CASE REPORT

Acute Combined Median and Radial Nerve Palsies after Distal Humeral Shaft Fracture

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Abstract

We report a case of a 29-year-old man who presented with a distal humeral shaft fracture sustained by blunt trauma. Physical examination and nerve conduction study were consistent with injury to the median and radial nerves proximal to the elbow. The patient underwent open reduction and internal fixation of the humeral shaft fracture with neurolysis of the median and radial nerves. Repeat electromyography at 6 months postoperatively showed recruitment of motor units in all muscles sampled, in keeping with clinical improvement. At 16 months follow-up, the patient was full strength in all muscle groups, was back to all activities with no restrictions, and was discharged from follow-up. Our case describes clinical improvement after surgical intervention in a patient with combined median and radial nerve palsies following distal humeral shaft fracture.

Level of Evidence: V

Keywords: Electromyography, Holstein-lewis fracture, Humeral shaft fracture, Median nerve, Nerve conduction study, Nerve palsy, Radial nerve

Introduction

Humeral shaft fractures usually occur in young adults after high-energy trauma and in the elderly following low-energy trauma. They account for approximately 5% of all fractures and represent the third most common type of long bone fracture (1). The annual incidence of humeral shaft fractures has been estimated to be between 10 and 14.5 per 100,000 individuals (2, 3). While fractures of the mid-diaphysis are most common, fractures of the distal third of the humerus carry the highest risk for radial nerve injury, especially in fractures that are significantly displaced or comminuted (1). A systematic review of radial nerve palsy following humeral shaft fracture found that the overall prevalence was approximately 11.8% of all cases (4). Spiral fractures of the distal humerus, known as Holstein-Lewis fractures, carry a risk of acute radial nerve palsy in up to 22% of patients (5). The most common clinical presentation of radial nerve injury is wrist drop although patients frequently also experience an inability to extend the thumb and fingers at the metacarpophalangeal joints (6, 7). Sensory deficits in radial nerve injuries at this level include the radial aspect of dorsum of the hand and wrist (8).

Humeral shaft fractures presenting with median nerve injury are rare, but can occur in open fractures or those associated with brachial plexus injury (1). Rohilla *et al.* presented a case of combined radial and median nerve palsies after humeral shaft fracture, treated operatively, with subsequent neurologic recovery (9). We present here a case of combined radial and median nerve palsies after a distal humeral shaft fracture.

Case presentation

History and Examination

A healthy 29-year-old man was evaluated in our upper extremity clinic approximately two weeks after sustaining a closed humeral shaft fracture from a physical altercation. The patient was initially managed nonoperatively in a coaptation splint before transition to a functional brace at one week follow-up. Electromyography and nerve conduction study was obtained 11 days after injury due to concern for nerve injury and showed severe axonal injury to the median and radial nerves proximal to the elbow. Given the atypical neurologic deficits in this patient, he

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Figure 1. AP plain film of the humerus at initial presentation. Injury plain film of the left humerus demonstrates a comminuted, displaced, and angulated distal humeral shaft fracture.

was referred to the hand and upper extremity clinic.

On examination, the skin was intact and the patient had a normal vascular exam. On sensory exam, he had decreased sensation in the median and radial nerve distributions in his hand. On motor exam, he had no motor function of wrist extensors, extensor pollicis longus (EPL), extensor digitorum communis (EDC), and flexor pollicis longus (FPL). He had trace motor function only of flexor digitorum superficialis (FDS) and flexor digitorum profundus (FDP) of the index finger. Motor function of FDP of the long, ring, and small fingers was intact. Motor function of the flexor carpi ulnaris (FCU) and dorsal interossei was intact.

Imaging Studies

Plain films of the left humerus demonstrated a comminuted, displaced, and angulated fracture of the distal humeral shaft [Figure 1]. After reduction and application of coaptation splint, plain films demonstrated improved alignment [Figure 2].

