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EFFECT OF FLAMINGO EXERCISES ON BALANCE IN PATIENTS WITH BALANCE IMPAIRMENT DUE TO SENILE OSTEOARTHRITIS

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ABSTRACT

Objective: To investigate the effect of flamingo exercise with or without KAT 2000 device on the balance problems due to senile OA.
Participants: Ninety elderly osteoarthritic patients with balance impairment.
Interventions: Participants were randomly assigned into three groups; Kinesthetic ability trainer (KAT 2000) training group (Group 1) (n = 30), Flamingo training group (Group 2) (n = 30), Combined training group (Group 3) (n = 30) group. 45 minutes individualized training sessions as three times a week for 4 weeks were given to all participants.
Main Outcome Measures: Patients were evaluated with Berg balance scale (BBS), kinesthetic ability trainer (KAT 2000) static and dynamic scores, timed up and go test (TUGT), walking speed (WS), Activities Specific Balance Confidence (ABC) Scale and Functional Reach Test (FRT) at the baseline and at the end of 4 weeks.
Results: At the end of the therapy, there were statistically significant improvements in KAT 2000 static and dynamic scores, TUGT scores, WS and ABC Scale in all groups ($p < 0.05$). At the end of the therapy there were statistically significant differences in Group 3 for KAT 2000 static and dynamic scores, TUGT scores, WS and ABC Scale than the other groups ($p < 0.05$). But there were no statistical difference in BBS and FRT score between the groups ($p > 0.05$).
Conclusions: Both flamingo and KAT2000 exercises device have positive effects on the balance problems due to senile OA. Combined with the KAT2000 device, the effects of flamingo exercises on balance disorder in senile osteoarthritis patients are more pronounced.

1. INTRODUCTION

Osteoarthritis (OA) is the most common cause of chronic disability in geriatric population; its prevalence increases with age such that 30 to 50% of adults over the age of 65 years (Lawrence, Felson, & Helmick, 2008). Balance status is an important indicator of physical function and it is related with risk of falls. Although the relationship between OA and fall risk is a challenging issue; it is well known that the deteriorations on gait and balance can occur secondarily to OA (Hunt, McManus, & Hinman, 2010; Ng & Tan, 2013).

Various types of treatment protocols have been employed in previously published trials for balance impairment due to OA (Krebs, Scarborough, & McGibbon, 2007; Mat, Tan, & Kamaruzzaman, 2015). Strengthening and aerobic exercises, Tai Chi, and additional vibration or neuromuscular electrical stimulation protocols were also studied for balance impairment and the results were highly varied in these studies (Mat et al., 2015). Kinesthetic Ability Trainer 2000 (KAT 2000) is a device which consists of a movable platform and a tilt sensor connected to a computer; this device evaluates and improves the balance ability (Crawford, Fleming, & Karabatsos, 1995; France, Derscheid, & Irrgang, 1992; Johnston, Howard, & Cawley, 1998). The previous studies demonstrated the effectiveness of KAT 2000 on balance disorders (Crawford et al., 1995; France et al., 1992; Johnston et al., 1998). Standing on one leg with the eyes open for 1 min 3 times a day; is an exercise which is described as dynamic flamingo therapy by Sakamoto and colleagues (Sakamoto, Endo, & Harada, 2013). This exercise uses the fact that one-leg standing places a load on the femoral head that is 2.75 times greater than the load on one leg when standing on two legs (Sakamoto et al., 2013). Flamingo exercise only uses the body's own weight as mechanical stress, no special equipment is required; so it is quite a cost effective therapy. On the other hand this is a very simple exercise therapy and the patient does not need a special exercise

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instruction. So this study was aimed to determine the effect of flamingo exercise with or without KAT 2000 device on the relief of the balance problems due to senile OA.

2. MATERIALS AND METHODS

2.1. Study Design

This randomized trial with a blind assessor was conducted in a university hospital. The study protocol was approved by the Institutional Review Board of the university ethics committee and registered with ClinicalTrials.gov (NCT03361449). The Declaration of Helsinki protocols were followed. All participants were informed about the study and signed written informed consent before interventions. The study was carried out from April 2018 through June 2018.

