Influence of Ankle Range of Motion on Balance Performance in Diabetic Elderly Subjects

Sherif M. Eissa
Physical Therapy Department for Cardiopulmonary disorders and Geriatrics, Faculty of Physical Therapy, Misr University for Science and Technology.

ABSTRACT

Background: *There is a correlation between balance performance and ankle joint range of motion in elderly subjects. The aim of this study was to determine the effect of change in ankle joint range of motion on performance of balance with diabetic elderly subjects.* ***Subjects and methods:*** *Thirty diabetic elderly subjects, divided into two equal groups. The experimental group received mobility exercise for two months, where the control group received no physical therapy. Measurements of ankle range of motion and balance performance recorded before and at the end of the study.* ***Results:*** *The experimental group showed a significant improvement in performance of balance with improving the ankle range of motion, while the control group showed no significant improvement.*

INTRODUCTION

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, and insulin action. One of the long term complications of diabetes is peripheral neuropathy[4]. Subjects with diabetes could demonstrate a loss of light touch and pressure detection ability and decreased vibratory sense; they also have been shown to have diminished movement perception at the ankle joint[5].

Several authors have documented that patients with diabetes mellitus showed less ankle mobility and power compared with age matched control groups. These limitations were believed to contribute to lower walking speed and stride length[7]. Furthermore; some subjects with diabetes mellitus have been showed to have altered gait characteristics and postural instability[8].

Ankle joint is basically a uniplaner hinge joint allows motion in the sagittal plane about a transverse axis. Motions allowed are dorsi flexion (Range from 0 to 20 degrees) and planter flexion (Range from 0 to 35 degrees), other studies suggest that the range of planter flexion from 0 to 50 degrees[9]. Range of motion tends to decline throughout life span due to age related changes in the mechanical properties and morphology of joint structures[5]. Decreased ankle range of motion in elderly subjects may be a risk Factor associated with decreased balance. A certain amount of ankle range of motion is needed for functional activities such as walking which requires minimum of 10 degree of dorsiflexion[5].

Fall prevention depends on a clear understanding of the risk factors associated with falls. Elderly subjects are facing many risk factors, including both extrinsic or environmental factors and intrinsic factors such as deficits in sensory, cognitive central integrative and musculoskeletal abilities[5].

The aim of this study was to determine the influence of improving the ankle joint range of motion on performance of balance with elderly diabetic subjects.

MATERIALS AND METHODS

Subjects

Thirty diabetic elderly subjects their age ranged from 65-75 years old. All subjects were volunteers with no history of musculoskeletal, neurological, cardiovascular or pulmonary diseases; the subjects were divided randomly into two equal groups.

Instrumentation

Ankle range of motion:

Geniometer was used where its axis is placed about 1.5 cm below the lateral malleolus to measure dorsi flexion, and planter flexion, start measurement while the ankle joint is in the neutral position and the foot in zero degree of inversion and eversion. The head of the fibula was used as a reference point for positioning the stationary arm.

Subject assumed the sitting position with leg over the edge of the table, and hands grasping the edge of the table. The ankle joint was in the neutral position. The investigator asked the subject to do the planter flexion and dorsi flexion then, the tester recorded the mean reading of 3 readings for the right and the left ankle joint of each subject in both groups.

Balance performance measurements:

Berg balance scale (BBS) was used for balance assessment as it was developed as a performance-oriented measure of balance in elderly individuals. The BBS consists of 14 items that are scored on a scale of zero to 4. A score of zero is given if the participant is unable to complete the task and score of 4 is given if the participant is able to complete the task based on the criterion that has been assigned to it. The maximum total score on the test is 56. The items include simple mobility tasks (e.g. Transfer, standing unsupported, sit to stand) and more difficult tasks (Turning 360 degrees, and single-leg stance)[4,9].

Measurements of BBS and ankle range of motion were carried out by the same investigator because considerable disagreement and poor intertester reliability exist when measurements made by different investigators as this disagreement could worsely influence the clinical decision making process[5].

Procedures

Subjects were assigned into two equal groups:

Group (1)

Fifteen elderly diabetic subjects were considered as an experimental group their ages were between 65 and 75 years ($\bar{X}$ = 67, SD± 10. 3). Subjects received stretching exercises for the ankle joint in order to increase range of motion of dorsi flexion and planter flexion while the patient assuming the supine lying position of 30 seconds then rest for 30 seconds for 15 minutes. Application of moist heat via the hot packs applied for 5 minutes before performing the stretching exercises. Patient received 3 sessions per week for two months.

