Pharmacophore, 8(6S) 2017, e-1173315,Pages 10

Pharmacophore

ISSN-2229-5402

Journal home page: http://www.pharmacophorejournal.com

INVESTIGATING THE IMPACT OF BALANCE EXERCISES ON BALANCE INDICES IN KNEE OSTEOARTHRITIS PATIENTS

Narges Jahantigh Akbari[1], Ahmad Reza Askary Ashtiani*[2], Mahdi Mohammadi[3]

1. ***Master student in Physiotherapy, Student Research Committee, Health Promotion Research Center, Zahedan University of Medical Sciences, Zahedan, Iran***
2. ***Assistant Professor of Physiotherapy, Health Promotion Research Center, Zahedan University of Medical Sciences, Zahedan, Iran***
3. ***Associate Professor in Epidemiology Department, Health Promotion Research Center, Zahedan University of Medical Sciences, Zahedan, Iran***

ARTICLE INFO

Received:
03th Jun 2017
Accepted:
29th Nov 2017
Available online:
14th Dec 2017

Keywords: *Balance Exercises, Knee Osteoarthritis, Balance Indices*

ABSTRACT

Objective and Background: Osteoarthritis is a chronic and degenerative joint disease. This musculoskeletal disease is associated with imbalance. The objective of this study was to investigate the impact of balance exercise on balance indices in knee osteoarthritis patients.
Methodology: 30 knee osteoarthritis patients were selected using simple and convenient sampling method in this one-blind randomized controlled clinical trial, and they were randomly assigned to balance exercises and control groups. The treatment program in the balance exercises group included balance exercises, and it included ultrasound, TENS(Transcutaneous Electrical Nerve Stimulation) and hot pack in the control group. Overall, anterior-posterior, and medial-lateral stability indices were measured by using Biodex balance system in static and dynamic states with open and closed eyes on one and two legs before and after treatment. Treatment was performed for both groups for 3 weeks and 5 times per week. Mann-Whitney and Wilcoxon statistical tests were used to analyze the data
Results: In the static state, the overall and anterior-posterior indices on two leg in the open eyes were reduced from 0.74 ± 0.42 to 0.52 ± 0.17 (P = 0.02) and from 0.57 ± 0.39 to 0.36 ± 0.12 (P = 0.04), respectively, in the balance exercise group. In the static state, the overall stability index on two legs in open and closed eyes was reduced from 1.16 ± 0.82 to 0.74 ± 0.46 (P = 0.04) and from 3.13 ± 1.74 to 2.20 ± 1.02 (P = 0.01), respectively, in the control group. No significant difference was found between the two groups except for the anterior-posterior stability index in the dynamic state on the involved leg in closed eyes (P <0.05).
Conclusion: Inter-group comparison revealed a significant difference between balance exercises group and control group in terms of impact on the anterior-posterior stability index in dynamic state on the involved leg in closed eyes. In intra-group comparison, balance exercises improved the number of balance indices compared to the control group both in static and dynamic states.

To Cite This Article: Narges Jahantigh Akbari, Ahmad Reza Askary Ashtiani, Mahdi Mohammadi, (2017), "investigating the impact of balance exercises on balance indices in knee osteoarthritis patients", ***Pharmacophore, 8(6S),*** *e-1173315.*

Introduction

Osteoarthritis is a chronic and degenerative joint disease (1-3). This disease can result in morphological and biomechanical changes in different joints of the body (4), in a way that abnormal loads can provide the conditions for knee osteoarthritis, while the knee joint plays a vital role in many activities (5).Knee osteoarthritis is progressively increasing as age increases, so that almost 80% of people over 75 years suffer from this disease (5, 6). Twenty and five percent of people with knee osteoarthritis report pain and almost half of these patients report disability during the disease (7).The highest complaint in patients with knee osteoarthritis is related to proprioception disorder, reduced balance and function (11-8). On the other hand,

