RESEARCH PAPER

Effects of Extracorporeal Shock Wave Therapy in Primary Knee Osteoarthritis: A Prospective Observational Study

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Abstract

Background: Knee osteoarthritis (KOA) is a leading cause of chronic musculoskeletal pain and functional disability worldwide. Conventional therapies often provide limited long-term relief, prompting exploration of non-invasive modalities such as extracorporeal shock wave therapy (ESWT).The objective of study is to evaluate the effectiveness of ESWT in reducing pain and improving functional outcomes in patients with primary knee osteoarthritis.

Methods: A hospital-based prospective observational study was conducted in the Department of Physical Medicine and Rehabilitation, Mahatma Gandhi Medical College and Hospital, Jaipur. Eighty patients aged 40–65 years with Kellgren–Lawrence grade II–III primary KOA received four weekly ESWT sessions (2000 pulses, 0.25 mJ/mm², 6 Hz). Pain severity was assessed using the Visual Analogue Scale (VAS) and Numerical Pain Rating Scale (NPRS), while functional outcomes were measured using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). Baseline scores were compared with follow-up values at 4 weeks and 3 months.

Results: Mean VAS score decreased from 6.10 ± 1.80 at baseline to 2.70 ± 1.36 at 3 months ($p < 0.001$). NPRS scores showed a significant reduction from 6.20 ± 1.73 to 2.82 ± 1.44 ($p < 0.001$). WOMAC total scores improved from 63.89 ± 17.56 to 31.90 ± 15.22 at 3 months ($p < 0.001$). More than 90% of patients achieved ≥30% improvement in pain and functional scores.

Conclusion: ESWT significantly reduces pain and improves functional outcomes in patients with mild-to-moderate knee osteoarthritis. The therapy represents a safe and effective non-invasive option in conservative management of KOA.

Keywords: Knee osteoarthritis, extracorporeal shock wave therapy, WOMAC, VAS, NPRS, rehabilitation

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Introduction

Osteoarthritis (OA) is the most prevalent degenerative joint disorder and represents a major cause of pain and disability worldwide. Among the affected joints, the knee is particularly vulnerable due to its weight-bearing function and complex biomechanical structure [1,2]. Epidemiological studies indicate that nearly half of individuals over the age of 60 demonstrate radiographic evidence of knee osteoarthritis (KOA), and the prevalence continues to rise with increasing life expectancy, sedentary lifestyle, and obesity [3].

The pathophysiology of KOA is multifactorial and involves degeneration of articular cartilage, remodeling of subchondral bone, synovial inflammation, and periarticular muscle weakness. Mechanical stress and inflammatory mediators stimulate matrix metalloproteinases and cytokines that degrade cartilage and disrupt joint homeostasis [4–6]. Clinically, patients present with progressive

knee pain, stiffness after inactivity, reduced range of motion, crepitus, and impaired physical function [7].

Management strategies aim to relieve pain, maintain joint mobility, and improve quality of life. Conventional treatments include lifestyle modification, physiotherapy, pharmacologic agents such as non-steroidal anti-inflammatory drugs, and intra-articular injections [8,9]. However, these therapies may provide only temporary relief and are associated with adverse effects, particularly in elderly patients with multiple comorbidities.

Extracorporeal shock wave therapy (ESWT) has recently emerged as a promising non-invasive modality in musculoskeletal rehabilitation. ESWT delivers high-energy acoustic waves to targeted tissues, producing mechanical and biological effects that promote tissue regeneration, reduce inflammation, and modulate pain transmission [10]. Experimental and clinical studies have demonstrated that ESWT stimulates angiogenesis, enhances subchondral bone remodeling, and reduces inflammatory cytokines within the osteoarthritic joint [11–13].

Despite encouraging results, there remains limited prospective clinical data from the Indian population evaluating ESWT in primary KOA. The present study was therefore conducted to assess the effectiveness of ESWT in reducing pain and improving functional outcomes in patients with knee osteoarthritis.

Methodology

Study Design and Setting

A prospective observational study was conducted in the Department of Physical Medicine and Rehabilitation at Mahatma Gandhi Medical College and Hospital, Jaipur, over an 18-month period from April 2024 to September 2025.

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Study Population

Eighty patients diagnosed with primary knee osteoarthritis attending the outpatient department were included.

