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# Rare Combination of Proximal Femoral Physeal Fracture and Quadrilateral Long Bone Fractures in a Toddler: A Case Report

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## Abstract

**Introduction:** Paediatric polytrauma is uncommon, and the simultaneous presence of multiple long bone fractures with a proximal femoral physeal injury is exceedingly rare. Proximal femoral epiphyseal (Delbet Type I) fractures account for less than 1% of paediatric femoral neck injuries and are associated with a high risk of avascular necrosis. When combined with multiple limb fractures, craniofacial trauma, and cerebral oedema, management becomes particularly complex and requires coordinated multidisciplinary intervention.

**Case Report:** We present the case of a 3-year-old boy involved in a pedestrian motor vehicle accident who sustained a rare constellation of injuries, including bilateral humeral fractures, a right femoral shaft fracture, a left Delbet Type I proximal femoral physeal fracture, a pelvic fracture, mild traumatic brain injury and an orbital blow-out fracture. Following Advanced Trauma Life Support (ATLS)–directed resuscitation and multidisciplinary stabilisation, the patient was managed conservatively for the traumatic brain injury and orbital fracture. Definitive orthopaedic management consisted of submuscular plating of the right femoral shaft, open reduction and cannulated screw fixation of the proximal femoral physeal fracture, and closed reduction with percutaneous pinning of both humeral fractures. Postoperative immobilisation and structured, caregiver-supported rehabilitation were essential due to complete functional dependency during recovery. The patient demonstrated progressive improvement on close follow-up, and at 12 weeks had achieved excellent functional recovery, ambulating independently with near-normal limb function, no pain or discomfort, and full reintegration into age-appropriate daily activities.

**Conclusion:** This case highlights the importance of early recognition, timely surgical intervention, and coordinated multidisciplinary care in the management of high-energy paediatric trauma. Despite the rarity of this injury pattern and the well-recognised risk of complications associated with Delbet Type I proximal femoral physeal fractures occurring in combination with quadrilateral long bone fractures, favourable outcomes can be achieved through meticulous resuscitation, appropriate operative planning, and dedicated caregiver involvement, resulting in good short- to medium-term functional outcome.

**Keywords:** Paediatric polytrauma; Femur fracture; Delbet Type I; Quadrilateral long bone fractures; Humeral fractures; Submuscular plating

## Introduction

Fractures in childhood represent a significant proportion of paediatric injuries, and large epidemiological studies have shown evolving patterns and mechanisms across different populations [1]. High-energy trauma is a well-recognised cause of severe injuries in young children, particularly involving the femur [2].

Proximal femoral physeal injuries are extremely rare, and Delbet Type I fractures represent the least common and most severe subtype, characterised by complete epiphyseal separation and historically associated with a high risk of avascular necrosis (AVN) [3]. Early anatomical reduction is critical because disruption of the epiphyseal blood supply significantly increases the probability of long-term complications [4-6].

The management of paediatric polytrauma requires attention to unique physiological characteristics and patterns of injury that distinguish children from adults. Studies of injury epidemiology and outcomes in paediatric trauma populations highlight the complexity of multisystem involvement and the importance of early, structured interventions to reduce morbidity [7]. Pedestrian vehicle accidents, in particular, have long been associated with characteristic multisystem injury patterns involving the head and extremities [8].

Definitive management of paediatric long bone fractures has advanced significantly with techniques such as submuscular plating, which preserves periosteal blood supply while providing stable fixation suitable for young children [9]. Upper-limb fractures in children can also be effectively treated through minimally invasive methods, including percutaneous pinning, which offers good stability with low soft-tissue disruption [10].

Optimal outcomes in severe paediatric trauma depend on coordinated multidisciplinary care. Trauma literature consistently supports the integration of orthopaedic surgeons, neurosurgeons, paediatric surgeons, anaesthetists, and critical care teams to optimise survival and functional results [11]. Beyond surgical management, recovery is also shaped by psychosocial and caregiver factors. Severe injury and immobilisation, especially involving multiple limbs, dramatically increase dependency, and caregiver burden has been shown to influence rehabilitation trajectories in paediatric trauma survivors [12].

