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Multimodal Physiotherapy Improves Knee Osteoarthritis Outcomes: A Case Report

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Abstract

Background: Knee osteoarthritis is a degenerative joint disorder characterized by progressive cartilage degradation, pain, and functional limitations. Multimodal physiotherapy is widely applied; however, evidence on short-term integrated interventions in real-world settings remains limited.

Objective: To evaluate the effects of a short-term multimodal physiotherapy intervention on pain, range of motion (ROM), muscle strength, and functional ability in a patient with knee osteoarthritis.

Methods: A single-case experimental study with an AB design was conducted in a 68-year-old female with right knee osteoarthritis. The intervention included Transcutaneous Electrical Nerve Stimulation (TENS), ultrasound therapy, and quadriceps–hamstring strengthening exercises administered over three sessions. Outcomes were measured using the Numeric Pain Rating Scale (NPRS), goniometric ROM, Manual Muscle Testing (MMT), and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). Data were analyzed descriptively based on trend changes.

Results: Clinically meaningful improvements were observed. NPRS scores decreased for rest pain (5–1), movement pain (6–3), and pressure pain (6–2), exceeding the minimal clinically important difference. Active ROM improved from 115° to 130%, and passive ROM from 130° to 135°. Muscle strength increased from MMT grade 4 to 5. WOMAC scores decreased from 32 to 22, indicating improved functional ability.

Conclusion: A short-term multimodal physiotherapy intervention may yield clinically meaningful improvements in pain, mobility, muscle strength, and function in knee osteoarthritis. Findings are limited to descriptive evidence from a single case.

Keywords
Osteoarthritis, Knee; Exercise Therapy; Transcutaneous Electrical Nerve Stimulation; Ultrasonic Therapy; Rehabilitation

Introduction

Knee osteoarthritis (OA) is a progressive degenerative disorder of synovial joints characterized by articular cartilage degradation, subchondral bone remodeling, osteophyte formation, and varying degrees of synovial inflammation, ultimately leading to pain and functional impairment.[1] Globally, osteoarthritis affects more than 528 million individuals, with the knee joint being the most commonly involved site, accounting for approximately 365 million cases.[2] The burden of knee OA increases substantially with age and represents one of the leading causes of disability among older adults, significantly reducing quality of life and independence.[3,4]

In addition to aging, several modifiable and non-modifiable risk factors contribute to the development and progression of knee OA. Obesity has been consistently identified as a major risk factor, with a substantially increased likelihood of disease onset due to both mechanical loading and metabolic factors.[5] Furthermore, sex-related differences have been reported, with a higher prevalence observed in women, particularly after menopause, which may be associated with hormonal changes, genetic predisposition, and altered cartilage metabolism.[6] Clinically, knee OA is characterized by joint pain exacerbated by activity, stiffness after periods of inactivity, reduced range of motion, and functional limitations in daily activities.[3]

Given the absence of curative treatment, current management strategies focus on symptom control and functional improvement. Physiotherapy plays a central role in conservative management, particularly through multimodal approaches that combine therapeutic modalities and exercise interventions.[7] Transcutaneous Electrical Nerve Stimulation (TENS) has been widely used as an adjunctive modality to reduce pain through mechanisms involving gate control and endogenous opioid release, thereby facilitating participation in therapeutic exercise.[8] Ultrasound therapy has also been proposed to exert both thermal and non-thermal effects, potentially enhancing tissue healing, modulating inflammation, and improving joint mobility.[9] In parallel, strengthening exercises targeting the quadriceps and hamstring muscles have demonstrated effectiveness in improving muscle function, reducing pain, and enhancing functional performance in patients with knee OA.[10]

Although the effectiveness of these interventions has been demonstrated individually, evidence regarding their combined application within a single integrated physiotherapy protocol remains limited. In particular, there is a lack of studies examining short-term multimodal interventions implemented in real-world clinical settings, where treatment duration is often constrained and individualized.[3,8] Recent studies have begun to explore multimodal rehabilitation strategies; however, most investigations focus on longer intervention periods or controlled experimental conditions, limiting their direct applicability to routine clinical practice.[4,8]

Therefore, this case report addresses a specific gap in the literature by evaluating the short-term effects of a multimodal physiotherapy program combining TENS, ultrasound therapy, and strengthening exercises within a real-world clinical context. This study provides practical clinical insight into the feasibility and potential effectiveness of a brief, integrated intervention in improving pain, joint mobility, muscle strength, and functional ability in patients with knee osteoarthritis.

