

Extensor Carpi Ulnaris Tendon Injuries in Golfers

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Abstract

Golf participation has increased significantly over the past 50 years. Injury rates have mirrored this increase with amateur and elite golfers suffering a similar injury incidence to rugby players. The upper limb is the second most common anatomical site of injury in this population. Wrist injury and specifically the ulnar side of the leading wrist is the most prevalent. The extensor carpi ulnaris tendon is regularly injured. The biomechanics of the swing are a major factor in this overuse type injury which can result in tendinitis, tendinopathy or subluxation. Treatment involves rest, anti-inflammatory treatments, Platelet Rich Plasma injection and occasionally surgery. Return to play requires golf biomechanical assessment and splinting.

Keywords: *Injuries in Golfers; Extensor Carpi Ulnaris, Tendinopathy*

Introduction

Golf participation has exploded in the past 2 decades. In 2018 there were 38,864 golf courses in 209 of the world's 249 countries [1]; 494 of these courses are in Ireland. There were 24.3 million golfers recorded in the USA in 2018. The Golf Industry is an economic driver producing a total economic output in California of \$15.1 bn in 2019.

Golf is both a recreational pass time and a competitive sporting pursuit. Golf started to thrive as a spectator sport in the 1920's and boomed in earnest in the 1960's with the arrival of live golf on TV. Its charm and allure might be the lack of age and gender barriers. Fundamentally it is a game of skill and guile requiring some athletic ability.

TV has pollinated a viewing population as well as the playing population. Unique to most sports golf has a dedicated TV channel, "The Golf Channel", watched and enjoyed by millions of viewers. 10 million patrons watched The Masters from the comfort of their living room this year. Off the couch golf is a great benefit to health [2] providing the perfect physiological work out to sustain health and longevity [3].

Golf injury incidence

Increased participation, just short of a million people play golf twice a month in England for the past 5 years [4], resulting in increased injury rates. In 2019 the BJSM reported that nearly 7 in 10 amateurs and 9 in 10 professionals will suffer a golf-related injury at least once in a lifetime [5]. Annual Injury incidences of between 2 and 4% are reported among golfers. Put more simply a golfer can expect to sustain an injury for every 100 hours of golf participation with an overall incidence for rate of injury of 15.8 injuries per 100 golfers and with a range of 0.36 to 0.60 injuries per 1,000 hours per person. 46.2% of injuries are reportedly sustained during the golf swing, and injury is most likely to occur at the point of ball impact (23.7%) [6]. Golf carries a significant injury rate with levels exceeding other non-contact sport. Perhaps golf is in fact a contact sport, with contact being made with turf and ball through a metal implement, frequently in a ferocious and repetitive manner.

Recent research has indicated that general exercise has an injury rate of 5.3 per 1,000 persons, golf having a similar injury rate to rugby at 1.5 per 1000 persons [7] The injury rate is significant but the over-arching benefits of playing golf outweigh the risks. The health benefit of golf on physical and mental well-being is significant (2 and 3).

Types of golf injury

All golfers are prone to injury. Amateur golfers have a lifetime incidence of injury ranging from 25.2% to 67.7%. Professional golfers have higher rates between 31% to 88.5% over a lifetime.

Many studies on golf injuries have found that low back injuries account for 15.2% to 34% of all golf injuries, followed by injuries to the elbow (7% to 27%) and shoulder (4% to 19%). The wrist accounts for 10% of all golf injuries. In professional golf, wrist injury incidence has been reported to be up to 54% [8], the leading wrist being most commonly compromised [9].

The change in the injury profile is associated with increased playing hours as well as the nature of golf. Newer golf clubs with composite heads and lighter shafts have allowed the golfer to swing faster in the constant and increasing race by club manufacturers to achieve greater distance.

The majority of golf injuries are referred to as “over-use injuries” caused by the repeated action of swinging the golf club and hitting the golf ball and turf. This activity not only takes place on the golf course where the average long shot golf rate is 40 to 50 swings per round but also on the practice tee and driving range where 100’s of balls are hit. Lighter clubs and the availability of golfing practice facilities have also impacted the increased injury rate.

Specific risk factors for overuse golf injuries are age, ability, and swing mechanics [10].

