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Research paper

Effect of Eight Weeks of Selected Core Stability Exercises on Balance and Quality of Life in Patients with Diabetic Neuropathy

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Abstract

Neuropathy is one of the most well-known complications of small vessels in diabetes, which leads to a decrease in balance, muscle strength and endurance, and quality of life due to impaired deep sensory function of the sensory-body system. Diabetic peripheral neuropathy also reduces balance in the lower extremities due to peripheral nerve involvement. The aim of the present study was to investigate the effect of eight weeks of selected core stability exercises on balance and quality of life in patients with diabetic neuropathy. The present study is an applied research and experimental type in which pre-test and post-test with control group have been used. 30 patients with neuropathy in a targeted and accessible manner were chosen. Then they were randomly divided into two groups of experimental and control. The experimental group performed selected 20-minute core stability exercises for eight weeks per week and the control group followed their normal treatment process. Before and after the training period, the variables of balance and quality of life of patients were evaluated by Berg balance test and short form of quality-of-life questionnaire for diabetic patients, respectively. Inferential analysis of data was performed using covariance test. The results showed that the selected core stability exercises had an effect on the balance of neuropathic patients and quality of life of neuropathic patients. Findings showed that eight weeks of core stability training can be used in the process of physical rehabilitation of patients with diabetic neuropathy.

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Introduction

Diabetes as a risk factor for type 2 diabetes is characterized by changes in blood sugar above normal levels. Research has shown that lifestyle modifications play an important role in preventing diabetes. Physical activity is an essential element of lifestyle and exercise is a subset of the spectrum of physical activity. Diabetes is still an important epidemic in the contemporary era. About 382 million people in the world live with diabetes, which accounts for about 8.3% of the world's population.

According to experts from the American Diabetes Association, about 70% of people with pre-diabetes eventually develop diabetes. In prediabetes, unbalanced fat metabolism leads to peripheral neuropathy. In diabetes, high blood sugar levels and metabolic disorders lead to a number of complications, including high blood pressure and hyperlipidemia, coagulation problems, kidney problems, vision disorders, neurological dysfunction, and cardiovascular disease. Diabetes can also lead to neurological disorders that affect different parts of the nervous system, including the peripheral and autonomic nerves. Diabetic peripheral neuropathy is one of the neurological complications of diabetes that may appear years after the onset of the disease. Among the complications of diabetes, neuropathies are among the long-term complications of diabetes that affect more than 50% of diabetics and its prevalence increases with the progression of diabetes.

Diabetes is associated with many symptoms, such as frequent urination, excessive thirst, weight loss, increased appetite and hunger, blurred vision, irritability and excessive fatigue. Worse than chronic symptoms are chronic complications, the most common of which is neuropathy, which occurs in 20 to 50 percent of diabetic patients who have been diagnosed with diabetes for 10 years.

More than one and a half million people in Iran have diabetes, neuropathy is one of the most common complications of diabetes that reduces the quality of life of diabetic patients and may eventually lead to ulcers and amputation. The risk of lifelong amputation in patients with polyneuropathy is 15%. The first step in creating and amputating a foot ulcer is polyneuropathy. 14% to 20% of diabetic patients with lower extremity ulcers need amputation (Boya et al., 2011[1]). Approximately 40 to 60 percent of lower limb amputations are performed in diabetics, and more than 85% of cases are due to a worsening of a gangrene or infection of the foot.

The negative effects of diabetic foot on the quality of life of the patient not only cause illness and disease but also cause disability and premature death. The highest prevalence of wounds is in the anterior region of the foot, which accounts for 71% of wounds. The most common sites of ulcers are the head of the first sole of the foot and the lower surface of the thumb. The average time of hospitalization of diabetic patients with wounds is longer than diabetics without wounds, while 15 to 20% of them need amputation and 85% of amputations are in the lower extremities. All daily activities need to maintain balance in stillness and movement. Balancing is a complex skill that describes the dynamics of stature in preventing falls. Equilibrium is defined as the process of maintaining the center of gravity within the level of reliance. Balance can be static and dynamic. Static balance is defined as level of reliance with minimal movement and dynamic balance is defined as performing an activity or task while maintaining a stable posture. Human balance control depends on the integration of afferent information from the vestibular system of sight and body.

