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ORIGINAL ARTICLE

Biomechanical Correction by Lateral Wedge Outsole in Osteoarthritis Knee Joint

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ABSTRACT

Background: Osteoarthritis (OA) Knee is one of the leading causes of pain and functional disability among painful joint conditions in adults. The overall prevalence of OA in India has been estimated to be around 28.7% which has been calculated based on data from five Indian states. Worldwide the prevalence of OA is estimated to be around 9.6% in men and 18% in women aged over 60 years. Nearly, 45% of women over the age of 65-years have symptoms while radiological evidence is found in 70% of them. OA of knee joint is diagnosed using American College of Rheumatology Criteria (ACR).

Lateral wedges reduce the peak knee adduction moment and are advocated for knee osteoarthritis. However, some patients demonstrate adverse biomechanical effects with treatment. Clinical management is hampered by lack of knowledge about their mechanism of effect. We evaluated effects of lateral wedges on frontal plane biomechanics, in order to elucidate mechanisms of effect.

Materials and Methods: This prospective observational study was conducted on 80 patients between 40-65 years of age, 56 were females and 24 males. With grade II & grade III osteoarthritis according to Kallgren-Lawrence grading scale, who reported to OPD of PMR Department of MGMCH, Jaipur from April 2022 to September 2024.

- Diagnosis of knee osteoarthritis was established clinically based on ACR criteria.
- Pain was recorded on Visual Analogue Scale (VAS) and quality of life by SF-36.
- History, clinical examination and X-rays were taken in all patients.
- Biomechanical correction was given by using ¼ inches lateral wedge outsole in the footwear.
- Follow up was conducted on monthly bases from 1 ½ months and on 6 months for evaluation of results. Patients improved symptomatically with pain and in quality of life.

Results: The mean age of the patients included was 52-years. All our patients presented with chronic pain in the knees and stiffness. The mean duration of symptoms at the time of presentation was 8-years. All of our patients had bilateral involvement of the knees showing medial joint space narrowing in radiographs. 56/80 patients were females, mostly housewives, and 24/80 were males with a history of prolonged standing at workplace. The mean weight of the patients was 60 ± 10 kg. The majority of our patients (50/80) were overweight having a BMI between 25 and 30 kg/m^2, (18/80) were obese, and (12/80) had a BMI < 25kg/m^2.

Conclusion: Use of lateral wedge outsoles signifies the redistribution of pressure and change in the ground reaction forces after shoe modification. Hence, lateral wedging provides symptomatic benefits in the mild and moderate OA knee.

Keywords: Osteoarthritis, Knee pain, Lateral wedge, KL grading, Visual Analog Scale, SF-36.

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INTRODUCTION

With increasing life expectancy, age-related diseases such as osteoarthritis (OA) have become a significant public health concern. Knee OA, in particular, is a leading cause of chronic pain and functional disability among older adults. The overall prevalence of knee OA in India is estimated at 28.7%, based on data from five states,[1,2] while globally, it affects approximately 9.6% of men, and 18% of women over the age of 60.

The knee is the most commonly affected joint, followed by the hip and other weight-bearing joints.[3] OA is typically classified as either primary (idiopathic) or secondary (resulting from trauma, deformities, or other conditions).

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Risk factors include advancing age, joint misalignment, repetitive stress, obesity, and prior injury. [4] The condition progresses through cartilage degradation, subchondral bone remodelling, osteophyte formation, and synovial inflammation, resulting in joint pain, stiffness, instability, and reduced mobility.[5]

From a biomechanical perspective, OA arises when mechanical stresses exceed the cartilage's ability to resist them, often due to poor joint alignment or weakened cartilage. The viscoelastic nature of cartilage, its ability to absorb shock, and its role in load distribution are central to joint function. Malalignment—such as varus (bow-legged) deformities—can exacerbate medial compartment loading, accelerating OA progression.[6]

Management of knee OA focuses on alleviating pain, improving joint function, and slowing disease progression. A stepped-care approach is commonly recommended, beginning with non-pharmacological strategies such as education, exercise therapy, weight management, and biomechanical interventions. Pharmacological options include acetaminophen, NSAIDs, and supplements like glucosamine. Orthotic devices, such as lateral wedge insoles, can redistribute joint loads and have shown potential in reducing pain and improving function.[7]

Despite their clinical promise, biomechanical interventions remain underexplored in the Indian context. This study aims to assess the efficacy of lateral wedge footwear as an affordable, non-invasive treatment for knee OA. It also seeks to promote preventive strategies and lifestyle modifications, particularly for patients who have limited access to advanced medical treatments.

