Journal of Health and Rehabilitation Research 2791-156X JHRR

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Original Article

Effectiveness of Lateral Shoe Wedging along with Quadriceps Strengthening and Life Style Modification in Knee Osteoarthritis

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ABSTRACT

Background: Knee osteoarthritis (OA), a common degenerative joint disorder, significantly impairs quality of life due to pain and functional limitations. Non-surgical interventions like lateral shoe wedging and quadriceps strengthening exercises are increasingly considered viable options for managing OA symptoms.

Objective: To assess the efficacy of lateral shoe wedges, both alone and in combination with quadriceps strengthening exercises, in treating medial knee OA.

Methods: In this randomized controlled trial, 60 adults with medial knee OA were assigned to one of three groups: Group A received only lateral shoe wedges; Group B received lateral shoe wedges and quadriceps strengthening exercises; Group C received lateral shoe wedges with lifestyle modifications. Measurements for pain, stiffness, and physical function were taken using the Numeric Pain Scale and WOMAC scale at baseline, 8 weeks, and 16 weeks.

Results: By Week 16, Group A (wedge only) reported a 70% compliance rate, with no significant changes in WOMAC stiffness and physical function scores. Group B (wedge & exercise) showed an 80% compliance rate, with pain scores reducing from 2.50±0.945 to 1.40±1.231 and significant improvements in WOMAC stiffness (1.40±1.231) and physical function (1.50±1.147). Group C (wedge & lifestyle modification) achieved a 100% compliance rate, with moderate improvements in all measured parameters.

Conclusion: The study concludes that the combination of lateral shoe wedging and quadriceps strengthening exercises (Group B) was most effective in alleviating pain and improving physical function in patients with medial knee OA. This suggests that a multimodal approach may be superior to singular interventions for managing OA symptoms.

Keywords: Knee Osteoarthritis, Lateral Shoe Wedging, Quadriceps Strengthening Exercises, Non-surgical Interventions, Randomized Controlled Trial, WOMAC Scale, Pain Reduction

INTRODUCTION

Degenerative arthritis, commonly known as Osteoarthritis (OA), is a condition characterized by the progressive degradation of joint components such as cartilage, ligaments, the synovial capsule, membrane, and subchondral bone (1). This degradation leads to pain and, ultimately, disability. OA predominantly affects the knee, hip, spine, ankle, and shoulder joints. It is projected to become the fourth leading cause of disability globally soon (2).

Among the various forms of OA, knee osteoarthritis is particularly significant. It is the most prevalent type of arthritis, especially affecting the knee joint and more commonly seen in women than men. The global standardized prevalence of knee OA is approximately 3.8%, making it a significant contributor to disability worldwide. Notably, about 60% of the global population over the age of 65, who show radiographic evidence of OA, exhibit symptomatic osteoarthritis. A specific study highlights that joint space narrowing in the medial tibiofemoral compartment (29.5%) is more prevalent than in the lateral compartment (8.2%) (3).

Non-pharmacological interventions form the cornerstone of OA management, given the high financial costs associated with knee replacement surgeries. These interventions include RICE therapy (Rest, Icing, Compression, Elevation), NSAIDs, physical therapy,

Journal of Health and Rehabilitation Research 2791-156X JHRR

lateral shoe wedging, braces, supportive devices, therapeutic injections, and lifestyle modifications (such as reducing activities that exacerbate symptoms like climbing stairs, weightlifting, smoking, and obesity) (4). Custom-designed orthotic insoles with a 10-degree lateral tilt, made from materials like tapiform or cork, are placed under the foot from the hindfoot to the forefoot (5). Isometric quadriceps exercises, which involve increasing quadriceps muscle tension without changing its length, are used to enhance the strength of the surrounding soft tissues, thereby improving knee stability. It is noted that quadriceps weakness is associated with OA in nearly all patients (6).