Inclusion Criteria

- Age between 40–65 years
- Primary knee osteoarthritis
- Radiographic Kellgren–Lawrence grade II or III
- Presence of knee pain or joint line tenderness
- Willingness to participate with informed consent

Exclusion Criteria

- Secondary osteoarthritis
- Previous knee surgery
- Intra-articular injections within the previous six months
- Severe osteoarthritis (K-L grade IV)
- Systemic inflammatory joint disease
- Inability to ambulate independently

Intervention

All participants received extracorporeal shock wave therapy (ESWT) using a shockwave therapy device.

Treatment protocol:

- Four sessions
- One session per week
- 2000 pulses per session
- Energy flux density: 0.25 mJ/mm²
- Frequency: 6 Hz

Shock waves were applied to the most tender medial joint line area with the knee flexed to approximately 90°.

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Outcome Measures

Pain and functional outcomes were assessed using validated clinical scales:

1. Visual Analogue Scale (VAS) – pain intensity (0–10)
2. Numerical Pain Rating Scale (NPRS)
3. Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)

Assessments were performed at:

- Baseline
- 4 weeks
- 3 months

Statistical Analysis

Data were analyzed using Microsoft Excel. Continuous variables were expressed as mean ±

standard deviation, while categorical variables were expressed as percentages. Pre- and post-treatment outcomes were compared using paired t-test and Wilcoxon signed-rank test. A p-value <0.05 was considered statistically significant.

Results

A total of 80 patients with primary knee osteoarthritis were included in the study. The demographic and clinical characteristics are summarized below.

Table 1: Demographic Characteristics of Participants

Variable	Value
Total patients	80
Mean age	53.82 ± 5.80 years
Female	54 (67.5%)
Male	26 (32.5%)
Mean BMI	29.10 ± 5.20 kg/m²
Overweight	34 (42.5%)
Obese	32 (40%)

Middle-aged individuals with overweight or obesity constituted the majority of the study population.

Table 2: Baseline Clinical Characteristics

Clinical Feature	Frequency (%)
Pain	100%
Tenderness	90%
Swelling	47.5%
Restricted movement	41.3%
Morning stiffness <15 min	65%
Bilateral involvement	66.2%

Pain was the predominant presenting symptom among all patien

Table 3: Changes in VAS Scores

Time Point	Mean ± SD	Mean Change	p-value
Baseline	6.10 ± 1.80	—	—
4 weeks	3.25 ± 1.48	−2.85	<0.001
3 months	2.70 ± 1.36	−3.40	<0.001

A significant reduction in pain intensity was observed over time.

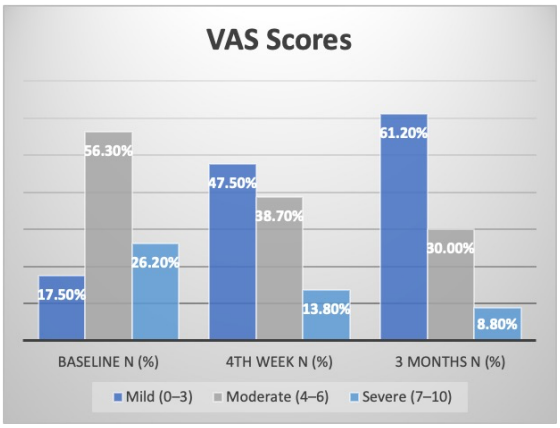

Table 4: NPRS Scores Pre- and Post-Treatment

Parameter	Pre-Treatment	Post-Treatment	Mean Change	p-value
NPRS score	6.20 ± 1.73	2.82 ± 1.44	−3.38 ± 1.21	<0.001

More than 92% of patients achieved ≥30% improvement in pain scores.

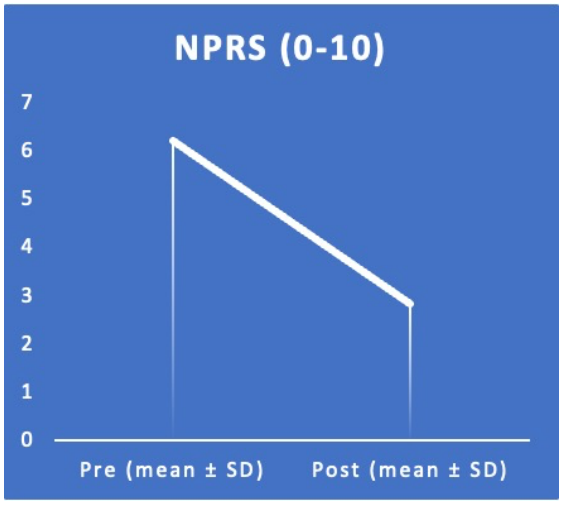

Table 5: WOMAC Score Improvement

Time Point	Mean ± SD	Mean Change	p-value
Baseline	63.89 ± 17.56	—	—
4 weeks	39.40 ± 15.85	−24.49	<0.001
3 months	31.90 ± 15.22	−32.00	<0.001

Functional ability improved significantly after ESWT.

