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Concomitant Ipsilateral Femoral Shaft and Ankle Fractures: A Case Series and Proposal of a Novel Classification System.

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Abstract
Background: The concomitant occurrence of a ipsilateral diaphyseal femoral shaft fracture and an ankle fracture is uncommon, and the incidence of this combined injury pattern has not been clearly defined in literature. The aims of this case series were to describe the clinical presentation, radiological characteristics, surgical management, and outcomes of patients with concomitant diaphyseal femoral shaft and ankle fractures; to highlight practical considerations regarding fixation sequence and implant selection; and to provide a focused review of relevant literature. ***Methods:*** A narrative review was conducted using selected peer-reviewed articles focusing on femur fracture and related ipsilateral lower limb injuries, including epidemiological studies, case reports. ***Results:*** Skeletal injury patterns consisted of diaphyseal femur fractures (AO/OTA 32) paired with malleolar ankle fractures (AO/OTA 44). Surgical stabilization was standardized across the cohort, utilizing intramedullary interlocking (IMIL) nailing for all femur fractures and open reduction and internal fixation (ORIF) plating for all ankle fractures. Surgical staging varied; simultaneous single-sitting stabilization was achieved in 33.3% (n=1) of cases, while the remaining 66.7% (n=2) underwent staged ankle fixation at a median of 4 days post-injury (range: 2–6 days). The mean total time from injury to definitive surgical fixation was 27.3 ± 23.1 hours. The mean timeline to achieve full weight-bearing (FWB) status was 7.3 ± 2.3 weeks. ***Conclusion:*** This case series highlights the rare and challenging injury pattern of concomitant diaphyseal femoral shaft and ipsilateral ankle fractures. We propose a novel classification system that incorporates injury definition, soft-tissue modifiers, surgical sequencing, implant selection, and postoperative rehabilitation protocols for these complex segmental lower-limb injuries. This classification provides a practical framework for clinical decision-making and may facilitate standardized management and future research in this uncommon injury pattern.

Keywords: Femur, Ankle, Concomitant.

INTRODUCTION

Femoral diaphyseal fractures are commonly caused by high-energy trauma in younger patients and low-energy falls in older adults. They are frequently associated with multisystem trauma and ipsilateral musculoskeletal injuries.[1,2] Commonly reported associated injuries include ipsilateral femoral neck fractures, tibial shaft fractures, and knee ligamentous or bony injuries.[3-8]

The concomitant occurrence of a diaphyseal femoral shaft fracture and an ankle fracture is uncommon, and the incidence of this combined injury pattern has not been clearly defined in literature. Most available evidence concerning multilevel ipsilateral lower-limb fractures consists of case reports or small clinical series describing fractures involving the femoral neck, shaft, distal femur, patella, or ankle region.[9-13]

The Winquist and Hansen classification remains a commonly used system for describing the degree of comminution in femoral shaft fractures, whereas the AO/OTA classification provides a standardized framework for reporting femoral shaft and malleolar fracture patterns.[14,15] Because of the rarity of this pattern, limited guidance exists regarding optimal surgical timing, fixation sequence, postoperative rehabilitation, and expected functional outcome.

The aims of this case series were to describe the clinical presentation, radiological characteristics, surgical management, and outcome of patients with concomitant diaphyseal femoral shaft and ankle fractures; to highlight practical considerations regarding fixation sequence and implant selection; and to provide a focused review of relevant literature.

MATERIALS AND METHODS

A single tertiary center retrospective observational review was conducted of three patients presenting with concomitant diaphyseal femoral shaft fracture and ankle fracture who were treated surgically at Christian Medical College and Hospital, Ludhiana, Punjab, India, between March 2024 and December 2025.

Inclusion Criteria

- Patients with a diaphyseal femoral shaft fracture associated with an ipsilateral ankle fracture
- Both open and closed injuries
- Managed operatively.