Methods

This study employed a single-case experimental design using an AB format to evaluate the effects of a multimodal physiotherapy intervention on clinical outcomes in a patient with knee osteoarthritis. The AB design consists of a baseline phase (A) followed by an intervention phase (B), allowing within-subject comparison over time. This design is appropriate for exploratory clinical evaluation in real-world settings, particularly when individualized responses are assessed.

The study was conducted at Indriati Hospital Solo Baru, Indonesia, in September 2025. Written informed consent was obtained from the patient prior to participation and publication. As a case report, formal ethical approval was not required according to institutional regulations. The study adhered to ethical principles, including patient confidentiality and voluntary participation.

The subject was a 68-year-old female diagnosed with right knee osteoarthritis based on clinical and radiographic findings. The patient reported chronic right knee pain exacerbated by walking and stair negotiation, accompanied by morning stiffness lasting approximately 15 minutes. Symptoms had persisted for approximately three years and progressively worsened. No history of trauma or systemic inflammatory disease was reported. Baseline clinical characteristics of the patient are summarized in Table 1.

Table 1. Baseline Characteristics of the Patient

Variable	Description
Age	68 years
Sex	Female
Diagnosis	Right knee osteoarthritis
Duration of symptoms	Approximately 3 years
Pain characteristics	Mechanical pain, aggravated by activity
Morning stiffness	Approximately 15 minutes
Body Mass Index	24.98 kg/m²
Comorbidities	None reported
Baseline physical activity	Moderate daily household activities (e.g., cooking, cleaning, and occasional walking), limited by knee pain

At baseline, pain intensity measured using the Numeric Pain Rating Scale (NPRS) was 6/10 during movement, 5/10 at rest, and 6/10 on palpation. Active knee range of motion (ROM) was limited to 115° of flexion with full extension (0°), while passive ROM reached 130°. Muscle strength assessed using Manual Muscle Testing (MMT) was graded 4 for both knee flexors and extensors. Functional ability assessed using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) yielded a total score of 32, indicating moderate functional impairment.

The intervention consisted of three physiotherapy sessions administered over a three-week period. Each session included Transcutaneous Electrical Nerve Stimulation (TENS), ultrasound therapy, and strengthening exercises targeting the quadriceps and hamstring muscles. To improve clarity of the intervention protocol, the detailed parameters of each modality are presented in Table 2.

Table 2. Physiotherapy Intervention Protocol

Intervention	Parameters	Rationale
TENS	Frequency: 1–250 Hz (sweep mode); Pulse duration: 80 µs; Duration: 15 minutes; Intensity: strong but comfortable sensation without muscle contraction	Enhances analgesia through gate control and endogenous opioid mechanisms[8]
Ultrasound therapy	Frequency: 1 MHz; Intensity: 0.1 W/cm²; Duration: 10 minutes	Promotes non-thermal effects, including tissue repair and modulation of inflammation[11]
Strengthening exercises	Quadriceps and hamstrings; 3 sets of 10–15 repetitions; progressive loading	Improves neuromuscular activation and muscle strength[10]

The patient was instructed to adhere to the intervention during supervised sessions. No structured home exercise program was prescribed; however, adherence during therapy sessions was reported as good. No adverse events were observed throughout the intervention period. Outcome measures included pain intensity assessed using the Numeric Pain Rating Scale (NPRS), joint range of motion measured with a goniometer, muscle strength evaluated using Manual Muscle Testing (MMT), and functional ability assessed using the WOMAC index. NPRS and WOMAC are widely recognized instruments with established validity and reliability in musculoskeletal conditions, while MMT remains a commonly used clinical tool despite its subjective nature.

Data were analyzed descriptively due to the single-case design. Outcomes were recorded at four time points (T0–T3), and changes were evaluated using visual trend analysis consistent with single-subject research methodology. Percentage improvement was calculated to quantify clinical changes, and results were interpreted based on established minimal clinically important differences (MCID), particularly for NPRS (≥2-point reduction). No inferential statistical analysis was performed.