This group of muscles, like a muscle belt, is used as a movement unit to stabilize the body and spine with and without lower limb movement. Core stability is expressed as the driving force of the foundation or the engine of all lower limb movements. Core stability exercises can be performed on stable surfaces (on the ground) and unstable surfaces. One way to improve core stability on unstable surfaces is to use a Swiss ball. Results of electromyographic analysis of upper torso, lower torso and abdominal muscles during advanced training in healthy individuals.

Trunk stability exercises with a Swiss ball have shown an increase in trunk stability in core trunk muscle function in the elderly. Various researches have been done about this research in Iran and different countries. Shundi et al. conducted a study entitled the effect of strength training on metabolic indicators, quality of life and mental health of women with type 2 diabetes. They finally concluded that strength training leads to lower fasting blood sugar and improved quality of life and mental health in women with type 2 diabetes) Shundi et al. 2010[2]).

Hassanvand et al. conducted a study to determine the effect of endurance and strength training on glycosylated hemoglobin and fasting blood sugar in patients with type 2 diabetes (Hassanvand et al. 2011[3]). Finally, at the end of the study, there was a significant decrease in glycosylated hemoglobin in the endurance group before and after exercise, but in the control group and strength training, the changes did not show a significant difference. Posttest fasting blood sugar decreased in the endurance and strength groups and this difference was significant, but the control group did not show a significant difference. Shirazi et

al. examined walking speed, balance time and sense of knee and ankle joint position in healthy individuals and patients with type 2 diabetes. (Shirazi et al. 2012[4])

The results showed that the balance time in people with type 2 diabetes was shorter than the healthy group. The sense of depth that was gained by measuring the amount of error in joint angle reconstruction is impaired, which may be due to the presence of neuropathy in them. Sarvestani et al. conducted a study on 30 inactive elderly in core stability exercises and water balance exercises for eight weeks, which were divided into three groups: control, core stability exercises, and water balance exercises (Sarvestani et al. 2012[5]). The Y balance test was performed to assess their dynamic balance in pre-test and post-test. One-way analysis of variance was used to compare the three groups, and both exercises significantly improved their dynamic balance.

Ebrahimi et al. showed that eight weeks of core stability training on a stable surface increased the endurance of the abdominal and back muscles of patients with low back pain due to disc herniation and had a significant reduction in pain intensity (Ebrahimi et al. 2014[6]). Kimberly et al. in a study examined the effect of a five-week core stability training program on dynamic balance in tennis athletes to measure the dynamic balance of the participants in the five-week protocol, the star equilibrium rotation test was used and no significant difference was observed in the dynamic balance between the two groups (Kimberly et al. 2005).

Freeman et al. in a study that examined the effect of core stability exercises on patients with MS, found that after eight weeks of core stability exercises, subjects' walking time and balance improved significantly (Freeman et al. 2010[7]). Song et al. conducted a study entitled the effect of an exercise program on the balance and body shape of the elderly in people with peripheral diabetic neuropathy (Song et al. 2011[8]). In this study, 38 patients with diabetes were divided into two groups. Both groups were given health training on diabetes for eight weeks, and the experimental group was given balance exercises that lasted eight weeks and twice a week for 60 minutes. The results showed that the postural fluctuations of the experimental group were reduced and the test time of standing on one leg was also increased. And balance exercises significantly improved the balance of patients with diabetic neuropathy.

Clark et al. showed that assessing postural stability by measuring the center of pressure using a foot scanner is a reliable method for assessing dancer balance (Clark et al. 2012[9]). He found that people with lower limb injuries had poorer postural control. In a study in the effects of exercise on the symptoms of neuropathy, nerve function, and skin irritation in diabetics with peripheral

neuropathy, Gooding et al. found that 10 weeks of aerobic and resistance training reduced pain and the symptoms of neuropathy (Gooding et al. 2010). In this study, using muscle sampling, an increase in nerve fibers due to regular exercise was also observed.

Toth et al. in a study entitled the role of exercise in comparison with teaching exercise tips in the treatment of pain and reducing exercise capacity due to peripheral neuropathy found that the improvement of pain due to neuropathy in the two groups was not significantly different. In fact, exercise could not significantly reduce patients' pain (Toth et al. 2012[10]). However, with the increase of Vo2 after the study period, the role of exercise in improving the blood supply capacity of these patients was proved. Scott et al. showed that training with a Swiss ball was more effective in stimulating the multifidus muscle and increasing its thickness in patients with chronic low back pain compared to training on the ground and had a greater effect on lumbar cross-section stability (Scott et al. 2015[11]).