The management of knee osteoarthritis (OA), a prevalent and debilitating joint condition, has evolved to include a combination of lateral shoe wedging, quadriceps strengthening, and lifestyle modification. These non-surgical approaches aim to alleviate pain and improve functionality in daily activities (7).

Recent research highlights the efficacy of these methods. Kumarahewa's study in 2020 demonstrated that a 4-week quadriceps strengthening program significantly reduced knee pain and enhanced the performance of daily activities in patients with knee OA (8). This finding underscores the critical role of muscular strength in managing OA symptoms.

In the realm of orthotic interventions, lateral wedge insoles have been the subject of varied findings. Patil's research in 2023 revealed that the use of these insoles led to a notable reduction in pain and functional improvement over a 12-month period (9-11). This suggests a long-term benefit of orthotic intervention in knee OA management (12). Conversely, Ferreira's study in the same year reported no significant differences in pain intensity or biomechanical parameters when comparing lateral wedge insoles to neutral insoles. This disparity in results points to a potential variability in response to orthotic treatments among OA patients (13, 14).

Further investigating this variability, Ferreira in 2022 delved into the biomechanical impacts of different degrees of lateral wedge insoles (15). His findings suggest that even slight variations in insole design can lead to significant changes in the biomechanical dynamics of the knee in osteoarthritis patients. This line of research indicates the importance of personalized approaches in the orthotic management of knee OA, considering individual biomechanical characteristics (13, 14).

In the context of Pakistan, various techniques are employed by therapists to alleviate the symptoms of this debilitating condition. However, the literature lacks comprehensive studies demonstrating the effectiveness of combining lateral wedge insoles with isometric quadriceps strengthening exercises. Some researchers have explored the relationship between disease severity, patient age, and the outcome of insole use, but findings have been inconsistent and contradictory. Furthermore, the direct clinical and biomechanical impacts of wedged insoles on long-term clinical outcomes have not been thoroughly examined.

Therefore, this study aims to assess not only the effectiveness of lateral shoe wedges combined with quadriceps exercises in the management of knee OA but also to determine the most effective treatment combination for conservative management. This approach is particularly important for enhancing physical function and managing pain while avoiding the expenses and adverse effects associated with surgical interventions typically reserved for the terminal stages of the disease. The study's findings could have significant implications for clinical practices and patient outcomes, potentially providing a more cost-effective and less invasive alternative to surgery for managing knee OA.

MATERIAL AND METHODS

A randomized controlled trial (RCT) design was utilized to evaluate the effectiveness of various interventions on 60 adults diagnosed with medial knee osteoarthritis. Participants were systematically sampled from the Physical Therapy & Orthotics department of the National Institute of Rehabilitation Medicine (NIRM) in Islamabad. Every third patient was assigned to experimental group B. Data collection involved comprehensive questionnaires to gather demographic information, along with assessments of pain and function. The study's inclusion criteria were specific to age, a confirmed diagnosis of medial knee osteoarthritis, and the provision of informed consent. Patients with lateral knee osteoarthritis, recent knee surgery, or recent medication usage for OA were excluded.

Participants were evenly distributed into three groups, each comprising 20 individuals. Group A was provided with custom-designed lateral wedge insoles made of tape form or cork, placed under the sole along the lateral border (from hindfoot to forefoot) with a 10-degree tilt. This design aimed to shift the load during weight-bearing and standing activities from the inner to the outer knee compartment. The advised wearing time was 12-14 hours per day for up to 4 months, including during walking, standing, and other high-impact activities at both workplace and home settings.

Group B received the same custom-designed lateral wedge insole as Group A, supplemented with isometric quadriceps strengthening exercises. These exercises were to be performed in 2-3 sessions per day, each session lasting 10-15 minutes with 10-15 repetitions. This regimen was maintained alongside the wearing of the insoles.

Group C was given identical custom-designed wedges as the other groups, with the addition of lifestyle modifications. These modifications included minimizing activities that exacerbate knee symptoms (e.g., climbing stairs, weightlifting, sitting on the floor with bent knees), transitioning from high to low force impact activities, weight loss, and smoking cessation.

