A Pictorial Review of Wrist Injuries in the Elite Golfer

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Learning objectives

Background

Introduction

Golf is a sport played and watched by millions of amateurs. It's popularity is increasing globally, with some 20 million players projected to play in China alone by 2020. At the pinnacle of the sport are small group of elite professional golfers who make a living from tournament prize money and sponsorship deals. The elite male golfer is young with an average age of 24, this along with different swing mechanics and increased repetitive strain is thought to result in injury patterns which differ from the amateur. The frequency and nature of wrist injuries in the elite golfer has not been reliably documented until recently; a study carried out by Hawkes on the top professional golfers on the European tour in 2009 reported that the majority of injuries were sustained in the leading wrist, with ulnar sided injuries being most commonly reported. Complex swing mechanics are thought to subject the leading wrist to considerable stress as it moves from ulnar to radial deviation and then back to ulnar deviation during the swing. There is also movement from pronation to supination and from flexion to extension through impact. This impact is substantial as professionals aim to 'hit through the ball' with the club face, often hitting the ground and taking a divot of turf in order to make more controlled shots through imparted spin. This article will review the common wrist injuries encountered by the examining sports physician in the elite golfer. Injuries to the wrist can be classified by the anatomical localisation of pain and other symptoms; common ulnar sided, radial sided and dorsal injuries will be evaluated.

The Golf Swing

The wrists link the body to the golf club and form the final component of a kinematic chain composed of the hips, spine and shoulders. An overview of wrist movement through the swing does however aid our appreciation of the stresses incurred at the wrist and provides a useful framework on which to correlate pathology.

The non-dominant wrist (the left wrist for right handed golfers) begins the golf swing in a position of ulnar deviation when addressing the ball. As the club is lifted away into the backswing, this wrist moves into radial deviation until it sits maximally radially deviated at the top of the backswing. At this point, the club changes direction to begin the downswing and the non dominant wrist returns to ulnar deviation until the ball is hit. The dominant wrist moves in a different path altogether, being in neutral at address before moving
quickly into maximal extension during the backswing and only coming back into neutral (and ultimately flexion) just before ball strike. In this way, the wrists control the golf club and impart significant power to the ball strike. The limited joint movement insures consistency and increased reproducibility in the swing.

These opposite motion paths (ulnar/radial deviation for the non-dominant wrist, flexion/extension for the dominant wrist) allow an understanding of the incidence of certain injury patterns in golf. The ulnar and radial deviation movements of the leading wrist are likely to predispose to problems with the tendons on the radial and ulnar borders of the wrist as they move through a near-maximal excursion with these wrist movements. This explains the high incidence of de Quervain's tendonitis and extensor carpi ulnaris (ECU) sheath and tendon problems in the non-dominant hand.

Images for this section:

Fig. 1: golf swing
Imaging findings OR Procedure Details

Ulnar Sided Injuries ECU pathology

Up to 67% of wrist injuries occur in the ulnar aspect of the lead wrist, (the left wrist in a right-hand dominant golfer). The extensor carpi ulnaris (ECU) tendon is involved in the majority of ulnar sided injuries. Typical ECU tendon pathology includes subluxation, dislocation, tendonopathy and tenosynovitis.

Dynamic ultrasound during pronation and supination easily evaluates the position of the ECU tendon within the ulnar groove. There is normal variation in tendon position throughout the range of wrist movements, with displacement toward the ulnar border of the groove being greatest in a flexed and supinated wrist. The sensitivity and specificity of ECU displacement in diagnosing true ECU instability has yet to be determined.

Hook of Hamate fractures

Although the true incidence of stress related fractures in golfers is unknown. The hook of the hamate fracture is a common ulnar sided wrist injury observed in golfers and is reported to be the most common stress fracture seen in golfers after rib fracture. Hook of hamate fractures can arise acutely from a direct blow by the counterforce of the proximal end of the grasped golf club, as it lies immediately adjacent to the hook of the hamate. If there is a slight relaxation of grasp at the conclusion of a swing or at the time of meeting a sudden resistance such as hitting the ground, the centrifugal force of the swing results in direct trauma upon the hook. Stress fractures of the hook of hamate may also present insidiously after repetitive microtrauma. The non-dominant/leading hand is usually affected in golfers in contrast to racquets players in whom the dominant hand is more likely to be involved.