Corresponding Author: Ahmad Reza Askary Ashtiani, Assistant Professor of Physiotherapy, Health Promotion Research Center, Zahedan U Dr. Hesabi Square, Jannat Blvd, Zahedan University of Medical Sciences, Faculty of Rehabilitation Sciences. E-mail: Ahmadaskary@gmail.com

knee osteoarthritis causes many psychological, social, economic, physical problems in everyday life of people (8, 12-17). Osteoarthritis usually occurs in weight-bearing joints (18). Osteoarthritis is seen more common in the knee joint than the hip joint (19). On the other hand, degenerative changes occur in the joint and tissues around the knee joint with osteoarthritis (6, 20-23). Knee osteoarthritis leads to many changes in the tissue, including lack of articular cartilage, synovial membrane inflammation, bone deformation, and muscle weakness (7, 20, 24). Reduced balance and increasing falls are a major concern for physiotherapists (25). Balance decreases as age increases, which it is associated with increased posterior sway and decreased stability in elderly patients (25-34). The balance is controlled by sensory input, central processing and neuromuscular responses (25). Sensory components include visual, vestibular, and proprioceptive systems (25). The proprioception sensation has been stated as awareness of limb position and movement in space (35). On the other hand, a proper and effective motor response requires a healthy neuromuscular system and adequate muscular strength to direct the center of mass or C.O.M into the supportive surface or B.O.S, when the balance is disturbed (25). Therefore, proprioception defects will cause joint degeneration due to abnormal neuromuscular control and abnormal distribution of knee loads. It can be said that the proprioception defect is caused by damage to the joint receptors resulting from degeneration along with knee osteoarthritis (35). Many treatments are used to increase the balance in patients with knee osteoarthritis (20). In a systematic review study conducted by Andressa Silva et al, it was reported that protective treatments, especially therapeutic exercises, including aerobic and strengthening exercises, improved the symptoms of patients with knee osteoarthritis. On the other hand, studies on the effects of exercise therapy on balance have been reported less in these patients (36-41). It has been reported in many studies that balance is necessary to prevent falling in people with knee osteoarthritis. Therefore, a suitable treatment program is prioritized for improving balance (6). In a study conducted by N. Shakoor et al, it was reported that pain is indirectly related to muscle strength and proprioception, in a way that change in the mean pain through 8 weeks of home exercise program can cause changes in muscle strength and proprioception (42). In a study conducted by Mattew W. Rogers et al, it was shown that exercises to improve the proprioception led to an increase in the dynamic balance and the efficiency of the individual in daily life activities (43). A study has shown that non-surgical interventions, such as the use of orthopedic brace or insoles, have been helpful in preventing the progress of knee osteoarthritis (44). In a systematic review study conducted by Sumaiyah Mat et al, it was shown that physiotherapy interventions such as strengthening exercises and aerobic exercise led to increased balance and reduced risk of falling in people with knee osteoarthritis (45). On the other hand, Monika Ratsepsoo et al found that interventions to increase muscle strength, postural stability, and to reduce falling risk are not only helpful over a short period of time, but also they can improve the results of surgical treatment, such as knee arthroplasty (46). In a study conducted by Chen Wang et al, it was shown that Tai Chi exercises led to improved pain, physical function, and health status in people with knee osteoarthritis, compared to control group, after 12 weeks (47). According to the studies conducted, knee osteoarthritis is associated with various symptoms, including chronic pain, decreased activity, proprioception disorder, and imbalance (49, 49).Therefore, patients with knee osteoarthritis are involved with many problems, such as inability to walk, climbing stairs, moving from sitting position to standing position, muscle weakness and knee instability (15, 50-52). Various studies have examined the effects of various types of physical therapy interventions on the balance in people with knee osteoarthritis .However, no study has been conducted so far to examine the impact of balance exercises on the static and dynamic balance in people with knee osteoarthritis. Therefore, the objective of this study was to examine the effect of balance exercises on balance indices in patients with knee osteoarthritis. It was hypothesized that both treatment methods of balance exercises and treatment in the control group would result in increased postural stability and the impact of balance exercises would be greater in postural stability compared to other group.

Methodology

Research design: This one-blind randomized clinical trial was carried out in Zahedan University of Medical Sciences in 2016. In this research, 30 people with knee osteoarthritis were randomly assigned into two groups of balance exercises (15 subjects) and control (15 subjects). The subjects were not aware of the two exercise groups. The treatment was carried out for both groups for 3 consecutive weeks and 5 times per week (69). The research variables were measured and recorded before and after treatment.

Population of study and patient screening: For this study, 30 patients with knee osteoarthritis were selected using simple and convenient sampling .