Exclusion Criteria

- A non-salvageable limb, non-operative management
- Femoral shaft fractures associated primarily with foot fractures rather than ankle fractures.

Diagnosis was based on plain radiographs of the pelvis with both hips, full-length anteroposterior and lateral radiographs of the femur, and anteroposterior, lateral, and mortise views of the ankle. Computed tomography was obtained when additional characterization of the ankle fracture or associated injury was required.

Clinical records and radiographs were reviewed for demographic details, mechanism of injury, fracture classification, open injury status, fixation method, surgical sequence, postoperative complications, radiological union, and functional recovery.

Data Collected

- Age and gender
- Mechanism of injury
- Fracture patten
- Time of presentation after injury
- Time to surgery after injury
- Sequence of fracture fixation
- Time from Injury to Presentation
- Type of fixation
- Complications

Written informed consent was obtained from all patients.

Case 1

A 28-year-old man with no significant medical history presented to the emergency department after a high-energy motor vehicle accident. He had pain and swelling in the right thigh and ankle, inability to bear weight on the right lower limb, and a post-traumatic soft-tissue defect over the posteromedial aspect of the middle third of the right leg. Examination revealed marked swelling and localized tenderness over the right thigh and ankle.

Radiographs demonstrated a diaphyseal femoral shaft fracture classified as AO/OTA 32A1.b and a bimalleolar ankle fracture classified as AO/OTA 44A2.3.[15] Computed tomography of the ankle was performed for preoperative planning. Nail length and diameter were measured preoperatively to guide implant selection.

The patient underwent staged fixation. The femoral fracture was treated first with closed reduction and intramedullary interlocking nailing. The ankle fracture was subsequently treated with open reduction and internal fixation using a one-third tubular plate and cannulated cancellous screws.

The soft-tissue defect was managed with serial vacuum-assisted closure dressings followed by split-thickness skin grafting. The postoperative course was uneventful. Immediate postoperative radiographs showed satisfactory length, alignment, and rotation.

Walker-assisted mobilization with limited weight-bearing was initiated. Radiographs at 6 weeks and 3 months showed progressive fracture healing. At 1 year, complete union of both femur and ankle fractures was confirmed radiologically, and the patient had returned to pre-injury activity without persistent pain or functional limitation.

Case 1 Images

Figure 1: Pre op clinical images.

Figure 2: Post op clinical images

Figure 3: Preoperative radiograph depicting diaphyseal femur and ankle fracture of case 1

Figure 4: Post operative radiograph depicting diaphyseal femur and ankle fracture

Case 2

A 45-year-old man with no significant medical history presented after a high-energy motor vehicle accident with pain and swelling of the right thigh and ankle and inability to bear weight on the right lower limb. Clinical examination revealed swelling and localized tenderness over the right thigh and ankle. Radiographs showed a diaphyseal femoral shaft fracture classified as AO/OTA 32A2 and a bimalleolar ankle fracture classified as AO/OTA 44B2.[15] Computed tomography of the ankle was performed to define the fracture configuration and aid preoperative planning. Nail length and diameter were measured before surgery. The femoral fracture was treated with closed reduction and intramedullary interlocking nailing. The ankle fracture was treated with open reduction and internal fixation using a reconstruction plate and cannulated cancellous screws. Immediate postoperative radiographs demonstrated satisfactory length, alignment, and rotation. Walker-assisted mobilization with limited weight-bearing was advised. Radiographs at 6 weeks and 3 months demonstrated progressive fracture healing. At 1 year, both fractures had united radiologically, and the patient had resumed pre-injury activity without persistent pain or functional restriction.

Case 2 Images

Figure 5: Preoperative radiograph depicting diaphyseal femur and ankle fracture of case 2

Figure 6: Post operative radiograph depicting diaphyseal femur and ankle fracture of case 2

Case 3

A 62-year-old man with hypertension presented after a high-energy motor vehicle accident with pain and swelling of the right thigh and ankle, inability to bear weight, and an open deep lacerated wound over the lateral aspect of the heel. He also had an associated head injury. After initial resuscitation and stabilization, a secondary survey was conducted. Examination revealed heel-pad avulsion with wound contamination, minimal soft-tissue loss, and localized tenderness over the right thigh and ankle.

