

Effect of Foam Pad Balance Training Versus Retro Walking Along with Pilates on Pain, Physical Function and Balance Ability in Patients with Knee Osteoarthritis: A Randomised Clinical Trial

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Abstract:

➤ Background:

Knee osteoarthritis is associated with pain, restricted physical function, and impaired balance. Exercise is a central component of conservative care, but the relative effects of foam-pad balance training and retro walking when each is combined with Pilates require comparison.

➤ Aim:

To compare the effects of foam-pad balance training combined with Pilates versus retro walking combined with Pilates on pain, physical function, and balance ability in patients with knee osteoarthritis.

➤ Objective:

To compare the effects of foam-pad balance training plus Pilates with retro walking plus Pilates on pain, physical function and balance ability in adults with knee osteoarthritis using the WOMAC and the Berg Balance Scale.

➤ Methods:

This two-arm randomised clinical trial included 42 participants aged 40–60 years with clinically diagnosed knee osteoarthritis (Kellgren–Lawrence grades I–III). Participants were allocated to foam-pad balance training plus Pilates (Group A, n=21) or retro walking plus Pilates (Group B, n=21) for eight weeks. Outcomes were assessed before and after intervention using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and Berg Balance Scale (BBS). Within-group changes and between-group differences in change scores were analysed using parametric or non-parametric tests according to distribution; statistical significance was set at $p < 0.05$.

➤ Results:

Both groups improved significantly after treatment ($p < 0.001$ for all within-group comparisons). Mean WOMAC reduction was 13.52 ± 4.32 in Group A and 10.76 ± 2.96 in Group B; the between-group difference was significant ($p = 0.020$; Cohen's $d = 0.75$). Mean BBS improvement was 10.57 ± 3.03 in Group A and 8.05 ± 2.22 in Group B, respectively; the between-group comparison was significant ($p = 0.006$; rank-biserial effect size reported as $r = 0.49$).

➤ Conclusion:

Both intervention combinations improved WOMAC and balance scores over eight weeks. In this study, foam-pad balance training combined with Pilates produced greater improvement than retro walking combined with Pilates.

Keywords: Knee Osteoarthritis; Foam-Pad Balance Training; Retro Walking; Pilates; WOMAC; Berg Balance Scale; Randomised Clinical Trial.

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I. INTRODUCTION

Knee osteoarthritis (KOA) is a chronic musculoskeletal condition characterised by progressive changes in the articular cartilage, subchondral bone, and other joint structures. It commonly presents with knee pain, stiffness, muscle weakness, and limitations in physical function. These impairments can interfere with routine activities such as walking, climbing stairs, and rising from a seated position, ultimately affecting independence and quality of life. Exercise-based physiotherapy plays an important role in the conservative management of KOA by addressing physical impairments and improving functional capacity [1,7].

In addition to pain and mobility restrictions, individuals with KOA may experience difficulties with postural stability and balance. Effective balance control depends on the integration of sensory information, proprioception, muscle strength, joint mobility, and coordinated neuromuscular responses. Alterations in these components may affect stability during movement and everyday activities. Research has identified an association between knee osteoarthritis severity and impaired balance control, highlighting the importance of including balance-oriented exercises in rehabilitation programmes [2–4,6].

Foam pad balance training is an exercise approach that challenges postural control by providing an unstable supporting surface. Maintaining stability on foam requires continuous adjustments in body position and lower-limb muscle activity. Such training may help improve weightshifting ability, postural responses, and functional balance. Previous research has investigated foam-based balance activities and proprioceptive exercises for improving balance and functional performance, supporting their potential application in individuals with knee osteoarthritis [8,9].

Retro walking, also known as backward walking, offers a different exercise stimulus by modifying the demands of conventional forward gait. It requires coordinated control of lower-limb movements and balance while the individual moves in an unfamiliar direction. Studies have investigated retro walking as a rehabilitation strategy for knee osteoarthritis, reporting potential benefits in pain, physical function, mobility, and related functional outcomes [5,10,11]. Its effects may complement those of balance training by challenging locomotor control and movement coordination.