2.2. Participants

The study was planned of a continuous response variable from independent control and experimental subjects with 1 control(s) per experimental subject. It was needed to study 17 experimental subjects and 17 control subjects to be able to reject the null hypothesis that the population means of the experimental and control groups are equal with probability (power) 0,8. The Type I error probability associated with this test of this null hypothesis was 0.05. Power and Sample Size Program (PASS; NCSS, Utah, USA) was used to estimate sample size.

Ninety elderly patients diagnosed with balance impairment and osteoarthritis diagnosis which determined by American College of Rheumatology criteria were recruited into the study (Altman, Asch, & Bloch, 1986). Inclusion criteria included age ≥65, no severe neurological or musculoskeletal diagnosis, met the criteria of balance impairment with a score of 41-56 (mild balance impairment) and 21-30 (severe balance impairment) due to Berg Balance Scale. Physical examination and weight-bearing radiographs were taken for all patients. Subjects whose full blood count, erythrocyte sedimentation rate (ESR), C- reactive protein (CRP) and biochemical markers were abnormal were excluded from the study. Individuals were excluded if they had any other neurologic or musculoskeletal diagnosis that can lead to balance impairment, significant visual and auditory impairments, sedative drug use, severe vitamin B12 deficiency, abnormal full blood count, abnormal ESR, abnormal CRP and abnormal biochemical markers.

2.3. Randomization

By using the website randomizer.org method participants were randomly assigned into three groups; Kinesthetic ability trainer (KAT 2000) training group (Group 1) (n = 30), Flamingo training group (Group 2) (n = 30), Combined training group (Group 3) (n = 30) (Anonymous, 2018). All of the patients and the physician who evaluated the outcome measures were blinded to treatment protocols; but the physiotherapist who applied the treatment protocol was aware of the procedure.

2.4. Interventions

Group 1 received only KAT2000 exercises. During this exercise, by using KAT2000 device both static and dynamic exercises were performed. The patients were asked to maintain their balance by tilting the platform in all directions without moving their feet. The center of gravity was changed only by trunk movements. For static balance exercise, the patients were asked to maintain their equilibrium by standing as motionless as they can stay and were told to keep the red X symbol in the center of the computer screen. For dynamic balance exercise, the patients were asked to superimpose the red X mark onto the moving cursor by making a circle which complete 360 degrees on the screen. Group 2 received flamingo exercise, in this exercise patents asked for standing on one leg with support from anywhere for three times in a day for one minute. When doing this exercise, they also asked eyes were open, the arm which does not support will be free and to stay as stable as he or she could (Fig. 1). Group 3 received both KAT2000 and flamingo exercises.

Fig. 1. Flamingo exercise.

2.5. Outcome Measures

Patients were evaluated with Berg balance scale (BBS), kinesthetic ability trainer (KAT 2000) static and dynamic scores, timed up and go test (TUGT), Walking Speed (WS), Activities Specific Balance Confidence (ABC) Scale and functional reach test (FRT) at the baseline and at the end of 4 weeks.

2.5.1. Berg Balance Scale

BBS contains 14 items about daily living activities [12]. Patients performed tasks related with static, dynamic and functional balance. Scores in BBS were scaled from 0, failure to perform the task, to 4, ability to perform the task independently and safely, the sum of the scores is maximum 56 (Berg, Maki, & Williams, 1992). The validity and reliability of the Turkish version of BBS have been performed by Sahin, Yilmaz, and Ozmaden, (2008).

2.5.2. Kinesthetic ability trainer (KAT 2000)

KAT 2000 device (OEM Medical, Carlsbad, USA) consists of a moving platform and a tilt sensor. By a computer-assisted system the deviation of the platform is registered from a reference position 18.2 times each second. The patients were asked to cross their arms over the chest to prevent the effects of the arms on balance. The patient can tilt

Table 1
Demographic characteristics and baseline values of the outcome measures.