Therefore, in view of the above, the researchers in the present study intend to examine the effect of core stability training as a non-invasive and low-cost strategy in the time and energy of these patients for the first time, in addition to consolidating the effect of exercise on these patients. Finally, present a protocol that includes invigorating and motivational exercises as a complementary therapeutic strategy to bring patients closer to better conditions. Given the above, the present study intends to answer the question of whether eight weeks of core stability training can affect the balance and quality of life of patients with diabetic neuropathy and reduce their problems and complications?

Research Methodology

The present study was a quasi-experimental study with two groups of control and experimental using pre-test and post-test design. The method of data collection was done in the field by the researchers. Thirty patients with diabetic neuropathy were referred by an endocrinologist. 15 people were in the experimental group and 15 people in the control group. Inclusion criteria are the definite existence of diabetic peripheral neuropathy syndrome, the absence of leg ulcers and no history of fractures and dislocations, the doctor's refusal to exercise, the desire to participate in the study. Exclusion criteria includeany unpredictable problem that occurs in the research process that causes the test to be absent.

Berg balance test (BBS-9) was used to measure balance and DQOL-BCI was used to measure quality of life. Berg balance test, designed to measure balance in the elderly by Katie Berg, a Canadian physiotherapist. The Berg balance test

is a performance appraisal consisting of 14 items that examines the quality and risk of falls in the elderly.

Developing and enhancing the applicability of the short version of the Berg balance test (BBS-9), which includes nine cases, was presented in 2012 by Kivimäki et al[12]. Berg balance test has been introduced as the most important predictor of fall risk in the elderly or disabled.

The time reliability of this test in the disabled and the elderly is 0.83 and its internal reliability is 0.99, which is calculated through Cronbach's alpha. The nine-case version of the Berg test showed a significant correlation with respect to the static and dynamic aspects of equilibrium. This test consists of nine items of the main Berg test, each of which consists of five levels. That is, it ranges from zero to four, where zero is a sign of inability to perform the test and four is a sign of normal performance, and the total score of the test is 36. People who get a score between zero and 32 in this test are in the risk group. And people whose score is in the range of 33 to 36 are in the non-risk group, also the score of 32 to 33 indicates moderate to good ability. The nine-item Berg test only takes 13 to 19 minutes to complete. While the main Berg test took 20 to 30 minutes.

The main DQOL-BCI questionnaire consisted of 60 questions, which were first validated by Thomas Burroughs and colleagues in 2004 and reduced to 15 questions. A 15-item questionnaire is used for type 1 and 2 diabetic patients. The questions of this questionnaire include two dimensions of patient care behaviors and satisfaction with disease control.

It takes about 10 minutes to complete this questionnaire. In internal studies, the reliability of the quality-of-life questionnaire was reported to be 0.77 (Nasihatkon et al., 2012[13]). After collecting the research information, the data related to the characteristics of the subjects such as age, height and weight along with the research variables in two sections of descriptive and inferential statistics from SPSS software version 24 were statistically analyzed. Kolmogorov-Smirnov and Shapiro-Wilk tests were used to determine the normality of the data, Levin test was used to determine the assumption of variance homogeneity, Box test was used to check the equality of covariances, and Machley test was used to check the covariance uniformity. Repeated measurement covariance test was used to compare the results obtained in pre-test and post-test. Also, the level of significance was considered 0.05 throughout the study.

The training program included selected core recording exercises with a physioball ball. The exercises were divided into three parts. The training program for the first two weeks, which was simple movements, consisted of 8 lying movements: bridging, lying on the abdomen, and in the bridge position,

placed a ball between the two knees and pressed the ball with both knees, lying movements and lying movements on the abdomen. Intermediate exercises for the second three weeks included cat movements, plank and side plank movements, and the movements with the ball were physiobal. Finally, moderate to advanced exercises for the last three weeks, which were the same movements but with a physioball ball. The number of repetitions was done in the first two weeks of each movement 3 * 10 and three weeks later 3 * 12, and finally the last three weeks 14 * 3 exercises. Cooling, which included stretching and relaxation for 10 minutes, and exercises to return to the original state.

Findings

Table (1) presents descriptive results of patients' demographic information.

