections resting on the floor were used on the next station. At the 10^{th} and 11^{th} stations, there was a box with grains and a two-cm mat. Balance and hip movements were trained at the 12^{th} station with medicine balls (diameter 75cm). At the last station, sandpaper was placed on the ground and the patients had to alternately slide their feet on it.

Statistical analysis

The sample size was calculated with the Graphpad Statemate 2.0 software (Power test). Calculations were based on means and standard deviations of the balance indices obtained in a pilot study with an α =0.05 and power of 80% and the estimated sample size was 14 patients.

Statistical analyses were completed using SPSS version 17.0 (SPSS, Inc, Chicago, IL). Normality of the data was determined with the Kolmogorov–Smirnov (KS) test for all statistical variables and the results confirmed use of parametric tests. Differences within the groups was determined by paired t -test and between groups by unpaired t- test. Standardized difference of the mean (SDM) was calculated based on Cohen d standard effect size index: small (SDM: ≤0.2), medium (SDM: >0.2 but ≤0.7), and large (SDM: ≥0.8 to 2.0).

RESULTS

All patients performed training without any complications and agreed to the use of their training data. Kolmogorov-Smirnov analysis of normality showed that data distribution assessments were normal. No baseline differences regarding descriptive and demographic characteristics were found between both groups (table 1). Likewise, no significant differences regarding the studied parameters were found before the intervention (table 3).

Biodex Balance System Indices

The mean Biodex balance system indices showed significant reductions for OSI, APSI and MLSI for control group (P< 0.05) and the proprioceptive training group (P=0.0001) (table 2). Moreover, a significant reduction was found after treatment between both groups. Overall, the difference was large in magnitude based on effect size as OSI (d=1), APSI (d=0.9) and MLSI (d=0.9) (table 3).

BBS scores

Significant increase in BBS scores was found for both control group (P=0.021) and the proprioceptive training group (P=0.0001) (Table 2). Additionally, the difference was large in magnitude based on effect size (d=.8) between both groups after treatment (Table 3).

Table (1): Patients' baseline descriptive and demographic characteristics.

	Control group (n=14)	Proprioceptive training group (n=14)	P
Males/females	7/7	6/8	Ns
Age(years)	60.3±2.6	61±2.4	.76
Body mass index(Kg/m^2)	27.5±1.1	27±1.6	.82
Duration of disease(years)	7±2.3	6.8±1.5	.87

Values are mean ± standard deviation

Table (2): Comparison of OSI, APSI and MLSI and BBS score mean values between before and after treatment for the control and proprioceptive training groups.

	Control group			Proprioceptive training group		
	Before	After	p	Before	After	p
OSI	6.02 ±1.2	4.8± 1.12	0.0123	5.9±1.1	3.83± 0.95	0.0001
APSI	4.95± 0.86	3.78± 0.84	0.0012	4.47± 0.97	2.44± 0.75	0.0001
MLSI	3.42± 0.93	2.4 ± 0.9	0.0073	3.7 ±0.88	1.58± 0.76	0.0001
BBS	33.71± 7.25	40.36± 7.06	0.0210	35.0± 4.93	46.14± 5.82	0.0001

Values are mean ± standard deviation, OSI: overall stability index; APSI: anterior–posterior stability index: ML: medial–lateral stability index and BBS: Berg balance scale.

Table (3): Results of the mean differences of OSI, APSI and MLSI in degrees and BBS scores before and after treatment for both control and Proprioceptive training groups.

	Before treatment		After treatment		
	Mean difference	p	Mean difference	P	Cohen's d
OSI	-0.02857	0.9483	-1.014	0.0154	1
APSI	-0.4786	0.1781	-1.343	0.0001	.9
MLSI	0.2786	0.4231	-0.8450	0.0119	.9
BBS	1.286	0.5878	5.786	0.0256	.8

DISCUSSION

The principal finding of the present study was that proprioceptive training along with conventional physiotherapy was significantly more effective than conventional physiotherapy alone in improving both balance indices (OASI, APSI and MLSI) as measured by Biodex balance system and functional balance, measured by BBS, in patients with diabetic polyneuropathy.

Limitations of the study were the absence of long-term follow up of participants and the inability to blind the trial practitioners.