The inclusion criteria for study included: males and females with chronic knee pain for at least 3 months (53), age between 46-72 (46), having grade 1-4 based on Kellgren Lawrence Revised Grade Scale (54), approval of knee osteoarthritis based on clinical symptoms, joint morning stiffness resolved after 30 minutes (52), lack of intra-articular injection drugs from the last 6 months (53), lack of history of injury (53) or surgery and lower limb fracture (20, 53), no history of joint threatening diseases (osteonecrosis, rheumatoid arthritis, and neuromuscular disease) (53), all of which are examined by rheumatologist and physiotherapist. Exclusion criteria included: history of cardiovascular disease (52), Parkinson disease (6, 20, 52), osteoporosis (52), physiotherapy intervention for their knees during the past six months (52), a history of Knee joint surgery (6), cerebellar problems (6), dizziness leading to imbalance (6), types of arthritis (20), previous leg fractures and neurological diseases such as stroke (20), vestibular disorder (8), severe visual disorders (8) and peripheral neuropathy (8). patients were included into research after Reading and signing a written informed consent letter. This research was approved by the Scientific Committee of the Rehabilitation Department and the Ethics Committee of Zahedan University of Medical Sciences. The rights of the participants in the research were kept at all stages of the study.

Data collection: Subjects were interviewed and investigated to ensure compliance with exclusion and inclusion criteria of research. Meter with a precision of cm was used to measure people's height, and digital scale was used to measure subjects' weight (to calculate body mass index) and Biodex balance system was used to measure balance indices.

Randomization: subjects were randomly assigned into two groups by a clinical physiotherapist.

Evaluation of balance indices: Overall, anterior-posterior and medial-lateral stability indices were measured by Biodex SD Balance System (Balance System New York, Biodex Medical System, Inc., SW 45-30D-E6N SD 950-304USA). In the Biodex Balance system, the lowest stable position was 1 and the highest stable position was 12. Overall stability index is displacement variance of the device plate in terms of degree to horizontal surface, anterior-posterior stability index is displacement variance of the device plate in terms of degrees to the horizontal surface for the sagittal surface movements, and the medial-lateral stability is displacement variance of the device plate in terms of degree to the horizontal surface for frontal surface movements . The amount of deviation from the center indicates a subject's score, in which lower score indicates a lower deviation and higher balance. To use the Biodex device, the person took his shoes and socks off, and then he was placed on the flat and comfortable balance-measuring plate, and he tried to control his position by looking at the monitor of the device. The subject performed static and dynamic balance tests in different states of standing on two legs with open and closed eyes and standing on involved leg with open and closed eyes. In the static state, the page should be fixed. To measure the dynamic balance, the force plate stiffness must be adjusted on number 8 from beginning to the end of the movement .Knowing the release time of the force plate, patient should keep the cursor in the middle of the small circle divided into 4 parts. Performing the main test in 3 repetitions, the results of the postural stability were presented in the form of overall, anterior- posterior, and medial- lateral indices in a table (56).

Treatment method

Intervention group was treated for 3 weeks, 5 sessions per week and 15 sessions (6), and each session lasted about 20 minutes and enough time was given between exercises to subject in order to rest. However, the control group was treated for 3 weeks, 5 sessions per week, and 15 sessions (6) and each session lasted 45 minutes. It should be stated that warm-up exercises should be performed before the intervention and control group. This research project was conducted at the Razmju Physiotherapy Center at Zahedan University of Medical Sciences.

Warm up exercises

These exercises are performed for 10 minutes before start of exercises and include the following exercises: 1) slowly walking for 5 minutes, stretching exercises including 2) the patient is placed in a supine position and the knees are smooth that in this position, the subject pulls himself toward left side of body with his right hand and he keeps for 10 seconds and perform this movement with other hand 3) The patient is placed in the supine position and pulls her knees with one or both legs to the chest. 4) Subject performs stretching movements related to hamstring muscles 5) Subject performs stretching movements related to propulsion and adductor muscles of hip joint. 6) Subject performs stretching movements related to muscles behind the leg.

