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Chronic Distal Radioulnar Instability- Diagnosis and Treatment: A Review

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Authors' contributions

This work was carried out in collaboration among all authors. Author SY designed the study and wrote the first draft of the manuscript. Authors AS and ZB managed the literature searches. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

The distal radioulnar joint is one of the inherently unstable joint in the body, its injury is commonly missed and the patient may present later with pain and restricted movement because of joint instability. The distal radioulnar joint instability could be dorsal , volar , or bidirectional, and it could be caused by soft tissue injury or bony injury and malunion. It is fundamentall to recognize the type of injury and the cause of instability to be able to provide the proper form of treatment to get the best results.

Keywords: Radioulnar; diagnosis; treatment; surgery.

1. ANATOMY AND STABILIZERS OF THE DISTAL RADIOULNAR JOINT

The distal radioulnar joint represents the distal articulation between radius and ulna, and the articulation occurs between the sigmoid notch of radius and the head of the ulna,the concave and shallow sigmoid notch has a radius of curvatureof 15 mm which does not match the radius of curvature of the ulnar head , the ulnar head is semicylindrical in shape with the convexity of 220° and radius of curvature of 10

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mm, as a result of this relationship between the sigmoid notch and the ulnar head the movement in this joint consist of both rotation in transverse plane and translation in the sagittal plane [1]. There is a 2.8 mm dorsal translation of the ulna during maximum pronation and 5.4 mm translation during maximum supination due to the difference in the radii of curvature of the two articular surfaces [2]. When the forearm in the neutral position of rotation the joint surface contact is about 60% but during maximum supination or pronation there is only 10% of contact between the articular surface [1]. Stabilizers of the distal radioulnar joints can be divided into a static and dynamic one, the static stabilizers include the joint morphology, capsule, dorsal and volar radioulnar ligaments, and the interosseous membrane. While dynamic stability is provided by the pronator quadratus and extensor carpi ulnaris muscles [3,4]. The sigmoid notch of the radius contributes to the joint stability by its depth and its dorsal, volar, and distal margins. Any defect in these margins by trauma significantly reduces the stability of the distal radioulnar joint [5,6]. Another major stabilizer of the distal radioulnar joint is the triangular fibrocartilage complex (TFCC) ,the TFCC is composed of the central articular disc, the dorsal and volar radioulnar ligaments , the sheath of the extensor carpi ulnaris , the ulnolunate, and ulnotriquetralligaments [7]. The mechanismby which the radioulnar ligaments stabilize the radioulanr joint is a debatable issue, Schuind et al concluded that during pronation, the dorsal radioulnar ligament becomes tight and prevents the ulna from displacing dorsally and the volar radioulnar ligament becomes tight during supination and prevent ulna from displacing volary [8]. Ekenstam in his cadaveric study reported that the volar radioulnar ligament prevents the ulna from dorsal dislocation during pronation, and the dorsal radioulnar ligament prevents the ulna from volar dislocation during supination [9]. Another study has found that both dorsal and volar radioulnar ligament contribute together to dorsal and volar stability of the distal radioulnar joint, during pronation the dorsal superficial and the deep volar parts of the radioulnar ligaments tighten, and during supination, the deep dorsal and the superficial volar parts of the radioulnar ligaments tighten and stabilize the distal radioulnar joint [10], the pronator quadratus stabilizes the ulnar head in the sigmoid notch actively during pronation and by passive viscoelastic force in supination [11,12] along with the extensor carpiulnaris maintained over the dorsal aspect of the distal ulna by its fibro-osseous tunnel and stabilize the distal radioulnar joint [13], the joint capsule also acts as a restraint and a stabilizer to the distal radioulnar joint [14,15]. Distal radioulnar instability could be caused by soft tissue injury like triangular fibrocartilage injury (table 1), dorsal or palmar radioulnar ligaments injuries, interosseous membrane or joint capsule injury or combined injury of those structures, or could be due to bony injuries like fracture distal radius, or distal ulna [16].

2. CLINICAL PRESENTATION AND IMAGING STUDY

Patients with distal radioulnar instability may have a previous history of distal radial fracture with malunion as it is the most common cause of distal radioulnar instability, other patients who gave no history of fractures may have a history of fall on the outstretched hand or

Table 1. Classification of TFCC lesions according to palmer

Traumatic Lesions
Class IA: Central rupture Class IB: Ulnar avulsion with/without disruption of the ulnar styloid process Class IC: Distal avulsion Class ID: Radial avulsion with/without osseous lesion of the radius
Degenerative Lesions
Class IIA: Superficial degenerative lesion Class IIB: Degenerative tear with cartilage lesion of the lunate or the ulna Class IIC: Degenerative disc perforation with cartilage lesion of the lunate or the ulna Class IID: Degenerative disc perforation with cartilage lesion of the lunate or the ulna and lunotriquentral instability Class IIE: Degenerative disc perforation with cartilage lesion of the lunate or the ulna, lunotriquentral instability and ulnocarpal arthrosis

