Majalah Ilmiah Fisioterapi Indonesia
Indonesian Scientific Journal of Physiotherapy

Case Reports / Case Studies
ISSN (Print): 2303-1921
ISSN (Online): 2722-0443
Volume 14, Number 1, Pages 353-358 (2026)
DOI: https://doi.org/10.24843/mifi.000001770

Effect of Multimodal Physiotherapy on Functional Recovery After Proximal Tibial Fracture: A Case Report

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Received 1 April 2026; Revised 11 April 2026; Accepted 11 April 2026; Published 4 May 2026
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Abstract

Background: Proximal tibial fractures commonly lead to pain, reduced range of motion (ROM), muscle weakness, and impaired functional mobility following surgical fixation. Physiotherapy is essential to restore function and prevent postoperative complications.
Objective: To evaluate the clinical outcomes of a multimodal physiotherapy intervention in a patient with a proximal tibial fracture.
Methods: This case report describes a 22-year-old female patient who underwent open reduction internal fixation for a left proximal tibial fracture. Physiotherapy was initiated three months postoperatively and conducted over three weeks (six sessions). The intervention included infrared therapy, transcutaneous electrical nerve stimulation (TENS), strengthening exercises, range of motion exercises, and gait training. Outcomes were assessed using the Numeric Rating Scale (NRS), goniometric ROM measurement, Manual Muscle Testing (MMT), and the Lower Extremity Functional Scale (LEFS).
Results: After six sessions, movement pain decreased from 5 to 3 and tenderness from 3 to 1 (NRS). Knee flexion improved from 100° to 120°, while muscle strength increased from MMT grade 3 to 4. Functional ability improved substantially, with LEFS scores increasing from 57.5 to 87.5, indicating clinically meaningful improvement.
Conclusion: Multimodal physiotherapy was associated with improvements in pain, joint mobility, muscle strength, and functional performance in a patient with a proximal tibial fracture. However, the findings are limited by the single-case design and short intervention duration.

Keywords
Tibial Fractures; Physical Therapy Modalities; Infrared Rays; Transcutaneous Electric Nerve Stimulation; Range of Motion Exercise; Gait Training

Introduction

Tibial fractures are among the most common long bone injuries and represent a significant source of morbidity, particularly in the active and productive population. These fractures frequently result from high-energy trauma such as road traffic accidents and are associated with substantial impairments, including pain, restricted joint mobility, muscle weakness, and limitations in functional activities.[1] Proximal tibial fractures, in particular, may disrupt the knee joint biomechanics and compromise weight-bearing capacity, thereby affecting overall mobility and independence.[2]

Surgical management, including open reduction and internal fixation (ORIF), is commonly performed to restore anatomical alignment and joint congruency.[3] However, despite successful surgical intervention, patients often experience persistent postoperative complications such as joint stiffness, quadriceps inhibition, altered gait patterns, and delayed functional recovery.[4] These impairments are frequently exacerbated by prolonged immobilization, which can lead to muscle atrophy, reduced cartilage nutrition, and decreased joint flexibility.[5]

Physiotherapy plays a crucial role in postoperative rehabilitation by addressing these impairments through a combination of pain management strategies and functional restoration approaches. Transcutaneous Electrical Nerve Stimulation (TENS) has been widely used for pain modulation through both peripheral and central mechanisms, including activation of inhibitory pathways in the central nervous system.[6] Infrared therapy contributes to increased local circulation, tissue extensibility, and muscle relaxation through thermal effects, thereby facilitating recovery of soft tissue function.[7]

Exercise-based interventions are fundamental components of rehabilitation. Strengthening exercises, particularly targeting the quadriceps and hamstring muscle groups, are essential for restoring muscle performance and joint stability.[8] Range of motion (ROM) exercises help prevent joint stiffness and improve flexibility, while gait training supports the re-establishment of coordinated movement patterns and progressive weight-bearing capacity.[9] These interventions collectively aim to restore functional independence and improve quality of life following injury.

Although previous studies have demonstrated the effectiveness of individual physiotherapy modalities in postoperative fracture rehabilitation, the evidence regarding the combined application of multimodal physiotherapy interventions remains limited, particularly in the context of proximal tibial fractures.[10] Existing literature often focuses on isolated interventions or generalized rehabilitation protocols without providing detailed clinical descriptions of integrated treatment approaches in real-world settings.