Treatment method:

Intervention group:

All patients met the inclusion criteria were already physically examined and the information related to medical and demographic history was collected. In the intervention group, balance exercises lasted for 3 weeks and 5 days a week, 1 session per day and 15 sessions (6) that each session lasted 20 minutes and enough rest time between each exercise was given for subjects. The way to perform exercises was in this way:

Balance exercises:

Standing on one leg: Subject was asked to stand on one leg, while he was standing close to a supportive surface or table, and the other leg stood up and knee is bent. Then, the balance of the subject was measured by standing on one leg (57). Every time a person could not maintain his balance, he stood at two legs for a few seconds. Then he stood on the other leg, and this exercise was repeated with same procedure, and the exercise was performed for 2 minutes (58). Stepping forward and backward then sides of body for each leg was performed in 30 repetitions. Along with this exercise with 30 repetitions, patients performed two-sided mini squat with a flexion angle of 15-30 degrees of knee in the painless range to strengthen the quadric muscle then in a standing position where the components of this balance exercise are as follows:

1) Stepping forward and backward with the left leg (30 repetitions)
2) two-sided mini squat (10 times)
3) Stepping forward and backward with right leg (30 times)
4) two-sided mini squat (10 times)
5)Stepping to left side (30 times)
6) two-sided mini squat (10 times)
7) Stepping to right side (30 times) (52)

Control group

Treatment in the control group lasted for 3 weeks, 5 sessions per week, 15 sessions (6) and each session lasted 45 minutes. In the control group, conventional physiotherapy treatments including quadriceps muscle strength exercises along with electrotherapy modalities such as TENS and US were used (59). Quadriceps muscle strength exercises were performed in 3 sets of 10 (30 repetitions in total) with low intensity (52). Enough rest time between each set was given. These exercises were performed to strengthen quadriceps muscle. These exercises ranged from easy to difficult and included exercises in 3 positions of supine, sitting, and standing. Duration of these exercises was about 20 minutes, while electrotherapy modalities lasted 25 minutes (59).

Quadriceps muscle strength exercises in supine position:

In this position, both 2 legs were placed on the ground and the patient was trained to push his knees to the ground and hold them for 5 seconds, and then relaxed (42).

Exercises in sitting position:

At the start of exercise, the knee was bent up to 90 °, then the knee was maximally extended to 180 ° and kept for 5 seconds, and patient was trained to contract his knee muscles in painless position and then to relax it (52).

Exercises in standing position:

In this position, the patient is asked to perform a two-sided mini-squat in the painless range (15- 30 ° knee flexion) to strengthen the quadriceps muscle (52).

Electrotherapy modalities:

TENS: 2 channels and 4 electrodes were used for electrical stimulation. In electrical stimulation, TENS at a frequency of 100 Hz and a pulse width of 50 microseconds and the intensity proportional to the sensory threshold of the individual in micro-ampere were used for duration of 20 minutes. In the TENS protocol, a towel was folded to be placed under the knee. In this case, the electrodes were placed on the anterior-internal and anterior-exterior of the knee for electrical stimulation (59).

US: in US protocol, continuous ultrasonic waves with frequency of 1 MHz and power of 0.8 watts per square centimeter were used (60). The patient was placed in the supine position. Gel with guiding capacity and without any active pharmaceutical particles was used. Then, US was applied to inner and outer parts of the knee with circular movements to ensure maximum absorption of energy. The duration of use was estimated 3-4 minutes, depending on the size of the knee (59).

Determining the sample size: According to previous studies, 30 patients with knee osteoarthritis were included in the study, so that 15 patients were placed in each group

Statistical analysis: Data were analyzed by SPSS 16 software. The normal distribution of data was examined by Shapiro Wilk test. Equality of variances was examined using Levine test. Wilcoxon and Mann-Whitney tests were used to compare intra-group and inter-group results. The significance level was considered to be less than 5%.

Results

The mean age, weight, height, and BMI in the two balance exercises and control groups are presented in Table 1. Using previous studies, the sample size was estimated to be 30 people in two groups (each group included 15 people). The normal distribution of data was examined by Shapiro Wilk test. The results showed that the distribution of data is normal (Table 1). Mean and standard deviation of data related to overall, anterior-posterior and medial lateral stability indices in standing position on two legs and involved leg in static and dynamic position in open and closed eyes, comparison of the results before and after treatment in 2 groups and P value related to comparing the results after and before treatment and comparing the results after treatment between the two groups and the P value related to comparing the results after treatment are presented in Tables 2 and 3.