Pilates is another exercise-based approach that emphasises controlled movement, breathing, muscular conditioning, flexibility, and postural alignment. These principles may support improved movement control and physical function in individuals with knee osteoarthritis. Previous research has examined Pilates in comparison with other therapeutic exercises and proprioceptive training,

suggesting its relevance as a component of rehabilitation for this population [12–14].

Although foam pad balance training, retro walking, and Pilates have each been investigated as exercise-based rehabilitation approaches, the direct comparison of foam pad balance training combined with Pilates against retro walking combined with Pilates remains an important research question. Comparing these combinations may help determine which approach provides greater improvement in patient-reported symptoms and functional balance.

Therefore, the present study aimed to compare the effects of foam pad balance training combined with Pilates and retro walking combined with Pilates on pain, physical function, and balance ability in patients with knee osteoarthritis. The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and the Berg Balance Scale (BBS) were used to evaluate the study outcomes.

II. MATERIAL AND METHODS

➤ Study Design and Setting

A comparative randomised clinical trial was conducted among individuals with knee osteoarthritis (KOA) in a tertiary-care hospital setting in Jalgaon, Maharashtra, India. The study was conducted over eight weeks to compare the effects of foam pad balance training combined with Pilates and retro-walking combined with Pilates on pain, physical function, and balance ability. A total of 42 participants were included in the study.

➤ Participants and Eligibility

Male and female participants aged 40–60 years with clinically diagnosed knee osteoarthritis of Kellgren–Lawrence grades I–III were included. Participants were required to have knee pain rated ≤ 8 on the Numerical Pain Rating Scale (NPRS), be able to walk independently without an assistive device, safely perform the baseline Berg Balance Scale assessment, and be willing and able to follow instructions and participate in the exercise interventions.

Participants were excluded if they had undergone knee surgery or received an intra-articular injection within the preceding three months; had neurological disorders affecting balance, such as stroke or Parkinson's disease; had vestibular dysfunction or uncorrected visual impairment; had systemic joint diseases such as rheumatoid arthritis; or had severe cardiovascular or respiratory conditions contraindicating exercise. Individuals who had participated regularly in balance training or Pilates during the preceding six months, or who were unable or unwilling to complete the study protocol, were also excluded.

➤ Sample Size, Group Allocation and Intervention:

A total of 42 participants with knee osteoarthritis were included in the study and randomly allocated into two groups

of 21 participants each. Group A received foam pad balance training along with Pilates, whereas Group B received retro-walking along with Pilates. Both groups underwent training three times per week for eight weeks.

Group A performed progressively challenging balance exercises on a foam pad

1. FOAM PAD BALANCE TRAINING.

Before starting the intervention, the therapist prepared a safe, non-slip area, assessed the patient's pain and readiness, and remained close for guarding with all required equipment nearby.

Frequency: 3 days/week.

Duration per session: 20–25 minutes

WEEK 1–2: Basic Balance

1. Double-leg standing on foam pad – 20–30 sec × 10 rep.
2. Weight shifting (side–side, front–back) – 15 reps.
3. Semi-squat on foam pad – 10 reps × 2.
4. Heel raises on pad – 10 reps × 2.
5. Eyes-open → eyes-closed standing – 10 sec × 2.

WEEK 3–4: Moderate Dynamic Balance

1. Single-leg stance (with support) – 10–15 sec × 3
2. Marching on foam pad – 30 sec × 3
3. Tandem standing (heel-toe) – 20 sec × 3
4. Mini step-ups on pad – 10 reps each leg
5. Hip abduction while standing on pad – 10 reps × 2

WEEK 5–6: Advanced Balance.