Group (2)

Fifteen elderly diabetic subjects were considered as a control group their ages were between 65 and 75 years ($\bar{X}$ = 68, SD ± 6. 4). Subjects received no therapeutic intervention except their daily routine and activities.

Measurements of balance performance by Berg Balance Scale (BBS) and ankle joint mobility (Dorsi flexion and planter flexion) was carried out before starting of the study and after 8 weeks at the end of the study.

Statistical analysis

The mean values of BBS and ankle joint dorsi flexion and planter flexion obtained before and after 8 weeks, of both training and control groups were compared by using the paired t test and the independent t test was used for the comparison between the two groups ($P < 0.05$).

RESULTS

Table (1) and figure (1): Show the difference between the pre and post values of Berg Balance Scale and ankle range of motion (Dorsi flexion and planter flexion) of both sides (Right and left sides) of the training group.

Table (1): Pre and post mean values of Berg Balance Scale and ankle range of motion (Dorsi flexion and planter flexion) of both sides (Right and Left) of the training group.

	Mean ± SD		t value	Significance
	Pre	Post		
Ankle dorsi flexion (right side)	10.48±2.32	16.23±2.56	3.65	**
Ankle dorsi flexion (left side)	11.13±2.15	15.61±2.79	4.12	**
Ankle planter flexion (right side)	28.12±3.26	33.86±3.81	4.53	**
Ankle planter flexion (left side)	27.98±3.71	35.12±3.85	4.89	**
Berg balance scale (BBS)	41.25±4.14	46.86±4.10	4.69	**

S.D.: Standard deviation Pre: Pre-treatment Post: Post-treatment **: Significance

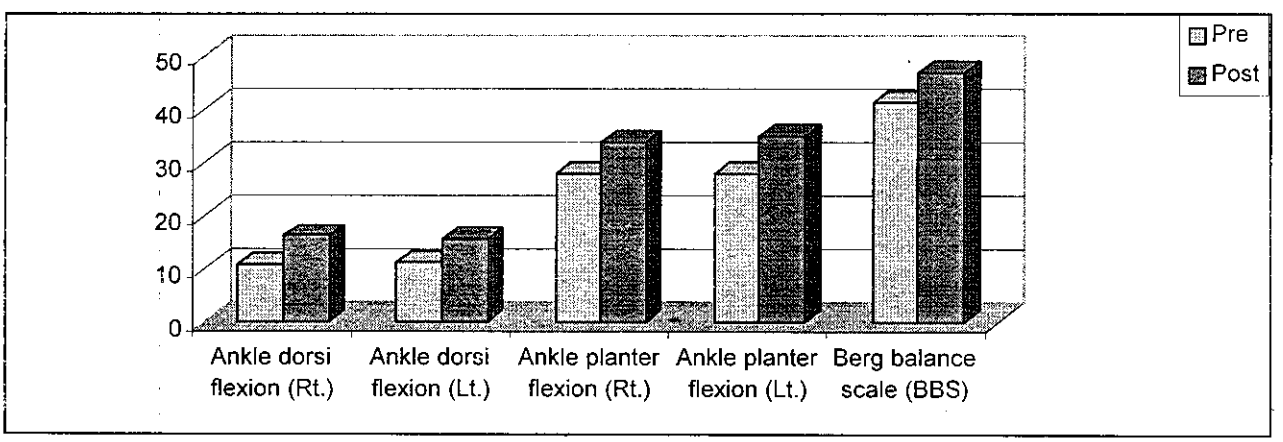

Fig. (1): Pre and post mean values of BBS and ankle range of motion (Dorsi flexion and planter flexion) of both sides (Right and Left) of the training group.

Table (2) and figure (2): Show the difference between the pre and post values of Berg Balance Scale and ankle range of motion (Dorsi flexion and planter flexion) of both sides (Right and Left) of the control group.

Table (2): Pre and post mean values of Berg Balance Scale and ankle range of motion (Dorsi flexion and planter flexion) of both sides (Right and Left) of the control group.

	Mean ± SD		t value	Significance
	Pre	Post		
Ankle dorsi flexion (right side)	11.22±2.56	12.13±2.67	0.812	Non sig.
Ankle dorsi flexion (left side)	10.80±2.32	11.91±2.83	0.935	Non sig.
Ankle planter flexion (right side)	27.68±3.62	28.01±3.71	0.635	Non sig.
Ankle planter flexion (left side)	28.53±3.88	29.65±3.913	0.789	Non sig.
Berg balance scale (BBS)	40.87±4.29	42.36±4.12	1.126	Non sig.

