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The effectiveness of balance and core stabilization training along with conventional therapy on Osteoarthritis knee during eyes open versus eyes closed to improve quality of life

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KEYWORDS
Knee osteoarthritis, core stabilization,balance training, eyes open, eyes closed, quality of life.

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ABSTRACT

Introduction: Osteoarthritis of the knee (OA) is a common degenerative joint disease that impairs quality of life, causes discomfort, and limits mobility, especially in older persons. While range-of-motion and strengthening exercises are common components of conventional physiotherapy, they could not adequately treat proprioceptive deficits and balance impairments. Functional results may be improved by core stabilization and balance training, especially when done in different sensory situations (eyes open vs. closed).

Objective: The purpose of this study was to evaluate the effects of core stabilization and balance training in conjunction with traditional physiotherapy on knee OA patients' pain, functional mobility, balance, and quality of life in both eyes-open and eyes-closed circumstances.

Methods: Thirty-six knee OA patients (aged 40–65) were divided into two groups at random: Group A (n = 18) received conventional therapy along with balance and core stabilization exercises performed with their eyes open, and Group B (n = 18) received the same exercises with their eyes closed. For six weeks, the interventions were given three days a week for forty-five minutes each. The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), the Berg Balance Scale (BBS), the Numeric Pain Rating Scale (NPRS), and the WHO Quality of Life-BREF (WHOQOL-BREF) were among the outcome measures that were evaluated at baseline, three weeks, and six weeks. Independent t-tests were used for between-group comparisons and one-way ANOVA for within-group comparisons.

Results: The NPRS, WOMAC, BBS, and WHOQOL-BREF ratings of both groups improved significantly ($p<0.05$) over the course of six weeks. Group B (eyes closed) outperformed Group A (eyes open) in pain reduction (NPRS), functional ability (WOMAC), balance (BBS), and quality of life (WHOQOL-BREF) by a considerable margin ($p<0.05$), indicating that eyes-closed training improves proprioceptive and functional abilities.
Conclusion: Patients with knee OA see significant improvements in pain, function, balance, and quality of life when core stabilization and balance training are combined with traditional physiotherapy. Due to increased proprioceptive demand, eyes-closed training seems to produce better results, which supports its use in knee OA rehabilitation protocols.
Keywords: Knee osteoarthritis, core stabilization, balance training, eyes open, eyes closed, quality of life.

INTRODUCTION

Knee osteoarthritis (OA) is a chronic, multifactorial degenerative joint disorder characterized by progressive deterioration of articular cartilage, subchondral bone sclerosis, and structural changes within the joint. These pathological alterations often result in pain, stiffness, reduced mobility, and functional impairment, significantly affecting an individual's quality of life. Osteoarthritis is considered one of the leading causes of disability worldwide, particularly among middle-aged and elderly populations (1). The prevalence of knee OA continues to rise due to increasing life expectancy and lifestyle-related risk factors such as obesity, prolonged occupational stress, metabolic disorders, and genetic predisposition (2).

Traditionally, osteoarthritis was considered a disease primarily affecting articular cartilage; however, current evidence suggests that OA is a disorder involving the entire joint structure, including the subchondral bone, synovium, ligaments, menisci, and surrounding musculature (3). These structural and biochemical changes alter normal joint biomechanics and contribute to functional limitations in individuals with knee OA. Epidemiological studies indicate that approximately 85% of individuals over the age of 45 years demonstrate radiographic signs of osteoarthritis, highlighting its growing public health burden (4).

In addition to structural degeneration, individuals with knee osteoarthritis frequently experience deficits in proprioception and postural control. Proprioception refers to the body's ability to

perceive joint position and movement through sensory information transmitted by mechanoreceptors located in muscles, ligaments, and joint capsules (5). Impairment in proprioceptive feedback can lead to reduced joint stability, altered neuromuscular coordination, and an increased risk of falls. Maintenance of balance depends on the effective integration of three major sensory systems: visual, vestibular, and somatosensory inputs, which together regulate the body's center of mass within the base of support (6).

Previous research has shown that individuals with knee OA often rely more heavily on visual input to maintain postural stability due to compromised proprioceptive function of the affected joint. When visual input is reduced, such as during eyes-closed conditions, postural sway tends to increase, indicating impaired balance control (7). Therefore, rehabilitation strategies aimed at enhancing proprioception and neuromuscular coordination may play a crucial role in improving functional stability in individuals with knee osteoarthritis.

Muscle weakness, particularly of the quadriceps femoris, is another common clinical feature of knee osteoarthritis and contributes significantly to joint instability and reduced functional capacity (8). Therapeutic exercise is therefore considered a cornerstone in the conservative management of knee OA. Both open kinetic chain exercises (OKCE) and closed kinetic chain exercises (CKCE) are commonly used in physiotherapy rehabilitation programs, with CKCE often considered more functional because they promote joint stability and simulate activities of daily living (9).

