Unravelling ulna-sided wrist pain

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Abstract

Ulna-sided wrist pain is a common presenting condition, however the unique and complex anatomy of that area presents wide-ranging diagnostic challenges. Ulnar-sided wrist pain can be due to: bony, cartilaginous or ligamentous injury; joint instability in the carpus or distal radioulnar joint; bony impingement; nerve compression; tendon dysfunction or arthritis. The aim of this review article is to detail the important relevant anatomy and the associated pathoanatomy in order to understand the conditions; and to highlight relevant history, examination findings, and investigations that can help decipher the problem and make a correct diagnosis.

Keywords Distal radioulnar joint; examination; history; radius; training; ulna; wrist; wrist pain

Introduction

Ulnar-sided wrist pain is a common presenting complaint in a hand and wrist clinic, however unravelling these symptoms and signs into a firm diagnosis is difficult due to the unique anatomy of the region and the number and complexity of the structures involved. The distal ulna is a point of confluence between cartilaginous, ligamentous, tendinous and synovial structures, any of which can be affected by varied pathological processes leading to several distinct clinical entities. The unique anatomy of the triangular fibrocartilage complex (TFCC), its attachments and the unique biomechanics that act on the ulnar side of the wrist and distal radioulnar joint (DRUJ) can lead to pathological processes developing in the presence of trauma or degenerative disease.

The focus of this review is to highlight the key areas of anatomy, how this anatomy may become injured or diseased, and how that results in several discrete pathologic conditions. It will then discuss how these conditions may present, focusing on the key aspects of the history and examination, including several clinical signs and tests, as well as describing the relevant investigations required to make a correct diagnosis.

Relevant anatomy

This section will highlight the key areas of anatomy that provide the foundation of understanding the ulnar side of the wrist. This includes: the distal radius, ulna and ulnar carpus; the DRUJ and TFCC; as well as the lunotriquetral joint, the flexor carpi ulnaris and Guyon's canal.

Bony anatomy

The sigmoid notch of the radius is the concave articular surface of the medial aspect of the distal radius forming the DRUJ through the articulation with the ulnar head. It has a radius of curvature of 19 mm (range 17–22 mm), larger than that of the distal ulna. Four different morphologies exist, as described by Tolat et al.[1] demonstrated in Figure 1:

- flat face (42%)
- C-type (30%)
- ski-slope (14%)
- S-type (14%).

The distal ulna comprises the expanded ulnar head and the ulnar styloid process. The ulnar head is usually cylindrical in shape, although it can be more spherical with ulnar positive variance, an oblique cylinder with negative variance, or more conical with extreme negative variance. It has a radius of curvature of 8–10 mm.

The volar, radial and dorsal aspects of the head are covered in hyaline cartilage over an arc of 220° where it articulates with the sigmoid notch of the radius. Distally the head is also covered in hyaline cartilage where it articulates with the underside of the triangular fibrocartilage (TFC). The ulnar styloid protrudes from the dorsoulnar aspect of the ulna head, is devoid of cartilage, and is the main attachment point for ligaments including the radioulnar ligaments. At the base of the ulnar styloid is a small depression, the fovea, which is not covered in cartilage and is the primary attachment site of the deep fibres of the radioulnar ligaments and the TFC (Figures 2a and b). Dorsoradially to the ulnar styloid, on the ulnar head, there is a shallow groove devoid of cartilage which is the location of the extensor carpi ulnaris (ECU) tendon.

Variance – ulnar variance describes the relative difference in lengths between the distal ulna and radius where they meet the carpal bones. Positive ulnar variance occurs when the ulna is longer than the radius as shown in Figure 3. Variance changes with forearm rotation (increases with pronation, decreases with supination) and increases with forcible gripping. In neutral rotation with a relaxed grip the normal range of ulnar variance is −4.2 to +2.3 mm, with a mean of −0.9 mm.[2] From relaxed supination to forcible pronation the variance can change by 1.3 ± 0.5 mm.[3]

Ulnar-sided carpal bones:

Lunate – a wedge-shaped bone with a wider convexity proximally that articulates with the lunate fossa of the radius and a narrower concavity distally which articulates with the capitate. It has flat articular facets laterally and medially to articulate with the scaphoid and triquetrum respectively. Lunates are classified as type 1, if they only have a single distal articular facet for the capitate, and type 2 if they have a second articular facet for articulation with the hamate. Type 2 lunates are slightly more common (up to 65% in some papers).

Triquetrum – a pyramidal-shaped bone which has a convex proximal surface which articulates with the TFCC. It has a circular convexity on the palmar surface for articulation with the

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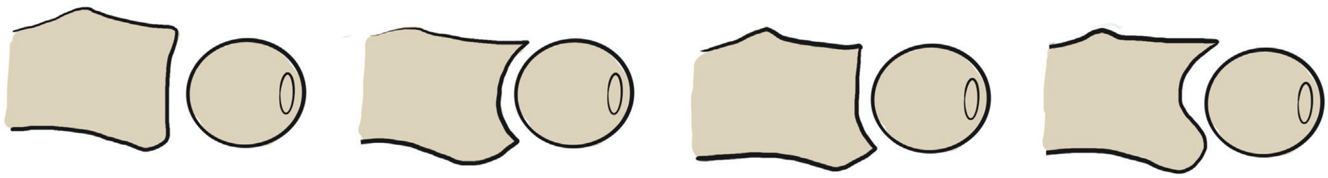

Figure 1 Sigmoid notch morphology. From left to right: flat face, C-type, ski-slope, S-type.[1]