Results

Clinical outcomes were evaluated at four time points: baseline (T0), after session 1 (T1), after session 2 (T2), and after session 3 (T3). Overall, consistent improvements were observed across all measured outcomes, including pain intensity, joint range of motion (ROM), muscle strength, and functional ability. The clinical timeline of the patient is presented in Table 3.

Table 3. Timeline of Clinical Events

Time	Event	Description
~3 years before treatment	Symptom onset	Gradual onset of right knee pain, progressively worsening
Prior to intervention	Symptom progression	Pain during walking and stair climbing, morning stiffness (~15 minutes)
Day 0	Diagnostic assessment	X-ray confirmed osteoarthritis (joint space narrowing, osteophytes, subchondral sclerosis)
Day 0	Baseline assessment (T0)	NPRS, ROM, MMT, WOMAC recorded
Week 1	Session 1 (T1)	Initiation of TENS, ultrasound, and strengthening exercises
Week 2	Session 2 (T2)	Continued intervention with progression
Week 3	Session 3 (T3)	Continued intervention with clinical improvement
Week 3	Re-evaluation	Outcome reassessment (NPRS, ROM, MMT, WOMAC)

Pain intensity measured using the Numeric Pain Rating Scale (NPRS) showed a consistent reduction across all parameters (Table 4).

Table 4. Pain Intensity (NPRS) Across Time Points

Parameter	T0	T1	T2	T3	Absolute Change	% Improvement
Rest pain	5	4	2	1	−4	80%
Movement pain	6	5	5	3	−3	50%
Pressure pain	6	4	3	2	−4	66.7%

A clinically meaningful reduction in pain was observed, with all parameters exceeding the minimal clinically important difference (MCID ≥2 points). The most notable reduction occurred in rest pain (80%) and pressure pain (66.7%).
Changes in knee joint range of motion are presented in Table 5.

Table 5. Knee Joint Range of Motion (ROM)

Movement	T0	T1	T2	T3	Absolute Change
Passive ROM (°)	0–0–130	0–0–130	0–0–135	0–0–135	+5°
Active ROM (°)	0–0–115	0–0–122	0–0–130	0–0–130	+15°

A progressive improvement in both active and passive ROM was observed. Active ROM increased by 15°, representing a meaningful functional gain, while passive ROM improved by 5° and reached near-normal values.
Muscle strength evaluation using Manual Muscle Testing (MMT) is summarized in Table 6.

Table 6. Muscle Strength (MMT)

Muscle Group	T0	T1	T2	T3
Knee flexors	4	4	4+	5
Knee extensors	4	4	4+	5

Muscle strength improved progressively from grade 4 at baseline to grade 5 at T3 in both muscle groups, indicating restoration to normal strength. Functional ability assessed using the WOMAC index is presented in Table 7.

Table 7. Functional Ability (WOMAC Index)

Parameter	T0	T1	T2	T3	Absolute Change	% Improvement
WOMAC score	32	28	25	22	−10	31.25%
Interpretation	Moderate	Moderate	Moderate	Mild	—	—

A reduction of 10 points in WOMAC score was observed, indicating a clinically meaningful improvement in functional ability, transitioning from moderate to mild impairment. To complement the trend analysis in this single-case design, data visualization was presented using single-subject research (SSR) graphs for pain and functional outcomes. These graphs illustrate longitudinal changes across four assessment points: baseline (T0), after session 1 (T1), after session 2 (T2), and after session 3 (T3). This visual approach facilitates interpretation of clinical changes by highlighting trend direction, slope, and consistency of response to the multimodal physiotherapy intervention.

As shown in Figure 1, the SSR graph for pain demonstrates a progressive reduction in NPRS scores from T0 to T3, indicating a consistent improvement in pain intensity throughout the intervention period. Similarly, as shown in Figure 2, the SSR graph for functional ability reveals a gradual decrease in WOMAC scores, reflecting meaningful improvements in functional performance. The overall pattern observed in both graphs indicates a stable and favorable trend, supporting the descriptive findings presented in the tabulated results.

