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Physiotherapy Management After Total Knee Replacement Using NMES and Stationary Cycling: A Case Report

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Abstract

Background: Patients undergoing total knee replacement (TKR) commonly experience postoperative pain, reduced muscle strength, limited joint range of motion, and impaired functional ability. Physiotherapy interventions are essential to support functional recovery.
Objective: To describe clinical outcomes following physiotherapy management using neuromuscular electrical stimulation (NMES) and stationary cycling in an elderly patient after TKR.
Methods: This case report was developed in accordance with CARE guidelines and involved a 75-year-old female patient three months after left TKR due to osteoarthritis. The intervention consisted of NMES (50 Hz, approximately 15 minutes) and stationary cycling (10–15 minutes) over three therapy sessions. Outcomes were assessed using the Numeric Rating Scale (NRS), range of motion (ROM), Manual Muscle Testing (MMT), and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). Data were analyzed descriptively using absolute changes.
Results: Movement pain decreased from NRS 6 to 2, and tenderness decreased from 2 to 1. Active knee ROM improved from −20°–0°–120° to −10°–0°–130°. Muscle strength increased from MMT grade 3 to 4. WOMAC score improved from 67 to 39, indicating functional improvement from severe to moderate disability. No adverse events were reported.
Conclusion: The combination of NMES and stationary cycling was associated with reduced pain and improved joint mobility, muscle strength, and functional ability in an elderly patient following TKR.

Keywords
Arthroplasty, Replacement, Knee; Osteoarthritis; Electric Stimulation Therapy; Muscle Strength; Rehabilitation

Introduction

Osteoarthritis (OA) is a progressive degenerative joint disease characterized by articular cartilage degradation, subchondral bone remodeling, osteophyte formation, and low-grade synovial inflammation, which collectively lead to pain, joint stiffness, reduced range of motion, and functional impairment.[1] The knee joint is one of the most commonly affected weight-bearing joints, particularly among older adults, where OA represents a major contributor to disability and decreased quality of life.[2]

Population aging has been associated with an increased prevalence of OA due to cumulative mechanical stress and age-related physiological decline.[3] Global estimates indicate that symptomatic knee OA affects approximately 10–18% of individuals aged over 60 years, with higher prevalence observed in women.[4] However, epidemiological data in Indonesia remain inconsistent, and some reports suggest disproportionately high prevalence rates that require verification using nationally representative data.[5]

When conservative management fails to control symptoms in advanced knee OA, total knee replacement (TKR) is considered an effective surgical intervention to reduce pain and restore joint function.[6] Despite its clinical benefits, a substantial proportion of patients continue to experience postoperative impairments, including quadriceps weakness, reduced joint mobility, and functional limitations.[7] It has been reported that up to 10–20% of patients remain dissatisfied after TKR, often due to persistent deficits in muscle strength and functional performance.[7]

Postoperative rehabilitation plays a crucial role in addressing these impairments and optimizing recovery outcomes. Neuromuscular electrical stimulation (NMES) has been widely studied as an adjunct therapy to improve quadriceps activation by enhancing motor unit recruitment and reducing arthrogenic muscle inhibition following TKR.[8] Systematic reviews and randomized controlled trials have demonstrated that NMES can significantly improve muscle strength, reduce pain, and enhance functional outcomes during early rehabilitation.[8]

In addition to NMES, exercise-based interventions such as stationary cycling have been shown to improve joint mobility and functional capacity through repetitive, low-impact movement patterns. Cycling facilitates continuous knee flexion–extension, promotes synovial fluid circulation, and reduces joint stiffness without imposing excessive mechanical load on the joint.[9] Recent randomized controlled trials have reported that cycling-based rehabilitation can significantly improve range of motion, muscle strength, and functional performance in patients following TKR.[10]

Although both NMES and cycling exercises have demonstrated individual benefits in postoperative rehabilitation, the combined application of these interventions in elderly patients following TKR has not been extensively described in detailed clinical reports. In particular, there is limited evidence documenting short-term clinical responses and functional outcomes in real-world physiotherapy settings.