Therefore, there remains a gap in the literature regarding the clinical application and outcomes of structured multimodal physiotherapy programs in patients with proximal tibial fractures, especially within a case-based framework that reflects routine clinical practice. Addressing this gap is important to provide practical insights for clinicians in designing comprehensive rehabilitation strategies.

This case report aims to describe and evaluate the clinical outcomes of a multimodal physiotherapy intervention in a patient following proximal tibial fracture surgery, with a specific focus on pain reduction, improvement in joint mobility, muscle strength, and functional performance.

Methods

This study was designed as a single-patient case report following the CARE (CAse REport) guidelines. The report aims to provide a detailed clinical description of the assessment, intervention, and outcomes of a multimodal physiotherapy program in a patient with a postoperative proximal tibial fracture. Although the data collected were primarily quantitative (e.g., NRS, ROM, MMT, LEFS), the study adopts a descriptive clinical approach rather than inferential statistical analysis, which is consistent with case report methodology.

A 22-year-old female patient presented with a history of left proximal tibial fracture following a motorcycle accident on July 8, 2025. The patient underwent open reduction internal fixation (ORIF) using plate and screw fixation. Physiotherapy intervention was initiated approximately three months postoperatively in an outpatient setting. The patient reported persistent pain around the surgical site, particularly during knee flexion, accompanied by stiffness, reduced mobility, and difficulty performing daily activities such as walking, squatting, and religious activities. Anthropometric data, comorbidities, medication history, and prior functional status were not fully documented.

The patient's anthropometric characteristics (e.g., height, weight, and body mass index), medical history, medication use, and detailed social history were not systematically recorded at the time of assessment. In addition, baseline functional status prior to injury was not formally documented. This represents a limitation of the clinical data collection.

A comprehensive physical examination was conducted, including inspection, palpation, movement assessment, and functional evaluation. The patient demonstrated localized tenderness around the incision site, limited knee flexion, and reduced muscle strength in the affected limb. Pain intensity was assessed using the Numeric Rating Scale (NRS), joint mobility using goniometric measurement, muscle strength using Manual Muscle Testing (MMT), and functional ability using the Lower Extremity Functional Scale (LEFS). These instruments are widely used in musculoskeletal rehabilitation and have established validity and reliability in clinical settings. Measurement procedures were standardized, with ROM assessed in a supine position using a universal goniometer and MMT performed according to conventional grading criteria. Baseline clinical characteristics were recorded prior to the first intervention session to establish the initial functional status of the patient.

Table 1. Baseline Characteristics of the Patient

Parameter	Value
Age	22 years
Sex	Female
Diagnosis	Postoperative proximal tibial fracture (left)
Pain (NRS) – movement	5/10
Pain (NRS) – tenderness	3/10
Knee ROM (flexion)	0–100°
Muscle strength (MMT)	Grade 3
LEFS score	57.5

To improve clarity and comply with CARE recommendations, the clinical course of the patient is summarized in a structured timeline.

Table 2. Clinical Timeline

Time Point	Event
July 2025	Injury and surgical fixation (ORIF)
October 2025	Initiation of physiotherapy
Week 1	Baseline assessment (T1)
Week 2	Mid-intervention assessment (T2)
Week 3	Final assessment (T3)

The clinical timeline was structured into distinct phases, including injury, surgical intervention, initiation of physiotherapy, and sequential outcome assessments (T1–T3), to improve clarity of patient progression. Figure 1. CARE timeline illustrating the sequence of patient management from injury, surgical intervention, initiation of physiotherapy, and outcome assessments at baseline (T1), mid-intervention (T2), and post-intervention (T3).

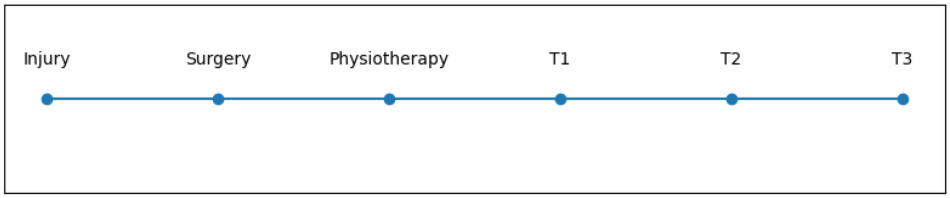

Figure 1. CARE Timeline of Patient Management in Proximal Tibial Fracture Rehabilitation

The diagnosis of proximal tibial fracture was established based on clinical examination and surgical management (ORIF). However, detailed radiological findings, fracture classification (e.g., AO classification), and differential diagnosis were not documented. [Perlu referensi tambahan: klasifikasi fraktur tibia dan peran imaging] The prognosis was considered favorable given the patient's young age and absence of reported complications, although this was not formally assessed using standardized prognostic tools.