Radiographs demonstrated a segmental diaphyseal femoral shaft fracture classified as AO/OTA 32C2, a bimalleolar ankle fracture classified as AO/OTA 44B1, and an extra-articular calcaneal fracture classified as AO/OTA 82A2.[15] The open calcaneal injury was classified as Gustilo-Anderson grade IIIB.[16] Computed tomography of the head revealed bitemporal subdural hematoma with left frontal extradural hematoma. Computed tomography was also used to further assess the ankle fracture for operative planning.

The patient underwent staged management. Initial wound debridement and heel-pad fixation with Kirschner wires were performed on the day of admission. After stabilization, the femoral fracture was treated with closed reduction and retrograde intramedullary nailing, and the ankle fracture was treated with open reduction and internal fixation using an anatomical plate. Serial wound debridement and vacuum-assisted closure were performed for the heel wound. Implant removal was required 2 months after surgery because of surgical-site infection after radiological evidence of union at the ankle and calcaneum. Early knee and ankle mobilization with restricted weight-bearing was followed. The ankle and calcaneal fractures united radiologically; however, the segmental femoral shaft fracture progressed to hypertrophic non-union.

Case 3 Images

Figure 7: Pre op clinical images of case 3

Figure 8: Preoperative radiograph depicting diaphyseal femur and ankle fracture of case 3

Figure 9: Preoperative radiograph depicting diaphyseal femur and ankle fracture of case 3

Figure 10: Post operative radiograph depicting diaphyseal femur and ankle fracture of case 3

RESULTS

Surgical and rehabilitation outcomes in this case series (n = 3), all patients were male with a mean age of 45 ± 17 years. The primary mechanism of injury was road traffic accidents (RTA, 100%). Skeletal injury patterns consisted of diaphyseal femur fractures (AO/OTA 32) paired with malleolar ankle fractures (AO/OTA 44). Surgical stabilization was standardized across the cohort, utilizing intramedullary interlocking (IMIL) nailing for all femur fractures and open reduction and internal fixation (ORIF) plating for all ankle fractures. Surgical staging varied; simultaneous single-sitting stabilization was achieved in 33.3% (n=1) of cases, while the remaining 66.7% (n=2) underwent staged ankle fixation at a median of 4 days post-injury (range: 2–6 days). The mean total time from injury to definitive surgical fixation was 27.3 ± 23.1 hours. The mean timeline to achieve full weight-bearing (FWB) status was 7.3 ± 2.3 weeks. Delayed functional recovery (10 weeks to FWB) and adverse events—specifically femur non-union and an ankle surgical site infection-were isolated to a single patient (n=1, 33.3%) who presented with a complex, multi-fragmentary 32C2 femur fracture pattern.

Using the proposed classification system, two cases were categorized as Type I and one case as Type III.

All patients underwent surgical management, either as a single-stage procedure or through a staged approach based on injury complexity. Simple femoral fractures were treated with antegrade intramedullary nailing, while complex femoral fractures mainly distal segmental fractures were managed using retrograde femoral nailing.

At a mean follow-up of three months:

- Two patients had no complications
- One patients developed surgical site infection at ankle and non union at femur.