S.D.: Standard deviation Pre: Pre-treatment Post: Post-treatment **: Significance

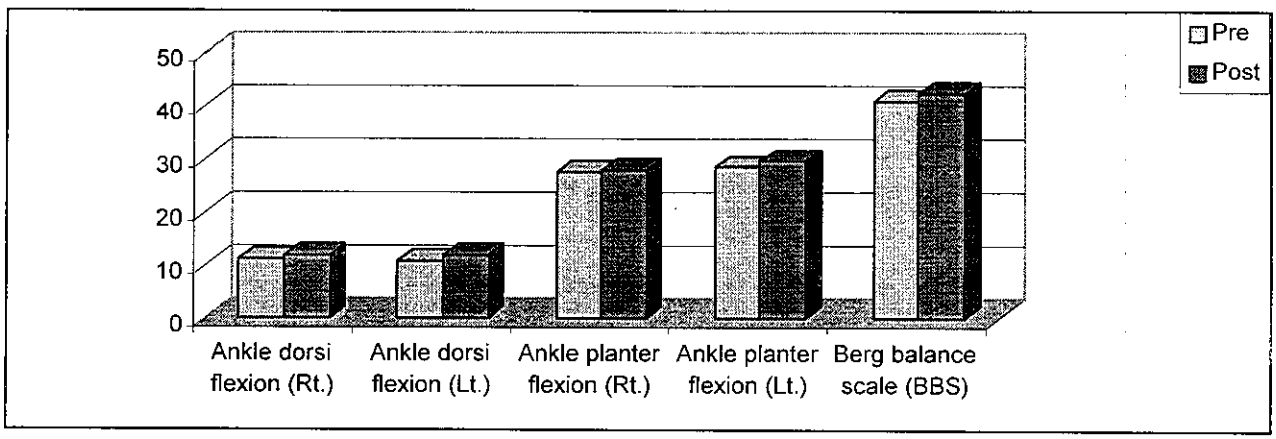

Fig. (2): Pre and post mean values of BBS and ankle range of motion (Dorsi flexion and planter flexion) of both sides (Right and Left) of the control group.

Table (3) and figure (3): Show the difference between the training group and the control group in Berg Balance Scale and ankle range of motion (Dorsi flexion and planter flexion) of both sides (Right and left sides).

Table (3): The mean values of the training group and the control group in Berg Balance Scale and ankle range of motion (Dorsi flexion and planter flexion) of both sides (Right and left).

	Mean ± SD		t value	significance
	Training group	Control group		
Ankle dorsi flexion (right side)	16.23± 2.56	12.13± 2.67	3.036	**
Ankle dorsi flexion (left side)	15.61± 2.79	11.91± 2.83	2.549	**
Ankle planter flexion (right side)	33.86± 3.82	28.01± 3.71	3.018	**
Ankle planter flexion (left side)	35.12± 3.85	29.65± 3.913	2.765	**
Berg balance scale (BBS)	46.86± 4.10	42.36± 4.12	2.113	**

