Majalah Ilmiah Fisioterapi Indonesia
Indonesian Scientific Journal of Physiotherapy

Case Reports / Case Studies
ISSN (Print): 2303-1921
ISSN (Online): 2722-0443
Volume 14, Number 2, Pages 577-581 (2026)
DOI: https://doi.org/10.24843/mifi.000001840

Early Physiotherapy After Surgery for Infected Distal Humerus Nonunion: A Case Report

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Received 20 April 2026; Revised 26 April 2026; Accepted 28 April 2026; Published 16 May 2026
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Abstract
Background: Infected nonunion of distal humerus fractures is a complex condition requiring infection control, stabilization, and rehabilitation to prevent stiffness and functional decline. Evidence regarding early physiotherapy during the acute postoperative phase remains limited.
Objective: To describe the clinical outcomes of early physiotherapy following surgery in a patient with infected distal humerus nonunion.
Methods: This case report involved a 32 year old male who underwent debridement, implant removal, antibiotic bone cement placement, and external fixation. Physiotherapy was initiated on postoperative day 1 and conducted over four sessions during hospitalization. Outcomes included pain using the Numeric Rating Scale (NRS), range of motion (ROM), muscle strength using Manual Muscle Testing (MMT), edema by limb circumference, and functional ability using the Patient Specific Functional Scale (PSFS). Elbow ROM was not assessed during the protective phase.
Results: Active movement pain decreased from 5/10 to 3/10, while passive movement pain decreased from 6/10 to 4/10. Wrist edema reduced from 19 cm to 18 cm. Shoulder ROM improved from 40° to 90°, and wrist ROM increased from 60° to 70°. Muscle strength improved from 3− to 3 at the shoulder and from 3− to 4 at the wrist. PSFS scores improved in finger movement and self care activities.
Conclusion: Early physiotherapy may help reduce pain and edema while preserving upper limb function during the postoperative protective phase in infected distal humerus nonunion.

Keywords
Fracture Nonunion; Humerus Fractures; External Fixators; Exercise Therapy; Rehabilitation

Introduction

Distal humerus fractures are relatively uncommon injuries, accounting for approximately 2% of all fractures, yet they represent a clinically challenging condition due to their intra-articular involvement and complex anatomical structure.[1] The incidence in adults is estimated at 5.7 cases per 100,000 population annually, with mechanisms ranging from high-energy trauma in younger individuals to low-energy falls in the elderly.[1]

One of the most significant complications following distal humerus fractures is nonunion, defined as the failure of bone healing within an expected period.[1] Despite advances in surgical techniques and fixation methods, nonunion remains a persistent clinical problem, occurring in approximately 8–25% of cases.[1]This condition is associated with chronic pain, joint instability, deformity, and severe functional limitation.[1] The complexity increases substantially in cases of infected (septic) nonunion, where the presence of infection disrupts osteogenesis, compromises vascularity, and impairs the structural integrity of surrounding soft tissues.[2]

The management of infected distal humerus nonunion requires a multifaceted approach that integrates infection control, mechanical stabilization, and functional rehabilitation.[3] Surgical strategies typically include radical debridement to remove necrotic tissue and bacterial biofilm, removal of previously implanted hardware, and the use of antibiotic-loaded bone cement to achieve high local antimicrobial concentrations.[4] In situations where internal fixation is not feasible due to poor bone quality or extensive tissue damage, external fixation is often employed as an alternative stabilization method, particularly in the presence of infection or bone loss.[3]

Although external fixation provides adequate mechanical stability, it is associated with a high risk of postoperative complications, particularly joint stiffness.[5] The elbow joint is especially vulnerable to stiffness due to its anatomical characteristics and the combined effects of trauma, inflammation, and immobilization.[6] Without appropriate management, this may lead to arthrofibrosis and long-term functional impairment.[5] Therefore, early rehabilitation plays a critical role in preventing secondary complications and optimizing functional recovery.[5]

