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Original Article

The Relationship between Geriatric Type 2 Diabetes Mellitus, Fear of Falling and Gait: A Controlled Study

Meltem Isintas Arik[1], Humeyra Kiloatar[1], Kevser Onbasi[2]

[1]Department of Physiotherapy and Rehabilitation, School of Health Science, Kutahya Health Science University, Campus of Evliya Celebi, 43100 Kutahya, Turkey
[2]Department of Internal Medicine, School of Health Science, Kutahya Health Science University, Campus of Evliya Celebi, 43100 Kutahya, Turkey

Address correspondence to:
Humeyra Kiloatar, Kutahya Health Science University, Kütahya Health School, Physiotherapy and Rehabilitation Department, Evliya Çelebi Campus, Kütahya, Turkey. Mob: 0535 769 0421; E-mail: humeyra.kiloatar@ksbu.edu.tr

ABSTRACT

Objectives: The purpose of this study is to investigate the fear of falling (FoF) and spatiotemporal and phase parameters of gait in geriatric type 2 diabetes mellitus (type 2 DM) patients.

Design: Controlled trial

Setting: Department of Internal Medicine and Physical Therapy, Dumlupinar University, Kütahya

Subjects: Thirty-one patients who were diagnosed with type 2 DM and 29 healthy individuals were included in the study.

Intervention: FoF was assessed on the International Falls Efficacy Scale (FES). The Timed Up and Go Test (TUG) was used to assess the mobility of the participants. Spatiotemporal and phase parameters of gait were measured with the Zebris™ FDM-2 instrument and recorded instantaneously.

Main outcome measures: Fear of falling, mobility, spatiotemporal and phase parameters of gait

Results: There was a statistically significant difference between the TUG scores ($p < 0.05$) of the two groups but not between the FES scores ($p > 0.05$). There was a statistically significant difference between the two groups' step length and gait velocity ($p < 0.05$), but there was no difference in step width, cadence and step time ($p > 0.05$). In the diabetes group, FoF showed a significantly negative correlation with step length, cadence, gait velocity, left swing phase, and right swing phase. Step duration was in positive correlation with left stance phase, right stance phase, and double support phase ($p < 0.05$). In the control group, there was no statistically correlation between FoF and gait parameters ($p > 0.05$).

Conclusions: FoF can affect spatiotemporal and phase parameters of gait in diabetic patients, but not in healthy geriatric individuals.

Key Words: diabetes mellitus, gait

INTRODUCTION

Diabetes is a group of metabolic diseases characterized by hyperglycemia, resulting from defects in insulin secretion, insulin action, or both[1]. Among the estimated 8.3% of people with diabetes, 90% have type 2 diabetes mellitus (DM), and the number of affected people is expected to increase by 55% by 2035[2]. DM is very common and is especially seen in the elderly population[3]. Associated diseases, such as age-related insulin secretion, increased insulin resistance, obesity, a low level of physical activity and medications may be cited as reasons for the high prevalence of diabetes in the elderly population[4].

While 1 in 3 of geriatric individuals experience falling every year, 1 in every 10 falls result in injury[5]. Patients with diabetes are more likely to fall than their peers[6,7]. Falling causes short and long term problems. In the long term, there is a decrease in muscle strength and physical activity, and an increase in fatigue and fear of falling (FoF); while the short term results are problems such as injury, fracture and traumatic brain injuries. Tinetti *et al* have defined FoF as a decline in perceived self-sufficiency to avoid falling in doing necessary and non-dangerous daily tasks[6]. FoF is the major cause of falling and falling injuries[10–12]. Fear of falling could be more common in diabetes given the high rate of gait impairments. Although FoF is an important symptom among diabetes patients, there are few studies in this regard[11,13].

Measurements of spatiotemporal gait parameters are frequently used to identify changes in walking, define appropriate treatment modalities, and changes in patients[9]. Deterioration in gait and balance in diabetics greatly increases the risk of falling. Walking anomalies are quite common in this population[10]. Increased diabetes prevalence emphasizes the necessity of understanding possible changes in gait parameters[11].

The purpose of this study is to investigate FoF, mobility and spatiotemporal and phase parameters of gait in type 2 DM patients.