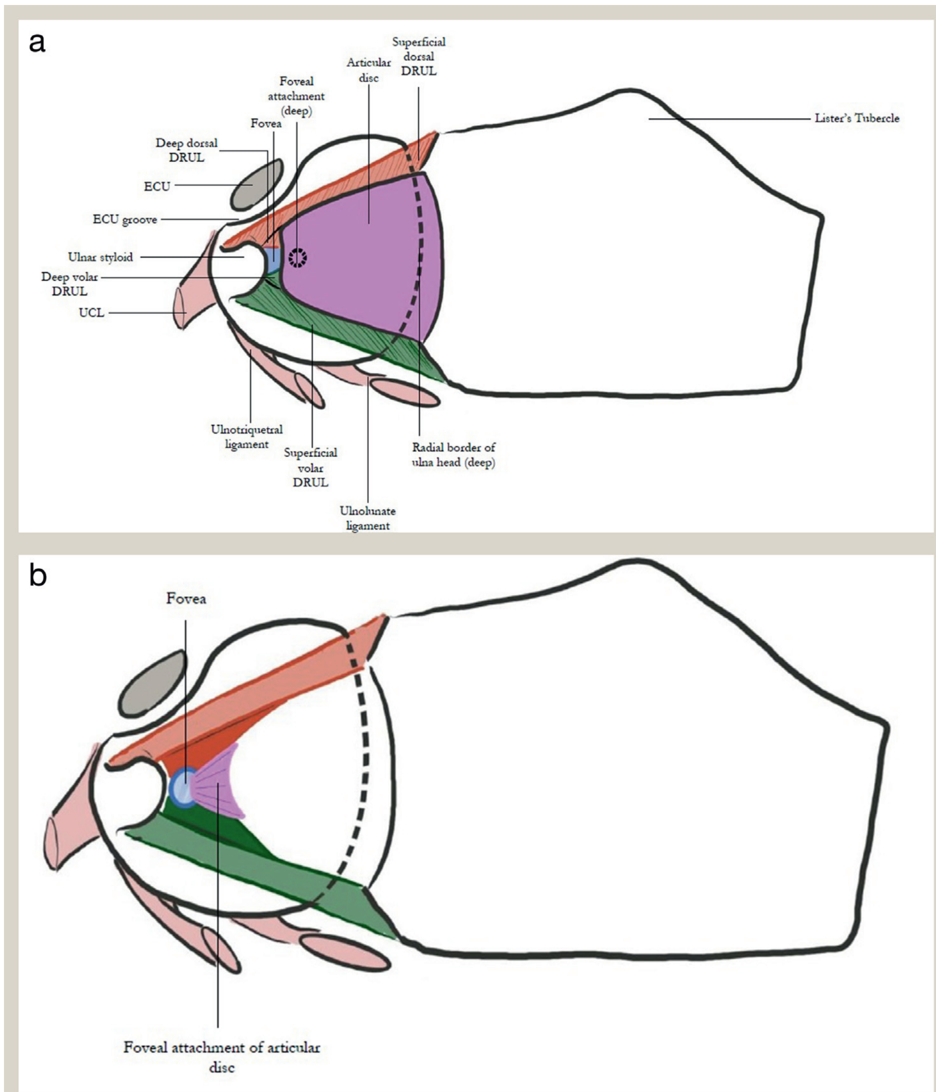

Figure 2 a. Schematic anatomical representation of the triangular fibrocartilage complex. DRUL, distal radioulnar ligament; ECU, extensor carpi ulnaris; UCL, ulna collateral ligament. **b**. Superficial and deep volar (green) and dorsal (orange) DRUL.

pisiform. The dorsal surface is devoid of cartilage and is the confluence of various extrinsic ligaments.

Hamate – other than its distinctive, radially concave, palmar hook, and its wider dorsal surface, the hamate is covered with articular cartilage for articulation with the triquetrum, the capitate and the 4th and 5th metacarpals.

Pisiform – a near spherical sesamoid bone within the flexor carpi ulnaris (FCU) tendon whose only cartilage covered area is the concavity of the dorsal surface for articulation with the triquetrum.

The distal radioulnar joint and the triangular fibrocartilage complex

The DRUJ is the articulation between the sigmoid notch of the distal radius and the ulnar head. It is vital to remember that the distal radius rotates around the stable ulnar head in pronation-supination. The radius of curvature of the sigmoid notch is larger than the ulnar head allowing translation of the ulna within the sigmoid notch during rotation with the ulna moving dorsally in pronation and volarly in supination.[1] This translation serves to extend the range of pronosupination from the 150° of

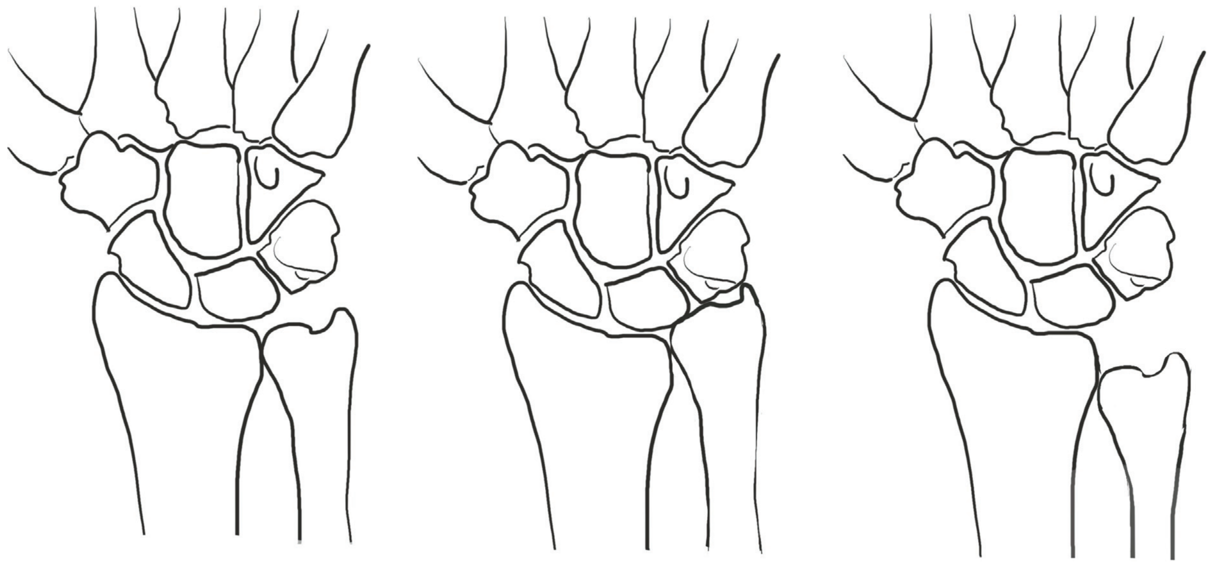

Figure 3 Ulna variance. Left to right: normal ulna variance, positive ulna variance, negative ulna variance.

true rotation to the 180° of functional rotation clinically observed.

It should be noted that technically it is the mobile radius that translates against a static ulna, however this movement, and the subluxations and dislocations associated with it, are always described by the direction the ulnar moves in relation to the radius.

The large range of motion possible at the DRUJ makes it a relatively unstable joint and it is reliant on its soft tissues to maintain stability in motion. These are separated into:

- intrinsic stabilizers — the components of the TFCC
- extrinsic stabilizers — the interosseous membrane, pronator quadratus muscle and FCU and ECU tendons.

The triangular fibrocartilage complex is a complex structure of ligament and cartilage providing stability during movement and cushion against forces. It consists principally of an articular disc (the TFC) and its foveal attachment, the volar and dorsal distal radioulnar ligaments, the ulnolunate, ulnotriquetral and ulnar collateral ligaments, and the ECU subsheath (Figure 2a).

The articular disc — a triangular flat fibrocartilage structure that lies in the transverse plane with its base attached to the ulnar margin of the distal articular surface of the distal radius (i.e. the distal aspect of the sigmoid notch). Towards its ulnar aspect it separates into two sections with the distal (superficial) part inserting into the radial aspect of the styloid and up towards its tip, and a proximal (deep) foveal attachment, inserting into the fovea of the ulnar head and the base of the ulnar styloid.

