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Case Report

Surgical encounter with radial nerve dysmorphogenesis in the arm: a case-based analysis and its operative implications

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ABSTRACT

Radial nerve palsy is a well-recognized complication of mid-shaft humeral fractures, with an incidence of 7% to 17%. Although most cases resolve spontaneously, anatomical variations in the radial nerve may complicate surgical management and increase the risk of iatrogenic injury. We report the case of a 42-year-old male who sustained a closed mid-shaft fracture of the left humerus following a road traffic accident, presenting with partial wrist and finger drop and diminished sensation over the first webspace in the dorsum of the hand. Surgical fixation was performed via posterior approach. Intraoperatively, multiple aberrant radial nerve branches with an unusual intramuscular course were identified in the posterior aspect of arm. Careful dissection with decompression and preservation of these aberrant branches were done without tension. The patient showed progressive neurological improvement over the ensuing weeks. By two months postoperatively, there was complete recovery of motor and sensory function in the radial nerve distribution with the patient resuming normal activities. This case highlights the significance of preoperative preparedness and intraoperative vigilance in the presence of radial nerve palsy associated with humeral shaft fractures. Awareness of potential anatomical variations in the radial nerve branching pattern is critical for preventing iatrogenic injury and ensuring favorable neurological outcomes.

Keywords: Radial nerve injuries, Humeral fractures, Peripheral nerves, Nerve compression syndromes

INTRODUCTION

Radial nerve palsy is a well-documented sequela of mid-shaft humerus fractures, occurring in up to 17% of cases.[1,2] While most nerve palsies resolve spontaneously, variations in the branching pattern of the radial nerve may pose challenges during surgical intervention.[3,4] Understanding and anticipating such variations are crucial to avoid iatrogenic injury and optimize outcomes.[5]

CASE REPORT

A 42-year-old right-hand dominant male, daily wager by profession, presented with a closed mid-shaft fracture of the left humerus and associated high radial nerve palsy following a road traffic accident. Clinical examination revealed partial wrist drop, reduced extension at the metacarpophalangeal joints, and diminished sensation in the dorsal aspect of the first webspace in hand (Figure 1). There was no neurodeficit pertaining to the ulnar and median nerve. The patient could extend his elbow when arm was stabilized and had sensation in the posterior aspect of arm confirming that the triceps function and the posterior cutaneous nerve of arm were spared. The limb was initially stabilized with a U-slab, and surgical intervention was scheduled after routine evaluation. Open reduction and internal fixation using a 4.5 mm narrow limited contact dynamic compression plate (LC DCP) was performed via a posterior approach.

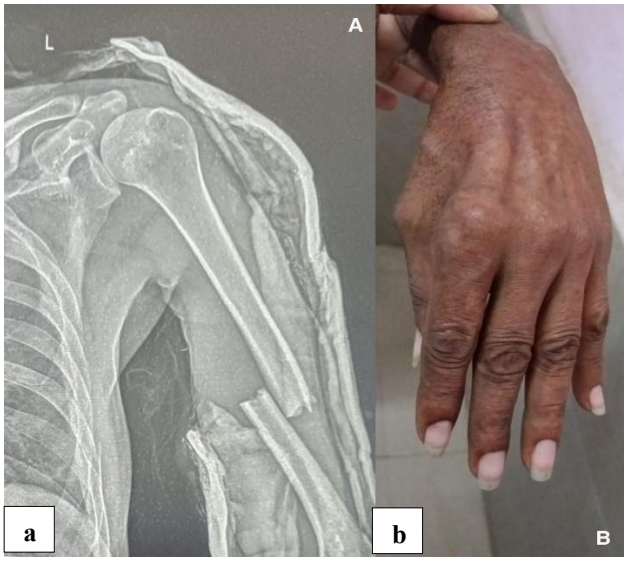

Figure 1: Preoperative imaging and clinical presentation of radial nerve palsy, (a) radiograph of the left arm showing a displaced mid-shaft fracture of the humerus, the fracture has been temporarily stabilized using a U-slab for initial immobilization; and (b) clinical photograph demonstrating partial wrist drop and finger drop at the metacarpophalangeal joints - inability to extend the wrist and fingers- indicative of high radial nerve palsy distal to the triceps innervation, elbow extension remains preserved, consistent with the nerve injury occurring at or distal to the spiral groove.