We present a rare and severe constellation of injuries—a proximal femoral physeal separation occurring simultaneously with quadrilateral long bone fractures and associated craniofacial trauma—in a toddler involved in a pedestrian vehicle accident. To our knowledge, this precise combination of injuries has not been previously documented.

## Case Presentation

A 3-year-old previously healthy male child was brought to the emergency department of a tertiary hospital following a high-energy pedestrian vehicle accident. According to witnesses, the child had been crossing a road unsupervised when he was struck by a moving vehicle. On arrival, he was crying, visibly distressed, and complained of pain in all four limbs. There was no witnessed loss of consciousness, although the child appeared confused, raising concern for possible head injury.

The patient was managed according to Advanced Trauma Life Support (ATLS) principles on arrival. His airway was patent, and breathing was spontaneous without signs of respiratory distress. Circulatory assessment revealed tachycardia with a normal blood pressure, consistent with compensated shock. Multiple abrasions and deformities involving all four limbs were noted. Disability assessment demonstrated a paediatric Glasgow Coma Scale (GCS) score of 13/15(E4/4, V4/5 (crying but consolable, M5/6 (inability to obey commands localising to pain), with no lateralising neurological deficits. Full exposure revealed extensive bruising and swelling over both upper arms, the right thigh, and the left hip region, raising concern for multiple long bone injuries.

Examination of the upper limbs demonstrated bilateral swelling, tenderness, deformity, and restricted range of motion, with intact distal pulses and preserved neurological status. The right thigh was shortened, swollen, and externally rotated, consistent with a displaced femoral shaft fracture. The left hip was painful with limited movement, suggesting a proximal femoral injury. Additional injuries included forehead and occipital lacerations, abrasions, and visible facial swelling.

Initial investigations demonstrated a metabolic acidosis on venous blood gas analysis, with an elevated lactate level of 3.9 mmol/L and a haemoglobin concentration of 9.9 g/dL, consistent with tissue hypoperfusion and early blood loss. An extended focused assessment with sonography for trauma (eFAST) was negative for intra-abdominal free fluid, and a chest radiograph showed no acute pathology. In view of the altered mental state, in accordance with the Paediatric Emergency Care Applied Research Network (PECARN) criteria, computed tomography of the brain was indicated. Given the high-energy mechanism of injury, a trauma pan-scan was performed, which demonstrated diffuse cerebral oedema and a right medial orbital blow-out fracture, with no evidence of intracranial haemorrhage or intra-thoraco-abdominal injuries.

Plain radiographs identified a right proximal humerus fracture, a left distal humerus fracture, a right femoral shaft fracture, a left proximal femoral physeal fracture (Delbet Type I), and a left superior pubic ramus fracture (Figure 1). The association of head injury, craniofacial trauma, and femoral fractures reflected features of Waddell's triad, commonly described in paediatric pedestrian motor vehicle collisions.

The child received intravenous fluid resuscitation, adequate analgesia, and prophylactic antibiotics. All lacerations were irrigated and sutured. He was admitted under a multidisciplinary team comprising paediatric trauma surgeons, neurosurgeons, ophthalmologists, and orthopaedic surgeons. Paediatric trauma surgery led ongoing resuscitation with the goal of achieving physiological stability to allow early total care. Serial neurological examinations were conducted, with close monitoring of paediatric GCS and vigilance for seizures or neurological deterioration; none were observed. The child was maintained euglycaemic and normothermic, with effective analgesia throughout this period.

Neurosurgical assessment recommended conservative neuroprotective management, as no operative intervention was indicated. Ophthalmological evaluation focused on monitoring periorbital swelling, ocular motility, visual acuity, and signs of extraocular muscle entrapment. The child demonstrated full extraocular range of motion with intact visual fields and no evidence of entrapment or visual compromise, allowing for non-operative management of the orbital fracture.

