



Rehabilitation of a grade 3B open Femur and Patella Fracture with CPM: A Case Report

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ABSTRACT

Managing Grade 3B open femoral shaft fractures in conjunction with patellar injuries presents significant challenges, particularly due to pain, stiffness, and delayed mobility recovery. Continuous Passive Motion (CPM) is widely recommended to promote early joint mobilization and facilitate rehabilitation. This case report describes the physiotherapeutic management of a 35-year-old male who sustained a Grade 3B open fracture of the left femoral shaft and a closed fracture of the left patella following a road traffic accident. Surgical intervention involved intramedullary interlocking nailing (ILN) for the femur and cerclage wiring for the patella. Physiotherapy commenced two months post-operatively with a structured rehabilitation plan focusing on pain reduction, range of motion (ROM) enhancement, and gait re-education. CPM was introduced early to support joint mobility. Rehabilitation progressed through acute, sub-acute, and advanced phases, integrating cryotherapy, transcutaneous electrical nerve stimulation (TENS), isometric and active ROM exercises, resistance training, proprioceptive drills, and functional retraining. CPM sessions were administered twice daily with gradual flexion increments. By the eighth week, the patient demonstrated marked improvements in knee

ROM, muscle strength, pain reduction, and independence in functional activities. This case highlights the effectiveness of a structured physiotherapy protocol incorporating CPM in the management of complex femoral and patellar fractures, emphasizing that early mobilization and targeted rehabilitation strategies can significantly improve recovery and functional outcomes in orthopaedic trauma cases.

Introduction

Open femoral shaft fractures accompanied by patella fractures pose significant challenges in post-operative rehabilitation due to pain, limited mobility, and risk of joint stiffness. Physiotherapy plays a crucial role in restoring joint function, strength, and gait. Continuous Passive Motion (CPM) is an effective modality to reduce stiffness and support early joint mobilization. CPM is a motor-driven device that passively moves joints through a defined range, promoting recovery without active muscle involvement. The technique was conceptualized by Robert Salter in the early 1980s to aid tissue healing.¹⁻⁴ Salter's hypothesis suggested that CPM supports optimal collagen alignment and tissue healing, reducing adhesions and promoting smoother joint movement.⁵ A Cochrane review on the topic concluded that use of CPM combined with PT offers beneficial results compared to PT alone in the short-term rehabilitation after TKA.⁶ CPM was also found to decrease the need for post-operative manipulation.⁷ Direct or indirect forces can cause patellar fractures. The majority of them are caused by direct injuries to the patella, such as a fall, a car accident, or a combination of these. In high-energy traumas, the patient with a patellar fracture should be checked for hip dislocations, ipsilateral femoral neck or shaft fractures, distal femur fractures, and proximal tibia fractures.⁸

Case Presentation

A 35-year-old male, with mesomorphic built and right-hand dominance presented to physiotherapy a month post-operatively after a road traffic accident (bike vs. car) on 13/05/2025. He sustained a Grade 3B open fracture of the left femoral shaft and a closed fracture of the left patella. Surgical intervention on 17/05/2025 included open reduction and internal fixation (ORIF) of the femur with an intramedullary interlocking nail (ILN) and cerclage wiring of the patella with 18 mm stainless steel wire. The patient was otherwise healthy at the time.

Postoperative radiological images of the left femoral shaft and patella fracture are shown in figure 1 and figure 2.

Figure 1. Postoperative X- ray of Grade 3B open fracture of the left femoral shaft surgically treated with open reduction and internal fixation (ORIF) of the femur with an intramedullary interlocking nail (ILN).

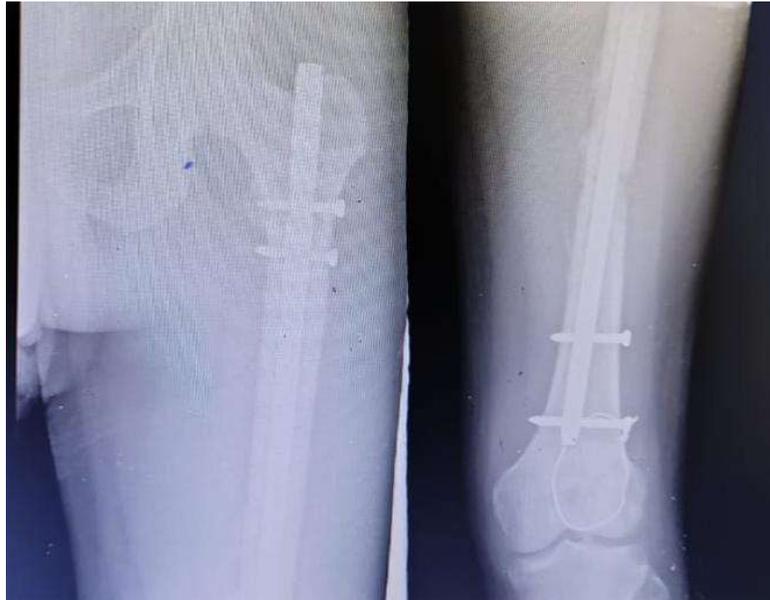


Figure 2. Postoperative X- ray of closed fracture of the left patella surgically treated with cerclage wiring of the patella with 18 mm stainless steel wire.