Radiological findings, fracture classification (e.g., AO classification), and detailed diagnostic imaging reports were not available in this case. Therefore, the diagnosis was based on clinical history and surgical intervention (open reduction internal fixation). Differential diagnosis was not formally explored due to the confirmed postoperative status.

The physiotherapy program consisted of a multimodal approach combining electrotherapy and exercise-based interventions. The intervention was administered over three weeks with a frequency of two sessions per week (total of six sessions). A structured summary of the intervention parameters is presented below.

Table 3. Physiotherapy Intervention Protocol

Intervention	Parameters
Infrared Therapy	15 minutes/session, 2×/week, luminous IR, distance 45 cm
TENS	15 minutes/session, frequency 60 Hz, monopolar electrode placement
Strengthening Exercises	3 sets × 10 repetitions, daily home program
ROM Exercises	Active and assisted movements, 3 sets × 10 repetitions
Gait Training	Partial to full weight-bearing progression, 15 minutes/session

Infrared therapy was applied to improve circulation, reduce muscle spasm, and promote tissue relaxation. TENS was used to modulate pain through sensory stimulation. However, specific parameters such as pulse width and modulation mode were not fully documented. The TENS intervention was applied at a frequency of 60 Hz; however, specific parameters such as pulse width and modulation mode were not documented, which limits reproducibility. [Perlu referensi tambahan: parameter optimal TENS] Exercise therapy included strengthening of the quadriceps and hamstrings, ROM exercises, and functional training. Gait training focused on progressive weight-bearing and correction of walking patterns. Progression of exercises was adjusted based on patient tolerance, although detailed progression criteria were not formally standardized. Exercise progression was adjusted based on patient tolerance and clinical response across sessions; however, detailed session-by-session progression parameters were not formally recorded.

Clinical outcomes were assessed at three predefined time points: baseline (T1), mid-intervention after three sessions (T2), and post-intervention after six sessions (T3). The evaluation focused on four primary outcomes, including pain intensity measured using the Numeric Rating Scale (NRS), joint mobility assessed through range of motion (ROM), muscle strength evaluated using Manual Muscle Testing (MMT), and functional performance measured with the Lower Extremity Functional Scale (LEFS). The LEFS is a validated instrument commonly used to assess lower extremity function, with higher scores indicating better functional ability.[2]

All assessments and interventions were conducted by the same physiotherapist. Blinding was not applied due to the nature of the case report. This may introduce potential measurement bias. The patient was instructed to perform home exercises daily. However, adherence to the home program was not objectively monitored. Information regarding concurrent pharmacological treatment (e.g., analgesics) was not documented. Adherence to the prescribed home exercise program was not objectively monitored, and information regarding concurrent pharmacological treatment was not available.

Written informed consent was obtained from the patient prior to participation and publication of this case report, including the use of anonymized clinical data.Formal ethical approval was not required for this study, as it represents a single case report without experimental intervention and was conducted as part of routine clinical practice.All procedures were carried out in accordance with the principles of the Declaration of Helsinki.

Results

Clinical outcomes were assessed at three time points: baseline (T1), mid-intervention (T2; after three sessions), and post-intervention (T3; after six sessions). The outcomes included pain intensity, joint range of motion (ROM), muscle strength, and functional ability. Pain intensity was measured using the Numeric Rating Scale (NRS) at rest, during movement, and upon palpation. The results are presented in Table 4.

Table 4. Pain Intensity (NRS) Across Time Points

Parameter	T1	T2	T3
Pain at rest	0	0	0
Pain during movement	5	4	3
Tenderness	3	2	1

Pain at rest remained unchanged at zero throughout the observation period. Pain during movement decreased progressively from T1 to T3. Similarly, tenderness showed a gradual reduction across all time points. Knee joint ROM was measured using a goniometer. The results are summarized in Table 5.

