Examination of the wrist

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Introduction

The wrist joint comprises several articulations, namely the radiocarpal, midcarpal and carpo-metacarpal joints (“wrist”) and the distal radioulnar joint (“distal forearm”). In considering these, it must be remembered that the entire forearm is also a “joint” between the radius and ulna and conditions affecting the elbow joint (particularly the proximal radioulnar joint) will have an effect distally. Thus, when examining the wrist joint, as in all good orthopaedic examinations, it is important to examine the “joint above and below”, namely the hand and elbow/forearm also.

History-taking in any examination is helpful. Examination without knowledge of differential diagnoses is like studying a map without knowing the territory. One informs the other; and thus with a history of symptoms, the effective examiner will have a good idea which conditions to expect to find, or exclude, on examination. In addition, a working knowledge of the anatomy of the structures passing over, or moving, the wrist is crucial to making sense of clinical findings. Further, conditions can be divided into certain subgroups, and each will be more or less likely dependent upon the patient’s age, sex, and other factors in the presenting history. Below, common conditions are briefly presented.

Instability

All joints can be affected by stiffness or, the opposite, by hypermobility. If instability is unidirectional then it is often due to trauma, while multidirectional instability is often due to an underlying disorder of the joint anatomy or physiology. Instabilities of any joint should be thought of in terms of bony pathology, intrinsic factors (joint labrum – if present – and stabilising ligaments) and extrinsic factors (myotendinous units acting directly, or indirectly, on a joint). If an examination suggests instability, it is imperative to examine the patient for generalised signs of hyperlaxity (see below, Beighton’s scoring) and to compare the affected wrist with the opposite side.

Traumatic

Injuries to the wrist include fracture (distal radius and scaphoid the commonest), non-union and ligament / tendon injury. Such conditions can occur at any age but can be assumed to be more frequent in younger to middle aged patients.

Degenerative

Arthropathy and tendinopathy will occur with increasing frequency with advancing age. Some tendinopathies occur because of overuse (intersection syndromes and tenosynovitis), while others are associated with generalised inflammatory states (autoimmune disorders such as rheumatoid arthritis can have secondary effects on overlying tendons). Some patterns of arthropathy are associated with previous injury (scaphoid fracture and scapholunate ligament rupture can both lead to secondary carpal collapse with resultant degenerative arthropathy), while others occur *de novo*.

Anatomy

A detailed description of the anatomy of the forearm and wrist is beyond the scope of this chapter. However, there follows a synopsis of the relevant clinical anatomy as it relates to wrist examination.

Bony

Proximally, the elbow joint is composed of the humeroulnar, radiocapitellar and proximal radioulnar joints (PRUJ). Distal to this, the radius and ulna are bound by an interosseus membrane which is nearly continuous with the PRUJ and distally, with the distal radioulnar joint (DRUJ). The ulna is the most firmly attached of the two to the humerus at the elbow (with a deeply congruent hinge joint and strong ligaments) while the radius is bound proximally only by ligaments (annular and lateral collateral). Therefore, the radius should be considered to be suspended off the ulna. This remains true distally, despite the radius being the larger bone (in cross section). Operations on the distal ulna (e.g. Darrach's excision arthroplasty) will affect this linkage and may lead to radioulnar impaction. In this situation, the radius should be considered to be the unstable bone, collapsing into the ulna, rather than the opposite. The distal ulna is nearly circular in cross section, and the distal radius has a reciprocal "socket" for the distal ulna ("sigmoid notch"). During forearm rotation (pronosupination), the radius describes an arc about the (proximally fixed) ulna. Thus, examination of the DRUJ and the distal ulna should be undertaken in various positions of forearm rotation. Distally both bones project styloid processes, which serve as points of attachment for extrinsic wrist ligaments. Both can be injured, leading to particular patterns of radiocarpal instability.