Overuse injuries

Overuse injuries affecting the musculoskeletal system are caused by repetitive trauma which result in micro trauma to soft tissue structures such as tendons, muscles ligaments as well as bones. The factors pertaining to these overuse injuries can be divided simply into: 1) Intrinsic causes; 2) Extrinsic causes

- Intrinsic risk factors can be modifiable or non-modifiable. Modifiable factors in golfers would include fitness, skill level and patterns of practice session. One of the major issues for a golfer is that often he or she is their own coach. In many cases this type of practice reinforces an intrinsic mistake in the swing biomechanics rather than corrects the imperfection. In these cases, “practice makes permanent rather than perfect”. Non-modifiable factors would include age, gender and body morphology, general health, joint or spine pathology and age. Quality of practice and play is always preferable to quantity. In golfers a faulty grip is frequently a fundamental flaw leading to overuse injury.
- Extrinsic factors include the conditions a golfer is exposed to. These include equipment and coaching. If either is inappropriate injuries will result. All golf coaches should take into account for golf biomechanics, prior injury and skill level. Practicing in the cold or when not warmed up will increase the risk of injury. Training error is a frequent culprit. Failure to warm up, hitting too many balls, hard surfaces, inappropriate equipment or an alteration in swing mechanics can all result in excessive loading and injury. This coupled with insufficient or inadequate recovery time, (golfers frequently play when injured) causes inflammation to tissues and injuries. A trained PGA golf professional will ensure that these common mistakes are avoided, however, most golfers are their own coaches and training errors mixed with other extrinsic and intrinsic issues result in injury.

Wrist injuries in golf

Wrist injuries are common [6] and particularly prevalent in elite golfers [10].

Golfers who sustain injuries to their wrist regularly fail to rest after practice sessions and do not allow adequate time for soft tissue recovery and adaptation after a heavy practice session. It is not uncommon for an elite golfer to hit balls every day. Enthusiastic amateurs can be seen hitting “buckets” of balls in an effort to groove a repetitive swing. A standard bucket of balls in a driving range contains 50 to 60 balls when a round of golf rarely exceeds 40 full shots. This simple training error often underpins wrist injuries.

These wrist injuries are often extended and exacerbated by “playing through the pain” which must always be discouraged. This behaviour is most prevalent in men who outweigh injuries in female golfers by 2 to 1 [6,11]. This area is also more frequently affected in the professional ranks as the golf swing is a means of income, much in the same way as other manual occupations such as painters and decorators [12] suffer from overuse injuries to the upper limb [11]. In a 30-person cohort 43% of hairdressers reported overuse injury symptoms to hands and wrists from their work activity [13].

In golf it is almost impossible to consistently hit a golf ball with an injury to the wrist or hand which is the second most common site for golf injuries and a result of impacting the ball incorrectly due to poor swing mechanics [6-10].

Patterns of injury differ based on level of play and time spent playing or practicing golf. Among golf professionals, the hand/wrist is the most commonly injured upper extremity structure. The elbow is more commonly injured than the wrist in amateur golfers [14].

Extensor carpi ulnaris tendon injuries in golfers

The extensor carpi ulnaris tendon (Figure 1) originates from the lateral epicondyle of the humerus and the dorsal surface of the ulna, passes through the groove dorsally at the ulnar head within a fibro-osseous tunnel of extensor retinaculum in the 6th compartment (Figure 2). It has its own tendon sub-sheath for its stabilization there and inserts on the base of the 5th metacarpal medially angled to its position in the groove of ulnar head. It acts to adduct (or ulnar deviate) and extend the wrist joint.

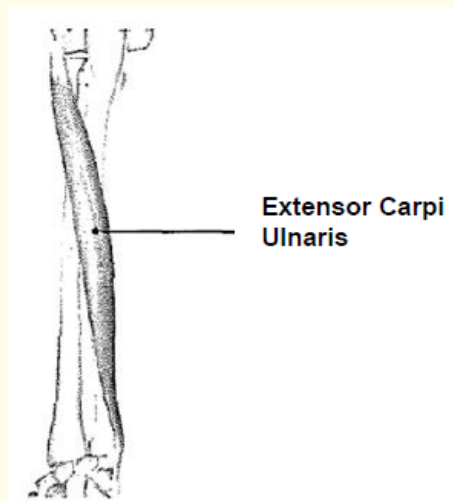


Figure 1: Extensor Carpi Ulnaris muscle and tendon.

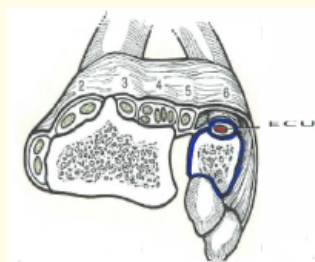


Figure 2: Extensor Carpi ulnaris tendon in the fibro-osseous tunnel of extensor retinaculum in the 6th compartment of the wrist.