Variables	Group I (n = 30) (min-max)	Group II (n = 30 (min-max)	Group III (n = 30) (min-max)	p
Age (mean ± SD)	76.33 ± 7.87	76.63 ± 7.63	74.70 ± 6.58	**0.442**
Sex (Female/Male)	23/7	22/8	19/11	**0.548**
BBS	39.5 (22 – 49)	39 (28 – 44)	38 (26 – 52)	**0.375***
KAT 2000 Static Score	875 (520-2400)	860 (545-2680)	752.5 (465-2155)	**0.096***
KAT 2000 Dynamic Score	1355 (760-3020)	1347.5 (1150-2980)	1296 (860- 2965)	**0.265***
TUGT (seconds)	15 (10 – 19)	16 (12 – 24)	15 (9.3 – 21.3)	**0.202***
Walking Speed (seconds)	14 (9 – 20)	15.5 (12 – 19)**	14 (4.5 – 18)**	**0.030***
ABC Scale	52 (33 – 63)	50.8 (15 – 63)	52.5 (33.3 – 65)	**0.733***
FRT (centimeters)	14 (7 – 19)	15 (7 – 18)	15 (9 – 23)	**0.769***

**Mann Whitney U Test ($p < 0.05$), (min-max); (minimum-maximum), mean ± SD; mean ± standard deviation, BBS; Berg balance scale, KAT 2000; kinesthetic ability trainer, TUGT; timed up and go test, ABC Scale; activities specific balance confidence scale, FRT; Functional Reach Test.
* Kruskal Wallis Test.

the platform to all directions for maintaining balance without changing the position of feet. A red ''X'' mark gives a feedback about the balance on the screen of the computer and patients were asked to stabilize the red X mark at the center of the screen during the static balance tests. In dynamic tests, the patients were asked to superimpose the red X mark onto the moving cursor which is making a circle on the screen. During the test, circling in the clockwise direction, counterclockwise rotation in the clockwise direction, square drawing, eight strokes were performed. All patients performed each test for 30 s and repeated three times. The best of the three scores was considered as the final score. Higher scores indicate a poor balance performance (Hansen, Dieckmann, & Jensen, 2000).

2.5.3. Timed up and go test (TUGT)

TUGT assesses mobility. The patients were seated on a back supported chair and then were asked to stand up from the chair, walk (3 meters or 10 feet away), turn, walk back to the chair and sit down. Time taken to complete the test was measured in seconds (Podsiadlo & Richardson, 1991).

Walking speed (WS): We used 10 meters (m) distance WS test because of it is a more reliable option (Middleton, Fritz, & Lusardi, 2015). The patients were asked to walk 10 m at a speed which they felt comfortable and at 6 m distance. The time was recorded with a chronometer as walking speed. Also the number of stopping was recorded for all patients.

2.5.4. Activites-specific Balance Confidence (ABC) Scale

ABC Scale short form is a scale that assesses fear of falling and it was developed by Powell and Myers. There are tasks related to indoor and outdoor daily living activities, to measure balance confidence in elderly people who have various levels of functioning in this scale (Powell & Myers, 1995; Schepens, Goldberg, & Wallace, 2010). Scores range from 0% (no confidence) to 100% (complete confidence) for each question item. Higher scores indicate greater confidence (Powell & Myers, 1995). The validity and reliability study of the Turkish version of this scale was conducted by Kibar, Konak, and Ay, (2015).

2.5.5. Functional Reach Test (FRT)

FRT was first developed by Duncan et al. in 1990. It is a quick and simple single-task dynamic test; the maximal distance the patient can reach forward beyond arm's length, while maintaining a fixed base of support in the standing position defines functional reach. (Duncan, Weiner, & Chandler, 1990).

2.6. Statistical analysis

Continuous variables were expressed as mean ± standard deviation, categorical data as number and percentage. Analysis of normality with Kolmogorov-Smirnov Harmonization Test was performed in intergroup analysis of continuous variables. T test was used for comparison between the two groups of normal distribution data, and Mann Whitney U Test was used for comparison of non-normal distribution data. The comparison of data for more than three groups Kruskal Wallis Test was used. The Mann Whitney U Test was used as a further analysis test to determine which subset of group led to significance. In intragroup comparisons; the data were first subjected to normality analysis. Because the data did not fit the normal distribution, pre- and post-treatment comparisons were analyzed by using the Wilcoxon Signed Rank Test. Chi-square test was used to compare categorical data. Analyzes were performed with IBM SPSS Packet Program version 24.0 (IBM Corporation, Armonk, NY, USA). Statistical significance level was considered as $p < 0.05$.