CT is far better at evaluating occult hamate fractures with a reported sensitivity of 100% and a specificity of 94% compared with 72% and 88% in plain radiographs. Associated injuries of hook of hamate fractures include injury to the ulnar nerve and artery and damage to the flexor carpi ulnaris tendon.

Hypothenar Hammer Syndrome (HHS)

HHS is a rare arteriopathy of the distal ulnar artery. Patients may present with pain in the palm, paresthesia, numbness, and signs of vascular insufficiency such as coldness, pallor, discoloration, and blanching of the affected ulnar sided fingers. Frequent blunt
trauma to the superficial segment of the ulnar artery at the hypothenar eminence compresses the artery against the hook of hamate triggering vasospasm of the artery. Vasospasm and repetitive trauma cause intimal damage resulting in platelet aggregation and thrombus formation. In addition to thrombosis, continued trauma can lead to damage of the tunica media and aneurysm formation. HSS syndrome has been reported in the past as an occupational disease occurring in workers using hammers and screwdrivers, and in subjects who use the hypothenar part of the hand as a ‘hammer’. It may be seen in any case of repetitive compression or blunt trauma to the hypothenar eminence. Furthermore, it has also been reported in sportsmen, particularly in mountain bikers, racquets players and there have also been case reports in golfers.

The ulnar artery in the hand can by imaged via conventional digital subtraction angiography, CTA or MRA, the diagnosis of HSS can be also confirmed easily with US. The angiographic findings characteristically show a 'corkscrew' elongation of the artery with segments of stenosis and ectasia. There maybe further upstream multiple digital artery occlusions which have been caused by occlusive microemboli. Conventional MR findings include isointense to hyperintense T1WI signal in the arterial lumen which is indicative of thrombus within a partially patent or occluded ulnar artery aneurysm.

**Dorsal Wrist Injury**

**Dorsal Rim Impaction Syndrome (DRIS)**

DRIS (also known as hypertrophic synovitis) is a type of carpal impingement syndrome which predominantly affects the trailing wrist in elite golfers. Dorsal impaction syndromes are also seen in athletes, notably gymnasts, weightlifters and those who do excessive press ups. It is caused by forced dorsiflexion or repetitive hyperextension particularly when accompanied by axial loading. In golfers continued impaction of the dorsal radial rim on the lunate and scaphoid when the club hits the ground can result in dorsal capsular hypertrophic synovitis. Clinical impingement occurs when the thickened dorsal wrist capsule becomes trapped and pinched between the radius, extensor carpi radialis brevis and the dorsal ridge of the scaphoid. A degenerative cascade can then ensue with subchondral cyst formation and bone oedema preceding radial and carpometacarpal osteoarthrosis but extreme progression is rarely seen in elite golfers as painful soft tissue impingement usually results in clinical presentation and treatment. DRIS presents with dorsal central wrist pain and specifically point tenderness in the radiolunate joint centred at the radiolunotriquetral ligament. The pain is exacerbated by hyperextension. In golfers it is caused by repeated loaded hyperextension of the trailing wrist. Plain x-rays and CT are usually normal as this condition, at least initially, is a capsular soft tissue abnormality. Dorsal capsular thickening can be shown on ultrasound or MR imaging but in our experience MR imaging is more reliable in documenting its extent as well as any concomitant injuries or bone marrow changes elsewhere in the wrist. Capsular
thickening and synovitis typically occurs dorsal to the scaphoid and lunate surrounding the extrinsic ligaments and extending inferiorly to the radius. The thickened tissue is low to intermediate signal on MRI T2 weighted images and is rarely markedly oedematous. Joint fluid usually outlines the irregular contour of the thickened capsule and synovitis. On ultrasound the thickening is usually hypoechoic and nodular but rarely shows any Doppler signal. Ultrasound is useful for guiding needle placement into the nodular tissue for therapeutic injection.