The 8 carpal bones are divided into proximal (3 bones) and distal (4 bones) rows, with the 8th (pisiform) forming a sesamoid within the tendon of flexor carpi ulnaris (FCU). The bones of the proximal row include the scaphoid (most radial), the lunate (central) and triquetrum (most ulnar). Conditions affecting the carpal bones most commonly affect one of these 3 (scaphoid fracture / non-union – radial wrist pain; Kienbock's lunate osteochondritis – central wrist pain; ulnotriquetral impaction – ulnar-sided pain). The distal carpal row, from radial to ulnar, includes trapezium ("under the thumb"), the trapezoid (inside / "insoide"), the capitate (central) and hamate. Each distal bone participates in the carpometacarpal articulation: trapezium with 1st, trapezoid with 2nd, capitate with 3rd and hamate with 4th and 5th. The pisiform grooves the palmar surface of the triquetrum and slides proximally-distally with wrist flexion / extension. Pisotriquetral degenerative change can cause palmar / ulnar-sided wrist pain. Normally the ulna is shorter than the radius but the "socket" of the distal forearm, into which the "ball" of the proximal carpal row fits, is created by the triangular fibrocartilaginous complex (TFCC) – a meniscal homologue – which attaches to the ulnar side of the radius without step-off, creating a continuous smooth articulation for the carpus. Its ulnar attachments (via various ligaments) bind it firmly to the distal ulna also, and it represents an important stabiliser of the DRUJ.

Myotendinous units

The palmar, or flexor, compartment of the forearm comprises 4 "pairs" of muscles which perform the 4 main actions of this group, namely forearm pronation, wrist flexion, finger flexion and thumb flexion. Thus, there are 2 pronators (pronator teres / PT, pronator quadratus / PQ), 2 wrist flexors (flexor carpi radialis / FCR, flexor carpi ulnaris / FCU), 2 finger flexors (flexor digitorum superficialis / FDS, flexor digitorum profundus / FDP) and 2 others (2 "long" muscles), one flexor of the thumb (flexor pollicis longus / FPL) and the vestigial palmaris longus (PL). This last inserts into the palmar fascia and is commonly used for tendon graft (e.g. reconstructing ruptured ligaments). Multiple scars, along the line where the tendon should be, are an indication of previous such tendon harvest. This "functional" method for recalling the muscles is helpful when considering reconstruction following paralysis (when selecting tendon transfers to restore lost function).

Another way to view the muscle groups is as encountered at dissection: the superficial 5 take origin from the medial epicondyle of the humerus (common flexor origin): from radial to ulnar these comprise PT (attaches to radius, junction mid-distal 1/3), FCR (attached to bases 2nd and 3rd metacarpals), PL (attaches to palmar fascia), FDS (4 individually controlled units, attaching to the middle phalanx of each digit) and FCU (attaching, as above, via the pisiform and pisometacarpal ligament to the base of the 5th metacarpal). The 3 deep muscles comprise FPL (radial border, attaches to distal phalanx thumb), FDP (4 proximally-conjoined mass-action units, attaching to the distal phalanx of each digit) and PQ (quadrate-shaped muscle running from ulna to radius over their distal 1/6). This anatomic method for recalling the muscles is helpful when considering nerve supply: the superficial group are supplied mainly by the median nerve (except FCU, supplied by the ulnar nerve, which pierces and runs deep to it). The deep group are supplied by the anterior interosseus nerve (AIN), the deep motor branch of the median nerve, except some of the bellies of FDP (variable innervation – the nerve which supplies the parent belly also supplies its lumbrical in the hand, thus the median nerve, the main nerve of this compartment does have some motor supply in the hand – see later chapter).

The arterial supply begins proximally and medially where the brachial artery, running with the median nerve and distal biceps tendon, divides into radial and ulnar arteries. These separate to run distally adjacent to the bone of the same name, the radial artery superficial, and the ulnar artery deep, to PT. The median nerve runs through the PT muscle, akin to the ulnar nerve piercing FCU.

The flexor muscles run through various compartments in the carpal tunnel, bounded dorsally by the arc of the carpal bones and palmar by the deep transverse carpal ligament. This tunnel contains the 8 finger flexor tendons, FPL and the median nerve. FCR runs just radially and superficially (in its own compartment of the carpal tunnel) while FCU attaches to the pisiform just superficial and ulnar to the tunnel. PL attaches to the palmar fascia superficial to the tunnel's ligament roof. The ulnar nerve runs adjacent to FCU (on its radial side) passing through the wrist in Guyon's canal to enter the palm, in turn with the ulnar artery to its radial side.

