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SEGMENTAL HUMERAL SHAFT FRACTURE WITH RADIAL NERVE PALSY IN HIGH-ENERGY POLYTRAUMA: A CASE REPORT

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ABSTRACT

Background: **High-energy pedestrian–vehicle collisions frequently result in complex multi-system orthopaedic injuries. The simultaneous presentation of pelvic ring disruption, segmental humeral shaft fracture with radial nerve palsy, and severe tibial comminution constitutes a significant management challenge.**

Case Presentation: **A 25-year-old right-hand dominant female financial analyst sustained polytrauma following a high-speed roadside collision. Injuries included a transverse superior pubic ramus fracture with sacroiliac disruption, a Neer two-part proximal humeral fracture extending into a segmental shaft fracture complicated by radial nerve palsy, and a Winquist type IV comminuted tibial shaft fracture with segmental fibular involvement. She underwent open reduction and internal fixation (ORIF) of the humerus with intra-operative radial nerve exploration, and closed reduction with locked intramedullary nailing of the tibia. Radial nerve continuity was confirmed intra-operatively. Progressive neurological and functional recovery was documented over six months using serial handwriting analysis.**

Conclusion: **Early skeletal stabilisation combined with selective radial nerve exploration in high-energy segmental humeral fractures optimises neurological and functional outcomes. Occupation-specific outcome tools provide superior patient-centred assessment beyond standard motor grading.**

Keywords: Polytrauma; Segmental humeral fracture; Radial nerve palsy; Intramedullary nailing; Winquist classification; Pelvic ring injury; Functional outcome

INTRODUCTION

High-energy pedestrian–vehicle collisions commonly produce complex, multi-system orthopaedic injuries in which the upper limb, lower limb, and pelvic ring are simultaneously involved. Segmental humeral shaft fractures are relatively uncommon, accounting for fewer than 5% of all humeral fractures, yet they carry a disproportionately high risk of radial nerve injury, because the nerve may be subjected to traction, contusion, or entrapment at more than one fracture level.[1] The reported incidence of radial nerve palsy in humeral shaft fractures ranges from 8% to 18% and rises further in segmental and comminuted patterns.[2,3] The optimal management of the associated nerve palsy — observation versus early surgical exploration — remains debated, and the decision becomes more complex when the fracture forms part of a polytrauma burden that also includes severe tibial comminution and pelvic ring disruption.

Conventional assessment of radial nerve recovery relies on motor grading and electrodiagnostic studies which, although informative, do not capture the integrated fine-motor performance demanded by skilled occupational tasks. For economically active patients, the restoration of vocationally relevant function is a more meaningful endpoint than isolated muscle power, yet such occupation-specific measures are seldom reported in the trauma literature.

Aim and objective: The aim of this case report is to describe the integrated, staged management of a high-energy segmental humeral shaft fracture with radial nerve palsy occurring alongside a Winquist type IV tibial shaft fracture and pelvic ring disruption in a young professional. The specific objective is to evaluate the role of early skeletal stabilisation with selective intra-operative radial nerve exploration, and to illustrate the use of serial handwriting analysis as an occupation-

specific functional outcome measure for monitoring neurological recovery.

CASE SUMMARY

A 25-year-old right-hand dominant female financial analyst presented four days post-injury following a high-velocity pedestrian–vehicle collision. She reported an inability to move her right upper limb, inability to bear weight on the right lower limb, and a history of transient loss of consciousness lasting approximately 30 minutes at the scene of the accident. There was no history of co-morbidities.

On clinical examination, the right upper limb exhibited classical wrist drop with complete loss of active wrist extension and metacarpophalangeal (MCP) joint extension. Thumb extension was absent. Sensory assessment revealed preserved sensation over the dorsal first web space, and distal radial and ulnar pulses were intact bilaterally. The right lower limb demonstrated gross swelling with visible shaft deformity at the mid-tibial level. Pelvic compression manoeuvre elicited pain without haemodynamic compromise. Vital signs were stable.

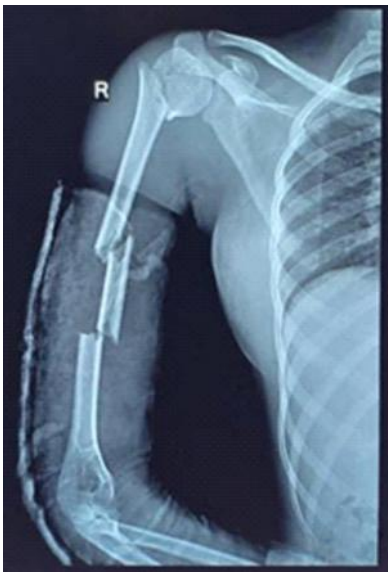


Figure 1: Pre-operative AP radiograph of right humerus showing segmental fracture pattern with proximal extension.