Distal sensorimotor polyneuropathy (DPN) is one of the most common long-term complications of diabetes mellitus. Up to 50% of elderly diabetic patients with a >25-year history of diabetes has DPN which leads to a distal to proximal deterioration of the nervous system in lower extremities[23,24,25], disrupts an important sensory system contributing in human postural control, i.e. somatosensory system[26]. Lack of accurate proprioceptive information from the lower extremities in DPN patient has resulted in postural instability during different static and dynamic situations, especially when the body is exposed to unexpected postural perturbations[24,26,27,28.29,30]. Therefore, those patients are at high risk for falling with its life threatening consequences[25,26,27,30].

Findings of the current study is in line with other studies that analyzed the effects of proprioceptive exercise programs for patients with diabetes[22,31,32]. They reported that balance and postural stability can be improved, probably by means of an increase in peripheral afference, leading to a reduction of falls related to sensory deficits.

Postural control is the resultant from the interaction of the vestibular, visual and sensory systems, and any alterations in one or more of these systems, such as sensory deficits on the feet, can result in postural instability. The reduction of OASI, APSI and MLSI indices observed in this study after the training protocol could be attributed to the multisensory nature of the stimulation provided by the intervention. The better improvement in the proprioceptive training group compared to control group might be due to the fact that, practicing balance training in progressive challenging levels as described in the study, can enhance somatosensory integration[33,34,35]. In addition, propriocetive training provides an unsteady surface that challenges the body to maintain balance. During the exercise intervention, sensory inputs were manipulated by altering the support surface. These manipulations forced participants to effectively reweigh remaining inputs within the CNS[36].

Evidence of similarly enhanced central integration, following sensory training has been found in previous studies, demonstrating improved stability during the manipulation of proprioceptive or vestibular environment[33,37]. Moreover proprioceptive training can also augment increased proprioceptive firing from the cutaneous receptors from the feet and also from mechanoreceptors of the muscle during co-contraction produced by the swaying movement[38]. It is also accountable that the new and augmented feedback might have enhanced motor learning which can also have an effect on the balance. Finally, proprioceptive training can be used as a simple and cost effective treatment program in improving functional balance in diabetic neuropathic patients. This may help the patient to improve their quality of life by reducing the risk of falls when performing activities of daily living.

Conclusion

Proprioceptive training along with conventional physiotherapy was more effective than conventional physiotherapy alone in improving functional balance and reducing balance indices in diabetic neuropathy.

