ABSTRACT
Distal radioulnar joint (DRUJ) dislocation without fracture is uncommon. Herein, we present three cases that were treated surgically and followed for a mean of 24 months. Symptoms of DRUJ dislocation without fracture may vary, so clinical suspicion for this injury should increase whenever there is a history of wrist trauma and evidence of restricted or painful forearm supination or pronation. Radiographic evaluation may be more accurate than physical examination for diagnosis. Surgical therapy with arthroscopy-assisted closed reduction and percutaneous Kirschner wire placement yields favorable clinical and functional results.

Key words: Dislocation, distal radioulnar joint, Kirschner wire, radiographic imaging, reduction, treatment

Surgical treatment of isolated acute dislocation of the distal radioulnar joint without fracture: Case reports of dorsal and volar dislocations

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Introduction
The distal radioulnar joint (DRUJ) is located at the level of the wrist and involves the two bones of the forearm - the radius and ulna. The DRUJ is one of two hemijoints that function to permit supination and pronation of the forearm. The DRUJ helps redistribute the load between the ulna and radius that is necessary following with changes in forearm rotation [1]. Several ligaments and muscles enhance the stability of the DRUJ, including the triangular fibrocartilage complex (TFCC), interosseous membrane, extensor retinaculum, ulnar carpal ligaments, and pronator quadratus muscle [2].

DRUJ dislocation is most often associated with fracture of the radius or ulna, and isolated DRUJ dislocation without fracture is uncommon [3,4]. Most of the literature concerning this entity has been in the form of either case reports or small series [5]. Dorsal DRUJ dislocations tend to result from hyperpronation forces, while the less frequent volar dislocations likely result from hypersupination forces [3]. Left untreated, these injuries can lead to significant chronic functional disability [6,7].

Isolated DRUJ dislocation can be difficult to diagnose because it can present with indistinct symptoms or may remain asymptomatic [8]. No universally accept-
ed classification schemes for DRUJ dislocations exist, though at least one working classification for different types of DRUJ injuries has been proposed [9]. While a variety of physical examination techniques have been described, we were unable to find clear recommendations for DRUJ dislocation diagnostic testing or criteria. Similarly, we could not find well-defined guidelines for treatment of isolated DRUJ dislocation.

In the following, we present three cases of isolated DRUJ dislocation without associated fracture. We include descriptions of our diagnostic methodologies, surgical techniques, and functional outcomes. Our objective was to add to the sparse amount of data in the literature on this uncommon problem, to describe our surgical approach, and to raise awareness of isolated DRUJ dislocations because they can easily be overlooked.

**Case Reports**

The demographic and clinical characteristics of our patients are summarized in Table 1. The patients were followed for a mean of 24 (range: 22 to 26) months after surgery.

**Case 1:** A 17-year-old female sustained an acute injury involving a fall onto the outstretched right hand while her forearm was in pronation. Upon presentation, she complained of wrist pain, her neurovascular exam was normal, and she had dorsal ulnar wrist laxity and tenderness, positive piano-key and ulnar fovea signs, and a negative grind test. Wrist anteroposterior (AP) and lateral X-rays showed no fracture or dislocation, while axial and 3-D computed tomography (CT) of the wrist revealed dorsal DRUJ dislocation without fracture (Figure 1A, 1B, and 1C). Using the working classification for DRUJ injuries proposed by Thomas and Sreekanth, we classified this as an A1 DRUJ injury [9].

**Case 2:** A 38-year-old male sustained an acute injury involving a fall onto the outstretched right hand while his forearm was in pronation. Upon presentation, he complained of wrist pain, his neurovascular exam was normal, and he had dorsal ulnar wrist laxity and tenderness, positive piano-key and ulnar fovea signs, and a negative grind test. Wrist anteroposterior (AP) and lateral X-rays showed no fracture or dislocation, while axial and 3-D computed tomography (CT) of the wrist revealed dorsal DRUJ dislocation without fracture (Figure 1A, 1B, and 1C). Using the working classification for DRUJ injuries proposed by Thomas and Sreekanth, we classified this as an A1 DRUJ injury [9].

**Case 3:** A 42-year-old male sustained an acute injury involving a fall onto the outstretched right hand while his forearm was in pronation. Upon presentation, he complained of wrist pain, his neurovascular exam was normal, and he had dorsal ulnar wrist laxity and tenderness, positive piano-key and ulnar fovea signs, and a negative grind test. Wrist anteroposterior (AP) and lateral X-rays showed no fracture or dislocation, while axial and 3-D computed tomography (CT) of the wrist revealed dorsal DRUJ dislocation without fracture (Figure 1A, 1B, and 1C). Using the working classification for DRUJ injuries proposed by Thomas and Sreekanth, we classified this as an A1 DRUJ injury [9].