3. RESULTS

A total of 90 patients were included into the study. All of the participants completed the whole study protocol and none of participants had any side effects. The results of full blood count, ESR, CRP and biochemical markers were in normal ranges for all groups. The demographic characteristics and baseline values of the outcome measures of the patients are presented in Table 1. There were no statistically significant differences between the groups for baseline values ($p > 0.05$) except WS ($p > 0.05$) (Table 1).

Statistically significant improvements were seen in BBS ($p < 0.001$ for all groups), KAT 2000 static ($p < 0.001$ for all groups) and dynamic scores ($p < 0.001$ for all groups), TUGT scores ($p < 0.001$ for all groups), WS ($p < 0.001$ for all groups), ABC Scale ($p < 0.001$ for all groups) and FRT scores ($p < 0.001$ for all groups) for all groups at the end of the therapy ($p < 0.05$) (Table 2).

At the end of the therapy statistically significant improvements were seen in KAT 2000 static ($p = 0.032$) and dynamic scores ($p = 0.021$), TUGT scores ($p = 0.004$), WS ($p < 0.001$), ABC Scale ($p = 0.001$) for Group 3 than the other groups (Table 2). But there were no statistical difference in BBS ($p = 0.48$), and FRT score ($p = 0.86$) between the groups (Table 2).

4. DISCUSSION

The aim of this study was to investigate whether flamingo exercise with or without KAT 2000 device has an additional effect on the relief of the balance problems due to senile OA. To our knowledge this is the first randomized study which determines the effects of flamingo exercise on balance in a senile OA population.

Various balance exercises have been conducted by the therapist for patients with balance disorder due to OA (Mat et al., 2015). However, there have been various reports about the superiority of these exercises.

Table 2
Comparison of the outcome measures in both groups before and after treatment.

Variable	Group 1 (n = 30) mean ± SD	Group 2 (n = 30) mean ± SD	Group 3 (n = 30) mean ± SD	p value
BBS				
Before treatment	39.5 (22 – 49)*	39 (28 – 44)	38 (26 – 52)	**0.480***
After treatment	44 (31 – 51)*	44 (33 – 49)	**44.5 (34 – 55)**	
p value	**< 0.001***	**< 0.001***	**< 0.001***	
KAT 2000 Static Score				
Before treatment	875 (520 – 2400)*	860 (545 – 2680)	752.5 (465 – 2155)	**0.032***
After treatment	745 (395 – 2140)*	645 (445 – 1705)	530 (230 – 1865)	
p value	**< 0.001***	**< 0.001***	**< 0.001***	
KAT 2000 Dynamic Score				
Before treatment	1355 (760 – 3020)*	1347.5 (1150 – 2980)	1296 (860 – 2965)	**0.021***
After treatment	1117.5 (535 - 2710)*	1175 (955 – 2855)	960 (525 – 2540)	
p value	**< 0.001***	**< 0.001***	**< 0.001***	
TUGT (seconds)				
Before treatment	15 (10 – 19)	16 (12 – 24)	15 (9.3 – 21.3)	**0.004***
After treatment	13 (8 – 17)	14 (10 – 22)	12 (8.1 – 17.8)	
p value	**< 0.001***	**< 0.001***	**< 0.001***	
Walking Speed (seconds)				
Before treatment	14 (9 – 20)	15.5 (12 – 19)	14 (4.5 – 18)	**< 0.001***
After treatment	13 (8 – 19.7)	13.5 (10 – 18)	11 (5.1 – 16)	
p value	**< 0.001***	**< 0.001***	**< 0.001***	
ABC Scale				
Before treatment	52 (33 – 63)	50.8 (15 – 63)	52.5 (33.3 – 65)	**0.001***
After treatment	57.0 (43 – 70)	61.5 (23 – 75)	65.5 (48.3 – 85)	
p value	**< 0.001***	**< 0.001***	**< 0.001***	
FRT(centimeters)				
Before treatment	14 (7 – 19)	15 (7 – 18)	15 (9 – 23)	**0.863***
After treatment	17.5 (10 – 23)	17 (9 – 20)	17 (12 – 24)	
p value	**< 0.001***	**< 0.001***	**< 0.001***	

**Mann Whitney U Test ($p < 0.05$), (min-max); (minimum-maximum), mean ± SD; mean ± standard deviation, BBS; Berg balance scale, KAT 2000; kinesthetic ability trainer, TUGT; timed up and go test, ABC Scale; activities specific balance confidence scale, FRT; Functional Reach Test.
* Kruskal Wallis Test.