Carpal bossing

A carpal boss is the description for a bony protruberance localised to the carpometacarpal region at the base of the index and middle finger metacarpal bones (the quadrangular joint). Bossing can result in significant morbidity and time away from practice and play for the golfer. Repetitive strain, specifically forced wrist extension, is thought to aggravate bossing symptoms due to adjacent tenosynovitis of the extensor carpi radialis longus and brevis at their basal insertions on the dorsal aspect of the second and third metacarpals. The diagnosis of carpal bossing is made on clinical and imaging findings after ruling out various differential diagnoses. Ganglion cysts are the most common cause of dorsal wrist protuberances. The differential diagnosis between a ganglion and carpal bossing is based on location and palpation. Between 60 and 70% of all ganglions occur over the scapholunate ligament while carpal bossing is always over the quadrangular joint. The aetiology of carpal bossing remains uncertain. Several mechanisms such as ununited fracture, chronic stress/periostitis, instability, accessory ossicles (os styloideum), ligamentous microrupture, degeneration and partial bony coalition have been postulated as possible causative factors however the evidence underlying these possible mechanisms remains limited. When bossing is present on radiographic imaging, there is typically no sclerosis or reduction of joint space suggesting that a degenerative aetiology is unlikely. It should also be remembered that this feature can be seen in asymptomatic patients and is not always relevant to wrist pain unless the clinical features correlate to this area. Plain x-rays can be diagnostic for its presence but if negative because of bony overlap CT or MR imaging can define the bossing. MR imaging should be performed routinely in elite golfers as this technique can also demonstrate associated bone marrow oedema, fracture, soft tissue oedema and/or tendon abnormality.

Ganglia

Dorsal ganglion cysts of the wrist are the most common focal lesions in the hand and wrist in the general adult population and are also common in elite golfers. They are not true cysts as they have no epithelial lining, but instead have a pseudocapsule of compressed loose areolar tissue. Although the pathogenesis remains unclear, a commonly held view
is that they are mucin filled lesions which arise from defects or tears in tendon sheaths and joint capsules. These defects lead to mucin extravasation through the damaged collagen bundles. The tight nature of the defects results in a one way valve system whereby the extravasated fluid can no longer return into its original space. Volar wrist ganglions are more common but tend to be asymptomatic. 60% of wrist ganglia that present clinically occur on the dorsal side typically as a 1-2cm painless soft tissue mass but they can cause be associated with a dull ache in the dorsum of the wrist which is more likely to irritate rather than debilitate. In elite golfers the majority occur in the leading wrist. The exact cause of pain is also controversial but compression of the terminal branches of the posterior interosseus nerve has been implicated as a potential cause. Dorsal ganglia tend to originate from the scapholunate joint or ligament and can also cause paraesthesia from compression of the ulnar or median nerves (or their branches). On MR imaging ganglia are typically fluid signal being low signal on T1 weighted images and high signal on T2 weighted images, but a high proteinaceous content or haemorrhage can result in lesions appearing isointense or hyperintense on T1 weighted images. A narrow stalk connecting the ganglion to the joint is often visualised. The sonographic findings mirror MR, typically a hypoechoic fluid filled mass is seen with a narrow stalk extending towards the joint. An elongated neck can cause the ganglion to surface at distance from the joint and appear at an apparent atypical location. Complex ganglions can contain septations or display comet-tail artefacts and they are typically larger than simple ganglia. Ganglia are usually not compressible and the surrounding soft tissues are not hyperaemic except when there has been recent ganglion rupture or leakage when the surrounding tissues may be mildly hyperaemic and oedematous. Sonographically solid appearing ganglions have also been reported in the literature. Solid appearing ganglion are characteristically collapsed and can demonstrate increased central and peripheral colour doppler flow. There characteristics are non specific and the differential diagnosis can include proliferative synovitis, nodular fasciitis, giant cell tumor of the tendon sheath or a focal granulomatous process.