Therefore, this case report aims to describe the physiotherapy management and clinical outcomes associated with the combined use of NMES and stationary cycling in an elderly patient following total knee replacement.

Methods

This study was designed as a single-case report developed in accordance with the CARE (CAse REport) guidelines to ensure systematic, transparent, and comprehensive reporting of clinical findings, interventions, and outcomes. The patient was a 75-year-old female who underwent left total knee replacement due to osteoarthritis. At the time of physiotherapy evaluation, the patient was in the third postoperative month and reported persistent knee pain, limited joint mobility, decreased muscle strength, and impaired functional ability in daily activities. The patient had a body weight of 42 kg and a height of 155 cm, corresponding to a body mass index (BMI) of 17.5 kg/m², indicating an underweight status. Comorbid conditions included hypertension and a prior history of left knee osteoarthritis.

Regarding rehabilitation history, the patient had undergone structured physiotherapy prior to and following surgery. Preoperatively, the patient received routine physiotherapy for three months (February–May 2025) at a primary healthcare center. Postoperatively, the patient participated in physiotherapy for two months (June–August 2025) at a specialized orthopedic hospital. Subsequently, the patient continued rehabilitation at RSUD Ibu Fatmawati Soekarno Surakarta, where the current intervention was administered. The patient was considered eligible for physiotherapy intervention based on stable general condition, ability to follow instructions, and tolerance to therapeutic exercises. Written informed consent was obtained prior to participation and publication.

Initial physiotherapy assessment revealed the presence of movement-related pain, localized tenderness, reduced active range of motion, decreased muscle strength in the quadriceps and hamstring muscle groups, and reduced functional capacity as measured by WOMAC. These findings indicated impairments across multiple domains, including pain, mobility, strength, and functional performance. To provide a clear chronological overview of the patient's clinical course and physiotherapy intervention, the timeline is presented in Table 1.

Table 1. Clinical Timeline of Patient Management

Time Period	Clinical Event	Description
August 2025	Postoperative phase	Patient underwent left total knee replacement due to osteoarthritis
October 2025	Initial assessment	Pain, limited ROM, muscle weakness, and functional limitation identified
Session 1 (Day 1)	Initial intervention	NMES and stationary cycling initiated
Session 2 (Day 3)	Follow-up intervention	Intervention continued based on patient tolerance
Session 3 (Day 5)	Final session	Final intervention and outcome evaluation conducted
End of program	Outcome assessment	NRS, ROM, MMT, and WOMAC reassessed

The diagnosis was established as postoperative status following total knee replacement due to osteoarthritis based on medical history and clinical presentation. In clinical practice, postoperative evaluation after total knee replacement typically includes physical examination, radiographic assessment to evaluate implant positioning and joint alignment, as well as functional outcome measures to monitor recovery progress.

Although imaging findings and formal differential diagnosis were not documented in this case, the clinical presentation was consistent with the expected postoperative course following total knee replacement. Functional assessment using validated outcome measures such as the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) is commonly recommended to evaluate recovery and functional status in patients after knee arthroplasty. The physiotherapy intervention consisted of a combination of neuromuscular electrical stimulation (NMES) and stationary cycling, administered over three sessions. To ensure reproducibility and clarity, the intervention parameters are detailed in Table 2.

Table 2. Physiotherapy Intervention Protocol

Intervention	Parameter	Description
NMES	Frequency	50 Hz
	Duration	~15 minutes per session
	Intensity	Sensory-motor level (visible muscle contraction without pain)
	Pulse duration	Not reported
	Duty cycle	Not reported
	Electrode placement	Not specified (targeting quadriceps region)
Cycling	Mode	Stationary cycling
	Duration	10–15 minutes per session
	Intensity	Low intensity, adjusted to patient tolerance
	Resistance	Not specified
	Cadence	Not specified

NMES was applied to facilitate quadriceps activation and reduce muscle inhibition following surgery. Stationary cycling was introduced as a low-impact exercise to improve joint mobility, muscle endurance, and functional performance. Exercise intensity was progressively adjusted according to the patient's tolerance and clinical response.

