



DIFFERENTIAL EFFICACY OF BALANCE AND PROPRIOCEPTION EXERCISE AND DYNAMIC RESISTANCE EXERCISE ON PAIN, FUNCTIONAL OUTCOMES, AND QUALITY OF LIFE IN ELDERLY PATIENTS WITH KNEE OSTEOARTHRITIS: A COMPARATIVE STUDY

Original Research Article

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ABSTRACT

Background: Osteoarthritis of the knee is a condition that commonly leads to pain, mobility issues, and a general decrease in quality of life for elderly individuals. Two forms of physical therapy that are often used as treatment for these symptoms include balance and proprioception exercises, as well as dynamic resistance exercises. Each of these forms of exercise work to address different aspects of mobility for these patients. For instance, balance and proprioception exercises help to improve a patient's ability to maintain their position while performing certain tasks, while dynamic resistance exercises help to increase the strength of the muscles that contribute to the mobility of the joint. Therefore, the goal of the study was to investigate and compare the effectiveness of each of these exercise regimes in elderly individuals with osteoarthritis of the knee. **Methods:** This study was conducted in the outpatient department of the Faculty of Physiotherapy, Dr. MGR Educational and Research Institute in Chennai. The study was conducted over a six-month period. Thirty elderly participants (aged ≥ 60 years) with clinically diagnosed knee osteoarthritis were enrolled through simple random sampling and allocated equally into two groups ($n = 15$ each). Group A received balance and proprioception exercises, while Group B underwent dynamic resistance exercises, each delivered under supervision three times weekly for eight weeks. Participants who could walk independently and had not undergone structured balance or resistance training in the preceding six months were included, while those with recent lower-limb fractures or surgery, neurological or vestibular disorders, uncontrolled hypertension, severe joint deformity, inflammatory arthritis, or cognitive impairment were excluded. Pain intensity and functional status were assessed before and after intervention using the Visual Analog Scale (VAS) and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). **Results:** Both groups demonstrated statistically significant within-group improvements in VAS and WOMAC scores following intervention ($P \leq 0.05$). Between-group comparison showed that Group A achieved a lower post-test mean VAS score (3.13 ± 0.52) than Group B (4.13 ± 0.64), and a lower post-test mean WOMAC score (60.00 ± 5.18) than Group B (70.00 ± 8.30), with both differences being statistically significant ($P \leq 0.05$). These findings led to rejection of the null hypothesis. **Conclusion:** Both balance and proprioception exercise and dynamic resistance exercise reduced pain and improved physical function in elderly patients with knee osteoarthritis, but balance and proprioception exercise produced superior outcomes. Incorporating balance and proprioception training into rehabilitation protocols may enhance therapeutic benefit for this population.

KEYWORDS

Knee Osteoarthritis, Balance Training, Proprioceptive Exercise, Resistance Training, Pain Management, Physical Function



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INTRODUCTION

Osteoarthritis is a type of degenerative arthritis that encompasses a wide range of conditions that display joint symptoms and indicators linked to the deterioration of articular cartilage, as well as bone and the edges of joints.[1] Although the condition's severity may vary, it typically affects strained joints and results in the formation of osteophytes and the degeneration of articular cartilage.[2] Numerous research has looked at how knee osteoarthritis affects daily activities because of pain and diminished physical function.[3] Osteoarthritis affects 33.6% of the population. About 80% of patients with osteoarthritis in their knees have some movement limitations, and 25% are unable to perform major activities of daily living. About 11% of people with osteoarthritis in their knees need help with personal care. [4] Among people aged 20 and over, there are 203 cases of osteoarthritis in the knee for every 10,000 person years worldwide. This translates to roughly 86.7 million cases annually worldwide. [5] Numerous factors, such as age, gender, weight and obesity, knee injuries, repetitive joint use, bone density, muscular weakness, and joint laxity, might contribute to osteoarthritis. It is possible to reduce the risk of osteoarthritis and prevent future pain and impairment by recognizing and changing risk factors, particularly in weight-bearing joints.[6] A variety of clinical symptoms, including pain, stiffness, oedema and effusion, decreased range of motion, joint deformity, muscle weakness and atrophy, and joint line soreness, are indicative of osteoarthritis in the knee, a degenerative joint condition.[7] For Treatment, Treatment options for osteoarthritis patients include physical therapy, exercise, weight loss, and the use of heel wedges or braces as physical modalities to control knee pain.[8] According to certain studies, a lateral heel wedge may lessen the requirement for non-steroidal anti-inflammatory drugs. Similar data suggest that a brace and lateral wedge insole may have a slight favourable effect. [9] Ginger may be clinically beneficial for patients with osteoarthritis in their knees; those who received 255 mg of ginger extract twice daily experienced less discomfort (63 percent against 50 percent in the placebo group).[10]

