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A COMPARATIVE STUDY OF BALANCE TRAINING WITH FOAM BALANCE ACTIVITY VERSUS PROPRIOCEPTIVE EXERCISE IN THE MANAGEMENT OF OSTEOARTHRITIS KNEE

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ABSTRACT

Background and Purpose: Osteoarthritis (OA) is a chronic progressive musculoskeletal disorder and a leading cause of functional disability in the elderly population. Balance training and proprioceptive exercises can indeed be important components of managing knee osteoarthritis. The purpose of this study was to find out the effectiveness of balance training with Foam balance activity versus proprioceptive exercise in the management of osteoarthritis knee. **Methods**: In this comparative study design, samples of 30 participants within the age group of 45 – 70 years with osteoarthritis knee were recruited from the outpatient department of JKK Munirajah Medical Research Foundation College of physiotherapy. Two groups were randomly selected from 30 participants. Group (n=15) were received foam balance activity using foam balance Pad, wax therapy and routine exercise programmes; and Group B (n=15) were received proprioceptive exercise along with wax therapy and routine exercise programmes. Treatment duration is about 3days/ week for 6 weeks. The outcome measures for the data collection were Functional Reach Test [FRT], and WOMA Cindex. Data obtained was analysed using paired t-test, unpaired t- test, Wilcoxon signed rank test and Mann- Whitney U test. **Results**: The result showed that, FRT and WOMAC were statistically significant between Group A and Group B. The p- value in the post-test analysis of Functional Reach Test and WOMAC for group A and B was < 0. 05. **Conclusion**: Foam balance activity was found to be more effective intervention for improving balance and functional ability in patients with osteoarthritis knee compared to proprioceptive exercises.

Keywords: Balance, Foam Balance Activity, Osteoarthritis Knee, Proprioceptive Exercise

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INTRODUCTION

The most prevalent musculoskeletal condition affecting the synovial joint is osteoarthritis (OA), also known as osteoarthrosis or degenerative joint disease. The American College of Rheumatology defines OA as a "heterogeneous group of conditions that lead to joint symptoms and signs which are associated with the progressive loss of articular cartilage, occur as a result of wear and tear changes brought on by aging[1].

The fourth most common cause of disability in worldwide is osteoarthritis; whereas, the prevalence rates in India indicate a substantial burden of the disease. OA prevalence rate is more common in women than men. Osteoarthritis predominantly affects older populations, particularly those over 45 years old. The disease rate is higher in the knee than other weight bearing joints, such as ankle and hip[2].

Age, weight, gender, genetics, repetitive stress injury, occupation, muscular weakness, and imbalance are risk factors for osteoarthritis that significantly impact the condition[3].

OA has been classified as primary or secondary OA. Primary osteoarthritis is indeed the most common form and often occurs without a specific underlying cause, typically developing due to a combination of genetic, environmental, and age-related factors. Secondary osteoarthritis, on the other hand, is linked to specific causes such as joint injuries, inflammatory conditions like rheumatoid arthritis, or other mechanical factorsthat accelerate joint degeneration[4].

The disease's characteristic symptoms and progression are brought on by the articular cartilage's deterioration, which also changes the cartilage's biomechanical characteristics. This results in thickening of the synovium, periarticular bone remodelling, subchondral cysts, loss of joint space, and focal loss of articular cartilage. It also causes subchondral bone eburnation[5].

The primary symptoms of osteoarthritis (OA) are pain, stiffness, and restriction of locomotion; additional symptoms include deformity, joint enlargement, muscular weakness, poor proprioception, balance deficit, and disability[6].

Individual with knee OA often experience increased balance impairment due to a decreased muscle strength and joint position sense. Proprioception and balance control may be directly impacted by changes in joint kinematics brought on by disease processes. Such Physical impairment causes functional activity restrictions in patients with osteoarthritis (OA) such as reduced walking ability and an increased risk of falling in comparison to healthy individuals[7].

A crucial element of many tasks is balance. Multiple neuromuscular systems, including sensory, motor, and integrative components, work together complexly to provide balance. Impaired balance is associated with a higher risk of falls and decreased mobility in older persons.

The ability of the body to instantly adjust muscle contraction in response to incoming information about an external force is known as proprioception. Force generation may be compromised by any disease that negatively impacts muscle function. The

generation of a smooth, stable gait and the preservation of balance depend on the proprioceptive activity system[8].