S.D.: Standard deviation **: Significance

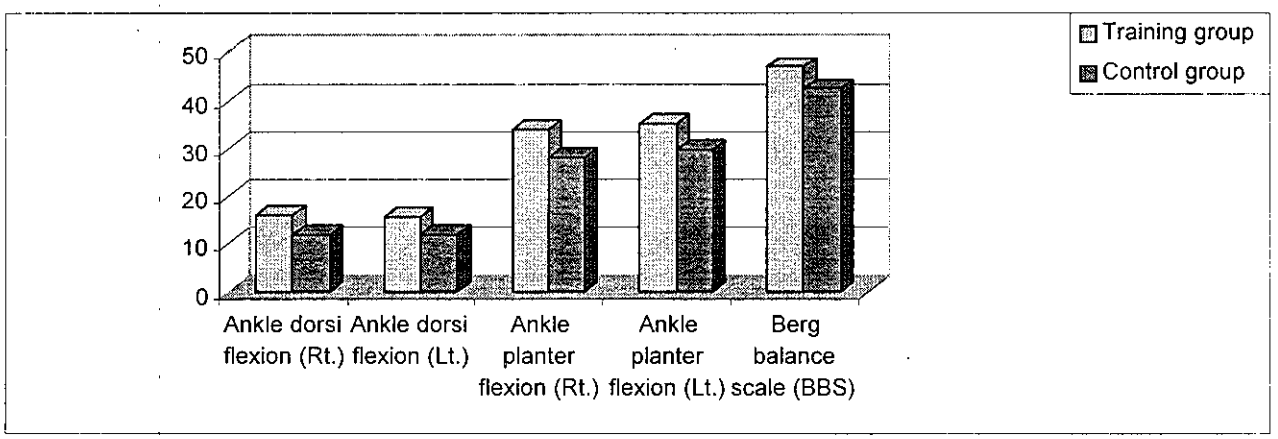

Fig. (3): The mean values of the training group and the control group in BBS and ankle range of motion (Dorsi flexion and planter flexion) of both sides (Right and left).

Table (4): Presents correlation coefficient test value and relationship between ankle range of motion and BBS in the experimental group.

Test	Pearson's value (r)
Ankle dorsiflexion (Rt. Side)	0.92
Ankle dorsiflexion (Lt. Side)	0.86
Ankle planterflexion (Rt. Side)	0,83
Ankle planterflexion (Lt. Side)	0.81

Table (5): Presents correlation coefficient test value and relationship between ankle range of motion and BBS in the control group.

Test	Pearson's value (r)
Ankle dorsiflexion (Rt. Side)	0.92
Ankle dorsiflexion (Lt. Side)	0.88
Ankle planterflexion (Rt. Side)	0,77
Ankle planterflexion (Lt. Side)	0.73

DISCUSSION

With elderly population, the prevention of disability has become a major focus in geriatrics. Many researches support the need to develop and use mechanisms for early identification of individuals who are at risk of functional decline and to establish interventions to reduce the progression toward disability.

Ankle joint strategy is a crucial component of balance and equilibrium reaction against falling. Continuous feedback throughout multiple interactions among intrinsic receptors such as muscle spindle, tendon receptors, joint senses, and special cues (Vision and auditory) represent the main key of feedback for postural control. It can be postulated that poor peripheral circulation due to diabetes lead the ankle joint to be unstable not only due to decreased in plantar flexion muscle torque but also decreased active range of motion[6,7].

Research has provided evidence that the ultra-structure of collagen, a component of the elastic elements of muscle is altered with long-term diabetes mellitus[14]. Several researchers documented that subjects with diabetes mellitus had decreased plantar flexor muscle peak torque and decreased ankle joint motion[1,2,3]. Furthermore, some subjects have been shown to have altered gait characteristics, postural instability, and stiffness during daily activities[11].

Ankle range of motion tends to decline throughout the life span due to age related changes in the mechanical properties of joint structures. The decreased ankle range of

motion may require change in movement patterns, and this change in movement patterns may affect balance, thus limiting activities as ambulation[7,10].

This study aimed to investigate the influence of change in the ankle range of motion on performance of balance in elderly diabetic subjects. The thirty subjects whom selected to participate in this study were divided into two equal groups. The experimental group received stretching exercises for planter flexors and dorsi flexors of the ankle joint in addition to hot packs application where the control group received no treatment intervention. Measurements in this study include ankle range of motion (planter flexion and dorsi flexion) and Berg Balance Scale. Measurements were taken before the study (pre-test) and repeated at the end of the study (post-test).

Results of this study indicated a significant influence for the improvement in the ankle range of motion on the balance performance with the experimental group while the control group showed a no significant change in these measurements. Also those findings support that there are several possible explanation as to why the subjects with diabetes mellitus demonstrated a decreased in rapidly available ankle balance recovery among older persons compared with younger subjects.

In the light of the diminished peak torque, ankle joint motion, and physiological changes in connective tissue that occur with diabetes mellitus, and aging process, It can expect how much the influence of the change in the ankle range of motion on the performance of balance could guide a good opportunity for many interventions to take place in geriatric care.

Although there is evidence to support that musculoskeletal impairments have an impact on function and disability in elderly persons, the type of impairments that most affect overall function have not been identified. Moreover, this information could be helpful in designing interventions to prevent and slow the disablement process. For those individuals who have functional limitations, this information would be helpful to optimize efforts to restore function by focusing on the most functionally limiting musculoskeletal impairments. The primary purpose of this study was to focus on one of the extremity musculoskeletal impairment that could best predict and help with the functional performance in elderly persons[12]. So, Focusing on lower extremity range of motion, especially the ankle joint could improve balance, reduce risk of falls and improve the ability to transfer safely in elderly subjects[7,13].