Epidemiology

Osteoarthritis is the second most common rheumatologic problem and it is most frequent joint disease. Worldwide, the prevalence of OA is estimated to be around 9.6% in men, and 18% in women aged over 60-years of age, and 4 out of every 5 will have limitations in movement and 1/4 out of these will have issues performing their major daily activities.[6] It is estimated that over 14 million people are having symptomatic OA and 7 million among this group are having advanced OA.[2] Nearly, 45% of women over the age of 65-years have symptoms while radiological evidence is found in 70% of those over 65-years. OA was estimated to be the 10th leading cause of nonfatal burden. Two randomized controlled trials demonstrated that the use of lateral wedging in shoes can decrease patient consumption of oral analgesics in medial KOA at 6 months and 2-years.[1] One study included patients in the age group 50 ± 10 years, and a slight female predominance was observed with 50 out of 70 patients being females.

AIMS: Aim of this study is to analysis the beneficial effect of biomechanical correction in the management of KOA.

OBJECTIVES

- To compare the X-ray findings pre and post biomechanical correction.
- To assess pain severity changes in VAS and quality of life by SF-36.
- To delay the progression of the KOA.

MATERIALS AND METHODS

This prospective pre-post observational study was conducted at the Department of Physical Medicine and Rehabilitation, Mahatma Gandhi Medical College and Hospital, Jaipur, over 18 months. We included 80 patients aged 40–65 years with knee osteoarthritis (KOA), diagnosed according to the ACR criteria and classified as grade II or III on the Kellgren-Lawrence (K-L) scale. Patients able and willing to provide informed consent were included, while those with secondary knee OA due to trauma, systemic illnesses, or prior surgeries were excluded.

Patients underwent baseline assessments, including X-rays, Visual Analog Scale (VAS) pain scores, and Short Form-36 (SF-36) for quality of life. All participants were given ¼ inch lateral wedge outsoles, modified into their existing footwear to minimize discomfort and costs. In addition, a home exercise program focusing on quadriceps, abdominal, and gluteal strengthening, along with calf, hamstring, and hip adductor stretches, was prescribed twice daily for the duration of the study.

Statistical Analysis

Data will be entered in Microsoft Office Excel worksheet. Appropriate statistical tests will be used to find significant association. *p-value* < 0.05 will be considered statistically significant.

RESULTS

This was an observational cross-sectional study conducted in the out-patient department of Physical Medicine and Rehabilitation of Mahatma Gandhi Hospital, Jaipur, for duration of 18 months. A total number of patients were screened for study, 80 patients satisfying the inclusion

criteria were enrolled into the study after written informed consent and rest were excluded from the study. Following observations were made in the study.

Demographic Data

Age Distribution

In our study age of the patients ranged from 45–65 years. Out of the 80 enrolled patients most of them fall in the age group of 45–50 years. The mean age of the patients was 52-years as shown in table 1.

Gender distribution

In our study, 80 subjects (70 %) were females and (30 %) were males as shown in table 2 and figure 2.

Table 1: Age Distribution.

Age group	No. of subjects
45–50	30
51–55	17
55–60	14
60–65	18

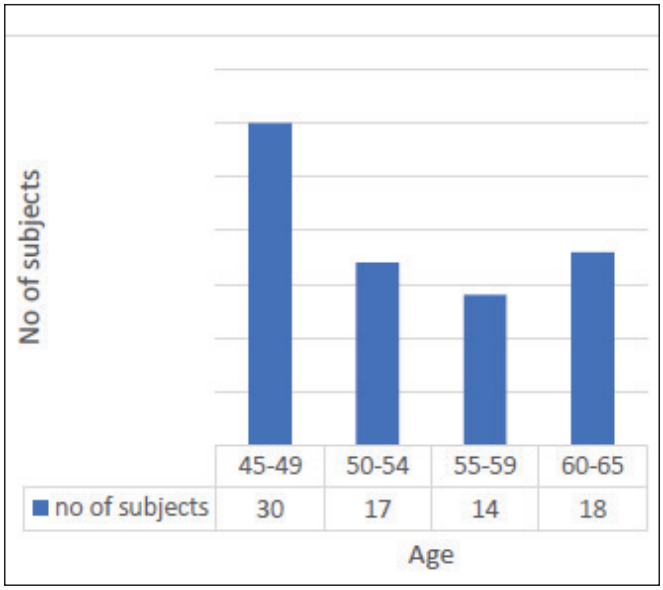

Figure 1: Age Distribution.

Table 2: Gender distribution.

Gender	Frequency	Percent (%)
Female	56	70%
Male	24	30%
Total	80	100%

Distribution of Level of Education

In our study of the subjects 44 (55%) were illiterate and 23 (28.75%) are educated up to primary class as shown in table 3 and figure 3.

