Distal Radioulnar Joint injuries: Surgical anatomy, physical examination, Imaging and principles of management

Anil K Bhat¹, N R Fijad¹

Abstract

Disorders of the Distal radioulnar joint injuries (DRUJ) are a major source of ulnar sided wrist pain. The complex anatomy of this joint makes the diagnosis challenging. Stabilization of this joint is provided by both intrinsic and extrinsic stabilizers and the joint capsule. Several clinical tests have been suggested to determine static or dynamic DRUJ stability. Radiologic evaluation of DRUJ instability begins with conventional radiographs. CT-scan seems to be the best additional modality to evaluate the osseous structures. MRI has proven to be more sensitive and specific for TFCC tears, potentially causing DRUJ instability, while arthroscopy is the gold standard for evaluation. Symptomatic DRUJ injuries treatment can be conservative or operative. Operative treatment consist of restoration of osseous and ligamentous anatomy. Chronic instability requires reconstruction of the stabilizing ligaments to avoid onset of arthritis. Salvage procedures in arthritis is gaining acceptance in the management of arthritis. This review covers various problems affecting the distal radioulnar joint, including fractures and dislocations, triangular fibrocartilage pathology and arthritis.

Keywords: Cadaveric and CT scan study, DRUJ instability, Sigmoid notch morphology.

Introduction

The distal radioulnar joint (DRUJ) is a diarthrodial, synovial articulation that provides the distal link between the radius and ulna and a pivot for pronation-supination. During forearm motion, the DRUJ moves synchronously with the proximal radioulnar joint and thus any injury or deformity involving the radius or ulna can alter the function of both joints. Injuries of the DRUJ may occur in isolation, or along with fractures of the distal radius. These may present acutely or as chronic instabilities or painful arthritis of the DRUJ.

This paper provides an overview of anatomy, clinical presentation, radiologic evaluation and treatment options related to stability and instability of the DRUJ.

Anatomy

The articulation of the distal radius and ulna is through the sigmoid notch of the radius and the ulnar head. The arc of curvature of the sigmoid notch ranges from 47° to 80°. Articular cartilage covers a much greater arc of the ulnar head, ranging from 90° to 135°. The radius of curvature of the sigmoid notch is 15 mm, compared with 10 mm for the ulna (Fig. 1), resulting in both rotational and sliding motions in the normal joint [1]. The articular shape of the DRUJ varies in both coronal and transverse planes. In the coronal plane, the opposing articular surfaces can be parallel, oblique, or reverse oblique [2] (Fig 2a).

The transverse plane, the shape of the sigmoid notch can be flat face, ski slope, “C” type, or “S” type3 (Fig. 2b). The ulnar styloid is a continuation of the subcutaneous ridge of the ulna, projecting 2–6 mm distally. At the base of the styloid lies a shallow concavity termed the fovea [4] and is an attachment site for triangular fibrocartilage complex (TFCC) . Identification of this site is essential for repair and reconstructive procedures because the axis of forearm motion passes through it.

The soft-tissue structures that contribute to DRUJ stability are the pronator quadratus (PQ), extensor carpi ulnaris (ECU), interosseous membrane (IOM), DRUJ capsule (Fig. 3a) and components of the TFCC(Fig.3b).

The TFCC is a complex of interconnected soft tissues that span
and support the DRUJ and ulnocarpal articulations and is the primary soft-tissue stabilizer of the DRUJ. The TFCC is triangular in shape which extends from the distal margin of the ulnar notch of radius and courses towards the ulna, inserting into the fovea at the base of the ulnar styloid process. The TFCC includes triangular fibrocartilage disc, the dorsal and palmar radioulnar ligaments, the meniscus homolog, capsule, sheath of the ECU and the origin of ulnolunate and ulnotriquetral ligaments [5].

The radio-ulnar ligaments of the TFCC provide primary intrinsic stability to the DRUJ. The PQ and ECU musculotendinous units provide dynamic stability whilst the ECU subsheath provides static stability. The IOM contributes significantly to forearm mechanical integrity and extrinsic DRUJ stability.

**History and Physical Examination**

A detailed history, clinical examination, provocative clinical tests, and appropriate diagnostic tests are most important for the diagnosis of DRUJ-related pathology.

History: Clinical examination is very important and it begins with a thorough history. In terms of mechanical injuries, hyper pronation injuries are a more common cause than hyper supination injuries, but forceful radial deviation can also be a cause. If the injury is recent, ecchymosis and soft tissue swelling will be evident.