Table 5. Knee Range of Motion (ROM)

Parameter	T1	T2	T3
Flexion	100°	110°	120°
Internal rotation	20°	25°	30°
External rotation	20°	25°	30°

Knee flexion demonstrated a progressive increase across time points. Rotational movements (internal and external rotation) also showed gradual improvement. Muscle strength was evaluated using Manual Muscle Testing (MMT). The results are shown in Table 6.

Table 6. Muscle Strength (MMT)

Muscle Group	T1	T2	T3
Knee flexors	3	3	4
Knee extensors	3	3	4

Muscle strength remained stable between T1 and T2 and increased at T3 for both flexor and extensor muscle groups. Functional ability was assessed using the Lower Extremity Functional Scale (LEFS). The results are presented in Table 7.

Table 7. Functional Outcome (LEFS Score)

Time Point	Score
T1	57.5
T2	75
T3	87.5

The LEFS score increased progressively across all time points, indicating improvement in functional ability. To enhance the clarity of the observed clinical changes, graphical representations of outcome trends across the three assessment time points (T1, T2, and T3) are presented. These figures illustrate the progression of pain intensity, joint range of motion, muscle strength, and functional performance following the multimodal physiotherapy intervention. As shown in Figure 2, pain intensity demonstrated a

progressive decline over time, both during movement and upon palpation. The graphical trend highlights a consistent reduction in NRS scores across all assessment points.

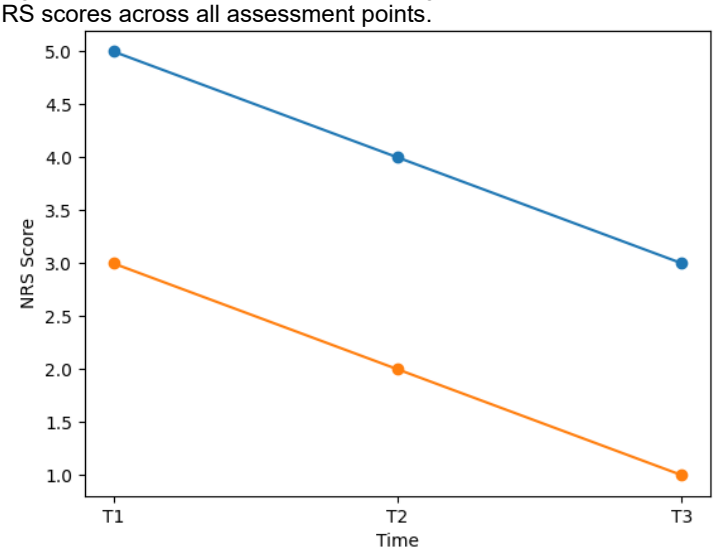

Figure 2. Pain Trend (NRS)

Changes in joint mobility are presented in Figure 3, which illustrates the gradual improvement in knee flexion as well as internal and external rotation angles throughout the intervention period.

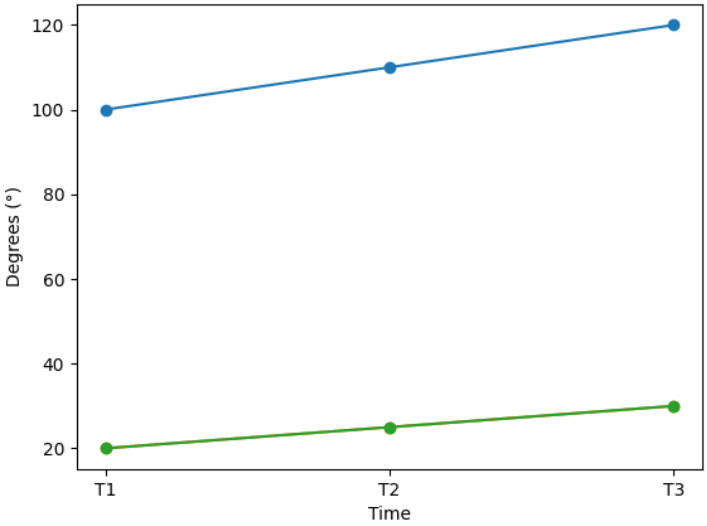

Figure 3. ROM Improvement

Muscle strength progression is depicted in Figure 4, showing changes in Manual Muscle Testing (MMT) grades for both flexor and extensor muscle groups across time.

