Published online: 2021-06-19

Distal Radioulnar Joint Instability and Associated Injuries: A Literature Review

Sohail Qazi[1] David Graham[2] Steven Regal[2] Peter Tang[2] Jon E. Hammarstedt[2]

[1]Department of Orthopaedic Surgery, Temple University Hospital, Philadelphia, Pennsylvania, United States
[2]Department of Orthopaedic Surgery, Allegheny General Hospital, Pittsburgh, Pennsylvania, United States

Address for correspondence Sohail Qazi, MD, Department of Orthopaedic Surgery, Allegheny General Hospital, 1307 Federal Street, 2nd Floor, Pittsburgh, PA - 15212, United Sates, (e-mail: tug30391@temple.edu).

J Hand Microsurg 2021;13:123–131.

Abstract

The distal radioulnar joint (DRUJ) allows supination and pronation of the distal forearm and wrist, an integral motion in everyday human activity. DRUJ injury and chronic instability can be a significant source of morbidity in patients' lives. Although often linked with distal radius fractures, DRUJ injury may occur in a variety of other upper extremity injuries, as well as an isolated pathology. Diagnosis of this injury requires the clinician to have a high index of suspicion and low threshold for clinical testing and further imaging of the DRUJ. The purpose of this article is to provide a review on DRUJ anatomy and biomechanics, to discuss common diagnostic and treatment modalities, and to identify common injuries associated with DRUJ instability.

Keywords
► DRUJ
► instability
► anatomy
► biomechanics

Introduction

Distal radioulnar joint (DRUJ) instability is a potential sequalae of fracture/dislocations of the upper extremity and can also present in isolation. As DRUJ instability is often secondary to other injuries, it can go unnoticed on initial presentation. The role of DRUJ instability in determining long-term functional outcomes in upper extremity injuries is still debated.[1-3] However, chronic instability can be a source of morbidity in patients, leading to pain, dysfunction, and arthritis.[4] Thus, DRUJ injury warrants a thorough clinical examination and when necessary, directed treatment modalities. The objective of this article is to review the literature on DRUJ instability and explore injuries of the upper extremity that are associated with DRUJ injury. We review relevant anatomy and biomechanics, common signs and symptoms in the evaluation, and diagnostic protocols including a discussion of relevant upper extremity fractures that should raise the clinicians' index of suspicion of DRUJ injury. Lastly, we will discuss the various treatment options available to maximize patient outcomes.

DRUJ Anatomy and Biomechanics

The DRUJ is an incongruent diarthrodial, synovial articulation between the distal radius and ulna (►**Fig. 1**). It provides a pivot for pronation–supination of the distal forearm. The normal total arc of motion at the DRUJ is 150 to 180 degrees, with an additional 30 degrees through the radiocarpal joint. DRUJ motion is primarily rotational with components of axial and translational motion.[5] In a normal wrist, the majority of the force at the wrist is transmitted through the radius (80%), with only 20% of the load transmitted through the ulna.[6] However, these forces can vary with ulnar and radial deviation. At the extremes of pronation and supination, there may be only 2 mm of articular contact at the rims of the notch that correspond at less than 10% of the articular surface area of the joint.[7] The shape of the sigmoid notch has important implications with respect to traumatic instability (►**Fig. 2**). Based on an anatomic study of 50 cadavers, Tolat et al observed four different sigmoid notch shapes: flat face (42%), ski slope (14%), "C" type (30%), and "S" type (14%).[8] A flat sigmoid notch may be more prone to instability and less responsive to treatment by soft tissue repair alone.[8]

Bony architecture only accounts for approximately 20% of the DRUJ's stability.[9] The remainder of the stability is afforded by the surrounding soft tissue. These soft tissue restraints include the triangular fibrocartilage complex (TFCC), joint capsule, interosseus membrane (IOM), and musculotendinous units consisting of the extensor carpi ulnaris (ECU) and pronator quadratus.[10,11] The TFCC is formed by the triangular

published online
June 19, 2021

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

DOI https://doi.org/10.1055/s-0041-1730886
ISSN 0974-3227

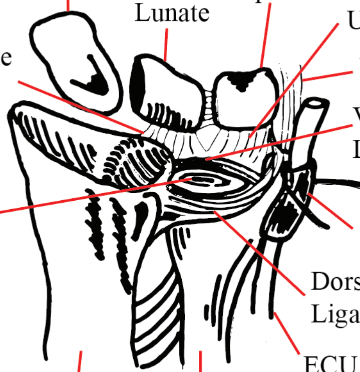

Fig. 1 Distal radioulnar joint anatomy. ECU, extensor carpi ulnaris.

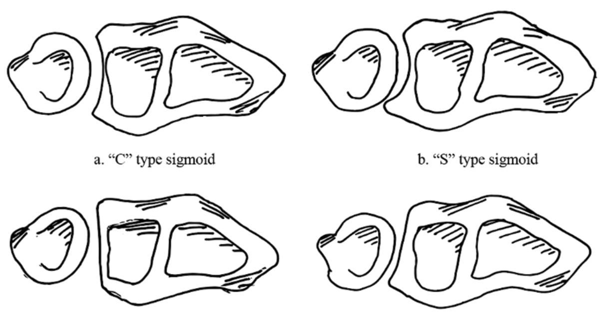

Fig. 2 Sigmoid notch shapes. (**a**) "C" type sigmoid. (**b**) "S" type sigmoid. (**c**) Flat face sigmoid. (**d**) Ski-slope sigmoid.

fibrocartilage proper, ulnocarpal meniscal homologue, the ulnar collateral ligament, the superficial and deep dorsal and volar radioulnar ligaments, and the sheath of the ECU.[12] The primary functions of the TFCC are to extend the articular surface of the distal radius to the ulnar head, transmit axial force across the ulnocarpal joint, provide a strong but flexible connection between the distal radius and ulna, and support the ulnar portion of the carpus.[4]

The radioulnar ligaments extend from the palmar and dorsal distal margins of the sigmoid notch and converge in a triangular configuration to attach to the ulna as the principal stabilizers of the DRUJ (►**Fig. 3**).[9] It is generally agreed that the TFCC acts in concert with the rims of the sigmoid notch to constrain the joint.[13] In the coronal plane they divide into two limbs: the deep (or proximal) limb attaches to the fovea and the superficial (or distal) limb attaches to the base and mid-portion of the ulnar styloid.[4] When the radius rotates around the ulna in pronation, the dorsal superficial fibers tighten, as do the deep palmar fibers. Conversely, in supination the palmar superficial fibers as well as the deep dorsal fibers tighten to constrain DRUJ motion.[9,11,13-15] The pronator quadratus is an important secondary stabilizer. The deep head of the pronator quadratus helps to stabilize the DRUJ by coapting the joint during active pronation and passive supination.[16-18] Other secondary stabilizers include the IOM, ECU subsheath, and the ulnocarpal ligaments. The IOM contributes to the mechanical integrity of the forearm and serves as a conduit for force transfer from the radius to the ulna, origin for several flexor and extensor muscles, maintenance of longitudinal forearm stability, and support for the DRUJ.[11,19,20]