SUBJECTS AND METHODS

Subjects

The study protocol was accepted by the ethics committee. Informed consent was obtained from all individual participants included in the study.

Thirty-one patients with type 2 DM and 29 age-matched, healthy individuals were included in the study. A written approval form was obtained from all participants. Subjects were included in the study if they were over the age of 55 and independently ambulatory without assistive devices. Subjects were excluded if they had a history of severe neurological disease or orthopedic problem, foot ulcers, severe visual impairment, severe cardiovascular and respiratory diseases, or active cancer.

Clinical evaluation

Study participants underwent a comprehensive assessment that included age, gender, visual problems, falling history, and chronic diseases. FoF was assessed on the International Falls Efficacy Scale (FES), which assesses concerns about falling during 16 daily activities, scored from 1 (not at all concerned) to “somewhat” (2), “fairly” (3), and 4 “very concerned“, yielding a maximum score of 64 (the higher the score, the worse the concern). The Timed Up and Go Test (TUG) was used to assess mobility. Based on a recent meta-analysis that defined normal ranges, abnormal TUG was defined by a TUG time of ≥10 s in 50 – 69 year-olds, ≥11 s in 70 – 79 year-olds and ≥13 s in 80 – 99 year-olds[12]. The starting position of the test was standardized. The test was initiated at the position where the patient's feet were flat on the floor with arms positioned on the armrest of the seat. TUG measures the time in seconds with a chronometer: the time it takes to stand up from a chair, walk 3 m, turn around, walk back, and sit down. The best of three trials was used in the analysis. Shorter time shows better balance and mobility.

Gait assessment

Spatiotemporal and phase parameters of gait were recorded using Zebris™ FDM-2. The Zebris FDM-2 is a device used in gait and balance assessment that has a frequency range of 120 Hz, a length of 2122 cm, a width of 605 mm and a height of 21 mm, and 15360 sensors. The data obtained from the device were recorded in a report via Zebris software installed on the computer. Participants were asked to walk at the device for 5 meters on the gait platform (3 meters) and at least 8 steps on the gait analysis platform (2 meters) at a comfortable velocity. Spatiotemporal gait characteristics were simultaneously recorded on the Zebris device; gait velocity (m/s), stride length (m), cadence (steps/min) and stride time (s) were recorded for each stride. The percentage of stance phase, the percentage of swing phase, and the double support phase were recorded from the phase parameters.

Data analysis

The Statistical Package for the Social Sciences, Version 13 for Windows (SPSS, Inc., Chicago, IL, USA) was used to conduct the statistical tests. The Kolmogorov-Smirnov test was used to analyze the normal distribution of the parameters. The independent t test was used for testing the significance of the difference between the measurement averages of the two groups. In both the diabetic and control groups, the relationship between FoF and gait parameters was analyzed with Pearson’s correlation test. A significance level of $p < 0.05$ was determined for the statistical analysis parameters.

The effect size of differences in spatiotemporal and phase parameters of gait in the diabetes group and the control group was assessed. If Cohen's d value is less than 0.2, the effect size is weak; if it is 0.5, it is medium and if it is larger than 0.8, it is defined as strong.

RESULTS

Clinical evaluation and gait analysis of 60 participants were performed. A total of 31 diabetic patients and 29 healthy individuals were included in the study. Clinical variables and demographic information are given in Table 1. No significant differences were found regarding age, height, weight, BMI, presence of chronic disease, visual impairment, fall history between patients and controls ($p > 0.05$). There was no statistical difference in FoF between patients and controls ($p > 0.05$). There was a statistically significant difference between the two groups in the TUG test ($p < 0.05$).

There was a statistically significant difference regarding step length and gait velocity between the two groups ($p < 0.05$), but there was no difference in step width, cadence and step time ($p > 0.05$, Table 2). In the diabetic group, it was determined that the step length and gait velocity were lower than in the control group.

A significant difference was found between the two groups in all phase parameters of gait ($p < 0.05$, Table 3). In the diabetes group, right, left stance phase and double support phase percentages were higher than in the control group.

The relationship between FoF and gait parameters in the diabetes group and control group are shown in Table 4. In the diabetes group, FoF showed a significant negative correlation in terms of step length, cadence, gait velocity, left swing phase, and right swing phase. Step duration was in positive correlation with left stance phase, right stance phase, and double support phase ($p < 0.05$). In the control group, there was no statistically correlation between FoF and gait parameters ($p > 0.05$).

