RELATIONSHIP BETWEEN GAIT DEVIATIONS AND RISK OF FALLS IN PATIENTS WITH TYPE 2 DIABETES

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Abstract

Diabetes mellitus (DM) is a major cause of morbidity. It is an epidemic that affects more than 300 million people worldwide. Elderly Individuals with DM are expected to be more prone to fall for reasons such as sensorimotor functions impairment, musculoskeletal limitation, joints pain, and pharmacological complications. The aim of this study is to find the relationship of gait deviations and risk of fall in community- dwelling DM patient with neuropathy and high HbA1c.

Method:

Fifteen male elderly subjects with type 2 DM, neuropathy and HbA1c >7, fifteen elderly male subjects with no DM, matched age average for both groups were 66 years. Both groups were evaluated for gait deviation using 4 digital cameras and digitally measure stride length and step width. Risk of fall was assisted using TUG test.

Results:

The results showed significant difference between groups in steps width, strides length and TUG test with P >0.05. There was a significant strong negative correlation between the HbA1c and Stride Length (r = -0.810, p = 0.000). There was a significant strong positive correlation between the HbA1c and Step Width (r = 0.759, p = 0.001). However, there was a non-significant weak positive correlation between the HbA1c and TUG test (r = 0.482, p = 0.069).

Conclusion

Diabetic subjects with neuropathy are having gait deviations that significantly correlated with risk of fall. That indicates the need for fall prevention programs for diabetic population, and more care to correct for gait deviations to lower the risk of falls.

Keywords: Diabetes, Geriatric, Gait deviation, Risk of falls, TUG test

Introduction

Diabetes mellitus (DM) is a major cause of morbidity. It is an epidemic that affects more than 300 million people worldwide. It is estimated that global number of adults suffering from any form of diabetes will reach 439 million in 2030(Ryan T, 2013), (Corriere M. et al 2013), (Shaw JE, et al 2010). DM is common among elderly population, with several potential complications that contribute to fall. However, diabetes mellitus is not widely recognized as an important adding risk factor for falls among elderly people. It is well recognized that elderly individual over 65 of age are at risk of fall. Elderly Individuals with DM are expected to be more prone to fall for reasons such as sensorimotor functions impairment, musculoskeletal limitation, foot and joints pain, and pharmacological complications. In addition, DM patients are prone to have more severe complications with falls than non-DM individuals. Fractures, and poor rehabilitation prognosis, are all concerns for care giver and family members. Falls and fall-related injuries are a major cause of death in older adults, and there-fore, are a major public health concern. (Hijmans JM. et al 2009). Gait analysis used by clinicians to identify any locomotion deviations affect on patients stability and functional activity. Hausdorff JM, et al 2001 in their prospective study Found that subjects with fall history in community-living older adults are having gait deviations.(Petrofsky et al 2003) Ambulation speed, and step width were the most factors measured in gait analysis procedure and used as indicator of gait deviations. Gait deviations may arise from muscle weakness, or somatosensory impairments. It is well established that human locomotion impairment. Older person expected to move slower than younger as a result neuromuscular and musculoskeletal impairment. This appears to be more significant when old person having systemic disease like diabetes.

Peripheral neuropathy is related to the level of glycimic control and the HbA1c level. (Loprenzi   et al 2013). High HbA1c has negative consequences on the nerves, muscle strength, motor control and on balance system (Vinik Al, et al 2008). Jeringan SD, et al 2012, found that diabetic autonomic neuropathy (DAN), and vestibular dysfunction was observed in diabetic subjects. Data from prospective and cross-sectional studies conclude that diabetic patients develop micro and macro-vascular impairments, and neuropathy (petrofsky J, et al 2004). It was concluded by (Menz HB, et al, 2004), and Fernando M, et al, 2013) that DM subjects with neuropathy have longer stance phase and more foot planter pressure.

Gait analysis plays a major role in diagnosis of age-related functional locomotion. (Petrofsky, et al 2005) found that subjects with diabetes walked significantly slower than control subjects and with awider steps during stance. When they evaluated subjects walking in a linear path, the velocity of

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subjects with diabetes was 62.2% that of controls, and stance was 134.9% wider than controls. (Barak Y, et al 2006)   confirmed that increased variability of gait patterns are an important fall risk factor in elderly people. (Lalli et al 2013) concluded that peripheral neuropathy contributes to gait deviations, and potentially contribute to the risk of fall in DM patients.