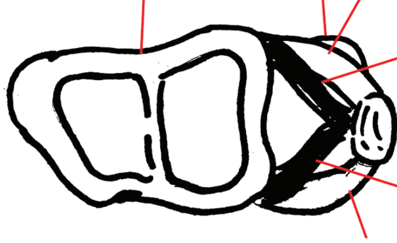

Fig. 3 Deep and superficial radioulnar ligaments.

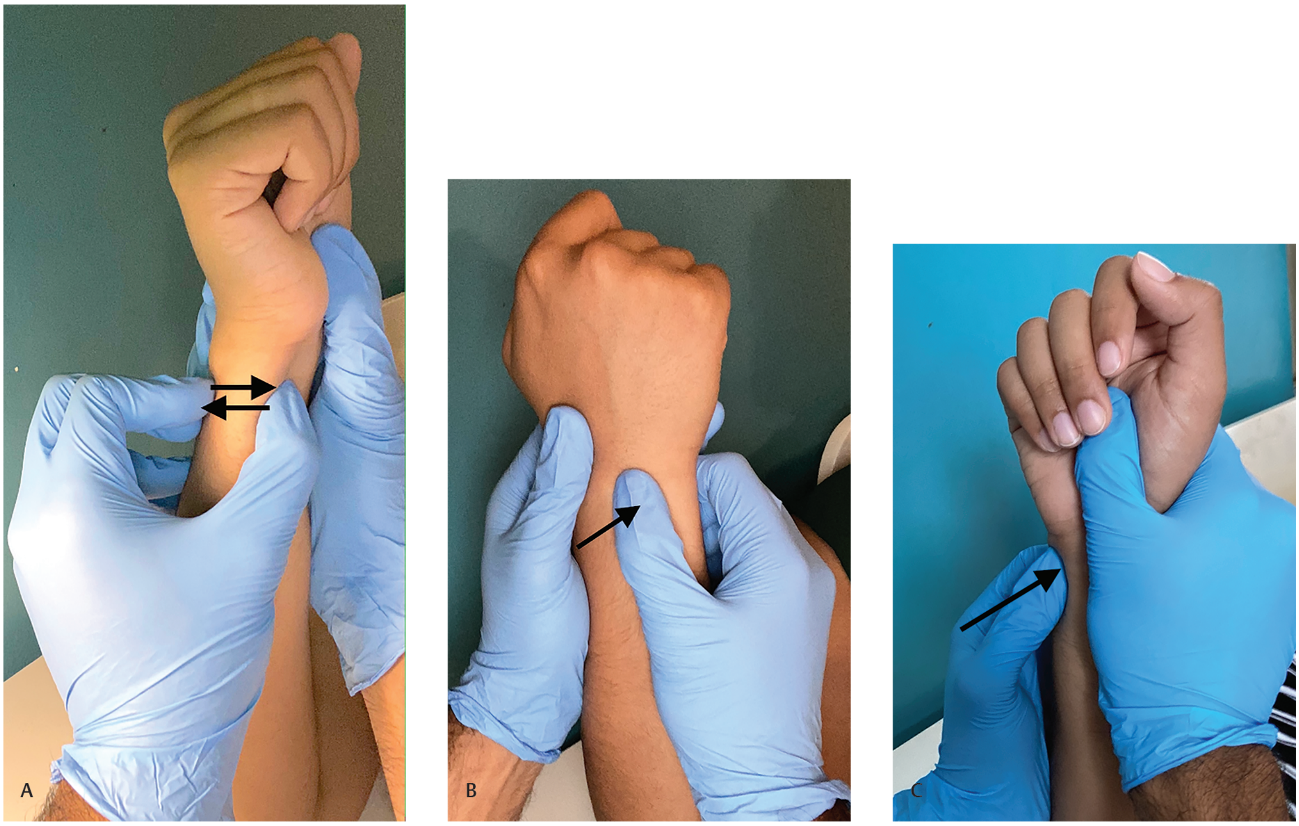

Fig. 4 (**A**) With the patient's forearm in neutral, the radius is stabilized and the distal ulna is shifted volar and dorsal to assess the amount of translation. (**B**) The examiner pulls the radius–carpus toward him/herself while also pressing the distal ulna volarly (toward the patient). (**C**) The examiner pulls the dorsal distal radius–carpus toward him/herself and presses the distal ulna dorsally (toward the patient).

A complete radioulnar dissociation at the DRUJ cannot occur unless the IOM is incompetent. Furthermore, an isolated lesion of the TFCC will not lead to incomplete instability, as an intact or repaired DRUJ capsule leads to significant restoration of DRUJ kinematics.[21]

Diagnosis

Physical Exam

Acute Dislocation

Diagnosing a DRUJ injury requires a high index of suspicion with recent wrist injuries and new findings such as limitation of pronation or supination. Acutely, a dorsal dislocation of the ulna presents with a dorsoulnar prominence and a block to supination, whereas a volar dislocation presents with a volar–ulnar prominence and block to pronation.[22] To assess the stability of the DRUJ, the patient's elbow should be stabilized on a table or arm rest and the hand should be pointed toward the ceiling. With the patient's forearm in neutral, the radius is stabilized and the distal ulna is shifted volar and dorsal to assess the amount of translation (►**Fig. 4A**). Then in pronation and in supination the distal radius and distal ulna are stabilized, and the ulna is pushed toward the patient to check the firmness of the end point and whether that elicits pain (►**Figs. 4B** and **C**). It is important to compare these findings to the contralateral side. An audible or palpable clink may occur with both active and passive pronation and supination. Obvious subluxation of the ulnar head indicates DRUJ instability.[23]

Chronic Dislocation

A chronic dislocation may present similarly with either dorsal or volar prominences and block to supination or pronation. There are a variety of clinical exams the clinician can use to further illicit DRUJ injury and/or instability. Seo et al proposed a useful classification to grade chronic DRUJ instability patients using the anteroposterior stress test (►**Table 1**).[24]