REFERENCES

1- Chalk, C., Benstead, T.J. and Moore, F.: Aldose reductase inhibi-tors for the treatment of diabetic polyneuropathy. Cochrane Database Syst Rev.; 17(4): CD004572. PMID: 17943821, 2007.
2- Maurer, M.S., Burcham, J. and Cheng, H.: Diabetes mellitus is associated with an increased risk of falls in elderly residents of a long-term care facility. J Gerontol A Biol Sci Med Sci.; 60(9):1157-1162, 2005.
3- Uccioli, L., Giacomini, P.G., Monticone, G., Magrini, A., Durola, L., Bruno, E., Parisi, L., Di Girolamo, S. and Menzinger, G.: Body sway in diabetic neuropathy. Diabetes Care.; 18(3): 339-344, 1995.
4- Ahmmed, A.U. and Mackenzie, I.J.: Posture changes in diabetes mellitus. J Laryngol Otol.; 117(5): 358-364, 2003.
5- Boucher, P., Teasdale, N., Courtemanche, R., Bard, C. and Fleury, M.: Postural stability in diabetic polyneuropathy. Diabetes Care.; 18(5):638-645, 1995.
6- Akbari, M., Karimi, H., Farahini, H. and Faghihzadeh, S.: Balance problems after unilateral lateral ankle sprains. J Rehabil Res Dev.; 43(7): 819-824, 2006.
7- De Oliveira, C.B., De Medeiros, I.R., Frota, N.A., Greters, M.E. and Conforto, A.B.: Balance control in hemiparetic stroke patients: main tools for evaluation. J Rehabil Res Dev.; 45(8):1215-1226, 2008.
8- Katoulis, E.C., Ebdon-Parry, M., Hollis, S., Harrison, A.J., Vileikyte, L., Kulkarni, J., Boulton, A.J.: Postural instability in diabetic neuropathic patients at risk of foot ulceration. Dia-bet Med.; 14(4): 296-300, 1997.
9- Fitzpatrick, R. and McCloskey, D.I.: Proprioceptive, visual and vestibular thresholds for the perception of sway during standing in humans. J Physiol; 478: 173-186, 1994.
10- Peterka, R.J. and Benolken, M.S.: Role of somatosensory and vestibular cues in attenuating visually induced human postural sway. Exp Brain Res; 105: 101-110, 1995.
11- Ledin, T., Odkvist, L.M., Vrethem, M. and Moller, C.: Dynamic posturography in assessment of polyneuropathic disease. J Vestib Res; 1: 123-128, 1991.
12- Boucher, P., Teasdale, N., Courtemanche, R., Bard, C. and Fleury, M.: Postural stability in diabetic polyneuropathy. Diabetes Care, 18: 638-645, 1995.
13- Lafond, D., Corriveau, H. and Prince, F.: Postural control mechanisms during quiet standing in patients with diabetic sensory neuropathy. Diabetes Care, 27: 173-178, 2004.
14- Berg, K.O., Wood-Dauphinee, S.L., Williams, J.I. and Maki, B.E.: Measuring balance in the elderly: validation of an instrument. Can J Public Health; 83(Suppl. 2): S7-11, 1992.
15- Berg, K.O., Maki, B.E., Williams, J.I., Holliday, P.J. and Wood-Dauphinee, S.L.: A comparison of clinically and laboratory measures of postural balance in an elderly population. Arch Phys Med Rehabil; 73: 1073-1083, 1992.
16- Berg, K.O., Wood-Dauphinee, S.L., Williams, J.I. and Gayton, D.: Measuring balance in the elderly: preliminary development of an instrument. Physiotherapy Canada; 41: 304-311, 1989.
17- Newstead, A.H., Hinman, M.R. and Tomberlin, J.A.: Reliability of the Berg Balance Scale and Balance Master Limits of Stability Tests for Individuals with Brain Injury. Journal of Neurologic Physical Therapy; 29: 18-23, 2005.

