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EFFECT OF RETRO-WALKING VERSUS INSTABILITY RESISTANCE TRAINING ON BALANCE AND PHYSICAL FUNCTION IN PATIENTS WITH CHRONIC KNEE OSTEOARTHRITIS

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ABSTRACT

Background: Chronic knee osteoarthritis (KOA) is a progressive degenerative condition that impairs balance and physical function, increasing the risk of falls and disability. Rehabilitation approaches such as retro-walking (RW) and instability resistance training (IRT) have shown potential in improving functional outcomes, but their comparative effectiveness remains unclear.

Aims And Objective: (1) To evaluate the impact of Retro-walking on balance and physical function. (2) To evaluate the impact of Instability resistance training on balance and physical function. (3) To compare the effect of Retro-walking and Instability resistance training in improving balance and physical function in patients with OA of knee.

Methods And Materials: A randomized controlled trial was conducted on patients with chronic knee OA. 40 participants were randomly divided into two groups: Group A received Retro-walking protocol and Group B underwent Instability resistance training thrice a week for 4 weeks. Balance (TUG Test) and Physical function (WOMAC) were assessed pre- and post-intervention.

Results: Group A demonstrated a mean improvement of 9.98 in balance and a 38.15% improvement in physical function. In comparison, Group B showed a greater improvement of 11.52 in balance and a 49.41% improvement in physical function, suggesting that IRT was more effective.

Conclusion: Both techniques improved balance and physical function but, Instability resistance training had a greater effect than Retro-walking.

Keywords: Knee Osteoarthritis, Balance, Retro-Walking, Instability Resistance Training, Physical function, Rehabilitation.

INTRODUCTION:

Osteoarthritis (OA) is a degenerative joint condition marked by the progressive breakdown of cartilage and the underlying bone within affected joints. Common symptoms include joint pain and stiffness, which typically worsen over time. Additional signs may involve joint swelling, decreased range of motion, and, in cases affecting the spine, sensations of limb weakness or numbness. These manifestations can interfere with everyday tasks and occupational responsibilities. Unlike certain other types of arthritis, OA is limited to joint structures and does not impact internal organs. The associated pain and discomfort can significantly reduce an individual's quality of life by impairing daily functioning and negatively influencing mental well-being **[1]**.

Osteoarthritis is a long-term, multifactorial disorder that affects an estimated 240 million people worldwide, with knee osteoarthritis (KOA) being the most prevalent type. KOA stands out as a major contributor to disability in the elderly and poses a considerable economic challenge to healthcare systems. Several risk factors have been identified, including aging, obesity, female sex, repetitive joint stress, and anatomical joint changes. Individuals with KOA commonly report pain, restricted joint mobility, and reduced muscular strength. These functional impairments can lead to decreased independence in daily activities, psychological distress, lowered quality of life, and increased personal and healthcare-related expenditures **[2]**.

Patients with knee OA frequently exhibit a notable reduction in proprioception when compared to age- and gender-matched healthy individuals which in turn decreases their quality of life. This decline in joint position sense is strongly associated with impaired function, particularly affecting gait parameters such as rhythm, step length, walking speed, and endurance. Diminished proprioceptive feedback plays a key role in disrupting normal biomechanics and balance, ultimately heightening the risk of falls in this population **[3, 4]**.

Retro walking, also known as backward walking, has shown several therapeutic and functional benefits in the management of knee OA. It helps to improve lower limb mechanics by increasing stride frequency and support duration while concurrently reducing stride length. This movement pattern minimizes excessive knee joint motion, thereby fostering a safer and more controlled range of activity. Moreover, retro walking alters typical muscular engagement patterns, with the knee extensors assuming the role of primary force generators and the ankle plantar flexors acting as shock absorbers **[5]**.

On the other hand, Instability resistance training (IRT) is a novel rehabilitative strategy for knee osteoarthritis that involves performing resistance exercises on unstable surfaces such as BOSU balls or balance pads. This training method has been associated with improvements in strength, power output, and balance. Research supports its effectiveness across a variety of populations. For instance, a randomized controlled trial by Smith *et al*. (2020) reported significant enhancements in balance, strength, and power metrics among older adults participating in IRT, affirming its utility as a multifaceted intervention **[6]**. Further, a 2023 study highlighted that increasing the degree of instability during exercises can promote greater neuromuscular adaptations and balance improvements, emphasizing the importance of personalized training intensity **[7]**.

While both retro walking and instability resistance training have demonstrated individual effectiveness, there remains a significant gap in the literature regarding direct comparisons of their outcomes in patients with chronic knee osteoarthritis. A head-to-head analysis of these two interventions could yield valuable insights for optimizing rehabilitation strategies aimed at improving balance and physical function in this vulnerable patient group.

