

# OVERUSE INJURIES OF THE UPPER EXTREMITY IN GOLF

John R. McCarroll, MD

The golf swing is physically demanding and contributes to various injuries. The person who does not play golf imagines it is less taxing than other sports; however, injuries are frequent and result in sprained wrists, aching shoulders, and sore elbows, and most injuries are related to the golf swing.<sup>15-17</sup>

## FREQUENCY

The frequency of overuse golf injuries to the upper extremity has received little attention in the literature. In a study of professional golfers, the left wrist was injured most frequently followed by the left hand, left shoulder, and left elbow (Table 1).<sup>15</sup> In the amateur golfer, the elbow was injured, most frequently followed by the hand and wrist and shoulder (Table 2).<sup>16</sup>

## CAUSES

The most common causes of overuse syndromes are summarized in Table 3. In the professional golfer,<sup>15</sup> the most common mechanism of injury was too much practice; in the amateur, the most common mechanism of injury was too much play or practice followed by poor swing mechanics (Table 3).<sup>16</sup>

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From the Methodist Sports Medicine Center, Indianapolis, Indiana

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**Table 1. UPPER EXTREMITY INJURIES IN THE PROFESSIONAL GOLFER**

	<b>PGA (n = 192)</b>	<b>LPGA (n = 201)</b>	<b>Total (n = 393)</b>
Left wrist	31 (16.1%)	63 (31.3%)	94 (24%)
Left hand	13 (6.8%)	15 (7.5%)	28 (7.1%)
Left shoulder	21 (10.9%)	6 (3.0%)	27 (7.1%)
Left elbow	6 (3.1%)	9 (4.5%)	15 (3.8%)
Left thumb	10 (5.2%)	3 (1.5%)	13 (3.3%)
Right wrist	3 (1.6%)	9 (4.5%)	12 (3.1%)
Right elbow	8 (4.2%)	3 (1.5%)	11 (2.8%)
Right shoulder	1 (0.5%)	9 (4.5%)	10 (2.5%)

PGA = Professional Golfers' Association; LPGA = Ladies Professional Golfers' Association.

**Table 2. UPPER EXTREMITY INJURIES IN THE AMATEUR GOLFER**

	<b>Male (Total = 584)</b>	<b>Female (Total = 124)</b>	<b>Total (708)</b>
Elbow	190 (32.5%)	44 (35.4%)	234 (33.1%)
Lateral	160 (27.4%)	34 (27.4%)	194 (27.4%)
Medial	30 (5.1%)	10 (8.1%)	40 (5.6%)
Hand and wrist	124 (21.2%)	18 (14.5%)	142 (20%)

**Table 3. MECHANISMS OF OVERUSE INJURIES**

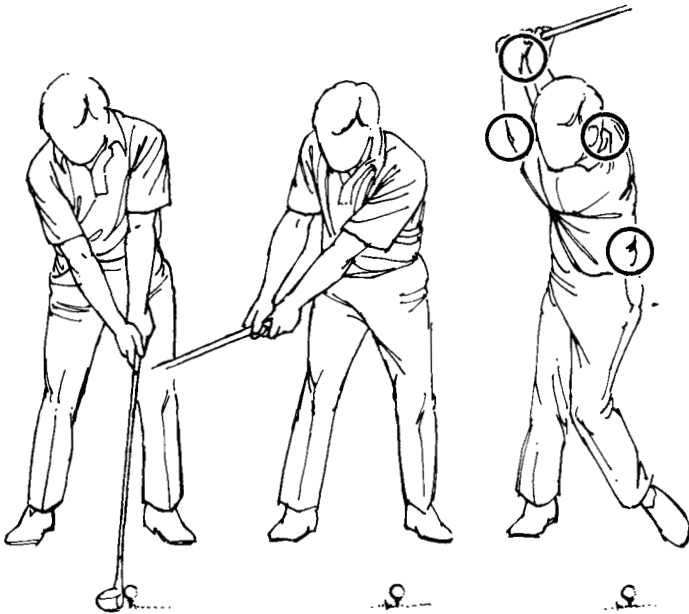
	<b>Amateur</b>	<b>Professional</b>
Too much play or practice	270	204
Poor swing mechanics	0	150
Hit ground (divot)	40	171
Overswing	0	85
Poor warm-up	0	60
Grip or swing change	0	26

