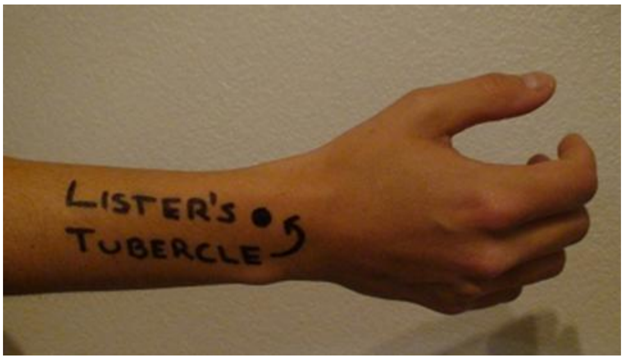
The Hand and Wrist: Enhancing Your Approach to Assessment and Treatment Mini Series

Session One: Improving Your Clinical Approach

Ian Gatt MSC OMPT MCSP BSc (HONS)



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Introduction

A review of the literature reveals that 3% to 9% of all sports injuries involve the hand and wrist (Usman & McIntosh, 2013; Shrier, 2009; Rettig, 2004)

In a sport like rugby, the hand is 1:3 times more likely to get injured when compared to the shoulder. Injuries by player position however indicate that areas more distal to the shoulder can actually have a higher severity when comparing to the shoulder (Usman & McIntosh, 2013). This indicates that a consideration for better knowledge around assessment and treatment of the distal components of the upper limb is essential in this sport. This should be considered for a wider array of sports.

Injuries to the Hand and Wrist

There are a variety of musculoskeletal injuries that occur in the hand and wrist. In sports, there a variety of conditions which include;

- Sprain and Strains (Wrist, Thumb, other joints)
- Fractures and/or Dislocations (Metacarpals/Phalanges)
- Tendon Injuries;
    - Pulley Injuries
    - Mallet Finger
    - Jersey Finger
    - Boutonniere Deformity
    - Swan Neck Deformity
    - ECU subluxation or dislocation
- Overuse tendon injuries;
    - DeQuervains
    - Intersection syndrome
    - ECU and FCU tendinopathy

Although the pathology is different, the common factor is an understanding of the underlying anatomy, and further the biomechanics of the Hand and Wrist.

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Restoring normal mechanics

Restoring normal mechanics of the hand and wrist requires not only the knowledge of the anatomical location of each joint but also other important aspects; convex and concave congruity to establish the appropriate rolling and gliding of the joint, the treatment plane rule (which dictates that it always stays/moves with the concave aspect of the joint), as well as the most 'loose' (least joint contact) and 'closed' (most joint contact) packed positions. When assessing a joint an understanding of normal and pathological end feels should be considered, which a practitioner can only acquire through repeated practice and therefore over extensive periods.

Assessment

When assessing the hand and wrist, the rest of the kinetic chain also require consideration, as most daily movements or sporting activities require a contribution from multiple joints in the Upper Limb (i.e. Elbow and Shoulder). Consideration for even more proximal joints (Neck/Thoracic) or Distal (Lower Limb) might also be required.

Anatomy

The hand consists of 27 bones (although mechanically one could say that it only consists of 19 bones (Metacarpal bones and Phalanges).

The wrist consists of 10 bones (8 carpal bones, Radius and Ulna).

The Ulna is not involved in wrist mechanics but the structures that attach to it; Triangular Fibrocartilage Complex (i.e. Triangular Fibrocartilage discus, radioulnar ligaments, and the ulnocarpal ligaments) are important in wrist stability. Ulna can glide on discus in pronation and supination whilst not influencing carpal movements.

The Pisiform is not involved in the direct mechanics of the wrist. It however provides a mechanical advantage to the Flexor Carpi Ulnaris, as well as providing an attachment for the Ulnar Collateral ligament of the wrist. This therefore provides an important role in overall wrist motion.