In recent years, rehabilitation approaches have increasingly emphasized the importance of core stabilization and balance training in the management of musculoskeletal disorders. Core stabilization exercises target deep trunk muscles such as the transversus abdominis and multifidus, which play a critical role in maintaining spinal stability, trunk control, and postural alignment (10). Strengthening these muscles may improve neuromuscular coordination and dynamic balance, thereby enhancing functional performance in individuals with knee osteoarthritis.

Although conventional physiotherapy interventions primarily focus on strengthening and mobility exercises, emerging evidence suggests that integrating balance training and core stabilization exercises may provide additional benefits in improving functional outcomes. However, limited studies have investigated the combined effects of core stabilization and balance training along with conventional physiotherapy in patients with knee osteoarthritis.

Therefore, the present study aims to evaluate the effectiveness of core stabilization and balance training combined with conventional physiotherapy in improving pain, functional ability, balance, and quality of life in individuals with knee osteoarthritis.

METHODOLOGY

This study was conducted in accordance with our institutional ethics policy. The institutional review board ((Registration No. ECR/710/Inst/UK/2015/RR-21) approved this study (No. SGRR/IEC/30/25). The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation. Informed written consent was obtained from all patients for providing patient information and any accompanying supplements, and for publication.

A comparative experimental design with pre-test and post-test was used in this investigation. Simple random sampling was used to recruit a total of 36 participants, and G*Power analysis was used to calculate the sample size. From March 2025 to July 2025, the study was carried out in the Physiotherapy Outpatient Department of Shri Mehant Indresh Hospital Dehradun (Uttarakhand). People with primary or secondary knee osteoarthritis (OA) who were categorized as grade 1 to 3 using the Kellgren and Lawrence radiographic grading system made up the study population. Individuals with subacute to chronic knee OA who had been experiencing knee pain for at least three months and were between the ages of 40 and 65 were taken into consideration. A score of ≤4 on the Numerical Pain Rating Scale (NPRS), no contraindications to electrotherapy, and the capacity to engage in mild to moderate activity, including balance training, without the need of assistive aids were prerequisites for eligibility. Additionally, participants had to be willing to give written informed consent and show quantifiable restrictions in mobility or daily activities, as measured by the WOMAC or Berg Balance Scale. Grade 4 OA, recent knee surgery or intra-articular injections (less than three months ago), neurological or vestibular disorders that impair balance, co-morbid conditions that restrict participation (e.g., respiratory or cardiovascular diseases), recent lower limb fractures, diabetic neuropathy, secondary arthritis (e.g., gout, rheumatoid arthritis), pregnancy, noncompliance with the study protocol, and visual or vestibular impairments like vertigo were among the exclusion criteria.
The participants were divided into two equal groups, Group A and Group B, at random. Along with standard physiotherapy, Group A (n = 18) underwent balance training and eye-open core stabilization exercises. The same intervention was given to Group B (n = 18), except throughout the balance and stabilizing activities, their eyes were closed. For a total of six weeks, both groups participated in three 45-minute supervised sessions per week.

The Berg Balance Scale, the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC – Pain Subscale), the Quality-of-Life Questionnaire (QOL-BREF), and the Numerical Pain Rating Scale (NPRS) were among the outcome measures. Pain, functional mobility, balance, and general quality of life were evaluated using these outcome measures both before and after the intervention period.

2.1 PROCEDURE

The subjects were taken for primary evaluation and those who satisfied the inclusion criteria will be randomly allocated into two groups A and B. Individuals selected for the study will be assessed prior and post of the interventions program with outcome measures like: NPRS, BERG BALANCE SCALE, WOMAC, Quality of life Questionnaire (QOL) BREF.

2.1.1 GROUP-A

Moist heat pack for 10 minutes, I.F.T. for 15 minutes'

Exercise 1. Quads strengthening Exercises
Starting position Sit in a firm chair (one that higher is possible)
Exercise Slowly lift your foot up and straighten the knee until its fully straight
Keep the back of your thigh on the chair. Hold for 5 secs and lower slowly with eyes open

Exercise 2
Starting position - Lie on a mat on the floor or on a firm bed.
Put a rolled-up towel under your arthritis knee. Your knee will be slightly bent. Keep the knee cap and toes pointing toward the roof with eyes open

Exercise 3. Sit to stand
Starting position -Sit in a firm chair. Place the chair back against a wall for support if needed. Place your feet shoulder width apart with eyes open.

Exercise 04. Partial wall squats
Starting position-Step your feet away from the wall (about 30cm) with your feet hip width apart. Slightly turn your feet outwards.
Exercise - Slowly slide down the wall. Stop before your knees cover up your toes (or less if it is painful). Hold for 5 seconds with eyes open.

