

A Case Report

Functional Rehabilitation After a Complex Subtrochanteric Fracture Treated with Locked Intramedullary Nail Osteosynthesis

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Abstract: Complex subtrochanteric fracture represents a severe injury of the proximal femur, with a significant functional impact and complex postoperative rehabilitation requirements. This case report describes the clinical evolution of a 54-year-old female patient admitted following a skiing accident, in whom radiographic examination revealed a complex subtrochanteric fracture with traumatic detachment and displacement of the lesser trochanter by 30 mm relative to the femoral shaft, surgically treated by osteosynthesis with a locked intramedullary nail. Postoperatively, the patient presented with pain in the hip joint and a significant limitation of hip range of motion, resulting in impaired overall functional capacity. An individualized physiotherapy program was initiated, focusing on pain control, restoration of joint mobility, and recovery of muscle strength. Clinical evolution was assessed using functional scales, goniometric measurements, and muscle strength testing. Following the rehabilitation intervention, progressive improvement in hip joint mobility, increased range of motion, and enhanced muscle strength were observed, together with an improvement in the patient's overall functional capacity. The results suggest the importance of a structured postoperative rehabilitation program in optimizing functional prognosis after complex subtrochanteric fractures.

Keywords: subtrochanteric fracture, hip rehabilitation, postoperative rehabilitation

1. Introduction

Subtrochanteric femoral fractures represent a complex subgroup of proximal femoral fractures, characterized by particular biomechanical features and increased challenges in treatment and rehabilitation [1, 2]. These fractures are located between the lesser trochanter and approximately 5 cm distal to it and are subjected to substantial mechanical forces, including axial compression, bending, and rotational forces [3].

Subtrochanteric femoral fractures have a multifactorial etiology and exhibit a bimodal distribution according to patient age and mechanism of injury. National data were used to analyze the epidemiology of femoral fractures between 1996 and 2006. The annual incidence of hip fractures decreased from 600 to 400 cases per 100,000 inhabitants, whereas no similar downward trend was observed for less common femoral fractures [4].

The incidence of subtrochanteric and femoral shaft fractures remained low, at fewer than 20 cases per 100,000 inhabitants. In younger patients, these fractures predominantly occur as a result of high-energy trauma, such as road traffic accidents or falls from height, which generate mechanical forces exceeding the strength of normal bone [5]. In contrast, among older adults, subtrochanteric fractures frequently result from low-energy trauma in the presence of osteoporosis and bone fragility.

A distinct subtype is represented by atypical subtrochanteric fractures associated with prolonged bisphosphonate use, which are characterized by stress-related mecha-

nisms and impaired bone remodeling [6]. The biomechanical characteristics of the subtrochanteric region, which is subjected to substantial muscular forces, contribute both to the occurrence of these fractures and to their clinical complexity.

Intramedullary fixation with a cephalomedullary nail represents one of the main surgical options for subtrochanteric fractures because of its biomechanical load-sharing advantages, construct stability, and the possibility of early mobilization [7, 8]. Studies have shown that intramedullary fixation reduces complication rates and allows faster functional recovery compared with extramedullary fixation methods [9].

Functional rehabilitation following surgically treated proximal femoral fractures is a fundamental component in achieving a favorable prognosis and facilitating the patient's return to activities of daily living. The literature indicates that early mobilization and individualized physiotherapy programs contribute substantially to improving mobility and muscle strength while reducing complications associated with prolonged immobilization, including muscle atrophy, joint stiffness, and loss of functional independence [10, 11].

Progressive balance exercises, gait training, and functional training are considered important components of postoperative rehabilitation and are associated with improved clinical outcomes and a better quality of life [12]. Furthermore, current guidelines recommend a multidisciplinary approach based on collaboration among the orthopedic surgeon, rehabilitation physician, and physiotherapist to optimize functional recovery after femoral fractures [13].

The aim of the present case report is to describe the clinical and functional evolution of a female patient with a complex subtrochanteric femoral fracture surgically treated by osteosynthesis with a locked intramedullary nail during an individualized and progressive rehabilitation program.

Patient progress was monitored through the assessment of pain, hip range of motion, muscle strength, weight-bearing and walking capacity, and functional independence. In addition, the study aims to highlight the role of a staged and individually adapted rehabilitation intervention in relation to postoperative recovery and the progressive increase in weight-bearing on the affected lower limb.

