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Therapeutic Ultrasound, TENS, and Exercise for Knee Osteoarthritis: A Case Report

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Abstract

Introduction: Osteoarthritis (OA) is a degenerative joint disease characterized by progressive cartilage damage, subchondral bone thickening, osteophyte formation, and nonspecific synovial inflammation. Patients often present with pain, stiffness, and functional limitation. This report describes the management of a 66-year-old woman with moderate (Kellgren–Lawrence grade III) left knee OA using a multimodal physiotherapy approach.

Methods: This single case study was conducted during a physiotherapy rehabilitation program. Interventions consisted of therapeutic ultrasound, transcutaneous electrical nerve stimulation (TENS), and structured exercise therapy. Outcomes were evaluated using pain assessment, manual muscle testing, range of motion (ROM), and functional activity observation.

Results: After four treatment sessions, the patient reported pain reduction, increased muscle strength, improved joint ROM, and enhanced functional capacity. Improvements were most notable in weight-bearing activities and daily mobility.

Conclusion: The combination of ultrasound therapy, TENS, and targeted exercise proved effective in reducing pain and improving joint mobility and function in a patient with moderate knee OA. This case highlights the potential role of multimodal physiotherapy interventions in OA rehabilitation.

Keywords

Osteoarthritis, Knee joint, Therapeutic ultrasound, Transcutaneous electrical nerve stimulation, Exercise therapy, Rehabilitation

Introduction

Osteoarthritis (OA) is a degenerative joint disease characterized by the destruction of articular cartilage, thickening of the subchondral bone, formation of osteophytes at the joint margins, and mild nonspecific synovial inflammation. OA is a chronic condition that progresses slowly, often with minimal or no inflammation, marked by deterioration and abrasion of articular cartilage and the formation of new bone at joint surfaces.[1] Risk factors for OA include age, sex, body mass index, family history, history of knee injury, hypertension, diabetes mellitus, hypercholesterolemia, smoking, occupation, and physical activity.[1]

According to the World Health Organization, the global prevalence of osteoarthritis is estimated at 9.6% in men and 18% in women.[2] In Indonesia, the prevalence of OA among individuals over the age of 61 is approximately 5%.[2] Data from the 2013 National Basic Health Survey (Riskesdas) indicated that the prevalence of joint disease among individuals aged ≥15 years was 11.9%, decreasing to 7.3% in 2018.[3] Among Indonesian provinces, Aceh recorded the highest prevalence (13.3%), while West Sulawesi had the lowest (3.2%).[3] South Kalimantan ranked as the fourth-lowest among the 34 provinces.[3]

Exercise therapy is one of the physiotherapeutic modalities that utilizes body movements, either active or passive, aimed at maintaining and improving muscle strength, endurance, cardiovascular capacity, balance, and functional coordination.[4] Therapeutic exercise can be used in the physiotherapy management of left knee osteoarthritis, including interventions such as Quadriceps Static Contraction and Resistance Band Knee Extension in Sitting.[4]

The subject of this study was a 55-year-old female who presented with complaints of left knee pain persisting for the past six months. Her primary complaint was a dull ache in the left knee that worsened during activities involving knee flexion, prolonged standing, or long-distance walking. The patient is a housewife whose daily activities include frequent washing and hanging clothes, which require prolonged standing. There was no family history of OA; however, the patient had a history of mild hypertension.

METHODS

This case report was conducted at Permata Medika Hospital, Semarang. The instruments used for data collection included: anthropometric measurements for assessing edema; Range of Motion (ROM) assessment to evaluate joint mobility, with a normal knee flexion range of 130°; Manual Muscle Testing (MMT) to measure muscle

strength, which showed a score of 3/5 in the quadriceps; and the Visual Analogue Scale (VAS) to assess pain intensity, which scored 6/10.