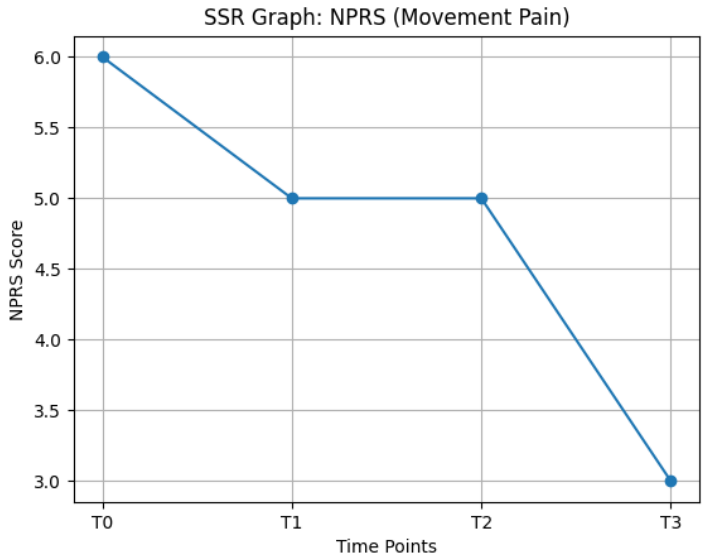

Figure 1. Single-Subject Research (SSR) Graph of Pain Intensity (NPRS) Changes Across T0–T3

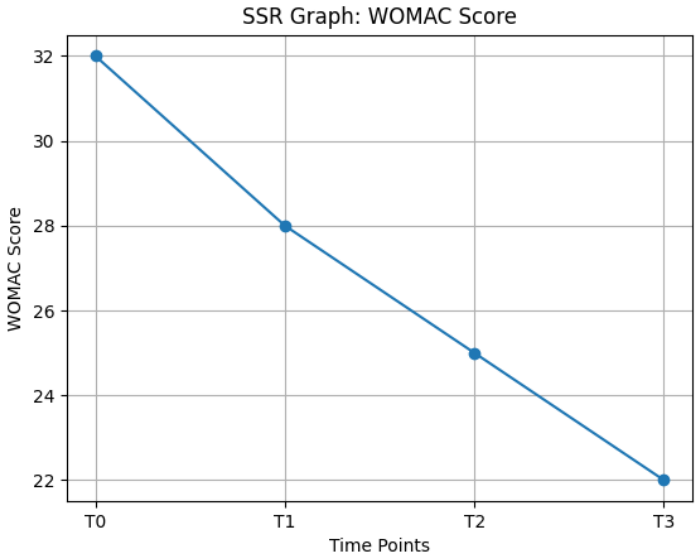

Figure 2. Single-Subject Research (SSR) Graph of Functional Ability (WOMAC) Changes Across T0–T3

Overall, trend analysis demonstrated a consistent pattern of improvement across all outcomes over time. The most prominent changes were observed in pain reduction and functional ability, followed by improvements in ROM and muscle strength. The patient also reported subjective improvements, including reduced pain during walking and stair negotiation, decreased morning stiffness, and enhanced ability to perform daily activities. Adherence to the intervention was good, and no adverse events were reported throughout the study period. Given the single-case design, all findings are presented descriptively without inferential statistical analysis.

Discussion

This case report demonstrated that a short-term multimodal physiotherapy intervention resulted in clinically meaningful improvements in pain, joint mobility, muscle strength, and functional ability in a patient with knee osteoarthritis. Notably, reductions in pain intensity exceeded the minimal clinically important difference (MCID ≥2 points), accompanied by measurable gains in ROM and muscle strength, and a transition in WOMAC classification from moderate to mild impairment. These findings support the potential effectiveness of integrated physiotherapy approaches in managing knee OA within a short clinical timeframe.

The observed reduction in pain is consistent with previous studies reporting the analgesic effects of Transcutaneous Electrical Nerve Stimulation (TENS) in patients with knee osteoarthritis. Katagiri et al. demonstrated that TENS combined with exercise significantly reduced pain and improved muscle strength in older adults with early-stage knee OA.[8,12] The analgesic effect of TENS is primarily explained by the gate control theory and the activation of endogenous opioid pathways, which modulate nociceptive transmission at both spinal and supraspinal levels. The reduction in pain observed in this case likely facilitated greater participation in exercise, thereby contributing indirectly to functional improvement.[13]

In addition to TENS, ultrasound therapy may have contributed to pain reduction and improved joint mobility. A recent systematic review and meta-analysis reported that low-intensity pulsed ultrasound can reduce pain and improve physical function in patients with knee osteoarthritis.[11] The underlying mechanisms include enhanced cellular activity, improved microcirculation, and modulation of inflammatory processes through mechanotransduction. In the present case, the improvement in ROM, particularly active ROM, may reflect reduced joint stiffness and increased soft tissue extensibility associated with these physiological effects.[14]