The management of Knee OA needs a multidisciplinary approach, which aims to control pain while improving function and quality of life. Physiotherapy interventions have been found to be effective in the management of OA Knee. Exercise therapy and electrotherapy are both used in the physical therapy management. Electrotherapy modalities include TENS, IFT, ultrasound, SWD, hot packs, LASER, wax therapy, and mechanical and manual knee traction. Exercise therapy consists of joint mobilization, tapping, strengthening and stretching activities, and quadriceps setting exercises[9].

When knee OA patients are being treated, balance training is often neglected. Many different kinds of exercises have been tried to enhance proprioception and balance in knee OA, according to the literature that is currently available. Through balance exercises, the patient can acquire the necessary motor skills to manage potentially destabilizing forces on the knee that may arise during regular activities. Proprioception, which is mediated by skin receptors in the soles of the feet and mechanoreceptors in the joints and muscles, is enhanced by balance training on an unstable surface. Proprioceptive exercises aim to gradually introduce individuals to activities that test their knee stability and balance while they are recovering. Programs designed to enhance proprioception and balance would therefore be beneficial in the treatment of patients with osteoarthritis (OA) of the knee[10].

Therefore, the aim of this study was to compare the efficacy of balance training using foam balance activities against proprioceptive exercise in the management of osteoarthritis knee.

MATERIALS AND METHODS

Using simple randomization, 30 participants with osteoarthritis knee who were willing to take part in the trial were included based on the selection criteria. Following the ethics committee's clearance, informed consent was obtained from all the participants and they were explained about the study's goal. Male and female participants with unilateral primary osteoarthritis between the ages of 45 and 70 years who also had a balance impairment and radiographic evidence of grades 1 and 2 according to the Kellegren and Lawrence criteria for knee osteoarthritis were eligible for inclusion.

Participants with rheumatoid arthritis, lower limb deformities, bilateral involvement of the knee joint, ligament injuries or neurological impairments, recent lower limb fractures (within the last six months), history of lower limb surgeries (within the last six months), and intra-articular corticosteroid injections (within the last six months) were excluded.

Two groups of subjects were randomly assigned: Group A (n = 15) received wax therapy, foam balance activities, and routine exercise programme; Group B (n = 15) received wax therapy, proprioceptive exercises, and routine exercise programme. A therapy session of 40 minutes was given for each participant; total treatment duration is about 3 days/ week which is continued for 6 weeks.

Balance training has been neglected in the management of osteoarthritis knee. Although

exercise programmes is used to improve balance ability, which have been found to be effective in reducing the fall risk for older adults. Balance training improves lower extremity muscle strength in addition to balance.

Foam balance activities include: double leg stance on a soft foam surface (repeated thrice hold for 20 seconds); single leg stance (repeated thrice hold for 10 seconds); medial lateral lilt (repeated 6 times); anterior posterior tilting (repeated 6 times); tilt forward and backward with feet facing either corner of the foam surface (repeated 6 times); heel and toe raises (repeated 3 times); balance with both legs - eyes opened then closed; balance with both legs foam surface was placed near a wall, then the patient was asked to stand on it and just try to maintain the balance[12] (Fig No.1). For six weeks, the activities were done three times a week.

Proprioception has been found to be impaired in the patients with osteoarthritis knee. Proprioception plays an important role in the maintenance of joint stability of the knee via the sensorimotor system. Proprioceptive training plays a major role in the management of osteoarthritis knee. So, the objective of this study was to compare the effectiveness of balance training using foam balance activities against proprioceptive exercise in the management of osteoarthritis knee.

Exercises that improve proprioception include, toe and heel walking, cross-body leg swinging, blind one-leg balancing, and one-leg balancing. Step up and down on a footstool, stand up and sit down in a stool, squatting and single leg squat[21] (Fig No.2). For six weeks, each exercise was done three times a week with ten repetitions.

Wax therapy was given on the affected knee for 10 – 15 minutes for 3 days per week for 6 weeks.

The routine exercise program consists of,

- **Isometric strengthening exercises**:
  - Quadriceps strengthening exercise,
  - Hamstring strengthening exercise.

  After 10-seconds hold, perform two sets of ten repetitions.

- **Knee range of motion exercises:**
  - Mid flexion to full extension.
  - Mid flexion to full flexion.

Perform two sets of ten repetitions. [30-seconds bout at end range was completed with a 3 -seconds hold].

a. Double leg stance b. single leg stance

Fig No.1- Balance training using foam pad.

a. Single leg stand b. Blind one leg stand

Fig No.2 – proprioceptive exercises

Outcome Measures:

Subjects in both the groups were evaluated in the period of pre and post intervention using Functional Reach Test (FRT) and WOMAC questionnaire

Functional Reach Test: The Functional Reach Test (FRT) is a single item test developed as a quick screen for balance problem in older adults.