Radiocarpal joint is the articulation between the radius and the scaphoid and lunate, there is a small area of contact with the triquetrium which has been observed in kinematic studies using biomechanical modelling through MRI imaging. It is an ellipsoid joint allowing 2 planes of motion in both sagittal and frontal planes.

Mid-carpal joint is formed by contact of the 4 distal carpal bones and the more proximal 3 carpal bones. It is an important component of wrist motion and stability. Radial deviation, although half the range of UD is important as it creates the stable position or closed pack which stabilises the wrist. This is essential for serving in tennis or adopting a hand stand in gymnastics.

The Scaphoid is considered the most important of the carpal bones as it is influential in all the movements happening at the wrist. It moves with the proximal row in flexion and with the distal row

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in extension. During radial deviation it impacts on the radial styloid, and in order not to create excessive compressive forces between these two bones it ‘moves out of the way’ by moving into flexion. The congruency of the surfaces of the Scaphoid and the Radius are therefore highly associated for this action to happen. The opposite occurs with ulnar deviation where extension of the scaphoid occurs. Scapholunate ligament (SLIL) integrity is important for this mechanism to occur particularly during radial and ulnar deviation. Loss of integrity can result in instability in this area leading to dysfunction and symptoms. Knowledge of these mechanics is useful when assessing using Watson’s Test, which assesses the SLIL.

Metacarpal bones together with the fingers are called rays and are described using roman numerals starting from the Thumb (1st ray or I) and moving towards the fifth finger. Carpometacarpal (CMC) joint of the first ray is a saddle joint between the trapezium and 1st Metacarpal bone. Flexion/Extension/Abduction/Adduction and some rotation (10-15 deg) are possible at this joint. The 1st Metacarpal bone sits at an angle of 60-80 degrees to the arch of the hand allowing for the functionality of the hand. This joint is extremely important to allow the intricate gripping movements required during daily activities.

The Thumb offers the precision and gripping abilities of the hand. Prehension (or Pinch Grip) occurs when the thumb is parallel to the fingers whilst gripping (or Key Grip) occurs with the thumb in a more adducted position (perpendicular to the fingers). It has 9 muscles that control its action; Intrinsic (Abductor Pollicis Brevis, Adductor Pollicis, First Dorsal Interosseous, Flexor Pollicis Brevis, Opponens Pollicis) and Extrinsic (Abductor Pollicis Longus, Extensor Pollicis Longus and Brevis, Flexor Pollicis Longus). These muscles are innervated either by the Radial, Ulnar or Median nerve which implies that any neural deficiency to either motor component of these nerves will have an impact on Thumb motion.

CMC joints 2-5 offer little movement apart from a glide that moves directionally with the carpals. 2-3rd CMC joints are very resistant due to their force bearing position. 4-5th CMC joints are more lax allowing 10-30 degrees of flexion. This might explain why people are more prone to fractures at the 5th metacarpal bone.

The MCPs (2-5) are condyloid joints, which like the radiocarpal joint allow movements in 2 planes (flexion and extension/abduction and adduction). The collateral ligaments and deep transverse ligaments create adduction of the MCPs during flexion for a more effective grip. These become more lax during extension allowing for abduction. Flex of the 2-5th MCPs is performed by interossei and lumbricals (which also create extension at the IP joints because they attach to the fibrous extensor hood running the length of the dorsal surface of the fingers). Therefore for full flexion of the MCPs, IPs, and DIPs the long flexors must override the extension component of the lumbricals and interossei. This is easier if tension is taken off the extensors by some wrist extension.

Extensor of the fingers is caused by the **Extensor Digitorum** (ED) which enters the hand as 4 tendon slips. The main slip enters the extensor hood and two collateral slips that connect into the adjacent slips. The extensor hood formed by the tendon of the ED and fibrous connective tissue wraps around the dorsal surface to the distal phalanx. Contraction of the extensor digitorum therefore puts tension on the extensor hood which facilitates the action of the lumbricals and dorsal interossei due to the tension created on these muscles, facilitating the action.