Intra-group comparison:

In the static state, in balance exercise group, the overall stability index (OSI) on two legs in open eyes, the anterior-posterior stability index (API) on two legs in open eyes, the overall stability index (OSI) on the involved leg in the closed eyes, and medial-lateral stability index (MLI) on involved leg in open and closed eyes (Table 2), and in the dynamic state, the indices of overall stability, the anterior-posterior and medial-lateral (API), (OSI) and (MLI) on two legs in open and closed eyes, overall and anterior-posterior stability index (OSI) and (API) on involved leg in closed and open eyes, and MLI index on involved leg in open eyes showed a significant decrease (P <0/05) (Table 3). In the static state, the overall stability index (OSI) on two legs in closed eyes, the anterior-posterior stability index (API) on two legs in closed eyes, medial- lateral stability index (MLI) on two legs in open and closed eyes, overall stability index (OSI) on the involved leg in open eye and the anterior-posterior stability index (API) on the involved leg in the open and closed eyes (Table 2) and in the dynamic state, medial-lateral stability index on the involved leg in the closed eyes did not show any significant significance (P> 0.05) (Table 3). In the control group in the static state, the overall stability index (OSI) on two legs in open and closed eyes, the anterior-posterior stability index (API) on the two legs in closed eyes and the medial- lateral stability index (MLI) on two legs in the closed eyes (Table 2) and in the dynamic state, overall stability index (OSI), the anterior-posterior index (API) and medial- lateral index (MLI) on two legs in open and closed eyes and the anterior-posterior stability index (API) on the involved leg in open eyes (Table 3) showed a significant decrease (P <0/05). In the static state, the anterior-posterior stability index (API) on two legs in open eyes state, medial-lateral stability index (MLI) on two legs in open eyes and overall stability index (OSI), anterior-posterior index (API) and medial- lateral index (MLI) on the involved leg in open and closed eyes (Table 2), and in the dynamic state, the overall stability index (OSI) on two legs in closed eyes, the overall stability index (OSI) on the involved leg in the open and closed eyes, the anterior-posterior stability index (API) on closed eye and medial- lateral stability index (MLI) on the involved leg in open and closed eyes (Table 3) showed no significant decrease (P> 0.05). Inter-group comparison: To compare the accuracy of the randomization process, we compared the data before study in two groups. The results showed that there was no difference between the two groups in terms of the variables studied and the patients were matched in two groups in terms of the variables studied (P> 0.05). Comparison of the results after treatment between the two groups showed that there is no significant difference between two balance exercises and control groups, except for the anterior-posterior stability index in the dynamic situation on the involved leg in the closed eye state (Table 3 and Table 2).

Discussion

The results of this study support the first hypothesis of the study stating that balance exercises and treatment in the control group would enhance postural stability. In contrast to second hypothesis of the study, there was no significant difference between two methods of treatment in terms of all postural stability indices, except for anterior-posterior stability index in the dynamic situation on the involved leg in the closed eye state, which it was improved in the balance exercise group.