2. Materials and Methods

The patient, a 54-year-old woman, presented to the medical rehabilitation department for initiation of a postoperative rehabilitation program following an injury sustained on December 24, 2025, while participating in a winter sport. The trauma resulted in a complex subtrochanteric fracture, which was surgically treated by osteosynthesis with a locked intramedullary nail.

Following the accident, the patient presented to the emergency department, where clinical examination revealed pain on palpation and during mobilization of the affected limb. The examination also demonstrated marked functional impairment and a significant limitation of left lower-limb mobility, predominantly involving the left thigh. Imaging investigations performed in the orthopedic department (Figs. 1–2) confirmed the diagnosis of a complex subtrochanteric fracture of the left femur.



Figure 1-2 .Pre-operative radiograph showing subtrochanteric femoral fracture.

The patient underwent surgery on December 29, 2025, consisting of osteosynthesis with a locked intramedullary nail (Fig. 3-4). The immediate postoperative course was favorable, with no significant local or systemic complications. Postoperatively, the patient required a period of immobilization of approximately 6 weeks, which resulted in substantial functional impairment, reduced muscle strength, and restricted joint mobility of the affected lower limb. The overall medical rehabilitation program, from the immobilization period through the final phase of recovery, extended over 24 weeks.

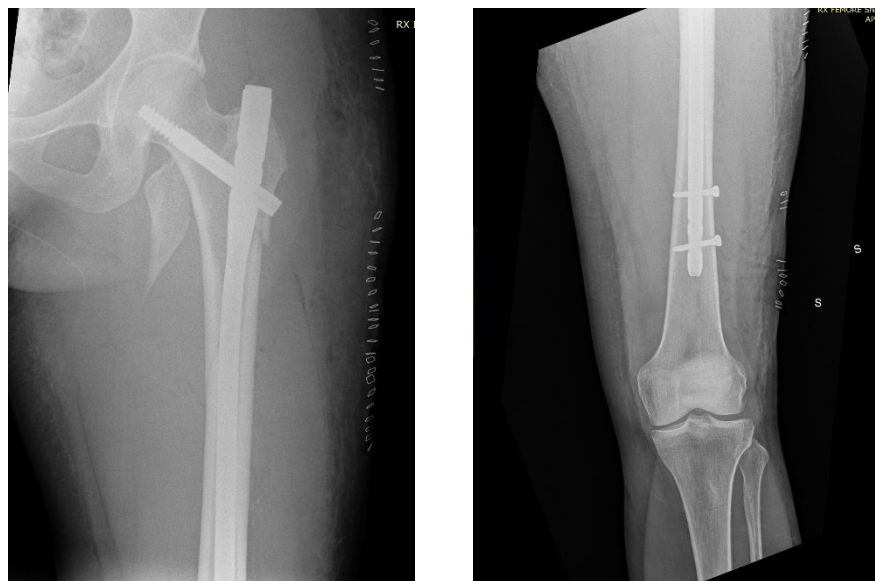


Figure 3-4. Post-operative radiograph showing subtrochanteric femoral fracture

During this immobilization period, an early rehabilitation program corresponding to Phase I of rehabilitation was initiated. The intervention included isometric exercises targeting the thigh and calf musculature, with the aim of maintaining muscle tone and preventing immobilization-related muscle atrophy. Active exercises for the unaffected body segments were also introduced to preserve overall mobility and general functional capacity. The program was progressively adapted according to the patient's exercise tolerance and postoperative status. The main objective of this phase was to prevent complications associated with immobilization and to prepare the patient for progression to the subsequent stages of functional rehabilitation.

Following the immobilization period, the patient presented to the Medical Rehabilitation Center for initiation of the functional rehabilitation program, at which time a comprehensive initial assessment was performed. This assessment included evaluation of overall functional status, clinical examination of joint mobility, muscle strength testing by muscle group, and quantification of pain intensity using the Visual Analogue Scale (VAS). Functional impairment in relation to activities of daily living was also assessed, together with postural stability and motor control during standing and walking.

At the time of the initial assessment, the patient reported pain in the left hip joint, which was exacerbated by movement and weight-bearing, with VAS scores of 8/10 during weight-bearing and 7/10 during movement. The examination revealed a marked limitation in joint range of motion, reduced muscle strength in the left lower limb, and substantial functional impairment, with difficulties in performing activities of daily living (Tables 1–2).