1. Single-leg stance with head turning – 10 turns × 2
2. Reaching in multiple directions – 2 rounds
3. Mini lunges onto foam pad – 10 reps each side
4. Heel-toe walking on foam pad – 10 steps × 2
5. Side-stepping on foam pad – 30 sec × 2

WEEK 7–8: Functional + Dual-Task

1. Single-leg stance with ball toss – 15 throws × 2
2. Tandem walking on pad – 10 steps × 2
3. Mini squat with arm lift – 10 reps × 2
4. Step-over obstacle placed before pad – 10 reps × 2.
5. Dual-task balance (talk/count on pad) – 30 sec × 2.



A. double leg stance B. mini squat with arm lift
Fig. No.1 Balance training using foam pad.

Group B performed retro walking.

2. RETROWALKING

The therapist prepared a safe, obstacle-free area, assessed the patient's readiness, and stayed close for support. The patient walked backwards with an upright posture, slight knee flexion, and short controlled steps, with speed and difficulty adjusted as needed to maintain comfort, balance, and safety.

Frequency: 3 sessions/week

Session Duration: ~ 20–30 minutes (progressive).

Setting: Flat safe surface (firm ground), support nearby initially, with therapist assistance.

Week Program Details

Week 1–2 Warm-up: 5 min (ankle/hamstring/calf mobility)

.Retro-walking: 10 min at a comfortable speed .

Cool-down: 5 min stretching.

Week 3-4 Increase retro-walk to 15 min per session.

Maintain warm-up/cool down.

Encourage slightly faster backwards walking if safe

Week 5–6 Retro-walking for 20 min/session.

Add a dual-task: e.g., backwards walking + counting or looking over the shoulder carefully.

Week 7–8 Retro-walking for 25–30 min/session (if tolerated) or maintain 20 min.

Optionally add mini “shuttle” backwards walking to increase control and functional challenge.



A. retro walking B. retro walking + looking backwards

Fig. No. 2 Retro walking.

. Both groups also performed Pilates exercises as prescribed in the study protocol.

3. PILATES INTERVENTION

Table 1. Pilates protocol

WEEK	THE EXERCISE	EXPLANATION	FREQUENCY
1 st week	Hundred 1/2/3	Lying on the back with your knees bent and up in the air, then position your knees and hips in 90-degree angles.	3 × 20 s
2 nd week	The 1st-week exercises þ One leg stretch1, Double leg stretch1/2, Clam	One leg stretch: Being lying on the floor with legs extended straight out in front letting the belly drop toward the floor Double leg stretch: Being lying on the floor with legs extended straight out in front. Press your legs together and point toes in the Pilates stance, and let the belly drop toward the floor. Clam: Lying on the side. Resting	3×20 s 3×5 repetitions with increase based on patient's ability

		the head on the arm or hand, then bend hips to approximately 45 and knees at 90. Make sure that one hip is lying above the other. Upper leg upwards while keeping the feet in contact with one another.	
3 rd week	The 2nd-week exercises þ One leg stretch 2, Shoulder Bridge 1	Lying on the back in neutral spine, with knees bent and feet on the floor. Come to a bridge position on your shoulders with knees, hips, and shoulders in one line. Your abs and hamstrings should be well engaged.	3 × 5 repetitions with increase based on patient's ability
4 th week	The 3rd-week exercises þ Shoulder bridge 2, Hip twist	Sitting on a mat and extending your legs in front. The body should be in the same position as a up. Rotate the hips to the right side of the body and	3 × 5 repetitions with increase based on patient's ability

		circle legs to the right and down.	
5 th week	The 4 th -week exercises Scissors 1, One leg kick	In the prone position, closing the back of the legs to the same leg hamstring and firming the buttock while increasing your abdominal strength. If you have tight quads, only bend your knee as far as is comfortable or feel free to pulse only once.	3 × 20 s
6 th week	The 5 th -week exercises Scissors 2, Sidekick 1	Lying on the side and line up ears, shoulders, hips, knees, and ankles. Then, abduct the upper leg.	3 × 5 repetitions, with increase based on patient's ability
7 th week	The 6 th -week exercises Sidekick 2, One leg circle 1/2	Lying on the back with legs extended. Bring your thigh as perpendicular to the floor as possible. Circle the leg down toward the	3 × 5 repetitions, with increase based on patient's ability

		mat, then out to the right, and finally back to centre.	
8 th week	The 7 th -week exercise	-	3 × 5 repetitions with increase based on patient's ability



Fig 3. Pilates

➤ Outcome Measures

Pain and physical function were assessed using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), while balance ability was assessed using the Berg Balance Scale (BBS). Assessments were performed at baseline and after eight weeks. Higher BBS scores indicate better balance, whereas lower WOMAC scores indicate fewer symptoms and better function.

