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DIAGNOSIS OF ULNAR WRIST PAIN

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INTRODUCTION

Various pathologies including degenerative arthritis, tendinitis, ulnar tunnel syndrome and ligamentous injury induce ulnar wrist pain. Until the 1980s a final diagnosis was frequently made based on the results of the selected treatment with incomplete knowledge about the ulnar wrist pathology and diagnosis. Recent progress in understanding the etiology of ulnar wrist pain by biomechanical studies, advanced imagings and wrist arthroscopy make the diagnostic procedure more systematic and comprehesive. Moreover, we can now differentiate ulnocarpal pain from the pain originating in the distal radio-ulnar joint. This article describes the current concept and diagnostic modalities of ulnar wrist pain of intra-articular origin together with our contributions to this field.

FUNCTIONAL ANATOMY AND CLASSIFICATION OF INTRA-ARTICULAR ULNAR WRIST PAIN

The wrist provides the pathway for the flexors, extensors, nerves and vessels from the forearm to the hand, and also receives the axial load from the hand and passes it along to the forearm. Therefore, the disorders of the wrist affect the function of the hand considerably. In ordinary use, most axial load (about 80%) to the wrist go through the radioscaphoid and radiolunate joints but the ulnocarpal load considerably increases with strenous activity or a predisposing ulnar positive variance (a relatively long ulna at the wrist).[1] Most ulnocarpal disorders interferes with strenous use of the hand including maximum grip and pushing the hand against the floor on standing.

Intra-articular ulnar wrist pain can be classified into three categories: ulnocarpal pain, distal radioulnar pain and pisotriquetral pain (Tabel 1). Pisotriquetral disorders are commonly isolated from the two other categories, but ulnocarpal disorders often accompany distal radioulnar joint disorders because the triangular fibrocartilage (Fig. 1) contains the dorsal and volar radioulnar ligaments which form the major stabilizing structure of the distal radioulnar joint. Conversely, dislocation of the distal radioulnar joint usually involves triangular fibrocartilage disruption. The triangular fibrocartilage originates from the sigmoid notch of the radius and is attached not only to the base of the ulnar styloid but also to the floor of the strong sheath of the extensor carpi ulnaris and lunotriquetral ligament. Thus, the triangular fibrocartilage complex is composed of the triangular fibrocartilage with a connecting ulnocarpal ligament and the sheath of the exten-

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Table 1 Classification of intra-articular ulnar wrist disorders

Ulnocarpal disorders
- traumatic triangular fibrocartilage tear
- traumatic lunotriquetral ligament tear
- ulnocarpal impaction syndrome
- ulnar styloid impaction syndrome
- inflammatory ulnocarpal arthritis
- ulnocarpal joint mouse

Disorders of the distal radioulnar joint
- subluxation, dislocation
- instability
- degenerative arthritis
- inflammatory arthritis
- joint mouse

Disorders of the pisotriquetral joint
- degenerative arthritis
- subluxation, dislocation

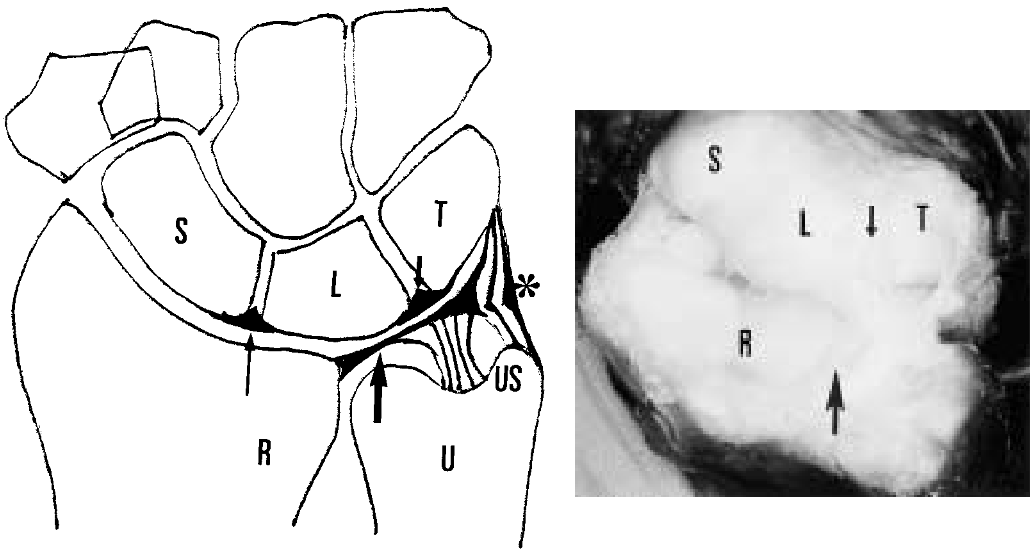

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Fig. 1 Intra-articular structure of ulnar wrist
a: scheme b: dissected cadever
R: Radius U: Ulna US: Ulnar styloid
S: Scaphoid L: Lunate T: Triquetrum
Large arrow: Triangular fibrocartilage
Small arrow: Lunotriquetral ligament
Narrow arrow: Scapholunate ligament
*: Meniscus homologue