The ulnar fovea sign is an exam that can indicate a TFCC injury.[25] It is performed with the patient's elbow at 90 degrees flexion, with the wrist and forearm in neutral (►**Fig. 5**). One of the examiner's hands supports the patient's wrist radially, and the opposite hand's thumb tip is pressed into the ulnar fovea. The fovea is the "soft spot" just distal to the ulnar head on the ulnar side of the wrist. A positive ulnar fovea sign will

Table 1 Grades of distal radioulnar joint instability during anteroposterior stress test[24]

Grade	Description
0	Normal stability
1	Increased laxity, no clinical symptoms
2	Increased translation, symptoms evoked without a firm end point
3	Subluxation during active forearm rotation

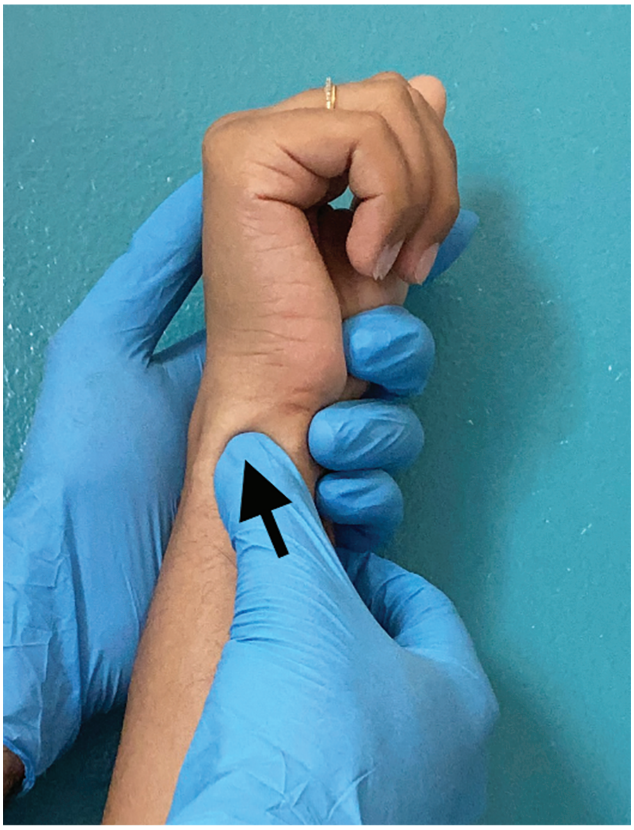

Fig. 5 Ulnar fovea sign—One of the examiner's hands supports the patient's hand dorsally, and the opposite hand's thumb tip is pressed deep into the ulnar fovea. The fovea is the "soft spot" between the ulnar styloid process and the flexor carpi ulnaris tendon.

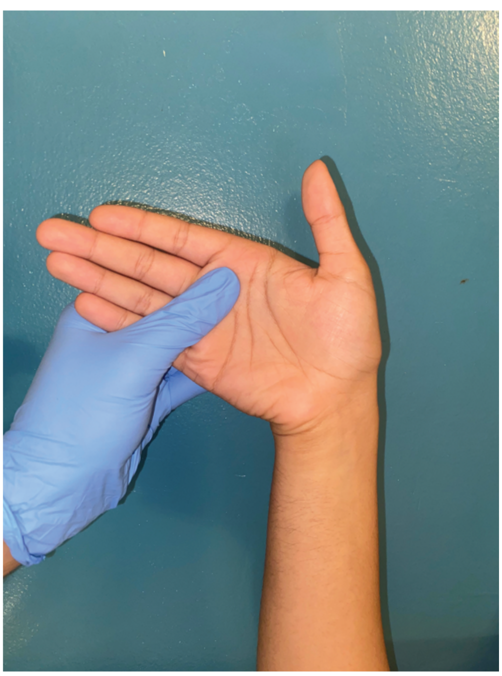

Fig. 6 Passive ulnar wrist deviation. If pain is elicited, this is a positive exam.

elicit tenderness and has a 95.2% sensitivity.[25] The TFCC stress test is a simple maneuver performed with passive ulnar wrist deviation (►**Fig. 6**). If pain is elicited, this is a positive exam.

The ulnocarpal stress test involves grinding the TFCC between the lunate/triquetrum and the distal ulna.[26] With the patient's arm at their side and the elbow flexed to 90 degrees, the examiner places one hand behind the distal humerus and the other hand in the patient's palm as if to shake their hand.[27] With the patient's wrist in ulnar deviation, an axial stress is applied while the wrist is passively ranged through pronation and supination (►**Fig. 7**). The presence of ulnar sided wrist pain signifies a positive exam.

The press test is a simple yet provocative test with a 100% sensitivity of TFCC tear detection in a study reported by Lester et al.[28] The patient is asked to rise from a seated position by pushing their body weight off the chair with both hands, creating an axial ulnar load.[28] Focal ulnar wrist pain represents a positive test. Furthermore, the piano key sign involves controlled dorsal–palmar radioulnar shucking. With the patient's forearm in neutral, the palm on the exam table and pronated, and the wrist in 20 to 30 degrees of extension, the examiner uses one hand to stabilize the radius and the other to grip the ulna and apply a dorsal to volar load (►**Fig. 8**).[29] The test is positive if the patient experiences pain or there is ulnar laxity as compared with the opposite extremity.

Hahn et al developed a new clinical test called the bilateral test, which directly observes the ulnar head's dynamic behavior and tests static DRUJ stability.[30] The patient sits with the elbows flexed to 90 degrees and the shoulders adducted. The

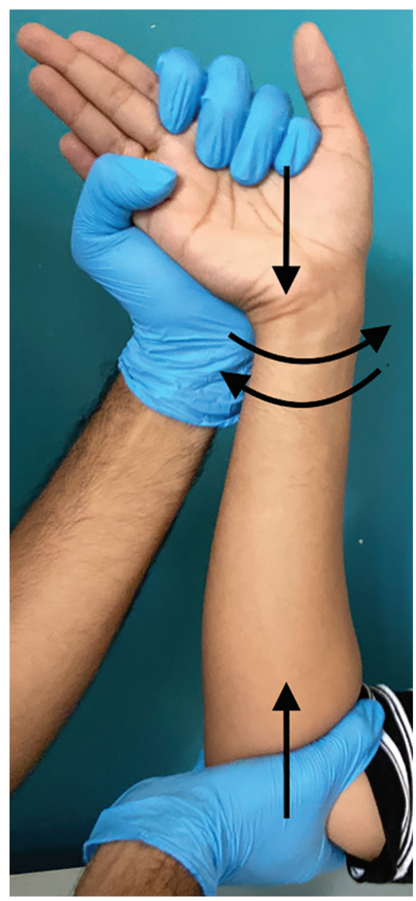

Fig. 7 Ulnocarpal stress test—With the patient's wrist in maximal ulnar deviation, an axial stress is applied with both examiner's hands while the wrist is passively ranged through pronation–supination.