**Radial Sided Injury**

*De Quervain's Tendonitis*

De Quervain's tendonitis has been reported as the leading cause of radial sided pain in the leading wrist in elite golfers, the severity of symptoms tend not to be as severe as ECU tendonitis. Finkelstein’s test is pathognomonic in making the diagnosis: the patient flexes the thumb into the palm while the examiner ulnarily deviates the wrist producing the patient's symptoms. It is an overuse phenomenon which causes retinacular friction in the first extensor compartment of the wrist.
Although considered a single compartment the first extensor compartment can be divided by a septum which separates the abductor pollicis longus (APL) and extensor pollic brevis (EPB) tendons. The incidence of this 'double tunnel' varies from 24% to 77.5% in cadaver studies. The US appearances of the septum in patients with de Quervain's disease are described as by hypoechoic structure between APL and EPB tendons. Several studies have noted that the presence of a septum splitting the first extensor compartment into two subcompartments was more frequent in patients with de Quervain’s disease, this supports the claim that this anatomic variation is involved in the pathogenesis of de Quervain's disease. The septum may be a cause of overcrowding in the fibro-osseous tunnel and may predispose to local tendon friction, especially in the EPB tendon subcompartment. Recognition of this septum plays a role in the nonsurgical management of de Quervain's disease. Injection into only one subcompartment is a well-known cause of unsuccessful blind injection of steroids. Sawaizumi et al., found that the outcome and the efficacy rate of local steroid injections increased to 100% when the two sites (APL and EPB tendons) were injected. US typically demonstrates hypoechoic tendinopathic changes with associated thickening and fibrosis of the tendon sheath which is seen as a low reflectivity, hypervascular halo around the tendon.

In stenosing de Quervain's tenosynovitis, the APL and EPB tendons become painful and swollen. The tendon sheath is thickened, with the greatest thickening being over the styloid process. Here it may be three to four times the normal thickness of 3 to 4 millimetres. The sheath takes on a cartilaginous consistency. Filmy adhesions seen at surgery are usually present around and between the tendons.

**Images for this section:**
Dynamic ultrasound during pronation and supination easily evaluates the position of the ECU tendon within the ulnar groove. There is normal variation in tendon position throughout the range of wrist movements (see figure below), with displacement toward the ulnar border of the groove being greatest in a flexed and supinated wrist. The sensitivity and specificity of ECU displacement in diagnosing true ECU instability has yet to be determined.
Fig. 2: ECU

CT and MRI demonstrating an occult hook of hamate fracture (red arrow) in a golfer which was not seen on xray.

Fig. 3: Hook of hamate fracture

Dorsal Rim Impaction Syndrome (DRIS)

Fig. 4: DRIS
Capsular thickening and synovitis (red arrow) typically occurs dorsal to the scaphoid and lunate surrounding the extrinsic ligaments and extending inferiorly to the radius.

**Fig. 5:** DRIS

Plain x-ray, MRI and 3D CT reformat of capitate bossing (red arrow). Associated extensor carpi radialis tenosynovitis noted on MRI (yellow arrow).

**Fig. 6:** Carpal bossing
Soft tissue lesion visualised on dorsum of hand on plain x-ray (red arrow). On ultrasound a hypoechoic fluid filled mass is seen with a narrow stalk (green arrow) extending towards the joint in keeping with a ganglion.

Fig. 7: ganglia

Fig. 8: Finkelstein's test
US typically demonstrates hypoechoic tendinopathic changes with associated thickening and fibrosis of the tendon sheath which is seen as a low reflectivity, hypervascular halo around the APL and EPB tendons (see red arrow).

**Fig. 9:** stenosing de Quervain's tenosynovitis
Conclusion

Summary

The injury patterns and range of pathologies of elite golfers differ markedly from non professionals. Anatomical classification is a useful mechanism to narrow the differential. A working knowledge of the complex swing mechanics along with precise history taking and deft examination is essential in formulating a diagnosis and requesting the correct radiological test.

References

Personal Information