sor carpi ulnaris.[2] This complex supports the ulnar carpus and stabilizes the distal radioulnar joint. Ulnar styloid fractures, especially those at its' base, are frequently seen in patients with dislocation or subluxation of the distal radioulnar joint, and reduction and fixation of the diplaced ulnar styloid yields a satisfactory restoration of the function of the distal radioulnar joint because the ulnar styloid fixation restores the stabilizing effect of the triangular fibrocartilage.[3-5] When triangular fibrocartilage loses its suspension function to the ulnar carpus (the triquetrum and ulnar aspect of the lunate) due to trauma or degeneration, the ulnar head impinges upon the ulnar carpus, developing an ulnocarpal impaction syndrome.[6] In an ulnocarpal impaction syndrome, the triangular fibrocartilage and lunotriquetral ligaments undergo wear or degenerative perforation, and the ulnar aspect of the lunate or radial aspect of the ulnar head shows fibrillation of the cartilage or an erosive change in the cartilage. An ulnocarpal impaction syndrome that does not respond well to conservative measures (splintage, intra-articular injection of steroids and anti-inflammatory drugs) can best be treated by ulnar shortening which relieves the ulnocarpal axial load. Palmer et al. demonstrated that shortening the ulna by 2.5 mm, decreases the ulnocarpal axial load from 20% to 4.8% of the total wrist axial load experimentary. If the ulna is legthened by 2.5 mm, the ulnocarpal load increased to 41.9%.[1] Therefore, a developmental positive ulnar variance (relatively higher incidence in Japanese than in Caucasian[7]) or a traumatic one (frequently seen after distal radius fractures as an after-treatments complication) predisposes one to ulnocarpal impaction syndrome. Anatomical studies identified an age-related degeneration of the avascular central part of the triangular fibrocartilage.[8,9] Mikic did not detect perforations until the 3rd decade of life, after which perforations steadily increased to 40% in the 5th decade.[8] Unlike those from ulnocarpal impaction syndrome, most of the age-related perforations are asymptomatic. A sharp disruption of the triangular fibrocartilage is usually due to trauma. Repeated stress to the ulnar wrist due to sports or job activity may cause ulnar impaction syndrome as an overuse syndrome. The pisiformis is considered to be a sesamoid bone in the flexor carpi ulnaris and is the only carpal bone into which a tendon inserts itself. Primary osteoarthritis of the piso-triquetral joint is extremely rare. Secondary osteoarthritis or flexor carpi ulnaris enthesopathy is a common pathology. Direct trauma and sports activity (volleyball, tennis, gymnastics) may cause pisotriquetral arthritis.

PROVACATIVE TEST FOR INTRA-ARTICULAR ULNAR WRIST PAIN

Physical examination of the ulnar wrist requires careful assessment, including inspection, observation of use, abnormality of motion and swelling. The site of pain and tenderness suggests the abnormality of underlying structures. Tenderness on the distal radioulnar joint frequently indicates disorders of this joint, and tenderness just distal to the ulnar head suggests ulnocarpal disorders. Several provocative test to reproduce ulnar wrist pain have been devised for differential diagnosis (Table 2).

An ulnocarpal stress test is performed using axial stress during passive supination-pronation with the wrist in maximum ulnar deviation (Fig. 2).[10] This test was initially described as a provocative test for ulnocarpal impaction syndrome.[11] We studied 45 patients with persistent ulnar wrist pain and found that not only ulnocarpal impaction syndrome but also other ulnocarpal disorders including triangular fibrocartilage traumatic tear, lunotriquetral ligament (Fig. 1) tear and ulnocarpal arthritis register positive on the test.[10] Therefore, the ulnocarpal stress test should be considered as a screening test for intra-articular ulnocarpal disorders.