The research design employed in this study was a case report**,** with a summarized clinical case and problem description as follows: Mrs. S, a 66-year-old woman, complained of a clicking sound in her left knee and pain when walking long distances, climbing stairs, and during prayer movements, particularly when transitioning from kneeling to standing. Table 1 presents a chronological overview of the patient's clinical condition, including the onset of symptoms, progression of pain, and key events during physiotherapy management. This timeline highlights the functional decline prior to therapy and the gradual improvements observed after four physiotherapy sessions using Transcutaneous Electrical Nerve Stimulation (TENS), ultrasound, and therapeutic exercises.

Table 1. Clinical Timeline of Patient with Left Knee Osteoarthritis

Date / Time	Clinical Events
~2 months prior	Pain began during activities such as squatting and stair climbing
Week 3	Pain worsened and appeared during light activities (e.g., sit-to-stand, prayer)
February 7, 2025	First physiotherapy assessment: pain, decreased ROM, and muscle strength
4 physiotherapy sessions	Interventions: TENS, ultrasound, quadriceps static and resistance band exercises
After 4 sessions	Reduced pain, improved muscle strength and ROM, enhanced functional activity

Vital signs on assessment: blood pressure 150/80 mmHg, pulse 91 bpm, respiratory rate 21 breaths/min, temperature 36.6°C. The patient was 145 cm in height and weighed 55.8 kg. The diagnosis was established based on typical clinical features of knee OA, the patient's age, and physical findings. There were no signs of acute inflammation or recent trauma. A similar condition in the right knee and progressive symptoms supported the diagnosis. Imaging was not performed, as the clinical presentation was characteristic and did not indicate an emergency condition.

In terms of body structure and function, the patient experienced movement-induced pain during left knee flexion, reduced quadriceps muscle strength, limited knee flexion ROM, quadriceps muscle spasm, and restrictions in functional activities such as stair climbing and long-distance walking. Regarding participation, strong family support was present, although consistent intervention by a physiotherapist was required to accelerate recovery.

Physiotherapy interventions for left knee osteoarthritis included ultrasound therapy, which was applied at a frequency of 1 MHz and an intensity of 2.00 W/cm² for 5 minutes over the internal aspect of the left knee. Transcutaneous Electrical Nerve Stimulation (TENS) was administered at a frequency of 100 Hz for 15 minutes, with electrodes placed transarticularly. Exercise therapy was also provided, consisting of two main components. The first was Quadriceps Static Contraction, involving 8-second muscle contractions followed by 5 seconds of relaxation, repeated for 10 repetitions; resistance was progressively increased in each session based on the patient's pain tolerance and improvement in muscle strength.

The second component was Resistance Band Knee Extension in Sitting, performed with 6-second muscle contractions repeated for 8 repetitions, with resistance similarly adjusted in accordance with pain tolerance and strength development. No excessive pain responses were reported during therapy, and therefore, no significant adjustments to the exercise protocol were required.

Results

The outcomes of the physiotherapy interventions—which included ultrasound, Transcutaneous Electrical Nerve Stimulation (TENS), and therapeutic exercises—administered across four treatment sessions to a patient with left knee osteoarthritis (Genu Sinistra) are presented below. A reduction in pain intensity during movement was observed following the intervention. This improvement in symptoms can be seen in Table 2.

Table 2. VAS (Visual Analogue Scale) Results

Type of Pain	T1	T2	T3	T4
Resting Pain	0	0	0	0
Tenderness Pain	0	0	0	0
Movement-Related Pain	5	5	4	4

Improvements in knee joint range of motion were recorded using a goniometer. The progression of both active and passive range of motion is detailed in Table 3**.**

Table 3. Goniometric Measurements (Range of Motion)

Movement	Active ROM	Passive ROM	Normal ROM
T1	S:00-00-110°	S:00-00-125°	S:00-00-130°
T2	S:00-00-110°	S:00-00-125°	S:00-00-130°
T3	S:00-00-125°	S:00-00-125°	S:00-00-130°
T4	S:00-00-125°	S:00-00-125°	S:00-00-130°

Muscle strength, particularly in the quadriceps and hamstrings, was evaluated through Manual Muscle Testing (MMT). The results of muscle strength progression are presented in Table 4**.**

Table 4. Manual Muscle Testing (MMT)