The NMES parameters applied in this case included a stimulation frequency of 50 Hz and a session duration of approximately 15 minutes. However, specific parameters such as pulse duration, duty cycle, and electrode placement were not systematically recorded during clinical practice. Similarly, detailed parameters for stationary cycling, including resistance level, cadence, and target intensity, were not formally documented.

Despite this limitation, the intervention followed standard physiotherapy practice aimed at achieving visible muscle contraction without discomfort and promoting low-impact joint movement. Previous studies suggest that NMES protocols for post-TKR rehabilitation commonly use pulse durations ranging from 200 to 400 μs and duty cycles between 1:3 and 1:5, while cycling intensity is typically adjusted based on patient tolerance and functional capacity.

Outcome evaluation focused on four primary domains: pain, joint mobility, muscle strength, and functional ability. Pain intensity was measured using the Numeric Rating Scale (NRS), including rest pain, tenderness, and movement pain. Joint range of motion was assessed using a goniometer for both active and passive movement. Muscle strength of the quadriceps and hamstring was evaluated using Manual Muscle Testing (MMT). Functional ability was assessed using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). All measurements were performed at baseline (T1) and after completion of the intervention program (T3).

The outcome measures used in this study have been widely validated in musculoskeletal and rehabilitation settings. The Numeric Rating Scale (NRS) is a reliable tool for pain assessment, WOMAC is a validated instrument for evaluating functional outcomes in knee osteoarthritis, and Manual Muscle Testing (MMT) demonstrates acceptable reliability for clinical strength assessment. Data were analyzed descriptively by comparing pre- and post-intervention values. Absolute changes and percentage improvements were calculated to provide a clearer quantitative interpretation of clinical outcomes.

Written informed consent was obtained from the patient prior to participation and publication of anonymized clinical data. The patient was informed about the purpose of the report, the procedures involved, and the use of clinical information for scientific publication. This case report was conducted in accordance with the principles of the Declaration of Helsinki. As this study involved a single case report without experimental intervention beyond standard clinical care, formal ethical approval was not required according to institutional policy. Patient confidentiality was strictly maintained, and all identifying information was removed to ensure anonymity.

Results

At baseline (T1), the patient presented with no rest pain (NRS 0), mild tenderness (NRS 2), and moderate movement pain (NRS 6). Passive knee range of motion was within normal limits (0°–0°–135°), whereas active ROM was limited to −20°–0°–120°, indicating an extension deficit of 20°. Muscle strength of both quadriceps and hamstring was graded at 3/5. Functional assessment using WOMAC yielded a total score of 67, indicating severe functional limitation.

Pain intensity showed a progressive reduction across the three intervention sessions. Movement pain decreased from NRS 6 at T1 to 2 at T3, representing an absolute reduction of 4 points (Δ = −4) or a 66.7% improvement. Tenderness decreased from NRS 2 to 1 (Δ = −1; 50% reduction), while rest pain remained at 0 throughout the intervention.

Table 3. Pain Outcomes Across Intervention Sessions

Parameter	T1	T2	T3	Δ (T1–T3)	% Change
Rest pain	0	0	0	0	0%
Tenderness	2	2	1	−1	−50%
Movement pain	6	4	2	−4	−66.7%

Passive ROM remained unchanged within normal limits throughout the intervention. In contrast, active ROM improved progressively. Knee extension improved from −20° to −10° (Δ = +10°), while flexion increased from 120° to 130° (Δ = +10°). This represents an approximate 50% reduction in extension deficit.

Table 4. Knee Range of Motion Outcomes

Measurement	T1	T2	T3	Δ (T1–T3)
Passive ROM	0°–0°–135°	0°–0°–135°	0°–0°–135°	0
Active ROM	−20°–0°–120°	−15°–0°–125°	−10°–0°–130°	+10° ext / +10° flex

Muscle strength improved from MMT grade 3 to 4 in both quadriceps and hamstring muscles, indicating the ability to perform movement against minimal resistance. This represents a one-grade improvement on the MMT scale.

