Assessment of Stability Deficits in Patients with Diabetic Peripheral Neuropathy

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ABSTRACT

***Purpose**: The purposes of this study were to identify stability deficits in patients with diabetic peripheral neuropathy (DPN) with or without visual feedback, and correlate duration of onset of DPN to stability deficits. **Subjects**: Thirty male patients, their age ranged from 40 to 60 years old, and diagnosed as having type II diabetes from 10 years and with DPN since one year at least (according to the clinical examination) have selected randomly to participate in this study. They were referred from the diabetic out patient's clinic of the Kaser El –Aini hospital. Thirty healthy male volunteers were participated to represent the control group, they were matched in age, weight and height to the diabetic patients. **Procedures:** Biodex stability system used to assess dynamic stability level "in the form of overall (SI), antroposterior (AP), and mediolateral (ML) stability indices" in both groups during standing on both feet with eyes open, then with closed eyes. **Results:** independent t-tests showed that the patients with DPN had significant stability deficits in comparison with healthy subjects. All the subjects had better stability during opened-eye condition than closed-eye conditions. Correlation analysis showed that stability deficits were correlated with the duration of onset of DPN. **Conclusion:** It had been concluded that visual feedback improved stability control in patients and healthy subjects. Patients with DPN had significantly lower stability control than healthy subjects, and that stability deficits in DPN had a trend to increase over time.*

***Key words:** Diabetes mellitus, Diabetic peripheral neuropathy Balance, Stability and dynamic control.*

INTRODUCTION

Diabetes mellitus is a complex metabolic disorder characterized by persistent hyperglycaemia resulting from deficits in insulin secretion that lead to disorder of carbohydrates, fat and protein metabolism, it affects 15% of world population over the age of 65 years in developed countries. The rate of incidence of diabetes reaches a percentage of 20-50% through out different age group[11,12].

Type 1 diabetes mellitus is the most common metabolic illness that is characterized by beta cell destruction caused by an autoimmune process. It usually leads to absolute insulin deficiency. It represents about 10% of all cases of diabetes[20]. Type II diabetes is the most common type of diabetes mellitus. It accounts around 90% of all cases of diabetes[10,13].

The incidence of type II increase with age, as the most cases being diagnosed after age of 40 years and it is highly associated with family history of diabetes, obesity, lack of exercise[17]. Type II diabetes is characterized by insulin resistance in peripheral tissue and hyperinsulinemia.[6] Neuropathy is a general term for physical damage or impairment of the human nervous system. It has many causes and

wide symptoms. Because a long period of time with elevated blood glucose can damage nerve fibers, diabetes is one of several major causes of neuropathy[7]. Diabetic patients are especially prone to the development of a neuro-osteoarthropathy[15].

The primary types of diabetic neuropathy are sensorimotor and autonomic. A patient may have only one type of neuropathy or might develop different combinations.[27]

The diabetic neuropathies presented in several ways. The commonest form is a diffuse progressive polyneuropathy affecting mainly the feet. It is predominantly sensory, often asymptomatic, and affects 40-50% of all diabetic patients[9].

Diabetic peripheral neuropathy (DPN) is a polyneuropathy because of the diffuse damage to all peripheral nerve fibers, motor, sensory and autonomic. Such damage occurs insidiously, progressively and characterized first by sensory loss and later by loss of motor function, in a stocking and glove distribution[8].

High incidence of DPN reaches up to 70% within five years of initial diagnosis. There after, DPN results in subclinical disequilibrium that may reflect the impairment of somatosensory and visual systems rather than a specific lesion of the related organs[26].

Balance control mechanisms are based on feed back system that generate different combinations of muscle action (e.g., ankle and hip strategies), based on postural sway information detected by visual, somatosensory and vestibular peripheral receptors[22].

Somatosensory information from periphery plays a key role in balance control especially in absence of visual or vestibular cues. Basically, somatosensory inputs are derived from extroceptors in skin at the sole of the foot and proprioceptors in other ligaments, tendons and joint structures of the foot and ankle[18].

Joint proprioceptors-spread in joint capsule and adjoining ligaments-relay information related to joint position sense, and kinesthesia. They play an important role in joints control and assist in maintaining proper alignment for balance control[15]. Plantar cutaneous was reported to share in balance control; cutaneous sensory loss is compensated by visual feedback as in open eye conditions[18].