Surgical Treatment

Three weeks after injury, due to intolerance of conservative therapy, the patient was taken for open reduction and internal fixation of the humeral shaft fracture with neurolysis of the median and radial nerves. The humerus was approached by a standard anterolateral approach. The radial nerve was found to be encased in a thick sheath of scar distally and draped over the fracture as it exited the spiral groove; however, at no point in its course was it entrapped in the fracture. The

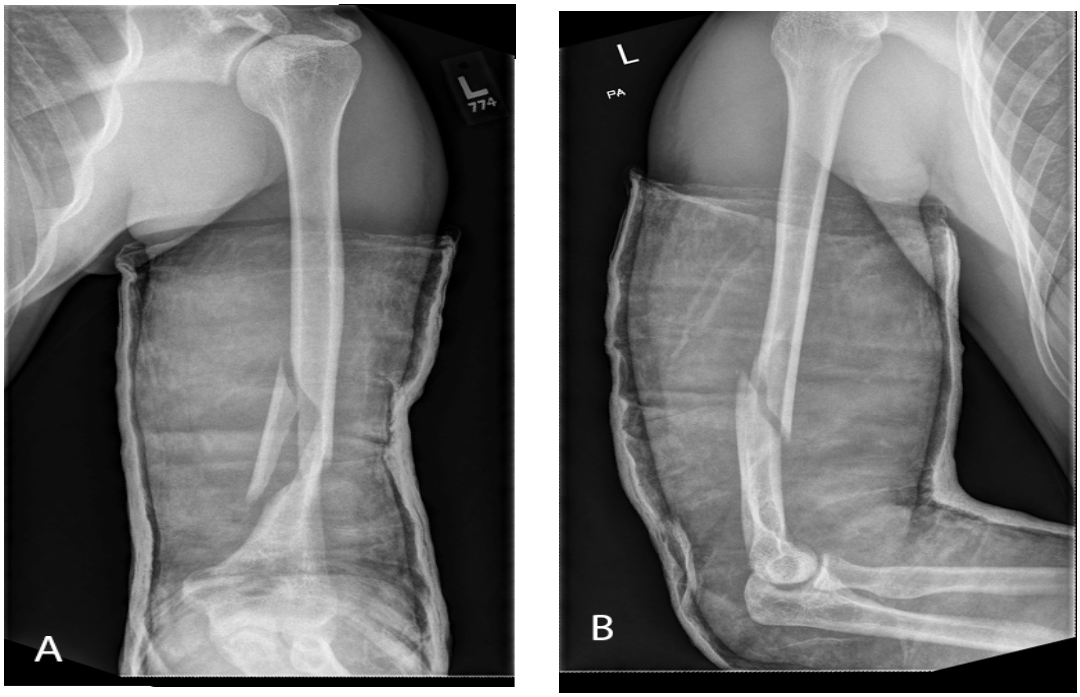

Figure 2. AP (A) and lateral (B) plain films of the humerus three days after reduction in a coaptation splint. Plain films of the left humerus demonstrate interval reduction of the distal humeral shaft fracture with improved alignment.