Table 5. Muscle Strength Outcomes

Muscle Group	T1	T2	T3	Δ
Hamstring	3	3	4	+1
Quadriceps	3	3	4	+1

Functional ability improved substantially following the intervention. The WOMAC total score decreased from 67 to 39, representing an absolute reduction of 28 points (Δ = −28) or a 41.8% improvement. Improvements were observed across all domains, including pain, stiffness, and physical function.

Table 6. WOMAC Outcomes

Parameter	T1	T3	Δ	% Change
Pain	12	7	−5	−41.7%
Stiffness	3	2	−1	−33.3%
Physical function	52	30	−22	−42.3%
Total score	67	39	−28	−41.8%

The patient completed all intervention sessions without interruption and demonstrated good tolerance to both NMES and stationary cycling. No adverse events or complications were reported during the intervention period. To enhance visualization of clinical trends, graphical representations of pain, ROM, muscle strength, and WOMAC changes are recommended (Figure 1–4). These graphs illustrate consistent improvement across all measured outcomes over the three sessions.

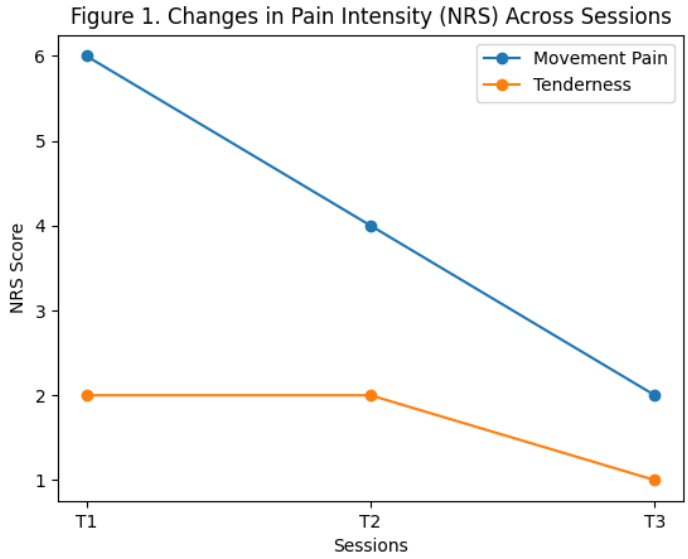

Figure 1. Changes in Pain Intensity (NRS) Across Sessions

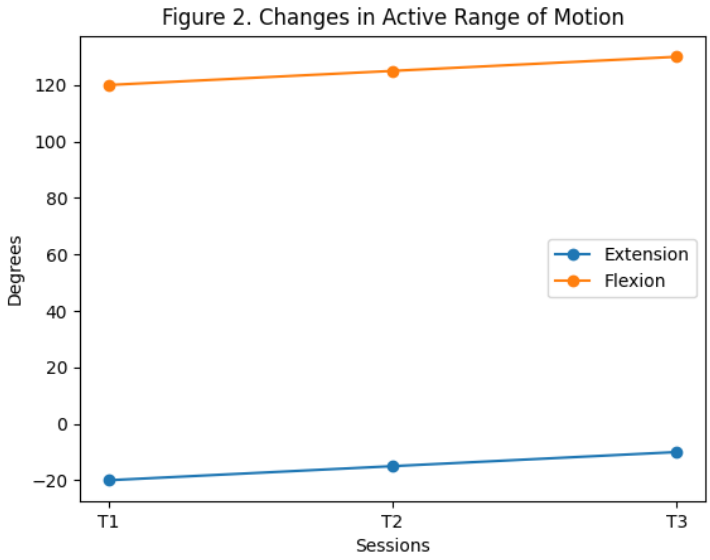

Figure 2. Changes in Active Range of Motion

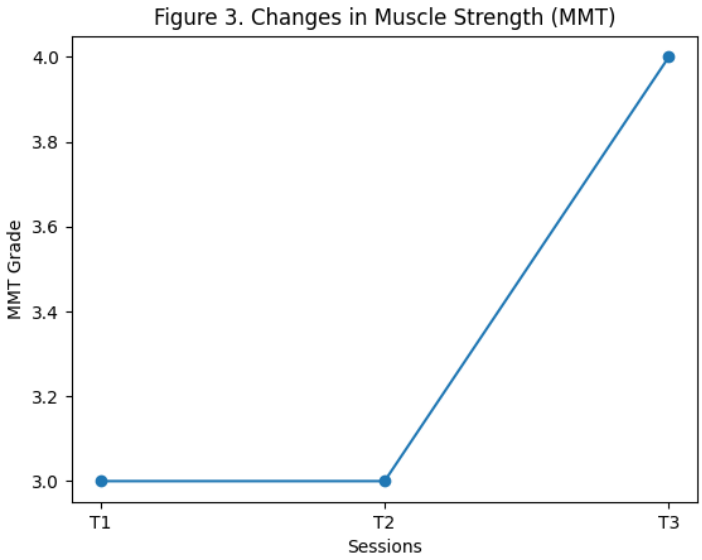

Figure 3. Changes in Muscle Strength (MMT)

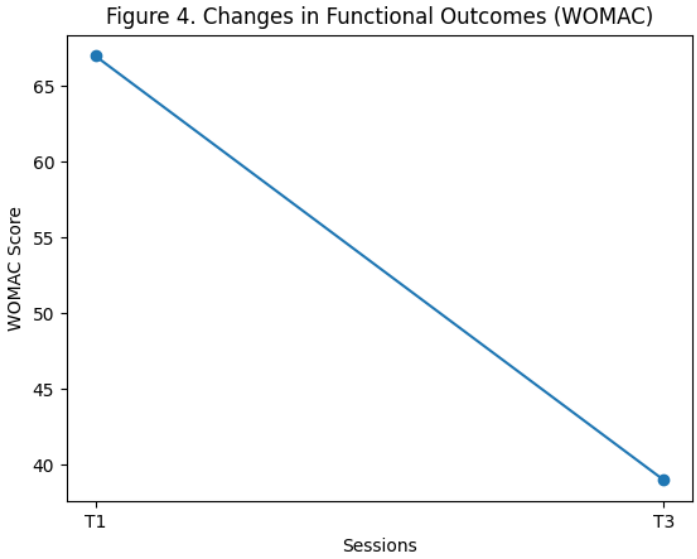

Figure 4. Changes in Functional Outcomes (WOMAC)

Discussion

This case report demonstrates that the combination of neuromuscular electrical stimulation (NMES) and stationary cycling was associated with clinically meaningful improvements in pain, joint mobility, muscle strength, and functional ability in an elderly patient following total knee replacement (TKR). The magnitude of improvement observed across multiple outcome measures suggests a positive short-term response to the intervention. The reduction in pain observed in this case is consistent with previous evidence indicating that NMES can modulate pain through both peripheral and central mechanisms.[11] NMES facilitates muscle contraction and improves local circulation, which may reduce nociceptive input and enhance endogenous pain modulation.[12] In addition, improved quadriceps activation may reduce joint loading asymmetry and contribute to decreased mechanical stress on the knee joint.[13]

The improvement in muscle strength from MMT grade 3 to 4 reflects enhanced neuromuscular activation, which is a key target in postoperative rehabilitation. Following TKR, quadriceps inhibition is commonly observed due to arthrogenic muscle inhibition, leading to persistent weakness and functional limitation.[14] NMES has been shown to counteract this inhibition by increasing motor unit recruitment and facilitating voluntary muscle activation. Systematic reviews and randomized controlled trials have demonstrated that NMES can significantly improve quadriceps strength and functional outcomes after TKR.[15] The observed increase in active range of motion (ROM) is likely attributable to the combined effects of NMES and stationary cycling. Cycling exercises provide repetitive, low-impact flexion–extension movements that enhance synovial fluid distribution, reduce joint stiffness, and improve tissue elasticity.[16] This mechanism supports gradual restoration of joint mobility without imposing excessive mechanical stress, which is particularly beneficial in elderly patients.

