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*Full Length Research Paper*

# The Effects of Balance Training by Tetrax Interactive Balance System on Fall Risk in Older Women with Knee Osteoarthritis: A Randomized Controlled Trial

**Mustafa Gulsen**

Department of Therapy and Rehabilitation, Vocational School of Health Sciences, Baskent University, Ankara, Turkey.

Email: mgulsen81@hotmail.com

## Abstract

**The number of falls in older people with knee osteoarthritis (KOA) is almost double the number experienced by people with no OA. The neuromuscular elements required to arrest a fall are more impaired in people with KOA compared to their asymptomatic counterparts. Therefore, these elements may need to be incorporated into an exercise intervention to reduce the risk of falling. This randomized controlled study aims to investigate the effect of balance training on fall risk in participants with knee osteoarthritis. The participants were 28 older female, (n=28, mean age= 70,76.±4.34years mean height=163.8±5.6 and mean weight=77.83±10.97) who were graded II and III knee osteoarthritis according to the ''Kellegren-Lawrence Scale'' were categorized into treatment and control groups. Socio-demographic features were recorded. Then their balance tests were applied with Tetrax Interactive Balance System Berg Balance Scale (BBS) was applied to assess the balance of patients. No statistically significant differences were observed between the groups at baseline in terms of age, height, weight and body mass index (p > 0.05). Statistically significant differences were found in all assessed parameters in both balance and control groups (all p<0.05) in a comparison of the two groups, statistically significant differences were found in all parameters (all p<0.05). We think that appropriate physiotherapy and rehabilitation programme that is prepared for knee osteoarthritis patients will contribute the improvements about correcting patients' balance according to this study.**

**Keywords: Knee, Osteoarthritis, Postural balance, fall risk.**

## INTRODUCTION

Knee osteoarthritis (KOA) is a common rheumatologic disorder that causes functional limitations and disability, and develops in older people, (Zhang *et al.,* 2015). Among older individuals, the prevalence of KOA is approximately 12.2%, with a higher prevalence in women (14.9%) than in men (8.7%), (Quintana *et al.,* 2008). Postural or balance disturbance normally prompts an equilibrium reaction that may involve adjustments at the ankle, hip, or stepping, depending on the muscle activation and the degree of postural disturbance. Postural sway can be assessed by questionnaires, physical/functional tests, and computer software or directly from a force platform, (Rugelj *et al.,* 2015). Although the relationship between knee OA and reduced balance is not fully understood, studies have shown that reduced quadriceps function and diminished

proprioception are associated with a deterioration in balance (ie, the ability to maintain the center of gravity within a base of support, with minimal sway or maximal steadiness) and confer upon the knee OA patient an increased risk of falls, (Walker *et al.,* 2001; Horak, 1987; Nashner and McCollum, 1985; Turcot *et al.,* 2015). Also reduced balance function is associated with an increased risk of falling, which is one of the leading causes of hospital admissions of older people, and could lead to other consequences such as fracture, joint dislocation, soft-tissue injury, loss of independence, and mortality, (Hsieh *et al.,* 2013). Many studies have shown that patients with KOA have impaired balance, and maintaining knee stability is important for such patients to prevent accidental injuries caused by falling, (Zhang *et al.,* 2015; Gauchard *et al.,* 2010). Patients with KOA lack proprioceptive sensation, which causes non-physiological joint loading and slow, progressive joint degeneration (Jadelis *et al.,* 2001). In addition, such patients have reduced muscle strength (particularly in the quadriceps muscles) and altered muscle-activation patterns, which could explain the poor balance (Hortob_agyi *et al.,* 2004). Our objective was therefore to examine the Effects of Balance Training by Terax Interactive Balance System on Fall Risk and Disability in Older Women with Knee Osteoarthritis.

## METHODS

This was a randomized controlled study, single blind conducted in Baskent University from 9-2-2018 to 12-15-2018. The sample size was calculated as 14 per group with the data obtained from the fall risk scores of a pilot study (80 % power, d = 0.99 effect size, α = 0.05 type I error, and β = 0.80 type II error).Randomization procedure was performed using an online random-allocation software program. Patients were randomly divided into 2groups: The first group (n=14) balance exercise programme;

The second group (n=14) undertook only home exercise programme. For the successfully conducted home exercise programme, our program included exercises to improve static and dynamic postural control. Exercises are explained and regularly reviewed by physiotherapist and a brief description of key elements for each exercise is provided using a printed manual. Training progress and adherence is supervised by weekly phone calls of the physiotherapist (for 5 weeks, 3 days a week).All patients provided written informed consent before the study began. This study was approved with the permission of Baskent University social and humanities and arts research board (Project no: 62310886-604.01.01).

The inclusion criteria for the patients were to be aged ≥ 65 years with either a history of 2 falls or 1 injurious fall over the past 12 months. Control participants consisted of older volunteers (aged ≥ 65 years) with no history of falls over the past 12 months, recruited through media and word-of-mouth advertising.