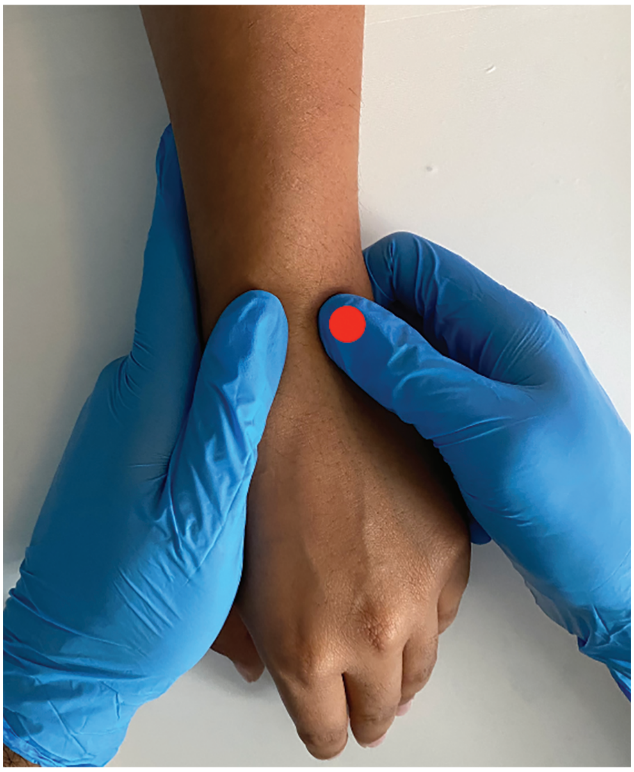

Fig. 8 Piano key sign—With the patient's palm flat on the table and wrist in full pronation, a dorsal to volar load is applied across the distal ulna. Pain should be reproduced at the distal radioulnar joint level and ulnar motion may be produced. The patient can also be asked to push the ulna into the exam table with the hand flat on the table and in full pronation. A positive exam will also induce pain and ulnar motion.

examiner bilaterally places the index finger on the DRUJ and the middle finger on the ulnar head, ranging the wrists from pronation to supination several times to provoke potential subluxation (►**Fig. 9**). Using the bilateral test on their cohort of 20 patients, the authors had a sensitivity of 90% in confirming positive clinical exam with computed tomography (CT) imaging.[30]

Imaging

Initial radiographic evaluation should start with a true posteroanterior (PA) and lateral of the affected forearm, wrist, and elbow. The imaging of the wrist should be done with the arm abducted at 90 degrees with the wrist in neutral rotation to measure ulnar variance.[23] A dorsal dislocation will show a widened DRUJ (as compared with the unaffected side) with divergence of the radius and ulna while a volar dislocation will show overlap of the radius and ulna at the level of the DRUJ due to the pull of the pronator quadratus.[31] The authors suggest contralateral radiographs comparison if there is concern for DRUJ injury.

On lateral X-rays, a prominence of the ulnar head may indicate DRUJ instability. Poor lateral X-rays can be misleading. Mino et al determined that with just 10 degrees of supination or pronation of the lateral X-ray, a subluxed DRUJ appeared reduced and a dislocated DRUJ appeared subluxed.[31] A reproducible way to determine a true lateral is to evaluate the scaphoid–pisiform–capitate relationship. The palmar surface of the pisiform is visualized midway between the palmar surfaces of the distal pole of the scaphoid and the capitate.[32] Due to the challenge of obtaining a true lateral, the standard lateral X-ray remains imprecise for the diagnosis of DRUJ subluxation.[31]

Evidence of DRUJ instability, however, can be exaggerated by utilizing a weighted lateral stress view. The patient sits with the elbow flexed at 90 degrees and forearm/wrist over the table, in full pronation. The patient is instructed to hold a 3 to 5-lb weight, keeping the arm off the table as a cross table lateral view is taken.[23] Several other radiographic signs indicating a possible DRUJ disruption include a fracture at the base of ulnar styloid, ulnar styloid fractures displaced > 2 mm, > 20 degrees dorsal angulation of distal radius fracture (DRF), and avulsion fractures of the sigmoid notch.[22]

CT scan is a useful tool in evaluating the congruity of the DRUJ and can be completed if there is clinical suspicion for a DRUJ injury. Several methods of evaluating DRUJ instability on CT scan have been described. Mino et al described a method in which CT scan of the DRUJ is done with the forearm in neutral rotation. Normal congruence is demonstrated when the ulnar head sits in the sigmoid notch of the radius (►**Fig. 10A**).[31] Lo et al found the radioulnar ratio superior to the Mino et al method, the epicenter method, and the congruency method in determining DRUJ instability (►**Fig. 10B**).[33] Park and Kim that the subluxation ratio method was the most reliable in regard to intra- and interobserver reliability (►**Fig. 10C**).[34]

Magnetic resonance imaging (MRI) is useful in evaluating the soft tissue restraints of the DRUJ, but its

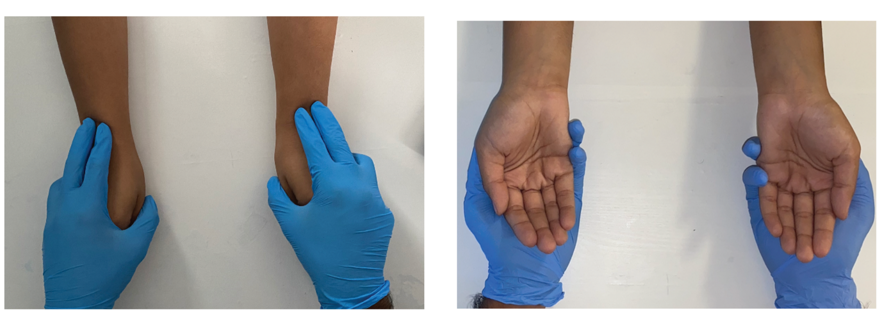

Fig. 9 Bilateral test—The examiner bilaterally places the index finger on the distal radioulnar joint and the middle finger on the ulnar head, ranging the wrists from pronation (**A**) to supination (**B**) several times to provoke potential subluxation.