Notably, improvements were observed within a relatively short intervention period of three sessions. This rapid response may be explained by early neuromuscular adaptations, including improved motor unit synchronization and reduced inhibitory reflex activity. However, these short-term gains should be interpreted with caution, as they may not fully reflect long-term functional recovery.[17] From a clinical perspective, the reduction in WOMAC score from 67 to 39 represents a substantial improvement of 28 points (41.8%). This exceeds the minimal clinically important difference (MCID) for WOMAC, which is generally reported to range between 12 and 15 points in patients with knee osteoarthritis.[18] Therefore, the observed changes can be considered not only statistically relevant but also clinically meaningful.

Compared with existing literature, the findings of this case report are consistent with higher-level evidence, including randomized controlled trials and systematic reviews supporting the use of NMES and exercise-based rehabilitation after TKR.[12–13] However, this report contributes additional clinical insight by describing the combined application of NMES and stationary cycling in a real-world setting, particularly in an elderly patient population, which remains underreported in the literature. The clinical implications of this case suggest that combining NMES with low-impact aerobic exercise such as stationary cycling may be beneficial in early rehabilitation following TKR. Specifically, this approach may be considered for patients presenting with quadriceps weakness, limited active ROM, and functional impairment. However, optimal intervention parameters, including NMES intensity, duty cycle, and cycling resistance, require further investigation.

From a practical perspective, NMES may be applied for approximately 15 minutes per session at a frequency of 50 Hz, combined with low-intensity stationary cycling for 10–15 minutes, adjusted according to patient tolerance. This approach may be particularly beneficial for elderly patients presenting with quadriceps weakness and limited joint mobility in early postoperative rehabilitation.

Several limitations should be acknowledged. First, this report involves a single patient, limiting the generalizability of the findings. Second, the short duration of intervention restricts the ability to assess long-term outcomes. Third, the absence of follow-up data prevents evaluation of sustained improvements. Additionally, potential sources of bias, including measurement bias and observer bias, cannot be excluded. Finally, the transferability of these findings to other patient populations, such as younger individuals or those with different comorbidities, remains uncertain. Future studies with larger sample sizes, standardized intervention protocols, and longer follow-up periods are needed to confirm the effectiveness and generalizability of combined NMES and stationary cycling in postoperative TKR rehabilitation.

Conclusion

This case report demonstrates that a physiotherapy program combining neuromuscular electrical stimulation (NMES) and stationary cycling was associated with short-term improvements in pain, joint range of motion, muscle strength, and functional ability

in an elderly patient following total knee replacement (TKR). The observed reduction in WOMAC score exceeded the minimal clinically important difference, indicating that the improvements were not only measurable but also clinically meaningful. These findings suggest that integrating NMES with low-impact aerobic exercise may provide a practical and effective approach for early postoperative rehabilitation, particularly in patients presenting with quadriceps weakness and limited mobility.

However, given the single-case design and short intervention duration, the results should be interpreted with caution. Further studies involving larger sample sizes, standardized intervention protocols, and long-term follow-up are required to confirm effectiveness and establish optimal treatment parameters. This case report provides additional clinical insight into the combined application of NMES and stationary cycling in an elderly patient, highlighting short-term functional improvements in a real-world rehabilitation setting.

Author Contribution

Talitha Qanitah: Conceptualization, data collection, manuscript drafting.
Agus Widodo: Methodology, supervision, critical revision of the manuscript.
Astuti: Data analysis, interpretation of results, manuscript editing.

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Conflict of Interest Statement

The authors declare no conflict of interest.

Funding Sources

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Ethics Statement

Written informed consent was obtained from the patient prior to participation and publication of anonymized clinical data. The study was conducted in accordance with the principles of the Declaration of Helsinki. As this report describes a single clinical case involving standard therapeutic intervention, formal ethical approval was not required according to institutional policy. Patient confidentiality was strictly maintained throughout the study. Formal ethical approval was waived according to institutional policy for single case reports involving standard clinical care.

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