Muscle Group	T1	T2	T3	T4
Quadriceps	3	3	4	4
Hamstrings	4	4	4	4

Functional improvement and reduction in symptoms were further evaluated using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). The detailed changes across the sessions are shown in Table 5

Table 5. WOMAC Scores

Session	Score
T1	26
T2	20
T3	12
T4	6

A follow-up assessment scheduled two weeks after the final session could not be conducted due to the patient's absence. A new appointment has been set to monitor the continuity of treatment outcomes. During the four therapy sessions, the patient showed good adherence to the intervention schedule and reported compliance with the prescribed home exercise program, which included quadriceps setting exercises performed twice daily. No adverse effects or negative reactions were noted during the use of TENS, ultrasound, or active exercises. The patient also did not report any increase in pain following the exercise sessions.

Discussion

The following section presents graphical data obtained after physiotherapy interventions, including ultrasound, TENS, and exercise therapy, which are associated with improvements in pain, joint range of motion, muscle strength, and functional ability from T1 to T4.

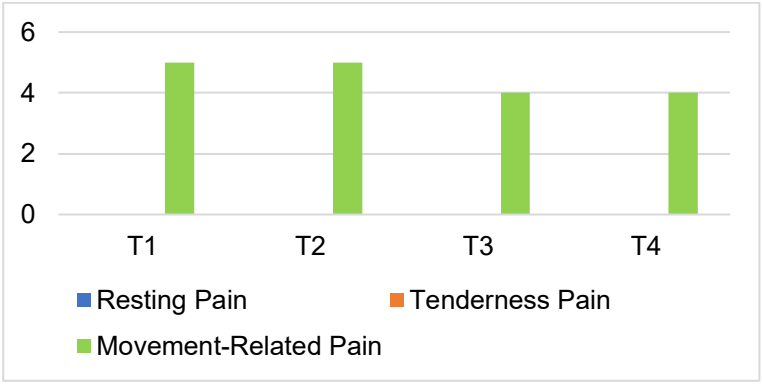

Figure1. Evaluation of Physiotherapy Management in Knee Osteoarthritis Using Ultrasound and Transcutaneous Electrical Nerve Stimulation (TENS)

Based on Graph 1, physiotherapy management in this case of left knee osteoarthritis showed a reduction in movement-related pain following the administration of TENS and ultrasound over four sessions. During the first and second sessions (T1 and T2), the movement pain score remained at 5, whereas during the third and fourth sessions (T3 and T4), the score decreased to 4.

This finding aligns with the study by Arif et al., which demonstrated a significant reduction in pain following ultrasound therapy. In their literature review titled *"Pengaruh Pemberian Terapi Ultrasound Terhadap Nyeri Pada Pasien Osteoarthritis Lutut"*, the authors concluded that ultrasound therapy—through both thermal and non-thermal mechanisms—exerts direct effects on muscles and surrounding tissues, making it a highly effective modality in managing osteoarthritis symptoms.[5]

The findings are also consistent with research by Jiemesha, which supported the effectiveness of TENS in reducing pain based on the gate control theory, as presented in the study *"Pengaruh Transcutaneous Electrical Nerve Stimulation Dengan Dan Tanpa Terapi Latihan Terhadap Nyeri Dan Kinerja Fisik Pada Penderita Osteoartritis Lutut"*.[6] TENS therapy reduces pain by stimulating A-beta nerve fibers, which modulate pain transmission at the spinal level (dorsal horn), in line with the gate control mechanism. After four therapy sessions incorporating both ultrasound and TENS, a significant reduction in movement-induced pain was observed.

The effectiveness of the intervention is supported by objective outcome measures such as VAS, ROM, MMT, and WOMAC scores. However, certain limitations should be acknowledged. No long-term follow-up was conducted to monitor sustained outcomes, and no radiologic examinations (e.g., X-ray or MRI) were performed to confirm the degree of joint degeneration. Additionally, the subjectivity inherent in tools such as the VAS and MMT may affect measurement reliability.