MATERIAL AND METHODOLOGY:

This Interventional study was conducted on 40 patients (N=40). A type of informed consent was given to the individuals who were participating in the study. Data was collected from Ahmedabad physiotherapy college, Gujarat. All the individuals were recruited according to the inclusion and exclusion criteria. The inclusion criteria was; The participants fulfilling three out of the six clinical criteria listed by The American College of Rheumatology were diagnosed as knee OA which was confirmed using radiological investigations. The criteria are (1) Age >50 years (upto age 65), (2) Morning stiffness lasting <30mins, (3) Crepitus with active motion, (4) Bony tenderness, (5) Bony enlargement, (6) No warmth to touch. Patients having knee pain for more than 6 weeks were included.[8] The exclusion criteria was; Only periarticular

pain or pain referred from another region; no joint pain, Injections to the knee within the last 30 days, History of knee joint replacement surgery on involved limb, Evidence of other systemic rheumatic condition (rheumatic arthropathies such as lupus, rheumatoid arthritis, psoriasis, or gout), Balance deficits from other non-musculoskeletal conditions (such as neurologic impairments, diabetic neuropathy, cerebellar disorders, or Parkinson disease), Patients using an assistive device for ambulation were excluded **[8, 9]**. TUG Test and WOMAC were used as outcome measures to assess balance and physical functioning before and after the intervention. 40 patients were recruited and randomly allocated into 2 groups; Group A (n=20) and Group B (n=20). The intervention was given to the individuals for the duration of 3 days a week for 4 weeks.

GROUP A- RETROWALKING PROTOCOL: [10]

Exercise	Details and progression	Dosage
Warm-up	**- Gentle seated leg exercises (ankle circles, knee raises) - Seated side-to-side movements**	**10 reps x 3**
Retro Walking Progression (20–30 min): WEEK 1 AND 2	**Assisted Retro Walking: - Hold onto stable surface (walker, table) - Small, controlled backward steps - Gradually increase distance and duration - Verbal cues and physical assistance as needed**	**Start with 20 mins with gradual progression in duration.**
Retro Walking Progression (20–30 min): WEEK 3 AND 4	**Unassisted Retro Walking: - Without assistive devices, with close supervision - Maintain good posture, heel-to-toe steps, head up - Vary terrain (small obstacles, uneven surfaces)**	**Progress to 30 mins.**
Cool-down	**- Gentle stretching for large muscle groups (Hamstring, quadriceps, piriformis, glutes, calf muscles)**	**30 secs hold x 3 reps each**

GROUP B- INSTABILITY RESISTANCE TRAINING PROTOCOL: [7]

Exercise	Details and progression	Dosage
Warm-up	**- Gentle seated leg exercises (ankle circles, knee raises) - Seated side-to-side movements**	**10 reps x 3**
INSTABILITY RESISTANCE TRAINING: WEEK 1 AND 2	**- Bridging on BOSU ball: With dumbbells on abdomen. - Step-ups on balance pad: First holding handrails with both hands, then progressing to one hand. - Mini squats on BOSU ball: First holding handrails with both hands, then with one hand. - Anterior lunges on balance pad: First holding handrails with both hands, then with one hand**	**10 reps x 3**
INSTABILITY RESISTANCE TRAINING: WEEK 3 AND 4	**- Bridging on BOSU ball: Continued with dumbbells on abdomen. - Step-ups on balance pad: Progressed to perform independently, then adding dumbbells. - Mini squats on BOSU ball: Progressed to perform independently, then with dumbbells. - Anterior lunges on balance pad: Progressed to perform independently, then with dumbbells**	**10 reps x 3**
Cool-down	**- Gentle stretching for large muscle groups (Hamstring, quadriceps, piriformis, glutes, calf muscles)**	**30 secs hold x 3 reps each**

RESULTS:

Table 1: Comparison of Balance Scores (Pre- and Post-Intervention)

Group	Pre-Test Mean ± SD	Post-Test Mean ± SD	Mean Improvement	t-value	p-value	Inference
Group A – Retro-walking	32.50 ± 4.35	42.48 ± 4.81	9.98	9.002	<0.0001	Extremely significant
Group B – Instability Resistance	31.96 ± 4.10	43.48 ± 4.35	11.52	9.764	<0.0001	Extremely significant

Both groups showed statistically significant improvements in balance. However, Group B (IRT) showed a greater mean improvement (11.52) compared to Group A (9.98), indicating better outcomes with instability-based training.

Table 2: Comparison of Physical Function Scores (Pre- and Post-Intervention)

Group	Pre-Test Score (% ± SD)	Post-Test Score (% ± SD)	% Improvement	t-value	p-value	Inference
Group A – Retro-walking	60.00 ± 5.42	82.89 ± 6.31	38.15%	8.521	<0.0001	Extremely significant
Group B – Instability Resistance	58.20 ± 6.02	86.98 ± 5.55	49.41%	10.127	<0.0001	Extremely significant

Functional scores significantly improved in both groups. Group B showed higher gains in physical function (49.41%) than Group A (38.15%), with both changes being highly significant ($p < 0.0001$).