Exercise 05: Bridging
Starting position -Lie on a mat on the floor or on a firm bed Place your feet hip-width apart.
Exercise - Lift your bottom off the floor/ bed. Keep shoulder blades on the floor/bed. Hold for 5 seconds.
Slowly lower your bottom back to the floor/bed. "Slowly up, hold, 2, 3, 4, 5, slowly down".
Keep your hips level as you lift.
Stop when you have made a straight line between your shoulders and your knee with your eyes open.

Exercise 06: Single-leg bridge
Starting position Lie on a mat on the floor or on a firm bed.
Place your feet about 10cm apart (slightly closer than hip-width apart) with eyes open.

Exercise 07: Single calf raises
Starting position Stand holding onto back of the chair. Stand on your arthritis leg.
Exercise Slowly rises onto your toes. Hold for 5 seconds with eyes open.

Exercise 08: Tandem stance
Starting position-Stand on a firm surface. Looking forwards focusing on a point on the wall. Use hand support (e.g. a chair) for balance if required.
Exercise Place one foot in front of the other so that feet make a straight line. Hold for 10 seconds with eyes open.

Exercise 09: Single leg balance
Starting position Stand with your feet shoulder width apart.
Stand close to a wall for support in case you over balance, if required. Use hand support (e.g. a chair) for balance, if required with eyes open.

2.1.2 GROUP-B
Moist heat pack for 10 minutes, I.F.T. for 15 minutes'

Exercise 1. Quads strengthening Exercises
Starting position Sit in a firm chair (one that higher is possible)
Exercise Slowly lift your foot up and straighten the knee until its fully straight
Keep the back of your thigh on the chair. Hold for 5 secs and lower slowly with eyes closed.

Exercise 2
Starting position - Lie on a mat on the floor or on a firm bed.
Put a rolled-up towel under your arthritis knee. Your knee will be slightly bent. Keep the knee cap and toes pointing toward the roof with eyes closed.

Exercise 3. Sit to stand
Starting position -Sit in a firm chair. Place the chair back against a wall for support if needed. Place your feet shoulder width apart with eyes closed.

Exercise 04. Partial wall squats
Starting position-Step your feet away from the wall (about 30cm) with your feet hip width apart. Slightly turn your feet outwards.
Exercise - Slowly slide down the wall. Stop before your knees cover up your toes (or less if it is painful). Hold for 5 seconds with eyes closed.

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Starting position -Lie on a mat on the floor or on a firm bed Place your feet hip-width apart.
Exercise - Lift your bottom off the floor/ bed. Keep shoulder blades on the floor/bed. Hold for 5 seconds.
Slowly lower your bottom back to the floor/bed. "Slowly up, hold, 2, 3, 4, 5, slowly down".

Keep your hips level as you lift.
Stop when you have made a straight line between your shoulders and your knee with your eyes closed.

Exercise 06: Single-leg bridge
Starting position Lie on a mat on the floor or on a firm bed.
Place your feet about 10cm apart (slightly closer than hip-width apart) with eyes open.

Exercise 07: Single calf raises
Starting position Stand holding onto back of the chair. Stand on your arthritis leg.
Exercise Slowly rises onto your toes. Hold for 5 seconds with eyes closed.

Exercise 08: Tandem stance
Starting position-Stand on a firm surface. Looking forwards focusing on a point on the wall. Use hand support (e.g. a chair) for balance if required.
Exercise Place one foot in front of the other so that feet make a straight line. Hold for 10 seconds with eyes closed.

Exercise 09: Single leg balance
Starting position Stand with your feet shoulder width apart.
Stand close to a wall for support in case you over balance, if required. Use hand support (e.g. a chair) for balance, if required with eyes closed.

3.RESULTS
To compare the effect of NPRS SCALE, WOMAC SCALE ,BERG BALACE SCALE and WHOQOL-BREF between Groups A and B, Independent t test was used.