The dorsal, or extensor compartment of the forearm comprises 4 "triplets" of muscle groups which can be thought of, in a similar fashion to the flexors, according to form or function. There are 3 movers of the forearm (anconeus, brachioradialis and supinator), 3 wrist extensors (extensor carpi radialis longus / ECRL, extensor carpi radialis brevis / ECRB and extensor carpi ulnaris / ECU), 3 finger extensors (extensor indicis proprius / EI, extensor digitorum communis / EDC and extensor digiti minimi / EDM (sometimes also termed extensor digiti quinti / EDQ)) and 3 movers of the thumb (abductor pollicis longus / APL, extensor pollicis brevis / EPB and extensor pollicis longus / EPL). The commonest tendon transfer performed in the upper limb is an EI to EPL reconstruction following EPL rupture (often after distal radius fracture.) The surgical scars can be seen over the metacarpophalangeal joint of the index finger; the wrist, distal to Lister's tubercle of the radius and along the metacarpal of the thumb.

From an anatomic perspective, anconeus and supinator attach proximally and, with regard wrist examination, may be ignored (except in wrist drop, where this may be due to entrapment of the posterior interosseus nerve as it runs within supinator). Brachioradialis runs down the radial border of the forearm to attach to the distal shaft / styloid process of the radius. Its action is to flex the elbow, while returning the radius to approximately mid-prone. It is a potent deforming force in a distal radius fracture and may cause loss of radial inclination in such injuries. The superficial radial nerve (sensory portion) runs deep to it and it may cause a localised compression neuropathy (Wartenburg's entrapment). ECRL & B run down the radial border of the dorsal forearm to attach to the bases of 2nd (ECRL) and 3rd (ECRB) metacarpals, in symmetry with FCR. Likewise, ECU attaches to the base of the 5th metacarpal, in symmetry with FCU. APL and EPB take origin more ulnar and run obliquely (distally and radially), superficial to the ECRL & B tendons. At the point where the 4 tendons intersect, a localised reactive bursitis can occur – "intersection syndrome". More distally, EPL runs ulnar to Lister's tubercle of the distal radius (a bony pulley) and again then runs radially, to attach to the thumb, superficial to ECRL & B. Similarly, local irritation here can lead to a more distal "intersection syndrome". EI, EDC and EDM run longitudinally to attach to their respective digits (EDC to index, long and ring, EDM to small). EI runs deep to EDC and its tendon runs ulnar to that of EDC to index. Most of these extensor compartment muscles are supplied by the posterior interosseus nerve (the motor branch of the radial nerve) except brachioradialis and ECRL (which take origin proximally) and anconeus: these are supplied by the radial nerve itself by branches given off above the elbow.

All of the extensor tendons crossing the wrist run in various synovial compartments (the extensor retinaculum). There are 6 compartments, labelled from radial to ulnar. In turn, these comprise 1 (APL, EPB), 2 (ECRL & B), 3 (EPL), 4 (EI & EDC), 5 (EDM) and 6 (ECU). Pain on palpation of these in turn may suggest a localised tendinopathy or tenosynovitis.

Functional anatomy

Radiocarpal movements are essentially combinations of action of the 5 prime movers: FCR, FCU, ECRL & B and ECU. For pure radial deviation, FCR and ECRL & B contract, while for pure extension, ECRL & B and ECU contract (and so on). The main functional movement of the radiocarpal joint is from extension and radial deviation (ECRL & B) to flexion and ulnar deviation (FCU) – sometimes termed the "dart-throwers' action".

Within the carpus, further more complex movements occur. As a simplification, during radiocarpal radial deviation the scaphoid must flex to allow approximation of the 1st metacarpal base towards the radial styloid; conversely during ulnar deviation, the scaphoid extends. This rotatory movement is translated by the scapholunate ligament to place a rotational torque onto the lunate. This force is counteracted (in the normal wrist) by an opposite torque from the triquetrum. In situations where one of these perilunate linkages is broken, the lunate rotates either into flexion (with the scaphoid) or extension (with the triquetrum), with a secondary "dissociative" carpal instability as the midcarpal joint becomes stretched by this (lunate) "intercalated segment" instability, or "ISI". When the lunate tilts dorsally this is termed a DISI and when volar (palmar), a VISI.