18- Teresa, M.S., Timothy, A.H. and Louise, M.: Age- and Gender-Related Test Performance in Community-Dwelling Elderly People: Six-Minute Walk Test, Berg Balance Scale, Timed Up & Go Test, and Gait Speeds. Physical Therapy; 82: 128-137, 2002.
19- Arnold, B.L. and Schmitz, R.J.: Examination of balance measures produced by the Biodex stability system. J Athl Train.; 33(4): 323-327, 1998.
20- Schmitz, R.J. and Arnold, B.: Intertester and intratester reliability of a dynamic balance protocol using the Biodex stability system. J Sport Rehabil.; 7(2): 95-101, 1998.
21- Richardson, J.K., Sandman, D. and Vela, S.: A focused exercise regimen improves clinical measures of balance in patients with peripheral neuropathy. Arch Phys Med Rehabil; 82: 205-209, 2001.
22- Santos, A., Bertato, F., Montebelo, M. and Guirro, E.: Effect of propriocetive training among diabetic women. Rev Bras Fisioter.; 12(3): 183-187, 2008.
23- Vinik, A.I. and Mehrabyan, A.: Diabetic neuropathy. Med Clin North Am; 88: 947-999, 2004.
24- Boulton, A.J., Malik, R.A., Arezzo, J.C. and Sosenko, J.M.: Diabetic somatic neuropathies. Diabetes Care; 27:1458-1486, 2004.
25- Cimbiz, A. and Cakir, O.: Evaluation of balance and physical fitness in diabetic neuropathy patients. J Diabetes Complications; 19: 160-164, 2005.
26- Gutierrez, E.M., Helber, M.D., Dealva, D., Ashton-Miller, J.A. and Richardson, J.K.: Mild diabetic neuropathy affects ankle motor function. Clin Biomech (Bristol Avon); 16: 522-528, 2001.
27- Nardone, A., Grasso, M. and Schieppati, M.: Balance control in peripheral neuropathy: are patients equally unstable under static and dynamic conditions? Gait Posture; 23: 364-373, 2006.
28- Yamamoto, R., Kinoshita, T., Momoki, T., Arai, T., Okamura, A. and Hirao, K.: Postural sway and diabetic peripheral neuropathy. Diabetes Res Clin Pract; 52: 213-221, 2001.
29- Nardone, A. and Schieppati, M.: Group 2 spinal fibres and afferent control of stance. Clues form diabetic neuropathy. Clin Neurophysiol; 115: 779-789, 2004.
30- Lafond, D., Corriveau, H. and Prince, F.: Postural control mechanisms during quit standing in patients with diabetic sensory neuropathy. Diabetes Care; 27: 173-178, 2004.
31- Richardson, J.K., Sandman, B.S. and Vela, S.: A focused exercise regimen improves clinical measures of balance in patients with peripheral neuropathy. Arch Phys Med Rehabil.; 82(2): 205-209, 2001.
32- Gauchard, G.C., Gangloff, P., Jeandel, C. and Perrin, P.P.: Physical activity improves gaze and posture control in the elderly. Neurosc Res.; 45(4): 409-417, 2003.
33- Kelly, P.W. and Elsie, G.C.: Sensory–specific balance training in older adults: Effect on proprioceptive reintegration and cognitive demands. Physical Therapy; 87: 1274-1283, 2007.
34- Phil, P.: Sensory motor training a global approach for balance training. Journal of Bodywork and Movement Therapy; 10: 77-84, 2006.
35- Robert, J.P., Patrick, J.L.: Dynamic Regulation of Sensorimotor Integration in Human Postural Control. Journal Neurophysiology; 91: 410-423, 2003.
36- Zhang, L.A., Critchley, Y.H. and Tam, B.T.: Short-term postural reflexes in diabetic patients with autonomic dysfunction. Diabetologia; 47; 304-311, 2004.
37- Tsang, W.W., Wong, V.S., Fu, S.N. and Hui-Chan, C.W.: Tai Chi improves standing balance control under reduced or conflicting sensory conditions. Archives of Physical Medicine & Rehabilitation; 85:129-137, 2004.
38- Fay, B.H.: Postural compensation for vestibular loss and implications for rehabilitation, Restorative Neurology and Neuroscience, IOS Press, 57-68, 2010.

الملخص العربي

عنوان البحث

خلفية : التهاب الأعصاب الطرفية هو من أكثر المضاعفات شيوع"لمرضى السكري وغالبا"ما يؤدي إلى إضطراب الاتزان .
الهدف : تهدف هذه الدراسة إلى معرفة تأثير برنامج تدريب حسي على الاتزان ومؤشر بيرج للاتزان في مرضى التهاب الأعصاب الطرفية الناتج عن السكري . **العينة :** تم اختيار ٢٨ مريضا"مصابون بالتهاب الأعصاب الطرفية و تم تقسيمهم إلى مجموعتين متساويتين : مجموعة ضابطة ومجموعة تدريب حسي . **الطريقة :** تم إختبارالاتزان للمجموعتين عن طريق قياس مؤشر بيرج وجهاز البيودكس أثناء وضع الوقوف للمريض على القدمين معاً مع غلق العينين . تلقت المجموعة الضابطة برنامج علاج طبيعي تقليدي لمده ٤٥ دقيقة بينما تلقت مجموعة التدريب الحسي برنامجاً مكون من ١٣ تمريناً حسياً بالاضافة الى برنامج العلاج الطبيعي التقليدي . تم تطبيق برنامجى العلاج الطبيعى بواقع جلستين أسبوعياً لمده ثمانية أسابيع . **النتائج :** سجل انخفاضاً ذو دلالة إحصائية في مؤشرات الاتزان وكذلك زيادة ملحوظة في مؤشر بيرج للاتزان فى مجموعة الدراسة بالمقارنة بالمجموعة الضابطة بعد البرنامج التدريبى .
الخلاصة : أشارت النتائج إلى أن برنامج التدريب الحسي، بالإضافة لبرنامج العلاج الطبيعى التقليدى، يؤدي الى تحسن الإتزان في مرضى التهاب الأعصاب الطرفية الناتج عن مرض السكري .