Results of our study showed that balance exercises in the static state improved the overall stability index (OSI) on two legs in open eyes, the anterior-posterior stability index (API) on two legs in open eyes, the overall stability index (OSI) on the involved leg in the closed eye state, and medial- lateral stability index (MLI) on two involved legs in open and closed eyes, and in the dynamic state, they improved the indices of overall stability, the anterior-posterior and medial- lateral (API), (OSI) and (MLI) on two legs in open and closed eyes, overall and anterior-posterior stability index (OSI) and (API) on involved leg in closed and open eyes, and medial-lateral stability index MLI on involved leg in open eyes (P <0/05) (Table 3). However, these exercises in the static state have no impact on the overall stability index (OSI) on two legs in closed eyes, anterior-posterior stability index (API) on two legs in closed eyes, medial-lateral stability index (MLI) on two legs in the open and closed eyes, overall stability index(OSI)on the involved leg in open eyes and the anterior-posterior stability index (API) on the involved leg in the open and closed eyes, and in the dynamic state, they showed no impact on medial- lateral stability index (MLI) on the involved leg in closed eyes .Treatment in the control group in the static state improved the overall stability index (OSI) on two leg in open and closed eyes, anterior-posterior stability index (API) on two legs in closed eyes and medial-lateral stability index MLI on two legs in closed eyes, and in dynamic status, it improved the overall stability index (OSI), anterior-posterior (API) and medial- lateral stability index (MLI) on two legs in open and closed eyes and the anterior-posterior stability index (API) on the involved leg in the open eyes. However, treatment in this group in the static state had no impact on the anterior-posterior stability index (API) on two legs in open eyes,medial- lateral stability index (MLI) on two legs in open eyes and overall stability index (OSI), anterior-posterior index (API) and medial- lateral stability index (MLI) on involved leg in open and closed eyes, and also in dynamic status, it had no impact on the overall stability index (OSI) on the involved leg in the open and closed eyes, the anterior-posterior stability index (API) on the involved leg in closed eyes and medial-lateral stability index (MLI) on the involved leg in open and closed eyes. Only the improvement of the anterior-posterior stability index in dynamic position on the involved leg in closed eyes was high in the balance exercise group compared to control group .In a study conducted by Ezadpanah et al in 2015 examined the impact of a course of movement therapy and lack of exercise after it on the balance of women with knee osteoarthritis. The results of this study were consistent with the results of our study. In this study, improvement in static balance indices can be attributed to the effects of movement therapy including physiological effects, muscle strengthening, and musculoskeletal coordination (61). In addition, considering the impact of exercises on static balance, it can be stated that balance control requires involvement in 3 areas of information processing by visual, arterial and sensory-motor senses, central integration in the brain and motor response, and any defect in these factors can lead into disorder in balance and falling. It can be said that a course of movement therapy facilitates the inputs of each of these senses and thus improves balance (53). Considering the impact of exercises on dynamic balance in people with knee osteoarthritis, it can be stated that dynamic balance is maintained through data collected by mechanical receptors in the lower extremities and combination of visual, arterial and sensory-motor data in order to create appropriate motor responses to control the state of the center of gravity in the supportive surface range (62). Improvement in dynamic balance is more due to improvement in proprioception (63). This suggests that movement therapy could effectively stimulate the mechanical receptors in the lower extremity and it had a significant impact on the strength of the knee muscles and led to improvements in dynamic balance (53). In the study conducted by Holden et al (64), no improvement was reported in the balance in patients with osteoarthritis that the results of this study were inconsistent with results of our study. Lack of improvement in balance may be due to the fact that more than 8 weeks are needed to achieve the required results in balance (65). Iltekin Domen et al (2011) reported that proprioception exercises improved the balance in patients with advanced knee osteoarthritis, which it is consistent with the results of our study .The observed improvement was due to the useful impacts of increased muscle strength and knee movement range (66). Monika Ratsepsoo et al in 2013 showed that the home exercises program for two months improved the strength of the leg extensor muscles postural stability, and fear of falling in women with advanced knee joint osteoarthritis, which results of this study were consistent with the results of our study. Improvement in postural stability might be due to the fact that postural stability is influenced by the strength of the knee extensor muscles and quadric muscle strength and proprioception of both of them are required to control the balance (46). The home exercises program improved muscle strength and balance, suggesting a significant relationship between balance and muscle strength (67). Shih-Hung Chuang et al in 2007 reported that knee sleeve improved the static and dynamic balance in patients with knee osteoarthritis, which it is consistent with the results of our study .The proprioception and strength of the lower extremity muscles are among the important factors in balance (68). Imbalance is more prevalent in dynamic state (15). Considering these results, it seems that wearing knee sleeve to play an important role in dynamic balance in patients with knee osteoarthritis (20).The knee sleeve provides as a rehabilitation device, provides heat and even pressure that may increase the joint proprioception (69). As a result, static and dynamic balance was improved in daily activities (20).The reason for the improvement of postural stability indices as a result of balance exercises might be explained to these cases. Considering the increased prevalence of this disease in the elderly people, it can be stated that it affects the body through several ways such as reducing the knee muscle strength, proprioception, and reducing the awareness of the joint position (25). Evidence suggests a correlation between abnormal muscle function and proprioception deficiency in patients with knee osteoarthritis (70-73). Previous studies have reported that power and proprioception are among the components of balance (25).According to the cased reported in this study, and as increased age has a harmful effect on proprioception leading to reduced knee dynamic stability (74), knee osteoarthritis may further damage the balance (25). Since balance is necessary for postural control in the space, preventing injuries resulting from falling in the elderly people with kneeosteoarthritis is necessary (6, 15, 23, 75-77).Therefore, in patients with knee osteoarthritis, evaluation and treatment of balance disorders should be considered (78). It has been reported that balance exercises lead to increased proprioception (74). Therefore, reduced proprioception defect can lead to increased knee dynamic stability and balance and improvement in performing the daily living activities in patients with knee osteoarthritis (74). Considering what was said, it could be stated that balance exercises in patients with knee osteoarthritis can be effective in improving postural stability indices. Balance exercises improved the stability indices more than the control group, although no significant difference was found between the two groups, except for the anterior-posterior stability index in the dynamic position on the involved leg in closed eyes, which it may be due to the short period of exercises. Therefore, it is recommended that further studies to be conducted to determine the impact of these exercises over longer time and the follow up period to be considered. In addition, it is recommended that other intervention exercises to be used in patients with knee osteoarthritis to compare their impact on the postural stability indices.

