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Original Article

Balance deficit among diabetic polyneuropathy Saudi patients

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Abstract:

BACKGROUND: Currently, the risk of fall is high among diabetic patients in Saudi Arabia. Nowadays, the interest is direct towards prevention of fall through the prospective research studies trying to reduce the fall risk. **OBJECTIVE**: The present study was intended to detect the fall incidence among diabetic Saudi patients with polyneuropathy. **MATERIALS and METHODS:** A total of 200 Saudi patients with type 2 diabetes mellitus, aged between 40 and 55 years, were enrolled in the study and divided into two distinct groups. One group consisted of individuals diagnosed with diabetes, while the other group included those with established peripheral neuropathy, referred to as the Diabetic Peripheral Neuropathy (DPN) group. The diagnosis of diabetes was made in accordance with clinical guidelines. To assess balance performance, participants underwent three established evaluation tests: the Functional Reach Test (FRT), the Timed Up and Go Test (TUG), and the Berg Balance Scale (BBS). **RESULTS:** There were significant differences between groups have been detected for BBS and FRT which was significantly lower for diabetic patients with peripheral neuropathy compared with diabetic patients. While significant higher values for diabetic patients with peripheral neuropathy were also detected for TUG compared with diabetic patients. **CONCLUSION:** Diabetic patients with peripheral neuropathy had more balance deficit than diabetic patients without peripheral neuropathy.

Keywords: Balance, Type 2 Diabetes Mellitus, Diabetic Peripheral Neuropathy

Introduction

Globally, it is estimated that the number of individuals with diabetes will exceed 350 million by 2030, largely driven by the global increase in obesity, which has contributed to a growing prevalence of type 2 diabetes mellitus (T2DM) [1]. Furthermore, diabetes is responsible for approximately 5.2% of all deaths worldwide [2]. Without concerted efforts to address the pathogenesis and treatment of this syndrome, the harmful macrovascular and microvascular outcomes of T2DM will remain a major burden for decades to come [3].

Polyneuropathy is one of the most prevalent serious consequences of diabetes that may cause many health-related complications amputations among diabetics [4]. The most frequent signs of poor polyneuropathy are abnormal sensations such as pain, loss of sensation, numbness, balance, sensation of instability and increase the risk of fall that is

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may be induced by gait deviations as decrease cadence and step length [5,6]. In addition, decreases in movement perception of the hip and ankle joints can induce static and dynamic balance instabilities and thus increase the risk of falling [7-9].

Peripheral sensations are found to be abnormal associated with muscle weakness among the diabetic patients who suffer from polyneuropathy which are the main cause of instability and fall among these patients [10,11]. There is a limited amount of research that compares balance performance between individuals with diabetes who have polyneuropathy and those who do not [12, 13]. Therefore, this research will report and keep records of accidents and incidents of fall that occur among diabetic Saudi patients with polyneuropathy.

Materials and Methods

Subjects

Two hundred patients with T2DM were randomly participated in this study, their age ranged from 40-55 years. The diabetic patients were included in two equal groups: The first group included type 2 diabetic patients with peripheral neuropathy, while the second group was type 2 diabetic patients without peripheral neuropathy. Diabetic Neuropathy Examination (DNE) was used to discriminate between patients with and without DPN [14-16]. The baseline and clinical criteria of all participants are presented in Table 1. All participants were out-patients of the Internal Medicine Department, King Abdalaziz University Hospital. This study had Faculty of Medical Rehabilitation Sciences Research Ethics Committee approval, and a written consent was signed by all participants.

Exclusion criteria included history of foot ulcers, internal otitis (labyrinthitis) or any other vestibular dysfunction, dizziness, vision impairment, musculoskeletal, neurological, or rheumatic disorders out of diabetes etiology, history alcohol intake, peripheral vascular disease, use of walking aids, nondiabetic neuropathy, cardiovascular disease, renal and hepatic dysfunction.

Methods

1. Evaluated parameters

A. Berg Balance Scale: Berg Balance Scale (BBS) is an assessment tool for both dynamic and static balance performance. The BBS required no specific training and little equipment as stopwatch, chair, step, ruler and space. Finally, health care personnel were only permitted to conduct the BBS in order to had the knowledge about how to mobilize patients safely [17- 19].

B. Functional reach test. It is a balance test to measure balance in standing position [20]. The participant was asked to assume standing position with barefoot with his arm stretched parallel to the wall and the shoulder joint was flexed to 90°. Then, the participant was asked to make a maximum forward inclination of the torso, with his upper limb reaching as far as possible without removing the heels from the floor and the distance in centimeters between the initial position and the final displacement from the trunk to the tip of the middle finger is the functional reach of the participant [21].