Midcarpal movements (scapho-trapezo-trapezoid / STT, scaphocapitate, capitolunate, capitohamate and triquetro-hamate) are those of a constrained "ball and socket", with this joint contributing both to wrist radial-ulnar deviation and to flexion-extension. This joint is more often affected by inflammatory, than degenerative, joint disease. Where there is excessive movement between the carpal rows such that one has to "catch up" with the other during certain movements, even when there is no intrinsic ligament deficiency, this is termed a "non-dissociative" carpal instability, usually perceived by the patient as a "clunk".

The movements of the trapeziometacarpal joint are also complex ("saddle shaped" joint) and this freedom of movement, coupled with the large joint reaction forces generated during pinch grip, render this joint the most commonly affected by degenerative joint disease / osteoarthritis in the hand and wrist.

The remaining carpometacarpal articulations become increasingly mobile from a radial to ulnar direction: the most mobility being seen at the base of 5th metacarpal, in contrast to the planar, almost immobile joints at the bases of 2nd and 3rd.

Examination

All orthopaedic examination follows the formula, "look, feel, move, special tests". Following on from the anatomy, and the history (radial-sided, central or ulnar-sided pain) certain diagnoses present themselves early in this schema.

Look

Obvious pathology on inspection includes

Asymmetry from the opposite side

Rheumatoid disease: radial deviation, palmar or ulnar subluxation, prominent distal ulna

Previous injury: distal radius fracture often has the appearance of radial translation of the wrist, sometimes with extension of the distal fragment (dinner fork deformity) and a resultant prominent ulna

Prominent distal ulna (in isolation or as part of above)

Dropped fingers / thumb (?tendon rupture)

Swellings (ganglion, dorsal synovitis – often affecting E4, where 2 swellings will be seen, as the soft tissue is contained under the extensor retinaculum, causing an hourglass constriction here). The commonest locations to find ganglia around the wrist are dorsally, overlying the scapholunate interval (therefore just distal to Lister's tubercle) or palmar, at the level of the radial styloid (where the radial pulse can also be palpated).

Scars from previous surgery, suggested by their site: common procedures include carpal tunnel release (longitudinal over carpal tunnel, sometimes with a proximal ulnarwards extension), ganglion excision, deQuervain's (E1) release, scaphoid non-union surgery (palmar or dorsal: consider looking at the iliac crest for donor site of bone graft), distal radial fracture fixation (palmar along the line of FCR, sometimes dorsal). As mentioned above, look for evidence of PL tendon harvest as graft for tendon / ligament reconstruction or for signs of tendon transfer.

Feel

If possible, ask the patient where the pain is centred, and begin the examination elsewhere. If not, perform a systematic palpation around the dorsal and palmar surfaces.

Dorsally, work sequentially through the 6 extensor compartments (as above). Tenderness over the 1st dorsal ("E1" or the compartment containing APL & EPB) suggests DeQuervain's disease – but while this is the commonest, a similar syndrome can affect any compartment , also seen over E5 (EDM) and E6 (ECU) but more rarely the others.

Proximally, palpate the intersection of the 1st and 2nd compartment tendons (?intersection syndrome) and also (less commonly) where EPL overlies the radial wrist extensors distal to Lister's tubercle. A Tinel's sign over the course of the superficial radial nerve (under brachioradialis) may indicate Wartenberg's entrapment, as above. Begin palpating again over the carpus: tenderness over the various joints may suggest extrinsic or intrinsic ligament injury (commonest scapholunate, just distal to Lister's tubercle). Dorsoradial tenderness in the region of the "anatomic snuffbox" may suggest scaphoid pathology (fracture or non-union) or STT degenerate change.

On the palmar aspect, tenderness over the scaphoid tubercle may again be a sign for scaphoid pathology, a palmar wrist ganglion may be palpated (if not seen) and there may be tenderness over FCR, indicating tendinopathy. On the ulnar side, tenderness over the pisiform may suggest pisotriquetral joint pathology (usually degenerative change), while more distally tenderness over the hook of the hamate may suggest non-union / fracture.

Tenderness distal to the radial styloid (true "radial" pain, either side of the traversing E1 tendons) may be due to radiocarpal degenerate change (usually secondary to chronic scaphoid or scapholunate pathology) and distal to the ulnar styloid (usually just palmar to ECU) may indicate pathology in the TFCC.