Journal of Health and Rehabilitation Research 2791-156X JHRR

The study spanned six months, with evaluations conducted at baseline, 8 weeks, and 16 weeks. For statistical analysis, a one-way ANOVA was performed to compare mean differences between groups, and a repeated-measures ANOVA was used for within-group comparisons. Data analysis was conducted using SPSS software version 21.

RESULTS

The study's compliance rates varied among the three groups over the course of 16 weeks. At the 8-week mark, 70% of the participants in both the 'Compliance with Wedge Only' and 'Compliance with Wedge & Exercise' groups adhered to their respective treatment protocols. The 'Compliance with Wedge & Lifestyle Modification' group demonstrated a slightly higher compliance rate of 80%. However, by Week 16, there was a notable increase in compliance in the latter two groups: the 'Compliance with Wedge & Exercise' group showed an increase to 80%, while the 'Compliance with Wedge & Lifestyle Modification' group reached a full 100% compliance rate. The 'Compliance with Wedge Only' group maintained a steady compliance rate of 70% throughout the study period.

Table 1 Compliance Rates by Group

Timepoint	Compliance with Wedge Only (n=20)	Compliance with Wedge & Exercise (n=20)	Compliance with Wedge & Lifestyle Modification (n=20)
Week 8	70%	70%	80%
Week 16	70%	80%	100%

In the evaluation of WOMAC Stiffness scores, all groups started with similar baseline scores in Week 0 (Group A: 2.00±0.917, Group B: 2.20±0.767, Group C: 2.30±0.470), with no significant difference (P-value = 0.43). By Week 8, Group A showed a slight reduction in stiffness (1.90±0.852), while Group B reported more noticeable improvement (1.60±0.940), and Group C's stiffness remained relatively unchanged (2.20±0.767). The trend continued until Week 16, where Group A's score decreased further to 1.50±0.945, and Group B showed the most significant reduction in stiffness (1.40±1.231). Group C, however, demonstrated a smaller decrease (2.10±0.852). The decreasing trend in stiffness scores indicates an improvement in symptoms, particularly notable in Group B.

Table 2 WOMAC Stiffness Scores

Timepoint	Group	Mean ± SD	P-value
Week 0	A	2.00±0.917	0.43
	B	2.20±0.767	
	C	2.30±0.470	
Week 8	A	1.90±0.852	0.09
	B	1.60±0.940	
	C	2.20±0.767	
Week 16	A	1.50±0.945	0.07
	B	1.40±1.231	
	C	2.10±0.852	

Regarding the WOMAC Physical Function scores, all groups again started with similar scores at Week 0 (Group A: 2.50±0.688, Group B: 2.70±0.923, Group C: 2.80±0.767). By Week 8, Group A maintained its initial score (2.50±0.688), Group B showed improvement (2.10±0.967), and Group C's score remained relatively high (2.70±0.801). At the end of the study period (Week 16), Group A had a minor improvement (2.30±0.801), Group B showed the most significant improvement (1.50±1.147), and Group C also improved slightly (2.40±0.820). The results suggest that the combination of wedge and exercises (Group B) was most effective in improving physical function in knee OA patients.

Table 3 WOMAC Physical Function Scores

Timepoint	Group	Mean ± SD	P-value
Week 0	A	2.50±0.688	0.48
	B	2.70±0.923	
	C	2.80±0.767	

Journal of Health and Rehabilitation Research 2791-156X JHRR

Timepoint	Group	Mean ± SD	P-value
Week 8	A	2.50±0.688	0.07
	B	2.10±0.967	
	C	2.70±0.801	
Week 16	A	2.30±0.801	0.00
	B	1.50±1.147	
	C	2.40±0.820	

The Pain- Numeric Rating Scale scores initially were quite similar across all groups at Week 0 (Group A: 2.70±0.923, Group B: 2.50±0.945, Group C: 2.60±0.680). By Week 8, Group A's score slightly decreased (2.60±0.940), Group B showed a more substantial decrease (1.80±1.196), and Group C had a minor reduction (2.30±1.031). By Week 16, all groups demonstrated a decrease in pain, with Group A at 2.30±1.031, Group B showing the most significant reduction to 1.40±1.231, and Group C at 2.20±0.767.