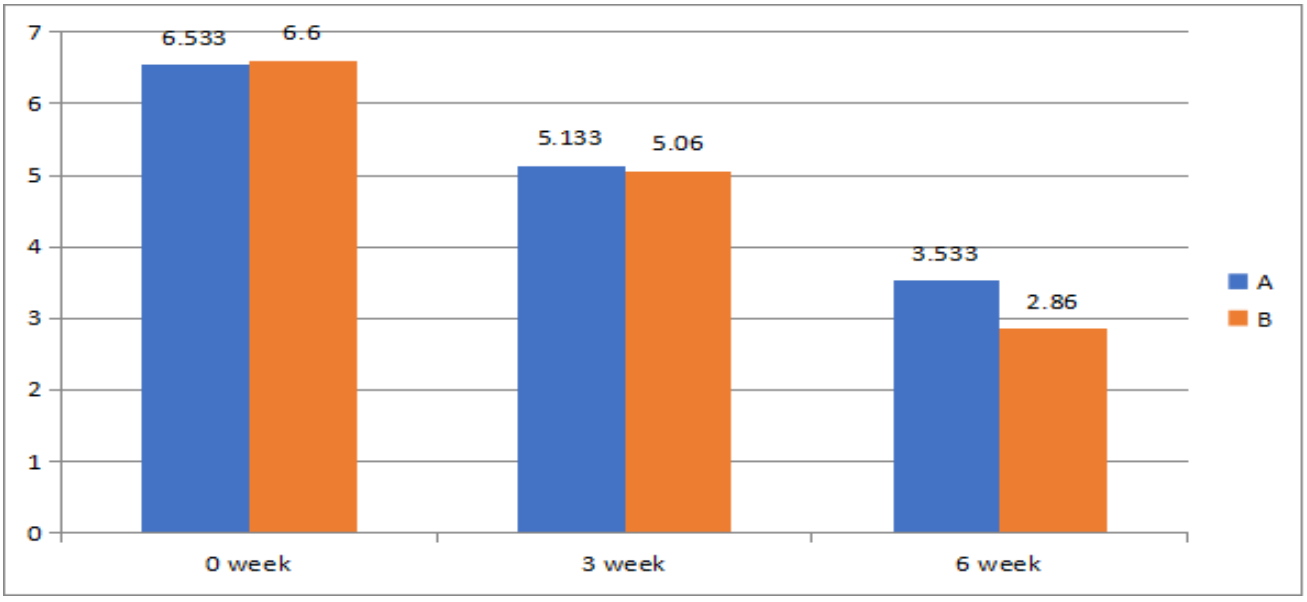
Table 3.1: To Analysis the difference between NPRS in Group A and Group B

Duration Group A	Mean ±SD	Duration Group B	Mean ±SD	t-value	P- Value	Result
0 week	6.533 ±0.516	0 week	6.60 ±0.507	4.012	0.03	Significant
3 week	5.133 ±.743	3 week	5.06 ±.1.66			
6 week	3.533 ±1.06	6 week	2.86 ±1.12			

Table-3.1: Comparison between Group A and B showing Mean ±SD of NPRS at 0 week, 3 week and 6 week measurement.

To analyze the difference in the NPRS between groups A and B independent t test was used. The difference in all the intervention in group A at 0 week, 3 week and 6 week Scores 6.533 ±0.516, 5.133 ±.743, 3.533 ±1.06 and group B are 6.60 ±0.507, 225.06 ±.1.66, 2.86 ±1.12 for 0 week, 3 week and 6 week measurement.

It was found that P value was less than 0.05 which implies statistical improvement in pain score of NPRS 0 week, 3 week and 6 week measurement. Thus, it says that there is statistically significant difference in NPRS participants from 0 week, 3week and 6 week measurement between groups A and B i.e. accepting the alternative hypothesis (H1) and rejecting the null hypothesis(H0)



GRAPH 1.The graphical representation showing the Comparison between Group A and B showing NPRS at 0 week, 3 week and 6 week measurement

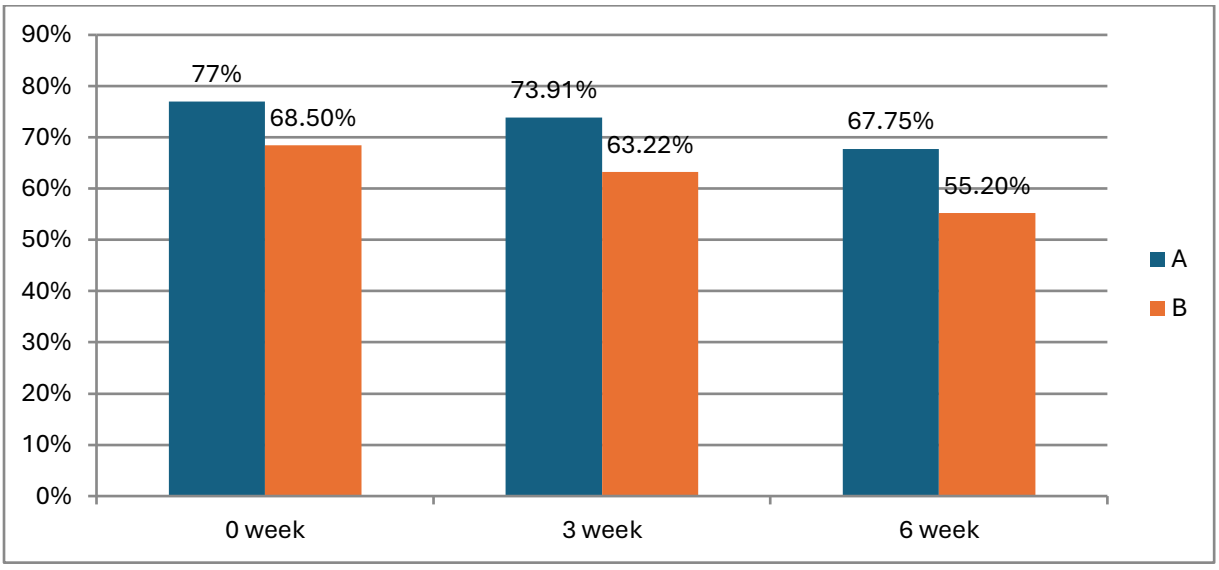
Table 3.2: To Analysis the difference between WOMAC SCALE in Group A and Group B