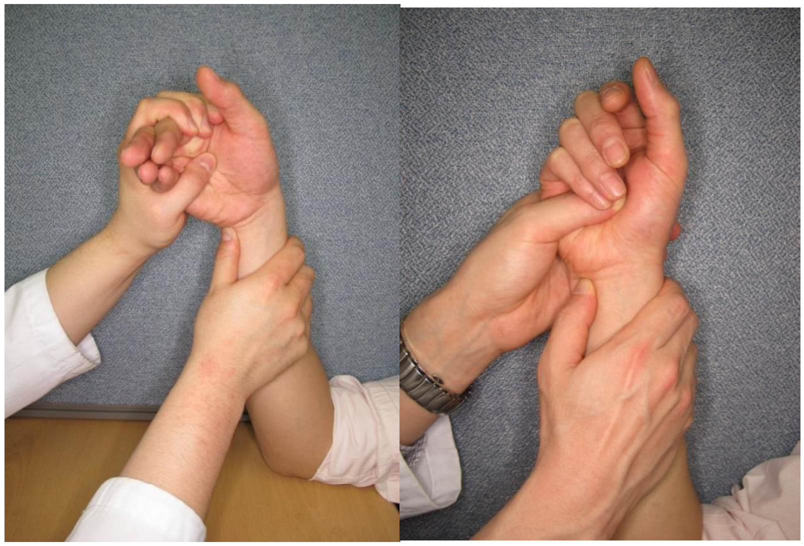


Fig. 1A. Ulnocarpal stress test
Fig. B. Fovea sign

forcible rotation of the forearm and presents with ulnar sided wrist pain with forearm rotation and ulnar deviation (ulnocarpal stress test) (Fig. 1) [17] tenderness in the area between the flexor carpi ulnaris (FCU) tendon and ulnar styloid is the most specific sign for TFCC injury it is called fovea sign (tay tomita fovea), radioulnar instability should be assessed in comparison to the contralateral side by stabilizing the radius by one hand and moving the ulna in dorsal and volar direction by the other hand and compare the amount of translation between both sides [17]. To examine the extensor carpi ulnaris (ECU) stability, flex the patient's elbow and ask the patient to pronate and supinate the hand while the wrist in ulnar deviation and watch the abnormal movement of the FCU tendon [16].

3. RADIOGRAPHIC EVALUATION

standard radiographs of the distal radius and ulna should be made for both side in order to compare with the non-affected side, standard postero-anterior radiographs should be made with the forearm in neutral rotation with shoulder and elbow in 90° of flexion, any changes in the standard position could lead to deference in ulnar variance measurement, changes in the true lateral radiograph more than 10° will adversely affect the accuracy of the examination [18]. radiographic signs of distal radioulnar injury are widening of the joint space, volar or dorsal displacement of the head of the ulna, more than 20° of distal radius dorsal angulation or more than 5 mm proximal displacement, and ulnar styloid avulsion fracture (Fig. 2) [16]. CT scan is more accurate for assessment of distal radioulnar incongruity, the same information can be gained by MRI in addition to soft tissue injuries. Magnetic resonance arthrography (MRA) is more accurate than the MRI in the assessment of TFCC tear (Fig. 3) (Fig. 4) [2,16,19], arthroscopy is the gold standard for TFCC injury diagnosis [17].

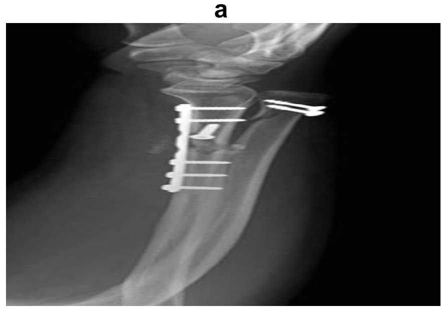
3. MANAGEMENT OF CHRONIC DISTAL RADIOULNAR INSTABILITY

The factors those determine the type of surgery in the unstable distal radioulnar joint are; the condition of the TFCC tear either repairable or not, the presence of arthritic changes, and if there is associated malunited distal radius fracture or ulnar variance discrepancy [20]. If the TFCC is repairable direct repair of the TFCC to the fovea from which it is usually avulsed is the first choice surgical procedure, other surgical procedures to stabilize the unstable distal radioulnar joint are indicated when TFCC repair is not possible [16], these procedures include the indirect stabilization procedures through ulno-carpal tenodesis as described by Hui and Linscheid [21], Tsai and Stilwell [22] direct radioulnar tether extrinsic to the joint as described by Fulkerson and Watson [23] or by dynamic muscle transfer as described by Johnson using pronator quadratus [11], other procedures to stabilize the unstable distal radioulnar joint are radioulnar ligament reconstruction procedures as described by Schecker et al [24], Sanders and Hawkins [25] and Bowers [26].