Once haemodynamic and physiological stability had been achieved, definitive orthopaedic management was undertaken. The right femoral shaft fracture was treated with open reduction and submuscular plating, selected for its minimally invasive nature and preservation of periosteal blood supply while providing stable fixation in a young child. The left proximal femoral physeal fracture (Delbet Type I), recognised as a high-risk injury for avascular necrosis, was managed with open reduction via a Smith–Petersen approach and fixation using cannulated screws to achieve anatomical alignment. Both humeral fractures were treated with closed reduction and percutaneous pinning, providing adequate stability with minimal soft-tissue disruption. All four limbs were immobilised postoperatively using backslabs.

This constellation of quadrilateral long bone fractures occurring in combination with a Delbet Type I proximal femoral physeal injury represents an exceptionally rare injury pattern that, to our knowledge, has not been previously reported in the paediatric trauma literature as listed below (Figure 1).

- Right proximal humerus fracture
- Left distal humerus fracture
- Right femoral shaft fracture
- Left femoral head fracture (Delbet Type I) — a rare and high-risk injury in children
- Left superior pubic rami fracture

Orthopaedic Management, given the severity of injuries and the benefits of early fracture stabilisation in polytrauma, operative intervention was undertaken once the child was haemodynamically stable. All limbs were immobilised postoperatively using backslabs.

**1.** Right Femoral Shaft Fracture: Treated with open reduction and submuscular plating, chosen for its minimally invasive nature and preservation of periosteal blood supply while providing robust fixation in a small child (Figure 2).

**2.** Left Femoral Head Fracture (Delbet I): This injury carries a very high risk of avascular necrosis. An open reduction was performed via the Smith-Petersen approach, achieving anatomical reduction, followed by fixation with cannulated screws (Figure 2).

**3.** Bilateral Humeral Fractures: (Right humerus proximal 1/3 extra-physeal, left humerus distal 1/3 also extra-physeal) were managed with closed reduction and percutaneous pinning, a technique offering stability with minimal soft-tissue and growth disruption (Figure 3).

**Postoperative Course**

The child was monitored in high care, receiving multimodal analgesia and physiotherapy input. Because all four limbs were immobilised, he became completely dependent on caregivers for feeding, toileting, hygiene, and mobilisation. Nursing staff and family received education on safe handling, plaster care, and prevention of pressure-related complications.

Despite the extent of injuries, recovery progressed well. At the 2-week review, wounds were healing appropriately. Limb swelling had reduced, and the child demonstrated improving comfort and early functional movement within safe limits.

**At the 6 week follow-up functional outcome**

Lower limbs child was able to take a few assisted steps (e.g. holding caregiver's hands), no limb length discrepancy or rotational malalignment clinically, hip range of motion improving but not yet full, particularly on the left side.

Upper Limbs use able to reach, grasp, and transfer objects, Feed self with assistance. There was mild restriction at shoulders and elbows, improving from previous follow up and no neurovascular deficits and removal of Kirschner wires in both humeri.

• Comfortable at rest and during handling

• Analgesia requirements minimal or intermittent

• No wound complications or signs of infection

• Radiographs showing maintained alignment and early callus formation

**Follow-Up and Functional Outcome**

At the 12-week follow-up, the child showed remarkable recovery. He had regained near-normal limb function and achieved independent mobility (Figure 4). There were no signs of neurovascular compromise or complications related to surgical fixation. Radiographs demonstrated excellent bony union of all fractures (Figure 5). The parents reported a full return to age-appropriate activities, and the child demonstrated normal play, coordination, and functional use of all limbs.