The lunotriquetral ballottement test,[12] lunotriquetral compression test,[13] shear test[14] and shuck test[15] are provocative tests for lunotriquetral ligament injury. Of these four provocative tests, we

Table 2 Provocative tests for ulnar wrist pain

Extensor carpi ulnaris subluxation test for ECU subluxation
Ulnocarpal stress test for intra-articular ulnocarpal disorders
Lunotriquetral ballottement test for LT ligament tear
Lunotriquetral compression test for LT ligament tear
Shear test for LT ligament tear
Shuck test for LT ligament tear
Ulnar styloid impaction test for ulnar styloid impaction syndrome
Piano-key sign for DRUJ instability
DRUJ compression test for DRUJ arthrosis
DRUJ rotation test for DRUJ arthrosis
Pisotriquetral grinding test

ECU : extensor carpi ulnaris
LT : lunotriquetral
DRUJ : distal radioulnar joint

Fig. 2 Ulnocarpal stress test.

recommend the lunotriquetral compression test because its sensitity and specificity are superior to that of the other three. This test is easily performed by supporting the wrist and pushing the triquetrum from an ulnar to a radial direction against the lunate. The piano-key test, distal radioulnar compression test and distal radioulnar rotation test elicit pain due to disorders of the distal radioulnar joint. The piano-key test mainly examines the stability of the distal radioulnar joint and often reveals instability that can not be detected even by a computed tomographic motion study. The piano-key sign is demonstrated by depressing the ulnar head while support-

Fig. 3 Pisotriquetral grinding test.

ing the forearm in pronation. When instability is present, the ulnar head springs back into position like a piano-key. The positive distal radioulnar compression test and positive distal radioulnar rotation test are used to detect incongruence of the distal radioulnar joint including inflammatory arthritis, degenerative arthritis and a deformed articular surface due to trauma.

The pisotriquetral grinding test is specific to pisotriquetral arthritis due to trauma or degenerative arthritis and is helpful in diagnosis. On the whole, provocative tests provides a helpful information for disgnosis and reliably reproduce ulnar wrist pain. Although a satisfactory differential diagnosis cannot be made by provocative tests, the site of disordors (ulnocarpal, distal radio-ulnar or pisotriquetral) can be determined.

IMAGINGS FOR ULNAR WRIST PAIN

Convensional posteroanterior X-rays of the wrists can detect ulceration or cyst formation at the ulnar base of the lunate in advanced ulnocarpal impaction syndrome, joint incongruence of the distal radioulnar joint, and positive ulnar ulnar variance (Fig. 4). A supinated oblique view shows the pisotriquetral joint and is helpful in diagnosing pisotriquetral arthrosis.

Carpal tunnel views are helpful for diagnosing hamate hook fractures and pisotriquetral disorders. A computed tomography is able to confirm carpal bone fractures including hamate hook fractures.[16] Computed tomographic motion study of the bilateral distal radioulnar joint is indispensable for diagnosing subluxation of this joint (Fig. 5). Bilateral examinations are required because a normal dorsal or volar displacement of the ulnar head relative to the sigmoid notch of the radius mimics the subluxation.[17] A 99mTechnetium bone scan provides a highly sensitive image of the site of disorders, but its specificity for each pathology is low.[18] Therefore, this modality should be considered as a screening examination for bone and joint abnormality.

Magnetic resonance imagings (MRI) depicts the fracture line of the carpal bones even in fractures that cannot be detected by X-rays and is the most reliable diagnostic tool for diagnosing carpal bone necrosis. As for ligamentous and chondral lesions, early studies showed that

Fig. 4 Posteroanterior X-ray in a patient with both ulnocarpal impaction syndrome and asymptomatic osteoarthritis of the distal radioulnar joint. X-ray shows a long ulna (positive ulnar variance).
(white arrow: lunate ulceration, black arrow: narrowed joint space and bony spur formation of the distal radioulnar joint).

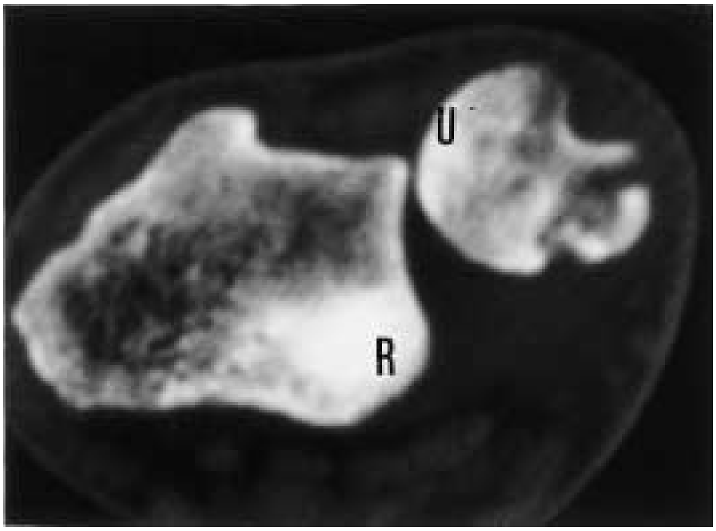


Fig. 5 Computed tomography of the distal radioulnar joint in a patient with dorsal subluxation (R: radius, U: ulna).