The TFC acts as a shock absorber across the ulnocarpal joint presenting a smooth articulating surface for the radiocarpal and ulnocarpal joint which moves with the radius during pronosupination, rotating around its foveal insertion (Figure 4). Its thickness varies with variance and is typically 1—2 mm. There is often a recess or defect between its insertions in the ulna at the base of the ulnar styloid.[4,5]

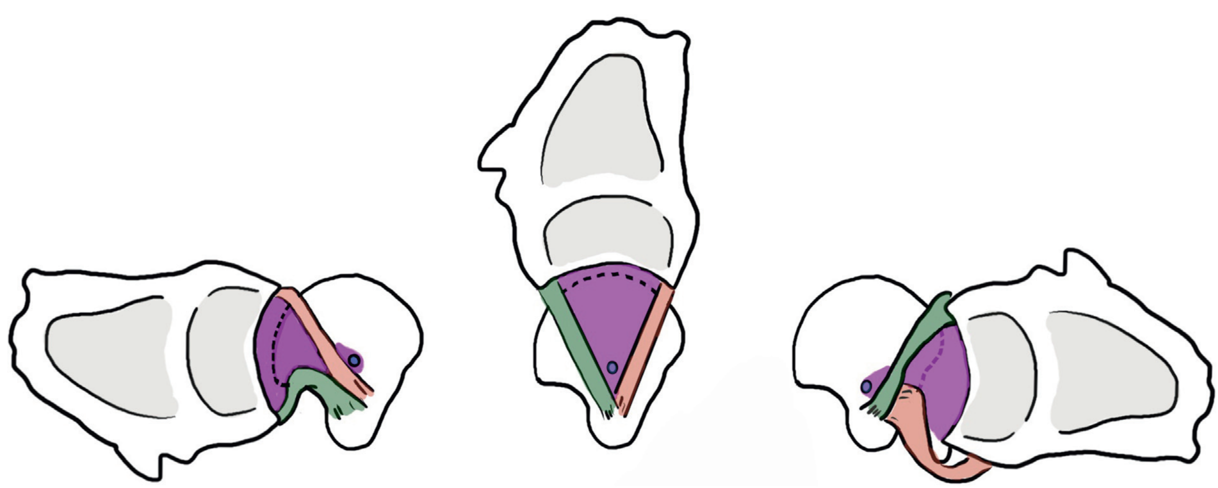

Figure 4 Left to right: axial view of distal radius and ulna in supination, neutral, pronation. Triangular fibrocartilage (purple), foveal insertion — deep insertion (blue) and distal radial ulnar ligaments in pronosupination (volar — orange, dorsal — green). Adapted from Schmidt et al.[6]

The distal radial ulnar ligaments — the volar and dorsal margins of the TFC blend with volar and dorsal ligaments that run from the margins of the sigmoid notch of radius to the base of the ulnar styloid (superficial fibres) and to the fovea (deep fibres) as seen in Figure 2b. These ligaments are important stabilizers of the DRUJ during rotation of the distal radius around the static distal ulna. They resist high tensile forces[4] and with the foveal attachment of the TFC, are the chief stabilizers of the DRUJ (Figure 4).

Ulnar collateral, ulnolunate and ulnotriquetral ligaments — as shown in Figure 5, the ulnar collateral ligament structure extends from the ulnar styloid to the triquetrum, pisiform and base of 5th metacarpal. Its principal function is to resist excessive radial deviation of the wrist and support the DRUJ.

The ulnolunate and ulnotrequetral ligaments are volar extrinsic ligaments that arise from the distal ulnar and volar distal radioulnar ligaments and insert into the carpal bones. They are important stabilizers of the wrist joint and with the ulnocapitate and dorsal ulnocarpal ligaments, (not technically part of the TFCC) form the ulnocarpal ligament complex (Figure 5).

Extensor carpi ulnaris subsheath — the ECU tendon lies in the sixth extensor compartment within its own subsheath which is deep to the extensor retinaculum. The ECU lies in the groove on the ulnar head within a fibro-osseous tunnel formed by the confluence of the dorsal radioulnar ligament and TFCC (Figures 2a and 5). Its function is to prevent the ECU subluxing during wrist movement and forearm rotation.

Other relevant anatomy

Interosseous membrane (IOM) and pronator quadratus: the bones of the forearm are connected together along their length by the IOM. In the midsection the fibres run from proximal radius to distal ulnar and act as a longitudinal stabilizer of the forearm. Distal to this central band, the distal oblique bundle runs in the opposite direction (Figure 6) and is an important stabilizer of the DRUJ. At its very distal end, sections of the interosseous membrane reinforce the capsule of the DRUJ further adding to stability; the posterior fibrous band is under tension in pronation

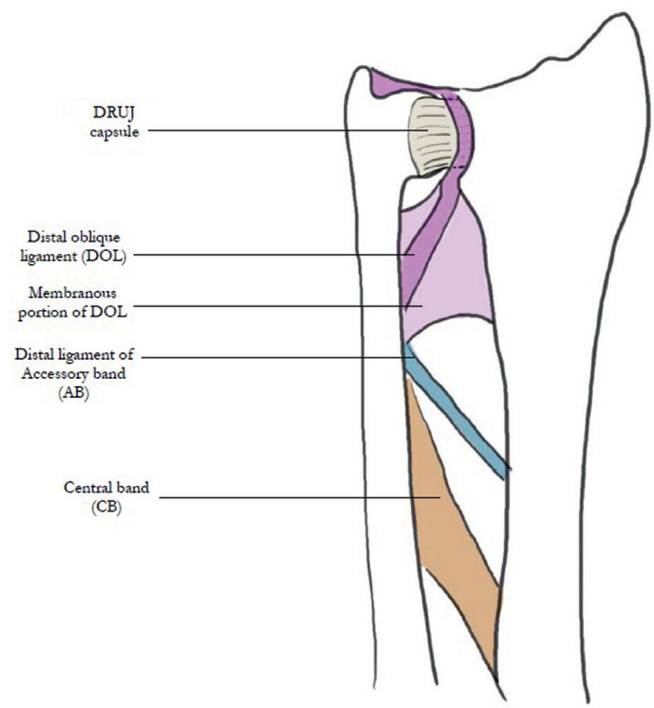

Figure 6 Important structures in the interosseous membrane. The joint capsule passes deep to the distal DOJ. DRUJ, distal radioulnar joint.

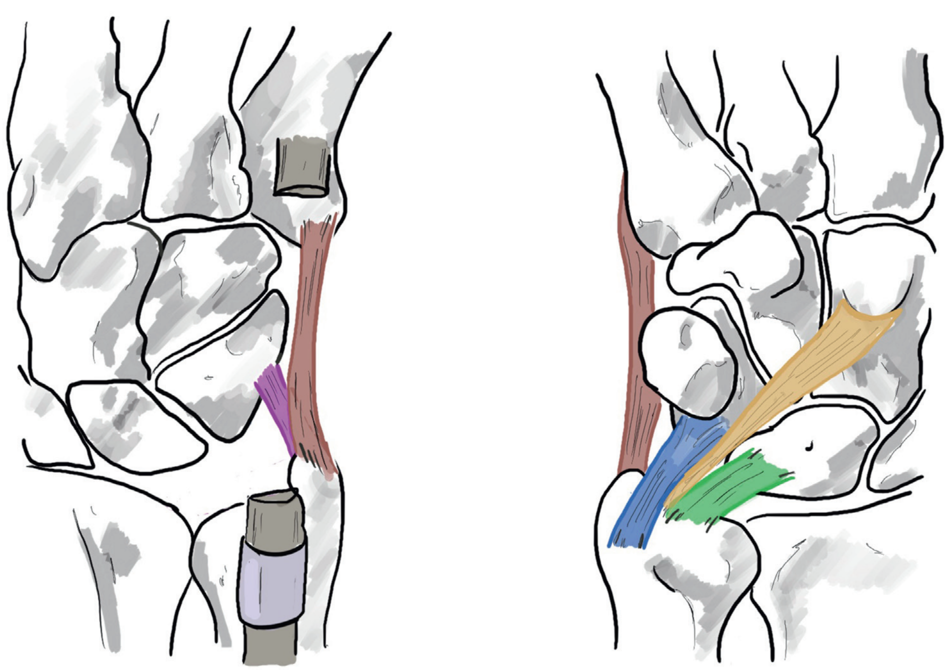

Figure 5 Ulnar-sided ligaments. Left — dorsal aspect; Right — volar aspect; Red — ulnar collateral ligament; Blue — ulnotriquetral ligament; Green — ulnolunate ligament; Grey — extensor carpi ulnaris (ECU); Yellow — ECU subsheath. Adapted from Schmidt et al.[6]