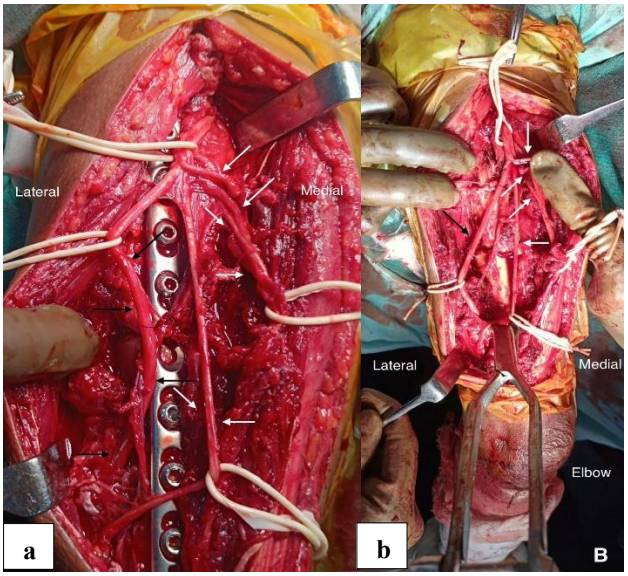

Figure 2 (a and b): Intraoperative photographs showing the radial nerve (black arrows) in the spiral groove of the humerus. Multiple aberrant fascicular branches (white arrows) are seen emerging from the main nerve trunk and coursing intramuscularly through the posterior compartment. Careful dissection was undertaken to preserve these branches during fracture fixation with 4.5 mm narrow LC DCP.

Intraoperatively, after exposure of the radial nerve in the spiral groove, a cluster of aberrantly branching fascicles were seen arising from the main radial nerve trunk at the junction of upper and middle third of the shaft and coursing both medially and downwards along the posterior aspect of arm. These branches had an atypical intramuscular course within the posterior compartment of the arm. The main trunk was seen to traverse the radial groove from medial to lateral direction along with the Profunda Brachi artery, ultimately piercing the lateral intermuscular septum and passing anterior to the lateral epicondyle of the humerus. As many as five aberrant bundles were seen arising from the main trunk (Figure 2).

The first two were seen coursing to the long head of the triceps with the third and fourth going medially underneath it. The fifth branch coursed downwards with a few small branches arising from it and supplying the lateral head of triceps. Careful dissection was undertaken proximally and distally to delineate the course of the branches, secure them from surrounding soft tissue, and preserve their continuity. At the level of the fracture, the main radial nerve trunk along with one aberrant branch were seen abutting the fracture (Figure 2b).

Figure 3: (a) Immediate postoperative lateral, and (b) anteroposterior radiographs of the left humerus showing stable internal fixation of a mid-shaft humerus fracture using a 4.5 mm narrow limited contact dynamic compression plate of 9 holes size. Satisfactory alignment and implant positioning are noted, with no evidence of hardware-related complications.

Due to limitations of intraoperative time period and risk of postoperative infection, extensive dissection of the lower three aberrant bundles could not be done beyond the designated operative field. The fracture was reduced following principles of plate assisted reduction with

minimal and judicious use of bone clamp and then fixed with a 4.5 mm narrow stainless steel LC DCP of 9 holes size (Figure 3).

Postoperative course

The patient tolerated the procedure well. Serial neurological evaluations showed progressive improvement in wrist extension followed by recovery in finger extension over the following 8 weeks. By the second postoperative month, significant motor recovery was evident, with complete restoration of sensory function as well (Figure 4).

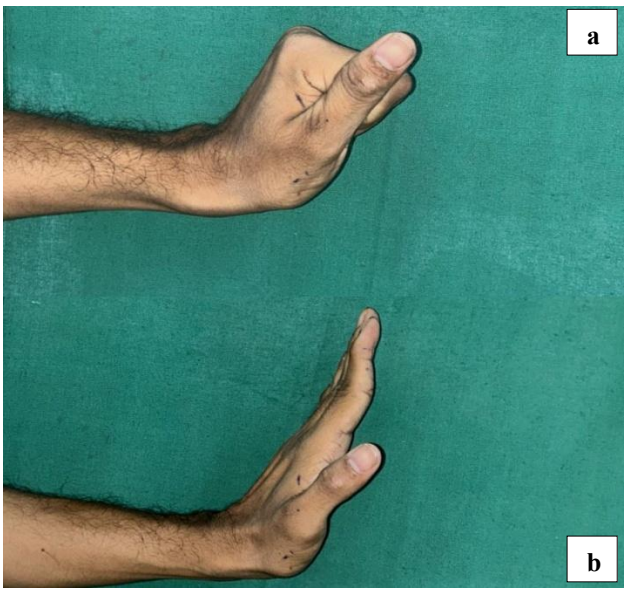

Figure 4: Clinical photographs at 3-month postoperative follow-up demonstrating neurological recovery, (a) the patient is able to actively extend the wrist against gravity, indicating reinnervation of the extensor carpi radialis muscles, and (b) active extension of the fingers at the metacarpophalangeal joints is observed, confirming functional recovery of the posterior interosseous nerve–innervated muscles. These findings reflect significant motor improvement following surgical decompression and anatomical preservation of the aberrant radial nerve branches.