C. The Timed "Up and Go" (TUG): The time taken for the participant to rise from a chair without arms, wearing his/her own shoes and using any usual assistive devices (none, cane, or walker) was recorded. The participant was asked to walk a distance of three meters, make a 180º turn, and return to sit on the same chair. Timing started when the participant's back moved away from the chair and ends when the back touched the chair again [22,23].

Statistical analysis

Mean values of BBS, FRT and TUG of both groups were compared using Independent "t" test ($P<0.05$). Pearson's correlation coefficient (r) was applied to detect the degree of correlation between degree of diabetic peripheral neuropathy and BBS, FRT & TUG.

Results

Demographic data

Table (1) summarizes the comparison between diabetic patients without PN (DM) and with PN (DPN). DPN patients showed significantly higher duration of diabetes, serum glucose, glycosylated hemoglobin (HbA1c) and serum insulin in comparison to diabetic patients without PN.

The mean values of BBS, FRT and TUG were significantly decreased in DPN patients. Also; there were significant differences between both groups (Table 2). The Pearson's correlation coefficients test for the relationship between the degree of peripheral neuropathy and BBS and FRT scores showed a strong inverse relationship, while there was a strong direct relationship between the degree of peripheral neuropathy and TUG (Table 3).

TABLE 1: THE SUBJECT CHARACTERISTICS FOR ALL PARTICIPANTS.

	Mean ±SD			
Characteristic	**Group (A)**	**Group (B)**	**T-value**	***p-value***
Age (y)	48.32 ± 2.75	46.71 ± 3.82	1.21	>0.05
Height (cm)	173.15 ± 3.35	172.45 ± 2.87	1.41	>0.05
Weight (kg)	96.22 ± 6.86	94.83 ± 7.14	1.68	>0.05
BMI (kg/m^2)	31.43 ± 1.92	32.62 ± 1.76	1.93	>0.05
Gender (M /F)	79/21	18/82	1.87	>0.05
Duration of diabetes	7.41 ± 1.16	11.83 ± 2.14*	3.96	<0.05
SBP (mm Hg)	135.11 ± 5.41	133.27 ± 4.66	1.94	>0.05
DBP (mm Hg)	85.83 ± 3.81	87.16 ± 3.52	1.76	>0.05
Glucose (mmol/l)	6.12 ± 0.64	7.48 ± 0.79*	4.12	<0.05
HbA1c (%)	5.11 ± 0.51	7.15 ± 0.83*	3.86	<0.05
Insulin (µU/ml)	9.12 ± 1.97	14.82 ± 2.57*	3.42	<0.05
Cholesterol (mmol/l)	4.96 ± 0.34	4.74 ± 0.32	1.04	>0.05
HDL-C (mmol/l)	1.54 ± 0.28	1.63 ± 0.26	1.13	>0.05
LDL-C (mmol/l)	2.74 ± 0.21	2.61 ± 0.25	1.08	>0.05
Triglyceride (mmol/l)	2.23 ± 0.72	2.11 ± 0.61	1.12	>0.05

BMI: Body Mass Index; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; HBA1c: glycosylated hemoglobin; HDL: High Density Lipoprotein; LDL: Low Density Lipoprotein; (*) indicates a significant difference between the two groups, P < 0.05.

Table 2: Mean values of BBS, FRT and TUG of group (A) and group (B).

	Mean ±SD			
	Group (A)	**Group (B)**	**T-value**	***p-value***
Berg Balance Scale (overall)	55.73 ± 2.15	49.81 ± 1.94	6.87	< 0.0
Functional Reach Test (cm)	46.92 ± 2.31	40.17 ± 2.28	5.63	< 0.0
The Timed "Up and Go" (sec)	9.17 ± 1.32	12.85 ± 1.63	5.32	< 0.0

FRT: Functional Reach Test; GUG: Timed Get Up Go Test; BBS: Berg Balance Scale.

TABLE 3: PEARSON'S CORRELATION COEFFICIENT BETWEEN DEGREE OF PERIPHERAL NEUROPATHY AND BBS, FRT& TUG SCORES IN PATIENTS WITH DPN.

Balance test	**Degree of peripheral neuropathy**
Berg Balance Scale (overall)	0.658*-
Functional Reach Test (cm)	0.791 **-
The Timed "Up and Go" (sec)	0.682*-

Spearman's correlation was used *: P < 0.05 **: P < 0.01

Discussion

The present study was to evaluate the risk of fall among the diabetic Saudi patients without peripheral neuropathy. Overall, our results confirmed that participants with DPN had lower scores of balance performance measured by BBS, FRT and TUG. These results were in line with many previous studies.