Table 1- Mean and Standard Deviation of Patients' Individual Characteristics

Variable	group	Average	Standard deviation	Statistics t	The significance level
Age (years)	Experimental	56.3	5.8	0.42	0.81
	Control	53.9	6.6		
Height (cm)	Experimental	153.5	7.1	0.58	0.77
	Control	156.4	7.4		
Weight (kg)	Experimental	72.5	8.1	2.5	0.056
	Control	75.8	7.9		
BMI	Experimental	32.6	6.7	0.63	0.53
	Control	33.1	8.4		
History of neuropathy	Experimental	12.6	5.3	1.2	0.29
Variable	Control	11.1	3.4		

In Table (1) descriptive information (mean, standard deviation), demographic information of patients including; age, height, weight, body mass index and history of neuropathy are shown in both experimental and control groups. The physical characteristics of the subjects in the experimental and control groups were not significant.

Table (2) provides descriptive information about the balance and quality of life of patients.

Table 2- Descriptive Information Related to Balance and Quality of Life

Post-test Standard deviation ± mean	pre-exam Standard deviation ± mean	Statistical index	Variables
31/32 ± 0/9	26/33 ± 0.4	Experimental (15 people)	Balance (points)
26/13 ± 0.3	26/43 ± 0.6	Control (15 people)	
21/65 ± 0.9	15/55 ± 0.8	Experimental (15 people)	Quality of life (patient caring behaviors)
14.64 ± 0.2	15/34 ± 0.5	Control (15 people)	
27/15 ± 0.8	18/4 ± 0.1	Experimental (15 people)	Quality of life (satisfaction with disease control)
16/83 ± 0.7	17/14 ± 0.6	Control (15 people)	
48/79 ± 0.8	33/58 ± 0.3	Experimental (15 people)	Total Quality of Life Score (Score)
31/45 ± 0.7	32/46 ± 0.9	Control (15 people)	

Table (2) shows the descriptive information related to balance and quality of life by experimental and control groups.

Based on the research data, the results of Levin test were confirmed to investigate the homogeneity of variances in the distribution of research variables. In addition, the box test was approved to check the equality of covariances in the scores of the distribution of research variables. The assumption of uniformity of covariances was based on Machley test in the distribution scores of research variables ($P < 0.01$) and Greenhouse-Geiser coefficient was used.

Table (3) shows the statistical indicators of covariance related to balance and quality of life.

Table 3- Results of Covariance Test in Balance and Quality of Life

Directions	Source of change	Groups	Test statistics	The significance level	Squared eta	Statistical power

Balance Intragroup		Test time	Test statistics	000/0	740/0	000/1
		Test time * Error group	79/767	000/0	788/0	000/1
		Error group	104/186	033/0	152/0	580/0
Patient Caring Behaviors	Intergroup	Test time	5/015	000/0	648/0	000/1
	Intragroup	Test time * Error group	51/554	000/0	750/0	000/1
		Error group	83/807	043/0	208/0	565/0

Table 3- Results of Covariance Test in Balance and Quality of Life

Directions	Source of change	Groups	Test statistics	The significance level	Squared eta	Statistical power
Satisfaction with disease control		Test time	4/758	000/0	780/0	000/1
Quality of Life	Intergroup	Test time * Error group	99/058	000/0	799/0	000/1
	Intragroup	Error group	111/334	002/0	292/0	906/0
		Test time	11/539	000/0	853/0	000/1
		Test time * Error group	162/613	000/0	883/0	000/1
Directions	Intergroup	Error group	211/645	003/0	274/0	880/0
Balance	Intragroup	Groups	10/541	The significance level	Squared eta	Statistical power

Interaction or Combined Effect of Two Factors

Balance: The average balance scores of the experimental group in the post-test were significantly higher than the pre-test. Also, balance changes between groups (control and experimental) were significantly different ($P < 0.05$). Moreover, a significant interaction was observed between the test time and the group ($P < 0.01$). According to the value of the square of ETA, about 79% of the changes in the dependent variable (equilibrium rate) are explained by the independent variable of the experimental group (selected core stability exercises).