Table 1. Initial Assessment of Hip Joint Range of Motion

Movement	Unaffected limb	Affected limb
Flexion	118°	72°
Extension	22°	8°
Abduction	45°	10°
Adduction	20°	7°
External rotation	38°	14°
Internal rotation	32°	10°

Table 2. Initial Assessment of Hip Muscle Strength

Movement	Unaffected limb	Affected limb
Flexion	5/5	3/5
Extension	5/5	3/5
Abduction	4/5	2/5
Adduction	4/5	3/5
External rotation	4/5	2/5
Internal rotation	4/5	2/5

Local examination also revealed the presence of a postoperative scar on the left thigh (Fig. 5), with an appearance consistent with a favorable postsurgical evolution and no clinical signs of local complications.



Figure 5. Postoperative scar following surgical treatment of a subtrochanteric femoral fracture

According to the orthopedic recommendations following cast removal, the weight-bearing protocol for the left lower limb was progressive. Initially, partial weight-bearing of approximately 30% was permitted using two axillary crutches for 7 days, followed by a gradual increase in loading until full weight-bearing was achieved.

Following the initial assessment, the objectives of the rehabilitation program were established. The main goals were to reduce pain in the left hip and improve functional comfort, while progressively increasing joint mobility through specific exercises and controlled mobilization techniques.

The rehabilitation program also aimed to restore muscle strength in the affected lower limb and improve pelvic stability, thereby addressing post-immobilization muscular and biomechanical imbalances. Another major objective was the gradual resumption of walking and retraining of motor control.

In the medium and long term, the objectives included overall functional recovery, increased independence in activities of daily living, and the patient's social and occupational reintegration through a staged rehabilitation program that was continuously monitored and adapted according to clinical progress.

During Phase II, corresponding to the acute and subacute stages of rehabilitation, the therapeutic protocol included TECAR therapy applied in combined capacitive and resistive modes for approximately 15 minutes per session. The main objectives were pain reduction, stimulation of local circulation, and enhancement of tissue recovery processes. This intervention was combined with manual therapy techniques, including deep-tissue techniques and manual lymphatic drainage, with the aim of reducing edema and improving local tissue trophicity.

Subsequently, cryo-ultrasound therapy was applied exclusively in cryogenic mode, without activation of the ultrasound component, in order to achieve local analgesic and anti-inflammatory effects. Deep-tissue techniques were extended to the lumbar region, hip joint, and the entire affected lower limb, with the aim of improving soft-tissue mobility, reducing muscular tension, and optimizing overall biomechanical function.

In accordance with orthopedic recommendations, the unloading and subsequent progressive loading protocol for the left lower limb was implemented in a staged manner. Initially, the patient used two axillary crutches, with approximately 30% weight-bearing on the affected limb for about one week. Thereafter, loading was progressively increased according to pain tolerance and neuromuscular control until full weight-bearing was achieved. Approximately 3–4 weeks after initiation of the rehabilitation program, the patient completely discontinued the use of walking aids and gradually resumed independent ambulation.

The physiotherapy program was progressively structured and included proprioceptive neuromuscular facilitation (PNF) techniques, such as hold-relax and contract-relax, which were used to increase hip range of motion and reduce muscular stiffness. Functional diagonal flexion-extension movement patterns were also applied, initially in simpler forms and subsequently in variations performed with the knee flexed, with the aim of improving intermuscular coordination and motor control.

The therapeutic program also incorporated exercises using various rehabilitation tools and devices, including elastic resistance bands with progressively increased resistance, therapeutic balls of different sizes, and exercises performed at the wall bars. These interventions were used to facilitate motor control, improve postural stability, and increase muscle strength in the affected lower limb. Ball exercises were directed toward both activation of the stabilizing musculature and improvement of coordination and balance, whereas elastic resistance bands were used to progressively increase muscular resistance in both open and closed kinetic chains.

Exercises performed at the wall bars included progressive body-weight support, balance training, gait retraining, and functional transfer exercises. During the progressive loading stage, the rehabilitation program also included specific exercises targeting the calf musculature, with the aim of improving the muscle pump mechanism, enhancing distal stability, and facilitating venous circulation.