Duration Group A	Mean ±SD	Duration Group B	Mean ±SD	t-value	P- Value	Result
0 week	77% ± 9.49	0 week	68.50% ± 12.94	10.230	0.001	Significant
3 week	73.91 % ± 9.41	3 week	63.22 % ± 12.96			
6 week	67.75 % ±10.53	6 week	55.20 % ±15.48			

Table-3.2: Comparison between Group A and B showing Mean ±SD of WOMAC SCALE at 0 week, 3 week and 6 week measurement.

To analyze the difference in the WOMAC SCALE between groups A and B independent t test was used. The difference in all the intervention in group A at 0 week, 3 week and 6 week Scores 77% ± 9.49, 73.91 % ± 9.41, 67.75 % ±10.53 and group B are 68.50% ± 12.94, 63.22 % ± 12.96, 55.20 % ±15.48 for 0 week, 3 week and 6 week measurement.

It was found that P value was less than 0.05 which implies statistical improvement in pain score of WOMAC SCALE 0-week, 3 week and 6-week measurement. Thus, it says that there is statistical significant difference in WOMAC SCALE participants from 0 week, 3 week and 6 week measurement between groups A and B i.e. accepting the alternative hypothesis (H1) and rejecting the null hypothesis(H0).



Graph 3.2: The graphical representation showing the difference between WOMAC SCALE in Group A and Group B

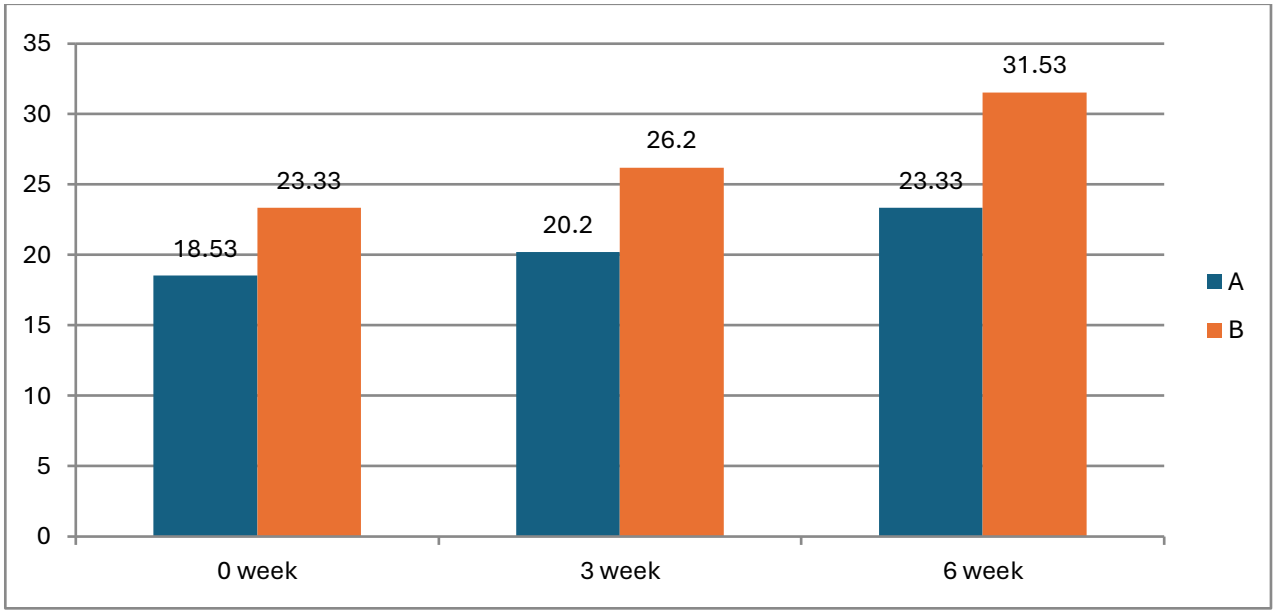
Table 3: To Analysis the difference between BERG BALACE SCALE in Group A and Group B

Duration Group A	Mean ±SD	Duration Group B	Mean ±SD	t-value	P- Value	Result
0 week	18.53 ±4.01	0 week	23.33 ± 6.77	8.321	0.021	Significant
3 week	20.20 ±4.27	3 week	26.20 ± 7.56			
6 week	23.33 ±4.46	6 week	31.53 ± 7.73			

Table-3.3: Comparison between Group A and B showing Mean ±SD of BERG BALACE SCALE at 0 week, 3 week and 6 week measurement.