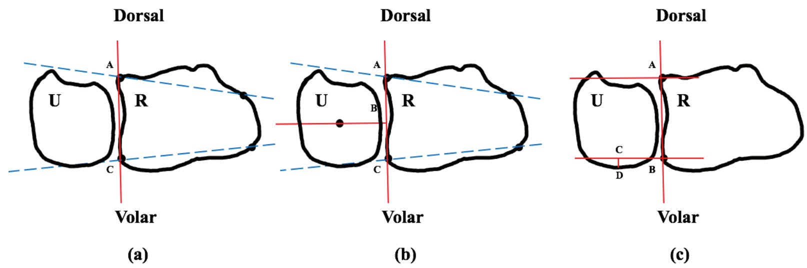

Fig. 10 (**A**) Mino et al method for determining distal radioulnar joint (DRUJ) congruity—draw a line through the volar ulnar/radial borders of the radius as well as one through the dorsal ulnar/radial borders of the radius. The ulnar head should lie between these two lines in a stable DRUJ. (**B**) The radioulnar ratio (RUR) method. The center of the ulnar head is found using concentric circles. A line similar to that used in the epicenter method is drawn from the dorsal and volar margins of the sigmoid notch. A line perpendicular to this line is drawn to the center of the ulnar head. The AB:AC ratio is the radioulnar ratio (RUR). (**C**) Two lines are drawn from the volar and dorsal margins of the sigmoid notch, connecting perpendicularly to a line connecting the volar and dorsal margins of the sigmoid notch. The amount of the ulnar head that was either volar or dorsal to these lines is measured, and the ratio of this distance to the length of the sigmoid notch is calculated.

sensitivity and specificity vary. The radiology literature recommends a high-resolution 3-T MRI with intraarticular contrast.[35] Recently, studies have suggested that performing wrist traction significantly improves the accuracy of MRI. In a prospective study of 40 wrists, the accuracy of tear detection improved after traction for the TFCC (98% after traction vs. 83% before traction), the lunotriquetral ligament (100 vs. 88%), and the scapholunate ligament (100 vs. 95%).[36] Despite the usefulness of the aforementioned imaging studies, arthroscopy remains the gold standard for evaluating TFCC pathology. It has been shown to be more sensitive and accurate than imaging modalities.[15]

Pathology

Isolated Acute Dislocation of DRUJ

Although rare, there are cases of isolated acute dislocations of the DRUJ without osseous involvement.[37-40] These injuries usually occur dorsally, and are associated with hyper-pronation and extension injuries. The patient presents with the hand fixed in pronation, with the inability to supinate and a dorsal prominence of the ulnar head.[40-42] A volar dislocation is often associated with hyper-supination with the inability to pronate.[5] A volar prominence of the ulnar head may be palpable, with an associated dorsal cavity. Isolated DRUJ dislocations often result from an acute disruption of the TFCC with possible disruption of the secondary stabilizers of the DRUJ. The amount of TFCC injury required for a dislocation has not been described, although it is known that DRUJ dislocations may not require complete disruption of the TFCC.[37,40]

Once diagnosed, an acute DRUJ dislocation can be closed reduced with local anesthesia with or without sedation. Digital pressure is placed on the distal part of the ulna and forceful supination/pronation is performed on the prominent ulna.[37,43] Simple dislocations can be easily reduced, or may undergo spontaneous reduction after the injury. A complex dislocation may be due to entrapment of the ECU, extensor digitorum communis to the second digit, TFCC, and/or extensor digiti minimi (EDM).

After reduction, the joint should be ranged to assess the stable arc of motion. Generally speaking, a dorsal dislocation is most stable in supination while a volar dislocation is more stable in pronation. If the DRUJ is unstable after reduction, the radioulnar joint may be pinned in the position of greatest stability. Dual Kirschner wires are driven through just proximal to the joint and left slightly prominent on the ulnar and radial border that allows for easy retrieval if the wires break between the radius and ulna.[4] Another option is to perform an open or arthroscopic TFCC repair. After the DRUJ is stabilized, immobilization is recommended. Many advocate cast immobilization of the forearm in the position of maximal stability for 4 weeks.[4] These injuries should be followed closely with interval X-rays to ensure stable reduction. After 4 to 6 weeks, a removable splint is provided and a gradual, progressive, active range of motion program is begun.

Distal Radius Fractures and DRUJ Instability

DRF may be associated with DRUJ instability. Geissler et al examined 60 consecutive young patients who had failed closed reduction in the distal radius and had greater than 2 mm of articular step off. Of these 60 patients, 26 (43%) of them were found to have an injury to the TFCC by arthroscopy.[44] Lindau et al studied 51 young patients prospectively with displaced DRF with arthroscopy and found that 43 patients (84%) had an injury of the TFCC.[45] At median follow-up of 12 months, 19 patients (37%) had DRUJ instability.[45] In addition, May et al retrospectively investigated 130 DRFs and found that 14 (11%) were complicated by either acute or chronic DRUJ instability.[46] Although the incidence varies across studies, TFCC injuries and DRUJ instability are potentially associated with DRFs. Multiple studies have found that DRUJ instability is an independent worsening risk factor in DRF that is associated with poorer outcomes.[2,47-50] Despite this, there is debate on the merit of DRUJ directed treatment and there is no widely accepted algorithm on how to treat potential instability with concomitant DRF.[5]

Concurrent DRUJ disruption with DRF is best assessed intraoperatively after fixation has been performed. Initial wide displacement of the DRUJ and severe radial shortening are the most important risk factors for persistent DRUJ instability.[4] Chronic DRUJ instability after accurate reduction and fixation of the radius is uncommon. This may be due to the fact that the secondary stabilizers of the DRUJ confer enough stability that allow the TFCC to heal with proper immobilization or after sufficient stability has been conferred by locking plate fixation of the distal radius.[4,51]

It has been found that proper fracture reduction and alignment are the most important factors associated with stable healing of the disrupted DRUJ.[4] If DRUJ instability persists despite adequate reduction and internal fixation of the DRF, treatment options include ulnar styloid repair, prolonged immobilization, arthroscopic or open repair of the TFCC, or any of these options with radioulnar pinning, or radioulnar pinning alone.[51] Persistent instability may be due to mal-reduction and may necessitate fixation of the sigmoid notch or ulnar corner fractures. Volar locked plating can capture many larger dorsal ulnar fragments. Smaller volar or dorsal fragments may require fragment specific fixation, independently stabilizing each fracture fragment.