WOMAC Index: The Western Ontario and McMaster Universities Osteoarthritis index (WOMAC) is a 24-item, condition-specific questionnaire used to assess hip and knee osteoarthritis.

•The WOMAC is composed of three subscales: physical function (17 items), stiffness (2 items), and pain (5 items).

•Pain, stiffness, and physical function subscales have a range of 0 to 20 points, 0 to 8 points, and 0 to 68 points, respectively.

•Worse pain, stiffness, and functional restrictions are indicated by higher scores.

Statistical analysis: statistical analysis was carried out by SPSS software version 29.0. Data follow normal distribution in FRT and non-normality in WOMAC, so the statistical tools used in this study were paired t-test, unpaired t- test, Wilcoxon signed rank test and Mann-Whitney U test. Statistical significance was considered as P<0. 05.

RESULTS

Totally 30 subjects were taken for study. The age of the Participants in the study was between 45-70 years. The mean age of the subjects in group A (Balance) was 58.33 years and in group B (Proprioceptive) was 59.46 years, the gender ratio in group A(Balance) was 5: 10 (5 males and 10 females) and in group B (Proprioceptive) was 3 : 12 (3 males and 12 females) (Table.No.1).

Variables	Group A	Group B
Mean-age (years)	58.33(45 - 70)	59.46 (45 - 70)
Gender (M:F)	(5: 10)	(3 : 12)

Table No. 1: Baseline demographic data of the subjects

Groups	Pre-test Mean±SD	Post-Test Mean±SD	P value	Interference
Group A	5.20± 1.47	11±1.65	<0. 001	Signifi-cant
Group B	5.53 ± 0.92	9.07±0.96	<0. 001	Signifi-cant

Table No. 2: Intra group comparison of FRT (within group) using paired t test.

Intra group comparison of FRT (within group) using paired-t test was done. The table shows the comparison of mean, standard deviation of pre and post values of group A and group B. In the group A, the mean value of 5.20± 1.47 on pre test was increased to a mean value of 11 ± 1.65 on post test after 18 sessions of intervention. The p value by paired "t" test was found to be< 0.05 which was statistically significant. In the group B, the mean value of 5.53 ± 0.92 on pre test was increased to a mean of 9.07 ± 0.96 on post test after 18 sessions of intervention. The p value by paired t test was found to be< 0.05which was statistically significant, (Table. No.2).

Functional Reach Test	Mean	SD	P value	Interference
Group A	11	1. 65	<0. 001	Significant
Group B	9. 07	0 .95		

Table No.3: Inter group comparison of FRT (between group) using unpaired t test.

Inter group comparison OF FRT (between group) using unpaired t test. The table shows the post-test analysis result in the Functional Reach Test for group A and B. The mean value of group A was 11 which were greater than group B value of 9. 07. It showed that there was a statistical significance difference between mean values of group A and B. The degree of improvement was higher in group A (Balance) than group B (Proprioceptive) with the p value < 0. 05. (Table.No.3).

Groups	Pre-test Mean±SD	Post-Test Mean± SD	MD	P value
Group A	5.20± 1.47	11± 1.65	21.33	<0. 001
Group B	5.53 ± 0.92	9.07± 0.96	14.46	<0. 001

Table No. 4: Intra group comparison of WOMAC (within group) using Wilcoxon signed Rank test.

Intra group comparison of WOMAC (within group) using Wilcoxon signed Rank test was done. The table shows the comparison of mean, standard deviation of pre and post values of group A and group B. In the group A, The pre and post test mean value was 62.40 and 41. 07. The mean difference is 21.33, the p value by Wilcoxon signed Rank test was found to be< 0.05 which was statistically significant. In the group B, The pre and post test mean value was 63.73 and 49. 27. The mean difference is 14.46**.** The p value by Wilcoxon signed Rank test was found to be< 0.05 which was statistically significant, (Table.No.4).

WOMAC	Mean rank	Sum of Ranks	Mann Whitney U test	P value
Group A	11. 63	174. 50	54. 50	0. 02
Group B	19. 37	290. 50		

Table No.5: Inter group comparison of WOMAC (between group) using Mann-Whitney U test.

Inter group comparison of WOMAC (between group) using Mann-Whitney U test was done. The above table shows the post-test analysis result in the WOMAC for group A and B. The mean rank value of group A was 11. 63, which was lesser than group B value of 19.37.

It showed that there was a statistical significance difference between mean rank values of group A and B. The degree of improvement was higher in group A (Balance) than group B (Proprioceptive) with the p value < 0. 05. (Table.No.5).