**Table 1.** Demographic and clinical characteristics of three patients treated surgically for traumatic isolated distal radioulnar dislocation without fracture.

| Characteristics                  | Case 1 | Case 2 | Case 3 |
|----------------------------------|--------|--------|--------|
| Age, years                       | 17     | 38     | 42     |
| Gender                           | Female | Male   | Male   |
| Traumatic mechanism              | (+)    | (+)    | (+)    |
| Side of injury                   | Right  | Right  | Left   |
| Location of dislocation          | Dorsal | Dorsal | Volar  |
| Wrist Tenderness, location       | (+) Dorsal | (+) Dorsal | (+) Volar |
| Ulnar fovea sign                 | (+)    | (+)    | (+)    |
| Piano-key sign                   | (+)    | (+)    | (-)    |
| Grind test result                | (-)    | (-)    | (+)    |
| AP and lateral X-ray result      | (-)    | (-)    | (+)    |
| Axial and 3-D CT result          | (+)    | (+)    | (+)    |
| K-wire placement                | Radius to ulna | Radius to ulna | Ulna to radius |
| Postoperative splint             | (+)    | (+)    | (+)    |
| Follow-up, months                | 22     | 24     | 26     |

AP, anteroposterior; CT, computed tomography; K-wire, Kirschner wire.

![Figure 1. Case 1 - Right wrist – (A) Preoperative X-rays (bilateral AP and lateral), (B) Axial CT, (C) 3-D CT.](image-url)
and a negative grind test. Wrist X-rays exhibited no fracture or dislocation, while axial and 3-D CT of the wrist revealed dorsal DRUJ dislocation without fracture (Figure 2A, 2B, and 2C). We classified this as an A1 DRUJ injury.

Case 3: A 42-year-old male sustained an injury involving a fall onto the outstretched left hand while his forearm was in supination, and this occurred one month prior to his presentation. Upon presentation, he complained of wrist pain and asymmetry, his neurovascular exam was normal, and he had volar ulnar wrist tenderness, a negative piano-key sign, a positive ulnar fovea sign, a positive grind test, and asymmetry between the wrists. Wrist X-rays as well as axial and 3-D CT scanning both demonstrated volar DRUJ dislocation without fracture (Figure 3A, 3B, and 3C). We classified this as a subacute A1 DRUJ injury.

Case Management and Results: Surgical and nonsurgical options for management were discussed with each patient, and prompt surgery was advised in all three cases, primarily because of the surgeon’s belief that this would lower the risk of recurrence. All surgeries were performed under general anesthesia by the same surgeon (the primary author). The surgery for each patient involved arthroscopy-guided closed reduction and percutaneous fixation with two Kirschner (K-) wires. As all surgeries were conducted as closed reductions, we were not able to determine if there was evidence of TFCC tear or radioulnar ligament or capsular disruption. In Cases 1 and 2, the K-wires were advanced from the ra-
the wrists postoperatively, and these splints remained on for approximately six weeks. When the patients were seen six weeks after surgery, all were pain-free and had no wrist tenderness. The K-wires were removed at that time in the outpatient setting. Active and passive joint movements were subsequently initiated. All three patients achieved complete range of movement within two weeks and they maintained this during their entire follow-up period. As well, there were no signs of residual TFCC tear, such as pain when bending the wrist, persistent wrist swelling, clicking of the wrist, or loss of grip strength during the follow-up period. Based on the fact that the patients were pain-free and maintained full wrist function without limitations, postoperative imaging was not performed.

**Discussion**

Acute isolated dislocation of the distal radioulnar joint without fracture was first described in a cadaver in 1777 by Desault [7]. Since then, information about this particular disorder has come mainly through case reports and a small series of cases [5]. Our case report adds to the current literature concerning this uncommon but problematic disorder.

Although isolated volar DRUJ dislocation is more common than isolated dorsal dislocation, only one of our three cases involved a volar dislocation [5]. Volar dislocation is most often caused by extreme supination of the forearm upon a fixed hand and has been reported to take place during a simple fall, from a direct blow to the wrist, during weight lifting, and while playing rugby [10-13]. The mechanism of injury in our single patient was a fall onto the outstretched left hand while his forearm was in supination. Hagert has described that in volar dislocation, the dorsal radioulnar ligament and volar joint capsule may be disrupted [14]. He has also noted that in cases of volar dislocation, the patient may be unable to pronate the forearm, there may be hollowness dorsally where the ulnar head is usually visible, and the wrist may appear narrow because of the compressive pull of the pronator quadratus muscle. Upon exami-
tion of our patient, we found there was asymmetry between the wrists and that the ipsilateral ulnar head was not visible dorsally.