In the previous studies it has been mentioned that strength training, Tai Chi and aerobic exercises significantly improved balance and fall risk (Mat et al., 2015). Flamingo exercise is a cost-effective and easily applicable exercise for patients. It is well known that the ground reaction force (GRF) is the most important element for body mass transition on the gait cycle (Turns, Neptune, & Kautz, 2007). When the body is under a weight-bearing condition, gait propulsion by GRF enables the anterior transition of the body segments (You, Her, Ko, & Chung, 2012). It is also reported that muscle strength is reduced in patients with OA and weight-bearing exercises showed significant improvements on walking speed possibly by optimizing neuromuscular control of the knee joint (Takacs, Carpenter, & Garland, 2013). Flamingo exercise cause placing a mechanical load on the femoral head, and the increase in one-leg standing time results in strengthening of quadriceps femoris muscle (Sakamoto et al., 2013). It was found that people who are more than 70 years old and can stand for a long time on one leg with eyes open are found to have high bone density (Sakai, Toba, & Takeda, 2009). By the increase in one-leg standing time, a larger total mechanical stress load on the femoral head can be achieved and this is an advantage to improve bone density of the proximal femur. Because of it was suggested that an exercise which have the properties of dynamic loading, short duration and customary mechanical loading environment is suitable for bone adaption the mechanical stimuli (Turner, 1998). Flamingo exercise meets these properties so this exercise type can be thought as an useful, pratical and cost- effective method for improvement of balance. Sakamoto et al. conducted a 6-month, randomized controlled trial with 410 patients to verify whether one-leg standing with eyes open for a total of 1 min, three times a day prevents falls and fractures and significant differences were seen in the increase in one-leg standing time with eyes open, improvements in daily living for women and a decrease on number of falls (Sakamoto et al., 2013). They also mentioned that there were no significant difference in fracture prevention in elderly women with poor balance because the number of fractures was not significantly different for men or women at the end of their study (Sakamoto et al., 2013). Our results were consistent with this study. We found significant improvements for KAT 2000 static and dynamic, TUGT, WS and ABC scale in all groups at the end of the therapy; on the other hand combination of KAT 2000 and flamingo exercise seems that had a more beneficial effect. But there were no statistically significant difference for BBS and FRT scores. In this study we only included patients which have mild or moderate BBS and moderate FRT scores but not severe scores; so the difference on the improvement between the groups can seem insignificant; but in-group analysis showed statistically significant improvements for all outcomes measures before and after treatment. So it can be mentioned that the combination of KAT 2000 and flamingo exercises has more beneficial effects on patients with balance disorder due to senile OA. On the other hand, flamingo exercise seems more preferable for patients with balance disorder due to senile OA because of cost-effectiveness and easy applicability

4.1. Study Limitations

There are some limitations for this study. First; only a 4-week exercise program was planned but it is well known that balance exercises for a prolonged intervention have more positive effects (Dohrn, Hagströmer, & Hellénius, 2017). Secondly, only patients with mild or moderate BBS score were included in the study; so we cannot generalize our results to the general population. Third, we did not evaluate the level of physical activity and previous exercise and balance trainings; and these can affect the results. There is need of studies with a longer

follow-up period and a more homogeneous population in terms of severity of balance disorder. On the other hand, this is the first study which investigates the effects of flamingo exercise on balance in a cohort of randomized osteoarthritic patients.

5. CONCLUSION

Flamingo and KAT 2000 exercises both seem as having positive effects on the balance for patients with balance disorder due to senile OA. In patients with senile osteoarthritis-related balance disorders, flamingo exercises and exercises performed with the KAT2000 device have positive effects on balance impairment. Combined with the KAT2000 device, the effects of flamingo exercises on balance disorder in senile osteoarthritis patients are more pronounced.

Ethical approval

The project was approved by hospital ethical committee. All procedures were performed in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its latter amendments.

Informed consent

Informed consent was obtained from individual participants included in the study.

Conflict of interest

We certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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