Move

The main movements of the wrist have been discussed above. The exact range of movement is less important than its comparison with the opposite side (assuming this is suitable as a reference range). Range of forearm pronosupination and wrist flexion / extension and radial / ulnar deviation should be assessed. Functionally, grip strength is greatest in wrist extension and often, for power grip, the wrist is also slightly radially-deviated. The importance of this wrist position may be the evolutionary reason for two radial sided wrist extensors, with different nerve supply (radial nerve to ECRL, PIN to ECRB). The “dart-thrower’s” movement comprises wrist flexion and ulnar deviation from this position and is probably the most physiological and functionally important.

Instability tests

As a prelude to any instability testing, a general assessment of joint laxity should be performed. Beighton described 5 tests (4 bilateral) giving a score out of 9 as a measure for laxity: positive results in the following should be recorded each as 1 point (2 if bilateral): ability to flex wrist and abduct thumb to place thumb tip on or very near to the radius; ability to hyperextend small finger beyond 90^o at the MCP joint; ability to hyperextend the elbow and / or knee; ability to flex the trunk forward with straight legs (extended knees), touching palms flat on the ground.

The main carpal instabilities comprise “dissociative” (CID - due to interruption of perilunate linkages, as above) and “non-dissociative” (CIND - midcarpal catch up clunks, joint laxity without intrinsic ligament deficiency). Following distal radius fracture malunion the carpus may adopt an “adaptive” posture (CIA - usually dorsal radial malunion, which leads to midcarpal flexion to maintain carpal co-linearity). A combination of these (usually the first 2) is termed carpal instability complex (CIC).

Kirk-Watson described the classic sign for CID where the dissociation is scapholunate. In radiocarpal ulnar deviation, the scaphoid is maximally extended (as above). Firm pressure, directed from palmar to dorsal, over the scaphoid tubercle will tend to maintain this extension. While continuing to apply this pressure, radially deviate the wrist. The scaphoid flexes but pressure over the tubercle may prevent this from projecting palmar. In the intact wrist, the examiner’s thumb is forced away. In the patient with scapholunate dissociation with no scapholunate ligament to stabilise it, the pressure forces entire the scaphoid to translate dorsally, and its proximal pole subluxes over the dorsal lip of the radius.

The “shuck test” identifies dissociative carpal instability due to lunotriquetral ligament rupture: firmly holding pisiform / triquetrum between the index finger and thumb of one hand and lunate between those of the other allows assessment of this linkage.

Midcarpal “catch up” clunks may be elicited as a sign of non-dissociative instability, although a large proportion of functionally normal wrists may also exhibit such clicks and clunks on provocation.

DRUJ stability is assessed with the forearm in full supination, neutral and full pronation. Stability is afforded by a number of structures, the main ones of which include the dorsal and palmar radioulnar ligaments, the TFCC and the ECU subsheath. Isolated injuries to each is rare, but an injury predominantly to the palmar or dorsal structures may cause an asymmetrical instability of the distal ulna in various attitudes of forearm rotation. In supination, the palmar structures should tighten – while in pronation the same is true of the dorsal stabilisers.

Degenerative change

Signs for ulnotriquetral impaction (usually implying TFCC pathology also) include ulnar-sided tenderness and pain which worsens with the wrist in ulnar deviation either (or both) in extension or flexion. Symptoms of DRUJ degenerative change may be provoked by compressing the two bones at the DRUJ. Radiocarpal osteoarthritis is often due to some other cause, most commonly scaphoid pathology (chronic scapholunate rupture with secondary collapse – SLAC, or chronic scaphoid non-union with advanced collapse – SNAC). Usually the midcarpal joint is more degenerate than the radiocarpal in these circumstances and pure flexion-extension may be preserved from the radiolunate joint. Often also, the radiographic appearances of the degenerate wrist far exceed the symptoms. STT degenerative change reduces scaphoid movement and in turn therefore hinders radial-ulnar deviation. The extreme example of this is seen following an STT arthrodesis (sometimes termed “triscaphe fusion”) which is associated with reduced movements in this plane. All of these conditions will therefore influence the physiological “dart-throwers” action.