and prevents volar translation of the ulnar head; an antagonistic structure, the falciform septum on the palmar side, prevents dorsal translation.

In the deepest layer of forearm muscles, just superficial to the DRUJ, the pronator quadratus, with its fibre orientation running transversely from the radius to the ulna, also acts as a dynamic stabilizer of the DRUJ.

Lunotriquetral joint: the joint surfaces between the lunate and triquetrum are flat and allow the triquetrum to move from proximally to distally during ulnar deviation. The bones are attached to each other by the strong intrinsic lunotriquetral (LT) ligament. This short C-shaped ligament runs from the dorsal, proximal and volar aspects of the bones and is deficient distally. The palmar portion is the strongest. The stability of the joint is reinforced by the ulnocarpal ligament complex.

The flexor carpi ulnaris (FCU) converges into a tendon that is in the superficial layer and is the most medial tendon at the wrist. It inserts into three bones within the carpus: the pisiform, at its articulation with the triquetrum, and then the hook of hamate and base of the 5th metacarpal. It is responsible for wrist flexion and ulnar deviation. It is wholly supplied by the ulnar nerve.

Ulnar nerve/Guyon's canal: Guyon's canal is a tunnel in the ulnar palm, superficial to the flexor retinaculum. It runs between the pisiform and hook of hamate, with the pisiform on its ulnar border and its radial border formed by the palmar aponeurosis. The ulnar nerve traverses the canal from forearm to hand (Figure 7).

Pathologic causes of ulnar-sided wrist pain

How injury or disease leads to specific conditions

Due to the nature of the presenting symptoms, many patients with overlapping pain or instability can be a challenge to diagnose. Subtle differences in the presentation can be the result of different pathologies requiring different treatment. The anatomical location of the pathology is therefore integral in making a diagnosis and Table 1 details the conditions caused by various pathologies to the anatomical structures previously described.

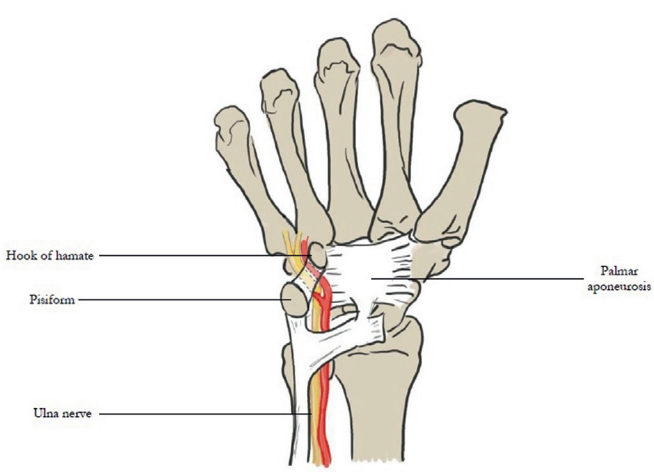

Figure 7 Guyon's canal.

The subsequent section provides more details for pathologies unique to the ulnar side of the wrist.

Sigmoid notch morphology: the flattened forms of sigmoid notch are more prone to issues with instability and TFCC pathology. The more congruent forms, C-type and ski-slope, have higher joint reaction forces and may therefore be more prone to arthrosis.

Distal ulna morphology and ulnar variance: ulnar variance predisposes the wrist to various conditions, as does abnormal morphology of the ulnar styloid. The words impingement, and impaction have often, erroneously been used interchangeably to describe the phenomenon of ulnar-sided pain resulting from morphological variations of the ulnar head due to congenital, inflammatory or traumatic aetiology. There are however three distinct conditions and understanding the difference between them is vital to ensure a correct diagnosis (Figure 8).

Ulnar impaction (or abutment) syndrome is the commonest of the three and occurs with ulna positive variance (which may only be dynamic) and causes the TFCC to be compressed between the ulnar head and the proximal aspects of either the medial border of the lunate or the lateral border of the triquetrum. It can be associated with degenerate tears of the TFC or lunotriquetral ligament.

Ulnar impingement occurs in ulnar negative variance and occurs when the ulnar head, or ulnar stump, impinges on the proximal end of the sigmoid notch during forceful activity or forearm rotation. It can be habitual, post-traumatic or iatrogenic, after Darrach's, Sauvé -Kapandji procedures or over-zealous ulna-shortening osteotomies.

Ulnar styloid impingement syndrome can occur with any ulnar variance and is due to an overly long ulnar styloid process, usually habitual or post-traumatic, which impinges with the side of the triquetrum during ulna deviation. Ulnar styloid non-unions are usually asymptomatic but might be associated with this or other pathologies (i.e. TFC tears).

Injury to the triangular fibrocartilage: palmer classified the injuries to the TFC into two main types depending on their aetiology with subcategorization depending on the anatomical location involved:[7]

Type 1 – Traumatic tears
- 1A – Central
- 1B – Ulnar-sided tear
- 1C – Volar/dorsal tear
- 1D – Radial sided tear

Type 2 – Degenerative tears
- 2A – TFC thinning
- 2B – TFC perforation
- 2C – TFC tear and chondromalacia
- 2D – TFC tear with ulnocarpal arthritis
- 2E – TFC tear with DRUJ arthritis.

1A and 1B tears tend to cause pain with catching/clicking. 1D tears tend to cause pain with mild instability. 1C tears tend to cause the most instability. 2A and 2B tears tend not to be symptomatic and may be considered a sign of normal ageing. 2C and 2D tears may be a result of ulnar impaction syndrome. 2E tears tend to be the result of DRUJ instability.