In one series, the results of closed reduction and long arm casting alone were equivalent to performing a TFCC repair or ulnar styloid fixation concurrently, providing a less invasive alternative.[4] Kim et al performed a prospective analysis of 84 patients with DRF with 12 months follow-up.[1] DRUJ laxity was assessed intraoperatively after fixation and those found to be lax were treated with an additional 4 weeks of immobilization in a postoperative sugar tong splint. No significant difference was observed between the two study groups in terms of overall wrist functional outcomes or subjective wrist pain.[1] It is debated whether DRUJ instability in DRF merits invasive treatment, but authors have had successful outcomes with conservative immobilization in these patients postreduction and fixation.[1,4]

Ulnar styloid fractures can occur in isolation, or in conjunction with a DRF. Frykman found ulnar styloid fractures occurred in approximately 61% of DRF.[52] Most of these fractures are not associated with DRUJ instability or long-term symptoms. However, fractures that occur specifically through the styloid base are associated with a higher risk of DRUJ instability.[53,54] Like a DRF, it is important to evaluate an ulnar styloid fracture with a true PA and lateral. If on the lateral the ulnar styloid lies palmar to the axis of the ulnar shaft, suspect that the stability of the DRUJ is compromised.[5] The treatment of ulnar styloid fractures hinges on the stability of the DRUJ. If the ulnar styloid fracture is associated with a DRF, the DRF should first be fixed and then the DRUJ can be tested for stability. If stable, the ulnar styloid fracture can be treated nonoperatively. If unstable, the ulnar styloid should be fixed. Treatment options include Kirschner wires, tension band wiring, compression screw fixation, mini-fragment plates, and suture anchors. If the DRUJ continues to be unstable, repair of the foveal attachment of the TFCC, which may be seen as a separate bony avulsion fragment adjacent to the styloid fracture and represents the foveal insertion of the radioulnar ligaments, should be performed arthroscopically or through an open approach.[48,55]

Galeazzi Fracture

Galeazzi published a series of 18 patients with diaphyseal radius fractures associated with dislocation of the DRUJ.[56] The mechanism of injury of Galeazzi fractures is commonly a high-energy trauma such as a motor vehicle accident or a fall from height with the wrist in hyperextension and pronated. A class 1B TFCC injury is almost universally present. Not all diaphyseal radius fractures result in an injury to the DRUJ. The distance that the fracture is located from the articular surface can help predict the likelihood of an injury to the DRUJ. If the fracture is located within 7.5 cm from the mid-articular surface of the radius, it has been found to have a higher incidence of DRUJ injury.[57] X-ray can be helpful in diagnosing DRUJ instability with diaphyseal radius fractures. This likely has to do with the high energy mechanism and the propensity of the DRUJ to completely displace, which makes it readily obvious on radiographic imaging.

The most common block to reduction in complex Galeazzi fractures is often the ECU tendon; however, other blocks have been described including the EDM tendon, extensor digitorum communis tendon to the second digit, as well as osseous blocks.[37,58-62] A Galeazzi fracture is considered a "fracture of necessity" as nonsurgical treatment yields a poor result. Casting alone is associated with strong deforming forces acting on the distal fragment by the pronator quadratus, brachioradialis, thumb extensors, and abductors.[57,63] At a minimum, the radius fracture should undergo an open reduction and internal fixation. After the radius has been fixed, the DRUJ should be stressed. If found stable, the patient can be immobilized and start early motion. If unstable, surgical stabilization should be achieved using the same protocol in the setting of the DRF with DRUJ instability (see previous section).

Essex-Lopresti Injury

In 1951, Essex-Lopresti described two cases of a dislocation injury of the DRUJ in combination with a comminuted radial head fracture.[64] This injury pattern became known as an Essex-Lopresti injury. It is caused by an axial compression force through the forearm involving disruption of the primary and secondary constraints of the radius. As a result, the radius migrates proximally, and the ulna impacts the carpus. These injuries can be accompanied by other injuries including a DRF as well as a radial shaft fracture.[65,66] Examination should include a thorough investigation of the elbow and the DRUJ. Inspection typically demonstrates a dorsally prominent ulna, tenderness along the IOM, limited wrist extension, and pronation and supination.

Radiographic evaluation should start with orthogonal X-rays of the elbow, forearm, and wrist. Special attention should be paid to the ulnar variance that can be calculated from a PA X-ray of the wrist.[67] The radius pull test, where a 9.1 kg distraction force is pulled through the radius, can be helpful in determining longitudinal stability of the forearm.[68] Smith et al found that proximal migration of at least 3 mm of the radius was achieved when the radial head and IOM were disrupted. Greater than 6 mm of proximal migration was visualized when the radial head, IOM, and TFCC were disrupted.[68]

Treatment of an Essex-Lopresti injury starts with determining between ORIF versus replacement of the radial head. Internal fixation reestablishes the integrity of the radial head, whereas replacement acts as an internal splint while the IOM and TFCC heal. Timing of treatment plays an important role. Trousdale et al found that early treatment within a week with reconstruction of the radiohumeral joint and immobilization of the distal radioulnar dissociation are necessary to obtain satisfactory results.[66] Nine out of 10 patients diagnosed and treated early had satisfactory results, while only 4 out of 14 patients treated more than a week after injury had satisfactory results.[64-66] Once stabilization of the radial head has been completed, the DRUJ should be assessed for stability. If the DRUJ remains unstable, then one can similarly consider arthroscopic versus open repair of the TFCC. The forearm should be immobilized in a long arm splint or cast to prevent rotation for 4 to 6 weeks.

Conclusion

DRUJ injury can often be undetected on initial presentation of an upper extremity injury. Clinically, there a variety of exam maneuvers that can help identify DRUJ instability. In addition to isolated acute injuries of the DRUJ, distal radial fractures, ulnar styloid base fractures, sigmoid notch and ulnar corner fractures, Galeazzi fractures, and Essex-Lopresti injuries were found to have a potential association with DRUJ injuries. It is important to have high clinical concern of DRUJ injury in these cases. Lateral X-ray imaging of the DRUJ is imprecise in determining injury, although sensitivity can be improved with a weighted lateral stress view. There are several methods of determining DRUJ congruity via CT imaging (►**Fig. 10**). Arthroscopy remains the gold standard in visualizing tears of the TFCC. Although there is still debate on treatment options, the majority of studies reported no chronic instability or loss in functional outcomes with adequate upper extremity fracture reduction/alignment and conservative treatment (cast immobilization in a position of maximal stability for 4–6 weeks) for the DRUJ. In cases of persistent DRUJ instability, treatment options consist of, arthroscopic or open TFCC repair, fixation of ulnar styloid fractures when present and DRUJ pinning.