To analyze the difference in the BERG BALACE SCALE S between groups A and B independent t test was used. The difference in all the intervention in group A at 0 week, 3 week and 6 week Scores 618.53 ±4.01, 20.20 ±4.27, 23.33 ±4.46and group B are 23.33 ± 6.77, 26.20 ± 7.56, 31.53 ± 7.73 for 0 week, 3 week and 6 week measurement.

It was found that P value was less than 0.05 which implies statistical improvement in pain score of BERG BALACE SCALE0 week, 3 week and 6 week measurement. Thus, it says that there is statistical significant difference in BERG BALACE SCALE participants from 0 week, 3 week and 6 week measurement between groups A and B i.e. accepting the alternative hypothesis (H1) and rejecting the null hypothesis..



Graph 3.3: The graphical representation showing the difference between berg balance scale in Group A and Group B

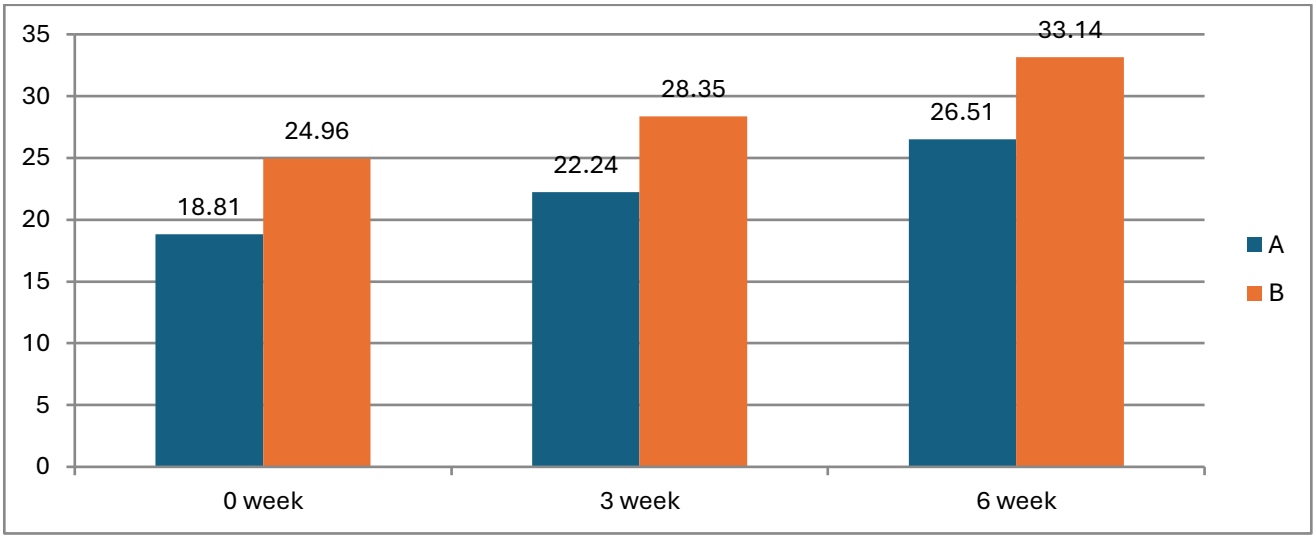
Table 3.4: To Analysis the difference between WHOQOL-BREFin Group A and Group B

Duration Group A	Mean ±SD	Duration Group B	Mean ±SD	t-value	P- Value	Result
0 week	18.81 ± 2.55	0 week	24.96 ± 4.05	11.321	0.0001	Significant
3 week	22.24 ± 3.03	3 week	28.35 ± 4.28			
6 week	26.51 ± 4.26	6 week	33.14 ± 6.90			

Table-3.4: Comparison between Group A and B showing Mean ±SD of WHOQOL-BREF at 0-week, 3 week and 6-week measurement.

To analyze the difference in the WHOQOL-BREF between groups A and B independent t test was used. The difference in all the intervention in group A at 0 week, 3 week and 6 week Scores 18.81 ± 2.55, 22.24 ± 3.03, 26.51 ± 4.26 and group B are 24.96 ± 4.05, 28.35 ± 4.28, 33.14 ± 6.90 for 0 week, 3 week and 6 week measurement.

It was found that P value was less than 0.05 which implies statistical improvement in pain score of WHOQOL-BREF0 week, 3 week and 6 week measurement. Thus, it says that there is statistical significant difference in WHOQOL-BREF participants from 0 week, 3 week and 6 week measurement between groups A and B i.e. accepting the alternative hypothesis (H1) and rejecting the null hypothesis(H0).