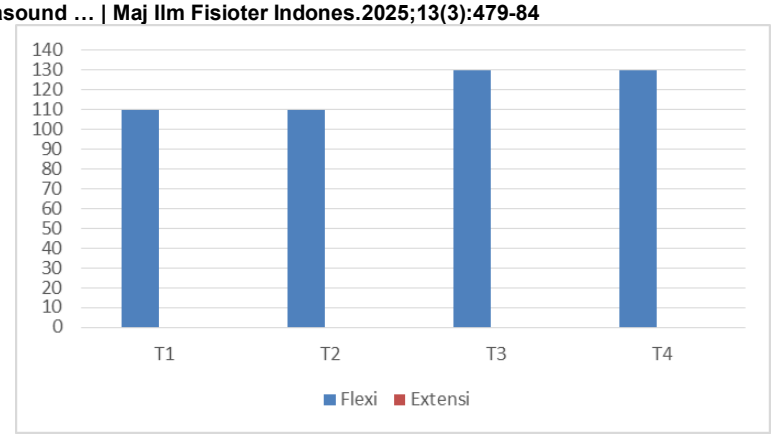

Figure 2. Evaluation of Physiotherapy Management in Knee Osteoarthritis Using Exercise Therapy

Graph 2 illustrates the improvement in active knee range of motion (ROM) following four sessions of physiotherapy. At baseline (T1), active ROM in the left knee was measured as S:00.00.110°, and by the fourth session (T4), it increased to S:00.00.125°. Passive ROM remained stable at S:00.00.125°.

This finding is in agreement with a case study by Pristianto titled *"Intervensi Fisioterapi dalam Peningkatan Kemampuan Fungsional Pasien Pasca Total Knee Replacement et causa Gonitis Tuberculosis"*, which emphasized the effectiveness of Quadriceps Static Contraction and Resistance Band Knee Extension in improving joint mobility.[7] In addition to exercise, the increase in ROM was likely influenced by reduced pain levels and muscle relaxation around the knee joint. As mobility increases, functional ROM also improves, enabling the patient to perform daily activities more effectively. Following four sessions of structured exercise therapy, a significant increase in joint ROM was observed.

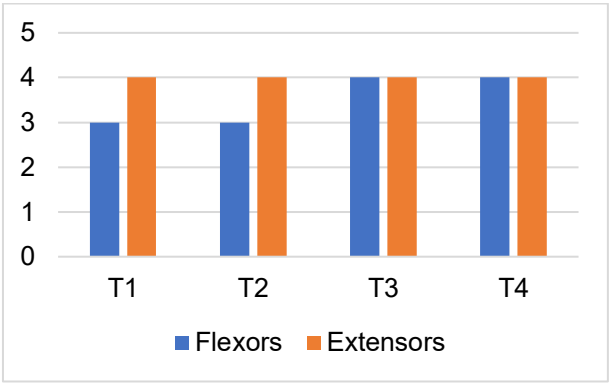

Figure 3. Evaluation of Physiotherapy Management in Knee Osteoarthritis Using Manual Muscle Testing (MMT)

Graph 3 presents changes in muscle strength assessed through MMT. For the hamstring muscle group (flexors), strength remained stable at grade 4 across all sessions (T1–T4). For the quadriceps (extensors), muscle strength improved from grade 3 to grade 4 between T2 and T3 and remained stable at grade 4 thereafter.

According to a study by Gouwanda titled *"Investigating Human Balance and Postural Control During Bilateral Stance on Bosu Balance Trainer"*, exercise performed using a BOSU balance trainer activates joint sense and improves proprioceptive function of active joint stabilizers, leading to increased muscle tone and strength.[8] Moreover, resistance band knee extensions induce isotonic contractions—eccentric and concentric—that stimulate proprioceptors, enhance motor unit recruitment, and improve intramuscular pressure, thereby increasing blood flow in a short duration.

The observed pain reduction can be attributed to the analgesic effects of TENS through A-beta nerve stimulation, which inhibits nociceptive input in the dorsal horn (gate control mechanism), as well as the thermal and micromassage effects of ultrasound that enhance local circulation. Functional exercise also contributed to quadriceps activation and improved proprioception, which are crucial for joint stabilization and reducing mechanical load on the knee joint.