## Golf Swing

To evaluate, treat, and prevent golf injuries, one must understand the biomechanics of the golf swing. For the purpose of this article, the golf swing is broken down into three parts: take away, impact, and follow-through. The golf swing occurs in two planes: the plane of the backswing and the plane of the downswing. The swing evolves around three dimensions: vertical, lateral, and rotatory.<sup>13</sup>

### Take Away

*Take away* consists of the setup and movement to the top of the backswing (Fig. 1). This phase starts when the golfer addresses the ball. During the backswing, the prime mover at this phase in the right shoulder is the supraspinatus portion of the rotator cuff, and not the deltoid. In the left shoulder of the right-handed golfer, the rotator cuff muscles fire minimally while the subscapularis is quite active.<sup>9</sup> The left thumb is hyperabducted, the left wrist is radially deviated, and the right wrist is dorsiflexed. Fewer than 25% of all golf injuries occur during this part of the swing, however (Table 4).



**Figure 1.** Take away. The circles indicate areas most frequently injured.

**Table 4.** RELATION OF INJURY TO SWING

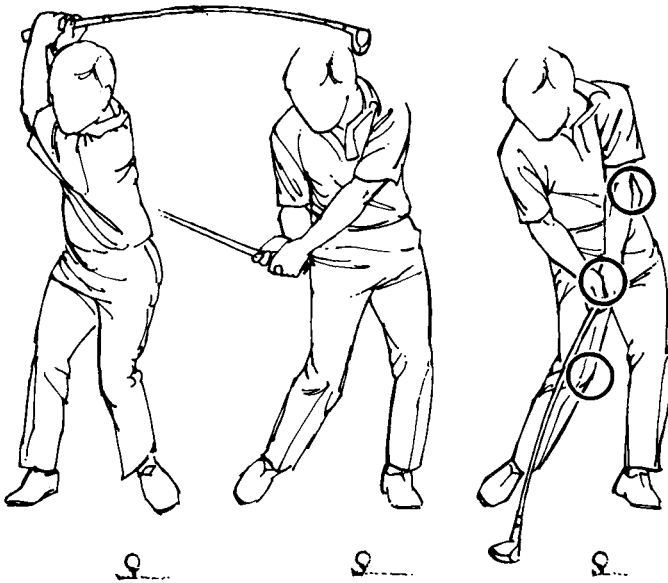
Swing	Injuries
Take away	Total injuries = 75
Back	28
Wrist	25
Elbow	9
Hand	7
Shoulder	6
Impact	Total injuries = 179
Wrist	73
Back	50
Elbow	22
Hand	16
Shoulder	9
Knee	7
Upper back	2
Follow-through	Total injuries = 106
Back	43
Shoulder	18
Ribs	12
Knee	10
Wrist	9
Neck	6
Hand	4
Elbow	4

### *Impact*

Impact consists of the *downswing* and the *impact* of the club with the ball (Fig. 2). Table 4 shows that more than twice as many injuries occur during impact than during take away. This is easy to believe because the club, during downswing, covers the same range of motion as does the backswing but moves about three times as fast.

As the downswing begins, the golfer shifts his or her weight to the left side by moving the hip toward the target. Good golfers actually begin this hip movement about 0.1 seconds before the downswing starts.<sup>4, 8</sup> To develop maximum acceleration in the downswing phase, the golfer applies the stretch-reflex principles. When the whole muscle is stretched, the stretch of the muscle spindles causes a reflex contraction of the host muscles. As a result, the contractile force of the muscle increases and facilitates the recoil of elastic tissue. Increasing the flexibility of the major muscle groups can further develop this reflex. Thus, the farther a person can rotate his or her shoulders away from the target, the greater the greater the clubhead speed that can be generated, thus increasing distance.