Physiotherapy during the acute postoperative phase focuses on pain and edema control, preservation of mobility in uninvolved joints, prevention of muscle atrophy, and maintenance of functional capacity.[7] Early mobilization of adjacent joints, combined with controlled muscle activation, has been shown to support circulation, reduce edema, and facilitate neuromuscular function.[7,8] However, rehabilitation in cases of infected nonunion with external fixation presents unique challenges, as interventions must balance tissue protection with functional preservation.[8]

Despite the recognized importance of early rehabilitation, current evidence remains limited regarding the application of physiotherapy in the acute phase of infected distal humerus nonunion, particularly in patients managed with external fixation. Existing studies predominantly focus on surgical outcomes or late-stage rehabilitation, with minimal emphasis on early-phase physiotherapy strategies and their clinical impact.

This case is therefore clinically relevant as it presents early physiotherapy management in a complex condition involving infected nonunion and external fixation, where rehabilitation must be carefully adapted to surgical constraints. Accordingly, this report aims to describe the clinical outcomes of early physiotherapy intervention in maintaining function and supporting recovery during the protective postoperative phase. Based on the existing evidence and clinical rationale, it is hypothesized that early physiotherapy initiated during the protective postoperative phase may contribute to pain reduction, edema control, and preservation of functional capacity without compromising surgical stability.

Methods

This study was designed as a descriptive single-patient case report and prepared in accordance with the CARE (CAse REport) guidelines to ensure transparency and completeness of clinical reporting. The patient was a 32-year-old male diagnosed with infected nonunion of the right distal humerus following previous surgical fixation failure. The case was selected due to its clinical complexity, involving infected nonunion managed with debridement, removal of implant, antibiotic-loaded bone cement, and external fixation, followed by early physiotherapy during the acute postoperative phase. At the time of reporting, detailed anthropometric data (height, weight), comorbidities, and laboratory parameters (e.g., inflammatory markers, glycemic status) were not fully available in the medical record. The patient's history of trauma and prior treatments before removal of implant could not be comprehensively reconstructed. These limitations are acknowledged as part of the clinical reporting constraints.

Clinical findings at baseline included postoperative pain, localized edema, limited mobility of the affected upper limb, and reduced functional ability. Inspection of the surgical site indicated the presence of external fixation and postoperative inflammatory signs without documented complications such as wound dehiscence or active drainage. A standardized neurological examination and detailed infection workup (e.g., microbiological culture results) were not available. The diagnosis of infected nonunion was established by the orthopedic surgical team based on clinical and intraoperative findings; however, specific diagnostic criteria and differential diagnoses were not explicitly documented. The diagnosis of infected distal humerus nonunion was established by the orthopedic surgical team based on clinical presentation and intraoperative findings, including the presence of nonunion and signs of infection. However, detailed diagnostic criteria, microbiological confirmation, and radiological progression data were not available in the medical record. Differential diagnoses, such as aseptic nonunion or delayed union, were not explicitly documented. These limitations are acknowledged and reflect constraints in retrospective clinical documentation.

Figure 1 illustrates the clinical timeline and rehabilitation workflow of a patient with distal humeral fracture nonunion accompanied by infection. The process began with the initial traumatic injury followed by surgical internal fixation. Subsequently, the patient developed nonunion associated with infection, requiring debridement and implant removal. Antibiotic bone cement was then applied, followed by external fixation to maintain joint stability. Physiotherapy intervention was initiated on the first postoperative day to facilitate functional recovery and prevent secondary complications. Serial evaluations were conducted at T0, T1, T2, and T3 throughout hospitalization to monitor pain, range of motion, muscle strength, edema, and functional outcomes.