➤ Study Procedure

Approval was obtained from the Institutional Ethics Committee of the college before the study was conducted. Participants were screened according to the predefined inclusion and exclusion criteria. The study procedure was explained to eligible participants, and written informed consent was obtained before participation.

Baseline assessments were performed using the WOMAC questionnaire and Berg Balance Scale.

Eligible participants were randomly allocated to Group A or Group B and received their respective intervention programmes over eight weeks. Following completion of the intervention, the same outcome measures were administered again. Pre-intervention and postintervention data were

collected to evaluate changes in pain, physical function, and balance ability within and between the two groups.

➤ Statistical Analysis

The collected data were statistically analysed to compare pre-intervention and post-intervention outcomes within each group and to assess differences in outcomes between the two groups. The analysis focused on changes in WOMAC scores and Berg Balance Scale scores following the eight-week intervention. Descriptive and inferential statistical methods were used as appropriate to the data and study objectives.

➤ Ethical Considerations and Trial Registration

Ethical approval was obtained from the Institutional Ethics Committee of the college, and written informed consent

was obtained from all participants before enrolment. The study was registered prospectively or retrospectively as applicable, with the Clinical Trials Registry–India (CTRI) under registration number CTRI/2026/10/119411.

III. RESULTS

The study included 42 participants, with 21 in each group. At baseline, the groups were comparable in age, gender distribution, WOMAC score, and BBS score; all reported baseline comparisons had p-values greater than 0.05 (Table 1). The mean age was 46.52 ± 5.27 years in Group A and 48.33 ± 5.81 years in Group B ($p=0.297$).

Table 2 Baseline Characteristics and Outcome Scores.

Variable	Foam Pad + Pilates	Retro Walking + Pilates	Test Applied	p-value	Inference
Age (years)	46.52 ± 5.27	48.33 ± 5.81	Independent t-test	0.297	Comparable
Gender (M / F)	5 / 16	6 / 15	Fisher's exact test	1.000	Comparable
WOMAC Pre	51.52 ± 6.44	51.71 ± 6.06	Independent t-test	0.922	Comparable
Berg Balance Pre	39.33 ± 4.63	40.24 ± 3.62	Independent t-test	0.485	Comparable

➤ Age-Wise Distribution

Table 3 Age-Wise Distribution

Age (years)	Group A: Foam Pad+ Pilates n (%)	Group B : Retro Walking + Pilates n (%)
40-44	8(38.10%)	6(28.57%)
45-49	6(28.57%)	7(33.33%)
50-54	5(23.81%)	4(19.05%)
55-59	2(9.52%)	4(19.05%)
Total	21(100%)	21(100%)

- Age: Group A had a mean age of 46.52 ± 5.27 years, while Group B had a mean age of 48.33 ± 5.81 years. There was no statistically significant difference between groups ($p=0.297$).

➤ Gender Wise Distribution

Table 4 Gender Wise Distribution

Gender	Group A: Foam pad + Pilates n (%)	Group B: Retro walking + Pilates n (%)
Female	16(76.19%)	15(71.43%)
Male	5(23.81%)	6(28.57%)
Total	21(100%)	21(100%)

- Gender: Group A consisted of 5 males and 16 females, whereas Group B consisted of 6 males and 15 females. The distribution was comparable between groups (Fisher's exact test, $p=1.000$).