Table 4 Pain- Numeric Rating Scale Scores

Timepoint	Group	Mean ± SD	P-value
Week 0	A	2.70±0.923	0.76
	B	2.50±0.945	
	C	2.60±0.680	
Week 8	A	2.60±0.940	0.06
	B	1.80±1.196	
	C	2.30±1.031	
Week 16	A	2.30±1.031	0.01
	B	1.40±1.231	
	C	2.20±0.767	

These results indicate that the combination of wedge and exercise was most effective in reducing pain in patients with knee OA.

DISCUSSION

This study aimed to evaluate the effectiveness of lateral shoe wedging combined with quadriceps strengthening exercises in treating medial knee osteoarthritis (OA). The participant demographic of 28.3% male and 71.6% female aligns closely with the gender distribution found in Hsieh RL et al.'s 2016 study (22.2% males and 77% females). Our study's mean age of 56.9 ± 9.77 years is also consistent with the findings of Khan MTI et al., which reported a mean age of 56.5 ± 10 years. Pain, physical function, and stiffness were measured using the Numeric Pain Scale and WOMAC scale, paralleling the methodology employed by Seifeldein et al. in their 2019 study (16).

In our study, the initial pain values at Week 0 ($p=0.76$) were not significantly different, but by Week 16, the change was highly significant ($p=0.01$). These findings resonate with Khan MTI et al.'s study, which observed a notable reduction in pain at the final follow-up. Particularly in Group B of our study, there was a significant reduction in pain at both the 8-week ($p=0.006$) and 16-week ($p=0.00$) follow-ups. This trend is in agreement with Ahmed A et al.'s findings regarding the impact of lateral raise in shoes on knee OA management. Furthermore, Alshahrani and Reddy also supported a favourable relationship between lateral wedges and pain reduction in medial knee OA (17).

While all groups showed an improvement in WOMAC stiffness from Week 0 to Week 16, these changes were not statistically significant ($p>0.05$). However, Group B exhibited a significant improvement, echoing the patterns observed in studies by Moznuzzaman et al (18). A study by Rafaqat et al. also reported similar findings, indicating significant improvements in WOMAC physical function and pain subscales over six months, but not in knee stiffness (18, 19).

The WOMAC physical function subscale in our study demonstrated significant improvement at the 16-week follow-up ($p=0.00$) across groups, with Group B showing a notable improvement at all measured time points. These results align with previous studies, reinforcing the notion that biomechanical interventions, including foot orthoses and exercises, are effective in reducing symptoms of medial knee OA (20).

Lithgow 2020 study meta-analysis both emphasize the importance of conservative rehabilitation strategies, including gait retraining, footwear, insoles, and exercise, in reducing knee loading and improving pain and function in knee OA patients (21).

Journal of Health and Rehabilitation Research 2791-156X JHRR

Given these findings, it is recommended that future studies expand to other hospitals with larger sample sizes to explore the broader applicability of these interventions. Cohort studies would be valuable to assess the impact of lateral wedges with isometric exercises on structural deformity improvement and to understand why some patients do not respond to treatment. Further investigation into the characteristics that mediate the effects of wedges is also needed (22).

CONCLUSION

In conclusion, our study indicates that among the groups studied, the one receiving lateral shoe wedges in conjunction with quadriceps strengthening exercises (Group B) showed the most significant improvement in managing medial knee osteoarthritis. This was evidenced by the relief in pain and improvement in daily functional abilities. The results suggest that combining biomechanical interventions with exercise regimens could be a pivotal approach in treating medial knee OA effectively.

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Journal of Health and Rehabilitation Research 2791-156X JHRR

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