DISCUSSION

The current study compared gait, FoF and mobility in geriatric patients with type 2 DM and in age- and gender-matched controls.

FoF has been shown to be affected by being of the female gender, aging, visual impairment, cognitive function, frailty, previous experience with falling, chronic diseases, BMI, depression and educational level[18,19]. Balance and mobility impairments, obesity, depression and diabetes-related complications have been pointed out as potential factors for increased prevalence of FoF in diabetic individuals[7]. Previous studies have demonstrated that diabetes is associated with increased prevalence of FoF[11,13]. Our study, however, showed that there was no difference in FoF between the diabetic and healthy elderly. This could be related to the fact that there was no difference between the two groups with regard to aging, previous experience with falling, chronic diseases, BMI, and visual impairment. The major limitation of the study was that cognitive function, frailty and depression in patients with type 2 DM was not evaluated, which could also have been an underlying reason that no difference was found between the fear of falling of type 2 DM and healthy elderly individuals.

Changes in microcirculation associated with poor glycemic control cause damage to vestibular, somatic and autonomic systems. For this reason, making changes in walking are compensatory strategies for diabetic individuals to improve stability and maintain balance[20,21]. Studies have shown that gait velocity and step length of type 2 DM patients are lower[20,22]. In our study, gait velocity and step length in patients with type 2 DM were significantly lower. Our results showed that the difference in the mean scores of the non-diabetic and diabetic older adults was 0.68 m/s, which exceeds the value of 0.10 m/s that is considered to signify a substantial clinical change, as suggested in a study about clinically significant changes in older adults[15]. A study emphasized that type 2 DM patients with FoF have lower gait velocity and step length[17], while another study did not find gait velocity and step length to be affected by diabetes[18]. While in our study, increased FoF affected gait velocity and step length negatively in the diabetic group, it did not affect the control group.

Brach *et al* reported that step width is wider in diabetics. The changes of the motor circuit of the basal ganglia may be related to the wider step[14]. The basal ganglia are a highly metabolic area that requires good circulation and energy to function properly. Diabetes mellitus, which is known to affect circulation and blood glucose levels, could have a detrimental effect on basal ganglia[19]. In our study, however, there was no difference between the control group and the diabetic group in terms of step width. FoF did not affect step width in either diabetic or healthy individuals. Increased step width related to aging may indicate that dynamic balance control has impaired the gait[13]. People with visual impairment and impairments in sensing vibrations in the lower extremities have a lower capacity to adjust step width[10]. To compensate for the impaired balance, elderly individuals either increase their step size or increase the duration of the double support phase to control the center of gravity in the base of support[9]. Since these adaptations are important for maintaining dynamic equilibrium, reduced step width may increase the risk of falling[10]. There was no difference between the two groups in terms of visual problems and falling history, which may have caused the difference between the two groups. The fact that the duration of the double support phase of our diabetic group was higher than in the control group suggests that this group may have been maintaining balance control by increasing the duration of the double support phase.

We found in our study that the percentages of stance and double support phases in diabetic patients were higher than in healthy individuals. Other studies have also shown in a similar manner that percentages of stance phase and duration of double support phase are longer in diabetic patients[9]. Increasing the duration of the double support phase is an adaptation for maintaining balance[9]. Moreira *et al* suggested that in diabetic people with FoF, the double support phase percentage is higher than in diabetic people without FoF[16]. Our study revealed no difference in FoF between diabetic and healthy individuals. There was however, a negative correlation between FoF and the duration of the double support phase in diabetic individuals.

The TUG test is a commonly used method of assessing the functional status of geriatric individuals[20]. Bruce *et al* showed that the functional status measured by the TUG test of type 2 diabetic patients was worse than in normoglycemic subjects[8]. However, diabetics reported no more falling history than normoglycemic subjects. This may be related to the mobility limitation of individuals with type 2 DM due to fear of activity-related falls, and to prevent the recurrence of falls[7]. Guerrero *et al* assessed that the TUG scores of geriatric type 2 DM patients were higher[21]. Tander *et al* showed that increased FoF decreased mobility[22]. In our study, it was found that the TUG scores of geriatric type 2 DM patients were higher than geriatric healthy individuals. Based on this, we cannot say that FoF by itself impacted mobility in diabetic individuals.

