Journal of Physiotherapy Directories,

ISSN: 3107- 6939

Journal of Physiotherapy Directories (JPD)

Novel Rehabilitation Strategies for Bilateral Calcaneal Fractures with minimal wedging of lumbar vertebra – A Case Report

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Vol 2, Issue 5: Page no. 252 - 263
Received: 10 Sept 2026, Accepted: 6 Oct 2026, Published: 1 Nov 2026

Abstract

The purpose of the article is to describe the case of early full-functional rehabilitation in bilateral calcaneal fractures and minimal wedging of the lumbar vertebra without the use of any invasive approach. In the follow-up to the first, the patient was enrolled in an interdisciplinary rehabilitation course based on the lower limbs and spine. Some of the rehabilitation involved early mobilization and restoring muscle power and joint mobility. This strategy focused on the functions that helped recovery and diminished the risk of the complications seen in the hospital. Overall, increases in mobility and function were seen post-rehabilitation on assessment, which reinforces the effectiveness of the developed rehabilitative strategies as individual-specific. This case demonstrates the importance of individualized care in achieving optimal outcomes for patients with complex musculoskeletal injuries.

Keywords: calcaneus fracture, minimal wedging, physical therapy, pain management, case report.

1. Introduction:

An injurious and incapacitating fracture of the calcaneus, or heel bone, is possible. When the heel is crushed beneath the body's weight during a high-energy incident, such as a car crash or a fall from a ladder, this kind of fracture frequently happens. The heel may enlarge, shorten, or develop deformities as a result [1]. Fractures of the calcaneus can be very serious. In order to allow patients to resume their regular activities, treatment frequently entails surgery to rebuild the heel's natural anatomy and regain mobility. However, some fractures may still cause long-term issues like pain, edema, limited mobility,

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and arthritis even after receiving the proper care [2]. Of all fractured tarsal bones, 50–60% are calcaneal fractures. Less than 10% of them have visible fractures. Because the incidents are mostly industrial, there has historically been a male preponderance of injured parties [3]. The heel bone may get shorter and wider due to a fracture. Most of the time, a fracture also affects the foot's subtalar joint. When this happens, harm to the joint's articular cartilage may result in long-term issues like arthritis, persistent discomfort, and decreased range of motion [4].

When a vertebra compresses or changes shape to resemble a wedge of its typical rectangular form observed in the lumbar or thoracic areas of the spine, this is known as minimal wedging [5]. Even while modest wedging is usually considered to be moderate and occasionally shows no symptoms, it can cause pain, stiffness, or restricted movement in the affected area. To prevent disorders from getting worse, early detection and effective management are essential [6]. Therapy for posture correction and rehabilitation is a common part of treatment, as is the sporadic use of medicines to reduce inflammation or strengthen bones. The spine is frequently affected by this illness, especially the lumbar (lower back) and thoracic (upper back) areas [7]. Numerous factors can contribute to it, including trauma from falls or heavy lifting, as well as osteoporosis, which weakens bones and increases their vulnerability to fractures. Age-related degenerative changes, scoliosis (abnormal curvature of the spine), poor posture, and lifestyle choices that put the spine under constant stress are further contributing causes. Although signs of mild wedging may not always be apparent, some people may report diminished spinal flexibility, stiffness, or localized back discomfort [8,9].

Bilateral calcaneal fractures require physical therapy during the rehabilitation process after the surgery has been done. Firstly, therapy helps to prevent the development of such issues as joint immobility, muscle wastage, and decreased physical activity [10]. As a part of physical therapy in the initial stages post-surgery, the patient is required to do non-weight-bearing exercises in order to preserve flexibility and circulation while avoiding risking stress on the bones that are joining together [11]. Ankle pumps, which are flexing and dorsiflexing of the ankle and toe stretchers, are incorporated to promote movements of the ankle and foot joints and to minimize contractures. Quadriceps, hamstrings, and calf muscles, which are grouped as the lower limb’s muscles, must not be allowed to get atrophied during the period that the patient is completely immobile, and isometric exercises are applied to them [12]. Physiotherapy is not just about pain relief; it is the foundation of an individual's recovery of movement, muscle strength, and quality of life in his/her feet. Bones require time to mend, and when in surgery, they also require gradual and controlled motion so that further complicated issues such as joint stiffness, muscle wastage, and altered freedom of movement do not occur [13]. It would mean that if physiotherapy is not carried out correctly, there would be a high chance of the patient developing chronic pain, loss of function in the affected foot, or even other complications in the knees, hips, and lower back as a result of adopting other movements to fill the existing gaps [14].