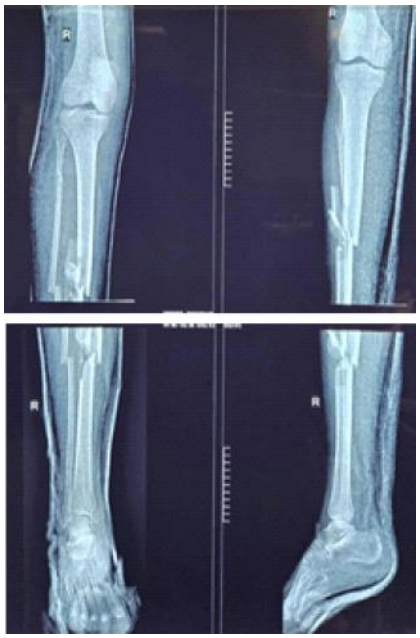
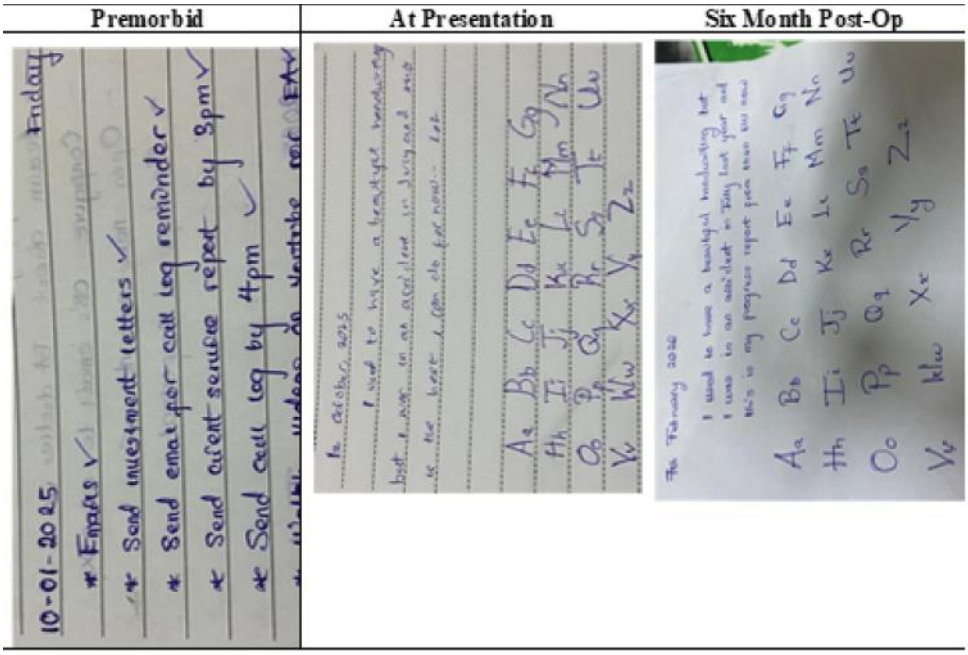


Figure 2: Pre-operative tibia radiographs confirming Winquist type IV comminution with segmental fibular involvement.

Plain radiographic evaluation confirmed three principal injuries: (1) a transverse fracture of the left superior pubic ramus with associated sacroiliac joint disruption; (2) a Neer two-part proximal humeral fracture extending distally into a segmental shaft fracture with



Figure 3: Post-operative radiographs: long PHILOS plate for humerus; locked intramedullary nail for tibia.



interposed comminuted fragments; and (3) a severely comminuted mid-shaft tibial fracture classified as Winquist type IV, with concurrent segmental fibular fracture.

Operative management was staged following haemodynamic optimisation. ORIF of the proximal humerus and shaft was performed using a long proximal Humerus Internal Locking System (PHILOS) anatomic plate and screws. Intra-operative radial nerve exploration confirmed nerve continuity; the nerve was contused and tethered at the fracture interface, and careful decompression with neurolysis was performed. The tibial fracture was managed by closed reduction and locked intramedullary nailing to preserve periosteal blood supply and facilitate biological healing.

Serial handwriting samples were obtained by managing consultant as an occupation-specific functional outcome measure. Pre-injury writing demonstrated fluid cursive control. At presentation, samples revealed loss of stroke continuity, irregular letter sizing, and compensatory proximal muscle recruitment consistent with wrist drop. At the six-month review, handwriting demonstrated restoration of spacing, alignment, and stroke precision, correlating with clinical recovery of wrist extension and progressive radial nerve power on Medical Research Council (MRC) grading.