In contrast, acute isolated dorsal DRUJ dislocation is often brought about by limited supination or locked pronation of the forearm associated with a fall on an outstretched hand or direct trauma. In our two patients, both had their forearms locked in pronation at the time of their falls. According to Russo and Maffulli, a dorsal dislocation can occur in one of three ways - a forced forearm pronation, direct force on the ulna driving it dorsally against the fixed radius and carpal bones, or a direct force on the radius driving it volarly against the fixed ulna [15]. In dorsal dislocation, the volar radioulnar ligament and dorsal joint capsule may be disrupted [14]. Patients with DRUJ dislocation may present with the head of the ulna being prominent dorsally and exhibiting ballottement compared to the unaffected side [2]. However, upon examination, our primary finding in both patients was laxity of the ulnar side of the wrist without the head of the ulna exhibiting dorsal prominence.

During our physical examinations, we also evaluated patients for signs of ulnar fovea, piano key, and with the grind test. The ulnar fovea test has been reported to have high sensitivity and specificity for distal radioulnar ligament disruption [16]. All of our patients had a positive signs of ulnar fovea, suggesting radioulnar ligament disruption. We could not confirm a disruption, however, because we used a closed technique for each case. The piano-key test is mainly performed to assess the stability of the distal radioulnar joint and has been established to identify instability that cannot be detected even with a CT motion study [17]. While this test is frequently employed, its diagnostic value remains disputed [8]. Our only two patients with dorsal DRUJ dislocation had positive piano-key signs, suggesting either that there tends to be more instability with dorsal than volar dislocations or that our case with volar dislocation had less instability, perhaps because of the delayed presentation. A positive grind test has been reported to indicate a TFCC injury [18]. This test was positive only in our case of volar DRUJ dislocation. While our surgical technique did not allow direct visualization of the TFCC, our postoperative examination uncovered no signs of residual TFCC injury. Thus, our findings are in line with those of others that concluded the clinical value of the grind test remains unclear [8].

Despite the various physical findings we have noted here, the correlation between physical examination findings and radiologic results for isolated DRUJ dislocation remains unclear [8]. A variety of radiologic techniques have been applied to diagnose the disorder, including plain X-ray (AP, lateral, and other views), CT, and Magnetic Resonance Imaging (MRI). Most advocate that radiologic evaluation of suspected DRUJ instability begin with plain-film radiographs in AP and true lateral views; if the results are inconclusive, CT is advised as the next best modality for employment [8]. Of note, there have been reports that plain imaging may be most helpful for volar dislocation because it shows an overlap of radius and ulna at the DRUJ based on the pull of the pronator quadratus muscle [7]. Consistent with those reports, we initially used AP and lateral wrist imaging in all three of our patients, and it provided a definitive diagnosis only in the case of volar dislocation. We also used both axial and 3-D CT for all patients, and this modality led to a definitive diagnosis of dislocation without fracture in all three cases.

The treatment of isolated DRUJ dislocation can be nonoperative or operative. Conservative management with closed reduction and above the elbow casting has been utilized successfully [19,20]. Others have supported open reduction and TFCC repair, especially when the dislocation proves to be irreducible, even with conscious sedation or general anesthesia [5]. A number of authors have suggested that operative treatment should consist of restoration of osseous and ligamentous anatomy, thereby improving the chances of retaining the normal function and load-bearing ca-
pability of the forearm [1,8]. However, we opted to use a less invasive surgical technique involving closed reduction with arthroscopy and fixation with percutaneous K-wire placement. We found that even in the case of delayed presentation, we were able to complete the procedure without substantial difficulty. In addition, all three of our patients had the return of full wrist function without pain after six weeks of immobilization, removal of their K-wires, and two weeks of active and passive joint movement. Additionally, our patients maintained this function and had no evidence of recurrence during a mean follow-up of 24 months. Others have reported similarly positive functional results with both nonsurgical and open surgical management [19].

**Conclusion**

DRUJ dislocation without fracture is uncommon. Clinical suspicion for this injury should increase whenever there is a history of wrist trauma and evidence of restricted or painful forearm supination or pronation. Radiographic evaluation may be more accurate than physical examination, and it should start with AP and lateral X-rays. If these are negative and the index of suspicion remains high, the clinician should proceed to CT. Surgical therapy with arthroscopy-assisted closed reduction and fixation with percutaneous K-wire placement yields robust intermediate-term functional and clinical results.

**Conflict of interest statement**

The authors have no conflicts of interest to declare.

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