Statistical dashboard: Concomittant FEMUR & ankle fractures (n=3 Cases)

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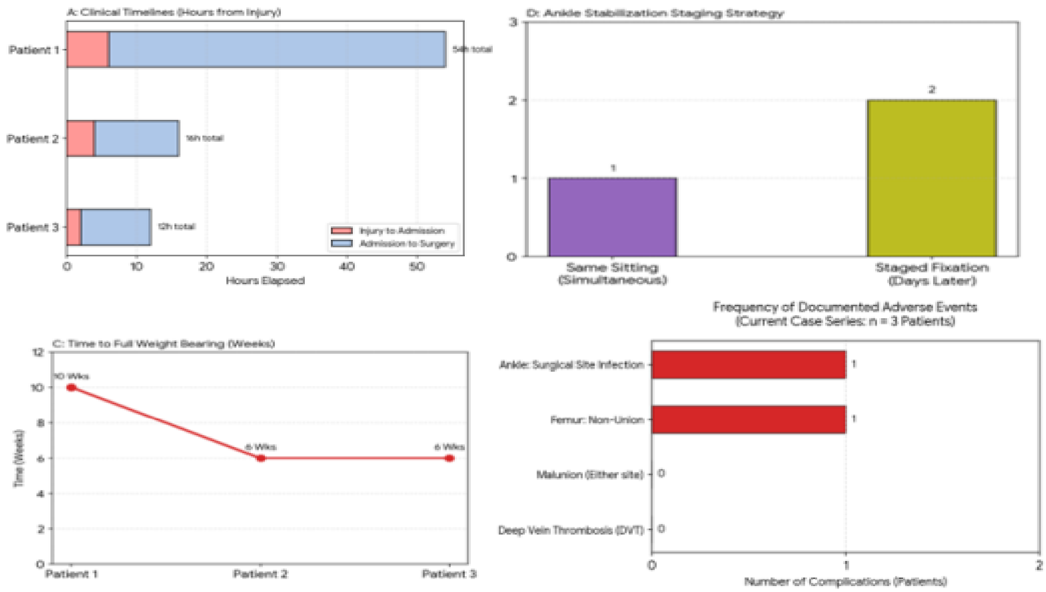

Graph 1: Analysis of patient case data.

DISCUSSION

Injury Configuration and Clinical Findings

This case series highlights a rare injury pattern involving simultaneous diaphyseal femoral shaft and ankle fractures. Previous literature has documented the association between femoral shaft fractures and ipsilateral ankle fractures; however, this injury pattern is rare, and consequently, the available literature remains limited.[17] The combination may be overlooked in the initial assessment because attention is often directed toward the more obvious femoral shaft fracture and associated systemic injuries. Careful examination of the entire limb and dedicated ankle radiographs are therefore essential in high-energy trauma. In all cases, the mechanism of injury was road traffic accidents, which generate substantial axial, rotational, and bending forces capable of producing fractures at multiple levels of the lower limb. The coexistence of femoral and ankle fractures likely reflects the transmission of energy through the entire extremity during impact, resulting in combined skeletal injuries.

Table 2. Diaphyseal fractures accompanied by other musculoskeletal injuries		
Ankle injury		
S Lal [17]	1 patient	Triple segmental shaft fracture with ankle fracture reported. Fixation done with Antegrade nailing of femur with plate and screw fixation for ankle.no complications
Hip fractures		
Laporte et al [5]	5.6%	All were high energy trauma.no complications were reported
Barei DP [13]	7patients	Non contiguous fracture of femur neck,shaft,distal femur. Differebnt implants were used like antegrade nail,retrograde nail and DHS
Casey and chapman [18]	73 patients	Delayed diagnosed patients developed Avascular necrosis,Non union.
Wiss et al [19]	2.5- 5%	18 % cases with symptomatic non union of hip fractures
Tibial plateau fractures		
Paul et al [20]	The series comprised 25 cases collected over 5 years, representing approximately 5 cases annually.	
Gregory et al [21]	47 cases in 6 years (7.8 per year)	

Clinical Implications and Management

In our series, fixation strategy was individualized according to fracture morphology, soft-tissue condition, and patient stability. Femoral stabilization was generally prioritized to restore limb length and facilitate mobilization, while ankle fixation was performed during the same sitting or as part of a staged protocol when soft-tissue management was required. Open injuries and contaminated wounds required staged debridement, temporary or definitive fixation as appropriate, and soft-tissue reconstruction.