Timed Up and Go (TUG) test used to evaluate risk of fall in elderly subjects with acceptable reliability.(Ries JD, et al, 2009) and (Zakaria NA, et al, 2013), Dunaway S[1], Montes J, Garber CE (2013) found that the TUG is effective and reliable procedure to identify the risk of fall, Balance and mobility in elderly population. Jernigan SD et al 2012 explored the diagnostic accuracy of four tools for risk of fall tools and they found the Timed TUG Test demonstrated the highest diagnostic accuracy at 88.9%. As it was described by Talia Herman et al 2011 the test procedure for the TUG is relatively simple. Subjects are asked to stand up from a standard chair (seat height between 44 and 47 cm), walk a distance of 3 m (marked on the floor) at a comfortable pace, turn, walk back and sit down. Subjects are permitted to use routine walking aids and are instructed not to use their arms to stand up. No physical assistance is given. The time to complete the task is measured with a stopwatch. Timing commences on the command 'go' and stops when the subject's back is positioned against the back of the chair after sitting down. Usually the task is performed twice.

The aim of this study is to find the relation of gait deviation and risk of falls in community- dwelling DM patient with neuropathy and high HbA1c. This will assist rehabilitation team in designing tailored fall prevention rehabilitation programs for this population.

Method

A convenience sample of thirty subjects, 15 of them are with type 2 DM and 15 of none diabetic subjects, were invited to participate in this study. Both groups were age average matched.

Age range for Type 2 DM group was 58-72 years with average of 66 years. All diabetic group were with 8-10 years DM history. Inclusion criteria for the diabetic group was HbA1c 7-10, no lower extremities surgery, No foot ulcers, not using assistive device for ambulation, and they diagnosed clinically with neuropathy in the feet. Control group of fifteen subjects without DM, no lower extremities surgery, they all were independent ambulatory and matched age average with the experimental group.

Both groups signed informed consent. All received explanation about the experiment procedure. They all had filled a demographic information and past medical history information. They Set for 10 minutes to acclimatize, and then asked to walk bare feet along with a straight line drawn on the floor for 20 meters. Observational gait analyses with four digital cameras were used to

record the gait quality. Number of steps, were counted and stride length measured from heel to heel distance. Step width between the two heels at the stand phase also measured with digital measure. After a short rest (5minutes) TUG test was explained to all subjects before administered, subject been asked to sit on a chair, then order to start, examiner start the stop watch, subject were asked to stand up without using hand, waked for three meters and turn back to set on the chair without using physical assistance, when the patient rest his back to the chair, examiner stop the stop watch. Same examiner have done the TUG test for all subjects

Results

Data of HbA1c, stride length and step width were collected. The mean HbA1c shows expected difference between the group, the experimental group was 8.99, and for the control group was 5.53. The variables were analyzed for normal and experimental groups; the data was analyzed using the Statistical Package for Social Sciences (version 20.0 for Windows; SPSS Inc., Chicago, IL). One-way multivariate analysis of variance (MANOVA) was conducted to compare the normal group with the experimental group. In cases where the F ratio was significant, the differences between both groups were examined using the Turkey's test. The level of significance was set at $P < 0.05$ for all statistical tests.

The bivariate correlations among each of the HbA1c, Stride length, Step width, TUG test in experimental group. HbA1c, Stride length, Step width, TUG test between groups were studied using the Pearson Product Moment Correlation Coefficient (r) with a significant level of 0.05.

The mean values of all variables in the normal and experimental groups are presented in Table 1, and figure 1. One-way MANOVA revealed that there was a significant difference in the mean values of HbA1c, Stride length, Step width, TUG test between the normal and experimental groups ($P < 0.05$). The Tukey's test showed that there was a significant increase in the mean values of HbA1c, Step Width, and TUG test in experimental group compared to that of normal group ($p < 0.05$). Moreover, there was a significant decrease in the mean values of Stride Length in experimental group compared to normal group ($p < 0.05$).

Table (1): The mean values and one-way MANOVA for variables in normal and experimental groups.