Many oral medications are available to alleviate knee pain associated with osteoarthritis. Acetaminophen is the suggested drug in accordance with American College of Rheumatology guidelines. [11] Intraarticular corticosteroid injections have a low risk of adverse effects and may provide short-term symptom alleviation for people with osteoarthritis in their knees. [12] Even though there is a strong correlation between knee osteoarthritis and age, it is crucial to remember that knee osteoarthritis is a disease in and of itself rather than just a result of aging. The difference in cartilage between aging and bone osteoarthritis supports this. Furthermore, whilst the enzymes that

cause cartilage degeneration are expressed at normal levels in normal aging cartilage, they are expressed in greater quantities in knee osteoarthritis. [13] Addressing balance problems is essential to minimizing falls and the associated fractures in older adults with osteoarthritis of the knee. Moreover, it is commonly known that a reduction in proprioception contributes to the emergence of activity limitations in knee osteoarthritis. [14]

Consequently, improving proprioception may slow the development of activity limitation and reduce the chance of falls. Exercise therapy has been shown to be helpful for patients with osteoarthritis in the knee and is recommended by several guidelines. [15] Proprioception exercises may be more advantageous than strengthening exercises because they promote cortical remodelling and muscle spindles. [16] The primary objective of balancing and proprioception exercises is to improve joint position awareness and stability. These exercises have been shown to significantly reduce the pain, stiffness, and physical function of patients with osteoarthritis in the knee. Proprioceptive training enhances knee range of motion, muscle strength, mobility, and joint position awareness, all of which contribute to better overall outcomes, according a systemic review and meta-analysis. [17] Another treatment for osteoarthritis that has been shown to be effective involves the use of dynamic resistance training. Dynamic resistance training is a form of exercise that provides a strengthening benefit to the muscles of the body by moving against resistance. The strengthening of the muscles that surround the knee joint can lead to improved function of that joint, as well as a reduction in the pain that is experienced from osteoarthritis of the knee. Furthermore, research into the effects of resistance training for patients with osteoarthritis has shown that such training can improve the physical performance of the patient with the condition, as well as reduce their discomfort from the joint disease. [18] One of the indicators of the presence of symptoms from and physical disability resulting from osteoarthritis is the Western Ontario and MC Master Universities and Osteoarthritis Index, or WOMAC for short. The WOMAC index was developed for patients with osteoarthritis of the knee joint. [19] Furthermore, the index was developed to help evaluate the impact of various therapeutic interventions on the health state of those patients with the condition. [20] The Visual Analog Scale [VAS] is a widely used tool for assessing pain, particularly in conditions like osteoarthritis of the knee. It consists of a 100mm horizontal line with the words "no pain" at one end and "worst imaginable pain" at the other. Patients mark the point on the line that corresponds to their perceived level of pain in order to gauge the severity of their discomfort. The distance from the "no pain" end is then measured in millimetres. [21] Osteoarthritis of the knee is a common condition in the elderly, leading to pain, reduced mobility and a lower quality of life. While both balance and proprioception exercises and dynamic resistance exercises are used for rehabilitation, their

comparative effectiveness remains unclear. This study is needed to identify the most effective approach for managing pain, enhancing function and improving the overall well-being of elderly patients with osteoarthritis knee.

METHODS

Study Design and Setting

This study was designed as a comparative, pre- and post-test interventional study conducted to evaluate the relative effectiveness of two physiotherapeutic approaches in elderly patients with knee osteoarthritis. The study was carried out in the Outpatient Department, Faculty of Physiotherapy, Dr. MGR Educational and Research Institute, Velappanchavadi, Chennai, India, over a total period of six months.

Participants

Elderly individuals aged 60 years and above who were clinically diagnosed with knee osteoarthritis and who attended the outpatient department were screened for eligibility.