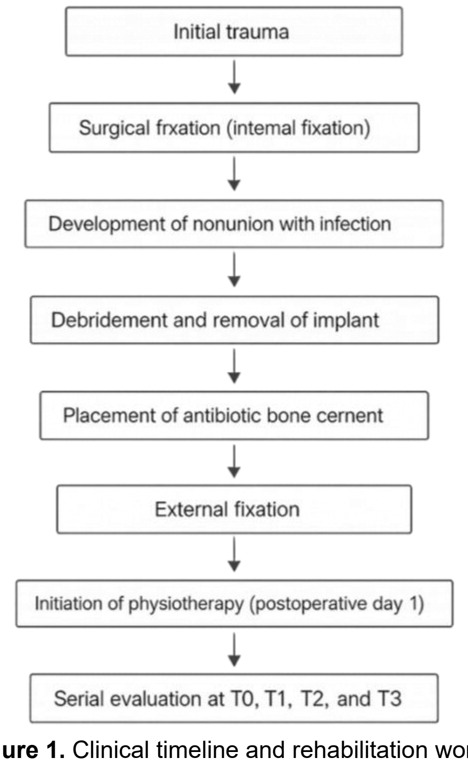

Figure 1. Clinical timeline and rehabilitation workflow in a patient with infected distal humeral fracture nonunion.

Physiotherapy intervention was initiated on the first postoperative day once the patient was clinically stable. The intervention was administered by a licensed physiotherapist in an inpatient setting. Treatment was conducted once daily over four consecutive sessions during hospitalization. Each session lasted approximately 20–30 minutes, depending on patient tolerance and clinical condition. The intervention program was designed based on postoperative rehabilitation principles for elbow surgery and adapted to the protective phase required by external fixation. Elbow joint movement was restricted to maintain mechanical stability and protect soft tissue healing. Therefore, therapeutic interventions focused on safe segments, including the shoulder, wrist, and hand. The intervention strategy was guided by clinical reasoning that prioritized protection of the surgical site while maintaining function in adjacent joints. This approach aimed to balance tissue healing requirements with the prevention of secondary complications such as stiffness and muscle atrophy.

Pain and edema management were addressed through limb positioning, gentle active movement, and patient education on joint protection. Active range of motion exercises were performed for the shoulder, wrist, and fingers within pain-free limits. Exercise dosage consisted of 2–3 sets of 8–10 repetitions per movement, adjusted according to patient tolerance. In addition, gentle isometric contractions of the elbow musculature were performed without producing joint movement to maintain neuromuscular activation while preserving fixation stability. Progression of the intervention was guided by daily clinical evaluation, particularly changes in pain intensity, edema, and functional ability.

Outcome measures were selected based on their clinical relevance and established measurement properties. Pain intensity was assessed using the Numeric Rating Scale (NRS), a valid and reliable tool for musculoskeletal pain evaluation.[9] Range of motion (ROM) was measured using a standard goniometer with the patient positioned in a standardized seated position, following conventional anatomical landmarks and alignment protocols for upper limb assessment.[10] Elbow ROM was not tested (NT) throughout the observation period due to surgical restrictions. Muscle strength was evaluated using Manual Muscle Testing (MMT), which is widely used in clinical settings for assessing muscle performance.[11] Edema was measured using a flexible tape measure at a standardized anatomical landmark at the wrist, with measurements taken consistently at the same location across sessions and compared with the contralateral limb to enhance reliability.[12] Functional ability was assessed using the Patient-Specific Functional Scale (PSFS), which allows individualized evaluation of patient-relevant activities and has demonstrated responsiveness in musculoskeletal rehabilitation.[13]

Outcome assessments were conducted at four time points: baseline (T0), and after each subsequent physiotherapy session (T1, T2, and T3). All measurements were performed by the same physiotherapist to reduce inter-rater variability.

Data analysis was conducted descriptively by comparing changes in outcome measures across time points. Absolute changes (Δ) were calculated for key variables, including NRS, edema, ROM, MMT, and PSFS scores, to illustrate clinical progression. Although inferential statistical analysis was not applicable due to the single-case design, clinical interpretation was supported by general thresholds of meaningful change reported in the literature. For pain outcomes, a reduction of approximately 2 points on the Numeric Rating Scale (NRS) is generally considered clinically meaningful.[9] For functional outcomes, the Patient-Specific Functional Scale (PSFS) demonstrates clinically meaningful changes typically ranging from 1.3 to 2.0 points depending on the clinical population.[13]

No adverse events were observed during the intervention period. All procedures were performed within patient tolerance, and continuous monitoring was conducted to ensure safety and prevent complications.