Acute injuries: In an acute isolated dislocation of the DRUJ, a deformity with the dislocated ulnar head, local tenderness, swelling, and limited motion can be observed. Deep tenderness along the IOM and pain at the proximal radioulnar joint may indicate a concomitant Essex-Lopresti injury.

The most common cause for DRUJ instability is distal radius fracture. Although instability after accurate reduction and fixation of the distal radius is relatively uncommon, it is important to evaluate DRUJ stability after treatment of a distal radius fracture.

Chronic injuries: Patients with DRUJ instability after a malunion of the distal radius fracture usually present with loss of
forearm rotation, prominence of the ulnar head, weakness, or ulnar-sided wrist pain.

Patients may present with chronic DRUJ instability without a history of a distal radius fracture. The most common history is a traumatic event involving a fall on the outstretched hand or an unexpected forcible rotation of the wrist. Patients usually report ulnar-sided wrist pain of a mechanical nature that is increased with wrist positions and activities that reproduce the mechanism of injury, such as forearm rotation or ulnar deviation of the wrist. In severe cases, there may be a painful clunk and loss of rotation due to chronic subluxation. In addition, patients with ulnar impaction syndrome with a considerably large ulnar positive variance may have instability symptoms in addition to typical ulnar abutment symptoms.

Examination: Examination should follow the standard systematic approach of look, feel, move, and special tests. Inspection may reveal a prominent ulnar head dorsally, deformities associated with previous injury, and surgical scars. Palpation for tenderness should be systematic and must include the foveal soft spot, ECU tendon.

Active and passive range of motion of the wrist and DRUJ should be measured and compared with the opposite side. Decreased motion and crepitus during prono-supination are signs of DRUJ arthritis and maybe accentuated by manually compressing the joint. With instability, dorsal subluxation of the ulnar head may be more prominent in full pronation. Examination should include a neurological assessment of the hand.

The special tests for DRUJ assessment are as follows:
1. The ulnar fovea sign - This test is performed by placing the patient’s wrist and forearm in neutral, while the clinician locates the ulnar fovea between the ulnar styloid dorsally and flexor carpi ulnaris tendon volarly using the tip of the thumb. Pressure is applied deep into the soft spot along the volar aspect of the ulna (i.e., fovea) (Fig. 4).

A positive test causes exquisite tenderness, reproducing the pain. This indicates a foveal disruption of the deep volar or dorsal radioulnar ligaments or an ulnotriquetral ligament tear [4].

2. Anteroposterior Stress Test / Piano key sign – Firmly grasp the distal radius with the one hand and hold the ulnar head with the other hand, and apply anteroposterior force (Fig. 5a). The amount of translation and the firmness of the end point should be compared with the contralateral side in neutral, pronation, and supination of the forearm [6].

Based on the anteroposterior stress test, DRUJ instability is graded into three grades (Table 1).

3. The ulnocarpal stress test: It is useful for provocating symptoms due to articular disc tear or ulnar impaction syndrome. For this test, the elbow is positioned in 90° of flexion, neutral forearm rotation, with maximal ulnar deviation of the wrist. An axial load is applied while passively supinating and pronating the ulnarily deviated wrist. A positive examination is when pain is re-

<table>
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<th>Grade</th>
<th>Description</th>
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<tr>
<td>0</td>
<td>Normal Stability</td>
</tr>
<tr>
<td>1</td>
<td>Partially unstable. Increased laxity with less than 50% translation.</td>
</tr>
<tr>
<td>2</td>
<td>Unstable. More than 50% translation.</td>
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DRUJ : Distal radioulnar joint

Table 1 - Based on the anteroposterior stress test, DRUJ instability is graded into three grades [6]

Figure 5a: Anteroposterior Stress Test

Figure 5b: The Modified Press test

Figure 6: (a) True posteroanterior view of the wrist, (b) – PA view showing widening of the distal radioulnar space > 2mm, (C) - PA view showing displaced ulnar styloid fracture & dorsal tilting of the distal radius
created with this manoeuvre [7].

4. The modified press test - Patient is asked to rise from a seated position in a chair with the assistance of both hands and wrists placed in front of him on the examining table. A positive press test is present when asymmetrical, increased depression of the distal ulna is noted and is often associated with pain (Fig. 5b)[8].