CONCLUSION

It can be concluded that there is a closed relationship between the ankle range of motion and the ability of elderly persons to maintain balance.

It can be recommended further researches to determine the relationship between the physiological indicators and functional ability, which will help in the development of goal-directed training programs as a base for improving and maintaining independent elderly people.

REFERENCES

1- Andersen, H., Poulsen, P.L., Mogensen, C.E. and Jakobsen, J.: Isokinetic muscle strength in long-term IDDM patients in relation to diabetic complications. Diabetes, 45: 440-445, 1996.

2- Andersen, H., Gadeberg, P.C., Brock, B. and Jakobsen, J.: Muscular atrophy in diabetic neuropathy: a stereological magnetic resonance imaging study. Diabetologia, 40: 1062-1069, 1997.

3- Andersen, H. and Mogensen, P.H.: Disordered mobility of large joints in association with neuropathy in patients with long-standing insulin-dependent diabetes mellitus. Diabet Med. 14: 221-227, 1997.
4- Beissner, K., Collins, J. and Holmes, H.: Muscle force and range of motion as predictors of function in older adults. Physical Therapy, 80: 556-563, 2000.
5- Bogle, T. and Newton, R.: Use of the balance berg test to predict falls in elderly persons. Physical Therapy, 76: 576-585, 1996.
6- Gandevia, S.C. and Burke, D.: Does the nervous system depend on kinesthetic information to control natural limb movements? Behav Brain Sci, 15: 614-632, 1992.
7- Mills, E.: The effect of low- intensity aerobic exercise on muscle strength, flexibility and balance among sedentary elderly persons. Nurs. Res., 43: 207-211, 1994.
8- Mueller, M., Mina, S. and Sharmann, S.: Differences in the gait characteristics of patients with diabetes and peripheral neuropathy compared with age-matched control. Physical Therapy, 74: 299-313, 1994.
9- Salsich, G., Mueller, M. and Sharmann, S.: Passive ankle stiffness in subjects with diabetes and peripheral neuropathy versus an age matched comparison group. Physical Therapy, 80: 352-362, 2000.
10- Saltzman, C.L. and Nawoczenski, D.A.: Complexities of foot architecture as a base of support. J Orthop Sports Phys Ther., 21: 354-360, 1995.
11- Simoneau, G.G., Ulbrecht, J.S. and Derr, J.A.: Postural instability in patients with diabetic sensory neuropathy. Diabetes Care, 17: 1411-1421, 1994.
12- Steffen, T., Hacker, T. and Mollinger, L.: Age and gender-related test performance in community-dewelling elderly people: Six-minute walk test, Berg balance scale, Timed up and go test and Gait speeds. Physical Therapy, 82: 128-137, 2000.
13- Province, M., Hadley, E. and Hornbrook, M.: The effects of exercise on falls in elderly patients. Jama, 273: 1341-1347, 1995.
14- Valssara, H.: Advanced nonenzymatic tissue glycosylation: cell-mediated interactions implicated in the complications associated with diabetes and aging. Blood Purif., 8: 223-232, 1990.

الملخص العربي

تأثير مدى حركة مفصل القدم على أداء الاتزان لدى الأشخاص المسنين ويعانون من داء البول السكري

حـــول علاقة أداء الاتزان ومدى حركة مفصل القدم للأشخاص المسنين ... أجري هذا البحث لدراسة تأثير التغيير في مدى حركة مفصـــل القدم على أداء أتزان الأشخاص المسنين ويعانون من داء البوال السكري. أشترك في الدراسة ثلاثون فردا يعانون من داء البوال السكري وتم تقسيمهم عشوائيا إلى مجموعتين متساويتين. المجموعة التجريبية تكونت من خمسة عشر فردا و تلقت تمرينات لزيادة المرونة لمـــدة شهرين. المجموعة الضابطة لم تتلقى أي وسائل علاجية. القياسات لمدى حركة القدم و أداء الاتزان تم تسجيلها قبل و بعد التدخل. أظهرت نتائج المجموعة التجريبية تحسن في أداء الاتزان عقب تحسن مدى حركة مفصل القدم في حين لم يحدث تغيير على أداء الاتزان للمجموعة الضابطة.