During Phase III, corresponding to the chronic stage of rehabilitation, the therapeutic intervention focused predominantly on progressive loading and stabilization exercises for the affected lower limb, with particular emphasis on restoring neuromuscular control and hip joint stability. The program included progressive strengthening exercises aimed at restoring muscle mass and tone, particularly in the muscle groups responsible for stabilizing the hip and lower limb. Muscular and functional endurance exercises were also incorporated to support restoration of normal hip biomechanics and global rebalancing of the biomechanical gait pattern, with improvements in coordination, postural stability, and functional efficiency during activities of daily living.

The patient's clinical evolution was favorable, with progressive improvement in motor control, reduction in pain, and increased stability during walking, allowing the transition from assisted to independent ambulation within approximately 5 weeks after initiation of the rehabilitation program.

3. Results

Following the comprehensive medical rehabilitation program, the patient showed a favorable clinical and functional evolution, characterized by a progressive reduction in pain symptoms and increased tolerance to mobilization and physical effort. Pain reduction was observed gradually throughout the treatment sessions and was associated with improved neuromuscular control and overall functional capacity.

During the initial phase of rehabilitation, the patient presented with marked limitation of mobility in the left lower limb, particularly in internal and external rotation of the hip joint, associated with substantial difficulties in mobilization and assisted ambulation, as well as reduced muscle strength throughout the kinetic chain of the lower limb. The functional deficit was accompanied by postural instability and a reduced ability to support body weight through the lower extremities.

Throughout the therapeutic intervention, a progressive increase in the range of motion of the hip and knee joints was observed, together with improvements in motor control and dynamic stability of the lower limb. Continuous adaptation of the rehabilitation program according to the patient's tolerance allowed controlled and effective functional progression.

The physiotherapy program included passive, active, and active-assisted mobilization exercises, as well as isometric and isotonic exercises targeting primarily the quadriceps femoris and gluteal musculature, with the aim of restoring joint stability and muscle strength. Gait retraining, postural control exercises, and static and dynamic balance training were also incorporated and adapted to the different stages of functional recovery.

Weight-bearing on the affected lower limb was resumed progressively, in accordance with orthopedic recommendations, beginning with approximately 30% partial weight-bearing using two axillary crutches for about 7 days. This was followed by progression to the use of a single crutch with approximately 50% weight-bearing for an additional 7 days, after which the degree of loading was gradually increased to approximately 75% until full weight-bearing was achieved and walking aids were discontinued. This progression was guided by pain control, joint stability, and neuromuscular control capacity.

At the end of the rehabilitation period, the patient demonstrated marked improvement in functional parameters, including increased walking capacity, partial normalization of the gait pattern, and a higher degree of independence in activities of daily living.

A reduction in joint stiffness, improvement in coordination and postural balance, and progressive recovery of muscle strength in the affected lower limb were also observed. Restoration of joint mobility and stabilization capacity contributed to improved overall biomechanical function and progressive functional reintegration of the patient (Tables 1 and 2).

Serial imaging assessments demonstrated progressive consolidation of the femoral fracture and a favorable postoperative evolution, consistent with the clinical and functional progress observed throughout the rehabilitation program. The association between improvement in clinical parameters and radiographic evolution supported the beneficial role of the multidisciplinary therapeutic intervention.

Table 3. Initial and Final Assessment of Hip Joint Range of Motion

Movement	Initial results	Final results
Flexion	72°	108°
Extension	8°	15°
Abduction	10°	32°
Adduction	7°	15°
External rotation	14°	30°
Internal rotation	10°	28°

Table 4. Initial and Final Assessment of Thigh Muscle Strength

Movement	Initial results	Final results
Flexion	3/5	5/5
Extension	3/5	4/5
Abduction	2/5	3/5
Adduction	3/5	4/5
External rotation	2/5	3/5
Internal rotation	2/5	3/5

The findings obtained in this clinical case support the beneficial role of an individualized physiotherapy program in the postoperative management of femoral fractures, highlighting the importance of early mobilization, gradual progression of weight-bearing, and functional retraining in promoting optimal recovery and the patient's functional reintegration.

4. Discussion

Subtrochanteric femoral fractures are complex injuries of the musculoskeletal system, associated with substantial impairment of lower-limb function and limitations in mobility and independence. The biomechanical characteristics of the subtrochanteric region, which is subjected to considerable mechanical loading and significant muscular forces acting on the bone fragments, require a carefully planned therapeutic approach and progressive rehabilitation adapted to each stage of healing.

