The Wrist

The wrist remains a very difficult area of the body to treat as it is intricate, contains very small joints and numerous ligaments. To complicate the issue, much literature exists which is either contradictory, confusing or highly detailed, and may render the reader baffled at first sitting. The following treatise is an attempt to simplify the understanding of the wrist, and to explain how the wrist works, and therefore is a basis for subsequent understanding of treatment. Starting proximally, the wrist comprises of the distal end of the radius and the triangular fibro-cartilage which sits over the head of the ulnar. These two bones articulate through the distal radio-ulnar joint. Normally, there is an angle of 15º from a line drawn horizontally through the radial styloid, to another line from the radial styloid to the head of the ulnar. In addition, there is a volar tilt on the radial articular surface of 12º. Both of these angles are pivotal to the biomechanical functioning of the wrist. The wrist then articulates with two rows of carpal bones. The proximal row comprises the scaphoid, lunate, triquetrum and piziform. The latter bone is a sesamoid bone (which is a bone within a tendon) that is embodied by the FCU tendon. The distal row of carpal bones comprises of the trapezium (that sits under the first metacarpal and over the scaphoid), the trapezoid, the capitate and the hammate. This distal row of carpal bones in turn articulates with the metacarpals.

The first metacarpal is very mobile in the trapezium. The 2nd and 3rd metacarpals virtually act as a block unit with the trapezoid, capitate and hammate. The 4th metacarpal has some mobility on the hammate and the 5th metacarpal has quite a degree of mobility on the hammate. The carpus hangs off the wrist by two very strong ligaments attaching the radius to the triquetrum. Norbert Kuhlmann described this, and therefore it is called Norbert Kuhlmann's sling. It is eccentrically placed so that the volar radio-triquetral ligament attaches to the radial styloid and runs across to the triquetrum. The dorsal radio-triquetral ligament attaches to the ulnar portion of the radius on the ulnar side of Lister's tubercle and then runs into the triquetrum. Both these ligaments are enormously strong.

The next ligament to hold the carpus in place is the radio-lunate ligament. Once again, this is an enormously strong tendon and this does not give way in trauma, rather, peri-lunate dislocation occurs, as everything around this ligament gives way in preference to a tear of this thick volar ligament. The next ligament is probably the key to understanding the movement of the wrist, that is, the radio-capitate ligament (in many articles this is erroneously called the 'radio-scapho-capitate ligament', but it does not attach to the scaphoid - in fact it is separated from the scaphoid by a synovial joint.) I will further discuss this ligament later, but will finish with an overview of the other ligaments first.

Next, there is a ligament that acts rather like the labrum on the glenoid of the shoulder, to deepen the distal articulation of the scaphoid with the trapezium and trapezoid. This is a ligament that runs from the trapezium to the capitate. Next, there are two ligaments that attach the scaphoid on one side to the trapezium, on the other side to the capitate. These ligaments have been described by Marc Garcia-Elias from Spain, and he has pointed out that they act rather like collateral ligaments in the MCP joint and become tight as the scaphoid flexes and therefore control this bone as it swings down into flexion, when the wrist radially deviates. This scapho-capitate limb of these collaterals is the reason that the radio-capitate ligament is sometimes erroneously called the 'radio-scaphoid-capitate ligament'. However, the two entities are entirely different and perform to entirely different functions.

Next there are joint thickenings with form ligaments between the scaphoid, the lunate, the lunate and the triquetrum. These are the scapho-lunate ligament and the luno-triquetral ligament. They are much flimsier than the aforementioned ligaments discussed above. The volar ligaments are the key players in understanding the biomechanics of the wrist, and as such will be concentrated on.

However, here I will mention the role of the FCU tendon. This attaches into the piziform bone and part of it goes on to insert into the base of the 5th metacarpal. However, another part of the tendon reflects around to become incorporated into the extensor retinaculum of the wrist. This also becomes integrally involved with the extensor carpi ulnaris (ECU) sub-sheath. These ligaments play a pivotal role in stabilizing the carpus in its correct position. If these ligaments give way, e.g. as in rheumatoid arthritis, then the carpus swings off the wrist, attached by Norbert Kuhlmann's sling and assumes the position volar and radial to its normal anatomical position. Coming back now to the radio-capitate ligament, this acts as a fulcrum for the scaphoid to rock around.