DISCUSSION

The purpose of the present study was to compare the effectiveness of balance training with Foam balance training and proprioceptive exercises in patients with osteoarthritis knee. The patients were treated for 3 sessions per week for 6 weeks. Balance and functional disability were assessed using Functional Reach Test and WOMAC before and after the intervention. A total of 30 patients had participated in the study after signing the informed consent form. They were assessed for the variable along with the demographic data collection and the findings were recorded.

The result of the present study indicated that both the Foam balance training and proprioceptive exercises were effective in improving balance and functional ability, thus statistically confirmed by the p-value (< 0.05). This study was concordance with the previous study. In order to reduce fall risk among physically active people with chronic knee osteoarthritis; Pavana et al, compared the effects of balance training with foam balance activity and tilt board exercises. They found that while both the foam balance activity and wobble board exercise groups demonstrated significant clinical improvements following the intervention, there was no statistically significant difference between the two groups[11].

The short-term clinical effects of kinaesthesia and balance exercises in patients with osteoarthritis (OA) were studied by Demirhan Diracoglu, MD, et al. The author came to the conclusion that there is evidence of the combined benefits of kinaesthesia and balance training. When applied in a clinical setting, they aimed to improve patient's functioning abilities. This could be the outcome of the muscle group's simultaneous and synergistic actions improving dynamic stabilization. Exercises for balance and kinaesthesia improve dynamic muscular stability by reducing aberrant joint translation that arises during daily motions and may enhance motor control via a reflex pathway[16].

A randomized controlled trial study by Tatsuya Hirase, PT, MS, et al. investigated whether balance training on a foam rubber pad was superior than balance training on a stable flat surface for older persons. The scientists verified that use a foam rubber pad during balance training improved balance more than other methods. Exercises involving balance on an unstable surface, such a balance board, enhanced muscle mechanoreceptor sensitivity and improved spinal cord proprioceptive input.

When body sway increased on an unstable surface, McIlroy et al. demonstrated that an increase in the afferent input from the cutaneous receptors in the soles of the feet served to mediate the postural reflex. Numerous research works have examined the connection between postural stability and Hoffmann reflex (H-reflex) modulation.

Researchers have found that when standing upright on a soft surface as opposed to a solid one, the amplitude of the soleus H-reflex is lower due to higher body sway [13].

A study on the quantitative benefits of Mulligan's MWM and proprioceptive exercises in individuals with arthritic knee was carried out by Ravi Kumar Gupta et al. The authors came to the conclusion that among OA knee participants using Mulligan's MWM, there was a statistically significant improvement in knee joint proprioception; when proprioceptive exercises were added to Mulligan's MWM, the improvement in all end measures increased [20].
In this study, improvement in knee joint proprioception was due to the mechanism that Proprioceptive exercise is a dynamic strengthening exercise that helps improve joint status in terms of pain, range of motion, proprioception, and function along with positional correction of the joint.

Therefore, the present study suggested that following the intervention, both the proprioceptive exercise group and the foam balance activity group shown significant clinical improvements; however, when the two groups were compared, the foam balance activity group exhibited a statistically significant difference that was greater than that of the proprioceptive exercise group.

Limitations: This study was conducted in small sized samples with age group of only 45-70 years. The study was not included the subjects with gender specific. It included only the subjects with unilateral primary OA with radiographic grade of 1 & 2 only. The duration of the study was limited to 6 weeks. On balance training, it was difficult to maintain balance on one leg stand for elderly patients.

Recommendations: The study can include subjects with bilateral involvement of OA knee.

Long-term follow up can be included to improve the results.

The study can include subjects with secondary OA.

Various other balance and proprioceptive techniques can also be use in the future study.

To evaluate balance in patients with osteoarthritis, future research can make use of other outcome measures such as the Berg balance scale, the Time Up-and-Go Test (TUGT), the One-Leg Stand Test (OLST), and other functional measures.

Ethical clearance: Ethical clearance was obtained from the Institutional ethical committee, JKKMMRF College of Physiotherapy, Komarapalayam with reference No. IRB/MPT/O-504/24, dated 03/03/2023.

Conflicts of Interest: There was no personal or institutional conflict of interest for this study.

Fund for the study: This was a self funded study.

CONCLUSION

The study which was conducted for 6 weeks period of intervention showed that Group A of those who received Foam balance activity resulted in better improvement on balance and functional ability than Group B who received Proprioceptive exercises.

The study concluded that balance training with Foam balance activity was more effective treatment for improving balance and functional ability in the management of osteoarthritis knee.

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