A clinical study was held to evaluate postural stability in diabetic polyneuropathy. Subjects were tested for postural sway using force platform system with vision, without vision, and during a recovery period after being without vision. Patients showed larger range of sway, faster sway speed and greater dispersion of sway than control healthy subjects even with visual feedback[6].

Assessment of weight distribution and postural sway were carried out clinically to compare diabetic subjects with and without neuropathy, with age and sex matched non diabetic subjects. Assessment was done with a portal sway weight. The study showed that peripheral neuropathy increase the postural sway especially in the absence of visual clues but this did not result in postural strategies causing significant limb load asymmetry[2].

Evaluation of postural sway in cases of diabetic neuropathy (DN) had been carried out clinically. Authors compared three groups, namely insulin dependant diabetes mellitus (IDDM) patients with DN, IDDM patients without DN and healthy control subjects. Results showed that there was a significant postural sway in DN patients group than the other two groups. In addition, there was a direct relationship between postural sway and some parameters of nerve conduction velocity studies[25].

The purposes of this study were to identify stability deficits in patients with diabetic peripheral neuropathy (DPN) with or

without visual feedback, identify the influence of visual feedback in stability indices, and correlate duration of onset of DPN to stability indices that might be there.

SUBJECTS AND PROCEDURES

Subjects

Sixty male subjects were included in the study. Their age ranged from, 40 to 60 years old with a mean value of 51.60 ±3.74 years. Thirty patients diagnosed as having type II diabetes mellitus since at least 10 years complicated with DPN (diabetic peripheral neuropathy) since one year at least have been selected to represent the study group. Fasting blood glucose level for those patients was measured within 24 hours before participation of study, and had to be below 160 mg/dl. They were referred from the diabetic out patient's clinic in Kaser El –Aini hospital. The other 30 subjects were matched healthy volunteers and were participated as control group, their age ranged from 41 to 57 years old, with a mean value of 50.96 ±3.75 years old.

Exclusion criteria

Patients with the following clinical disorders were excluded from participating in the study

1. Diabetic foot ulcers
2. Uncontrolled blood glucose level
3. Middle ear infections, neural diseases or any other disease contribute to balance and stability.
4. Muscloskeletal problems as deformities of the spine or extremities.

Instrumentation

Biodex Balance System

It is a commercially available dynamic postural stability tnemssessa and training system. It was used to assess double and single leg static balance. It consists of movable balance platform, which provides 20° of surface tilting in 360° range and is interfaced with a microprocessor based actuator. The actuator controls the manually present degree of surface instability, which ranges from a completely firm surface with stability level 8, to a very unstable surface, with stability level 2. Biodex stability system is used to evaluate stability indices (SI) in degrees, anteroposterior stability (AP) in degrees and mediolateral stability (ML) in degrees

Assessment Procedures

Each testing session took a total period of 15-20 minutes, including patient orientation and assessment procedures. The patient should center him-self on the platform before starting the test. Then the patient is instructed to keep this position while investigator identifies the patient's foot or feet position on platform grid through recording the heel coordinates and foot angle. All these values of position are recorded on the balance system computer soft ware (centered position of patients). The patients underwent the tests at stability level 8 for a period of 20 seconds for each test (the test was performed for 3 trials and the end result as a mean of 3 trials was calculated). The subject was instructed to maintain a level platform for a period 20 seconds for each test and rest by sitting for one minute after each test. The test was performed in opened - eye condition then with closed eye condition.

Statistical Analysis

- The data were analyzed by calculating: Mean ± Standard deviation.
- Student t. test was used to compare the mean stability level between control group and study group.
- Paired t-test was used to compare the mean stability level between opened - eye condition and closed- eye conditions within each group.
- Pearson correlation coefficients ware used to test the presence of linear relationship

between the duration of DPN and stability deficits in both open-eye condition and closed eye condition in the diabetic patients

RESULTS

The results showed a significant difference in overall stability indices (SI), antero-posterior stability indices (A/P), and medio-lateral (M/L) between Open eye condition and closed eye condition in diabetic patients with more stability control during open eye condition than closed eye condition (table 1 & figure 1).