2. Case Presentation:

Patient information

A 19-year-old male, while working he got fell from the 1st floor. He first went to the local Ayurvedic hospital, where primary treatment was taken, but the swelling was not reduced. Then, he went to the government hospital, where an x-ray was taken, which revealed a bilateral comminuted calcaneal fracture and lumbar vertebrae fracture. Here was advised for surgery. So, he visited the hospital on 28/08/2024 with the complaint of pain and swelling over bilateral ankle and lower back pain. Here, investigations like X-rays were done. For which he was advised to have surgery. For calcaneal fracture, he was operated on with open reduction internal fixation with nailing plating, and osteosynthesis, and for lumbar fracture, minimal wedging was done on 09/09/2024. After surgery, the patient complained

of pain and limited mobility of the bilateral lower limb. For these complaints, physiotherapy was started for the patient using a proper protocol.

Timeline-

In August 2024, the patient was admitted to the Male Orthopaedics ward.

Sr. no.	Dates	Events
1.	28/08/2024	The patient was admitted to the orthopedic ward.
2.	29/08/2024	The first diagnostic tests have been done.
3.	09/09/2024	The operation was done.
4.	16/09/2024	physical therapy rehabilitation was started.

Table 1: Timeline

3. Clinical Findings

The patient's informed consent was taken before the assessment, and then the patient was evaluated. The patient was seen in the supine position with hip and knee in extension and ankle in an elevated position. On inspection, swelling was localized to the heel and ankle of both feet. On physical findings at the time of hospital admission, there was a diffuse swelling present; no scars were seen overlying the skin. Normal local temperature was observed on palpation, and tenderness was present over the posterior and medial aspects of the heel and ankle joints. On musculoskeletal examination, the range of motion of both hip and knee joints was found to be normal, but in both, the ankle joints were limited and painful due to swelling and stiffness. Muscle strength was evaluated, which showed both hip and knee muscle strength was normal, but ankle muscle strength was reduced.

Diagnostic assessment

Investigations such as X-rays, histopathological tests, and a complete blood count (CBC) were performed and showed normal result.