Patient Care Behaviors: The mean scores of patient care behaviors in the experimental group in the post-test were significantly higher than the pre-test. Furthermore, changes in patient care behaviors were significantly different between the groups (control and experimental) ($P < 0.05$). Also, a significant interaction was observed between the test time and the group ($P < 0.01$). According to the amount of ETA squared, about 75% of the changes in the dependent variable (the amount of patient care behaviors) are explained by the independent variable of the experimental group (selected core stability exercises). Satisfaction with disease control: The mean scores of satisfactions with disease control in the experimental group in the post-test was significantly higher than the pre-test. Also, changes in satisfaction with disease control were significantly different between groups (control and experimental) ($P < 0.01$). Besides, a significant interaction was observed between the test time and the group
($P < 0.01$). According to the ETA squared value, about 80% of the changes in the dependent variable (satisfaction with disease control) are explained by the independent variable of the experimental group (selected core stability exercises).

Quality of Life: The average scores of quality of life of the experimental group in the post-test were significantly higher than the pre-test. Also, changes in quality of life between the group (control and experimental) were significantly different ($P < 0.01$).

Additionally, a significant interaction was observed between the test time and the group ($P < 0.01$). According to the ETA squared value, about 88% of the changes in the dependent variable (quality of life) are explained by the independent variable of the experimental group (selected core stability exercises).

Discussion and Conclusion

In the present study, after eight weeks of core stability training, the balance and quality of life of diabetic neuropathic patients in the experimental group increased compared to the control group. The results showed that diabetic neuropathic patients can use core stability training to reduce neuropathic complications. And the use of such exercises improves the quality of life of these patients. In all these studies that have been done inside and outside the country, the effect of core stability exercises on patients with diabetic neuropathy has been proven. Further, the factors studied in these studies have been examined in the present study and the results of the present study have complemented the previous research.

Sarvestani et al. examined the effect of eight weeks of core stability training and water balance training on the elderly, both of which significantly improved their dynamic balance (Sarvestani et al. 2012[5]). In addition, Ebrahimi et al[6]. and Song et al[8]. examined the effect of eight weeks of core stability training on abdominal and back muscle endurance in patients with low back pain and balance and torso in the elderly with peripheral diabetic neuropathy. The pre-test and post-test results had a significant difference that is consistent with the present study.

Freeman et al. examined the effect of eight weeks of core stability training on MS patients and found that after eight weeks of core stability training, subjects' walking time and balance improved significantly, which is consistent with the present study (Freeman et al. 2010[7]). Kimberly et al. investigated the effect of a five-week core stability training program on dynamic balance in tennis athletes and found that there was no significant difference in dynamic balance between the two groups. The results of this study are not consistent with the present study and the reason for this discrepancy may be due to differences in the duration of the training protocol used (Kimberly et al., 2005). Based on the available evidence, we obtained similar results with internal and external studies. Based on the above, we concluded that eight weeks of selected core stability exercises affect the balance and quality of life of patients with diabetic neuropathy. And core stability exercises can be used as a therapeutic goal in improving diabetic neuropathy and increasing the quality of life of this group of patients. However, there are various points in this regard and should be studied and researched in the future.

The importance of prevention and treatment of diabetic patients through core stability training methods (best results in the shortest time) in maintaining the health of these patients becomes more prominent.

In conducting this research, the researcher encountered limitations that some of these limitations are inevitable due to the nature of this type of scientific research that is in the human field. Lack of familiarity of the respondents with the research questions on how honestly they answered the questions of the questionnaire. Lack of knowledge about the extent to which the questionnaire questions were comprehensible to the subject and answered by understanding and inference. Limitations on control of variables, all variables that interfere with the research situation may affect the research results. Sampling this study does not seem to be sufficient for the statistical population of all diabetic neuropathy patients and inevitably the results of this study should be generalized to other people with caution.

During the different stages of this research, new points were realized and at the same time with the progress of this research, more ambiguities were created in

front of the researcher, which due to the existing limitations, their study requires more research.

According to the results of this research, some suggestions are presented including the use of core stability exercises as an effective therapeutic target in diabetes prevention and pre-diabetes treatment. It is recommended that after the exercises, they examine the changes in the respiratory capacity of the subjects in the pre-test and post-test. To design a core stability exercise program and the optimal effect of the exercises, pay attention to the chain reactions of the body. According to the findings of this study, its results can be used to improve the scientific and practical level of rehabilitation centers for physical and sports fitness trainers and rehabilitation centers to return injured people, etc. to daily life. The results of this research should be made available to medical centers, health centers, sports centers, and sports clubs.

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