Clinical Findings

The patient presents with anterior thigh pain rated 5/10 on the Visual Analog Scale (VAS), accompanied by significantly limited left knee flexion ($\sim 30^\circ$) and an antalgic gait, requiring the use of a crutch for ambulation. Physical examination reveals asymmetry in lower limb girth, with the left thigh measuring 16 inches, compared to the right thigh (15 inches) above the knee, and the left calf measuring 13.5 inches versus the right calf (13 inches) below the knee. This discrepancy may suggest muscle hypertrophy (possibly due to compensatory mechanisms or post-surgical changes).

Manual muscle testing (MMT) demonstrates preserved strength (5/5) in the right lower limb and left hip, but mild weakness (4/5) in the left knee extensors and ankle musculature, indicating possible neuromuscular impairment. The diminished deep tendon reflexes on the left side further support a neurological component, such as femoral nerve dysfunction, L3-L4 radiculopathy, or a residual deficit from prior surgery. Despite the weakness and reflex changes, sensory integrity remains intact, which may help localize the lesion (e.g., motor-predominant neuropathy or central involvement is less likely).

Swelling over the left knee joint is noted, though no tenderness is present on palpation, which could be due to joint effusion, post-traumatic changes, or chronic synovitis. The presence of healed surgical scars suggests a prior intervention, possibly related to knee surgery, quadriceps repair, or nerve decompression, though the exact procedure is unspecified.

Parameter	Findings
Pain (VAS)	5/10 – Anterior thigh pain
Mobility & Gait	Ambulates with crutch; limping gait
Surgical Site	Healed surgical scars on left thigh and knee
Knee Range of Motion (ROM)	Limited left knee flexion ($\sim 30^\circ$)
Muscle Girth(Inches)	Thigh (Above knee): Left = 16 in, Right = 15 in Leg (Below knee): Left = 13.5 in, Right = 13 in
Manual Muscle Testing (MMT)	Right lower limb: 5/5 all joints Left Hip: 5/5 Left Knee & Ankle: 4/5
Reflexes	Diminished on the left side
Sensory Integrity	Intact bilaterally
Swelling	Present over the left knee joint

Palpation	No tenderness
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Fig 3. Initial 30° active knee flexion on day one.



Fig 4. Knee flexion in prone lying



Fig 5. Knee flexion in long sitting



Assessment and Goals

Observation indicated decreased muscle bulk and antalgic gait. Functional limitations included difficulty squatting, stair climbing, and prolonged standing. Physiotherapy goals included: Short-term: Reduce pain, improve knee ROM, minimize atrophy, normalize gait. Long-term: Restore full knee ROM (>110°), regain strength (5/5), enable independent ambulation and return to activities of daily living.

Intervention and Continuous Passive Motion (CPM)

Rehabilitation was structured in three phases. In the acute phase, cryotherapy and TENS were applied, and isometric exercises initiated. CPM was employed daily for 15-20 minutes for 6 days per week starting with 0–30° flexion, gradually progressing based on tolerance. The sub-acute phase introduced



active ROM, resistance exercises, and continued CPM as needed. Advanced rehab included functional tasks, gait training, static cycling and proprioception exercises.

Fig 6. Active knee flexion



Fig 7. Active knee bending in prone lying



Fig 8. Active knee bending in long sitting



Fig 9. Knee flexion by CPM



Fig 10 -11 closed chain knee flexion 90°



Fig 12. Static bicycling



Outcome and Prognosis

The patient showed marked improvement in range of motion, strength, and gait pattern. By the fifteenth day, the patient was independent in basic functional activities with reduced pain and improved mobility. CPM contributed to joint mobility and helped prevent stiffness. The knee ROM was noted, as in table 1.