In the present case, the primary objective of the rehabilitation program was to restore locomotor function by improving joint mobility, recovering muscle strength, and progressively resuming walking. The favorable clinical evolution of the patient highlights the importance of an individualized therapeutic approach in which exercise progression and the degree of weight-bearing were continuously adapted to the stage of fracture consolidation and the patient's functional tolerance.

During the initial phases of rehabilitation, emphasis was placed on pain control, reduction of inflammatory symptoms, and maintenance of periarticular soft-tissue mobility. The combined use of TECAR therapy, manual therapy techniques, massage, and cryotherapy was intended to optimize local conditions for implementation of the rehabilitation program and to facilitate functional recovery. Massage applied to the lower limb, hip region, and lumbar area contributed to reducing muscular tension and improving the mobility of the soft tissues involved in the rehabilitation process.

The physiotherapy component represented the central element of the rehabilitation program. During the initial stage, isometric exercises and non-weight-bearing mobilization exercises were used to maintain muscle activation and prevent physical deconditioning associated with the immobilization period. As the patient's functional status improved, the program progressed toward active exercises, functional exercises, and proprioceptive neuromuscular facilitation techniques aimed at restoring mobility, coordination, and motor control.

Hold-relax and contract-relax techniques, together with functional flexion-extension diagonal movement patterns, contributed to increasing range of motion and facilitating muscle recruitment within a functional context. The integration of these techniques into the therapeutic program supported the progressive restoration of stability and neuromuscular control required for walking and transfer activities.

As weight-bearing was progressively increased, the rehabilitation program incorporated stabilization exercises, elastic resistance bands, therapeutic balls, and functional activities performed at the wall bars. These interventions were aimed at developing muscle strength, improving postural control, and optimizing the biomechanics of the affected lower limb. The gradual transition from non-weight-bearing exercises to more complex functional activities allowed progressive adaptation of the musculoskeletal structures and restoration of weight-bearing capacity.

During the chronic phase of rehabilitation, the therapeutic focus shifted toward stabilization exercises, progressive muscle strengthening, and enhancement of functional endurance. These interventions were intended to restore the muscle mass reduced during the immobilization period, re-establish normal hip biomechanics, and promote effective reintegration of the affected lower limb into the overall kinetic chain. Additional objectives included improving balance, increasing confidence during weight-bearing on the affected limb, and enhancing functional performance in activities of daily living.

The results demonstrated progressive improvements in joint mobility, muscle strength, and walking capacity, accompanied by reduced pain and increased functional independence. The favorable clinical evolution was also supported by progressive radiographic consolidation of the fracture, indicating a positive association between the applied therapeutic approach and the observed functional recovery.

The present case highlights the importance of an individualized and progressive rehabilitation program adapted to the biological stages of healing in order to promote optimal functional recovery following subtrochanteric femoral fractures. The integration of orthopedic management with physiotherapeutic intervention represented an important component in restoring locomotor function and facilitating the patient's return to activities of daily living.

5. Conclusions

Subtrochanteric femoral fracture is a condition with a major functional impact that requires an integrated therapeutic approach and carefully individualized rehabilitation in order to achieve optimal functional outcomes. The present case highlights the importance of collaboration between orthopedic treatment and physiotherapeutic intervention in restoring mobility, muscle strength, and functional independence.

The implementation of a staged rehabilitation program, adapted to the biological stage of healing and the permitted degree of weight-bearing, contributed to pain reduction, improvement in joint mobility, recovery of neuromuscular control, and the

progressive resumption of walking. The integration of physiotherapy techniques, manual therapy, and a progressive therapeutic exercise program allowed simultaneous management of functional limitations, muscle deficits, and biomechanical alterations resulting from the trauma and the period of immobilization.

The patient's favorable evolution, characterized by progressive recovery of locomotor function, increased weight-bearing capacity, and improvement in functional parameters, supports the beneficial role of an individualized and multidisciplinary therapeutic intervention. Moreover, the concordance between clinical improvement and progressive radiographic fracture consolidation highlights the importance of continuous monitoring and ongoing adaptation of the rehabilitation program.

In conclusion, functional rehabilitation following subtrochanteric femoral fractures should aim not only to support bone healing but also to restore normal lower-limb biomechanics, postural balance, and functional independence. The implementation of a progressive and personalized rehabilitation protocol may contribute substantially to optimizing clinical outcomes and facilitating the patient's return to daily and socio-occupational activities.

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