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Late Distal Radio-Ulnar Joint Instability after Childhood Distal Forearm Fracture

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Abstract **Case Report**

Introduction: Paediatric distal radius fractures are considered benign, and associated ulnar styloid injury is mostly ignored. Although a significant portion evolves to non-union, only a minority present associated complications such as ulnar pain, ulnocarpal abutment, or distal radio-ulnar instability. Distal radio-ulnar dislocations are rare and point to failure of the stabilizing mechanisms of this joint, warranting urgent reduction. ***Case Report*:** 18-years old male presents to the emergency department with a volar distal radio-ulnar joint dislocation after a twisting motion of the left wrist. Patient was submitted to urgent closed reduction under general anesthesia and cast immobilization, and surgical repair of ulnar styloid non-union and triangular fibrocartilage complex tear was performed 1 week later. At 6 months follow up the patient as achieved pain free full mobility without instability. ***Conclusion***: The triangular fibrocartilage complex and distal radio-ulnar joint may be affected by seemingly benign injuries, later presenting with acute complications. Fracture and subsequent non-union of the ulnar styloid in the setting of a distal radius fracture is common and underdiagnosed, but clinical significance of and optimal treatment of this injury are still undefined.

Keywords: Ulnar styloid, Dislocation, Distal Radio-Ulnar Joint instability, Triangular Fibrocartilage Complex.

INTRODUCTION

Pediatric distal radius fractures are extremely common and considered benign, due to the great bone remodeling at that site and excellent long-term outcomes and seldom warrant surgical treatment, with ulnar styloid process (USP) fractures mostly ignored or underdiagnosed *(Andersson et al., 2014; Eberl et al., 2008; Korhonen et al.,* 2019). Diagnosis of ulnar conditions in adult age and retrospective examination of several cases indicate the pediatric trauma as the most probable cause of such conditions, and there is raising awareness for early diagnosis (Andersson *et al*., 2014; Eberl *et al*., 2008; Hauck *et al.*, 1996; Korhonen *et al.*, 2019; Protopsaltis *et al*., 2010). Various pathologies present with ulnar wrist pain such as ulnocarpal abutment syndrome, lunotriquetral instability, lunotriquetral coalition, tendinopathies, triangular fibrocartilage complex (TFCC) tears or distal radio-ulnar joint instability (DRUJ) (Korhonen *et al*., 2019; Nakamura *et al*., 1998; Protopsaltis *et al*., 2010; Sachar, 2012). These can be related to non-union of the USP or the original trauma, and instability can be asymptomatic until a dislocation occurs (Mulford *et al.*, 2010).

This report presents a DRUJ dislocation on a setting of a USP non-union 11 years after the original fracture.

CASE REPORT

18-years old male, right hand dominant presents to the emergency department after a forced supination and extension movement. The patient complains of wrist pain, inability to pronate the forearm and numbness of the 5th finger, without loss of motion of the fingers. The patient reported a left DRF at the age of 7, treated non-surgically with apparent uneventful healing, and reported no prior dislocation or wrist pain. Examination reveals a locked forearm in 50º supination, a depression in the ulnar aspect of the wrist (Figure 1) and hypoestesia of the 5th and ulnar 4th fingers, without motor deficit. Distal pulses were intact, and no wound was identified. Posteroanterior radiograph (Figure 2A) shows a superposition of the distal ulnar head and cubital aspect of the radius, with USP non-union present. Lateral radiograph (figure 2B) presents loss of alignment of the ulna and radius, and computed tomography scan (CT) (Figure 3) confirmed a volar dislocation of the ulna.

Closed reduction was achieved in the emergency department under general anesthesia, by applying digital pressure on the distal end of the ulna and interosseous membrane in a volar to dorsal direction, with simultaneous forearm pronation. Gentle pronation and supination without dislocation was achieved, ulnar ballottement test was positive, identifying Distal Radio-Ulnar Joint (DRUJ) instability. The forearm was immobilized with an above-elbow slab in neutral position (figure 4) and, upon waking up, the patient reported improvement of pain and finger sensitivity.

One week after the initial presentation, the patient was submitted to open repair of the non-union and Triangular Fibrocartilage Complex (TFCC): through a direct ulnar approach, the non-union was decorticated and the USP reinserted along with the foveal attachment of the TFCC, with a 2-0 non-absorbable suture, through a trans-osseous tunnel. The DRUJ was stable after the procedure and a sugar thong splint was applied for 3 weeks, substituted afterwards for a Munster orthosis for 4 weeks. At the 8th week patient showed slightly limited pronation, which improved after rehabilitation. At 6 months, patient has painless, unlimited range of motion and stable DRUJ, although non-union is still evident in radiography (figure 5). Further follow-up was scheduled for one year.