Both groups showed statistically significant within-group improvement in WOMAC and BBS scores after eight weeks ($p<0.001$ for each comparison). In Group A, mean

WOMAC decreased from 51.52 ± 6.44 to 38.00 ± 6.48 , a mean reduction of 13.52 ± 4.32 points. In Group B, WOMAC decreased from 51.71 ± 6.06 to 40.95 ± 5.39 , a mean reduction of 10.76 ± 2.96 points.

Mean BBS increased from 39.33 ± 4.63 to 49.90 ± 3.83 in Group A, a mean increase of 10.57 ± 3.03 points. In Group B, BBS increased from 40.24 ± 3.62 to 48.29 ± 2.97 , a mean increase of 8.05 ± 2.22 points.

Table 4 Between-Group Comparison of Change Scores.

Outcome	Foam Pad + Pilates	Retro Walking + Pilates	Test Applied	p- value	Effect Size	Inference
WOMAC (reduction)	13.5 2 ± 4.32	10.7 6 ± 2.96	Independent t-test	0.020	d =0.75 (medium-large)	Significant
Berg Balance (increase)	10.5 7 ± 3.03	8.05 ± 2.22	Mann-Whitney U	0.006	r = 0.49 (medium-large)	Significant

Between-group analysis showed a greater reduction in WOMAC in Group A than Group B ($p=0.020$; Cohen's $d=0.75$). The increase in BBS was also greater in Group A ($p=0.006$; rank-based effect size reported as $r=0.49$). Thus, both groups improved, with larger average changes in the foam-pad balance training plus Pilates group.

IV. DISCUSSION

The present study compared the effects of foam-pad balance training combined with Pilates and retro walking combined with Pilates in patients with knee osteoarthritis. Both groups demonstrated statistically significant improvements in WOMAC and Berg Balance Scale (BBS) scores after eight weeks of intervention.

Group A showed a greater reduction in WOMAC scores (13.52 ± 4.32) than Group B (10.76 ± 2.96), with a statistically significant between-group difference ($p = 0.020$). These findings suggest that foam-pad balance training combined with Pilates may provide additional benefits in improving overall osteoarthritis-related symptoms and functional limitations. Previous research has highlighted the potential benefits of exercise and Pilates-based interventions in patients with knee osteoarthritis [7,13,14].

Similarly, BBS scores improved in both groups, with a greater mean increase in Group A (10.57 ± 3.03) compared with Group B (8.05 ± 2.22). This difference was statistically significant ($p = 0.006$). The improvement observed in Group A may be associated with the postural control and balance demands of foam-pad training. Previous studies have explored balance and proprioceptive training as approaches to improving functional outcomes in patients with knee osteoarthritis [4,8,9].

Retro walking combined with Pilates also produced significant improvements in both outcomes, supporting its potential role in rehabilitation for knee osteoarthritis. Previous research has investigated retro walking as an intervention for improving pain and physical function in this population [10,11]. However, the present study showed greater improvements in both measured outcomes in Group A.

V. CONCLUSION

The present study concluded that both foam-pad balance training combined with Pilates and retro walking combined with Pilates significantly improved WOMAC and Berg Balance Scale (BBS) scores in patients with knee osteoarthritis following eight weeks of intervention ($p < 0.001$). However, the foam-pad balance training group demonstrated significantly greater improvement in WOMAC scores ($p =$

0.020) and BBS scores ($p = 0.006$) compared with the retro walking group. Therefore, foam-pad balance training combined with Pilates was more effective than retro walking combined with Pilates in improving osteoarthritis-related symptoms and balance ability in the study population.

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➤ Ethics Statement

Ethical clearance for the study was granted by the Research and Ethics Committee of Dr Ulhas Patil College of Physiotherapy, Jalgaon, Maharashtra, India, on 18 April 2026. We obtained written informed consent from all participants before they participated in the study. The study was registered with the Clinical Trials Registry–India (CTRI) under registration number CTRI/2026/10/119411.

➤ Data Availability

The study data are summarised in the project report.

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