Fig. 6 High-resolution magnetic resonance image in a patient with a suspected triangular fibrocartilage traumatic tear (arrow) This image shows only a minor tear, but arthroscopy revealed a major flap tear.

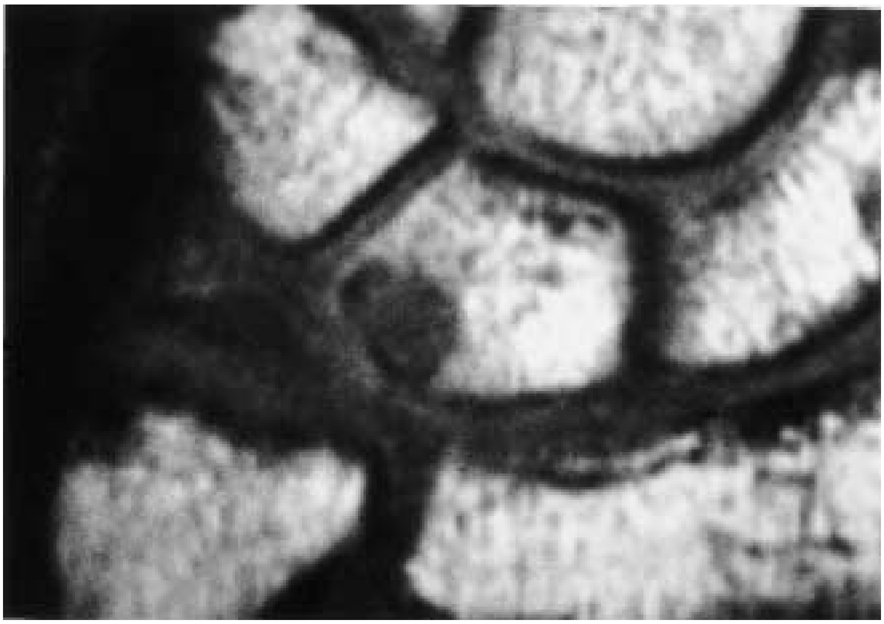


Fig. 7 Typical T1-weighted magnetic resonance image of advanced ulnar impaction syndrome. Low signal intensity at the ulnar base of the lunate is evident, but this finding is absent in most patients with ulnocarpal impaction syndrome.

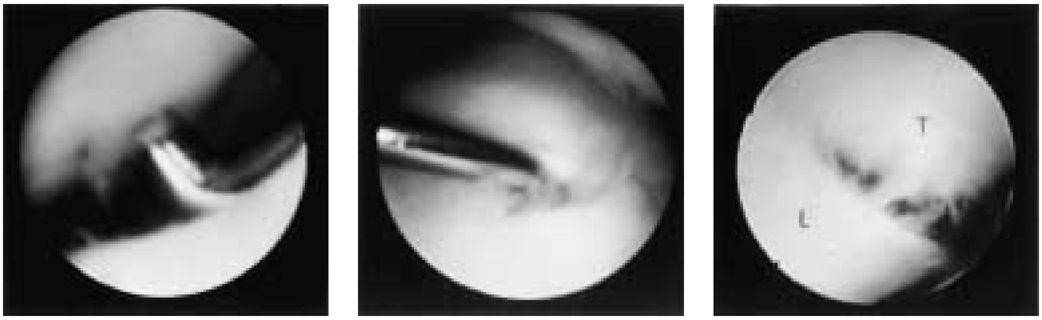
MRI is reliable in detecting these disorders. Zlatokin et al.[19] reported that MRI results in an accuracy of 90% compared with arthroscopy in the diagnosis of triangular fibrocatilage tear, and an accuracy of 80% in the diagnosis of lunotriquetral ligament tear. They suggested that MRI will replace wrist arthrography in the diagnosis of triangular fibrocartilage abnormalties and lunotriquetral ligament injuries.[19-25] However, our studies revealed that arthrography provides greater accuracy (92%) than MRI (73%) in diagnosing triangular fibrocartilage full-thickness tear.[26] Further studies comparing high-resolution MRI with standard MRI showed 79% of accuracy for the former and 76% for the latter in detecting triangular fibrocartilage tear (Fig. 6).[27] Reported MRI sensitivity rates compared with arthroscopy for the diagnosis of triangular fibrocartilage tears range from 72% to 93%, which is similar to or less than the sensitivity of wrist arthrography. MRI produces false-negative images, but only a few false-positives.[19-26] Therefore, even high-resolution MRI is unsatisfactory for a diagnosis of triangular fibrocartilage tears. MRI has also been advocated as a way to diagnose ulnocarpal impaction syndrome (Fig. 7).[29,30] Our recent study showed excellent specificity, but sensitivity was only 36%. This may be because MRI cannot detect early osteoarthritic changes confined to joint cartilage, as noted by several authors who studied knee joint cartilage.[31-33] Imaging studies for intra-articular disorders should be considered supplementary to the patient history, physical exmination and arthroscopic findings. And abnormal imagings that do not consistent with the physical signs should be considered to be innocent.