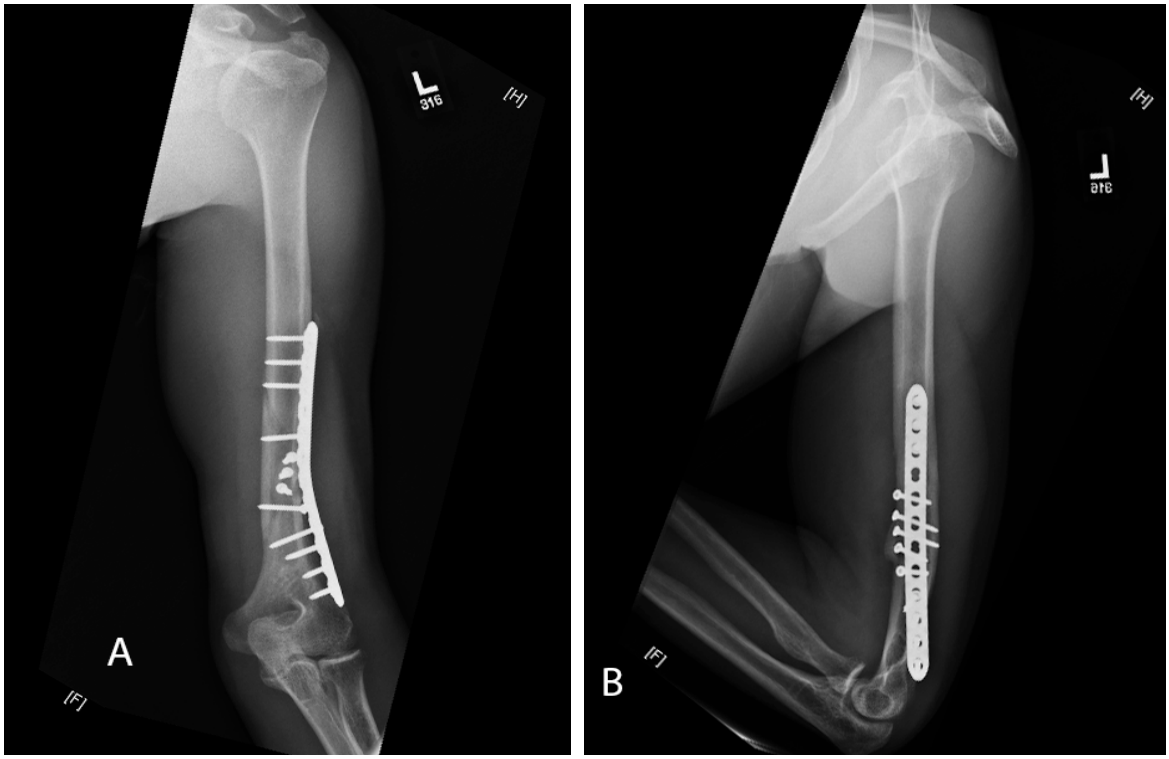

Figure 3. AP (A) and lateral (B) plain films of the humerus six months postoperatively. Plain films of the left humerus demonstrate interval healing of the distal humeral shaft fracture with no evidence of hardware complications.

radial nerve appeared contused but in continuity; it was decompressed throughout the zone of injury. The median nerve was also found to be encased in a thick sheath of scar. While contused, the median nerve was in continuity and also decompressed throughout the zone of injury. The fracture was fixed with lag screws and locking neutralization plate.

Postoperative Course

The procedure was complicated by an infected hematoma one week postoperatively requiring irrigation and debridement with hardware retention, with resolution after a prolonged course of antibiotics. Home occupational therapy was initiated starting 2 weeks postoperatively. At 6 weeks postoperatively from the index surgery, the patient regained trace motor function of his wrist extensors. At 12 weeks postoperatively from the index surgery, the patient regained 4/5 strength in wrist extension. Trace FPL activity returned at 18 weeks postoperatively, and trace EDC activity returned at 20 weeks postoperatively. At 6 months follow-up, the patient had regained clinical function in all affected muscle groups, including wrist extensors, EPL, EDC, FPL, FDS, and FDP. Repeat electromyography at 6 months postoperatively showed recruitment of motor units in all muscles sampled, in accordance with his clinical improvement. Plain films at 6 months postoperatively showed fracture healing with no hardware complications [Figure 3]. At 16 months follow-up, the patient was full strength in all muscle groups, was back to all activities with no restrictions, and was discharged from follow-up.

Discussion

We have presented a rare case of combined median and radial nerve palsies in a patient with a closed distal humeral shaft fracture. Given the close anatomical relationship between the posterior diaphysis of the humerus and the radial nerve, which traverses approximately 6.5 centimeters in the spiral groove, radial nerve injuries occur in 11.8% of all humeral shaft fractures and in up to 22% of spiral fractures of the distal third of the humerus (1, 4, 5, 10). In fractures of the middle third of the humerus, radial nerve injuries are likely a result of the proximity of the nerve to the bone; however, the association between radial nerve injuries and distal humeral shaft fractures is more likely a function of the fracture pattern and energy of trauma through the bone (6). Since the radial nerve is separated from the distal humeral shaft by up to 5 cm of muscle, comminution or displacement of the intermuscular septum by fracture fragment displacement endangers the nerve (7). It is thought that the radial nerve is tethered at the level of the distal humerus where it pierces through the intermuscular septum and is therefore at risk from traction injury from fracture displacement. This mechanism is likely what contributed to the palsies

noted in our patient.