Duration of Disease

Among the 80 patients, 22 patients were having disease duration between 2-5 years, 34 patients with disease duration between 5-10 years, and 11 patients with disease duration between 10-15 years, and 13 patients were having disease duration between 15-20 years. The mean duration of illness found in our study is 8-years, as shown in table 4.1, 4.2 and figure 4.

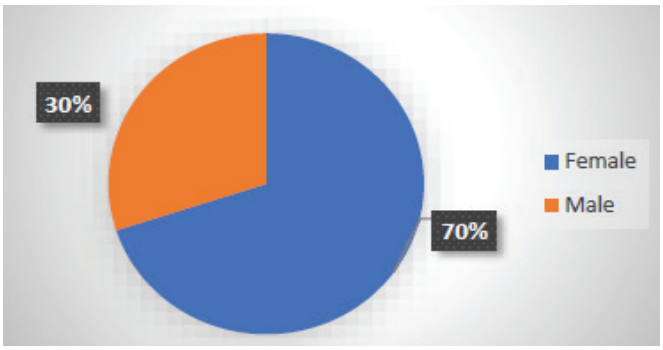

Figure 2: Gender distribution.

Table 3: Level of education.

Level of education	Frequency	Percent (%)
Illiterate	44	55%
Inter	9	11.25%
Middle	4	5%
Primary	23	28.75%
Total	80	100%

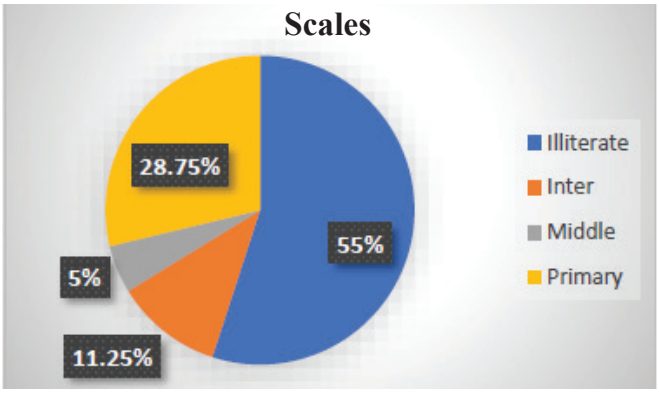

Figure 3: Level of education.

Body Mass Index (kg/m^2) of study Patients

In our study, subjects around 5 (6.25%) were having BMI > 30, 40 (50%) were having BMI between 25–30 and 36 (45%) were having BMI below 25, majority being females. Shown in table 5 and figure 5.

Table 4.1: Showing mean duration of disease.

	Minimum	Maximum	Mean	Std. Deviation
Duration	2	18	8.0375	4.484

Table 4.2: Total duration of disease.

Duration in yrs	2–5 years	5–10 years	10–15 years	15–20 years
No of patients	22	34	11	13

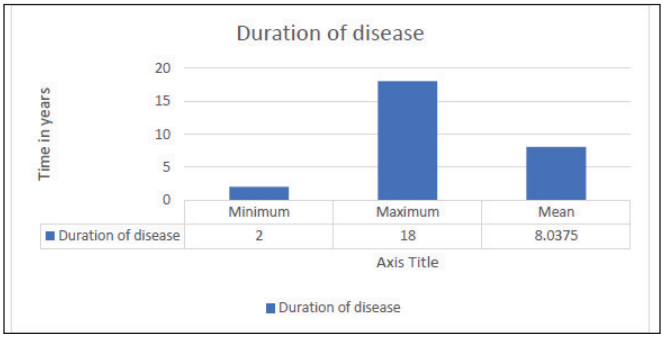

Figure 4: Duration of disease.

Table 5: BMI of Patients.

BMI (Kg/m^2)	Class	No. of patients
20–25	Normal	12
25–30	Overweight	50
>30	Class I obesity	18

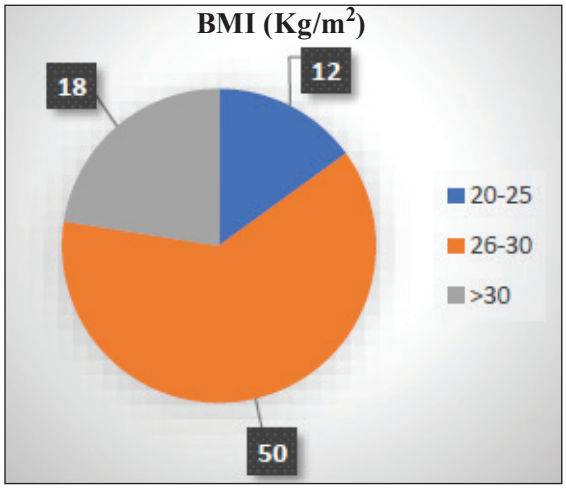

Figure 5: BMI of patients.