Table (1): The mean difference of SI, A/P, M/L stability indices in degrees during open eye and closed eye conditions in the study group

variables	Open eye	Closed eye	T-Test	
	Mean ± S.D	Mean ± S.D	T. Value	Sig.
SI	9.7° ± 0.95°	11.17° ± 0.80°	-10.28	0.000 *
A/P	7.9° ± 1.17°	9.13° ± 1.14°	-7.077	0.000 *
M/L	6.32° ± 1.19°	7.17° ± 1.40°	-5.33	0.000 *

*Sig. P ‹ 0.05 "°": degrees A/P: Anterioposterior. M/L: Mediolateral. SI : Overall stability indices

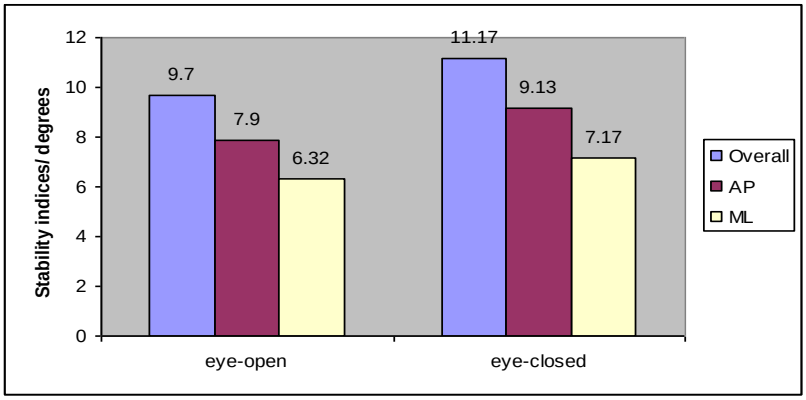

Fig. (1): The mean values of over all stability (SI), A/P and M/L stability indices in degrees open eye and closed eye conditions in study group.

In addition there was a significant difference in overall stability indices (SI), antero-posterior stability indices (A/P), and medio-lateral (M/L) between Open eye condition and closed eye condition in normal subjects with more stability control during open eye condition than closed eye condition (table 2 & figure 2).

Table (2): The mean difference of SI, A/P, M/L stability indices in degrees during open eye and closed eye conditions in control group

variables	Open eye	Closed eye	T-Test	
	Mean ± S.D	Mean ± S.D	T. Value	Sig.
SI	6.24° ± 1.26°	6.49° ± 1.25°	-10.35	0.000 *
A/P	4.10° ± 1.09°	5.38 °± 1.33°	- 7.48	0.000 *
M/L	3.13° ± 0.98°	4.24° ± 1.09°	- 7.46	0.000 *

"°" : degrees *Sig. P ‹ 0.05

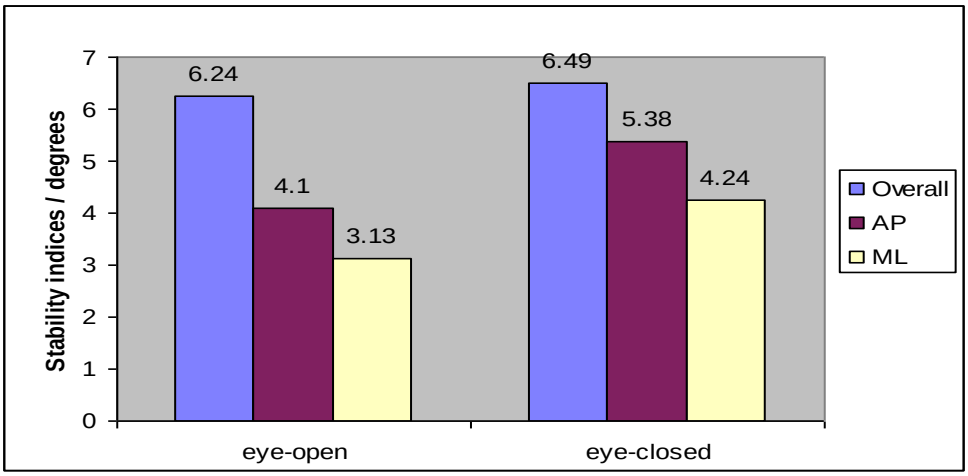

Fig. (2): The mean values of over all stability (SI), A/P and M/L stability indices in degrees open eye and closed eye conditions in control group.