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At the hand, strength (or Power grip) is determined by wrist joint position. The wrist lies naturally at an angle of 15-20 degrees allowing for an improved mechanical advantage of the **hand flexors** (Flexor Digitorum Superficialis and Profundus). Studies have shown significant changes in Grip strength between extreme positions of 40 degrees flexion and 40 degrees of extension of the wrist joint. It was noted that there is more strength in a wrist extended position indicating the importance of wrist posture. Other studies have also indicated that with more than 20 degrees of ulnar deviation an increase in the ability to produce force has been noted. Flexor Digitorum Profundus cannot independently flex the DIP (3-5th) but due to the separation for the index, the index DIP is possible. Flexor Digitorum Superficialis can independently flex the PIP and IP joints. 5th finger flexion is also assisted by Flexor Digiti Minimi brevis.

39 muscles act at the hand and wrist. Most of the muscles acting at the hand originate outside the hand and are termed extrinsic (enter the hand as tendons not to make the hand bulky). These muscles are held in place by the flexor and extensor retinacula. A concave transverse arch runs through the carpals, and metacarpals, forming the floor of the carpal tunnel through which the flexor tendons pass through together with the median nerve. This structure is important as it allows the most available space for tendons to move through considerable distance both proximally and distally when using the hand. Narrowing of this space due to pathology can provide dysfunction through sensory and/or motor neural disruption. This concave arch also serves a mechanical function by facilitating gripping

Wrist Flexors (Flexor Carpi Ulnaris, Palmaris Longus and Flexor Carpi Radialis) originate at the medial epicondyle and become tendons halfway along the forearm. Palmaris Longus is variable and absent in a percentage (13%) of the population. Flexor Carpi Ulnaris is the strongest of the group. This is important since flexion is actually considered to be a coupled movement occurring with ulnar deviation.

Wrist Extensors (Extensor Carpi Ulnaris, Extensor Carpi Radialis Longus and Brevis) originate in the vicinity of the lateral malleolus. They become tendons 1/3 down the way (1/3 proximal forearm). Extensor Carpi Radialis Longus and Brevis create flexion at the elbow with a fixed wrist, and can be enhanced as wrist extensor by extending the elbow. This is important since extension is actually considered to be a coupled movement occurring with radial deviation.

When assessing the Hand and wrist it is important to understand the **neural innervation**; both sensory and motor. Out of the 3 main nerves that innervate the Upper Limb, the radial nerve only provides sensory input to the hand and wrist, whilst both the Ulnar and Median nerves have distinguish sensory and motor input. Although most test books will clearly define the respective distributions of sensory and motor, a variance among the general population can be expected which needs to be considered. Example Flexor Pollicis Brevis is innervated by the Median nerve, however in some individuals it can be innervated by the Ulnar nerve.

The forearm: Consists of the proximal and distal radioulnar joints which are both pivot joints. Movement occurs around the transverse plane (pronation and supination). This movement occurs by the hand, wrist and radius rotating over a stable ulna and elbow. The interosseous membrane (which consists of 3 portions; a membranous distal and proximal aspect, and a middle ligamentous) is important for stability between the radius and ulna, allowing the appropriate mechanics during rotation. It also limits pronation and prevents from radial migration of the radius, when it crosses

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over the ulna during this movement. 80% of forces are typically applied to the radius in a supinated position; this reduces by about 20% with the arm in a more pronated position. The interosseous membrane also serves to transmit forces from the radius to the ulna.

Conclusion

In order to appropriately assess and treat MSK injuries at the hand and wrist, as well as the rest of the human body, a thorough understanding of the underlying anatomy and biomechanics is important. Part 1 of this series is aimed at improving this knowledge to allow practitioners to consider a different approach in future practice.

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