Summary of pathology per anatomical location and conditions caused

Anatomical location	Variant or pathoanatomy	Condition caused
Sigmoid notch of radius	Flattened subtype	DRUJ instability
Ulnar head	Ulnar positive variance	Ulnar impaction syndrome, degenerate TFCC tear
	Ulnar negative variance	Ulnar impingement syndrome
Ulnar styloid	Long styloid, previous trauma	Ulnar styloid impingement
	Previous trauma	Non-union
Lunate	Type 2 subtype	Lunohamate impaction, arthritis
Triquetrum	Trauma	Triquetral avulsion fracture
Hook of hamate	Previous trauma	Non-union of hook of hamate
Pisiform	Instability, degeneration	Pisotriquetral arthrosis
Distal radioulnar joint	Degeneration/inflammation	DRUJ arthritis
Triangular fibrocartilage	Central tear	Pain
	Foveal attachment tear	DRUJ instability
Distal radioulnar ligaments	Tear	DRUJ instability
Ulnocarpal ligament complex	Tear	DRUJ, ulnocarpal or lunotriquetral instability
ECU subsheath	Subsheath tear	Snapping ECU syndrome
Interosseous membrane	Complete injury	Longitudinal instability (Essex-Lopresti syndrome)
	Distal injury	DRUJ instability
Lunotriquetral joint	Lunotriquetral ligament tear	Instability
ECU	Degeneration	ECU tendinosis
	Attrition rupture at DRUJ	Vaughan-Jackson syndrome
FCU	Degeneration	FCU tendinosis
Guyon's canal	Stenosis, space-occupying lesions, repetitive trauma	Ulnar nerve neuropathy

DRUJ, distal radioulnar joint; ECU, extensor carpi ulnaris; FCU, flexor carpi ulnaris; TFCC, triangular fibrocartilage complex.

Table 1

Type 1C volar and dorsal tears — the importance of these tears is that they are often associated with damage to the deep radioulnar ligaments and the foveal attachment of the TFC. This causes the DRUJ to become unstable resulting in mechanical symptoms associated with pain. Essentially any pathology to the foveal attachment removes the anchor point that the TFC and the

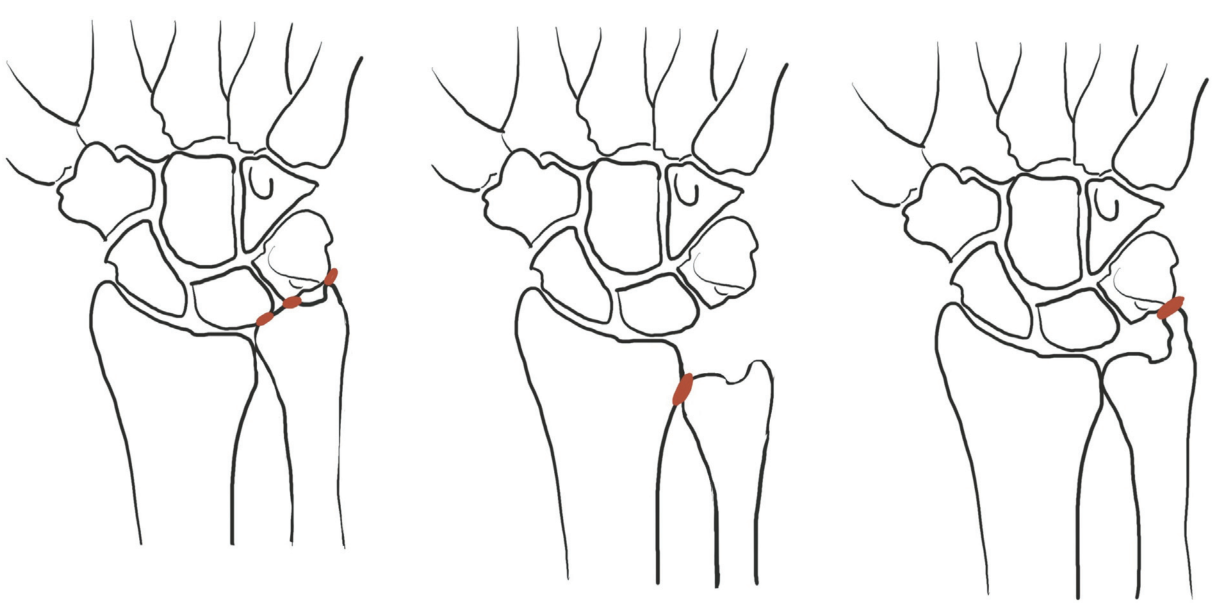

Figure 8 Left to right: Ulnar impaction, ulnar impingement, and ulna styloid impaction.

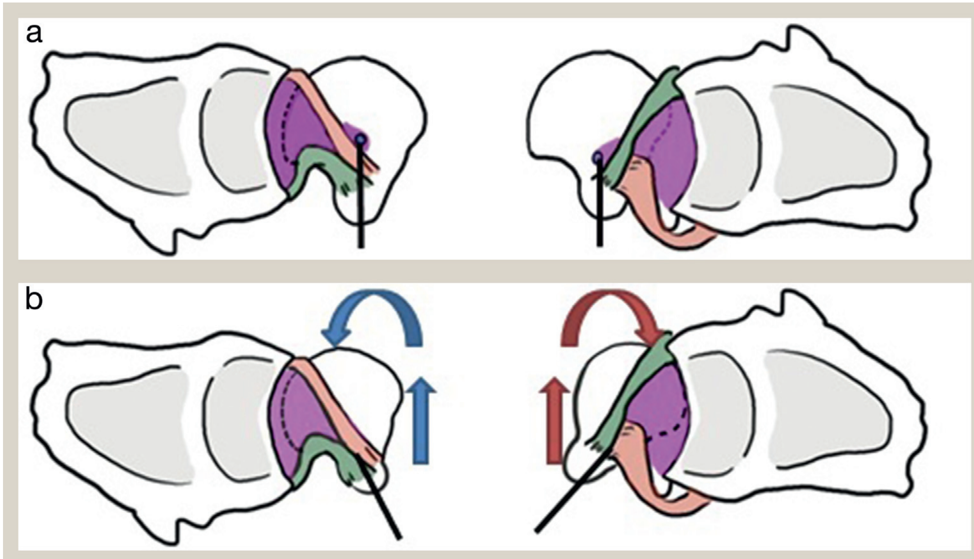

Figure 9 a. Left: Supination with normal foveal attachment. Right: Pronation with normal foveal attachment. **b**. Loss of foveal attachment causes unstable rotational and translational movements of the ulna head. Left: Supination with loss of foveal attachment causing abnormal ulna rotation and translation (in neutral or volar) as indicated by the blue arrows. Right: Pronation with loss of foveal attachment causing abnormal ulna rotation and translation (dorsally) as indicated by the red arrows. Adapted from Schmidt et al.[6]

radius rotate around resulting in abnormal movements and abnormal biomechanical forces and if uncorrected will lead to arthritis (Figures 9a and b).

Carpal pathology:

Hamatolunate impingement – this phenomenon occurs in the presence of hypoplastic capitate or type 2 lunate. In the former, a morphologically smaller capitate results in increased motion between the lunate and hamate. In a type 2 lunate a separate articulating facet with the hamate is formed which is biomechanically disadvantageous (Figure 10). Over time forces through this hamatolunate joint and the resulting impingement can lead to degenerative processes occurring.