With comparison of the stability indices between patients in study group and control group in open eye condition the results showed that there were significant reduction in overall, A/P and M/L stability indices in control group than study group. This indicated that balance deficiency in diabetic patients is more than in normal subjects (table 3 & figure3).

Table (3): The mean values of over all stability (SI), A/P and M/L stability indices in degrees in study group versus control group during open eye condition

variables	study group	Control group	T-Test	
	Mean ± S.D	Mean ± S.D	T. Value	Sig.
SI	9.7° ± 0.95°	6.24° ± 1.26°	12.04	0.000 *
A/P	7.9° ± 1.17°	4.10° ± 1.09°	13.009	0.000 *
M/L	6.32° ± 1.19°	3.13° ± 0.98°	11.26	0.000 *

*Sig. P ‹ 0.05 "°" : degrees

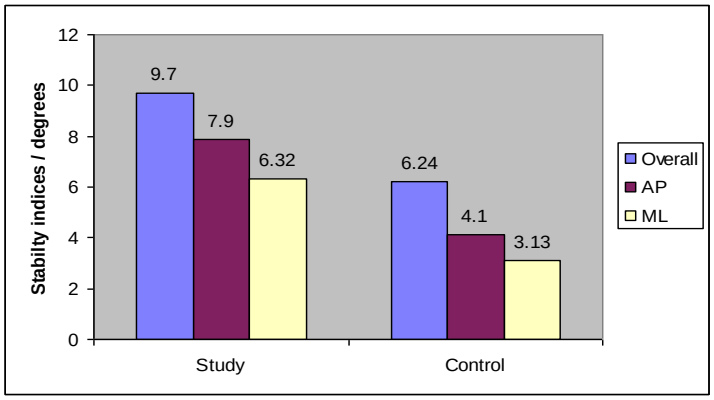

Fig. (3): The mean values of over all stability (SI), A/P and M/L stability indices in degrees in study group versus control group during open eye condition.

Also in eye-closed condition the stability indices in control group were lower (better stability) than that in study group. This indicated that balance deficiency in diabetic patients is more than in normal subjects during eye-closed condition (table 4 & figure 4).

Table (4): The mean values of over all stability (SI), A/P and M/L stability indices in degrees in study group versus control group during eye-closed condition

variables	study group	Control group	T-Test	
	Mean ± S.D	Mean ± S.D	T. Value	Sig.
SI	11.17° ± 0.80°	6.49° ± 1.25°	17.31	0.000 *
A/P	9.13° ± 1.14°	5.38° ± 1.33°	11.75	0.000 *
M/L	7.17° ± 1.40°	4.24° ± 1.09°	9.09	0.000 *

*Sig. P ‹ 0.05. "°" : degrees

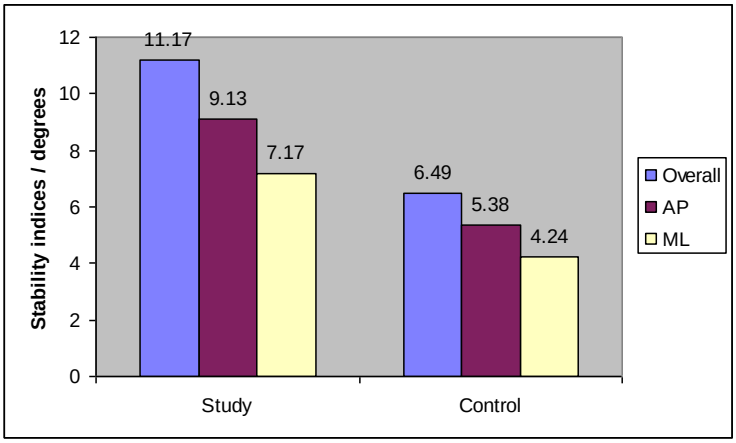

Fig. (4): The mean values of over all stability (SI), A/P and M/L stability indices in degrees in study group versus control group during eye-closed condition.

The correlation between the time of onset of DPN with overall SI, A/P, and M/L in open eye condition in study group showed positive correlation between time of onset of DPN and overall SI, and A/P and a positive but very weak correlation had also been identified between time of onset of DPN and M/L. (table 5 & figs. 5, 6 & 7).