Conflict of Interest
None declared.

References

1 Kim JK, Yi JW, Jeon SH. The effect of acute distal radioulnar joint laxity on outcome after volar plate fixation of distal radius fractures. J Orthop Trauma 2013;27(12):735–739
2 Lindau T, Hagberg L, Adlercreutz C, Jonsson K, Aspenberg P. Distal radioulnar instability is an independent worsening factor in distal radial fractures. Clin Orthop Relat Res 2000; (376):229–235
3 Wijffels MM, Krijnen P, Schipper IB. Clinical DRUJ instability does not influence the long-term functional outcome of conservatively treated distal radius fractures. Eur J Trauma Emerg Surg 2017;43(2):227–232
4 Wolfe SW, Pederson WC, Hotchkiss RN, Kozin SH, Cohen MS, Green's Operative Hand Surgery: Expert Consult: Online and Print. Philadelphia, PA: Elsevier Health Sciences; 2010
5 Carlsen BT, Dennison DG, Moran SL. Acute dislocations of the distal radioulnar joint and distal ulna fractures. Hand Clin 2010;26(4):503–516
6 Palmer AK, Werner FW. Biomechanics of the distal radioulnar joint. Clin Orthop Relat Res 1984; (187):26–35
7 af Ekenstam F, Hagert CG. Anatomical studies on the geometry and stability of the distal radio ulnar joint. Scand J Plast Reconstr Surg 1985;19(1):17–25
8 Tolat AR, Stanley JK, Trail IA. A cadaveric study of the anatomy and stability of the distal radioulnar joint in the coronal and transverse planes. J Hand Surg [Br] 1996;21(5):587–594
9 Stuart PR, Berger RA, Linscheid RL, An KN. The dorsopalmar stability of the distal radioulnar joint. J Hand Surg Am 2000;25(4):689–699
10 Gofton WT, Gordon KD, Dunning CE, Johnson JA, King GJW. Soft-tissue stabilizers of the distal radioulnar joint: an in vitro kinematic study. J Hand Surg Am 2004;29(3):423–431
11 Kihara H, Short WH, Werner FW, Fortino MD, Palmer AK. The stabilizing mechanism of the distal radioulnar joint during pronation and supination. J Hand Surg Am 1995;20(6):930–936
12 Palmer AK, Werner FW. The triangular fibrocartilage complex of the wrist–anatomy and function. J Hand Surg Am 1981;6(2):153–162
13 Ward LD, Ambrose CG, Masson MV, Levaro F. The role of the distal radioulnar ligaments, interosseous membrane, and joint capsule in distal radioulnar joint stability. J Hand Surg Am 2000;25(2):341–351
14 af Ekenstam F. Anatomy of the distal radioulnar joint. Clin Orthop Relat Res 1992; (275):14–18
15 Schuind F, An KN, Berglund L, et al. The distal radioulnar ligaments: a biomechanical study. J Hand Surg Am 1991;16(6):1106–1114
16 Johnson RK. Stabilization of the distal ulna by transfer of the pronator quadratus origin. Clin Orthop Relat Res 1992; (275):130–132
17 Johnson RK, Shrewsbury MM. The pronator quadratus in motions and in stabilization of the radius and ulna at the distal radioulnar joint. J Hand Surg Am 1976;1(3):205–209
18 Stuart PR. Pronator quadratus revisited. J Hand Surg [Br] 1996;21(6):714–722
19 Moritomo H, Noda K, Goto A, Murase T, Yoshikawa H, Sugamoto K. Interosseous membrane of the forearm: length change of ligaments during forearm rotation. J Hand Surg Am 2009;34(4):685–691
20 Watanabe H, Berger RA, Berglund LJ, Zobitz ME, An K-N. Contribution of the interosseous membrane to distal radioulnar joint constraint. J Hand Surg Am 2005;30(6):1164–1171
21 Gofton WT, Gordon KD, Dunning CE, Johnson JA, King GJW. Comparison of distal radioulnar joint reconstructions using an active joint motion simulator. J Hand Surg Am 2005;30(4):733–742
22 Szabo RM. Distal radioulnar joint instability. Instr Course Lect 2007;56:79–89
23 Neumann JA, Kirkendall DT, III CTM. Sports Medicine for the Orthopedic Resident. Singapore: World Scientific Publishing Company; 2016
24 Seo KN, Park MJ, Kang HJ. Anatomic reconstruction of the distal radioulnar ligament for posttraumatic distal radioulnar joint instability. Clin Orthop Surg 2009;1(3):138–145
25 Tay SC, Tomita K, Berger RA. The "ulnar fovea sign" for defining ulnar wrist pain: an analysis of sensitivity and specificity. J Hand Surg Am 2007;32(4):438–444
26 Friedman SL, Palmer AK. The ulnar impaction syndrome. Hand Clin 1991;7(2):295–310