Figure 1: Photograph depicting deformity in left forearm (red circle)

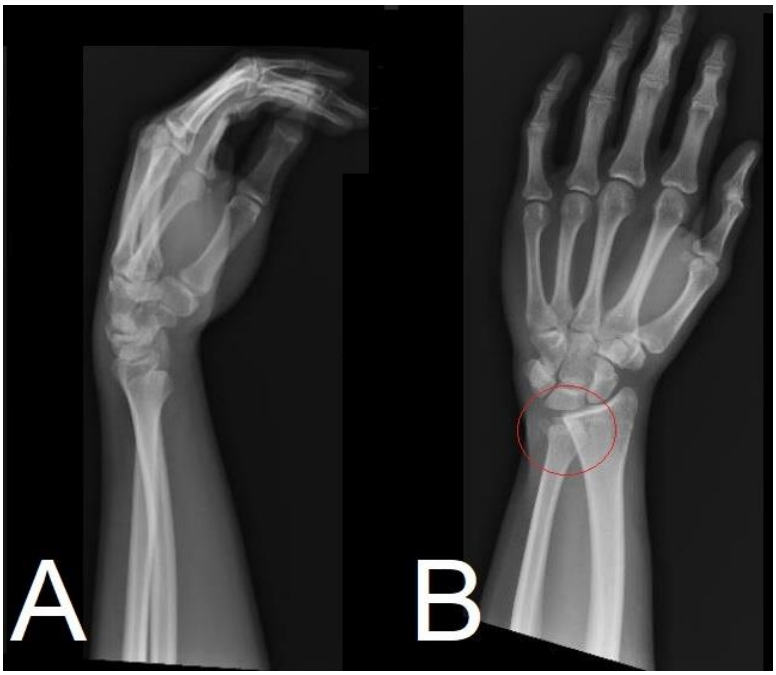

Figure 2: Lateral (A) and Posteroanterior (B) radiographs at initial presentation