Table (5): correlation between duration of affection with DPN and overall SI, A/P, M/L stability indices in both eye-open and eye-closed conditions in study group

		Duration of affection DN
Open eye	Overall SI	*r = 0.531
	A/P SI	*r =0.293
	M/L SI	*r =0.001
Closed eye	Overall SI	*r= 0.626
	A/P SI	*r= 0.535
	M/L SI	*r = 0.059

*r is symbol of Pearson correlation coefficient

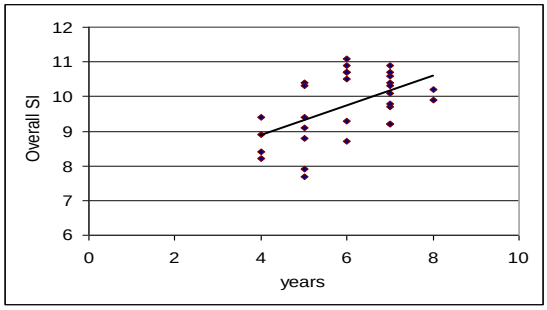

Fig. (5): Correlation between duration of affection by DPN and overall SI in open-eye condition.

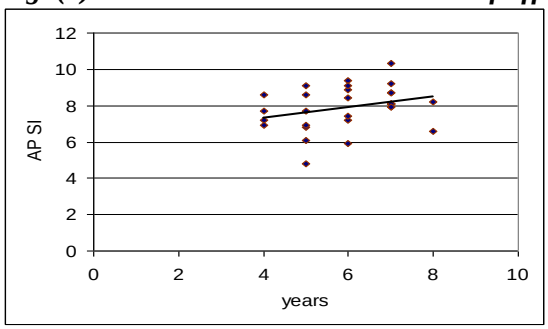

Fig. (6): Correlation between duration of affection by DPN and A/P in open-eye condition.

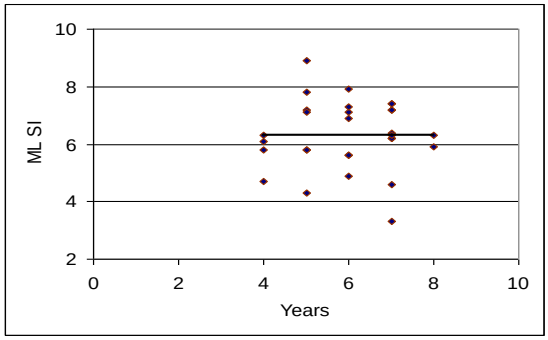

Fig. (7): Correlation between duration of affection by DPN and M/L in eye-open condition.

Results in eye closed condition showed a positive correlation between time of onset of DPN and overall SI and A/P. Concerning very weak positive correlation of M/L SI (table 5 & figs. 8, 9&10).

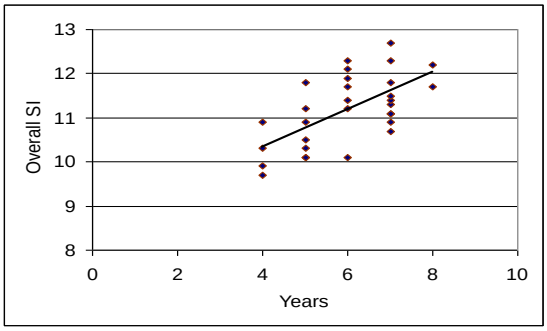

Fig. (8): Correlation between duration of Affection by DN and overall SI In closed-eye condition.

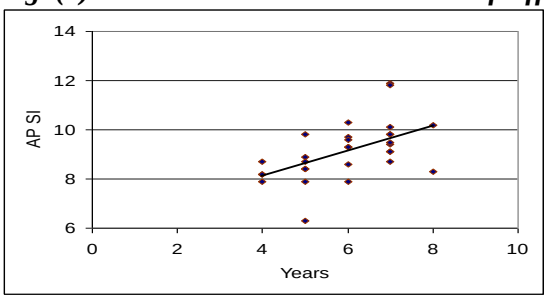

Fig. (9): Correlation between duration of affection by DN and A/P SI in closed-eye condition.