Graph 3.4 : The graphical representation showing the difference between WHOQOL - BREF in Group A and Group B

DISCUSSION

The study compared how effective core stabilization and balance training were when combined with conventional physiotherapy for people with knee osteoarthritis (OA). This was tested under two visual conditions: eyes open (Group A) and eyes closed (Group B). The data analysis used SPSS 23. One-way ANOVA examined within-group differences, while independent t-tests looked at between-group differences, with significance set at $p < 0.05$. The outcome measures included the Numeric Pain Rating Scale (NPRS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Berg Balance Scale, and WHO Quality of Life-BREF (WHOQOL-BREF). The results strongly support the effectiveness of the interventions, especially showing better results in the eyes-closed condition. Below is a detailed discussion of the findings, their implications, and their connection to existing research.
Discussion of the findings, their implications, and their connection to existing literature.

Within-Group Analysis
The within-group analysis showed significant improvements ($p < 0.05$) in all outcome measures for both Group A (eyes open) and Group B (eyes closed) during the 6-week intervention. This indicates that both protocols effectively addressed important aspects of knee OA, including pain, functional disability, balance, and quality of life.

NPRS (Pain):
Group A (Eyes Open): NPRS scores dropped from 6.53 ± 0.52 at baseline to 5.13 ± 0.74 at 3 weeks and 3.53 ± 1.06 at 6 weeks. This notable decrease suggests that balance and core stabilization exercises, combined with conventional physiotherapy (interferential therapy [IFT] and moist heat packs [MHP]), effectively reduced pain. The gradual decline matches previous studies showing that exercise interventions can lessen pain by improving muscle strength and joint stability8 .

Group B (Eyes Closed): NPRS scores showed a more marked reduction, from 6.60 ± 0.51 at baseline to 5.06 ± 1.66 at 3 weeks and 2.86 ± 1.12 at 6 weeks. The greater pain relief in Group B may result from the increased proprioceptive challenge of eyes-closed exercises, which likely improved neuromuscular control and lessened stress on the knee joint. This finding aligns with research suggesting that sensory-challenged exercises improve pain outcomes by enhancing joint position sense 13.

WOMAC (Functional Outcomes):

Group A: WOMAC scores changed from 77% ± 9.49 at baseline to 73.91% ± 9.41 at 3 weeks and 67.75% ± 10.53 at 6 weeks, showing a reduction in functional disability and better physical function. This improvement likely comes from the combined effects of core stabilization, which boosts trunk stability, and balance training, which enhances lower limb coordination, as supported by19 .
Group B: WOMAC scores showed a more significant improvement, changing from 68.50% ± 12.94 at baseline to 63.22% ± 12.96 at 3 weeks and 55.20% ± 15.48 at 6 weeks. The larger decrease in Group B indicates that the eyes-closed condition may more effectively impact functional mobility, possibly by improving proprioceptive feedback and motor control, which are crucial for daily activities like walking and climbing stairs .

Berg Balance Scale (Balance):
Group A: Balance scores increased from 18.53 ± 4.01 at baseline to 20.20 ± 4.27 at 3 weeks and 23.33 ± 4.46 at 6 weeks. This improvement shows better postural stability, likely due to strengthening core muscles (e.g., transversus abdominis and multifidus) and balance exercises that enhance lower limb coordination 6.

Group B: Balance scores showed even more improvement, from 23.33 ± 6.77 at baseline to 26.20 ± 7.56 at 3 weeks and 31.53 ± 7.73 at 6 weeks. The greater advancement in Group B suggests that eyes-closed balance training boosts proprioceptive reliance, which is vital for knee OA patients who often have impaired joint position sense from degenerative changes20. This matches studies showing that sensory-challenged exercises improve postural control by engaging vestibular and proprioceptive systems18.
WHOQOL-BREF (Quality of Life):
Group A: Quality of life scores went up from 18.81 ± 2.55 at baseline to 22.24 ± 3.03 at 3 weeks and 26.51 ± 4.26 at 6 weeks. This improvement reflects the positive effects of lower pain and better function on psychological and social well-being, as prior research linked exercise to better quality of life in OA patients17.
Group B: Quality of life scores showed a more significant increase, rising from 24.96 ± 4.05 at baseline to 28.35 ± 4.28 at 3 weeks and 33.14 ± 6.90 at 6 weeks. The larger improvement in Group B may come from greater confidence in movement and reduced fear of falling, thanks to better balance and proprioceptive control. This is consistent with studies showing that balance training eases kinesiophobia and enhances psychological health in OA populations 5.