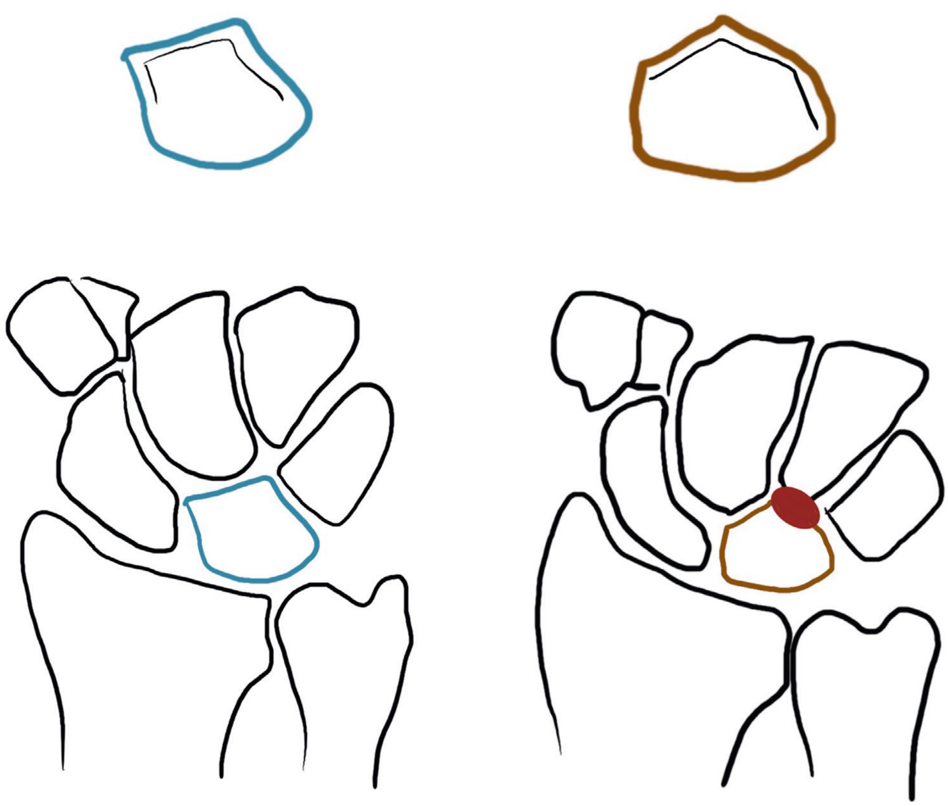

Figure 10 Left – type 1 lunate, Right – type 2 lunate. Hamatolunate impingement with type 2 lunate highlighted in red.

In the context of normal anatomy, repetitive loading in an ulnar deviated wrist can result in impaction forces causing increased hamatolunate contact, such as in racket sports. Ulnar translation of the carpus as a consequence of degenerative TFCC tear can also result in increased hamatolunate contact.

Lunotriquetral instability: a relatively rare ligamentous injury of the wrist and due to difficulty in diagnosis often presents late. Usually, the result of relatively high-energy trauma such as fall onto outstretch hand during sport or hyperextension with the wrist in pronation. The important pathology is rupture of the intrinsic LT ligament normally associated with dorsal radiolunate and radiotriquetral ligament rupture. With an intact LT ligament, the triquetrum acts to resist the lunate flexing with the scaphoid, with a LT ligament rupture there is nothing to oppose this flexion. Isolated injuries often do not cause significant instability whereas more complex injuries lead to a flexed lunate and volar intercalated segment instability (VISI) with a decreased scapholunate angle (<30°).[8]

Tendon conditions:

ECU impingement – degenerate tendonopathies of the ECU tendon are common and may be occur in the presence of normal anatomy or as a result of impingement or attrition over abnormal anatomy. Positive ulnar variance can abnormally trap the ECU tendon, prominent ulnar heads due to instability, or bony spurs or osteophytes, can all cause tendinopathy and rupture. If severe this can also affect the digital extensors. The specific findings of extensor tendon attrition rupture as a result of pathology in the DRUJ is known as Vaughan-Jackson syndrome and is common in rheumatoid arthritis.[9]

ECU subsheath tears and snapping ECU syndrome – subsheath tears and the resultant ECU instability are often secondary to sports requiring repetitive movements that can stress the ulnar side of the wrist including tennis and golf.[10] A torn subsheath can result in the ECU not being contained in its groove and "snapping" on movement. Interestingly the location of the tear can affect prognosis, with ulnar-sided tears leading to only a transient dislocation of the ECU tendon, with relocation on pronation. A radial-sided tear tends to result in the dislocated tendon remaining on top of the torn subsheath after relocation leading to chronic symptoms.

Nerve pathology:

Compressive neuropathy in Guyon's canal – the ulnar nerve at the wrist can be affected by space occupying lesions in Guyon's canal (e.g. ganglion, bone spur etc.), inflammation, or trauma to the hook of hamate. As the dorsal sensory nerve is given off proximally to Guyon's canal, dorsal sensation is usually spared.

Compression of the ulnar nerve at Guyon's canal also causes clawing of the ulnar two digits and is one of the situations leading to the so called 'ulnar paradox'. In general, more proximal nerve lesions result in more visible distal deformity, as the more muscle groups that are affected the greater the imbalance and more severe deformity. With the ulnar nerve this is not the case.

'Ulnar clawing' of the hand results from an imbalance between the intrinsic muscles of the hand and extrinsic muscles of the forearm that are innervated by the ulnar nerve. The claw develops by the nerve injury inhibiting the lumbricals' ability to flex the metacarpophalangeal joints (MCPJs) while keeping the interphalangeal joints (IPJs) extended; the finger adopting the opposite position with extended MCPJs and flexed IPJs. If the powerful extrinsic, flexor digitorum profundus (FDP), muscles are still functional this causes a more pronounced 'claw'. The 'ulnar paradox' occurs because lesions of the ulnar nerve in Guyon's canal at the wrist only affect the intrinsics, with FDP remaining active. Proximal lesions in the elbow also inhibit these powerful extrinsics resulting in a less pronounced claw deformity. The aphorism "the closer to the paw, the worse the claw" can help to remember this phenomenon.

Assessing patients with ulnar-sided wrist pain

Understanding normal wrist anatomy provides the foundation into understanding how pathological anatomy results in a patient's symptoms. This section will detail the important aspects of history and examination, and investigations required to make an accurate diagnosis. Like many conditions in medicine, 70% of the diagnoses of ulnar-sided wrist pain are made from the history alone.

History

Ulnar-sided wrist symptoms can be divided predominantly into pain, mechanical symptoms and neurological symptoms. As always, age, dominance, work and hobbies, and any specific, heavy or repetitive motions they entail, are vital parts of the history.

Pain: the location of the pain is often the most important part of the history. Does the patient point to a specific point or is it more diffuse? The duration of symptoms can often assist in understanding the likely pathology. Acute pain following trauma or injury will most likely point to a traumatic tear, whereas long standing symptoms might suggest a degenerative pathology such as osteoarthritis. Movement specific pain might be as a result of impingement or mechanical instability.

The character of the pain is often the most challenging aspect for a patient to describe. Adjectives such as aching, burning, sharp, stabbing, electric shock etc. can contribute to narrowing down the diagnosis.

Ulnar-sided wrist pain might be associated with broader pathologies of the wrist, particularly in cases of osteoarthritis. Inquire about radial sided pain, globalized wrist pain or additional symptoms such as radiation proximally or distally into the hand.