Counterclockwise torque in the upper body is generated by the buttocks, quadriceps, hamstrings, and lower back muscles. The torque causes moderate levels of activity in the pectoralis major, latissimus dorsi, and rotator cuff muscles in both shoulders.<sup>9</sup> During the downswing, the wrists apply a negative torque by remaining cocked. The



**Figure 2.** Impact. The circles indicate areas most frequently injured.

right wrist is in maximum dorsiflexion, the left thumb is hyperabducted, and the left ulnar nerve, elbow, and forearm muscles are under tension. When the club is approximately horizontal to the ground, the wrists uncock, thus accelerating the club into the ball. The pectoralis major, subscapularis, and latissimus dorsi of both arms power these movements.<sup>9</sup>

The impact stage of the golf swing begins the instant before contact, when the clubhead has attained its maximum velocity, to the instant the ball has completely left the tee. From a performance aspect, the purpose of impact is to hit the ball as far as possible in the proper direction. From a safety aspect, the purpose of the impact stage is to have a smooth transition from acceleration to deceleration.

During impact, both wrists are under compression, and the left elbow extensor mass contracts. The left wrist, hand, and elbow are often hurt during the compression of impact.

### *Follow-through*

About 25% of all golf swing injuries occur during follow through (Fig. 3; Table 4). After impact, in the right-handed golfer, the left forearm supinates, the right forearm pronates, and the lumbar and cervical spines rotate and hyperextend. The subscapularis continues activity at the same level, while the latissimus dorsi and pectoralis muscles of both arms become less active, decelerating the swing.<sup>9</sup>

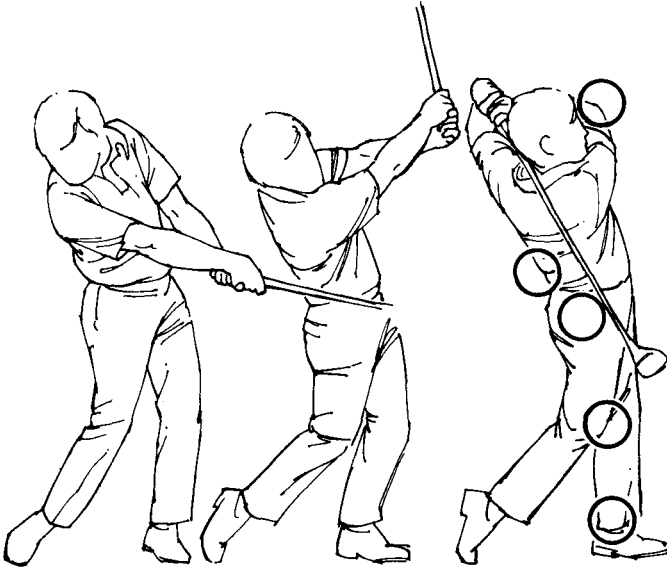


Figure 3. Follow through. The circles indicate areas most frequently injured.

## HAND AND WRIST INJURIES

Tendinitis is the most common problem seen in the wrist and forearm of the golfer. It is due to the repetitive dorsiflexion and palmar flexion motions of the right wrist, the radial deviation–ulnar deviation motion of the left wrist, and extremes of pronation and supination. Ulnar deviation of the left wrist occurs only minimally just before impact, but it occurs at a faster speed while the wrist is under high degrees of stress. Tendinitis can involve the extensor carpi ulnaris, extensor carpi radialis longus, extensor carpi radialis brevis, flexor carpi ulnaris, and flexor carpi radialis.

Tendinitis usually presents as aching or burning pain in the affected tendon. Physical examination reveals tenderness and sometimes crepitus in the specific tendon or tendons. The golfer also can experience pain with resisted dorsiflexion or palmar flexion.

Treatment of tendinitis of the wrist extensors and flexors consists of immobilization, rest, and nonsteroidal anti-inflammatory medications. This treatment depends on the severity and duration of pain. One must closely monitor the pain and dictate the advancement of the golfer through the three phases of treatment.

Phase I consists of icing and cross-friction massage.<sup>6</sup> In addition, stretching is advocated before and after exercise.<sup>1, 5</sup> Phonophoresis and low-voltage electrical stimulation also can be used.

Phase II is started when pain has decreased to a tolerable level. It

includes an eccentric exercise program described by Standish et al.<sup>21</sup> Exercises also are performed to increase grip and pinch strength.

Phase III includes a functional progression golf program (Table 5). Progression depends on the severity of the problem.