This case report involved routine clinical care and did not require formal ethical approval according to institutional policy. However, written informed consent was obtained from the patient for participation and publication of anonymized clinical data in accordance with ethical standards for case reporting.

Results

This case report presents the clinical outcomes of early physiotherapy initiated during the acute postoperative phase in a patient with infected distal humerus nonunion. Outcome measures were assessed at four time points: baseline (T0), and after each physiotherapy session (T1, T2, and T3), to capture short-term clinical changes during hospitalization. To provide an integrated overview of all outcome measures, the overall clinical progression across the intervention period is summarized in Table 1. This table presents key parameters and their changes over time, including absolute differences (Δ) from baseline to the final evaluation.

Table 1. Summary of Clinical Changes from T0 to T3

Parameter	T0	T1	T2	T3	Δ (T0–T3)
NRS (active pain)	5/10	5/10	3/10	3/10	−2
NRS (passive pain)	6/10	5/10	4/10	4/10	−2
NRS (rest pain)	2/10	2/10	1/10	1/10	−1
NRS (tenderness)	7/10	7/10	6/10	6/10	−1
Wrist edema (cm)	19	19	18.5	18	−1
Shoulder MMT	3−	3−	3	3	+
Elbow MMT	1	1	1	1	0
Wrist MMT	3−	3	4	4	+
PSFS (finger movement)	3	4	5	5	+2
PSFS (feeding)	1	2	2	2	+1
PSFS (self-care)	1	2	2	2	+1

Pain intensity was further detailed to illustrate changes across different pain conditions, including rest, active movement, passive movement, and tenderness, as presented in Table 2.

Table 2. Changes in Pain Intensity (NRS)

Pain Type	T0	T1	T2	T3
Rest pain	2/10	2/10	1/10	1/10
Active movement pain	5/10	5/10	3/10	3/10
Passive movement pain	6/10	5/10	4/10	4/10
Tenderness	7/10	7/10	6/10	6/10

A graphical representation of pain intensity trends (NRS) across time points (T0–T3) is recommended to enhance visualization of clinical progression. Range of motion (ROM) was evaluated in the shoulder and wrist joints, while elbow ROM was not tested (NT) due to the protective postoperative phase and external fixation. Detailed measurements are presented in Table 3.

Table 3. Changes in Range of Motion (ROM)

Joint	Measurement	T0	T1	T2	T3
Shoulder	Active (extension–flexion)	40°–10°	80°–20°	90°–20°	90°–20°
Shoulder	Passive (extension–flexion)	50°–30°	90°–30°	100°–30°	115°–30°
Elbow	Active & Passive	NT	NT	NT	NT
Wrist	Active	60°	65°	70°	70°
Wrist	Passive	70°	80°	80°	80°

Muscle strength changes assessed using Manual Muscle Testing (MMT) are summarized in Table 4.

Table 4. Changes in Muscle Strength (MMT)

Region	T0	T1	T2	T3
Shoulder	3−	3−	3	3
Elbow	1	1	1	1
Wrist	3−	3	4	4

Edema changes based on wrist circumference measurements are presented in Table 5.

Table 5. Changes in Wrist Edema

Side	T0	T1	T2	T3
Right (affected)	19 cm	19 cm	18.5 cm	18 cm
Left (unaffected)	17 cm	17 cm	17 cm	17 cm

Functional outcomes assessed using the Patient-Specific Functional Scale (PSFS) are presented in Table 6.

Table 6. Changes in Functional Ability (PSFS)

Activity	T0	T1	T2	T3
Finger movement	3	4	5	5
Feeding	1	2	2	2
Self-care	1	2	2	2

When analyzed as an aggregate score, the mean PSFS improved from 1.67 at baseline (T0) to 3.00 at T3, indicating an overall functional improvement of +1.33 points. To further highlight the temporal pattern of clinical changes across all parameters, a consolidated progression overview is presented in Table 7. This table summarizes the qualitative progression observed at each evaluation point.