Timing of symptoms is also important. Acute pathology is often associated with injury or trauma. Acute-on-chronic symptoms may have an underlying pathology that is potentiated by a traumatic episode. Chronic pain tends to be due to degenerative pathology. In the absence of any specific identifiable structural cause it is also important to exclude problems occurring proximally in the elbow, shoulder and neck.

Activities that exacerbate pain can include repetitive movements, specific movements, or composite movements. Methods of relieving symptoms include splinting, transient immobilization and pain relief. Any prior intervention needs considered as to its efficacy and duration of symptom relief.

One of the more subjective hallmarks in the history is the patient's perception of the severity of their pain. A simple grade of 0–10 has limited value and is as much an assessment of the patient as the pathology. What is more useful is the activities that are limited because of the symptoms' severity. What can't a patient do now because of the pain that they could do before? How is it affecting their day to day activities? What time frame has resulted in a change in the patient's severity of their pain? Acute severe pain with a trauma history will result in a different clinical outcome to a chronic low-grade pain that is only now resulting in significant functional deficit.

Mechanical symptoms are an umbrella term for those symptoms that patients can feel specifically on wrist movement. These include catching, snapping, clicking, clunking or grinding. Soft tissue clicks are often not pathological, painful clunks are often a sign of instability, and grinding may indicate degenerate disease. These symptoms are often reproducible on the same specific movement e.g. in ECU instability, the ECU tendon may subluxate on active wrist flexion and reduce on wrist extension.

Neurological symptoms: any pathology affecting the ulnar nerve can result in symptoms including ulnar-sided wrist pain, tingling, numbness, pins and needles and burning symptoms. Motor symptoms may also be present, secondary to intrinsic muscle weakness and deformity, leading to reduced function.

Examination

It is important to be specific in the wrist examination to elucidate the likely area of pathology. Patients need to be told clearly or be demonstrated, the specific movements required. Ask them to describe, in their own words, what they are experiencing during the examination. There are many described tests for ulnar-sided pathology; some of the more important ones are described here.

DRUJ-specific examination:

DRUJ ballottement test – the patient rests their elbow on the table and flexes it to 90°. The examiner clasps the distal radius and distal ulna in their hands. They gently ballot the DRUJ. In pronation, the DRUJ should be able to translate, with reduced translation in neutral and no translation in supination. Translation of the DRUJ on balloting in supination suggests the DRUJ is unstable.

Ulnocarpal stress test – also known as the ulnar grind test. With the patient sitting with elbow flexed to 90°, the examiner takes one hand to stabilize the forearm. The other hand applies an axial force to an ulnarly deviated wrist through the arc of pronation–supination. Pain possibly with clicking or grinding suggests TFCC pathology (worse in supination) or ulnar impaction (worse in pronation).

Tendon-specific examination:

ECU examination – move the patient into ulnar deviation and get them to extend the wrist against resistance. Weakness or pain would suggest issue with ECU.

The ECU can subluxate during supination, ulnar deviation and flexion. Observe and palpate for any movement of the ECU during these movements. Gentle pressure on the ECU in pronation can prevent it subluxing when the wrist is gently supinated. 'Snapping', 'clicking' or visible movements confirm instability.

FCU examination – move the patient into ulnar deviation and get them to flex the wrist against resistance. Weakness or pain would suggest issue with FCU.

Neurological examination:

Motor examination – clawing, guttering (atrophy of interossei), and Wartenberg's sign (involuntary abduction of the little finger due a weak palmar interosseous muscle) may be visible. Froment's test demonstrates an inability to grasp a flat object between index and thumb without using flexor pollicis longus suggests adductor pollicis weakness. Weakness in resisted index finger and little finger abduction suggests interossei weakness.

Sensory examination – assess fine touch, and pin-prick sensation against the ulnar border of the little finger on both dorsal and volar surfaces.

Tinel test in Guyon's canal – tapping the wrist at the position of Guyon's canal can exacerbate neurological symptoms of the ulnar nerve.

Investigations:

The main imaging modalities for investigating wrist pathology include the following:

X-ray – a plain radiograph is useful for investigating radiographic appearances of arthritis in carpal bones or DRUJ; ulnar morphology and ulnar variance; bony injury, trauma, malunion or non-union.

The principal views used are posteroanterior (PA), lateral, hook of hamate view, pisotriquetral view, and clenched fist PA for DRUJ instability.[11]

Ultrasound scan is useful for assessing tendon architecture and dynamic changes in tendon movement. It is useful, with doppler, in localizing inflammation and can be useful for targeted, diagnostic, injections to joints and tendons. It is also sensitive in identifying early arthritis.

MRI sequence and relevant anatomy evaluated.[12]

MRI sequence	Best for evaluating
Intermediate-weighted (fat saturated)	Bone/soft tissue characterization; TFCC; intercarpal ligaments
T1 weighted C+ (fat saturated)	Ligament and TFCC injury; tumour; inflammatory conditions; nerve disorders
T1 weighted	Bony anatomy, fractures, chronic changes
T2 weighted	Bone/soft tissue characterization, tumours, nerve disorders
3D images	Scapholunate/lunotriquetral dissociation, TFCC injury, chondropathy

3D, three-dimensional; TFCC, triangular fibrocartilage complex.

Table 2

CT scan provides better three-dimensional evaluation for DRUJ instability in pronation and supination, especially if compared with unaffected contralateral side. Useful to confirm fractures and union as well as identifying early arthritis.

MRI scan is useful for investigating the soft tissue morphology including TFCC tears, ligamentous injury, occult fractures, early avascular necrosis. Table 2 details the MRI sequences typically used. With a newer more powerful 3T scanner it is not normally necessary to combine with an arthrogram, although the latter can be useful in evaluating intrinsic ligament and TFC tears.

Examination under anaesthesia/fluoroscopy/arthroscopy — examining a patient under anaesthesia can be useful allowing more accurate assessment of DRUJ and carpal instability in balloting with contralateral comparison. A diagnostic arthroscopy can also be performed to confirm or exclude certain diagnoses.

Unravelling ulnar-sided wrist pain: the specific causes

We now have all the information required to unravel ulnar-sided wrist pain and make an accurate diagnosis. To pull everything together we will now look at each condition in turn and summarize the key facts regarding cause, presentation, assessment and diagnosis.

DRUJ instability

Loss of stability at the DRUJ is a spectrum from a mild instability causing pain but no mechanical symptoms to gross instability with subluxation of the joint. The amount of instability varies with the location and extent of the pathology.

Key symptoms: pain, with or without clunking, overlying DRUJ on pronation and supination.

Key examination: prominent ulnar head compared with unaffected contralateral side. Increased dorsal and volar mobility on balloting the DRUJ particularly in neutral rotation or supination.

Key findings on investigation: radiographs and CT may demonstrate subluxation. MRI may demonstrate damage to the distal radioulnar ligaments, particularly their deep fibres with or without injury to the foveal attachment of the TFC.

DRUJ arthritis

Arthritis of the DRUJ can be primary osteoarthritis, secondary to trauma to the sigmoid notch (or rarely the ulnar head), malunion following distal radius fracture, or instability. DRUJ arthritis can also be inflammatory.

