IFSSH Scientific Committee on Bone and Joint Injuries: Distal Radioulnar Joint Instability

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Introduction

The distal radioulnar joint (DRUJ) links the radius and ulna with the proximal radioulnar joint. The osseous structure of the DRUJ has minimal inherent stability. Thus, the DRUJ relies heavily on soft tissue structures, and instability of the joint is a common clinical problem. The current concept of the anatomy, clinical presentation and examination, imaging studies, classification of the triangular fibrocartilage complex lesions, and treatment of DRUJ instability, will be reviewed.

Anatomy

1. Bony anatomy

The axis of forearm rotation is near the centers of the radial head proximally and ulnar head distally. The radius of curvature of the sigmoid notch is 50% to 100% greater than that of the ulnar head. Therefore, translation occurs between the ulnar head and sigmoid notch, and rolling and sliding movements occur with forearm rotation. At the level of the DRUJ, the ulnar head shifts dorsally with pronation and volarly with supination. Total dorsal and volar translation of the DRUJ was 8 to 9 mm when force was applied externally in a cadaver study.[1] At the extremes of pronation and supination, articular contact decreases significantly, to as little as 10% of the articular surface area.[2] Although the sigmoid notch is shallow, its dorsal and volar rims contribute to DRUJ stability, and deficiencies in these rims due to trauma considerably reduce the stability of the joint.[3-5] In the coronal and transverse planes, the DRUJ has some variations in shape. A study has found that the slope of the sigmoid notch articular surface may be parallel, oblique, or reverse oblique relative to the long axis of the radius in the coronal plane, and that there are four different sigmoid notch shapes: flat face, ski slope, "C" type, and "S" type in the transverse plane.[4] A flat type may be associated with suboptimal outcome after soft tissue reconstruction for DRUJ instability.

2. Soft tissue anatomy

The triangular fibrocartilage complex (TFCC) is the most important anatomical structure for maintaining normal DRUJ kinematics, and is composed of the articular disc, the dorsal and volar radioulnar ligaments, the meniscus homologue, the sheath of the extensor carpi ulnaris, and the ulnolunate and ulnotriquetral ligaments (Figure 1).[6] The radioulnar ligaments are the principal stabilizers of the DRUJ. The deep limb attaches to the fovea, and the superficial limb attaches to the base of the ulnar styloid. The superficial limb becomes unstable with a fracture of the base of the ulnar styloid. The articular disc is composed of fibrocartilage that bears compressive loads through its central portion, but does not contribute much to the DRUJ stability. The ECU sheath augments the dorsal capsule and provides some stabilizing effects. The ulnocarpal ligaments are thought to contribute to both DRUJ and ulnocarpal stability. Other soft tissue structures, such as the pronator quadratus, extensor carpi ulnaris tendon, interosseous membrane, and DRUJ capsule also contribute to DRUJ stability.[7]