Strengthening exercises targeting the quadriceps and hamstring muscles also played a critical role in improving muscle strength and functional outcomes. Previous randomized controlled trials have demonstrated that structured strengthening programs significantly improve pain, muscle performance, and functional ability in individuals with knee osteoarthritis.[10] Increased muscle strength enhances joint stability, reduces mechanical stress on the knee, and supports more efficient movement patterns during daily activities. The progression from MMT grade 4 to 5 observed in this case suggests meaningful neuromuscular adaptation over a relatively short intervention period.[15]

Importantly, the combined application of TENS, ultrasound therapy, and strengthening exercises may have produced a synergistic effect. Rather than acting independently, these modalities likely interacted to optimize treatment outcomes: TENS reduced pain and enabled active participation, ultrasound improved tissue condition and joint mobility, and strengthening exercises restored muscle function. This multimodal synergy aligns with emerging evidence suggesting that integrated rehabilitation approaches may be more effective than single-modality interventions in managing knee osteoarthritis.[3,8]

From a clinical perspective, the findings of this case have practical implications for outpatient physiotherapy settings. The results suggest that a short-term, three-session multimodal intervention may be sufficient to produce clinically meaningful improvements in selected patients with knee osteoarthritis. This is particularly relevant in real-world clinical environments where treatment duration may be limited by logistical or economic factors. Clinicians may consider implementing a structured multimodal protocol combining analgesic modalities and targeted strengthening exercises to optimize outcomes within a limited timeframe.

However, these findings should be interpreted within the context of the study design. As a single-case report, this study represents a low level of evidence and does not allow for causal inference or generalization to broader populations. The absence of a control condition limits the ability to attribute observed improvements solely to the intervention, as natural recovery or placebo effects cannot be excluded. In addition, the short duration of follow-up precludes assessment of long-term sustainability of the observed benefits.

Several methodological limitations should also be acknowledged. Muscle strength assessment using Manual Muscle Testing (MMT) is inherently subjective and may be susceptible to measurement bias. The lack of detailed quantification of physical activity outside the intervention sessions may also influence outcomes. Furthermore, the absence of objective biomarkers or imaging follow-up limits the ability to assess structural changes associated with the intervention.

Future research should aim to validate these findings through well-designed randomized controlled trials with larger sample sizes and longer follow-up periods. Comparative studies evaluating multimodal versus single-modality interventions would be particularly valuable in clarifying the added benefit of integrated approaches. Additionally, the inclusion of objective outcome measures and standardized reporting frameworks would enhance the robustness and reproducibility of findings in this field. Overall, this case provides preliminary clinical insight into the potential benefits of short-term multimodal physiotherapy in knee osteoarthritis, while highlighting the need for higher-level evidence to support its widespread implementation.

Conclusion

This case report suggests that a short-term multimodal physiotherapy intervention combining Transcutaneous Electrical Nerve Stimulation (TENS), ultrasound therapy, and strengthening exercises may lead to clinically meaningful improvements in pain, joint mobility, muscle strength, and functional ability in a patient with knee osteoarthritis. Reductions in pain exceeded the minimal clinically important difference, accompanied by measurable functional gains within a limited treatment duration.

These findings should be interpreted as descriptive evidence derived from a single-case design without inferential statistical analysis. While the results indicate potential clinical benefits, they cannot be generalized to broader populations. From a practical perspective, this case highlights that a structured multimodal physiotherapy program may be feasible and potentially effective for short-term outpatient rehabilitation in individuals with knee osteoarthritis. Further high-quality studies are required to confirm these findings and establish standardized protocols.

Author Contribution

Anggaraini Aprilianti: conceptualization, data collection, intervention implementation, manuscript drafting.
Wijianto: supervision, methodology, critical revision of the manuscript.
Widyo Bintoro: clinical supervision, validation, and review of the manuscript.

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Conflict of Interest Statement

The authors declare no conflict of interest.

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Ethics Statement

This study was conducted in accordance with ethical principles for clinical case reporting. Formal ethical approval was not required for this single-case report according to institutional policy. Written informed consent was obtained from the patient for participation and publication of clinical data.

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