Key symptoms: ulnar-sided pain, especially on pronosupination.

Key examination: swelling over DRUJ crepitus on forearm rotation, which may be reduced.

Key findings on investigation: usually obvious on plain radiographs. CT helps look at the morphology and presence of arthritis of the sigmoid notch.

Acute TFC tear (not 1C)

Pain especially on ulnar deviation and loading following trauma (usually fall onto outstretched hand or forced hyperextension).

Key symptoms: discrete pain just proximal to the ulnar styloid, worse on loading, often associated with clicking/catching sensation.

Key examination: pain on palpation overlying the DRUJ; pain on ulnar deviating a pronated wrist; soft clicking during pronation-supination arc.

Key findings on investigation: the tear and its size and location are easily visible on 3T MRI or on MRA.

Ulnar impaction syndrome

The distal ulna is ulnar positive resulting in excessive forces through the TFCC and ulnar-sided proximal carpal row resulting in degenerative TFCC tears and arthritis. This can be habitual or due to malunion of the distal radius.

Key symptoms: ulnar-sided wrist pain, reduced grip strength, mechanical symptoms.

Key examination: pain on ulnar deviation and pronation.

Key findings on investigation: X-ray demonstrates ulnar positive variance, which may be more obvious on clenched fist view, in addition to sclerosis or cysts; oedema and chondral damage (which is more obvious on MRI).

Ulnar impingement syndrome

The distal ulna has a negative ulnar variance resulting in impingement between ulnar head and radius proximal to sigmoid notch. This can be due to habitual, or secondary to trauma or over correction, or stump instability following Darrach's or Sauvé—Kapandji procedure.

Key symptoms: pain overlying DRUJ pain on pronation and supination.

Key examination: tenderness localized over the DRUJ on palpation; pain on DRUJ balloting in pronation-supination arc.

Key findings on investigation: sclerosis/notching on radius, localized inflammation on MRI/ultrasound scan.

Ulnar styloid impingement syndrome

This is an inherent issue within the ulnar styloid rather than the ulna. It often has an abnormal morphology (over-long) which causes contact with the triquetrum in ulnar deviation. The elongated styloid may be secondary to a previous styloid fracture.

Key symptoms: discrete pain over the ulnar styloid.

Key examination: pain worse on pronation and ulna deviation.

Key findings on investigation: abnormal or prominent ulnar styloid morphology or malunion on X-ray. Oedema in styloid tip or ulnar border of triquetrum on MRI.

ECU instability

May be the result of acute trauma or repetitive, usually sporting, activities.

Key symptoms: discrete pain overlying ECU on repetitive movements; mechanical 'snapping' symptoms overlying the tendon.

Key examination: visible or palpable subluxation of ECU tendon during pronosupination or flexion—extension arc.

Key findings on investigation: ultrasound scan will demonstrate the location of the tear and the degree of snapping in real time; MRI more sensitive for small subsheath tears.

ECU tendinopathy

Degenerate ECU tendinopathies at the level of the distal ulna are common. Although some are idiopathic others are a result of overuse or attrition on abnormal anatomy.

Key symptoms: ulnar-sided wrist pain; mechanical symptoms during wrist extension over ulnar side.

Key examination: pain on palpation over ECU; weakness on wrist extension and ulnar deviation.

Key findings on investigation: ultrasound scan may demonstrate ECU impingement in-situ, inflammation or a partially or completed ruptured tendon.

FCU tendinopathy

The FCU tendon can also be prone to developing abnormalities on the spectrum of tendinopathy, tendinitis and tear. It principally will result in pain on wrist flexion. FCU tendon hypertrophy can rarely cause compression of the ulnar nerve at the pisiform and hamate and result in compressive neuropathic symptoms or paraesthesia.

Key symptoms: volar sited pain on flexion and ulnar deviation.

Key examination: weakness or pain on resisted wrist flexion and ulnar deviation, possible localized swelling over tendon.

Key findings on investigation: ultrasound scan may demonstrate abnormal thickening of the FCR tendon in addition to partial or complete rupture of the tendon.

Lunotriquetral instability

Ulnar-sided wrist pain following trauma. Often presents late with pain and rarely mechanical symptoms.

Key symptoms: ulnar-sided pain with loading in pronation, occasionally with clicking feeling or noise.

Key examination: pain and excessive movement on balloting the joint.

Key findings on investigation: VISI deformity on lateral radiograph, tear of LT and associated extrinsic ligaments are visible on MRI.

Hamatolunate arthrosis

Impingement and later arthrosis caused by abnormal forces through the separate hamatolunate facet in a type 2 lunate.

Key symptoms: ulnar-sided wrist pain; activity-related pain particularly on repetitive motion.

Key examination: discrete pain on palpation over hamatolunate joint; especially on ulna deviation.

Key findings on investigation: X-ray findings may demonstrate type 2 lunate with joint space narrowing, subchondral sclerosis or cysts in the hamatolunate joint; MRI changes may show bony oedema in the proximal hamate or distal lunate or a readily identifiable type 2 lunate.

Pisotriquetral arthritis

Primary osteoarthritis at the pisiform-triquetral joint is generally uncommon. Predisposing factors include heavy manual work, previous trauma or excessive motion between the pisiform and triquetrum. Additionally inflammatory pathology can cause arthritis here.

Key symptoms: non-specific ulnar-sided wrist pain.

Key examination: discrete tenderness on palpation of pisotriquetral joint.

Key findings on investigation: joint space narrowing, cysts or subchondral sclerosis in the pisotriquetral joint.

Hook of hamate non-union

The hook of the hamate can be acutely fractured following a fall or can occur as a stress fracture following repetitive activities in work or sports. Non-unions are relatively common.

Key symptoms: volar ulnar-sided pain, especially on weight-bearing or impact.

Key examination: localized tenderness on direct palpation.

Key findings on investigation: requires specific hook of hamate or carpal tunnel view. CT will help diagnose fracture and MRI can assess healing potential.

Ulnar (Guyon's) tunnel syndrome

An uncommon cause of ulnar nerve dysfunction caused by compression of the nerve with Guyon's canal.

Key symptoms: tingling, numbness, pins and needles, weakness, burning pain in an ulnar nerve distribution.

Key examination: ulnar claw, Wartenberg's sign, Froment's test, ulnar paradox, preserved dorsal hand sensation.

Key findings on investigation: nerve conduction studies demonstrate reduced conduction velocity in the ulnar nerve, localizable to the wrist.

Conclusion

Ulnar-sided wrist pain is a common clinical entity and one that can be examined at final orthopaedic postgraduate examinations. Although, initially this can be a daunting, with a wide series of conditions to unravel, an understanding of the normal anatomy provides a useful framework to comprehend what happens when this anatomy is deranged by pathological processes. This is particularly highlighted with reference to the TFC, its foveal attachments and the radioulnar ligaments and their importance to normal wrist motion and DRUJ stability.

With this understanding of normal and pathological anatomy; a careful history, focused examination and the use of directed investigations should enable us to unravel the many causes of ulnar-sided wrist pain into a specific diagnosis and allow successful treatment. ◆

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