The Extensor Carpi Ulnaris tendon (ECU) is particularly vulnerable to injury in the golfing population because of the complex nature of the golf swing. During the golf swing the leading wrist goes through a complex motion involving ulnar and radial deviation, extension and flexion and pronation and supination. These manoeuvres send forces through the wrist joint culminating with the impact of club on ball (Figure 3). The anatomical location of the ECU tendon in the 6th extensor compartment held in a tendon sheath makes it liable to injury due to the excessive tensile loading and subsequent breakdown of the loaded tendon [15,16]. The ECU Tendinopathies account for significant lost time in practice and competition [17,18].

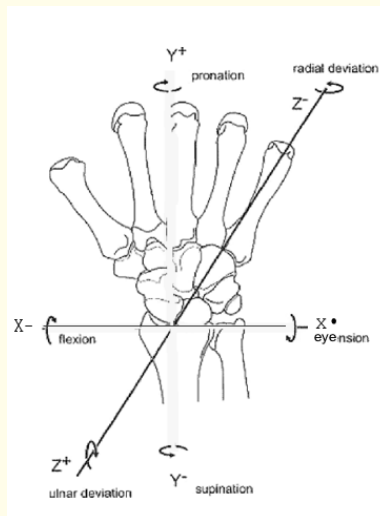


Figure 3: Directions of leading wrist motion during a golf swing.

Golf swing biomechanics and ECU tendon injury

During the golf swing the leading wrist joint and dorsal carpal row transition through a variety of positions; the wrist joint flexing, extending, radial and ulnar deviation, as well as pronating and supinating. The severity of motion depends on the initial grip and subsequent individual preferences and biomechanical biases. Each motion places different stresses on soft and bony structures.

At address the leading wrist [left wrist in a right-handed golfer] is held in slight ulnar deviation, (Figure 4) the degree depending on the strength of the grip. A “strong grip” where more knuckles are visible will place greater stress on the ECU by provoking pronation in the distal carpal row. The height of the hands at address also place different degrees of stress on the ECU tendon. Lower hand position, where the hands are closer to the body loads the ECU tendon “cocking up” the wrist at address. This position is also favoured by modern professional players but places further stresses on the ECU tendon, which is inserted into the base of the 5th metacarpal.

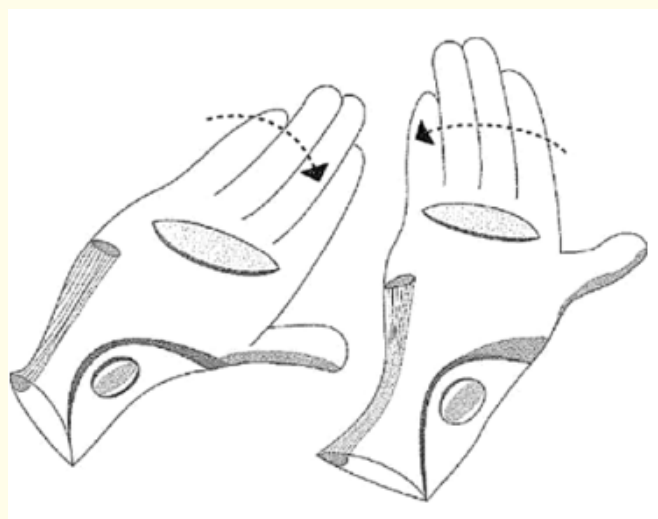


Figure 4: Leading wrist in ulnar deviation at address (right) and impact and in radial deviation at the top of the back swing (left).

During the takeaway phase the wrist travels into radial deviation as it tracks to the top of the back swing, where the wrist is held in a significant radial deviation (Figure 3). In this position the ECU tendon contracts. The tendinitis symptoms are made worse by combined wrist motion during the golf swing.

On the down swing to the ball the ECU reverts to an ulnar deviation direction allowing supination of the distal carpal bones at impact. This combination of motions leaves the ECU tendon particularly vulnerable to injury due to the biomechanics of the golf swing.

At impact the ECU tendon and wrist motion back to ulnar. This occurs at a faster speed while the wrist is under high degrees of stress.

Elite golfers who are “handsy” often manipulate their hands at impact to create specific shot shape. Holding the left wrist firm at impact to execute a “hold off” shot where the ball spins in a left to right direction. Handsy players are particularly susceptible to wrist tendon injuries.