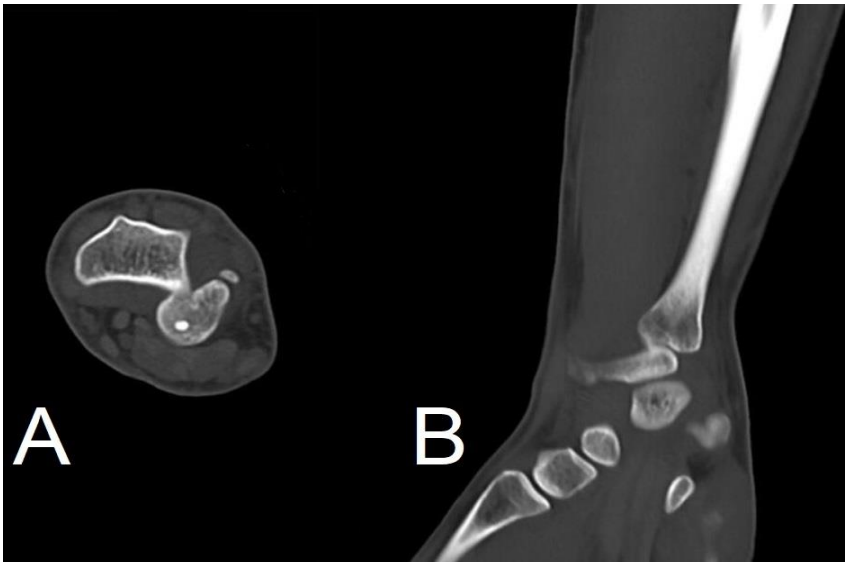

Figure 3: Axial (A) Coronal (B) CT-scans of the forearm

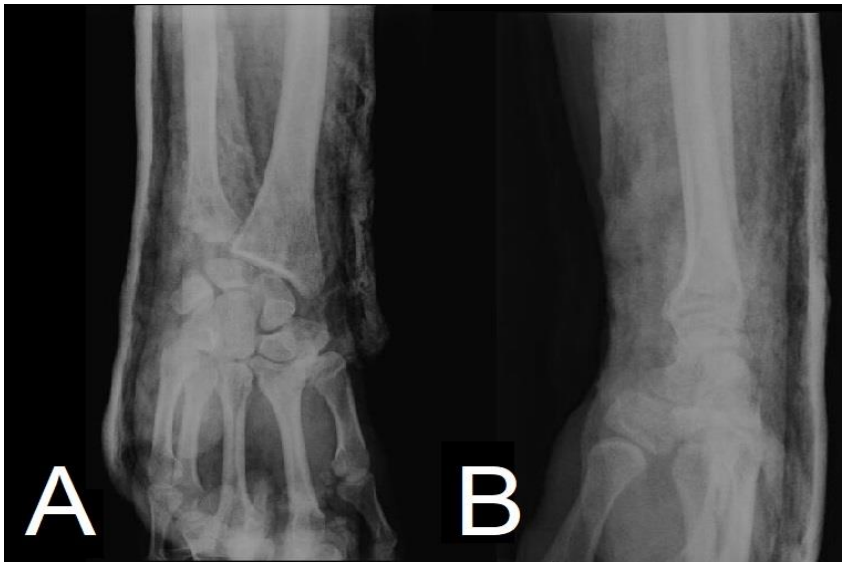

Figure 4: Post-reduction posteroanterior (A) and lateral (B) radiographs

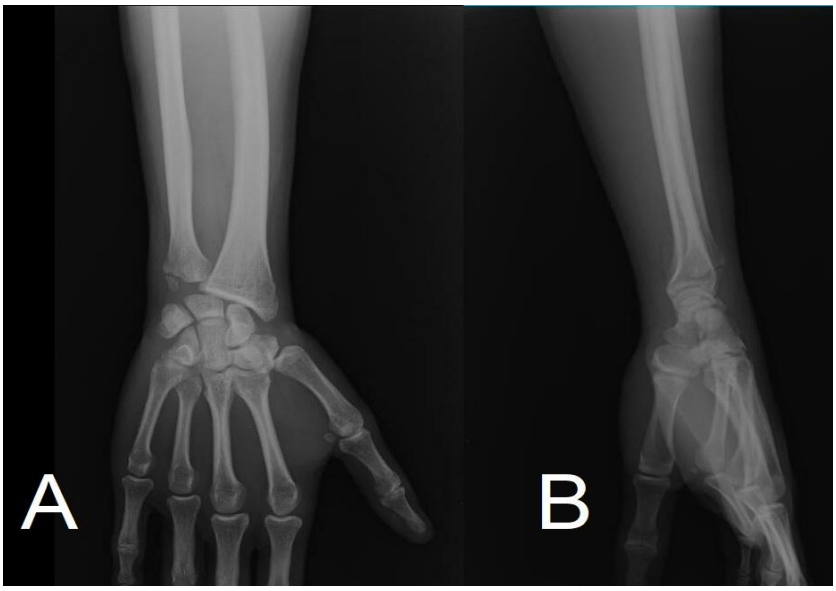

Figure 5: 7-months follow-up posteroanterior (A) and lateral (B) radiographs

DISCUSSION

DRF is usual in children, with rising incidence reported on the last 40 years (Kazemian *et al*., 2011; Khosla *et al*., 2003). Simultaneous USP fractures are reported in 30% to 50% of paediatric distal radius fracture (Gogna *et al*., 2016; Wijffels *et al*., 2014). The distal ulnar epiphysis is cartilaginous and may not be identifiably under the age of 5 to 9 years, leading to misdiagnosis of fractures at this site, commonly described as isolated DRF, therefore leading to late diagnosis of USP in adult (Abid *et al.*, 2008; Bae & Waters, 2006; Korhonen *et al.*, 2019; Wijffels *et al.*, 2014). Either isolated or in association with a DRF, USP rarely justify surgical treatment, even if addressing the DRF surgically (Logan & Lindau, 2008; Souer *et al*., 2009; Zoetsch *et al*., 2013) and below elbow cast immobilization is the norm, with some authors defending casting in ulnar inclination to minimize fragment dislocation (Korhonen *et al*., 2019). USP fracture non-union after paediatric DRF can range from 16% to 20%, with ill-defined risk factors and a low progression to bony ossification (Abid et *al.*, 2008; Gogna *et al.*, 2016; Korhonen *et al*., 2019).

Most non-unions remain asymptomatic despite fracture displacement on radiographs. Symptomatic USP non-unions can be caused by movement at the union site, instability of the DRUJ or tear injury in the TFCC (Hauck *et al*., 1996; Protopsaltis & Ruch, 2010). Persistent, chronic instability at this joint is associated with many long-term complications, with specific links to ulnar sided arthritis, wrist pain, reduced grip strength, and motion limitation (Xiao *et al*., 2021).