Inclusion Criteria

- Elderly individuals aged 60 years and above.
- Clinical diagnosis of knee osteoarthritis.
- Ability to walk independently without an assistive device.
- No prior participation in structured balance or resistance exercise in the preceding six months.
- Willingness to participate for the full eight-week study duration.

Exclusion Criteria

- History of lower-limb fracture or surgery within the preceding year.
- Neurological disorders affecting balance (e.g., Parkinson's disease, stroke).
- Vestibular disorders or uncontrolled hypertension.
- Severe joint deformity or inflammatory arthritis.
- Cognitive impairment that would have affected participation.

Sample Size and Sampling Method:

A total of thirty participants were recruited and allocated into two groups of fifteen participants each using simple random sampling. Both male and female participants aged 60 years and above who satisfied the eligibility criteria were included.

Randomization and Ethical Considerations:

Eligible participants were randomly allocated to either Group A or Group B through simple random sampling. Written consent was obtained from all participants prior to their enrollment into the study. Each participant was provided with a detailed explanation of the treatment to be provided to them as part of the study prior to the commencement of the treatment.

Intervention Protocol

Group A was to participate in a program that focused upon balance and proprioception exercises, while Group B was to participate in a program that focused upon dynamic resistance exercises. Each participant in both groups completed their respective exercises three times each week for an eight-week period, with each session taking place for periods of between 30 and 40 minutes, and under the supervision of a physiotherapist. The protocols that were followed by each group is presented in Table 1. The assessment protocol to be applied to each participant after the intervention period is presented in the same table as well.

Group A was to complete exercises that included single-leg stance exercises, tandem standing exercises, weight shifting exercises, mini squats, step-ups exercises, and toe and heel walking exercises. The complete protocol for Group A is presented in Table 2.

Group B was to complete exercises that included seated knee extension exercises, sit-to-stand exercises, standing hamstring curls exercises, quarter squats exercises, and calf raises exercises using elastic resistance bands. The complete protocol for Group B is presented in Table 3.

Outcome Measures:

Each participant was to report on their levels of pain on the Visual Analog Scale (VAS) prior to and following the intervention. Additionally, each participant was to complete the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) survey to assess their symptoms of pain, stiffness, and physical function both prior to and following the intervention.

Statistical Analysis

The data from the participants was tabulated and analyzed using descriptive and inferential statistical tests. The data was analyzed using the Statistical Package for the Social Sciences (SPSS) software package, version 24. All statistical analyses used in the project were performed using SPSS, and a P value of less than 0.05 and 95% confidence intervals were applied to determine statistical significance. The Shapiro-Wilk test was used to test the normality of the distribution of the data; the test revealed that the dependent variables were normally distributed within each group ($P > 0.05$). Consequently, parametric statistical tests were applied to the data. Paired t-tests were used to determine the difference within each group prior to and after the intervention, while independent (unpaired) t-tests were used to determine the difference between the two groups.

TABLE 1. GENERAL EXERCISE PROTOCOL COMMON TO BOTH GROUPS

Component	Description
Warm-up	5–10 minutes of light walking and active range-of-motion exercise to prepare the joints and muscles.
Cool-down	Gentle static stretching of the quadriceps, hamstring, and calf muscles, followed by deep breathing exercises to facilitate recovery.
Monitoring	Pain (Visual Analog Scale), fatigue, swelling, and exertion level were monitored regularly throughout each session to ensure participant safety.
Precautions / stopping rules	Exercise was stopped or modified if pain exceeded 5/10 on the Visual Analog Scale, or if dizziness, joint instability, or severe discomfort occurred.
Session frequency and duration	3 sessions per week on alternate days for 8 weeks; each session lasted approximately 30–40 minutes.
Supervision	All sessions were conducted under the direct supervision of a qualified physiotherapist.