Radiologic Evaluation

X ray: Posteroanterior (PA) and true lateral radiographs of both the wrists should be taken to compare the injured with the uninjured side. Secure positioning is essential in this respect. PA View: In true PA view in which the forearm is positioned in neutral pronation, the shoulder is abducted 90° from the side, the elbow is flexed 90°, and the wrist is maintained in neutral position. In this position, the ulnar styloid process projects along the ulnar edge of the ulna, and the fovea at the base of the ulnar styloid is clearly profiled (Fig.6a) [9]. Lateral view: The lateral view is obtained with the patient’s shoulder adducted to the side, the elbow flexed 90°, and the forearm in neutral position. On a true lateral view, the pisiform should overlie the distal third to fourth of the distal pole of the scaphoid (Fig.7a). Comparison of lateral views taken with the identical rotation of both forearms may show DRUJ subluxation or dislocation. However, one must be cautious about over interpreting a single lateral view, as this can be a pitfall in diagnosing DRUJ subluxation. A few degrees of rotation can make the normal ulnar head appear dorsally or palmarly subluxated. Radiographic sign that indicates DRUJ instability, is as follows:

- Widening of the distal radio ulnar space > 2mm on the PA radiograph, relative to the unaffected side (Fig 6b).
- On the true lateral view, a radio ulnar distance of 6mm or more, between the most dorsal cortices, indicates DRUJ instability [7] (Fig 7b).
- Indirect signs, which may indicate DRUJ instability [7], are as follows:
  - Ulnar styloid base fracture (Fig. 6c).
  - 15° or more dorsal tilting of the distal radius.
  - Radial shortening of > 4 mm.
  - Radial inclination < 0°.

Computed tomography (CT) Scan: C T has become the standard method for imaging DRUJ instability. To be a valuable study, both wrists must be evaluated on the same images and in identical forearm positions to make accurate comparisons between the normal and affected sides. It is important to align the forearms in the axis of the gantry and to image in neutral, supination and pronation. (Fig.8) Since CT accurately delineates the cross-sectional anatomy of the DRUJ, it is also useful for assessing sigmoid notch competency, ulnar head deformity, and DRUJ arthritis and direction of instability, which are important in selecting proper surgical treatment[10].

Magnetic resonance imaging (MRI): Compared to CT scan, MRI has greater sensitivity for soft tissue contrast but provides less osseous details. MRI is widely used for the evaluation of TFCC tears. Traumatic tears are best diagnosed on T2-weighted images in the coronal plane. High signal intensity in the TFCC may be found when synovial fluid fills a tear. In MR arthrography, contrast leaking into the DRUJ can be indicative of a TFCC tear [11]. It is important to note that MRI can generate many radiological findings within the wrist, which may have no relationship to the presenting complaint, and therefore, the results of imaging must be correlated with clinical findings.

Principles of management

Types of DRUJ injuries can be broadly classified to acute dislocations of DRUJ, acute TFCC injuries, DRUJ injuries associated with fractures and fracture dislocations, chronic DRUJ injuries, chronic TFCC injuries, ulnar Impaction syndromes, and DRUJ Arthritis. Evaluation and treatment depends on
the nature and type of DRUJ injury.

**Isolated DRUJ dislocations:**
Isolated DRUJ dislocations without associated fracture are relatively uncommon. Treatment is closed manipulation and reduction under anaesthesia. Forcible supination of radius while pushing the ulna head volarwards reduces dorsal dislocation, while forcible pronation with dorsally directed pressure on the ulna head reduces volarward DRUJ dislocations. Once the joint is reduced, stability must be verified by translating the ulna volar and dorsally and immobilized in an above elbow cast in supination, for 3 weeks. If instability persists after reduction, radioulnar pinning is done in reduced position to allow soft tissue healing.

**TFCC lesions**
The TFCC is a major stabilizer of the DRUJ, and injury to this structure may lead to DRUJ instability. The most widely used classification is the Palmer classification1 (Table 2). Traumatic TFCC injuries (Type 1) are classified according to the location of the tear and the structure that is disrupted. Degenerative lesions (Type 2) are classified on the location and severity of degeneration involving the TFCC, ulnar head, and carpus.