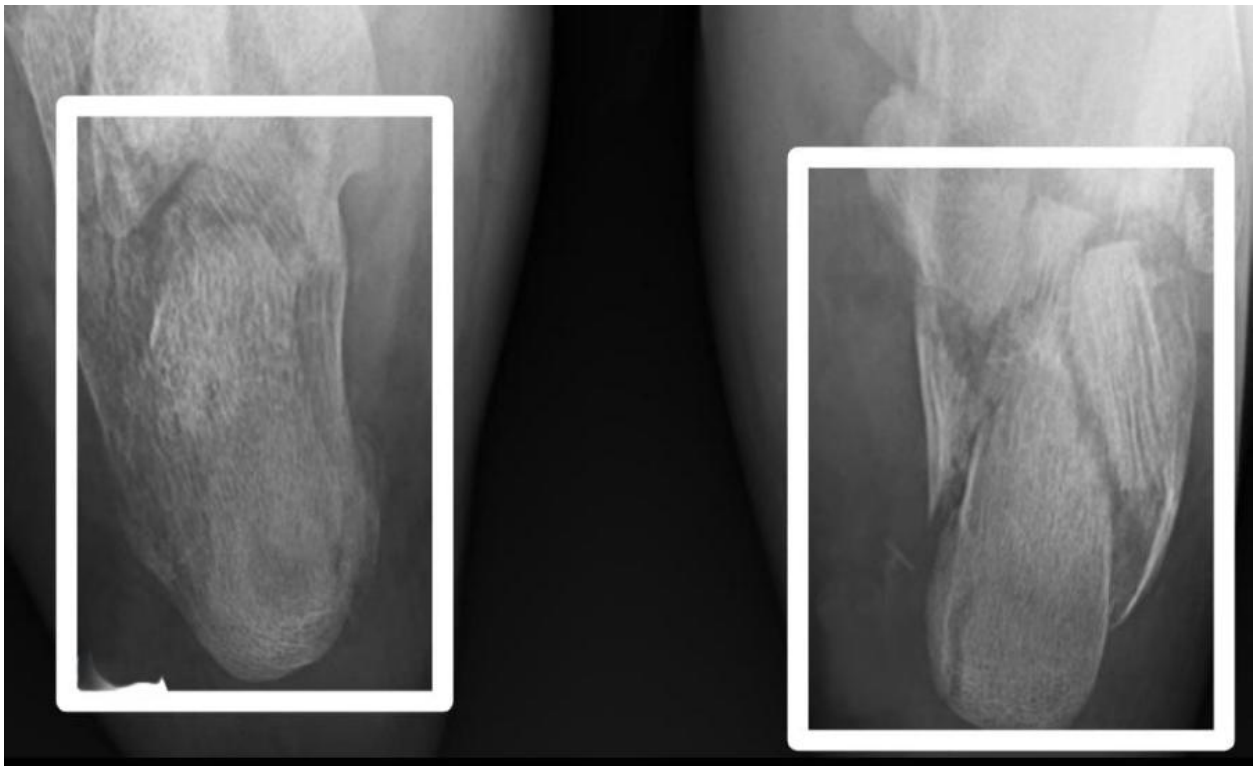


Fig 1. Pre-operative x-ray Showing AP view of bilateral ankle joint indicates the calcaneal fracture