Table 1. baseline assessment of Range of Motion of knee joint

Baseline measurement of ROM		
	Right knee	Left knee
Active flexion	0-135 degrees	0-45 degrees
Active extension	0 degrees	0 degrees
Passive flexion	0-135 degrees	0-55 degrees
Passive extension	0 degrees	0 degrees

Table 2. Knee range of motion assessed on day fifteen

Outcome measurement of ROM on day 15		
	Right knee	Left knee
Active flexion	0-135 degrees	0- 100degrees
Active extension	0 degrees	0 degrees
Passive flexion	0-135 degrees	0-120degrees
Passive extension	0 degrees	0 degrees



Discussion

The post-operative rehabilitation of complex lower limb injuries, particularly those involving simultaneous fractures of the femoral shaft and patella, requires a carefully structured and evidence-informed approach. This case study illustrates the positive impact of a comprehensive physiotherapy regimen that included Continuous Passive Motion (CPM), progressive strengthening exercises, and staged gait training, contributing to a successful functional recovery over a 12-week period.

Continuous Passive Motion and Joint Mobility

The use of Continuous Passive Motion (CPM) in this case began at eight weeks post-operatively when the patient's knee flexion was severely restricted (35°) and a 10° extension lag was present. While CPM has long been a subject of debate within rehabilitation circles, emerging evidence supports its use in certain intra-articular injuries where joint stiffness and adhesions pose a significant risk. In this case, the gradual progression of ROM settings in the CPM device (starting at $0\text{--}30^\circ$ and increasing by $5\text{--}10^\circ$ per session) correlated with measurable improvements in mobility, reaching 95° of flexion and full extension by week 12. These results suggest that when combined with active therapy, CPM can effectively complement efforts to restore joint function and prevent capsular contracture.

Strength Restoration and Functional Gains

Post-traumatic and post-surgical disuse often lead to profound muscle weakness, particularly affecting the quadriceps and hamstrings. The implementation of a structured strengthening program—including static quadriceps sets, straight-leg raises, and resistance training—facilitated significant gains in muscle strength. Notably, the patient's quadriceps strength improved from Grade 2/5 to 4/5 on the Oxford Scale by the end of the 12-week period. Functional recovery, assessed through the patient's ability to perform sit-to-stand transitions, stair climbing, and unaided walking, was achieved progressively and safely, supported by these strength gains.

Progressive Weight-Bearing and Gait Training

Controlled and gradual reintroduction of weight-bearing is a critical component of post-operative rehabilitation in long bone fractures. In this case, partial weight-bearing was initiated in week 9, followed by full weight-bearing in week 11. This phased approach not only aligned with the biological healing timeline of bone and soft tissues but also allowed for safe reactivation of proprioceptive and



neuromuscular mechanisms. Gait training with a walker, and later a cane, was supplemented with stair navigation and obstacle walking tasks to simulate real-life functional challenges.

Adherence and Patient-Centered Rehabilitation

A notable factor in the patient's favorable outcome was high adherence to both supervised and home-based rehabilitation protocols. Regular engagement in therapeutic activities, along with education about the importance of continued exercise and mobility, enhanced compliance and motivation. The patient expressed satisfaction with the pace and extent of recovery and was able to resume light-duty tasks by week 12—indicating both functional and psychosocial recovery.

Clinical Implications

This case reinforces the utility of a holistic and phased physiotherapy program in managing post-operative recovery following complex knee and femoral injuries. It underscores that while CPM should not replace active rehabilitation, it can play a valuable adjunctive role when used judiciously. The synergy between passive mobility interventions, active muscle strengthening, and timely functional training is essential for optimizing patient outcomes in orthopedic rehabilitation.

Conclusion

The rehabilitation of complex orthopedic injuries, such as a Grade 3B open fracture of the femoral shaft combined with a patella fracture, poses a multifaceted challenge that requires a comprehensive, individualized, and phased approach to physiotherapy. This report demonstrates that a structured physiotherapy regimen, including CPM, can greatly accelerate functional recovery in complex orthopedic trauma cases.

CPM played an important role in maintaining and improving joint mobility in the early stages of rehabilitation, thereby reducing the risk of postoperative stiffness and adhesions. Alongside CPM, interventions like cryotherapy, TENS, isometric and isotonic exercises, active range of motion, gait training, and proprioceptive exercises collectively contributed to the patient's progressive improvement in function and pain reduction.

Notably, by the end of the second week of physiotherapy, the patient demonstrated marked gains in knee flexion—from 45° to 100° active range and 55° to 120° passive range—accompanied by reduced pain and increased muscle strength. This functional improvement translated into greater independence in activities of daily living, improved gait, and enhanced quality of life.



This case underscores the importance of early mobilization and phase-wise goal-oriented physiotherapy in managing high-grade open fractures with joint involvement. Incorporating CPM as an adjunct to conventional physiotherapy can offer additional benefits in restoring joint function and accelerating rehabilitation in complex trauma cases. Future recommendations include broader clinical studies to establish standardized protocols for such injuries, including timing, duration, and intensity of CPM use.

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