27 Nakamura R, Horii E, Imaeda T, Nakao E, Kato H, Watanabe K. The ulnocarpal stress test in the diagnosis of ulnar-sided wrist pain. J Hand Surg [Br] 1997;22(6):719–723
28 Lester B, Halbrecht J, Levy IM, Gaudinez R. "Press test" for office diagnosis of triangular fibrocartilage complex tears of the wrist. Ann Plast Surg 1995;35(1):41–45
29 Sachar K. Ulnar-sided wrist pain: evaluation and treatment of triangular fibrocartilage complex tears, ulnocarpal impaction syndrome, and lunotriquetral ligament tears. J Hand Surg Am 2008;33(9):1669–1679
30 Hahn P, Wolf MB, Unglaub F. Bilateral test for potential subluxation of the DRUJ. Arch Orthop Trauma Surg 2013;133(10):1459–1461
31 Mino DE, Palmer AK, Levinsohn EM. Radiography and computerized tomography in the diagnosis of incongruity of the distal radio-ulnar joint. A prospective study. J Bone Joint Surg Am 1985;67(2):247–252
32 Yang Z, Mann FA, Gilula LA, Haerr C, Larsen CF. Scaphopisocapitate alignment: criterion to establish a neutral lateral view of the wrist. Radiology 1997;205(3):865–869
33 Lo IK, MacDermid JC, Bennett JD, Bogoch E, King GJ. The radioulnar ratio: a new method of quantifying distal radioulnar joint subluxation. J Hand Surg Am 2001;26(2):236–243
34 Park MJ, Kim JP. Reliability and normal values of various computed tomography methods for quantifying distal radioulnar joint translation. J Bone Joint Surg Am 2008;90(1):145–153
35 Chhabra A, Soldatos T, Thawait GK, et al. Current perspectives on the advantages of 3-T MR imaging of the wrist. Radiographics 2012;32(3):879–896
36 Lee RKL, Griffith JF, Ng AWH, Nung RCH, Yeung DKW. Wrist traction during MR arthrography improves detection of triangular fibrocartilage complex and intrinsic ligament tears and visibility of articular cartilage. AJR Am J Roentgenol 2016;206(1):155–161
37 Bruckner JD, Lichtman DM, Alexander AH. Complex dislocations of the distal radioulnar joint. Recognition and management. Clin Orthop Relat Res 1992; (275):90–103
38 Albert MJ, Engber WD. Dorsal dislocation of the distal radioulnar joint secondary to plastic deformation of the ulna. J Orthop Trauma 1990;4(4):466–469
39 Hanel DP, Scheid DK. Irreducible fracture-dislocation of the distal radioulnar joint secondary to entrapment of the extensor carpi ulnaris tendon. Clin Orthop Relat Res 1988; (234):56–60
40 Rose-Innes AP. Anterior dislocation of the ulna at the inferior radio-ulnar joint. Case report, with a discussion of the anatomy of rotation of the forearm. J Bone Joint Surg Br 1960;42-B:515–521
41 Buterbaugh GA, Palmer AK. Fractures and dislocations of the distal radioulnar joint. Hand Clin 1988;4(3):361–375
42 Hui FC, Linscheid RL. Ulnotriquetral augmentation tenodesis: a reconstructive procedure for dorsal subluxation of the distal radioulnar joint. J Hand Surg Am 1982;7(3):230–236
43 Heiple KG, Freehafer AA, Van'T Hof A. Isolated traumatic dislocation of the distal end of the ulna or distal radio-ulnar joint. J Bone Joint Surg Am 1962;44-A:1387–1394
44 Geissler WB, Freeland AE, Savoie FH, McIntyre LW, Whipple TL. Intracarpal soft-tissue lesions associated with an intra-articular fracture of the distal end of the radius. J Bone Joint Surg Am 1996;78(3):357–365
45 Lindau T, Adlercreutz C, Aspenberg P. Peripheral tears of the triangular fibrocartilage complex cause distal radioulnar joint instability after distal radial fractures. J Hand Surg Am 2000;25(3):464–468
46 May MM, Lawton JN, Blazar PE. Ulnar styloid fractures associated with distal radius fractures: incidence and implications for distal radioulnar joint instability. J Hand Surg Am 2002;27(6):965–971
47 Morrissy RT, Nalebuff EA. Dislocation of the distal radioulnar joint: anatomy and clues to prompt diagnosis. Clin Orthop Relat Res 1979; (144):154–158
48 Melone CP Jr, Nathan R. Traumatic disruption of the triangular fibrocartilage complex. Pathoanatomy. Clin Orthop Relat Res 1992; (275):65–73
49 Roysam GS. The distal radio-ulnar joint in Colles' fractures. J Bone Joint Surg Br 1993;75(1):58–60
50 Stoffelen D, De Smet L, Broos P. The importance of the distal radioulnar joint in distal radial fractures. J Hand Surg [Br] 1998;23(4):507–511
51 Thomas BP, Sreekanth R. Distal radioulnar joint injuries. Indian J Orthop 2012;46(5):493–504
52 Frykman G. Fracture of the distal radius including sequelae–shoulder-hand-finger syndrome, disturbance in the distal radio-ulnar joint and impairment of nerve function. A clinical and experimental study. Acta Orthop Scand 1967;Suppl 108 :3
53 Mikic ZD. Treatment of acute injuries of the triangular fibrocartilage complex associated with distal radioulnar joint instability. J Hand Surg Am 1995;20(2):319–323
54 Nakamura R, Horii E, Imaeda T, Nakao E, Shionoya K, Kato H. Ulnar styloid malunion with dislocation of the distal radioulnar joint. J Hand Surg [Br] 1998;23(2):173–175
55 Adams BD, Samani JE, Holley KA. Triangular fibrocartilage injury: a laboratory model. J Hand Surg Am 1996;21(2):189–193
56 Galeazzi R. Di una particolare sindrome traumatica dello scheletro dell' avambraccio. Atti e memorie della Società lombarda di chirurgia 1934;2:663–666. Available at: https://ci.nii.ac.jp/naid/10016117871/. Last accessed on May 20, 2021
57 Rettig ME, Raskin KB. Galeazzi fracture-dislocation: a new treatment-oriented classification. J Hand Surg Am 2001;26(2):228–235
58 Alexander AH, Lichtman DM. Irreducible distal radioulnar joint occurring in a Galeazzi fracture - case report. J Hand Surg Am 1981;6(3):258–261
59 Cetti NE. An unusual cause of blocked reduction of the Galeazzi injury. Injury 1977;9(1):59–61
60 Itoh Y, Horiuchi Y, Takahashi M, Uchinishi K, Yabe Y. Extensor tendon involvement in Smith's and Galeazzi's fractures. J Hand Surg Am 1987;12(4):535–540
61 Jenkins NH, Mintowt-Czyz WJ, Fairclough JA. Irreducible dislocation of the distal radioulnar joint. Injury 1987;18(1):40–43
62 Paley D, Rubenstein J, McMurtry RY. Irreducible dislocation of distal radial ulnar joint. Orthop Rev 1986;15(4):228–231
63 Giannoulis FS, Sotereanos DG. Galeazzi fractures and dislocations. Hand Clin 2007;23(2):153–163, v
64 Essex-Lopresti P. Fractures of the radial head with distal radio-ulnar dislocation; report of two cases. J Bone Joint Surg Br 1951;33B(2):244–247
65 Edwards GS Jr, Jupiter JB. Radial head fractures with acute distal radioulnar dislocation. Essex-Lopresti revisited. Clin Orthop Relat Res 1988; (234):61–69
66 Trousdale RT, Amadio PC, Cooney WP, Morrey BF. Radio-ulnar dissociation. A review of twenty cases. J Bone Joint Surg Am 1992;74(10):1486–1497
67 Schuind FA, Linscheid RL, An KN, Chao EY. A normal data base of posteroanterior roentgenographic measurements of the wrist. J Bone Joint Surg Am 1992;74(9):1418–1429
68 Smith AM, Urbanosky LR, Castle JA, Rushing JT, Ruch DS. Radius pull test: predictor of longitudinal forearm instability. J Bone Joint Surg Am 2002;84(11):1970–1976