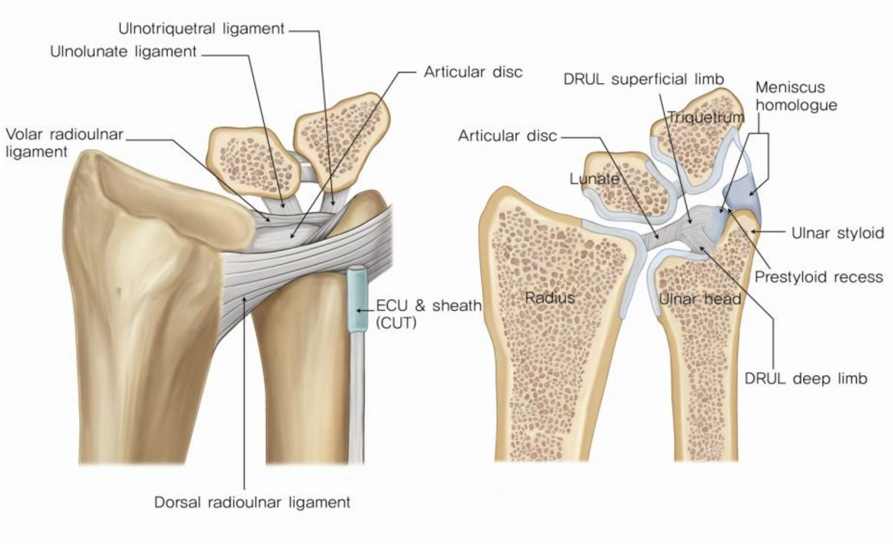

Figure 1. Anatomy around distal radioulnar joint

There are some debates regarding the role of the radioulnar ligaments.[8,9] One theory is that the dorsal ligament prevents the ulna from dorsal displacement during pronation and the volar ligament prevents volar displacement during supination.[8] Another theory is that the volar ligament prevents dorsal displacement in pronation and the dorsal ligament prevents volar displacement in supination.[9] An in vivo study has found that in forearm pronation, the dorsal superficial radioulnar ligament and volar deep radioulnar ligament tighten, and in forearm supination, the volar superficial radioulnar ligament and dorsal deep radioulnar ligament tighten, maintaining stability of the DRUJ.[10] Therefore, although one ligament may provide the dominant restraint, the other ligament provides a secondary restraint.

Clinical presentation and physical examination

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 interosseous membrane and pain at the proximal radioulnar joint may indicate a concomitant Essex-Lopresti injury.

The most common cause for DRUJ instability is a 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. 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. A dorsally angulated malunion usually presents with volar displacement of the ulna and volar instability, and a volarly angulated malunion usually presents with dorsal displacement of the ulna that may limit forearm supination.

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. Localized swelling, crepitus, weakness, and a sense of instability may exist. 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.

The ulnar fovea sign consists of tenderness when pressure is applied to the region of the fovea, in the soft depression between the flexor carpi ulnaris (FCU) tendon, ulnar styloid, and triquetrum (Figure 2). This sign is the most specific clinical examination for injuries of the TFCC at this location.[11] The physician should test the DRUJ stability by stabilizing the radius and translating the ulna to its volar and dorsal limits. 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. In addition, the physician should measure active and passive ranges of supination and pronation of the DRUJ. Decreased motion and crepitus during rotation are signs of DRUJ arthritis. ECU instability can be evaluated by testing for abnormal ECU motion during forearm rotation in ulnar deviation, and ECU subluxation is most apparent in supination and ulnar deviation. In the shear or ballottement test for examining the lunotriquetral joint, the physician stabilizes the lunate with one hand while manually shearing the triquetrum against the lunate articular surface volarly and dorsally with the other hand.

The ulnocarpal stress test is useful for provocating symptoms due to articular disc tear or ulnar impaction syndrome (Figure 3). For this test, the forearm is placed vertically on the table, and the physician holds the hand and compresses the wrist ulnarly. This test is performed in neutral, pronation and supination.[12] The press test, which axially loads the wrist in ulnar deviation as the patient pushes him or herself up from a seated position, can also provoke pain by dynamic loading of the TFCC.

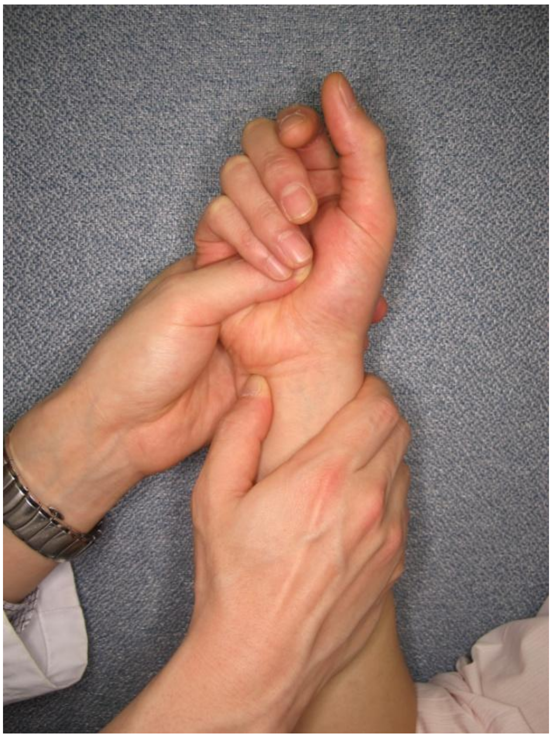

Figure 2. Test for "ulnar fovea sign"

Figure 3. Ulnocarpal stress test

Imaging studies

Initial radiographic evaluation of the DRUJ includes a standard posteroanterior (PA) view and a true lateral radiograph of the wrist in neutral forearm rotation. A neutral rotation position is necessary to standardize ulnar variance measurement. A PA view with the forearm pronated and the patient making a power grip may reveal a dynamic ulnar positive variance,[14] and may reveal an increase in the DRUJ gap distance.[15] The lateral view is not accurate for the diagnosis of DRUJ subluxation, because as little as 10 degrees of rotation can make the joint appear reduced even when the joint is dislocated. The physician should search for signs of arthritic changes of the DRUJ, such as osteophytes at the ulnar head.