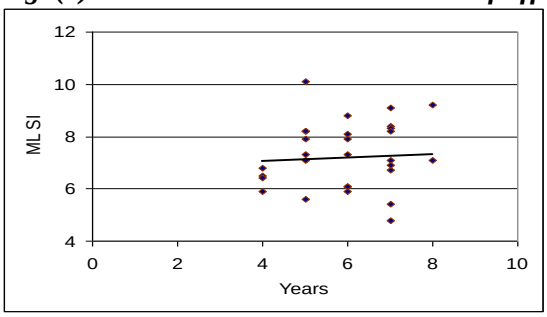

Fig. (10): Correlation between duration of affection by DN and M/L SI in closed-eye condition.

DISCUSSION

The results of this study showed that the overall SI, A/P and M/L stability indices were significantly lower in degrees (better postural control) in eye- open condition than eye-closed condition in both the study and control groups. These results indicated that visual feedback provides better balance control and minimize postural sway either in normal or pathological condition. Open eye condition showed significantly better balance control and less postural sway in both study and control groups than eye-closed condition. The importance of visual feedback and its contribution to balance control even in healthy subjects had been declared several times in literature and the results of the present study was in agreement with several previous studies as it has been identified that balance control is the result of interaction of different central and peripheral nervous system inputs[3]. It has been also emphasized that vision is a major contributor to balance control.[14] Another previous study has investigated the effect of visual feed back on balance control in diabetic patients, and it has been found that DM with

neuropathy increased postural sway in absence of visual feedback[2].

The results of the present study showed also that all stability indices (overall, A/P and M/L) were significantly lower in the control group in both eye-open and eye-closed conditions. These results indicated that patients with DPN had higher degree of postural sway, .and compromised balance control in comparison with the matched healthy subjects. These results had been generally supported by previous researchers who found that there were no significant differences between diabetic patients without neuropathy and healthy control subjects while patients with DPN showed disturbed control of upright posture in comparing diabetic patients with and without neuropathy and normal controls.[21] In accordance with present results, it was reported that a greater postural sway was found in diabetic patients with cutaneous sensory deficit in the feet than those with normal cutaneous sensitivity in the feet [2,16]. In assessing postural function in diabetic patients, it has been reported that postural sway was exaggerated in both IDDM & NIDDM in comparison to matched healthy subjects.[4] Similar results were reported as the peripheral neuropathy increased postural sway especially in absence of visual cues[2].

The pathological changes of DPN that could explain balance control deficits noted in this study could be attributed to axonal degeneration in nerves of the foot and ankle that resulted in slow nerve conduction velocity, and reduced somatosensory cues relayed from ankle-foot complex available for balance control. Such explanation is supported by previous study, where they investigated the effect of diabetic peripheral neuropathy on balance control during standing. They identified that nerve conduction velocity was significantly reduced, with axonal involvement of the medium size fibers that clinically reduced leg muscle strength, tactile senses, vibration, and joint position sense[1].

Correlating analysis showed that overall SI, A/P, and M/L in both eye- open and eye-closed conditions were positively correlated with the duration of DPN and these correlations were more evident in overall and A/P indices than M/L indices. These correlation results showed that balance control deficits in DPN has a general trend to deteriorate over time. Such selective affection of the A/P stability more than the M/L stability may be related to the fact that AP stability mainly depends on muscles activity susceptible to weakness and dysfunction related to presence and severity of DPN [5,19], while the M/L sway relies more in the hip abductor/ adductor activity commonly less involved in DPN[22].

In support of the basic concept and the possibility of balance deterioration in DPN over time it can be suggested also that the deterioration in the condition of peripheral nerves involved in DPN pathology over time may progressively reduce somatosensory cues from the periphery and aggravate disturbances in balance control[23, 24].

Conclusion

It had been concluded that visual feedback improved balance control in patients and healthy subjects, which proved that visual feedback is capable to a great extent to compensate for deficits in somatosensory input. Patients with DPN had significantly lower balance control than normal, which was attributed mainly to the sensory loss associated with DPN that distort somatosensory feedback both from the sole of the foot and ankle muscles serving proprioceptive functions. Finally balance deficits in DPN had a trend to increase over time, presumably due to

progressive sensory loss overtime noted in cases of DPN.