KL Grading Radilogically

In our study, most of the subjects around 61 (76%) were having grade II and 19 (24%) were having grade III on KL grading scale shown in table 6 and figure 6.

Disease Severity

Disease severity was assessed in terms of VAS and quality of life by Short Form (SF)-36 are shown in table 7 and figure 7 & 8.

Pain Measurement on Analog Scale

All patients reported some degree of relief in pain with the treatment. VAS after 3-months of treatment, the mean score on VAS for pain which was initially 5.5 reduced

Table 6: KL grading.

KL grading	No of patients	Percent (%)
Grade II	61	76.25
Grade III	19	23.75
Total	80	100%

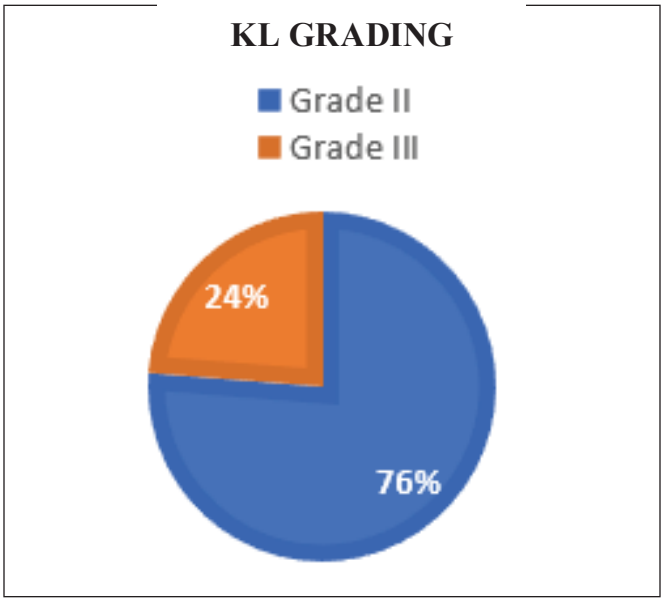

Figure 6: KL Grading.

Table 7: VAS and SF-36.

Score	Day 0 Mean	6 weeks Mean	3-months Mean	Std. Deviation
VAS	5.5	2.32	1.4	2.16
SF-36	101.3	54.17	44.28	24.65

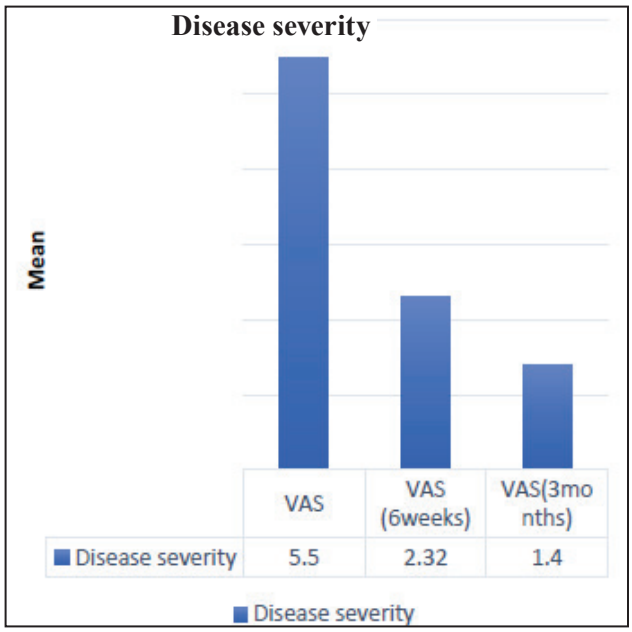

Figure 7: VAS, 6 weeks and 3-months follow up.