The ECU distal row of carpal bones in pronation. This extreme position is exacerbated if the left wrist is bowed at the top of the swing. Bowing of the wrist is favoured by many modern professionals, as it creates a closed position for the club head, which is considered to be a more powerful position.

Types of ECU tendon injury

ECU tendon injuries come in many varieties and severities but can be simply divided into 3 major categories of injury.

There are 3 types of injury that occur to the ECU tendon in the golfing population. Each is associated with overuse caused by excessive play and practice accompanied by poor swing technique [14].

- ECU Tendinopathy
- ECU tenosynovitis or tendinitis 2- ECU Tendinosis.
- ECU Subluxation, (of which there are 3 varieties).

Injury to the ECU tendon in the leading wrist of a golfer is common due to the forceful return of the ball as the leading wrist travels from a radial deviated position at the top of the backswing to an ulnar deviated position at impact with the second carpal row transitioning into a supinate position. Injury and subluxation of the ECU tendon are exacerbated by ulnar deviation and supination [19], which is the classical position of the leading wrist at impact during a golf swing. Hence the frequency of this injury in golfers.

ECU tendinopathy

Tendinopathy or tendinosis refers to the breakdown of collagen in a tendon. Tendinopathy is often the long consequence of long-term inflammation caused by tendinitis. This causes burning pain in addition to reduced flexibility and range of motion.

The collagen loss being a function of tenocyte malfunction secondary to chronic and reoccurring inflammation and injury. ECU tendinopathy occurs over time due to repetitive insults. The Tendinopathy is a pathological adaptive response resulting in degeneration due to the tendon's collagen loss in response to chronic overuse. Loss of function as well as pain on activity are cardinal complaints.

ECU Tendinitis

Tendinitis is the inflammation of the tendon and results from micro-tears that happen when the musculotendinous unit is acutely overloaded with a tensile force that is too heavy and/or too sudden. ECU tenosynovitis can occur when the extensor retinaculum tears. It can result in mechanical friction between the ECU tendon and the ulnar groove [13]. It usually starts as tendon irritation manifesting as pain and can progress to friction between the tendon and the ulnar groove. In the golf swing the ECU is irritated by the motion to and from

ulnar and radial deviation with the wrist in a supinated position. Symptoms include wrist pain and loss of grip strength.

ECU tendon subluxation

If the tendon sheath and sub sheath rupture or stretch, the ECU tendon can then migrate to the medial or ulnar side of the wrist. This is caused by a rupture on the ulnar or radial side of the tendon sub-sheath, or if the sub-sheath is stretched due to stripping of the periosteum. Each type results in subluxation and relocation producing a snapping sensation at the wrist during the golf swing. There are 3 types of ECU tendon sub-sheath injury.

Type 1 rupture occurs on the lateral side of the sub sheath. The tendon subluxes through the radial side of the sheath and returns to rest on the ulnar groove on top of the remaining sheath.

Type 2 rupture occurs on the medial side resulting in a tendon subluxing in an ulnar direction before returning to the ulnar groove without resting on top of the sheath.

Type 3 subluxation occurs if the ECU sheath does not rupture but the force causes ulnar periosteum stripping: The ECU sheath pulls the

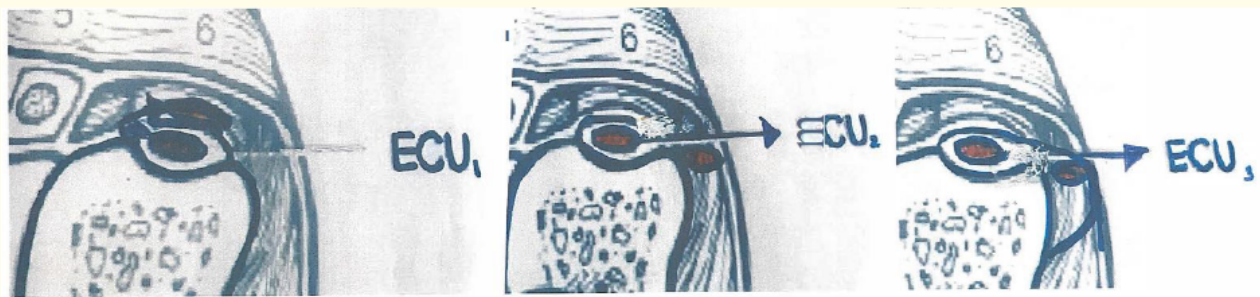


Figure 5: The 3 types of ECU sub sheath injury resulting in subluxation of tendon.

periosteum off the ulna on the ulnar side and forms a false pouch into which the tendon dislocates before relocating back onto the ulnar groove (Figure 5).