REFERENCES

1. Abduelkarem, A.R., Sackville, M.A., Morgan, R.M. and Hildreth, A.J.: "Is it time to change diabetic disease nomenclature?" Pharm World Sci.26 (1): 3-5, 2004.
2. Ahmmed, A.U. and Mackenzie, I.L.: "Posture changes in diabetes mellitus. J Laryngol Otol., 117(5): 358-364, 2003.
3. Alexander, K.M. and La Pier, T.L.: Differences in static balance and weight distribution between normal subjects and subjects with chronic unilateral low back pain. JOSPT, 28: 378–383, 1998.
4. Bacsi, A.M. and Cole Batch, J.G.**:** Evidence for reflex and perceptual vestibular contributions to postural control. Exp BrainRes. 18: 167-177, 2004.
5. Baker, V., Bennel, J., Stillman, B., Cowan, S. and Crossley, J.: "Abnormal knee joint position sense in individuals with patellofemoral pain syndrome". J Orthop Res. 20(2): 208-214, 2002.
6. Boss, A.P. and Hintermann, B.: "Anatomical study of the medial ankle ligament comlex". Foot Ankle Int., 23(6): 547-553, 2002.
7. Boulton, A.L., Vinik, A.I., Arezzo, J.C., Bril, V., Felddman, E.L., Freeman, R., Malik, R.A., Maser, R.E., Sossenko, J.M. and Ziegler, D.: "Diabetic neuropathies: a statement by the American Diabetes Associatioin". Diabetes Care. 28(4): 956-962, 2005.
8. Carrington, A.L., Abbot, C.A., Griffiths, J.J., Ackson, N., Johnson, S.R., Kulkarni, J., Van, E.R. and Asndd Boulton, A.J.: "Prepheral vascular and nerve function associated with lower limb amputation in people with and without diabetess". Clin Sci (Lond) 101: 261-266, 2001.
9. Duby, J.J., Campbell, R.K., Setter, S.M., White, J.U.R. and Rasmussen, K.A.: "Diabetic neuropathy: an intensive review .Am J Health Syst Pharm., 15; 61(2): 160-173, 2004.
10. Ehtisham, S., Barrett, T.G. and Shaw, N.J.: "Type II diabetes mellitus in UK Children – an emerging problem". Diabet Med. 17(12): 867-871, 2000.
11. Expert Committee on the Diagnosis and Classification of Diabetes Mellitus: "Follow – up report on the diagnosis of diabetes mellitus". Diabetic Care. 26: 3160-3167, 2003.
12. Laaksonen, D.E., Lakka, H.M., Niskanen, L.K., Kaplan, G.A., Salonen, J.T. and Lakka, T.A.: "Metabolic syndrome and development of diabetes mellitus: application and validation of recently suggested definition of the metabolic syndrome in prospective cohort study". Am. J. Epidemiol, 156(11): 1070-1077, 2002.
13. Li., C.L., Tsai, S.T. and Chou, P.: "Persistenet impaired glucose tolerance, insulin resistance, and beta- cell dysfunction were independent predictors of type II diabetes" J Clin E pidemiol .58 (7): 728- 732, 2005.
14. Lord, S.R. and Molyneaux, D.L.: "The physiology of falling: assessment and prevention strategies for older people .J Sci MedSport, 8(1): 35-42, 2005.
15. Margolis, D.J., Kantor, J., Santanna, J., Strom, B.L. and Berlin, J.A.: "Risk factors for delayed healing of neuropathic diabetic foot ulcers: a pooled analysis". Arch Dermatol. 136(12): 1531-1535, 2000.
16. Maurer, C., Mergner, T., Bolha, B. and Havacka, F.: "Human balance control during cutaneous stimulation of the plantar soles". Neurosci Lett., 302(1): 45-48, 2001.
17. Meyer, K.A., Kushi, L.H., Jacobs, D.R. and Folsom, A.R.: "Diatry fat and incidence of Type II diabetes mellitus in older Iowa women" Diabetic Care. 24(9): 1528-1535, 2001.
18. Meyer, P.F., Oddsson, L.I. and De Luca, C.J.: "The role of plantar cutaneous sensation in unperturbed stance". Exp Brain Res., 156(4): 505-512, 2004.
19. Milner, C.E. and Soames, R.W.: "Anatomy of the collateral ligaments of the human ankle joint". Foot Ankle Int., 19(11): 757-760, 1998.