Management of distal third humeral shaft fractures remains controversial, and often involves balancing the risks of wound complications and radial nerve injury with operative treatment against malalignment and inability to tolerate immobilization with nonoperative treatment (11). Median and ulnar palsies after humeral shaft fracture are rare, and are usually only seen in cases of open fractures, significant muscle damage, and total or partial brachial plexus injury (1). There have only been two case reports of humeral shaft fractures resulting in isolated median nerve palsy (11, 12). Apergis *et al.* reported a case of a 19-year-old man who sustained a closed humeral shaft fracture and an ipsilateral nondisplaced distal radius fracture after motorcycle accident who developed acute median nerve palsy (12). He showed clinical evidence of anterior interosseous nerve dysfunction, exhibiting weakness of his FPL and FDP of the index finger. Electromyography, however, demonstrated denervation of all muscles innervated by the median nerve. There were no sensory deficits. The patient was managed conservatively and achieved union by 8 weeks, with neurologic improvement at 12 weeks and full recovery at 20 weeks post-injury. Macnicol described a case of a 10-year-old girl who sustained a greenstick fracture of her humeral shaft after a mechanical fall and developed median nerve entrapment.[8] She did not exhibit any immediate neurologic sequelae, however she complained of difficulty moving her hand one week after casting. After conservative management resulted in fracture healing, five months after initial injury, the patient displayed thenar wasting, hypoesthesia of the palmar aspect of the index, long, and radial half of the ring fingers, and total paralysis of all muscles innervated by the median nerve except for the FDP to the index and long fingers. Surgical exploration of the median nerve two years after the acute injury revealed entrapment of the nerve in the humerus with neuroma formation. Excision of neuroma, neurolysis of the median nerve, and multiple tendon transfers were performed.

There has been one case of combined radial and median nerve injury in a humeral shaft fracture previously reported by Rohilla *et al* (9). The patient sustained a transverse humeral shaft fracture at the junction of the middle and distal thirds secondary to a motor vehicle collision. The patient was treated surgically and had complete neurologic recovery after 12 weeks. We report a rare case of combined radial and median nerve injuries, including both sensory and motor deficits in both distributions, after distal humeral shaft fracture. Our patient sustained a comminuted fracture of the distal humerus, and developed electrical study confirmed severe axonal injury of both nerves. Our decision to transition the patient from conservative to operative management was a result of intolerance of nonoperative treatment after three weeks of conservative therapy.

Our case represents a unique combination of injuries to two nerves following humeral shaft fracture. Due to the rarity of this presentation, the preferred treatment algorithm for this condition is unclear. For isolated, closed, non-penetrating radial nerve injuries associated with humerus fractures, the literature supports conservative management with functional bracing (13, 14). Sonneveld *et al*. reported that early surgical exploration revealed undamaged radial nerves in 13 of 14 patients, and that delayed exploration did not adversely affect motor recovery in cases where spontaneous recovery did not occur (14). A more recent study of patients with complete sensory and motor radial nerve palsy following closed humeral shaft fracture found that the mean time to spontaneous recovery of the radial nerve was 12 weeks after fracture (13). Median nerve injuries associated with humerus fractures are rare, and no preferred treatment algorithm exists. Both reported cases of isolated median nerve injury after humerus fracture were treated conservatively, one with neurologic recovery and the other complicated by nerve entrapment and neuroma development (12, 14). Our case describes clinical improvement after surgical intervention in a patient with combined median and radial nerve palsies following distal humeral shaft fracture.

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