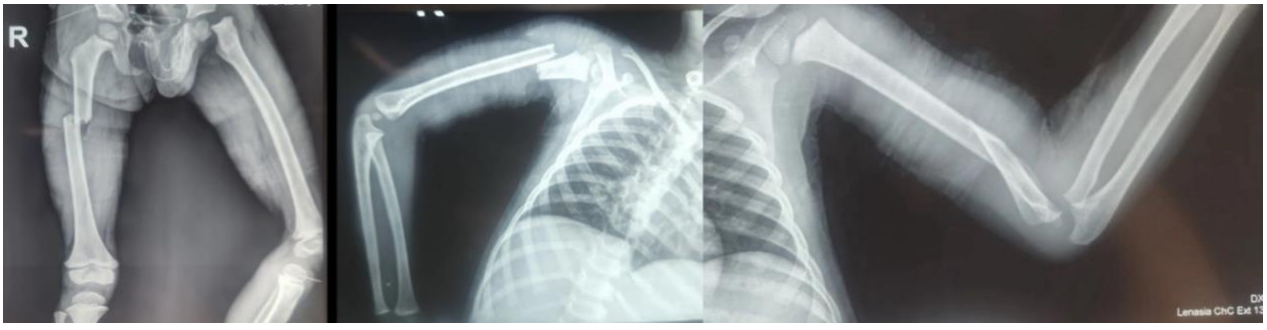


**Figure 1:** Preoperative radiographs demonstrating fractures involving all four limbs, including a right midshaft femoral fracture, a left proximal femoral physeal fracture (Delbet Type I), a right proximal humeral extraphyseal fracture, and a left distal humeral extraphyseal fracture.

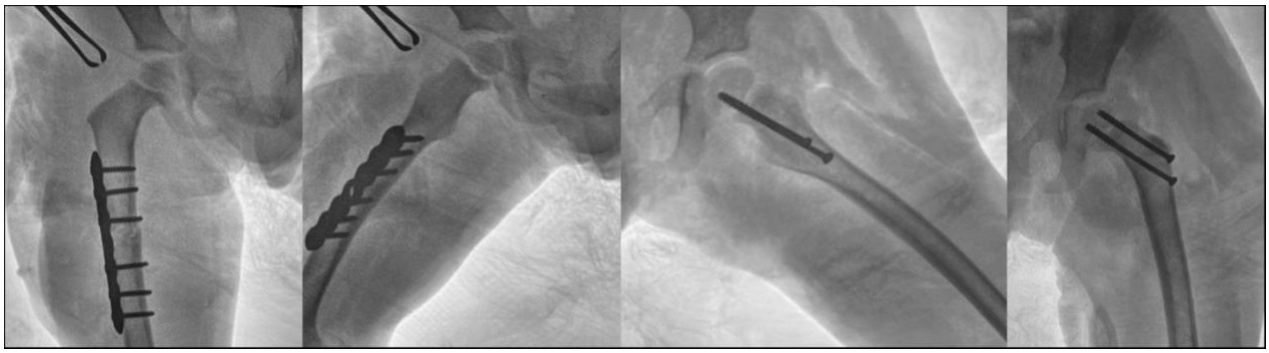

**Figure 2:** Intraoperative fluoroscopic images demonstrating submuscular plate fixation of the right femoral shaft and cannulated screw fixation of the left proximal femoral physeal fracture.