Exclusion criteria included lower limb joint replacement, knee surgery for the past 12 months, any lower limb fractures during the past six months, intra-articular injection in the previous 6 months, neurological disorders, diabetes mellitus, history of recent fall (past 12 months), underwent treatments such as rehabilitation programs (physiotherapy and hydrotherapy) and supplements (e.g. glucosamine) and any other condition that might impair balance.

## Procedures

Patients who were graded II and III knee osteoartrit according to the "Kellegren-Lawrence Scale" were categorized into treatment and control groups.

### Kellgren-Lawrence Grading Scale

Grade 1: Doubtful narrowing of joint space and possible osteophytic. Lipping.
Grade 2: Definite osteophytes, definite narrowing of joint space.
Grade 3: Moderate multiple osteophytes, definite narrowing of joints space, some sclerosis and possible deformity of bone contour.
Grade 4: Large osteophytes, marked narrowing of joint space, severe sclerosis and definite deformity of bone contour.

Sociodemographic and clinical characteristics of patients were recorded. All assessments were done before and after the treatments (5th week). Fall risks were evaluated.

### Berg Balance Scale (BBS)

It is a scale composed of 14 tests which measures different positions, postural changes and the ability to maintain balance during movement. Grading is done by scoring between 0 (notable to perform) and 4 (normal performance) and the total score ranges between 0 (dependent) and 56 (independent), (Qutubuddin *et al.,* 2005).

### Evaluation of Fall Risk by Tetraks Interactive Balance System

Tetraks Interactive Balance Sytem (Tetraks Ltd., 56 Miryam st., Ramat Gan, Israel) is a valid and reliable method to evaluate balance and fall risk. The system obtains data by using 4 different platforms which measure vertical pressure fluctuations arising from two heels and two fingertips. It can record the data coming from four different measurement platforms in a certain time period digitally and document them as visual and
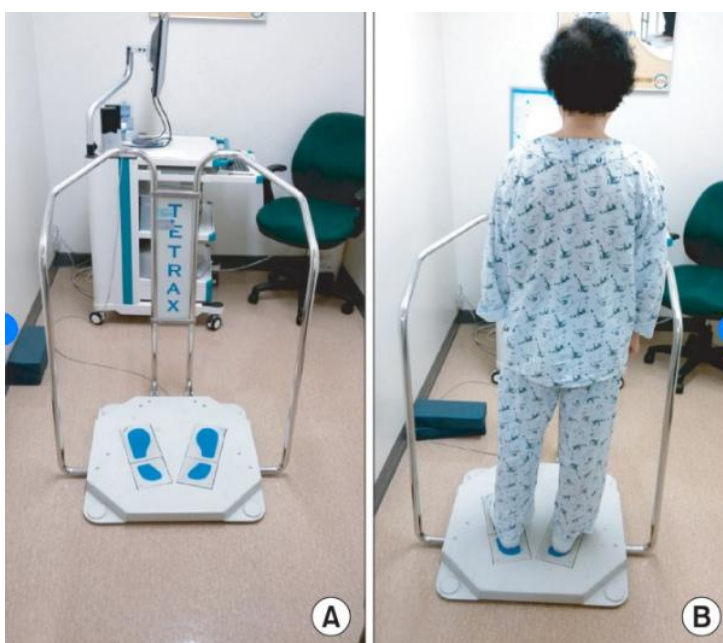
**Table 1.** Demographic characteristics of the groups

|  | Control group Mean± Sd | Balance group Mean ± Sd |
|---|---|---|
| Age (Years) | 71,68± 4,85 | 69,71±3,56 |
| Height (CM) | 163,31± 6,3 | 164,35±5,01 |
| Weight (KG) | 75,87 ±12,25 | 80,07±9,23 |
| BMI (KG/CM$^2$) | 28,37 ±3,46 | 29,55±2,64 |

numerical data. The fall risks of the patients were calculated as percentage (%) by a posturographic program considering the oscillation rates, (Kohen-Raz, 1991)

**Balance Training**

The patients received balance training with TIBS for 5 weeks 25 minutes a day and 3 days a week (a total of 15 sessions) (Figure 1). After the operation to be performed was demonstrated for three times, evaluations and training were realized in a room isolated form visual and auditory stimuli.



**Figure 1:** (A) Tetra Interactive Balance System (B) A patient using Tetrax program

**Data Analysis**

Demographic and clinical characteristics of the patients were described by means and standard deviations (SD) or frequencies and percentages according to the type of the variable. Normal distribution of the data was checked with the Shapiro-Wilk test. As the outcome measures were not normally distributed, nonparametric tests were used. The Kruskal-Wallis test was used to establish differences between groups. To compare pre-treatment and post-treatment values, the Wilcoxon test was used. The level of significance was set at p = 0.05. All analysis ware performed using SPSS version 18 (IBM, Armonk, NY, USA). G*Power package software program (G*Power, Version 3.0.10, Franz Faul, Universität Kiel,

German) was used to determine the required sample size for the study. The sample size was calculated as 14 per group with the data obtained from the fall risk scores of a pilot study (80 % power, d = 0.99 effect size, α = 0.05 type I error, and β = 0.80 type II error), however an increased number of patients was included in each group, in case of dropout.

**RESULTS**

No statistically significant differences were observed between the groups at baseline in terms of age, height, weight and body mass index (p > 0.05) (Table1).