All reconstructive procedures are contraindicated presence of arthritic changes [20]. The reconstruction procedures were found to be superior to the radioulnar tethering procedures in a cadaveric study conducted by Gofton et al, 2005 [3]. One of the commonly used soft tissue reconstructive procedures is the ECU/FCU tenodesis as described by Breen and Jupiter (Fig. 5). In this technique, both dorsal and palmar incisions are utilized. Through the dorsal incision, the extensor retinaculum is divided and constructed into a pully for the ECU tendon, the distal ulna is resected just proximal to the sigmoid notch then a slip of ECU tendon is created, through the palmar incision a slip of FCU tendon is created too, then with the use of drill a communicating longitudinal and perpendicular holes in the distal ulna are created and both ECU tendon and FCU tendons slips are passed through these holes and sutured to each other. Finally, the ECU tendon is stabilized dorsally by the circular pully created from the extensor retinaculum [20].

Pronator quadratus advancement in a more lateral and posterior insertion in the distal ulna was proposed by Jonson to decrease dorsal instability of the distal ulna [27]. Adams et al. described an anatomic ligamentous reconstruction procedure to reconstruct both palmar and dorsal ligaments by using to incisions volar and dorsal,

a



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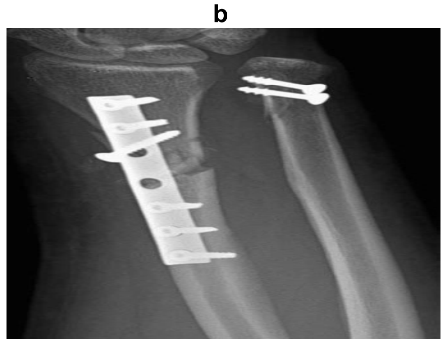
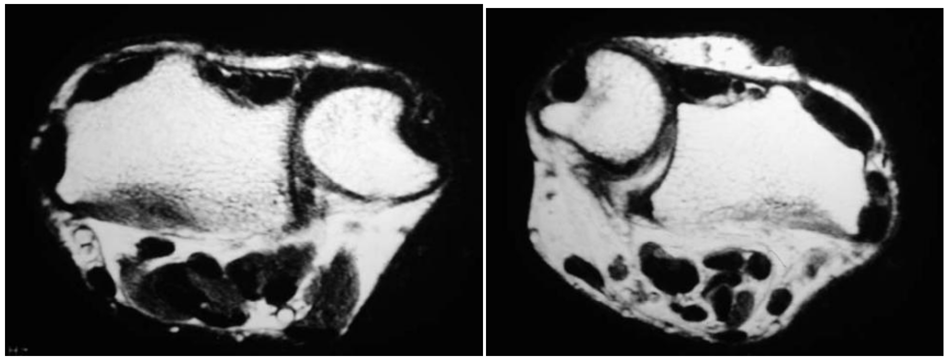


c

Fig. 2A. Ulnar styloid fracture with avulsed basal fragment represents the site of the attatcment of the TFCC. Fig. 2B. Dorsal dislocation of the ulnar head. Fig. 2C. Joint space widening.



a b

Fig. 3. T1 weighted image of both wrists (a) normal side (b) shows the dorsal subluxation of the distal radioulnar joint.

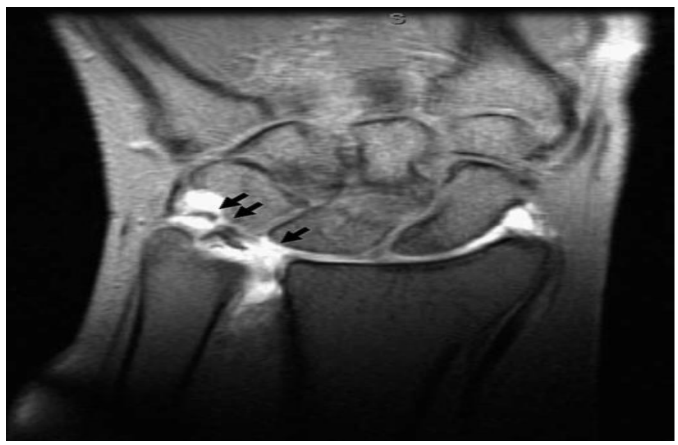


Fig. 4. T2 weighted image show peripheral tear (double arrows) and radial side tear (single arrow) of the TFCC