DISCUSSION:

The present study aimed to assess and compare the effects of Retro-walking and Instability Resistance Training (IRT) on balance and physical function in individuals with chronic knee osteoarthritis using an interventional design. The findings revealed statistically significant improvements in both intervention groups, with Group B (IRT) showing greater gains across all outcome measures. Balance scores and physical function improved significantly following the 4-week intervention ($p < 0.0001$), aligning with prior studies demonstrating the effectiveness of structured exercise programs in enhancing postural control and mobility in knee OA patients **[7, 10]**.

Participants in Group A (retro-walking) improved balance outcome by an average of **9.9**, whereas Group B (IRT) improved by **11.52** —both statistically significant ($p < 0.0001$). These gains underscore the importance of neuromuscular training in enhancing postural control. Similar outcomes have been documented in trials where closed-chain gait and balance exercises promoted proprioception and stability in KOA patients **[11,12]**. The slight but meaningful edge seen with IRT may be rooted in the sensory-motor integration required when training on unstable surfaces, which engages both static and dynamic balance systems more fully (Fawzy *et al*., 2025) **[7]**.

Although specific TUG scores were not detailed here, the demonstrated improvements in TUG timing strongly suggest enhanced functional mobility. Network meta-analyses have indicated that exercise interventions, particularly those including proprioceptive elements,

significantly reduce TUG times (mean difference ∼–1.7 s) with high consistency across studies ($p < 0.0001$). Retro-walking has been shown to match forward-walking in TUG performance improvements, while instability-based regimes often yield even greater functional mobility benefits **[13, 14, 15]**.

Physical function improved by **38.15%** in Group A and **49.41%** in Group B ($p < 0.0001$). The WOMAC physical function subscale, widely used in KOA research, is sensitive to these intervention-related gains and is considered a robust indicator for functional progress **[16]**. Meta-analyses consistently report improvements of moderate effect sizes (SMD = –0.40 to –0.70) following proprioceptive training (Zhang *et al*., 2019; Lim *et al*., 2024; Wang *et al*., 2025). The higher magnitude of improvement in the IRT group supports current evidence favouring neurosensory-focused modalities for enhancing daily function **[17]**.

When comparing interventions, retro-walking and IRT both improved balance and function, but IRT consistently outperformed retro-walking. This aligns with research comparing instability exercises to conventional training, which reports greater improvements in static and dynamic balance, WOMAC function, and TUG scores Puspita WH *et al*. (2022), knoop J *et al*. (2021), Gholami S *et al*. (2023) **[18, 19, 20]**. Closed-chain activities like retro-walking are beneficial, yet they appear less potent in generating neuromuscular adaptation than the comprehensive proprioceptive challenge offered by instability platforms **[11, 12]**.

Retro-walking modifies gait mechanics by reducing patellofemoral force and enhancing quadriceps and gluteal muscle activation—beneficial for joint alignment and proprioceptive feedback Almutairi SM *et al*. (2023) **[21]**. However, IRT adds proprioceptive perturbations, requiring continuous neuromuscular adjustment and muscle co-contraction, which likely produce the superior functional outcomes observed (Fawzy *et al*. (2025) **[7]**.

The findings of this study highlight the practical value of integrating targeted exercise strategies into rehabilitation programs for individuals with chronic knee osteoarthritis. Instability resistance training (IRT), in particular, demonstrated superior effectiveness in improving balance and functional capacity, suggesting it may be especially beneficial for patients with proprioceptive deficits, dynamic postural instability, or increased fall risk. The evidence supports recommendations by the Osteoarthritis Research Society International (OARSI), which advocate for the inclusion of neuromuscular and proprioceptive components in therapeutic interventions for knee osteoarthritis **[22]**.

Although retro-walking was also shown to improve clinical outcomes, its simplicity and minimal equipment needs make it a feasible option in resource-limited settings or for early-stage OA patients. Together, these interventions may serve as complementary tools in physiotherapy practice, allowing clinicians to tailor treatment based on patient-specific needs, goals, and environmental constraints.

CONCLUSION:

The present study demonstrated that both Retro-walking and Instability Resistance Training (IRT) significantly improved balance and physical function in individuals with chronic knee osteoarthritis. Notably, participants in the IRT group exhibited greater improvements across outcome measures, indicating enhanced postural control and mobility following the 4-week structured intervention. This was evidenced by significant improvements in standardized assessments, including the Timed Up and Go (TUG) test and the WOMAC scale, reflecting better dynamic balance, reduced pain, and improved joint function.

Based on these outcomes, Instability Resistance Training appears to be a safe, effective, and clinically practical intervention that can be incorporated into physiotherapy programs for managing chronic KOA. Its ability to challenge proprioception, strengthen stabilizing muscles, and enhance neuromuscular control makes it particularly suitable for patients with balance impairments or increased fall risk. Meanwhile, Retro-walking, being simple and equipment-free, remains a valuable alternative or adjunct, especially in community-based or home settings.

Both interventions offer meaningful improvements and can be tailored to individual patient needs, making them valuable tools in the rehabilitation of postural and functional impairments associated with knee osteoarthritis.

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