Table 7. Clinical Progression Overview

Time Point	Clinical Status Summary
T0	Moderate pain, edema, limited mobility, reduced strength, impaired function
T1	Minimal change, early stabilization phase
T2	Reduction in pain and edema, improvement in ROM and strength
T3	Stabilization of improvements with functional gains

No adverse events were reported during the intervention period.

Discussion

This case report demonstrates short-term improvements in pain intensity, edema, muscle strength, and functional ability following early physiotherapy initiated during the acute postoperative phase in a patient with infected distal humerus nonunion. These findings highlight the potential role of early rehabilitation in preserving upper limb function despite surgical constraints and joint immobilization.[7,8]

Compared with previous studies on postoperative rehabilitation in upper limb injuries, the improvements observed in this case are consistent with findings that early mobilization of uninvolved joints contributes to pain reduction and functional preservation.[7,8] However, unlike controlled studies, the absence of a comparator group in this case limits causal inference. Furthermore, most existing literature focuses on non-infected cases or later rehabilitation phases, highlighting the limited evidence available for early physiotherapy in infected nonunion with external fixation. This underscores the need for cautious interpretation and further investigation.

The observed reduction in pain across multiple conditions, including active and passive movement, may be explained by the combined effects of postoperative recovery and physiotherapy interventions targeting edema control and neuromuscular activation.[8] Pain in distal humerus nonunion is commonly associated with mechanical instability and inflammatory processes within periarticular tissues.[1,4] Early physiotherapy interventions, such as gentle mobilization of uninvolved joints and isometric muscle activation, may contribute to improved circulation and reduced nociceptive input, thereby facilitating pain modulation.[6] These findings are consistent with previous reports indicating that early rehabilitation can reduce postoperative pain and improve tolerance to movement in upper limb injuries.[14]The observed reduction of 2 points in NRS meets the commonly accepted threshold for minimal clinically important difference (MCID), suggesting that the improvement is not only statistically observable but also clinically meaningful.[9]

The gradual reduction in edema observed in this case further supports the effectiveness of early mobilization strategies.[7,8] Postoperative edema is influenced by inflammatory responses, impaired venous return, and reduced muscle pump activity due to immobilization.[5] The implementation of active movement in the shoulder, wrist, and fingers likely enhanced lymphatic and venous drainage, contributing to the observed decrease in limb circumference.[7] This is clinically important, as persistent edema may lead to fibrosis, joint stiffness, and delayed functional recovery.[8,14]

Although elbow joint movement was restricted due to the protective phase and external fixation, improvements in shoulder and wrist range of motion were observed. This reflects the principle of regional interdependence in rehabilitation, where maintaining mobility in adjacent joints can prevent secondary complications and support overall limb function.[7,8] The preservation of proximal and distal joint mobility is particularly critical in cases involving prolonged immobilization of the primary joint, as it helps reduce compensatory movement patterns and functional decline.[8,14]

Muscle strength improvements were evident in the shoulder and wrist, while elbow strength remained limited due to immobilization. The use of isometric contractions at the elbow likely contributed to maintaining neuromuscular activation without compromising fixation stability.[7,8] Previous studies have emphasized the importance of early muscle activation in preventing disuse atrophy and promoting neuromuscular efficiency during immobilization periods.[7,14] However, the use of Manual Muscle Testing (MMT) as an outcome measure should be interpreted cautiously, as it has limited sensitivity in detecting small but clinically relevant changes in muscle strength.[11]

Functional improvements, as measured by the Patient-Specific Functional Scale (PSFS), were most pronounced in distal hand activities, particularly finger movement. This finding aligns with the clinical expectation that distal functions recover earlier when proximal joints remain restricted.[6,8] However, improvements in more complex activities, such as feeding and self-care, were modest, reflecting the ongoing limitation imposed by elbow immobilization.[6,8] These findings emphasize the importance of staged rehabilitation, where early gains in distal function may serve as a foundation for subsequent recovery once joint mobilization is permitted.[8,14] Similarly, the PSFS improvement of approximately 1.33–2 points approaches the reported MCID range, indicating clinically relevant functional gains.