Conclusion: The results of this study revealed that there is no difference between balance exercises and treatment in the control group in terms of impact on postural stability indices, except for anterior-posterior stability index in the dynamic situation on the involved leg in closed eyes. However, balance exercises improved the number of balance indices compared to the control group.

Acknowledgment

The authors of this paper appreciate research Deputy of Zahedan University of Medical Sciences in for financing this research. They also appreciate the colleagues working in physiotherapy department of Razmju Mogadam Clinic for their assistance and cooperation in performing this project as well as all of the patients who participated in this project.

Table 1. Comparing demographic characteristics between two groups

Variable	**balance exercises (n=15)**	**Control group (n=15)**	***p value**
Age (year)	****8.80±49.20**	**6.64±51.93**	**0.34**
Weight (kg)	**12.30±76.13**	**10.80±72.40**	**0.38**
Height (m)	**0.10 ±1.58**	**0.07 ±1.57**	**0.67**
Body mass index (kg per square meter)	**8.15±31.01**	**5.87 ±29.65**	**0.60**

* P<0.05 is significant
** Data were stated in the form of SD±mean

Table 2. Comparing mean of data before and after treatment of overall stability, posterior-anterior, and medial lateral indices in two groups and comparing the results after treatment between two groups in the static status

	First group (balance exercises) (n=15)			Second group (control) (n=15)			Comparing the results after intervention
Variable	Before intervention	After intervention	P value	Before intervention	After intervention	P value	P value
SMOSIBEO	0.74±0.42	0.52±0.17	0.02*	1.16±0.82	0.74±0.46	0.04*	0.54
SMOSIBEC	2.60±1.60	1.64±0.71	0.12	3.13±1.74	2.20±1.02	0.01*	0.13
SMAPIBEO	0.57±0.39	0.36±0.12	0.04*	0.80±0.53	0.54±0.35	0.10	0.26
SMAPIBEC	2.14±1.71	1.23±0.70	0.16	2.66±1.74	1.83±1.07	0.01*	0.14

SMMLIBEO	0.31±0.12	0.30±0.13	0.80	0.60±0.71	0.38±0.28	0.30	0.69
SMMLIBEC	1.03±0.47	0.80±0.43	0.05	1.20±0.50	0.87±0.35	0.02*	0.57
SMOSIUSIEO	8.74±3.15	7.83±2.81	0.10	9.54±3.45	9.30±3.30	0.37	0.35
SMOSIUSIEC	9.57±3.15	7.97±2.85	0.00*	9.85±3.98	9.14±2.87	0.14	0.39
SMAPIUSIEO	2.90±2.05	2.12±1.69	0.33	2.10±1.50	2.14±1.57	0.87	0.88
SMAPIUSIEC	3.75±2.11	2.77±1.42	0.06	3.20±2.20	2.89±2.11	0.60	0.83
SMMLIUSIEO	7.94±3.07	7.26±2.78	0.00*	8.80±3.69	8.85±3.26	0.14	0.34
SMMLIUSIEC	8.42±3.10	7.16±2.95	0.01*	9.03±3.68	8.36±2.69	0.36	0.23

** Data were stated in the form of SD±mean
* P<0.05 is significant

Table 3. Comparing mean of data before and after treatment of overall stability, posterior-anterior, and medial lateral indices in two groups and comparing the results after treatment between two groups in the dynamic status