**Table 2.** Comparison between pre-treatment and post-treatment results of assessment parameters

| | CONTROL GROUP MEAN± Sd | BALANCE GROUP MEAN ± Sd | P |
|---|---|---|---|
| Tetrax Pre-treatment | 39,12±19,78 | 35,42±30,57 | |
| Tetrax Post-treatment | 23,5±10,1 | 46,57±31,12 | 0.016* |
| p | 0,000* | 0,005* | |
| Berg Pre-treatment | 36,68±11,29 | 31,85±9,16 | |
| Berg Post-treatment | 42,87±10,65 | 30,21±10,19 | 0.003* |
| p | 0,000* | 0,102 | |

*p<0.05

Statistically significant differences were found in all assessed parameters in both balance and control groups except balance group's berg post-treatment value (all p<0.05). In a comparison of the two groups, statistically significant differences were found in all parameters (all p<0.05) (Table 2).

**CONCLUSION**

Knee OA is a factor that lowers the quality of life in the older people, (Masui *et al.,* 2006). The prevalence of knee OA in the older varies from 26% to 63% depending on age and sex, (Yoshida *et al.,* 2002). Considering that our society is rapidly changing into an aging society, the complications arising from the deterioration of balance control ability associated with knee OA will continue to be a point of interest.

Age is an important factor for osteoarthritis, Wu *et al.,* 2005. By the American Rheumatology Association (ACR), has been reported that osteoarthritis is a disease that can be seen over the age of 38, (Wu *et al.,* 2005). Foley *et al.,* Also included 850 patients with a mean age of 62.5 ± 7.4 in the 50-80 age group diagnosed with knee osteoarthritis, (Foley *et al.,* 2006). In our study, the age range of the experimental group was 65-77 years and the mean age was 69,71±3,56 years.

In particular, the decline of balance control can lead to fall injuries which result in serious physical, psychological, and social loss. As such, many studies concerning the prevention of falls and loss of balance control are in progress, (Barnett *et al.,* 2003). An accurate evaluation of balance control in knee OA patients is necessary before further treatment can be recommended or developed. BBS test is widely used as clinical assessment tools of balance control. These methods are easy to use by anyone and are reported to have high reliability between examiners and test-retests, (Dinçer *et al.,* 2008). We were able to confirm that BBS was clinically useful for rating balance control by proving a statistically significant difference between OA group and a control group. However, this clinical test may allow for interference of subjective factors and may be difficult to apply with certain degrees of balance control loss.

In a study of 56 geriatric patients with knee osteoarthritis, Sun et al. compared the results of the Berg balance scale with the healthy control group of 50 patients, and reported that the Berg balance test score decreased in knee osteoarthritis cases, (Jadelis *et al.,* 2001). In our study, the results of the Berg balance test were found to be lower compared to the control group. Dinçer *et al.,* 2008 performed a study to investigate the effect of exercise program and 15 session's physical therapy program on balance. The study included 40 knee OA patients and divided them into two groups of 20 patients. As a result, there was a statistically significant improvement in the Berg scale values in both the physical therapy group and the exercise group compared to the baseline values after 15 sessions physical therapy and exercise administration (p <0.05).In our study, there were significant improvements in berg balance test scores in balance group compared to the control group after 5 weeks training assessments.

The control of the balance is a complex process. For postural balance, stimulation from the visual, auditory and peripheral sensory systems in the central system and an adequate motor control are required. Knee osteoarthritis has a negative effect on balance by decreasing muscle strength and proprioception, (Jadelis *et al.,* 2001). In parallel with the information in this study, we found that the balance was improved by giving balance training to the patients with osteoarthritis and this had a positive effect on the fall risk. Therefore, this study indicates that not only treatment for OA but also training to prevent falls is necessary in patients with progressive knee OA.

Both our study and other studies show that balance is impaired in knee osteoarthritis. As a result, the risk of falling is expected to increase. Falling occurs mostly during daily life activities, ie in situations requiring dynamic postural balance, (Hinman *et al.,* 2002). Therefore, balance assessment and treatment are important in knee osteoarthritis. Bateni (2011) evaluated older people who were aged between 53 and 91 by using the wii-fit balance board in a study. In the study, both

physiotherapy and balance exercises were given to the first group, only balance exercise was given to group 2, and only physiotherapy was given to group 3. As a result of the study, it was found that improvement of balance parameters of 1st and 3rd group was better than group 2, (Bateni, 2012). In this study, different from our study, physiotherapy and balance exercise together improve the balance of the older people.

Lai et al., (2013) by another study; again, older people aged 65 and over were given balance training with virtual reality practice. As a result of the study; they found an improvement in the balance of the older people same as our study. Both our study and other studies show that balance is impaired in knee osteoarthritis. As a result, the risk of falling is expected to increase. Falling occurs mostly during daily life activities, ie in situations requiring dynamic postural control, (Hinman *et al.,* 2002). Therefore, balance assessment and treatment are important in knee osteoarthritis. Increasing the number of cases and evaluating the functional parameters in future studies will shed light on the treatment of patients and improvement of their balance.

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