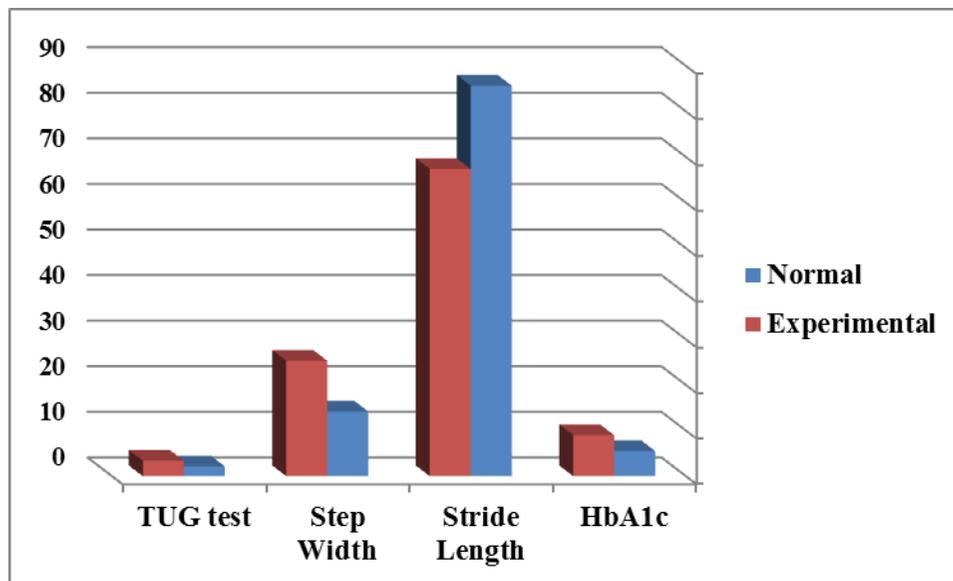| variables	Control Mean ±SD	Experimental Mean ±SD	F-value	P-value
HbA1c	5.53 ± 0.37	8.99 ± 0.68		0.000*
Stride Length/Cm	85.67 ± 1.84	67.40 ± 5.84	124.35	0.000*
Step Width/Cm	14.20 ± 1.66	25.33 ± 1.59		0.000*
TUG test/seconds	15.0 ± 0.12	38.2 ± 0.14		0.000*

* Significant at alpha level 0.05.

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Fig. 1: The mean values of HbA1c, Stride Length, Step Width, and TUG test of normal and experimental groups.

Among the normal group, there was a non-significant weak positive correlation between the HbA1c and Stride Length ($r = 0.142$, $p = 0.613$). However, there was non-significant weak negative correlation between the HbA1c and Step Width, TUG test ($r = -0.196$, $p = 0.483$; $r = -0.185$, $p = 0.509$, respectively).

Regarding the experimental group, there was a significant strong negative correlation between the HbA1c and Stride Length ($r = -0.810$, $p = 0.000$). Moreover, there was a significant strong positive correlation between the HbA1c and Step Width ($r = 0.759$, $p = 0.001$). However, there was a non-significant weak positive correlation between the HbA1c and TUG test ($r = 0.482$, $p = 0.069$).

Discussion

Our results in this study confirmed a strong correlation between all factors, with significant differences between experimental and control group. Step width and step length, which is show the gait deviation were significantly different between the two groups. Step length was significantly shorter in the diabetic group and that may be due muscle weakness, major joints tremor, and somatosensory deficit (R. ORR, 2010). Step width was significantly larger and that's may be related to patient trying to improve his stability by widening his base of support and reach some dynamic equilibrium. It is well known that, widening the base of support will lower the center of gravity and improve dynamic balance during ambulation.

(Pamela K, 2001). Elderly subjects were using this mechanism to gain some stability, but it was clear that subjects in the diabetic group have exaggerated the step width may be due their feeling of instability and fear of fall. If diabetic subject is not able to reach the dynamic balance, they will be at risk of fall. The fall may occur at the moment of disturbance of subject attention or when they ambulate on roughed irregular surface.   Our result is in agreement with the results reached by (Maurer MS, et al, 2005) and (Hausdorff JM et al, 2001).

There was a significant positive correlation between gait deviations and TUG test which is used by many clinicians to evaluate patient risk of fall with high confidence. This result is indicating that gait deviation gives good indicator of risk of fall among the diabetic group. The results confirm that the DM subjects with high HbA1c and neuropathy are at risk of fall. It is important to recommend lower extremities exercise to correct for gait deviations for subjects with diabetes to lower the risk of fall among this population.

Gait deviations are noted among DM with neuropathy and that will put them at risk of fall. This result is in agreement with the work of (Lalli et al 2013) where they concluded that peripheral neuropathy contributes to gait deviations, and potentially contribute to the risk of fall in DM patients.

Conclusion

Diabetic subjects with neuropathy are having gait deviations that significantly correlated with TUG test and risk of fall. That indicates the need for fall prevention programs for diabetic population, and more care to correct for gait deviations to lower the risk of falls among this population.

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