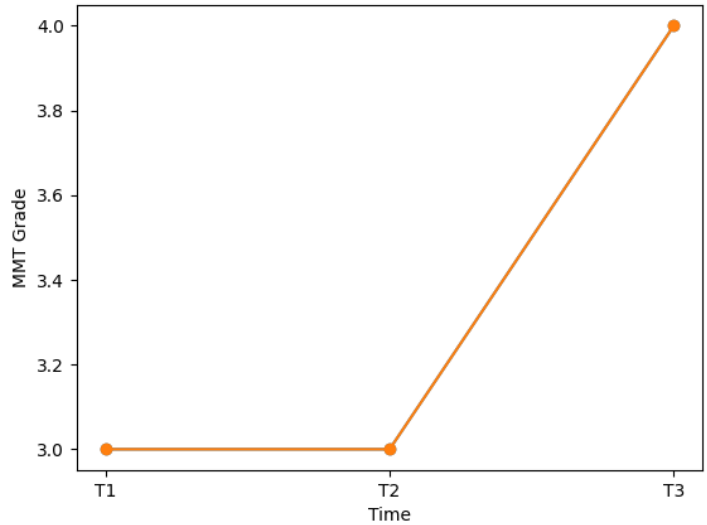

Figure 4. Muscle Strength (MMT)

Finally, functional outcomes are summarized in **Figure 5**, which demonstrates the increase in Lower Extremity Functional Scale (LEFS) scores, reflecting improved functional capacity over the course of treatment.

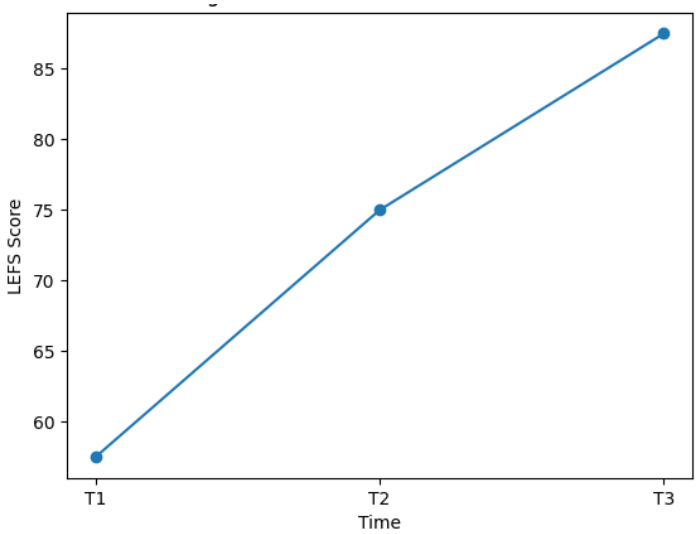

Figure 5. Functional Outcome (LEFS)

No adverse events, complications, or worsening of symptoms were observed during the intervention period.

Discussion

This case report describes the clinical outcomes of a multimodal physiotherapy program in a patient following proximal tibial fracture surgery. The findings demonstrate progressive improvements in pain, joint mobility, muscle strength, and functional performance over a three-week intervention period.

Pain reduction observed in this case is consistent with previous evidence supporting the analgesic effects of Transcutaneous Electrical Nerve Stimulation (TENS) and thermal modalities. TENS is known to modulate nociceptive transmission through activation of descending inhibitory pathways and stimulation of large-diameter afferent fibers, thereby reducing pain perception.[11] In addition, infrared therapy contributes to vasodilation and increased local blood flow, which may enhance tissue metabolism and facilitate the removal of inflammatory mediators associated with pain.[12] The gradual decrease in movement pain and tenderness across sessions in this case aligns with these physiological mechanisms.

Improvements in joint range of motion (ROM) observed in this patient are likely attributable to the combined effects of active exercise and soft tissue adaptation. Immobilization following fracture is a major contributor to joint stiffness and periarticular fibrosis.[13] Early and progressive ROM exercises help maintain joint nutrition, prevent adhesions, and improve capsular extensibility. Similar findings have been reported in previous case studies, where structured rehabilitation programs resulted in significant gains in knee mobility after tibial fracture surgery.[14]

Muscle strength improvements, particularly in the quadriceps and hamstring muscle groups, are consistent with the effects of progressive strengthening exercises. Postoperative quadriceps inhibition is a well-documented phenomenon that can delay functional recovery.[10] Strengthening interventions, including isometric and active exercises, facilitate neuromuscular reactivation and improve force-generating capacity.[15] In the present case, the increase in Manual Muscle Testing (MMT) grade from 3 to 4 indicates improved ability to generate force against gravity and minimal resistance, which is clinically relevant for functional activities.