DISCUSSION

This case illustrates the clinical complexity and management priorities inherent to high-energy trauma in a young adult. Segmental humeral shaft fractures are relatively uncommon, constituting less than 5% of all humeral fractures, yet carry a disproportionately elevated risk of radial nerve injury due to traction, contusion, or entrapment at multiple fracture levels.[1] The reported incidence of radial nerve palsy in humeral shaft fractures ranges from 8% to 18%, rising substantially in segmental and comminuted patterns.[2,3] The management of radial nerve palsy associated with humeral fractures remains a subject of ongoing debate. Conservative observation remains acceptable for isolated mid-shaft fractures with low-energy mechanisms, given that spontaneous neurological recovery occurs in up to 70% of cases.[4,5] However, in high-energy segmental fractures, intra-operative exploration is strongly advocated to exclude nerve transection, relieve entrapment, and facilitate neurolysis where continuity is confirmed.[6] In the present case, nerve continuity was established, and decompression was performed, likely contributing to the progressive neurological recovery observed.

The choice of fixation for segmental humeral fractures must balance mechanical stability against soft tissue preservation. ORIF with plating provides anatomical reduction and rigid fixation essential for nerve exploration and early mobilisation.[7] Intramedullary nailing, while applicable in diaphyseal fractures, carries technical limitations in segmental patterns and poses risks of rotator cuff injury.[8] The use of a long PHILOS plate in this case addressed both components of the injury while affording nerve access through the same surgical field.

Tibial shaft fractures classified as Winquist type IV represent severe comminution with complete loss of cortical contact between fragments.[9] Locked intramedullary nailing remains the gold standard for

displaced tibial shaft fractures in adults, providing load-sharing fixation, preserving periosteal perfusion, and permitting early mobilisation.[10,11] Biological fixation principles were adhered to by avoiding extensive periosteal stripping, thereby supporting secondary bone healing through callus formation.

Pelvic ring injuries accompanying long-bone fractures in polytrauma represent a source of haemodynamic instability and long-term functional impairment.[12] Superior pubic ramus fractures with posterior sacroiliac disruption require careful classification and may necessitate surgical stabilisation when instability is confirmed.[13] In this patient, haemodynamic stability permitted deferment of definitive pelvic fixation within the context of damage control orthopaedics principles.[14]

A salient feature of this case was the application of serial handwriting analysis as an occupation-specific functional outcome measure. Standard neurological assessment tools such as MRC grading and electromyographic studies, while diagnostically informative, do not capture the integrated fine motor performance demanded by professional tasks.[15] Handwriting requires coordinated wrist extension, intrinsic digital control, and proprioceptive precision — functions selectively disrupted by radial nerve injury. Documenting handwriting recovery provided a visible, reproducible, and patient-meaningful metric of neurological restitution, reinforcing the value of occupation-tailored outcome assessment in trauma care.[16]

RECOMMENDATIONS

Based on the findings of this case and supporting literature, the following clinical recommendations are proposed:

1. Intra-operative radial nerve exploration should be performed in all high-energy segmental humeral shaft fractures to establish continuity and relieve nerve entrapment, rather than adopting a wait-and-see approach applicable to low-energy injuries.
2. Open reduction and internal fixation with anatomical plating constructs (PHILOS plate) is preferred over intramedullary nailing in segmental humeral fractures to facilitate nerve access, maintain fracture reduction, and permit early physiotherapy.
3. Locked intramedullary nailing remains the optimal fixation modality for Winquist type III–IV tibial shaft fractures. Biological principles including avoidance of excessive soft tissue disruption should be strictly followed to support secondary bone healing.
4. Occupation-specific functional assessments, such as handwriting analysis for professionals, should be incorporated alongside standard neurological scoring tools in the monitoring of peripheral nerve recovery following upper limb trauma.
5. Multidisciplinary trauma team involvement — including orthopaedic surgery, neurology, physiotherapy, and occupational therapy — should be initiated early to coordinate rehabilitation goals aligned with the patient's vocational demands.
6. Staged operative management adhering to damage control orthopaedics principles is recommended in polytrauma patients to minimise physiological insult while addressing life-threatening and limb-threatening injuries in an appropriate sequence.

CONCLUSION

This case report describes the successful integrated management of high-energy polytrauma encompassing segmental humeral shaft fracture with radial nerve palsy, Winquist type IV tibial shaft fracture, and pelvic ring disruption in a young professional. Early skeletal stabilisation with intra-operative radial nerve exploration achieved progressive neurological and functional recovery. Serial handwriting analysis served as a pragmatic and occupation-meaningful outcome measure, documenting restoration of fine motor precision correlating with clinical nerve recovery. This approach underscores the importance of integrating neurological and functional assessment into trauma management pathways for economically active patients.

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