Table 6: Treatment Response (≥30% Improvement)

Outcome	4 Weeks	3 Months
VAS improvement	86.2%	92.5%
NPRS improvement	88.8%	91.2%
WOMAC improvement	82.5%	90%

A large majority of patients demonstrated clinically meaningful improvement.

Discussion

The present prospective study evaluated the clinical effectiveness of extracorporeal shock wave therapy in patients with primary knee osteoarthritis and demonstrated significant improvements in pain and functional outcomes over a three-month follow-up period.

The demographic profile of the study population revealed a mean age of 53.82 years, with a predominance of female patients. This finding aligns with epidemiological observations indicating that knee osteoarthritis is more common in middle-aged and elderly women due to hormonal changes and biomechanical factors affecting joint stability [14]. Similarly, several ESWT trials have reported a female predominance ranging from 60–75% [15].

A large proportion of participants in the present study were overweight or obese. Increased body weight is a well-recognized risk factor for osteoarthritis because of increased mechanical load on the knee joint and associated metabolic inflammation [16]. Previous studies evaluating ESWT in osteoarthritis have reported comparable BMI distributions among participants, suggesting that obesity is frequently encountered in clinical cohorts undergoing shock wave therapy [17].

Pain reduction was the primary outcome of the study. The mean VAS score decreased significantly from 6.10 at baseline to 2.70 at three months, indicating a reduction of approximately 56%. This magnitude of improvement is comparable with findings reported by Zhao et al., who observed significant pain reduction following four sessions of ESWT in patients with knee osteoarthritis [18]. Similarly, Kim et al. demonstrated dose-dependent reductions in pain intensity after shockwave therapy, emphasizing the therapeutic relevance of energy flux density in achieving optimal clinical outcomes [19].

The Numeric Pain Rating Scale also demonstrated a marked reduction following therapy, with more than 90% of participants achieving clinically meaningful improvement. These results are consistent with meta-analyses showing that ESWT significantly reduces pain scores compared with placebo and conventional physiotherapy [20]. The analgesic effect of ESWT is thought to occur through multiple mechanisms including modulation of nociceptor activity, reduction of substance P, and suppression of inflammatory mediators within periarticular tissues [21].

Functional improvement, as measured by the WOMAC index, was another key outcome of the study. The mean WOMAC score decreased from 63.89 at baseline to 31.90 at three months, reflecting significant improvements in pain, stiffness, and physical function. Similar findings have been reported in systematic reviews demonstrating that ESWT significantly improves WOMAC scores and joint mobility in patients with mild to moderate osteoarthritis [22].

The biological effects of ESWT extend beyond pain modulation. Shock waves stimulate angiogenesis, increase local blood circulation, and promote tissue regeneration through activation of mechanotransduction pathways [23]. Experimental studies have demonstrated that ESWT enhances chondrocyte proliferation and improves subchondral bone remodeling, thereby contributing to joint repair and improved biomechanics [24].

Responder analysis in the present study showed that more than 90% of patients experienced clinically meaningful improvement in pain and function. These findings support previous evidence suggesting that ESWT is particularly effective in early stages of osteoarthritis before irreversible cartilage destruction occurs [25].

Overall, the results of this study reinforce the role of ESWT as a safe, non-invasive modality in the conservative management of knee osteoarthritis. The therapy may be particularly beneficial for

patients who are not candidates for surgery or who wish to delay invasive procedures.

Conclusion

Extracorporeal shock wave therapy significantly reduces pain and improves functional outcomes in patients with primary knee osteoarthritis. The treatment demonstrated substantial improvements in VAS, NPRS, and WOMAC scores within three months of therapy.

ESWT represents a safe, non-invasive, and effective adjunct in the conservative management of mild to moderate knee osteoarthritis. Early application of this modality may help reduce pain, improve mobility, and delay the need for surgical intervention.

Further randomized controlled trials with larger sample sizes and longer follow-up periods are recommended to establish standardized treatment protocols and evaluate long-term benefits.

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