TABLE 2. GROUP A — BALANCE AND PROPRIOCEPTION EXERCISE PROTOCOL

Exercise	Technique	Dosage	Target Benefit
Single-leg stance	Participants stood on one leg with the contralateral foot lifted off the ground, then switched legs.	3 sets × 5 repetitions per leg; 10–15 s hold each	Enhanced joint stability and neuromuscular coordination
Tandem standing	Participants stood with one foot directly in front of the other, heel-to-toe, with eyes closed.	3 sets × 3 trials	Improved postural control and reduced fall risk
Weight shifting	Participants stood with feet shoulder-width apart and shifted body weight side-to-side and front-to-back.	3 sets × 10 repetitions per direction	Improved weight-bearing symmetry and movement awareness
Mini squats	Participants performed partial squats to 30°–45° of knee flexion with feet shoulder-width apart, keeping the knees aligned.	3 sets × 10 repetitions	Strengthened quadriceps and improved knee control during functional activity
Step-ups	Participants stepped up onto a 5-inch stool, bringing the contralateral foot up to meet it.	3 sets × 10 repetitions per leg	Improved functional strength and mobility for stair and curb negotiation
Toe and heel walking	Participants walked 5 meters on their toes, followed by 5 meters on their heels.	3 sets × 2 rounds	Improved ankle stability and gait efficiency

TABLE 3. GROUP B — DYNAMIC RESISTANCE EXERCISE PROTOCOL

Exercise	Technique	Dosage	Target Benefit
Seated knee extension	Participants sat in a supported chair and slowly extended the knee with the foot held in dorsiflexion, then returned to the starting position.	3 sets × 10–15 repetitions per leg	Reduced knee pain and strengthened the quadriceps supporting the knee joint
Sit-to-stand	With an elastic resistance band anchored under the thighs, participants stood up from a sturdy chair while keeping the back straight and core engaged, then slowly sat back down.	3 sets × 10 repetitions	Strengthened lower-extremity musculature and improved functional mobility and balance
Standing hamstring curls	With an elastic band anchored around one ankle, participants flexed the knee while standing, curling the heel toward the glutes.	3 sets × 10 repetitions per leg	Strengthened hamstrings to improve gait and joint protection
Quarter squats	With an elastic band anchored around the thighs, participants lowered the body into a partial squat while keeping the back straight and core engaged.	3 sets × 10 repetitions	Strengthened quadriceps, gluteal, and calf muscles, and improved dynamic balance
Calf raises	In a long-sitting position with an elastic band anchored under the feet, participants raised onto their toes and then lowered back down.	3 sets × 15 repetitions	Improved ankle mobility and stability

RESULTS

Comparison of the post-intervention mean Visual Analog Scale (VAS) scores between the two groups revealed a statistically significant reduction in pain intensity in both Group A and Group B following the respective interventions. However, Group A (3.13 ± 0.516) demonstrated a lower post-test mean VAS score than Group B (4.13 ± 0.639), [Table 4] indicating that the balance and proprioception exercise program produced a greater reduction in pain intensity than the dynamic resistance exercise program ($P \leq 0.05$). Based on this finding, the null hypothesis was rejected.

TABLE- 4 - COMPARISON OF VAS SCORE BETWEEN GROUP – A AND GROUP - B IN PRE AND POST TEST

TEST	GROUP - A		GROUP - B		t - TEST	df	SIGNIFICANCE
	MEAN	S.D	MEAN	S.D			
PRE TEST	7.40	1.12	7.73	1.16	-.799	28	.431*
POST TEST	3.13	.516	4.13	.639	-4.71	28	.001**

(* - $P > 0.05$ - Not Significant) & (** - $P \leq 0.05$ - Significant).

A similar pattern was observed for the WOMAC scores. Both groups showed a statistically significant decline in post-intervention WOMAC scores, reflecting improvement in pain, stiffness, and physical function. Nevertheless, Group A (60.00 ± 5.18) exhibited a lower post-test mean WOMAC score than Group B (70.00 ± 8.30), [Table 5] suggesting that balance and proprioception training was more effective than dynamic resistance training in improving overall functional outcomes in elderly patients with knee osteoarthritis ($P \leq 0.05$). Accordingly, the null hypothesis was rejected for this outcome measure as well.

Within-group analysis comparing pre- and post-intervention scores in both Group A and Group B revealed statistically significant improvements in VAS and WOMAC scores following the eight-week intervention period ($P \leq 0.05$). This indicates that both balance and proprioception exercise and dynamic resistance exercise were independently effective in reducing pain and improving functional status, although the magnitude of improvement was greater in the group receiving balance and proprioception training.