DISCUSSION

The radial nerve arises from the posterior cord of the brachial plexus and typically follows a predictable course through the posterior compartment of the arm. However, variations in its branching pattern and trajectory may result from developmental anomalies during embryogenesis. The limb bud mesenchyme, innervated by the growing motor axons from the brachial plexus around the fifth week of gestation, plays a critical role in guiding nerve patterning. Aberrant fascicular branching, like what is encountered in this case, may result from disruptions in axonal pathfinding or target-derived neurotrophic signals during this critical period. While rare, these anatomical variants have been documented in cadaveric and imaging studies, with clinical implications during fracture fixation or nerve decompression procedures. Such dysmorphogenesis can predispose patients to nerve entrapment or misidentification intraoperatively, underlining the importance of meticulous dissection and anatomical familiarity in surgical planning.[6]

Radial nerve injury in the setting of mid-shaft humeral fractures is most commonly neuropraxic and resolves with conservative management.[1,2] However, in cases with aberrant nerve anatomy, surgical exposure and manipulation pose a heightened risk of iatrogenic injury.[4,7]

Intraoperative identification of aberrant fascicular branching, as seen in this case, is rare but surgically significant. Their presence may suggest dysmorphogenesis during embryonic development, which can predispose the nerve to compression or entrapment following trauma.[8]

Lombardo et al noticed an unusual communication between the radial and ulnar nerves in the arm during repair of a humerus fracture.[9] The patient had loss of both radial and ulnar nerve sensorimotor functions. In our case, there were no such symptoms of ulnar neurodeficit.

Patel et al encountered an abnormal course of the superficial branch of the radial nerve during the harvest of a radial forearm free flap.[10] Their study documented the aberrant branching pattern in forearm whereas the site of our findings is the arm.

Gupta et al in their case report mentioned about an aberrant posterior division of the radial nerve in the distal third shaft of humerus supplying the long head of triceps.[11] The patient in their study had no neurodeficit preoperatively which is in contrast to our case.

Similar finding of one aberrant posterior division of radial nerve was noted by Ramasamy et al during their fixation of humeral shaft fracture through anterior approach.[12] The current case report shows at least five distinct bundles of aberrant branches arising from the main radial nerve trunk.

Jamuna reported that the radial nerve originating from the posterior cord was found splitting into anterior and posterior divisions. Both the divisions coursed through the radial groove and the posterior division was giving off the branches which are expected to have origin from the main radial nerve. The anterior division continued as the main radial nerve and had a usual course in rest of the upper limb.[13]

Taheri et al in their cadaveric study found a connecting branch between radial and ulnar nerve originating from the former in the anterior aspect of the arm near the base of axillary fossa and joining the later at the middle two-fourth of arm.[14]

Uerpairojkit et al studied branching patterns of radial nerve to the triceps brachi in 79 arms from 46 cadavers and gave

a classification according to their dissection.[15] The first aberrant branch in our case supplied the long head of the triceps, staying consistent with their study but the rest of the branches in our case did not follow any of their described patterns.

Most of the literature on aberrant branching pattern of radial nerve were based on cadaveric studies. Literature on aberrant branching patterns of radial nerve encountered in routine orthopaedic procedures are scarce. The rare pattern observed in the current study is one of a kind and has not been depicted elsewhere highlighting the paramount importance of its surgical implications.

Some authors advocate for early nerve exploration in closed humerus fractures when nerve palsy coexists with signs of entrapment or aberrant recovery.[16,17] This case supports such a stance, particularly when preoperative neurological deficit is present and anatomical anomalies are suspected. Preoperative imaging tools, such as high-resolution ultrasound or magnetic resonance neurography, may assist in surgical planning but are not routinely employed.[4] In our case, due consideration of the financial limitations of the patient was exercised, hence, advanced imaging could not be done.

The gradual postoperative recovery in this patient reinforces that prompt surgical decompression and anatomical preservation can yield favorable outcomes, even in the context of nerve dysmorphogenesis.[18]

CONCLUSION

Radial nerve palsy is a well-recognized complication of mid-shaft humeral fractures. Literature is abound with cadaveric studies showing abnormalities in the radial nerve anatomy. Literature in which such anomalies have been encountered during routine surgical fixation of humeral shaft fractures are few and emergent. The current case report is the only study which shows a unique and extensive branching pattern encountered intraoperatively, not aligning with any of the previously described cadaver based classification and illustrates the importance of such complex nerve pathologies that can be routinely encountered. Furthermore, intraoperative awareness, meticulous dissection and anatomical vigilance are key to avoiding iatrogenic nerve injuries. This case also highlights that with proper surgical technique, even complex nerve variations can be managed effectively, with encouraging neurological recovery.

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