Many studies proved that there is a deficit in postural control among patients with DPN using platform and posturography systems in measuring postural sway properties [24-25]. While Ghanavati and colleagues confirmed patients with DPN total score of BBS test was significantly lower than their healthy control subjects [26]. However, Resnick et al. (2002) found that diabetic subjects with PDN had significantly worse dynamic and static balance and coordination relative to non-diabetic subjects [27, 28]. However, Lord et al. (1999) stated that strength of the antigravity muscles of lower limbs was weak among patients with DPN [29]. Also, Ozdirenc et al. (2003) reported that elderly subjects either older adults with or without DPN had reduced walking speed and balance performance [30].

Turcot and colleagues (2009) conducted the first study to investigate the balance instability of 24 diabetic patients using accelerometers; their results confirmed that diabetic patients with peripheral neuropathy had greater postural instability with higher acceleration values than healthy subjects and diabetic patients without peripheral neuropathy [31]. However, Cimbiz and Cakir (2005) proved that investigation of standing on dominant and non-dominant leg, functional reach and physical fitness tests revealed that all of these measures were lower in Type 2 diabetic neuropathic patients than healthy control subjects [32]. Also, Lim and colleagues (2005) proved that functional limitations and dynamic balance instability were more noticeable among diabetic patients with peripheral neuropathy than healthy subjects and diabetic patients without peripheral neuropathy [33].

Regarding Pearson's correlation coefficient between degree of peripheral neuropathy and BBS, FRT& TUG scores in patients with DPN, our results confirmed that there was a strong direct relationship between TUG and the severity of DPN. However, there was a strong inverse relationship between BBS& FRT and the severity of DPN. These findings are similar to finding of Lafond et al. (2004) [34] and Boucher et al. (1995) [35] stated that

the score of BBS was significantly reduced as the severity DPN increased.

The possible mechanism of the balance deficit among PND may be due to decline of sensory function since many everyday balance and walking activities require optimal sensory and proprioceptive input to be performed successfully [36]. Impaired balance may be related to DPN somatosensory deficit that include loss of lower limb muscle spindle function, ankle joint movement perception and plantar cutaneous sensation [37, 38]. Consequently, the loss of appropriate sensory input related to neuropathy impacts everyday movements and has been directly linked to increased incidence of falls [39-41].

Conclusion

Diabetic patients with peripheral neuropathy had more balance deficit than diabetic patients without peripheral neuropathy.

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This study was conducted without external financial support.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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خلل التوازن بين مرضى السكري السعوديين

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المستخلص:

الخلفية: حاليا خطر السقوط مرتفع بين مرضى السكري في المملكة العربية السعودية. في الوقت الحاضر، ينصب الاهتمام مباشرة على الوقاية من السقوط من خلال الدراسات البحثية المستقبلية التي تحاول تقليل مخاطر السقوط. **الهدف:** كانت الدراسة الحالية تهدف إلى الكشف عن حدوث السقوط بين مرضى السكري السعوديين المصابين باعتلال الأعصاب المتعددة. **المواد والطرق:** تم تقسيم مائتي مريض سعودي مصاب بداء السكري من النوع 2، تراوحت أعمارهم بين 40 و 55 عامًا، إلى مجموعتين: مرضى السكري والذين يعانون من اعتلال الأعصاب المحيطية الراسخ (مجموعة الاعتلال العصبي المحيطي السكري) الذين تم تشخيص مرض السكري لهم من خلال الإرشادات السريرية وتم تقييم أداء التوازن باستخدام اختبار الوصول الوظيفي(FRT) ، واختبار المتابعة الموقوتة (TUG) ومقياس بيرج للتوازن .(BBS). **النتائج:** تم اكتشاف اختلافات معنوية بين المجموعات لمرض BBS و FRT والتي كانت أقل بشكل ملحوظ لمرضى السكري الذين يعانون من اعتلال الأعصاب المحيطية مقارنة بمرضى السكري. بينما ، تم الكشف أيضا عن قيم أعلى معنوية لمرضى السكري الذين يعانون من اعتلال الأعصاب المحيطي ل TUG مقارنة بمرضى السكري. **الخلاصة:** نقدم دليلا على أن مرضى السكري الذين يعانون من اعتلال الأعصاب المحيطية يعانون من عجز أكبر في التوازن مقارنة بمرضى السكري الذين لا يعانون من اعتلال الأعصاب المحيطية.

الكلمات الدالة: التوازن. نوع 2 داء السكري; الاعتلال العصبي المحيطي السكري.

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