TABLE – 5 - COMPARISON OF WOMAC SCORE BETWEEN GROUP – A AND GROUP - B IN PRE AND POST TEST

TEST	GROUP - A		GROUP - B		t - TEST	df	SIGNIFICANCE
	MEAN	S.D	MEAN	S.D			
PRE TEST	80.93	7.15	78.80	6.83	.835	28	.411*
POST TEST	60.00	5.18	70.00	8.30	-3.95	28	.001**

(* - $P > 0.05$ - Not Significant) & (** - $P \leq 0.05$ - Significant)

DISCUSSION

Osteoarthritis of the knee is a degenerative joint disease that affects the elderly population, causing pain, stiffness and impaired function. Due to these limitations, the mobility and quality of life of the elderly population is significantly reduced. The aim of the present study was to investigate the effectiveness of balance and proprioception exercises compared to dynamic resistance exercises on elderly patients with knee osteoarthritis in relation to their pain, function, and quality of life. Thirty elderly patients with osteoarthritis of the knee were divided into two groups; Group A was trained in balance and proprioception exercises while Group B was trained in dynamic resistance exercises. Both groups were trained for an 8-week period with three training sessions per week. Both groups exhibited a statistically significant reduction in VAS and WOMAC scores prior to and after the intervention; indicating the benefit of both exercise categories. Group A had significant reduction in VAS scores of 3.13 ± 0.516 as compared to Group B's VAS score of 4.13 ± 0.639 ; as well as a reduction in WOMAC scores of 60.00 ± 5.18 as compared to Group B's score of 70.00 ± 8.30 . These results indicate that balance and proprioception exercises may be more beneficial to those with knee osteoarthritis as they offer benefits to pain relief and functional gain of those elderly patients with OA of the knee. Thus, these results support the hypothesis that proprioceptive and balance exercises may lead to improved sensory and motor function of the joint, leading to enhanced benefits for those with osteoarthritis of the knee. While previous studies have established the benefits of resistance training in improving joint function, our results align with emerging literature that highlights the importance of sensorimotor rehabilitation in managing chronic joint conditions. Recent evidence by **Vahid sobhani et al., (2024)** proprioceptive exercises demonstrated superior efficacy in reducing pain, enhancing balance and mitigating fall risk in the elderly with knee osteoarthritis. these findings suggest that proprioceptive exercises should be considered as a valuable component of comprehensive rehabilitation programs for this population. [22] **Bugra Ince et al., (2023)** concluded that balance and proprioception exercise may have positive effects on dynamic balance and pain. additional research with a bigger sample size should be conducted to examine the effects on physical function and quality of life. [23] **Isabella k wiesmeier et al., (2017)** Balance training reduced overactive proprioceptive feedback and restored vestibular orientation in elderly. based on the assumption of a linear deterioration of postural control across the life span, the training effect can be extrapolated as a juvenescence of 10 years. [24] this study points to a considerable benefit of a continuous balance training in elderly, even without any sensorimotor deficits. Practically speaking, these results suggest that balance and proprioception exercises will lead to greater clinical outcomes from rehab programs For elderly individuals with OA knees.

Such exercises will increase the confidence of elderly individuals with OA and reduce their risk of falling. From a theoretical standpoint, these results demonstrate the various ways in which knee osteoarthritis must be approached in order to provide effective treatment to those affected by the condition. Thus, the results of this specific study confirm that balance and proprioception exercises are superior to dynamic resistance exercises in relation to the outcomes of pain, function and quality of life in elderly patients with osteoarthritis of the knee.

CONCLUSION

Both forms of exercise, balance and proprioception exercises as well dynamic resistance exercises, are effective in reducing the pain that is experienced by elderly patients with osteoarthritis of the knee and improving their quality of life. However, balance and proprioception exercises are significantly more effective than dynamic resistance exercises.

LIMITATIONS OF THE STUDY

There were a few limitations to the study. The first of these limitations was related to the relatively small size of the sample of participants that was used for the study. Additionally, the length of the study was limited to eight weeks, which made it impossible to determine the long-term effects of either form of exercise. Finally, the elderly individuals that were included in the study were all between the ages of 60 and 75 years old, which limits the generalizability of the results to the overall elderly population.

RECOMMENDATIONS FOR FUTURE RESEARCH

Future research would benefit from addressing the limitations of this study. For instance, it may be beneficial to include more individuals into the study to increase the statistical validity of the research. Additionally, extending the length of the study would allow for the determination of any lasting effects of these exercise programs. Finally, including elderly individuals of various ages and utilizing additional measures of quality of life would help to provide a more complete understanding of the impact that these exercise programs have upon elderly individuals with osteoarthritis of the knee.

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