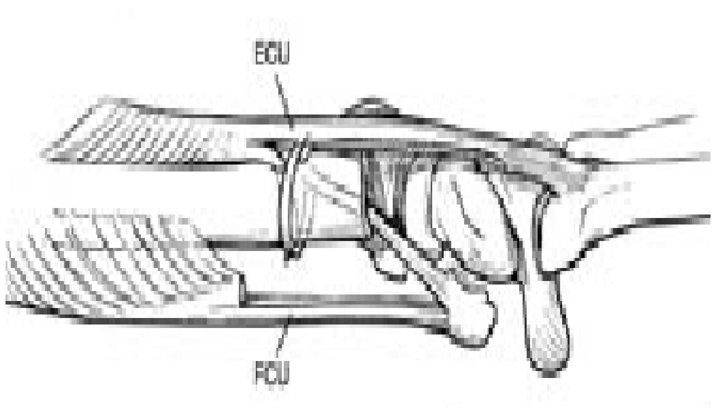


Fig. 5 ECU /FCU tenodesis described by breen and jupiter

through a dorsal incision between the fifth and sixth extensor compartment an L shaped capsulotomy is made and the periosteum beneath the fourth compartment is elevated from the sigmoid notch and then 3.5 drill bit is used to make a tunnel approximately 5 mm proximal to the lunate fossa and 5 mm radial to the articular surface of the sigmoid notch, another tunnel is made in the distal ulna between the fovea and the ulnar neck, a tendon graft is used from palmaris longus or a strip from ECU or FCU is used and passed in the radial tunnel from dorsal side to volar side by using suture retriever which is passed from the volar side through a 5 cm incision extending proximally from proximal wrist crease between the finger flexors and the ulnar neurovascular bundle, the volar end of the graft is returned back dorsally by using a straight hemostate which is pushed from dorsal to volar incisions over the ulnar head and proximal to the remaining TFCC. The volar end of the graft is grasped and pulled back dorsally, then through the dorsal incision the two limbs of the graft are passed through the ulnar tunnel to exit the ulnar neck then the limbs passed in opposite direction around the neck of the ulna and then tied together and secured with sutures with the forearm in neutral rotation and the DRUJ compressed manually [2].

In case of presence of arthritic changes in the distal radioulnar joint or subluxation of the ulna after excision of the ulnar head, the Sauvé-Kapandji procedure is indicated, it involves arthrodesis of the distal radioulnar joint and creation of a pseudoarthrosis just proximal to the ulnar head (Fig. 7) to allow supination and pronation to occur through it [16]. If there is subluxation of the proximal ulna stump following the Sauvé-Kapandji procedure it could be stabilized by extensor carpi ulnaris tenodesis, as described by Minami et al. [28] or a flexor carpi ulnaristenodesis, as described by Lamey and Fernandez [29].

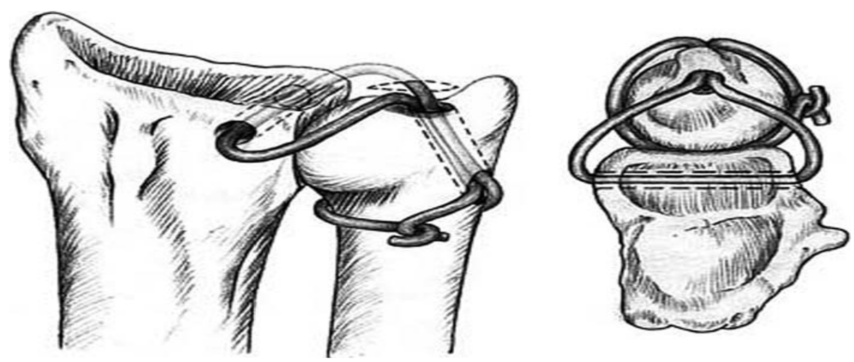


Fig. 6. Anatomic reconstruction of the distal radioulnar ligament described by adams and divelbiss for treatment of chronic distal radioulnar joint instability.

Fig. 7. Sauvé-kapandji procedure used for the treatment of unstable arthritic distal radioulnar joint following distal radius fracture

4. CONCLUSION

The distal radioulnar joint injury needs careful assessment to provide the best treatment option for the patient. Acute injury should be reduced and treated by cast immobilization, in case of irreducible injury, surgery is indicated. In acute cases with triangular fibrocartilage complex injury repair is warranted, careful assessment of any bony injury is paramount to get a proper outcome. In case of malunion of the distal radius or deficient sigmoid notch, a corrective osteotomy is indicated. In case of chronic distal radioulnar subluxation, an anatomic reconstruction of the volar and dorsal ligament is a very good option, but if there are arthritic changes a salvage procedure like the Sauvé-Kapandji procedure should be performed, with stabilization of the proximal stump with a slip of either the flexor carpi ulnaris or the extensor carpi ulnaris.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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