Computed tomography (CT) can be used to evaluate DRUJ congruency, using several methods including the Mino method,[16] the congruency method,[17] and the radioulnar ratio method.[18] As distal radius fractures frequently involve the sigmoid notch, especially the dorsal rim, the extent of involvement can be better evaluated by CT.

Magnetic resonance imaging (MRI) is the primary advanced imaging method used for evaluating TFCC injuries. Magnetic resonance arthrography (MRA) is superior to MRI in the investigation of full-thickness TFCC tear.[19]

Arthroscopy is the gold standard for the diagnosis of TFCC articular disc tear. However, tears of the radioulnar ligaments at the radius or at the fovea are not visualized from the radiocarpal joint. DRUJ arthroscopy is necessary to see the foveal attachment. By radiocarpal arthroscopy, an avulsion of the foveal TFCC insertion can be determined by a loss of the normal trampoline effect (trampoline test) and a displacement of the TFCC radially by pulling on the TFCC using a probe (hook test) (Figure 4).

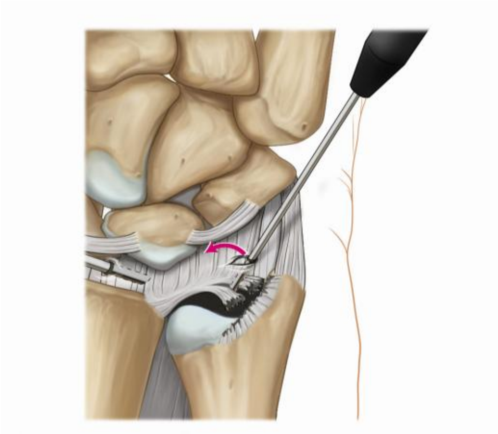

Figure 4. Radial displacement of the TFCC by pulling on it using a probe, indicates avulsion of the foveal TFCC insertion (hook test).

TFCC lesions and DRUJ instability

Management of an acute ulnar wrist injury needs defining the disrupted anatomic structures. Palmer's classification divides TFCC lesions into two categories: traumatic (class 1) and degenerative (class 2). Traumatic TFCC injuries are classified according to the tear location (Figure 5). Degenerative TFCC tears result from chronic and excessive loading through the ulnocarpal joint, and are classified according to the location and severity of degeneration involving the TFCC, ulnar head, and carpal bones.