	First group (balance exercises) (n=15)			Second group (control) (n=15)			Comparing the results after intervention
Variable	Before intervention	After intervention	P value	Before intervention	After intervention	P value	P value
DMOSIBEO	2.85±1.86	1.56±0.89	0.00*	3.09±2.40	1.97±0.84	0.03*	0.20
DMOSIBEC	5.83±2.86	3.04±1.18	0.00*	5.96±2.97	3.86±1.60	0.00*	0.16
DMAPIBEO	2.28±1.84	1.27±1.18	0.00*	2.38±2.17	1.41±0.72	0.03*	0.21
DMAPIBEC	4.41±2.90	2.18±0.92	0.00*	4.32±2.76	2.84±1.48	0.00*	0.22
DMMLIBEO	1.20±0.60	0.73±0.24	0.00*	1.56±0.93	1.06±0.54	0.03*	0.16
DMMLIBEC	2.84±1.06	1.66±0.81	0.00*	3.14±1.81	2.00±0.88	0.00*	0.38
DMOSIUSIEO	13.70±4.92	10.83±5.06	0.00*	13.88±4.66	12.92±5.25	0.47	0.30
DSMOSIUSIEC	13.84±4.73	11.50±5.30	0.02*	14.52±4.75	14.28±4.83	0.53	0.10
DMAPIUSIEO	3.60±2.14	2.34±1.42	0.02*	3.84±2.01	2.66±1.55	0.03*	0.60
DMAPIUSIEC	4.52±1.60	2.50±1.44	0.00*	4.48±2.31	4.34±2.31	0.95	0.00*
DSMMLIUSIEO	12.81±4.73	10.34±5.06	0.02*	12.96±4.83	12.90±5.57	0.93	0.18
DMMLIUSIEC	12.67±4.86	10.90±5.36	0.06	13.36±4.59	13.15±4.91	0.37	0.25

** Data were stated in the form of SD±mean
* P<0.05 is significant

SMOSIBEO: STATIC MEAN OVERAL STABILITY INDEX BILATERAL EYES OPEN
SMOSIBEC: STATIC MEAN OVERAL STABILITY INDEX BILATERAL EYES CLOSE
SMAPIBEO:STATIC MEAN ANTERIOR POSTERIOR INDEX BILATERAL EYES OPEN
SMAPIBEC: STATIC MEAN ANTERIOR POSTERIOR INDEX BILATERAL EYES CLOSE
SMMLIBEO: STATIC MEAN MEDIAL LATERAL INDEX BILATERAL EYES OPEN
SMMLIBEC: STATIC MEAN MEDIAL LATERAL INDEX BILATERAL EYES CLOSE
SMOSIUSIEO: STATIC MEAN OVERAL STABILITY INDEX UNILATERAL STANCE INVOLVED EYES OPEN
SMOSIUSIEC: STATIC MEAN OVERAL STABILITY INDEX UNILATERAL STANCE INVOLVED EYES CLOSE
SMAPIUSIEO: STATIC MEAN ANTERIOR POSTERIOR INDEX UNILATERAL STANCE INVOLVED EYES OPEN
SMAPIUSIEC: STATIC MEAN ANTERIOR POSTERIOR INDEX UNILATERAL STANCE INVOLVED EYES CLOSE
SMMLIUSIEO: STATIC MEAN MEDIAL LATERAL INDEX UNILATERAL STANCE INVOLVED EYES OPEN
SMMLIUSIEC: STATIC MEAN MEDIAL LATERAL INDEX UNILATERAL STANCE INVOLVED EYES CLOSE

DMOSIBEO: DYNAMIC MEAN OVERAL STABILITY INDEX BILATERAL EYES OPEN
DMOSIBEC: DYNAMIC MEAN OVERAL STABILITY INDEX BILATERAL EYES CLOSE
DMAPIBEO: DYNAMIC MEAN ANTERIOR POSTERIOR INDEX BILATERAL EYES OPEN
DMAPIBEC: DYNAMIC MEAN ANTERIOR POSTERIOR INDEX BILATERAL EYES CLOSE
DMMLIBEO: DYNAMIC MEAN MEDIAL LATERAL INDEX BILATERAL EYES OPEN
DMMLIBEC: DYNAMIC MEAN MEDIAL LATERAL INDEX BILATERAL EYES CLOSE
DMOSIUSIEO: DYNAMIC MEAN OVERAL STABILITY INDEX UNILATERAL STANCE INVOLVED EYES OPEN
DMOSIUSIEC: DYNAMIC MEAN OVERAL STABILITY INDEX UNILATERAL STANCE INVOLVED EYES CLOSE
DMAPIUSIEO: DYNAMIC MEAN ANTERIOR POSTERIOR INDEX UNILATERAL STANCE INVOLVED EYES OPEN
DMAPIUSIEC: DYNAMIC MEAN ANTERIOR POSTERIOR INDEX UNILATERAL STANCE INVOLVED EYES CLOSE

DMMLIUSIEO: DYNAMIC MEAN MEDIAL LATERAL INDEX UNILATERAL STANCE INVOLVED EYES OPEN
DMMLIUSIEC: DYNAMIC MEAN MEDIAL LATERAL INDEX UNILATERAL STANCE INVOLVED EYES CLOSE

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