Differential diagnosis of ECU tendon injury in a golfing population

Injury to the ECU tendon is a challenging diagnosis and great care is needed in confirming the pathology. This is in part due to the symptomatology and presentation of injury with players reporting pain on the ulnar aspect of the wrist and hand accompanied by a loss of dexterity and occasionally sensory alteration affecting the fingers. Other conditions to consider in the differential diagnosis include:

- Triangular Fibro-cartilage injury.
- Hook of Hamate injury.
- Guyon`s Canal Syndrome.
- Carpal Tunnel Syndrome.

The triangular fibrocartilage injury of the wrist

The triangular fibrocartilage complex (TFCC) is a load-bearing structure between the lunate, triquetrum, and ulnar head. It is a hammock-like structure made up of cartilage and ligaments. It stabilizes the bones in the wrist, acts as a shock absorber and enables smooth movements. Forced ulnar deviation and positive ulnar variation are associated with injuries to the TFCC. A “weak” golf grip and swing biomechanics abnormalities makes injury to this structure more common.

The TFCC complex is prone to degeneration and wear-and-tear injuries. Injury occurs when compressive loads are placed on the TFCC during marked ulnar deviation. This occurs in the golf swing when the radial deviation of the wrist at the top of the back swing converts into ulnar deviation under significant force at impact. The triangular fibrocartilage disc attachment on the radial side is to hyaline cartilage. This makes the area vulnerable to injury as it is weaker when compared to the ulnar side whose attachment is bony.

Injury to the TFCC can lead to pain, weakness and instability. Patients with TFCC injury will present with ulnar-sided wrist pain that may present with clicking or point tenderness between the pisiform and the ulnar head.

The TFCC can be strained or torn from over-swinging or from “hitting down on the ball”. Hitting out of heavy rough or on hard practice mats are also extrinsic culprits in the development of this injury in the golfing population.

Diagnosis is confirmed by assessment of the sixth extensor compartment. At this location the TFCC is examined in combination with the ECU tendon. The ECU relies on the TFCC for movement and hence both structures can be injured in combination.

Radiology may reveal avulsion of ulnar styloid, and ulnar variance in cases of the TFCC injury. High-resolution dynamic ultrasound (US) has emerged as a useful and valid tool for the diagnosis of this disorders [20-22].

Hook of the hamate

The hamate bone is one of the largest carpal bones and is located on the ulnar side of the palm of the hand and forms part of the distal carpal row. It has a protrusion called the “hook of hamate” which with the pisiform bones form the bony boundaries of Guyon’s Canal through which the ulnar nerve enters the wrist joint. Hook fractures can occur from a direct injury to the bone or from an indirect blow that occurs most commonly in sports [23].

In golf, most hook of hamate fractures occur because of the position of the golf club resting on the hook when hitting “down” on the ball, when it is buried in rough or embedded in a divot. These injuries are also common when hitting buckets of balls from a mat at the driving range. Many of the older ranges are built on concrete and injuries occur when the club head stops abruptly on the mat covering the concrete. The force of the impact is conducted through the club shaft and grip into the base of the hand and hamate bone, resulting in injury. That force is transmitted directly to the wrist and can cause a fracture of the hook of the hamate. These injuries occur more common in the following wrist [right hand in a right-handed golfer]. While fractures are rare and underreported, they are also frequently misdiagnosed as the initial trauma may seem trivial and present with a working diagnosis of a wrist sprain. Palpation of the hamate with or without ulnar nerve symptoms are cardinal findings. Plain radiology will confirm the diagnosis and conservative treatment such as rest and splinting usually resolves the problem.

Carpal tunnel syndrome [CTS]

Carpal Tunnel Syndrome is the entrapment of the median nerve and repetitive use of the hands and wrists seen in golf contribute to the development of CTS. Repetitive activity such as golf swinging and practicing can result in flexor tenosynovitis as one or more of the 9 flexor tendons that travel through the Carpal Tunnel in the company of the median nerve become inflamed. Inflammation in the affected tendons in the wrist result in swelling of the sheath. This fluid will compromise the function of the nerve resulting in the symptoms of distal median neuropathy.