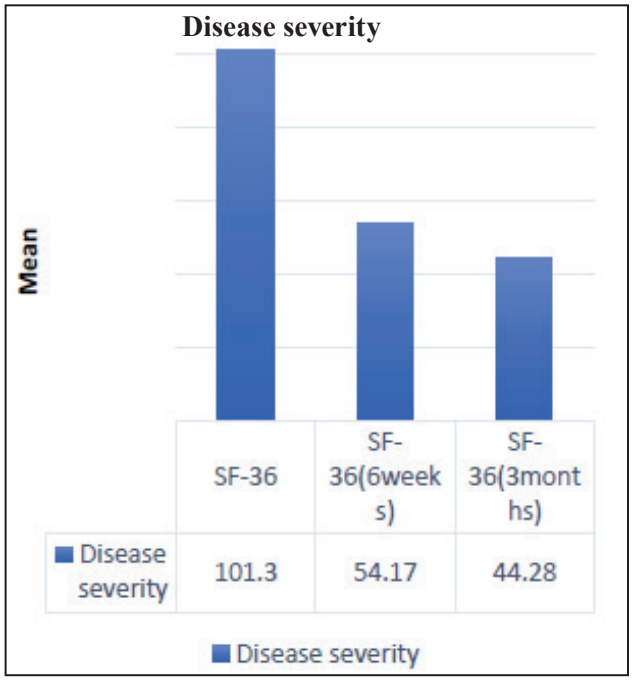

Figure 8: SF-36 ,6 weeks and 3-months of follow up.

to 1.4 which was statistically significant with *p-value* < 0.001.

DISCUSSION

Osteoarthritis (OA), also known as degenerative joint disease, is the most common musculoskeletal condition and a leading cause of disability in the elderly. It is characterized by the progressive degeneration of articular cartilage, subchondral bone sclerosis, osteophyte formation, and joint deformity. The prevalence of OA increases with age, while numerous studies have assessed the clinical effects of laterally wedged outsoles, few have objectively evaluated their impact using both pain (VAS) and quality of life (SF-36) measures.

In our study, the majority of participants (30%) were aged 45–50, with a mean age of 52 years. Women constituted 70% of the sample, aligning with findings from Somya Saxena *et al.*[8], who also reported a female predominance. However, our gender distribution contrasts with G. J. Chapman *et al.*[9], where most participants were male. A large proportion of patients (62.5%) were overweight (BMI > 25), and 22.5% were obese—consistent with obesity as a risk factor for knee OA (KOA).

Most participants (76.25%) had grade II KOA per Kellgren-Lawrence (KL) criteria, comparable to findings by Richard K. Jones *et al.*[10] and Somya Saxena *et al.*[8] Additionally, 55% of the study population was illiterate, and 28.75% had only primary education, suggesting a higher prevalence among the less educated, consistent with Venkatachalam J *et al.*[11] The average disease duration was 8-years, with 34 patients experiencing symptoms for 5–10 years.

Over half the patients presented with genu varus, which is associated with KOA progression. This malalignment increases medial knee loading and may amplify the effect of obesity. Lateral-wedged outsoles reduce this varus alignment by promoting ankle pronation, thereby offloading the medial compartment.

In our intervention, all patients received lateral-wedged footwear, as recommended by the American College of Rheumatology and OARSI. Previous randomized controlled trials have shown reduced analgesic use in KOA patients after 3-months of using wedged footwear. Although long-term effects remain unclear—especially in those with foot issues or advanced KOA—wedged outsoles are a simple, cost-effective conservative treatment option.

Our study demonstrated significant improvement in pain and quality of life. VAS scores decreased from 5.5 (moderate) to 2.32 at 6 weeks and 1.4 at 3 months. SF-36 scores improved from 101.3 to 54.17 and then to 44.28. These findings are supported by earlier research from Ahlbäck *et al.*[12] and Ivan Luis Andrade Araujo *et al.,*[13] indicating improved function and independence in KOA patients.

L. Sharma *et al.*[14] also highlighted that disease severity and deformity increase with radiological progression. We observed a shift in pressure distribution from the medial to the lateral foot in most patients' post-intervention. However, not all patients exhibited this change, and the shifts were not statistically significant—possibly due to limited transmission of the wedge effect or individual gait adaptation. These shifts may reflect changes in the center of pressure after using laterally wedged footwear.

CONCLUSION

Osteoarthritis (OA) is a prevalent chronic disease, affecting 10% of individuals over 50–60 years, leading to joint pain and disability. Poor lower limb biomechanics, often due to anatomical deformities, are key risk factors for knee OA. In our study, 30% of patients were aged 45–50, 70% were female, 55% were illiterate, 62.5% had a BMI >25, and 22.5% were obese. Most (76.25%) had grade II OA based on KL grading, with an average illness duration of 8-years.

Baseline VAS pain score was 5.5 (moderate), and SF-36 quality of life score was 101.3. Post-intervention with lateral wedge shoe modifications, VAS scores improved to 2.32 at 6 weeks and 1.4 at 3 months; SF-36 scores improved to 54.17 and 44.28, respectively. Pressure redistribution and altered ground reaction forces from lateral wedges showed statistically significant improvements in pain and quality of life. Thus, lateral wedging in footwear provides effective symptomatic relief in knee OA.

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