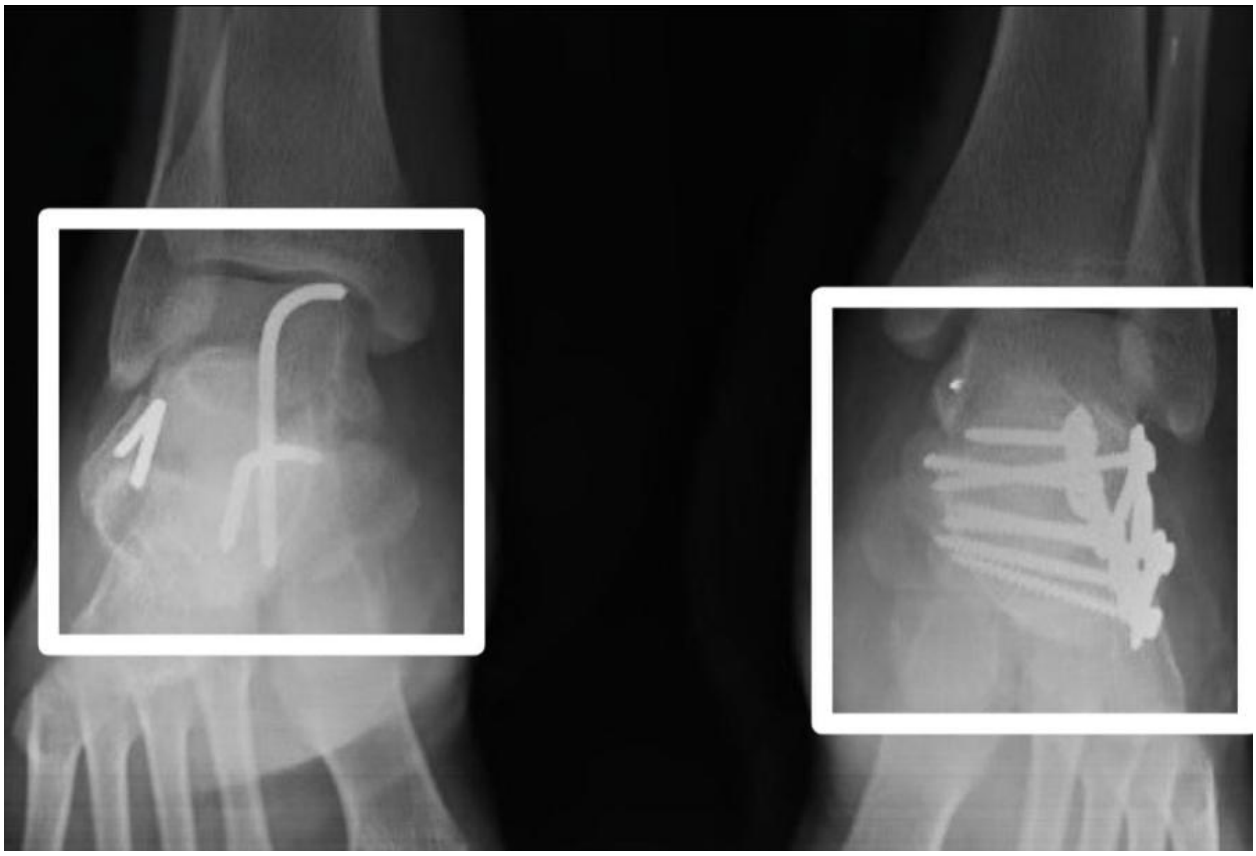


Fig 2. Post-operative x-ray Showing open reduction internal fixation with nailing plating, and osteosynthesis for calcaneus.

Therapeutic interventions-

Table 2 shows physiotherapeutic rehabilitation for the patient.

Phase	Intervention	Details/Exercises	Duration	Goals	Dosage	Precautions
Phase 1: Early Stage (0-6 Weeks)	Pain & Edema Management	- Ice therapy, elevation - TENS for pain - Manual lymphatic drainage	10–15 min, 3-4 times/day	Control pain and reduce swelling	- Ice: 10-15 min - TENS: 20-30 min	N.W.B. or PWB, spinal precautions (no bending, twisting)
	Immobilization & Protection	- Immobilization as per surgeon's instructions - Use of assistive devices	Continuous	Protect the surgical site and promote healing	Assistive devices as needed (NWB)	Prevent weight-bearing on the fractured calcaneus

		(crutches, walker)				
	ROM Exercises (Ankle & Spine)	- Ankle: Passive and active-assisted ROM - Back isometric exercises - Hot pack for back	10–15 min, 2-3 times/day	Maintain joint mobility	- Ankle ROM: 10 reps - Back exercises: 10 reps	Avoid stressing the surgical area and spine.
	Core Stabilization	- Pelvic tilts - Abdominal bracing - Diaphragmatic breathing	10-15 min, 2-3 times/day	Activate core muscles without spinal load	10-15 reps of each exercise	Avoid trunk flexion and excessive movement
The outcome measure after phase 1 rehabilitation taken was NPRS was 6/10 on activity and 4/10 on rest, and FADI 37/100						
Phase 2: Intermediate (6-12 Weeks)	Progressive Weight Bearing	- Gradually increase from PWB to FWB (as instructed) - Gait training with assistive devices	10-15 min, 2-3 times/day	Reintroduce normal gait pattern	- PWB to FWB as instructed - 5-10 min gait training	Ensure proper gait mechanics.
	Strengthening (Ankle & Lower Body)	- Ankle: Isometric to isotonic (TheraBand resistance) - Hip knee strengthening (e.g., seated knee extensions)	20-30 min, 2-3 times/week	Build muscle strength and endurance	2-3 sets of 10-15 reps	Avoid aggressive loading on the ankle and spine
	Spinal Stability Exercises	- Pelvic tilts - Bird-dog	10-15 min, 2-3 times/day	Improve spinal stability	10-15 reps of	No excessive spinal

		- Modified planks			each exercise	extension or flexion
	Balance & Proprioception	- Static balance: Single-leg stance (supported) - Dynamic balance: Seated balance, progressing to standing on a foam pad	10-15 min, 3 times/week	Restore balance and proprioception	2-3 sets, 30 sec-1 min holds	Avoid activities that cause spinal strain
	Scar Tissue Mobilization	- Gentle scar massage around the ORIF site - Myofascial release	5-10 min, 2-3 times/week	Prevent excessive scar tissue formation	- 5-10 min per session	Ensure the incision site has healed adequately
The outcome measure after phase 2 rehabilitation taken was NPRS was 4/10 on activity and 3/10 on rest, and FADI 56/100						
Phase 3: Late Stage (12-24 Weeks)	Full Weight Bearing & Gait Training	- Progress to full weight-bearing without devices - Gait re-education (heel-to-toe walking)	10-15 min, 2-3 times/day	Normalize gait mechanics	- 5-10 min gait training	Monitor for compensations during gait
	Advanced Strengthening	- Lower body: Squats, lunges (progressively loaded) - Ankle: TheraBand resistance for dorsiflexors, evertors, investors - standing calf raises	30-45 min, 2-3 times/week	Build functional strength	2-3 sets of 10-15 reps	Avoid overloading the calcaneus and spine