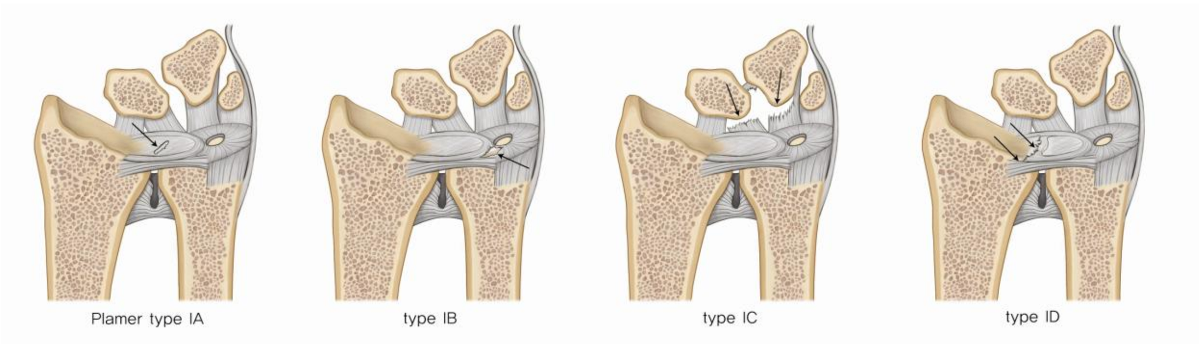

Figure 5. Palmer's classification of traumatic TFCC injuries

The Palmer class 1A tear involves a simple tear near the radial insertion of the articular disc in the sagittal plane (anterior to posterior) because the strain is usually applied in the radioulnar axis. This lesion is relatively common and does not cause DRUJ instability. The Palmer class 1B tear involves injury to the ulnar attachment of the TFCC either by ligament avulsion from the fovea or via fracture through the base of the ulnar styloid, resulting in DRUJ instability. DRUJ instability may not be present with partial tear, and DRJU instability may be present without a styloid fracture or a tip fracture of the styloid. For this type of injury, integrity of the ulnar styloid or the radioulnar ligament should be restored, either by immobilization or surgery. The Palmer class 1C lesion is an injury to the volar ulnar extrinsic ligaments. Complete disruption of these ligaments is rare, requiring high-energy. Most of these injuries occur in combination with class 1B tears and/or lunotriquetral ligament tears. These injuries are generally managed conservatively unless mechanical instability is present. The Palmer class 1D lesion is a partial or complete traumatic avulsion of the TFCC from the radius. These injuries usually occur with a distal radius fracture at the margin of the sigmoid notch, and do not cause DRUJ instability if the fixation and reduction of the fracture is adequate.

Treatment

Initial management of isolated TFCC injury is nonsurgical such as immobilization with splinting, medication, and physical therapy according to the stability of the DRUJ. When the DRUJ is unstable, the forearm should be immobilized for 4 to 6 weeks, and the stability should be reevaluated.

When DRJU instability is associated with a distal radius fracture, accurate reduction of the fracture and maintenance of the radial alignment is important to allow stable healing of soft tissues around the DRUJ. When there is an ulnar styloid fracture, stable fixation of the radius alone without fixation of the styloid can obtain equivalent results compared with ulnar styloid fixation.[20] However, in young patients with a distal radius fracture, unrepaired peripheral tears of the TFCC can be a common cause of persistent symptomatic instability.[21] Therefore, when severe instability exists after reduction of the radius, especially in young or active patients, fixation of the ulnar styloid or repair of the TFCC should be considered. In some cases with ulnar head dislocation, reduction and fixation with temporary K-wire can be performed.

Surgical treatment of TFCC injury includes debridement and repair, and most surgical procedures can be performed arthroscopically. For the Palmer class 1A lesion, surgical treatment usually involves arthroscopic debridement of the torn flap of the articular disc and making the residual rim smooth and stable. Arthroscopic repair is used in Palmer class 1B or 1D lesion. Radial-sided detachments can be repaired using double-armed long meniscal repair sutures. Advancing age as well as postoperative ulnar positive variance are poor prognostic factors.[22] Ulnar detachment can also be repaired arthroscopically or by open technique.[23,24] Direct reinsertion of the radioulnar ligaments to the fovea can be done by using transosseous drill holes or by using a bone anchor. Type 1B lesions can be classified into reparable and non-reparable lesions.[25] Reparable tear of distal component of TFCC which shows none to slight DRUJ instability, can be repaired by ligament-to-capsule suture. Reparable tear of both components or proximal component of TFCC which shows mild to severe DRUJ instability, can be repaired by arthroscopic foveal fixation.

The first surgical option for DRUJ instability is delayed direct repair of the TFCC. However, when repair of the TFCC is impossible, other reconstructive techniques can be used to restore DRUJ stability. Late reconstructions for DRUJ instability include 3 categories: (1) a direct radioulnar tether extrinsic to the joint, (2) an indirect radioulnar link via tenodesis, and (3) reconstruction of the radioulnar ligaments.[26] A radioulnar tether is not anatomic, and does not restore normal joint stability or mechanics of the DRUJ. Reconstruction of the distal radioulnar ligaments offers the best possibility of restoring normal DRUJ primary constraints and kinematics.

In patients with ulnar impaction syndrome and combined DRUJ instability, ulnar shortening osteotomy can improve DRUJ stability by increasing the tension of the ulnocarpal ligaments.[27,28] A recent biomechanical study found that ulnar shortening with osteotomy carried out proximal to the attachment of the distal interosseous membrane had a more favorable effect on DRUJ stability compared with distal osteotomy.[29]

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