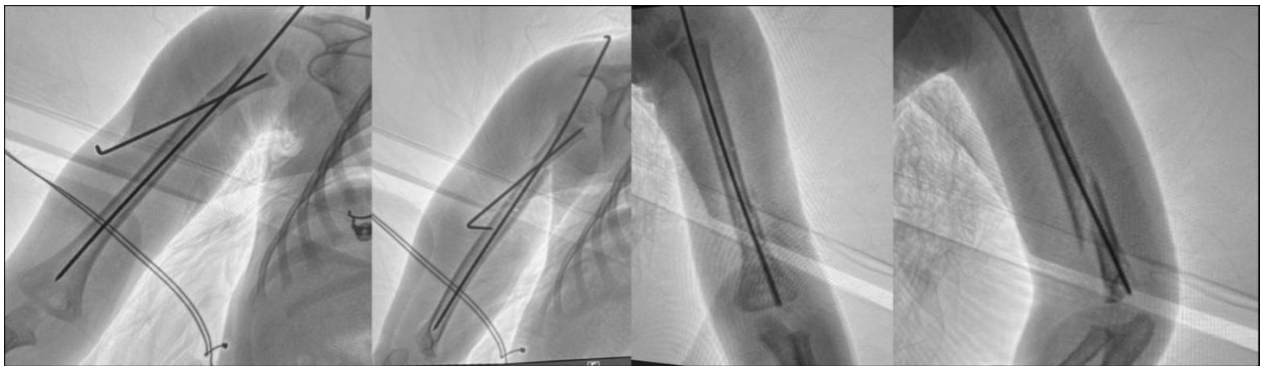

**Figure 3:** Intraoperative fluoroscopic images demonstrating closed reduction and percutaneous pinning of bilateral humeral fractures.

**Figure 4:** Twelve-week postoperative clinical photographs demonstrating excellent range of motion of all limbs and full weight-bearing ambulation.


**Figure 5:** Twelve-week postoperative radiographs demonstrating adequate radiographic union of all four limb fractures.

## Discussion

This case represents an extremely rare pattern of injury in paediatric trauma: simultaneous fractures of all four long bones together with a Delbet Type I proximal femoral physeal injury. Large paediatric fracture epidemiology studies highlight the frequency of fractures in children but do not describe this combination, underscoring the rarity of the injury constellation [1,2].

The presence of a Delbet Type I fracture is particularly significant. These injuries involve epiphyseal displacement and are associated with the highest risk of avascular necrosis due to disruption of the tenuous vascular supply to the femoral head [3]. Literature consistently emphasises the need for urgent anatomical reduction, as delayed or inadequate fixation increases the likelihood of long-term complications [4-6].

The child's right femoral shaft fracture was treated with submuscular plating, a technique supported by paediatric orthopaedic literature for its ability to provide stable fixation while preserving vascularity and allowing early mobilisation [9]. Bilateral humeral fractures were managed with percutaneous pinning, an approach widely regarded as effective and minimally invasive in children [10].

Multisystem involvement—craniofacial trauma, cerebral oedema, and multiple long bone fractures—required coordinated multidisciplinary management. Such integrated trauma approaches have been shown to improve outcomes and reduce complications in paediatric polytrauma [11].

Rehabilitation was particularly challenging in this child given immobilisation of all four limbs. Studies on caregiver burden in paediatric trauma have shown that high-dependency care significantly affects both recovery and psychosocial outcomes, reinforcing the importance of caregiver education and support throughout the rehabilitation process [12].

## Conclusion

A rare constellation of injuries involving a proximal femoral physeal separation combined with quadrilateral long bone fractures was successfully managed through ATLS-guided resuscitation, early surgical stabilisation, and multidisciplinary care. Despite the severity of the injury pattern and the recognised risks associated with Delbet Type I fractures, the child achieved excellent functional recovery at 12 weeks. Long-term follow-up remains essential given the known risks of avascular necrosis and growth disturbance in such injuries.

**Clinical Message**

Even exceptionally rare and severe patterns of paediatric polytrauma can achieve favourable outcomes when managed with timely fracture stabilisation, anatomical reduction of physeal injuries, coordinated multidisciplinary care, and strong caregiver support.

**Learning point of the Article**

Quadrilateral long bone fractures occurring in conjunction with a Delbet Type I proximal femoral physeal fracture represent a rare and high-risk paediatric trauma pattern. Prompt recognition, prioritisation of anatomical reduction of the proximal femoral physis, and early stabilisation of associated long bone fractures within a multidisciplinary setting are critical to achieving favourable functional outcomes.

## Abbreviations

ATLS: Advanced Trauma Life Support; AVN: Avascular necrosis; CT: Computed tomography; eFAST: Extended focused assessment with sonography for trauma; GCS: Glasgow Coma Scale; MVA: Motor vehicle accident; PECARN: Paediatric Emergency Care Applied Research Network

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