		- inversion and eversion exercise				
	Functional & Dynamic Activities	- Stair climbing, sit-to-stand - Walking on uneven surfaces	20-30 min, 2-3 times/week	Restore function for daily activities	- 10-15 reps of each activity	Ensure controlled progression
	Spinal Strengthening	- Controlled back extensions (modified) - McKenzie exercises (modified)	10-15 min, 2-3 times/week	Strengthen spinal extensors safely	10-15 reps of each exercise	Avoid overloading the lumbar spine
Outcome measure after phase 3 rehabilitation taken were NPRS was 4/10 on activity and 2/10 on rest and FADI 72/100						
Phase 4: Return to Activity (6+ Months)	Sport-Specific Training	- Gradual reintroduction of sports drills	20-30 min, 2-3 times/week	Safely return to pre-injury activities	Progress based on tolerance	Avoid high-impact or contact until full recovery
	Plyometrics & High-Level Balance	- Box jumps - Single-leg hops - balance boards with perturbations	20-30 min, 2-3 times/week	Restore dynamic balance and power	2-3 sets of 10-15 reps	Ensure full lower extremity control and spinal safety
	High-Intensity Interval Training (HIIT)	Sprint intervals, Tabata exercise (high knees, mountain climbers, jumping lunge, jumping jacks, burpees, jump squats)	10 min warm-up, 4 min Tabata workout, and 5 min cool-down	Enhance Cardiovascular Endurance	8-10 reps, 2 sets	
Outcome measure after phase 4 rehabilitation taken were NPRS was 2/10 on activity and 0/10 on rest and FADI 92/100						

Outcome measures

Following a four-week course of therapeutic intervention, a subsequent assessment was conducted. The outcome measures were taken before and after rehabilitation; it includes Numerical pain rating scale (NPRS), foot and ankle disability index, oxford muscle grading scale and SF-36. The interpretation for pre-treatment and post-treatment score is given in table 5.

Scale	Pre-treatment score	Post-treatment score
NPRS	8/10	3/10
Foot and ankle disability index	37/100	92/100
Oxford Muscle grading scale	20/100	90/100
SF 36	46/100	83/100

Table 3 - Outcome measure pre-treatment and post-treatment

The table shows pre- treatment and post-treatment of manual muscle testing of the lower limbs. The pre-treatment score indicates that the patient has significant weakness in both lower limbs, particularly in the ankle joint, with muscle strength as low as 2/5, and the post-treatment score shows remarkable improvement, with all muscle groups achieving normal strength (5/5).

	MMT of lower limb	Pre-treatment		Post-treatment	
Joint		Right	Left	Right	Left
Hip	Flexors	3/5	3/5	5/5	5/5
	Extensors	3/5	3/5	5/5	5/5
	Abductors	3/5	3/5	5/5	5/5
	Adductors	3/5	3/5	5/5	5/5
	Internal rotators	3/5	3/5	5/5	5/5
	External rotators	3/5	3/5	5/5	5/5
Knee	Flexors	3/5	3/5	5/5	5/5
	Extensors	3/5	3/5	5/5	5/5
Ankle	Dorsiflexor	2/5	2/5	5/5	5/5
	Plantar flexor	2/5	2/5	5/5	5/5
	Inversion	2/5	2/5	5/5	5/5
	Eversion	2/5	2/5	5/5	5/5

Table 4 - pre- treatment and post-treatment Manual Muscle Testing (MMT) of Lower limb

(0= no muscle contraction, 1= flickering contraction, 2= complete range of motion with gravity eliminated, 3= complete range of motion against gravity, 4= complete range of motion against gravity with minimal resistance, 5= complete range of motion against gravity with maximum resistance)

This table shows the pre- interpretation and post-interpretation of a range of motion of the bilateral lower limb. The pre-treatment score indicates that the patient has significant decrease in both lower limbs,

particularly in the ankle joint and the post-treatment score shows remarkable improvement, with all movements achieving normal range of motion.