CONCLUSION

In conclusion, our study showed that gait velocity and step length of geriatric type-2 DM patients were lower, duration of the stance phase and double support phase were longer and their functionality was lower than in healthy individuals. FoF had a negative impact on gait parameters in type 2 DM patients. It is therefore important to understand the changes that occur in gait so that complications that may occur in diabetic patients may be prevented, early diagnosis and intervention may be achieved in the event of a problem, and a decision about appropriate approaches for treatment can be made. For future studies, the recommendation would be that studies are undertaken to explore the short and long-term effects of gait training in geriatric type 2 DM patients.

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Table 1: Demographic information

Variable	Diabetes	Control	p-value
Age (years)	62.9 ± 6.1	60.93 ± 5.25	0.186
Height (cm)	162.48 ± 9.01	78.6 ± 18.57	0.491
Weight (kg)	84.6 ± 16.30	164.17 ± 9.84	0.232
BMI	31.82 ± 5.6	29.0 ± 5.98	0.065
TUG (sn)	11.87 ± 3.98	9.31 ± 2.17	0.03*
Fear of falling	22.16 ± 9.57	20.62 ± 6.17	0.465
Chronic disease			
Yes (%)	67.7	51.7	0.209
No (%)	32.3	48.3	
Fall history			
Yes (%)	12.9	24.1	0.265
No (%)	87.1	75.9	
Visual problem			
Yes (%)	58.1	79.3	0.080
No (%)	41.9	20.7	

* p<0.05; BMI: body mass index; TUG: Timed Up and Go Test

Data are shown as mean ± SD or percentage

Table 2: Spatiotemporal parameters of gait

Spatiotemporal parameters of gait	Diabetes (n = 31) (mean ± SD)	Control (n = 29) (mean ± SD)	p-value	Cohen's d
Step length (cm)	93.2903 ± 15.20349	112.3448 ± 12.75392	0.000*	1.357
Step width (cm)	15.6452 ± 2.88153	14.5172 ± 2.87378	0.135	0.393
Step time (s)	1.2023 ± 0.09674	1.1776 ± 0.13948	0.427	0.268
Cadence	100.3548 ± 8.10575	103.4828 ± 12.70720	0.265	0.293
Speed (km/h)	2.8226 ± 0.55840	3.5034 ± 0.61265	0.000*	1.170

* p <0.05

Table 3: Phase parameters of gait

Phase parameters of gait	Diabetes (n = 31) (mean ± SD)	Control (n = 29) (mean ± SD)	p-value	Cohen's d
Left stance phase (%)	67.1000 ± 3.12741	65.1241 ± 2.73282	0.012*	0.675
Right stance phase (%)	67.3677 ± 2.81997	65.2276 ± 2.35279	0.02*	0.826
Left swing phase (%)	32.9000 ± 3.12741	34.8759 ± 2.73282	0.012*	0.672
Right swing phase (%)	32.6323 ± 2.81997	34.7724 ± 2.35279	0.02*	0.826
Double support time (%)	34.4161 ± 5.46010	30.2586 ± 4.73056	0.03*	0.814

* p<0.05

Table 4: The effect of fear of falling on gait parameters

Parameters of gait		**Control**	**Diabetes**
Step length (cm)	r	-0.065	-0.660
	p	>0.05	<0.05*
Step width (cm)	r	-0.180	-0.160
	p	>0.05	>0.05
Step time (s)	r	0.045	0.390
	p	>0.05	<0.05*
Cadence	r	-0.053	-0.401
	p	>0.05	<0.05*
Speed (km/h)	r	-0.070	-0.651
	p	>0.05	<0.05*
Left stance phase %	r	0.041	0.572
	p	>0.05	<0.05*
Right stance phase %	r	0.226	0.447
	p	>0.05	<0.05*
Left swing phase %	r	-0.041	-0.572
	p	>0.05	<0.05*
Right swing phase %	r	-0.226	-0.447
	p	>0.05	<0.05*
Double support time %	r	0.143	0.628
	p	>0.05	<0.05*

* p<0.05