De Quervain's syndrome (tenosynovitis of the first dorsal compartment) is a specific tendonitis that deserves special attention. This syndrome is the result of repetitive practice. The diagnostic sign is Finkelstein's test, which is performed with the thumb and hand forced and deviated toward the ulnar side of the wrist.<sup>7</sup> This test is similar to the mechanisms that are involved in hitting the golf ball, especially at preimpact and impact. Exquisite pain over the radial styloid process and the common sheath of the first compartment constitutes a positive test. Conservative treatment of de Quervain's disease usually involves splints, ice, and medication. Injection or operative treatment is considered only in resistant cases.

The most common stress fracture is the fracture of the hook of the hamate in the left hand of a right-handed golfer.<sup>23</sup> Fractures occur in golf when the grip of the club strikes the hook of the hamate. Clinical examination shows tenderness over the hook of the hamate. Radiographs should include anterior-posterior, lateral, oblique, and carpal tunnel views and a special supination view described by Stark.<sup>22</sup> If these views do not show a fracture but the injury is still suspected, then a bone scan or computed tomography (CT) scan can be helpful. In the acute nondisplaced fracture, the treatment is a short arm cast and rest for 6

**Table 5.** INTERVAL GOLF REHABILITATION PROGRAM

Week	Monday	Wednesday	Friday
1	5 min chip & putt 5 min rest 5 min chip	5 min chip & putt 5 min rest 5 min chip 5 min rest 5 min chip	5 min chip & putt 5 min rest 5 min chip 5 min rest 5 min chip
2	10 min chip 10 min rest 10 min short iron	10 min chip 10 min rest 10 min short iron 10 min rest 10 min short iron	10 min short iron 10 min rest 10 min short iron 10 min rest 10 min short iron
3	15 min short iron 10 min rest 15 min long iron 10 min rest 15 min long iron	15 min short iron 10 min rest 15 min long iron 10 min rest 15 min long iron	15 min short iron 10 min rest 15 min long iron 10 min rest 15 min long iron
4	15 min short iron 10 min rest 15 min long iron 10 min rest 15 min long iron	Play 9 holes	Play 18 holes

Stretch before exercise and ice after hitting.

weeks. The incidence of nonunion of this fracture is high, however. In a badly displaced fracture or nonunion, excision of the hook of the hamate is indicated.

The golfer can suffer from other miscellaneous hand and wrist conditions, including ligamentous sprains, carpal tunnel syndrome, Guyon canal syndrome, impaction-impingement syndromes, occult or overt ganglia, ulnar compression syndromes, and distal radial ulnar joint syndrome.<sup>1, 3, 7, 11, 18, 21</sup> All of these occur during the golf swing and must be considered when treating hand and wrist injuries.

## ELBOW INJURIES

The golfer can suffer two common elbow injuries: medial and lateral epicondylitis. During the backswing, little physical stress is put on the elbows or forearms. A slower and smoother backswing, however, allowing the wrist to cock naturally, causes even less force on these muscles and tendons. At the transition to the downswing and impact, stress is reduced if motion is begun by the hips, with forward arm motion initiated by the shoulder, not the wrists. The common swing fault of "casting" the club into the swing or hitting from the top can be a major contributor to the development of medial epicondylitis. At impact, this deceleration, especially when taking a divot, requires significant counteracting forearm muscle force to maintain control of the clubface and places a further strain on either the lateral or medial epicondyle. Most elbow injuries take place during impact (see Fig. 2 and Table 4).

Epicondylitis results in varying degrees of disability. In mild cases, pain is felt only when the golfer swings the club. In more severe cases, sufferers can find themselves unable to perform even everyday tasks. The diagnosis of epicondylitis usually can be determined by a series of simple tests. Tenderness to palpation over either epicondyle and pain with resisted dorsiflexion or volar flexion of the wrist are symptoms. Tendinitis is by far the most common of all elbow injuries, but one must consider radial tunnel syndrome and ulnar nerve entrapment as causes of these symptoms. Furthermore, degenerative changes in the cervical spine in the region of C5 and C6 can cause radiating pain.