	Lower Limb	Pre-treatment		Post-treatment	
		Right	Left	Right	Left
Joints	flexion	0-90°	0-90°	0-120°	0-120°
Hip	Extension	0-10°	0-10°	0-30°	0-30°
	Abduction	0-15°	0-15°	0-45°	0-45°
	Adduction	0-10°	0-10°	0-30°	0-30°
	Internal Rotation	0-10°	0-10°	0-45°	0-45°
	External Rotation	0-15°	0-15°	0-45°	0-45°
Knee	flexion	0-90°	0-90°	0-135°	0-135°
	Extension	0-10°	0-10°	0°	0°
Ankle	Dorsiflexion	0-10°	0-10°	0-15°	0-15°
	Plantarflexion	0-20°	0-20°	0-35°	0-35°
	Inversion	0-10°	0-10°	0-25°	0-25°
	Eversion	0-10°	0-10°	0-15°	0-15°

Table 5 - pre- treatment and post-treatment Range of motion of lower limb joints.

5. Discussion:

Rehabilitation for bilateral calcaneal fractures, particularly when accompanied by minimal wedging of lumbar vertebrae, necessitates a comprehensive and individualized approach. Initially, a thorough assessment, including imaging, is crucial for understanding the extent of the injuries [15]. Pain management strategies should be implemented to facilitate early mobilization, beginning with controlled weight-bearing exercises as tolerated, alongside non-weight-bearing activities to maintain overall fitness. As recovery progresses, strengthening exercises for the ankle and core stability work is essential to support the lumbar spine and enhance overall stability [16]. Incorporating balance and proprioception training is vital to reduce the risk of future injuries, while the use of orthotic supports can provide additional alignment and comfort. Education on the healing process, activity modification, and psychosocial support play important roles in the rehabilitation journey [17].

A 12-week Tabata-style functional HIIT program was very effective in lowering body fat, enhancing cardiorespiratory fitness, and improving various cardiometabolic health outcomes, according to the findings of Yining et al.'s study [18]. According to Ramzi et al., the current exercise intervention program modeled after McKenzie appears to increase lower limb strength, ROM, disability, and discomfort. This case shows that rehabilitation therapies after lumbar spine procedures can be successful, particularly for individuals who have recurrent herniated discs [19]. Early gait training is crucial for recovery after calcaneal fracture surgery, according to Chirayath et al. Gait abnormalities and related consequences can be avoided by maintaining an appropriate and effective walking pattern. The main goals of gait training are to improve balance, optimize weight distribution, and restore a normal walking gait. This component of rehabilitation is essential to enabling a seamless shift from protected to full weight bearing [20]. In the end, it helps patients feel more confident in their ability to walk. According to Yu Li et al., early partial weight-bearing rehabilitation exercise can significantly improve patients' functional recovery following surgery for calcaneal fractures while not affecting internal fixation or the form of the calcaneus [21].

Adhya et al. Appropriate rehabilitation, like resistance training, helps to minimize the complications and ensure an early return to normal function. Education on the healing process, activity modification, and psychosocial support play important roles in the rehabilitation journey [22,23]. Regular follow-ups are necessary to monitor progress and adjust strategies accordingly, ensuring a safe reintegration into normal activities. By employing these novel rehabilitation strategies, patients can optimize recovery and improve mobility while minimizing complications.

6. Conclusion:

This case report highlights the effective rehabilitation strategies employed for a patient with bilateral calcaneal fractures and minimal wedging of the lumbar vertebra. A multidisciplinary approach, including pain management, early mobilization, targeted physical therapy, and individualized exercise regimens, facilitated optimal recovery. The integration of functional activities aimed at restoring strength, flexibility, and balance proved essential in the rehabilitation process. The outcomes suggest that with tailored interventions, patients with complex injuries can achieve significant improvements in mobility and quality of life.

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