The TFCC is the primary stabilizer of the DRUJ. It's composed of several structures, including the triangular fibrocartilage (TFC), the ulnocarpal meniscus (meniscus homolog), the ulnar collateral ligament, the dorsal radioulnar ligament (RUL), the palmar RUL, and the subsheath of the extensor carpi ulnaris. The RUL are thought to be responsible for most of the stability at the DRUJ (Haugstvedt *et al*., 2017) and present superficial and deep portions which attach to the base of the ulnar styloid and fovea, respectively. As such, the superficial portion is susceptible to injury in cases of peripheral TFCC tears, while the deep portion, also referred as ligamentum subcruentum, is susceptible to injury in cases of basilar ulnar styloid fractures (Andersson *et al*., 2014; Maniglio *et al.*, 2021). Comparing ulnar fracture types, the greatest amount of rotational and dorso-palmar translation occurs in fractures involving the fovea (Maniglio *et al*., 2021). In this setting, instability correlates with how much of the bony fragment includes the origin of the RUL. Vice versa, if a patient with tip or middle ulnar styloid fracture has clinical DRUJ instability, their RUL must, by anatomic definition, be disrupted (Nakamura *et al*., 2021).

Dorsal dislocations area a result of hyperpronation force and tend to have injuries to the deep volar RUL and dorsal joint capsule, impeding supination and with the ulnar head prominent on the dorsal wrist (Carlsen *et al*., 2010). Volar dislocation occurs with hypersupination, rendering the patient unable to pronate. The ulnar head becomes dislodged, leaving a dorsal gap, while the ulnar head usually is not noticeable because of overlying palmar soft tissues. The wrist can appear narrow because of the now compressive pull of the pronator quadratus muscle, resulting in a diminished transverse dimension, although swelling and pain may mask such findings (Carlsen *et al*., 2010).

Wrist radiographs should be obtained both in the posteroanterior and lateral projection. The lateral view is the most significant to evaluate DRUJ dislocation but poor positioning due to patient's pain and limited range of motion may lead to false negatives (Carlsen *et al*., 2010; Duryea *et al*., 2016). A true lateral radiograph can be confirmed by evaluating the scaphopisocapitate relationship, and rotation as little as 10º may lead to misdiagnosis, although displacement of the ulna beyond the cortices of the radius is not pathognomonic of DRUJ dislocation. Posteroanterior view may show a slight overlap of the distal radius and ulna, and contralateral radiographs may aid in the diagnosis (Amrami *et al*., 2010; Duryea *et al*., 2016).

CT can be used in dislocated DRUJ to evaluate for entrapment or bony injuries unrecognized in the radiographs. It is also used in subtle instability to evaluate the dynamic relationship between the distal forearm bones in different positions and under loads and bilateral CT is considered the gold standard for evaluation of DRUJ congruency. MRI can also be considered for proper evaluation of these cases, particularly in a chronic setting and to rule out concomitant injuries such as degenerative changes of the triangular fibrocartilage with or without chondrosis of the distal ulna, triquetrum, and lunate (Amrami *et al*., 2010; Duryea *et al.*, 2016).

TFCC tears with associated USP fracture are classified as Palmer class 1B (Palmer, 1989). Hauck classified and proposed fragment excision for symptomatic USP non-unions regarding DRUJ instability: type 1 presents with a stable DRUJ and shows good outcome with fragment excision, while type 2 shows DRUJ instability and a TFCC repair is warranted with or without conserving the bone fragment (Hauck *et al*., 1996). Open or arthroscopic repair (Bayoumy *et al*., 2017) of the TFCC tear is also a possibility, and non-union can be addressed through tension band wiring or plate osteosynthesis after debridement of non-union(Chen *et al.*, 2018, 2020; Gogna *et al*., 2016; Souer *et al*., 2009). If the DRUJ is impossible to reduce or to prevent postoperative

ulnocarpal abutment syndrome, ulnar shortening osteotomy might be necessary (Nakamura *et al*., 1998).

There is some conflicting evidence regarding USP fracture treatment in DRF setting, with some authors reporting no effect on wrist function, radiological evaluation or patient related scores (Xiao *et al*., 2021; Yuan *et al*., 2017). A symptomatic wrist with a USP non-union should be thoroughly evaluated for other causes of pain such as ulnar impaction syndrome, ligamenteous tears, TFCC injuries, and posttraumatic degenerative changes (Sachar, 2012).

CONCLUSION

Pediatric DRF may have associated, unrecognized, USP fracture which may lead to late complications. Instability in the context of symptomatic non-union, albeit uncommon, must be addressed to prevent further damage to the DRUJ and ulno-carpal joint, but further evidence is needed for the optimal form of treatment.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Abbreviations:

CT – Computed Tomography scan
DRUJ – Distal Radio-Ulnar Joint instability
RUL – Radioulnar ligament
TFCC – Triangular Fibrocartilage Complex
USP – Ulnar styloid process

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