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<tr>
<th>Class 1: Traumatic</th>
<th>Class 2: Degenerative</th>
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<td>IA- Central perforation</td>
<td>IIA TFCC wear</td>
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<tr>
<td>IB- Ulnar avulsion with or without styloid fracture</td>
<td>IIB TFCC wear + lunate/unlar head chondromalacia</td>
</tr>
<tr>
<td>IC- Distal avulsion (from carpus)</td>
<td>IIC- TFCC perforation + lunate/unlar head chondromalacia</td>
</tr>
<tr>
<td>ID- Radial avulsion with or without sigmoid-notch fracture</td>
<td>IID- TFCC perforation + lunate or unlar head chondromalacia + LT ligament perforation</td>
</tr>
<tr>
<td>TFCC: Triangular fibrocartilage complex</td>
<td>IIE -TFCC perforation + lunate/unlar head chondromalacia + LT ligament perforation + ulnocarpal arthritis</td>
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Treatment of TFCC injuries commences with non-operative measures such as splinting or above elbow cast, modification of activity, occupational therapy, and nonsteroidal anti-inflammatory drugs. TFCC tears that fail to clinically improve following conservative care requires surgical treatment. Arthroscopic TFCC debridement or repair has been described for the treatment of acute and degenerative tears based on the location and size of the tears.

DRUJ injuries associated with fractures and fracture dislocations
Treatment consist of open reduction and internal fixation of distal radius. The DRUJ stability is then confirmed by the surgeon using the anteroposterior stress Testō when the forearm is in supination, pronation, or neutral rotation. This examination should be performed in the operation room immediately after the distal radius fixation. Pre operatively this test has to be also done in the contralateral limb to assess any obvious generalized ligament laxity. If DRUJ is unstable (Grade 2) during intraoperative assessment using the anteroposterior stress test, then it should be fixed by a 1.2-mm K-wire placed transversely proximal to the sigmoid notch (Fig. 9). This K wire will be retained for 3 weeks. After 3 weeks, K wire is removed and range of motion exercises is to be started.

Ulnar styloid fractures, are most commonly associated with distal radius fractures. An ulnar styloid base fracture which is displaced completely predicts a TFCC avulsion injury from fovea. Fixation of styloid fracture makes the DRUJ stable. Various fixation techniques that have been described for styloid fractures include closed pinning, tension band wiring, compression, and screw fixation. Comminated, unstable, or displaced distal ulna neck fractures must also be fixed to maintain DRUJ stability and congruence [12].

Galeazzi fracture- dislocation is a diaphyseal fracture of radius with associated DRUJ dislocation. When the radius fracture is within 7.5 cm of the distal radius, DRUJ injury is highly likely13. Once the radius is stabilized, the DRUJ usually falls into position in most cases (simple dislocations). Further, instability is checked and, if present, the DRUJ is pinned transversely.

**Chronic DRUJ instability**
Chronic instability may develop as a residuum of an injury to DRUJ stabilizing structures or in association with malunion or non-union of a distal radius fracture. Soft tissue reconstruction is indicated when the TFCC is irreparable and the sigmoid notch is competent[14].

Non-operative management of chronic
DRUJ instability involves splinting, anti-inflammatory medication, and physiotherapy for forearm and wrist strengthening. This may be appropriate in low-demand patients with mild instability.

DRUJ ligament reconstructive techniques are as follows:
- Direct radio-ulnar tether extrinsic to the DRUJ [15].
- An indirect radio-ulnar link via an ulnocarpal sling or tenodesis procedure [15].
- Adams and Berger described a technique of anatomic reconstruction of radio-ulnar ligaments using a tendon graft [16]. DRUJ stability and good to excellent functional outcomes have been reported with this procedure.

**DRUJ arthritis**
Degeneration of the DRUJ can be caused by post-traumatic arthritis, inflammatory arthritis, and osteoarthritis, or rarely, can be secondary to long-standing DRUJ instability. In the Darrach's procedure (distal ulna resection) [17], the ulnar head is resected through the ulna neck and totally excised. Instability of the distal ulnar stump is a recognized complication. (Fig.10)

In Sauve-Kapandji procedure (Fig.11) the radio-ulnar joint is fused and a pseudoarthrosis is created proximal to the fusion through the ulnar neck [18]. Potential complications include ulnar stump instability and regeneration of the resected segment, which can result in loss of motion.

**Other Disorders with DRUJ involvement**
Involvement of the DRUJ is found in Madelung’s deformity, which is characterized by palmar subluxation of the hand, long distal ulna, and ulnar/palmar angulation of the distal radius [19].

Hereditary multiple exostosis can involve the DRUJ [20]. The degree of involvement depends on the location of the osteochondromas.

![Figure 10: Darrach's procedure](image1)

![Figure 11: Sauve-Kapandji procedure](image2)

**References**