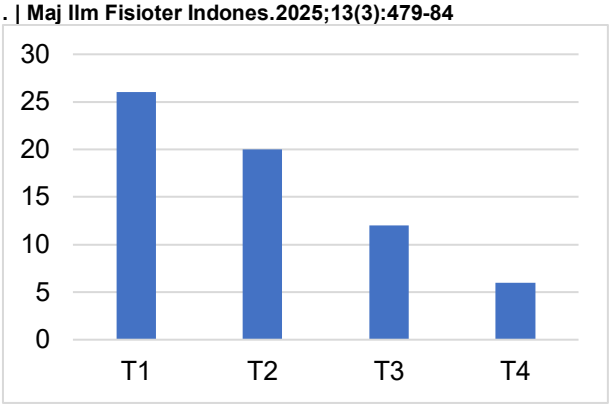

Figure 4. Evaluation of Physiotherapy Management in Knee Osteoarthritis Using WOMAC Scores

Graph 4 shows a progressive improvement in functional ability, as reflected by decreased WOMAC scores. After four sessions of physiotherapy, the WOMAC score improved from 26 (interpreted as moderate disability) at T1 to 6 (interpreted as mild disability) at T4. This indicates a notable improvement in the patient's ability to perform daily functional activities.

The combination of pain reduction and enhanced muscle strength likely contributed to this outcome. These findings are consistent with the study by Huang et al. titled *"Pengaruh Latihan Fungsional Quadriceps dengan Kontraksi Isometrik dalam Pengobatan Osteoarthitis Lutut"*, which demonstrated that functional quadriceps exercises with isometric contraction significantly improved WOMAC scores by reducing pain, increasing ROM, and enhancing muscle strength.[9] This, in turn, enables patients to engage in their environmental and daily activities without significant limitation.

While the results suggest positive clinical outcomes, several limitations must be acknowledged. First, no long-term follow-up was conducted to determine whether the improvements were sustained. Second, the absence of radiological evaluation (e.g., MRI or X-ray) limits the ability to assess structural changes in the joint. Third, outcome measures such as VAS and MMT are subjective and may be influenced by patient perception and therapist interpretation.

Despite these limitations, the integration of TENS, ultrasound, and structured therapeutic exercise demonstrated meaningful improvements in pain management, joint mobility, muscle strength, and functional performance over a short period of intervention.

Conclusion

Based on the physiotherapy management administered to a 66-year-old female patient diagnosed with left knee osteoarthritis (genu sinistra), who initially presented with complaints of pain during activities such as rising from a squat, prolonged standing, and performing prayers, a structured treatment protocol consisting of four sessions was implemented. The intervention combined therapeutic modalities including ultrasound, transcutaneous electrical nerve stimulation (TENS), and targeted exercise therapy.

Following the intervention, the patient demonstrated notable clinical improvements. Movement-related pain, as assessed by the Visual Analogue Scale (VAS), showed a measurable reduction. Manual Muscle Testing (MMT) indicated an increase in quadriceps muscle strength, while goniometric evaluation revealed an improvement in active knee joint range of motion. Additionally, the patient's functional ability, assessed through the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), showed significant enhancement, reflecting improved performance in daily activities.

These outcomes suggest that a multimodal physiotherapy approach incorporating electrotherapy and structured exercise can effectively reduce pain, enhance joint mobility, strengthen periarticular muscles, and improve overall functional capacity in patients with knee osteoarthritis. This case highlights the clinical relevance of integrating individualized, evidence-based physiotherapy interventions for managing degenerative joint conditions and optimizing patient quality of life.

Author Contribution

Alifatul Mufida: conceptualization, patient management, data collection, and manuscript drafting.
Boki Jaleha: supervision, methodology, data analysis, and critical revision of the manuscript.
All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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Conflict of Interest Statement

The authors declare that there are no conflicts of interest related to this study.

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Ethics Statement

Ethical approval was not required for this case report as all interventions were part of routine physiotherapy care. Written informed consent was obtained from the patient for participation and publication of anonymized clinical data. Patient confidentiality and anonymity were strictly maintained throughout the preparation of this report.

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