The principal complication occurred in the patient with associated heel-pad avulsion and open calcaneal injury, emphasizing the importance of soft-tissue status in determining outcome. Although ankle and calcaneal union was achieved, the segmental femoral fracture progressed to hypertrophic non-union. This suggests that high-energy segmental femoral fractures with associated open injuries may require close surveillance for delayed union or non-union.

STRENGTHS AND LIMITATIONS

Strengths

- First institutional series focusing on ipsilateral femur and ankle fractures
- Highlights orthopaedic surgical decision-making
- Provides clinical learning points and proposed classification

Limitations

- Small sample size
- Retrospective design.
- Single-centre study.
- Limited long-term functional outcome data.

CONCLUSION

Concomitant diaphyseal femoral shaft and ankle fractures are rare injuries usually resulting from high-energy trauma. A systematic trauma evaluation, dedicated imaging of the entire injured limb, early recognition of associated ankle and soft-tissue injuries, and individualized surgical sequencing are essential for optimal outcomes. Intramedullary nailing remains suitable for most femoral shaft fractures, while implant selection should be modified in patients with pre-existing deformity, previous surgery, or complex fracture morphology. Larger multicentre studies are required to define the incidence, optimal fixation sequence, rehabilitation protocols, and long-term outcomes of this uncommon injury pattern. We have proposed a classification system for such injuries (Table 3.1 & 3.2) along with definitive surgical sequencing (table 4), implant choice (Table5) and post op rehabilitation protocol (table 6).

Table 1: Juvin & Samuel Proposed Classification for Concomittant Diaphyseal femur and Ankle Fracture

Types	Definition	Femur Criteria (AO/OTA & Winquist)	Ankle Criteria (Weber & AO Patterns)	Clinical Implications & Soft-Tissue Risk
Type 1	Simple Femur + Simple Ankle	• AO/OTA Type 32-A • Winquist Type 0–I	• Isolated Weber A or B (no syndesmotic instability)**(44A1,44B1)** • Bimalleolar with minimal displacement**(44 A2,44B2)**	• Low systemic load • Good soft tissue envelope • Concurrent definitive fixation safe
Type 2	Simple Femur + Complex Ankle	• AO/OTA Type 32-A • Winquist Type 0–I	• Weber C with syndesmotic disruption**(44C3)** • Trimalleolar with posterior subluxation**(44B3,44C3)** • Pilon-variant extension **(44C2,44C3)**	• High local ankle soft-tissue risk • Priority: Immediate femur fixation + urgent ankle bridging/ORIF
Type 3	Complex Femur + Simple Ankle	• AO/OTA Type 32-B (wedge) or 32-C (comminuted) • Winquist Type II–IV	• Isolated Weber A or Weber B • Stable injury pattern**(44A1,44A2,44A3,44B1)**	• High systemic load (fat embolism/SIRS risk) • Priority: Local/damage-control femur management; delay/splint ankle
Type 4	Complex Femur + Complex Ankle	• AO/OTA Type 32-B/C • Winquist Type II–IV	• Weber C with syndesmotic rupture**(44C3)** • Comminuted trimalleolar fractures**(44B3,44C3)**	• Extreme high-energy pattern • High systemic load + severe local soft-tissue risk

Table 2: Soft-Tissue Modifiers ("S" Modifier)

Modifier	Status	Clinical Presentation & Risk	Immediate Surgical Action Required
S0	Closed	Skin intact at both fracture sites; low infection risk.	Routine planned surgical scheduling.
S1	Femur Open	Gustilo-Anderson Grade I, II, or III femur fracture.	**Emergency:** Immediate debridement and stabilization.
S2	Ankle Open	Open fracture, severe fracture blisters, or skin tenting.	**Urgent:** Debridement and temporary external fixation.
S3	Combined Open	Both femur and ankle fractures are open.	**Limb-threatening Emergency:** Immediate bilateral debridement.