Treatment is divided into four stages: (1) Relief of acute or chronic inflammation, which is accomplished by rest, ice, nonsteroidal anti-inflammatory medication, and splinting. (2) Increased forearm muscle strength, flexibility, and endurance, which are accomplished through physical therapy that stresses flexibility of the muscles and eccentric exercises to increase strength of the muscles in conjunction with cross-friction massage. (3) Decreased movement of force at the wrist, which can be addressed by altering swing mechanics. One must correct poor swing technique to ensure that the injury does not recur. Equipment changes also can be necessary to correct the force applied to the forearm muscles, including using a larger grip size and graphite shafts, which



cause less torque to the forearm and elbow. Elbow supports or counterforce bracing also can help provide a reactive force against the contractile muscles and either spread the force over a wider area or decrease the contracture pull on the epicondyle. (4) Corticosteroid injections are used if no other treatment has improved symptoms. If injections do not help and all other conservative treatment fails, surgery must be considered.<sup>19, 20</sup>

## SHOULDER INJURIES

Repetitive overuse of the shoulder in golf yields rotator cuff pathology. Disregarding pathology in the sternoclavicular, scapulothoracic, and acromioclavicular joints, which must be considered in the clinical setting, the overuse injury usually affects the rotator cuff tendons.<sup>2, 14</sup> This overuse syndrome can range from tendinitis or subacromial bursitis to impingement syndrome and perhaps, eventually, to rotator cuff tears.

Initially, after the diagnosis of rotator cuff overuse, the patient is placed on a therapy program, which includes treatment to rest the irritated shoulder by decreasing the activity that precipitated the condition. During this time, it is important to maintain mobility with stretching and strengthening exercises. A nonsteroidal anti-inflammatory medication can help decrease pain and inflammation. Many times, the subacromial injection can be given with local anesthetic and corticosteroid to support the diagnosis of impingement and decrease irritation in the subacromial bursa.

Once stiffness and sensitivity have been overcome, attention should be directed toward recovering tone and strength. Poor swing mechanics also should be corrected.

If conservative measures are inadequate, further work-up including magnetic resonance (MR) imaging should be done to rule out rotator cuff tear. Surgery may be necessary to correct impingement or repair the rotator cuff pathology, or both. In the golfer, as well as any overhead athlete, one must make certain that the glenohumeral dysfunction is not due to instability, which must be corrected for a successful surgical outcome.

## PREVENTION OF GOLF INJURIES

The golfer should start with a professional to assure proper swing mechanics and the proper equipment to prevent injuries and to reduce abnormal stresses to various body parts. Preventing injury in any sport is difficult, and golf is an activity demanding a high degree of refined motor skills. Many frustrated golfers try to play when they are not in shape. The weekend and even the professional golfer must condition the body or assume the risk of injury.

Three types of exercises are required to reduce the risk of injury: (1)

**Table 6.** NAUTILUS WORKOUT PROGRAM FOR GOLF

<b>Exercise</b>	<b>Muscles</b>	<b>Skills</b>
Hip and back	Buttocks, lower back	Driving power Walking endurance
Leg extension	Quadriceps	Driving power Walking endurance
Leg curl	Hamstrings	Hip turn Driving
Double shoulder (lateral press)	Deltoids	Club control Impact
Double shoulder (seated press)	Deltoids, triceps	Shoulder turn Club extension
Pull over	Latissimus dorsi	Shoulder turn Club extension
Wrist curl	Forearm flexors	Club head control Impact Power
Reverse wrist curl	Forearm extensors	Club head control Acceleration

Stretching exercises maintain complete range of motion of the hamstrings, back, and shoulder to ensure that abnormal stress is not placed on various body parts during the swing<sup>10</sup>; (2) Unlike other sports, golf is not a strength game. Strength, however, allows the player to strike shots with more consistent explosive power over extended periods. One can use equipment such as Nautilus, universal gyms, or home devices to increase strength. These workout programs also develop endurance to repeat the swing over and over during the game of gold (Table 6). Perform one set of 8 to 12 repetitions of each exercise, taking no more than 60 seconds to perform each set. Rest no more than 30 seconds between sets; (3) Cardiovascular exercise for endurance is another essential part of conditioning. Climbing hills and walking 18 holes is impossible without a cardiovascular system that responds to strenuous exercise.

## SUMMARY

Golfers are athletes, for golf is a sport. To play it well, one must have athletic ability, strength, agility, coordination, and endurance. The golf swing is physically demanding and has contributed to overuse injuries in the upper extremity. The wrist, elbow, and shoulder are the most frequently injured joints.

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*Address reprint requests to*

John R. McCarroll, MD  
Methodist Sports Medicine Center  
201 Pennsylvania Parkway, #200  
Indianapolis, IN 46280