Between-Group Analysis
The independent t-test revealed significant differences ($p < 0.05$) between Group A and Group B in all outcome measures at the 6-week mark, with Group B consistently performing better. This suggests that the eyes-closed condition offers added benefits compared to the eyes-open condition in managing knee OA.
NPRS and WOMAC: Group B had lower mean scores for NPRS (2.86 ± 1.12 vs. 3.53 ± 1.06) and WOMAC (55.20% ± 15.48 vs. 67.75% ± 10.53) compared to Group A at 6 weeks. These findings show that eyes-closed training may lead to bigger reductions in pain and functional disability. The sensory deprivation in Group B likely increased reliance on proprioceptive and vestibular inputs, enhancing neuromuscular changes and reducing joint stress, as supported by studies on sensory-challenged balance training 19.
Berg Balance Scale and WHOQOL-BREF: Group B had higher mean scores for the Berg Balance Scale (31.53 ± 7.73 vs. 23.33 ± 4.46) and WHOQOL-BREF (33.14 ± 6.90 vs. 26.51 ± 4.26) compared to Group A. The better balance results in Group B likely stem from the increased proprioceptive challenge, which boosts the activation of deep trunk muscles and improves center of mass stability (Joshi et al., 2019). The greater quality of life improvement in Group B may indicate increased functional confidence and less fear of falling, which are important for psychological well-being in OA patients17.

Interpretation and Connection to Literature
The superior outcomes in Group B support the alternative hypothesis (H1) that balance and core stabilization training with conventional therapy, especially under eyes-closed conditions, improves outcomes in knee OA patients. The rejection of the null hypothesis (H0) across all measures highlights the effectiveness of sensory-challenged exercises. The findings connect with several key points from the literature:

Proprioceptive Improvement: The eyes-closed condition forces reliance on proprioceptive and vestibular systems, often impaired in knee OA due to joint degeneration 20. This aligns with studies showing that sensory-challenged exercises improve joint position sense and postural stability 15.

Core Stabilization Advantages: Core stabilization exercises target muscles like the transversus abdominis and multifidus, improving trunk stability, which is vital for lower limb function and preventing falls in OA patients6 15 .

Balance and Fall Prevention: The notable improvement in Berg Balance Scale scores, particularly in Group B, highlights the role of balance training in lowering fall risk, a major concern in knee OA due to impaired proprioception and muscle weakness20 .

Functional and Psychological Outcomes: The enhancements in WOMAC and WHOQOL-BREF scores align with research indicating that exercise interventions improve functional mobility and quality of life by reducing pain and boosting confidence in movement21.

Clinical Implications
The findings have several clinical implications for managing knee OA:
Integration of Sensory-Challenged Exercises: Adding eyes-closed balance training into rehabilitation programs can enhance proprioceptive feedback, leading to greater improvements in pain, function, and balance. This is particularly important for older adults with knee OA, who face higher fall risks due to sensory and proprioceptive issues.

Holistic Rehabilitation Approach: Combining core stabilization and balance training addresses both core and lower limb weaknesses, offering a thorough approach to improving joint stability and functional mobility.

Fall Prevention Strategies: The better balance outcomes in Group B suggest that eyes-closed training could be a key part of fall prevention programs, lowering the risk of severe injuries and associated healthcare costs.

Patient-Centered Outcomes: The significant quality of life improvement, especially in Group B, emphasizes the need to address psychological factors like fear of falling and kinesiophobia, common in OA patients.

STUDY LIMITTIONS
This study has several limitations that need to be recognized. First, the relatively small sample size limits how much the results can be applied to larger groups. Second, the 6-week intervention period may not be long enough to assess long-term effects and the durability of clinical improvements, suggesting that future studies should include longer follow-up periods. Third, the absence of a control group receiving only standard physiotherapy makes it hard to pinpoint the specific effects of the core stabilization and balance training intervention.

FUTURE SCOPE OF THE STUDY

Future studies should include larger and more diverse groups of people. They should have longer follow-up periods and include control groups to make the evidence stronger. Using objective biomechanical tools, such as gait analysis and EMG, is recommended to better understand the effects on the nervous system and muscles. Research should also look at eyes-closed balance training in a wider range of populations, including those with neurological issues or who have had surgery. Finally, tailored interventions based on individual proprioceptive function might improve clinical outcomes.

CONCLUSION

When comparing the effectiveness between Group A and Group B, the p-value was found to be less than 0.05 across all scales—NPRS, WHOQOL-BREF, BERG BALANCE SCALE, WOMAC and BERG BALANCE SCALE—indicating a statistically significant difference between the groups. In the NPRS scale and WOMAC SCALE, the mean score was lower in Group B compared to Group A, suggesting better outcomes (i.e., less pain) in Group B. Similarly, in the BERG BALACE SCALE and WHOQOL-BRE, Group B showed higher mean scores than Group A, further indicating that Group B performed better across all assessed parameters.

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