Table 3: Definitive Surgical Sequencing

For Types...	Step 1: First Priority	Step 2: Second Priority	Definitive Ankle Timeline
Type 1 & Type 3 *(Simple Ankle)*	**Fix Femur First** • Retrograde IM nail (preferred for flat-table efficiency) or Antegrade IM nail.	**Fix Ankle Second** • Immediate ORIF of fibula, medial malleolus, and syndesmosis (if needed).	Done **concurrently** during the same operative setting.
Type 2 & Type 4 *(Complex Ankle)*	**Temporize Ankle First** • Place a spanning ankle external fixator (delta frame) to reduce deformity and protect skin.	**Fix Femur Second** • Proceed with definitive fixation of the femur via IM nail.	**Delayed ORIF (7–14 days):** Leave ex-fix until swelling drops, blisters resolve, and wrinkle sign returns.

Table 4: Specific Implant Choices for Complex Ankle Patterns

Anatomic Zone	Fracture Presentation / Pathology	Recommended Implant Solution	Surgical Mode / Technique
1. Lateral Malleolus	• Short oblique or comminuted geometry • Severe comminution (shattered zone)	Anatomic Locking Distal Fibula Plate	Fixed-angle stability for osteoporotic bone.
2. Medial Malleolus	• Simple vertical or transverse fractures • Vertical shear fractures	• Dual 4.0mm Partially Threaded Cannulated Screws • Antiglide / Buttress Plate	• Standard compression fixation. • One-third tubular or locking plate on medial cortex to stop proximal migration.
3. Posterior Malleolus	• Fragment >20% of joint surface or subluxation	Posterolateral Locking Plate	Buttress plating via a posterolateral approach to restore tibial plafond.
4. Syndesmosis	• Dynamic unstable ankle joint spacing	Flexible Fixation (Suture Buttons / Suture-Tapes)	**Highly Recommended:** Allows physiological micro-motion while keeping alignment.
	• Rigid mechanical stabilization	Syndesmotic Screws	Two quadricortical 3.5mm or 4.5mm screws, parallel to and 2cm above joint line.

Table 5: Postoperative Rehabilitation Protocol.

Phase & Timeline	Weight-Bearing Status	Immobilization Device	Prescribed Exercises & Interventions
1 **Phase 1: Acute Protection** *(Weeks 0–2)*	**Strictly Non-Weight Bearing (NWB)** • Driven by ankle protection.	Well-padded short-leg splint **OR** removable CAM boot (controlled Ankle Motion) locked at neutral (90°).	• Active knee flexion and extension. • Quadriceps isometrics. • Hamstring isometrics. • Prevents stiffness at femoral nail entry site.
2 **Phase 2: Early Range of Motion** *(Weeks 2–6)*	**Remain Non-Weight Bearing (NWB)** • No weight allowed on lower extremity.	Removable CAM boot • Transition once surgical wounds are fully healed.	• Remove boot 3x daily for gentle, active ankle dorsiflexion and plantarflexion. • **Strictly avoid** inversion and eversion. • Continue aggressive knee range of motion.
3 **Phase 3: Progressive Weight Bearing** *(Weeks 6–12)*	**Progressive Partial Weight Bearing (PWB)** • *Prerequisite:* 6-week X-rays show early bone healing at both sites. • Start at 25% body weight in CAM boot. • Progress by 25% weekly toward Full Weight Bearing (FWB) by week 10–12.	CAM boot used during all weight-bearing activities.	• Initiate closed-chain exercises (e.g., low-resistance stationary cycling). • Proprioception training. • Balance exercises.
4 **Phase 4: Advanced Strengthening** *(Week 12+)*	**Full Weight Bearing (FWB)** • Normal weight-bearing allowed.	**Discontinue CAM boot** • Transition to standard athletic shoes.	• Resistance training. • Calf raises. • Eccentric ankle strengthening. • Gait normalization drills.

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