Golfers can be difficult to convince that the tingling fingers, numb hands or aching thumb or wrist pain is a result of Carpal Tunnel Syndrome. CTS is considered a disorder that only affects those who do intense repetitive activities all day long at work, [24, 25] such as block laying, hairdressing [26] or computer keyboard work. However, in modern society golf driving ranges and facilities are readily available and frequently recreational golfers work harder on their golf than many other vocational pursuits.

Sports, pass times and hobbies can play a major role in contributing to this repetitive strain induced hand and wrist condition. The repetitive activity causes inflammation to some of the 9 flexor tendons that travel through the Carpal Tunnel. This inflammation results in swelling which ultimately affects the function of the median nerve. CTS diagnosis is made by a combination of electrodiagnostic nerve conduction studies and ultrasound examinations. Treatment of this common condition which affects between 5% and 21% of the population [27-30] involves a combination of treatments including splinting the wrist, injection therapy and surgery. In the golfer, correction of golf biomechanics and golf club customization are helpful in preventing reoccurrence.

Guyon's canal syndrome

Guyon's canal syndrome is a condition where there is compression and irritation of the ulnar nerve at the wrist. The ulnar nerve is responsible for strength and sensation on the little finger's side of the fourth finger and the entire fifth finger. Golfers with this condition may present with pain at the base of the wrist, loss of finger function and grip pressure as well as sensory alteration in the 4th and 5th fingers.

The hand may become clumsy when the muscles controlled by the ulnar nerve become weak. Weakness can affect the small muscles in the palm of the hand and the muscle that pulls the thumb into the palm.

Golfers are prone to irritation at Guyon's canal from local trauma to the nerve associated with an improper golf grip and trauma from the butt of the golf club impacting at the base of the wrist [31]. Hard playing surfaces and hitting down on the ball are risk factors.

Diagnosis is made by Electrodiagnostic testing of the distal ulnar nerve. Ultrasound is also used to rule out other space occupying lesions such as a ganglion cyst or schwannoma.

This syndrome is much less common than carpal tunnel syndrome (CTS), yet both conditions can occur at the same time. The numbness by Guyon's syndrome usually spares the thumb, index and long fingers.

Diagnosis

The diagnosis of ECU tendon pathology in a golfer requires a high index of suspicion as many patients battle on through the pain thereby worsening the pathology. Excluding the other common injuries can be achieved by a combination of careful history, clinical examination and the use of special tests such as Electrodiagnostic Medicine and radiology.

Dynamic ultrasound is very useful in diagnosing and differentiating the type of tendon pathology. It is the ideal tool to confirm a subluxing tendon as it observes the subluxation during ulnar and radial deviation and in flexion and extension motion [18]. The direction of subluxation and the type of sub-sheath injury being confirmed by dynamic imaging. This is an important element of diagnosis in cases of significant subluxation in professional golfers. Surgery is often warranted to repair this type of subluxation.

Treatment

Treatment for these varieties of ECU tendon injury should initially follow the normal treatment for tendinitis such as rest NSAID medication and splinting. Deep Oscillation Therapy has also been shown to be a promising treatment in swelling and symptom reduction [32]. Ultrasound guided injections may also be required in resistant cases. In cases of tendinosis a similar approach is made with the addition of Platelet-Rich Plasma (PRP) injections in resistant cases. This is a minimally invasive surgical alternative that uses components from a

patient's own blood to regrow tissue and relieve pain and promotes tendon regeneration by reducing inflammation and promoting the expression of anabolic genes and proteins [33].

Rest and splinting are the cornerstone for treating a subluxing ECU tendon, with regular revaluations with Ultrasound. If the subluxing ECU tendon fails to respond to conservative therapy, surgical reconstruction of the roof of the 6th dorsal extensor compartment using a portion of the flexor carpi ulnaris is performed [34]. Type I subluxation frequently requires surgery.

Return to play will require appropriate alteration in golf grip and swing biomechanics. Therefore, the return to play protocol for this injury in the golfing population should always include an assessment from a registered golf professional. In some instances, customized splinting of the wrist will prevent reoccurrence and allow a golfer return to a bespoke practice regimen. The message of qualitative rather than quantitative practice should be reinforced to avoid a training error reoccurrence, with 30 - 40 balls a good rule of thumb per practice session.

Conclusion

Wrist injuries in golf are common and significantly interfere with a player's ability to play and enjoy this common sporting pursuit. The ECU tendon is a frequent cause of wrist pain in the golfer. The sports medicine physician should have a high index of suspicion when

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