The distal carpal row (trapezium, trapezoid, capitate, hammate) appears to merely act as a platform and shows very little active movement in any plane. The proximal row however, particularly the scaphoid, lunate and triquetrum, form a dynamic structure which acts rather like a see-saw. The moment arms on the radial side of the wrist as a result of the longitudinal pressure exerted by both the intrinsic and extrinsic musculature transversing the fingers into the forearm, produce flexion on the radial side, and extension on the ulnar side of the wrist. In addition, radial deviation of the wrist causes the scaphoid to flex down in order to make room for the immobile distal row, as it approaches the radius during this movement of the wrist. On the contrary, when the wrist is ulnarly deviated, the scaphoid extends up and the triquetrum flexes down. Normally, the weaker thickenings in the joint capsules, i.e. the scapho-lunate ligament and the luno-triquetral ligaments, produce an intercalated chain, so that when the scaphoid flexes, the lunate and the triquetrum are linked and the triquetrum extends and the lunate rocks in-between. Likewise, when the scaphoid extends, the lunate rocks and the triquetrum flexes down into the palm.

One of the most important movements in the wrist is the “dart throwing movement”, which is used for many activities of daily living. This movement requires a rocking of the proximal row against the distal row of carpal bones through the mid carpal joint, and is centered around the capitate head. Approximately 30% of wrist flexion occurs at this joint, but this movement is vital.

Interruption of the proximal row carpal chain upsets the biomechanics of the wrist. In particular, if the scapho-lunate ligament ruptures, the scaphoid flexes unopposed, and the lunate is pulled into extension with the triquetrum in neutral position. This has been described as a DISI deformity, or dorsal intercalated segment instability. In rarer instances, the ligament between the lunate and the triquetrum ruptures. In these instances, the scaphoid and the lunate both flexed unopposed by the triquetrum, and the triquetrum extends unopposed by the linkage with the lunate. This is called a VISI deformity, or volar intercalated segment instability deformity. In addition, the length of the ligaments varies when the wrist is pronated and supinated. Even though the ligaments are enormously strong, they have an ability to

compress and to some degree be extended. During supination, the radio-capitate ligament is tight, which affects the movement of the scaphoid around the capitate. In supination, the scaphoid is held quite vertically in relation to the capitate, and flexes up and down in a rather vertical direction. In pronation however, the radio-capitate ligament is more lax and allows the scaphoid to rock around behind the capitate; although it still flexes and extends, it does so in a more slumped position. This observation may have a bearing on how the radio-carpal joint wears with time, and particularly if there is any pathology in the wrist. The triangular fibro-cartilage is a complex structure which attaches to the styloid process of the ulnar and blends with the articular surface of the radius. Usually this blend is seamless, however there may be anatomical variations, with an anatomical split between the triangular fibro-cartilage and the radius. There also may be pathological tears in the triangular fibro-cartilage, which may be symptomatic. These may be caused by direct trauma, or by a syndrome, where the ulnar is proportionally longer than the radius, and therefore pinches the triangular fibro-cartilage between the ulnar head and the lunate, producing pain and arthritis (ulnar impaction syndrome).

I will not enter into a detailed discussion of the triangular fibro-cartilage in this document.
I would like to briefly touch on the 1st carpo-metacarpal joint, as this is rather unique.

There are 27 stabilizing ligaments around the base of the thumb, however, the main stabilizing ligaments are the anterior and posterior oblique ligaments, the intermetacarpal ligament between the 2nd metacarpal base and the 1st metacarpal base, and to a lesser extent the APL tendon. The joint surface itself has been described as "saddle shaped", but more accurately, it would be a saddle that fitted on a scoliotic horse (as described by Kapanje). To this end, the joint allows side-to-side rocking in two planes, but also some rotatory movement as the side-to-side plane is not strictly transverse but is more semi-circular in shape. This aids in opposition of the thumb to the little finger.

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