WRIST ARTHROSCOPY FOR ULNAR WRIST PAIN

Endoscopic evaluation of joints was initiated in 1939, when Dr. Takagi (Tokyo University) performed the first recorded knee arthroscopy.[34] Then Dr. Watanabe (Tokyo Community Hospital) developed an arthroscope for clinical use. However, the sophiscated wrist arthroscopy system currently in use was introduced by Poehling, Roth and Whipple in United States.[35-39] Many surgeons believe that this technique is already the diagnostic standard for chronic wrist pain because wrist arthroscopy often reveals cartilagenous or ligamentous lesions that cannot be detected by various imagings techniques.

For cartilaginous lesions, Koman et al. reviewed 54 consecutive arthroscopies in patients with wrist pain and found cartilagenous lesions in 34 of 54 patients, in none of whom such lesions had been diagnosed before arthroscopy.[40] Most traumatic and degenerative cartilagenous lesions require wrist arthroscopy or arthrotomy for definitive diagnosis, although the latter is not a realistic option. Symptomatic early ulnocarpal impaction syndrome shows that degenerative change confined to the cartilage of the lunate and ulnar head (so called fibrillation or degenerative flap, Fig. 8a) which may be undetectable by imagings can be detected by arthroscopy.

Triangular fibrocartulage complex abnomalities can be diagnosed by wrist arthrography, but this modality would not identify a partial tear and can not differentiate degenerative lesions from traumatic ones. If a tear is present, it can be assessed by direct visualization through the scope with respect to the size of perforation, location and type (Fig. 8b). Some triangular fibrocartilage complex lesions can be advantageously treated during the same surgical procedure with using an arthroscope.[41-43] For diagnosing ligamentous lesions including scapholunate ligament rupture and lunotriquetral ligament rupture, arthroscopy provides detailed information about the size, and distinguishes between a partial tear or complete tear and a traumatic tear or degenerative tear (Fig. 8c). Arthroscopy is also useful as a diagnostic and a therapeutic tool in dealing with synovitis including that due to rheumatoid arthritis. In contrast to the elbow joint where loose bodies can be detected on plain film, loose bodies in the wrist joint even if of bony ori-



a b c

Fig. 8 Arthroscopic view of abnormalities
a. Traumatic chondral lesion of the lunate (tip of a probe)
b. Degenerative triangular fibrocartilage tear (tip of a probe) in a patient with ulnocarpal impaction syndrome.
c. Old lunotriquetral ligament traumatic tear (L: lunate, T: triquetrum).

gin often remain undetected by imagings. Arthroscopy is an excellent means of diagnosing loose fragments. Rheumatoid arthritis often starts from synovitis in the distal radioulnar joint or ulnocarpal articulation. Among the disadvantages of wrist arthroscopy are its invasive nature (even though minimally so) and demands technique to decrease the dead angle.

SUMMARY

In the diagnosis of ulnar wrist pain, physical examinations including provacative tests are primary elements in identifying the site and nature of ulnar wrist pain. Imagings techniques are helpful for diagnosing occult fractures and distal radioulnar subluxation, but unsatisfactory for diagnosing ulnocarpal impaction syndrome, tears of the triangular fibrocartilage complex and lunotriquetral ligament, and joint mouse, imagings. Therefore, prior to surgical intervention arthroscopy is recommended for patients with persistent ulnar wrist pain that interferes with their daily activity.

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