Functional recovery, as reflected by the increase in Lower Extremity Functional Scale (LEFS) score from 57.5 to 87.5, represents a substantial improvement in the patient's ability to perform daily activities. The magnitude of change (30 points) exceeds the reported minimal clinically important difference (MCID) for LEFS, which is approximately 9 points, indicating that the observed improvement is clinically meaningful.[16] This functional gain is likely influenced by the integration of gait training, which facilitates coordinated movement, weight-bearing progression, and balance control.[17]

Importantly, the multimodal nature of the intervention may have contributed to the overall outcome through complementary mechanisms. While electrotherapy modalities primarily address pain, exercise-based interventions target impairments in strength, mobility, and motor control. The combination of these approaches may enhance rehabilitation efficiency compared to single-modality interventions, although the specific contribution of each component cannot be isolated in this case.

However, several factors should be considered when interpreting these findings. First, natural healing processes following fracture may have contributed to the observed improvements, independent of the intervention. Second, placebo effects and patient expectations may influence perceived outcomes, particularly in pain-related measures. Third, the absence of a control condition and standardized progression criteria limits the ability to establish causal relationships between the intervention and outcomes.

This study has several limitations. As a single-case report, the findings cannot be generalized to a broader population. The short duration of follow-up (three weeks) does not allow assessment of long-term outcomes. Additionally, the lack of detailed intervention parameters, such as TENS pulse width and progression criteria, reduces reproducibility. The absence of patient-reported qualitative data also limits understanding of the patient's subjective experience during rehabilitation. No long-term follow-up assessment was conducted beyond the three-week intervention period, which limits the ability to evaluate the sustainability of the observed improvements.

Despite these limitations, this case report provides practical insights into the application of a multimodal physiotherapy program in postoperative tibial fracture management. Clinically, the findings suggest that integrating electrotherapy with progressive exercise and gait training may support functional recovery. Future studies with larger sample sizes, controlled designs, and longer follow-up periods are needed to confirm these findings and establish evidence-based rehabilitation protocols.

Conclusion

This case report demonstrates that a multimodal physiotherapy program, consisting of infrared therapy, transcutaneous electrical nerve stimulation, strengthening exercises, range of motion exercises, and gait training, was associated with improvements in pain, joint mobility, muscle strength, and functional performance in a patient following proximal tibial fracture surgery. The observed

improvement in functional outcome, reflected by a substantial increase in LEFS score exceeding the minimal clinically important difference, highlights the potential clinical relevance of this intervention.

However, as this report is based on a single case with a short follow-up duration, the findings should be interpreted with caution. The results cannot be generalized, and the contribution of natural healing processes cannot be excluded. Future research employing larger sample sizes, controlled study designs, and longer follow-up periods is required to establish the effectiveness and optimize the protocol of multimodal physiotherapy interventions in postoperative tibial fracture rehabilitation.

Author Contribution

Andini Nurul Fadhilah: Conceptualization, data collection, manuscript drafting.
Totok Budi Santoso: Supervision, methodology, critical revision of the manuscript.
Lathiifah Muknatun Amiin: Data analysis, interpretation of results, manuscript editing.

Acknowledgments

The authors would like to thank the patient for her participation and consent in this case report.

Conflict of Interest Statement

The authors declare no conflict of interest.

Funding Sources

This study received no external funding.

Ethics Statement

Written informed consent was obtained from the patient for participation and publication of this case report, including anonymized clinical data. Formal ethical approval was not required as this study represents a single case report conducted as part of routine clinical practice. All procedures were conducted in accordance with the principles of the Declaration of Helsinki.
Written informed consent was obtained from the patient prior to publication of this case report.

Patient Perspective

The patient reported a noticeable reduction in pain during movement and expressed increased confidence in performing daily activities such as walking and squatting. The patient also indicated satisfaction with the rehabilitation process and perceived gradual improvement in independence. No major barriers to participation were reported.

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