20. Neu, A., Ehehalt, S., Willasch, A., Keherer, M., Hub, R. and Ranke, M.B.: "Rising incidence of type I diabetes in Germany: 12 – years trend analysis in children 0-14 years of age". Diabetic Care. 24(4): 785-786, 2001.
21. Okuda, K., Abe, N., Katayama, Y., Senda, M., Kuroda, T. and Inoue, H.: Effect of vision on postural sway in anterior cruciate ligament injured knees. Orthop Sci. 10(3): 277-283, 2005.
22. Peterka, R.J.: "Sensorimotor integration in human postural control". J Neurophysiol. 88(3): 1097-1118, 2002.
23. Prentki, M., Joly, E. and El Assaad, W.: "Malonyl-CoAsignaling, lipid partitioning and glucolipotoxicity: role in beta- cell adaptation and failure in the etiology of diabetes". Diabetes, 51(suppl. 3), S405-S413, 2002.
24. Stratton, I.M., Adler, A.I., Neil, H.A., Matthews, D.R., Manley, S., Cull, C.A., Hadden, D., Turner, R.C. and Holman, R.: Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study". B.M.J., 321: 405-412, 2000.
25. Uccioli, L., Giacomini, P.G., Monticone, G., Magrini, A., Durola, L., Bruno, E., Parisi, L., Di., Girolamo, S.S. and Menzinger, G.: "Body sway in diabetic neuropathy". Diabtes Care. 18(3): 339-344, 1995.
26. Vinik, A.I.: "Management of neuropathy and foot problems in diabetic patients". Clin Cornerstone. 5(2): 38-55, 2003.
27. Wein, T.H. and Albers, J.W.: "Diabetic neuropathies."Phys Med Rehabil .Clin N Am. 12(2): 307-320, 2001.

الملخص العربى

قياس معاملات الثبات فى مرضى البوال السكرى المصابين بألتهاب الأعصاب الطرفية

تهدف هذه الدراسة الى تحديد معاملات الثبات فى مرضى البوال السكرى المصابين باالتهاب الاعصاب الطرفية باستخدام الاستدلال البصرى او بدونه وتحديد تاثير البصر فى تحكم الثبات وكذلك الى توضيح اى ارتباط محتمل بين مدة الاصابة بالتهاب الاعصاب الطرفية وشدة تأثر التحكم بالثبات لدى البوال السكرى وقد تم اختيار 30 مريضا من الذكور المصابين بالبوال السكرى لمدة لا تقل عن 10 سنوات والذين اصيبوا باالتهاب الاعصاب الطرفية من مدة لا تقل عن سنة عشوائيا (مجموعة الدراسة). كما تم ضم30 متطوعا من الذكور متوافقا مع المرضى فى السن والوزن والطول ومعامل كتلة الجسم (المجموعة الضابطة) وقد تم اختبار تحكم الثبات لدى المشاركين فى كلتا المجموعتين واجرى الاختبار مرتان لكل مشارك ؛ المرة الاولى بالعين المفتوحة ثم الثانية بالعين المغلقة كانت النتائج على هيئة 3 معاملات للثبات ؛ معامل الثبات العام ؛ معامل الثبات الامام الخلفى ؛ معامل الثبات الجانبي . وقد اوضحت النتائج ان جميع معاملات الثبات كانت اقل بفارق ذو دلالة معنوية فى حالة العين المفتوحة عن العين المغلقة وقد كانت جميع معاملات الثبات اقل بفارق ذو دلالة معنوية فى المجموعة الضابطة فى الحالتين (العين المفتوحة والمغلقة) وكذلك اوضحت النتائج ارتباط جميع معاملات الثبات بمدة الاصابة باالتهاب الاعصاب الطرفية خاصة المعامل العام والمعامل الامامى الخلفى وقد استخلص من هذه الدراسة ان البصر يحسن الثبات لدى كل من الاصحاء والمرضى وان مرضى البوال السكرى المصابين باالتهاب الاعصاب الطرفية لديهم قدرة اقل على التحكم بالثبات من اقرانهم من الاصحاء ولديهم قابلية عامة لتدهور الثبات كلما طالت مدة الاصابة باالتهاب الاعصاب الطرفية.