The combined surgical and physiotherapy approach observed in this case is consistent with current principles in the management of infected nonunion, which emphasize infection control, mechanical stability, and functional preservation.[2,4] While surgical intervention addresses the underlying pathology, physiotherapy plays a complementary role in mitigating secondary complications, such as stiffness and muscle weakness.[7,8] The integration of these approaches is critical in optimizing patient outcomes.[2,4,7]

Despite these positive findings, several limitations must be acknowledged. First, as a single-case report, the findings cannot be generalized to broader populations. Second, the duration of follow-up was limited to the acute inpatient phase, preventing evaluation of long-term functional outcomes. Third, the absence of standardized neuropathic or infection severity assessments and incomplete clinical data (e.g., laboratory findings, comorbidities) limit the depth of clinical interpretation. Fourth, no control condition was available, making it difficult to isolate the specific effects of physiotherapy from natural postoperative recovery. Additionally, no patient-reported outcomes beyond PSFS were included, limiting insight into perceived quality of life.

Furthermore, the lack of detailed diagnostic confirmation, such as microbiological findings or radiological progression, restricts the ability to fully contextualize the severity of the condition.[2,4] Potential sources of bias inherent in case reports, including selection bias and reporting bias, must also be considered when interpreting the findings.

From a clinical perspective, this case highlights the importance of early physiotherapy intervention in complex orthopedic conditions involving infection and external fixation.[4,7] The findings suggest that even in the presence of joint immobilization, targeted rehabilitation strategies focusing on safe segments can contribute to maintaining function and preventing secondary complications.[6,8,14]

Future research should focus on prospective studies or randomized controlled trials to evaluate the effectiveness of early physiotherapy in infected nonunion cases. Standardization of intervention protocols, inclusion of objective outcome measures, and longer follow-up periods are essential to strengthen the evidence base and guide clinical practice.[4] The patient reported subjective improvement in comfort and the ability to perform basic hand movements during the intervention period. Although functional limitations remained due to elbow immobilization, the patient expressed increased confidence in using the affected limb for simple daily activities.

Conclusion

This case report demonstrates that early physiotherapy initiated during the acute postoperative phase in a patient with infected distal humerus nonunion was associated with reductions in pain and edema, as well as preservation of muscle strength and functional ability in unaffected segments. These findings directly address the study objective, indicating that targeted rehabilitation strategies can be implemented safely during the elbow protective phase without compromising surgical outcomes.

From a clinical perspective, early physiotherapy focusing on pain control, edema management, and mobilization of adjacent joints may help prevent secondary complications such as stiffness and functional decline. However, these findings should be interpreted with caution due to the single-case design, short follow-up duration, and limited availability of comprehensive clinical data.

Future research should include well-designed prospective studies with larger sample sizes, standardized intervention protocols, and extended follow-up periods to determine the effectiveness and generalizability of early physiotherapy in patients with infected nonunion of the distal humerus. This case contributes to the limited body of evidence on early physiotherapy in infected distal humerus nonunion with external fixation, highlighting its potential role in maintaining function during the protective postoperative phase.

Author Contribution

Arini Ishmah Rose Haryanto: Conceptualization, Methodology, Investigation, Data Curation, Writing Original Draft.
Arif Pristianto: Supervision, Formal Analysis, Validation, Writing Review and Editing.
Prihantoro Larasati: Investigation, Resources, Visualization, Data Curation.

Acknowledgments

The authors would like to acknowledge the clinical team involved in the patient’s care and thank the patient for providing consent to share this case for academic purposes.

Conflict of Interest Statement

The authors declare no conflict of interest.

Funding Sources

This study received no external funding.

Ethics Statement

This case report was conducted as part of routine clinical care and did not require formal ethical approval according to institutional policy of the treating hospital. Written informed consent was obtained from the patient. Written informed consent was obtained from the patient for participation and publication of anonymized clinical data in accordance with ethical standards for case reporting.

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