

## Chapter 2

# Tennis Elbow in Athletes: More Than Just Tennis?

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### Lateral Epicondylitis: Origins in Sport

From the earliest descriptions of lateral epicondylitis pathology, there has been an association with sport. These descriptions include a letter by Henry J. Morris published in *Lancet* in 1882 describing the condition of “lawn tennis arm [1].” Soon after, Major used the term “lawn tennis elbow” published in the *British Medical Journal* in 1883, to describe the painful condition of epicondylitis in participants in the newly popular game [2]. This makes it the forerunner of sport specific elbow pathology that now includes golfer’s elbow, pitcher’s elbow, and Little Leaguer’s elbow to describe specific pathologies recognized in sport. From the time of that first description, and despite many etiologic, diagnostic, and therapeutic studies on the subject, the relationship with sport has been preserved. Although less than 10 % of patients with this condition will be tennis players, or for that matter, athletes, we are compelled to further explore the relationship of this entity with sport, and to understand that tennis is not the only competitive activity among which this injury pattern can be recognized.

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## Biomechanics of Tennis

Although lateral epicondylitis can be caused by many sporting activities, there is no other event that causes it with the frequency of tennis. It has been estimated that up to 50 % of all recreational players will experience the condition at some point of their career [3]. Furthermore, the link between increased playing time and increased risk of developing the condition has also been well established with twofold or higher incidence in players with more than 2 hours of racquet time per week [4]. For this reason, tennis-specific activities have been the subject of the most intense scrutiny of sport-specific factors contributing to lateral epicondylitis.

The origin of tennis elbow pathology remains unclear. Repetitive contractions have been implicated by causing microtrauma to the common extensor origin, with cumulative degeneration leading to pain and disability [5]. Morris and associates evaluated tennis players using electromyography (EMG) analysis. Healthy high-level tennis players performed groundstrokes with the findings of greatest muscle activity noted in those muscles stabilizing the wrist, specifically the extensor carpi radialis brevis (ECRB), the extensor carpi radialis longus (ECRL), and the extensor digitorum communis (EDC). Amongst these, the ECRB was noted to have the greatest activity. The authors suggest that these muscles provide optimal stability for these phases of the groundstroke by maintaining the position of the wrist in extension and radial deviation [6]. The repetitive focus of stress on the ECRB predisposes this location to injury.

Other proposed mechanisms leading to lateral epicondylitis symptoms include mechanical impingement of the ECRB tendon against the lateral edge of the capitulum during elbow motion [7]. Repetitive abrasion through the arc of motion could help explain the wide variety of sporting and occupational associations. A neurogenic cause of these symptoms has also been proposed based on the anatomy of nerve innervation to the ECRB [8]. In a cadaver study, 40.2 % of specimens had either a muscular or tendinous arch around the posterior branch of the radial nerve, which the authors proposed as a potential cause of tennis elbow symptoms.

Whether traumatic, degenerative, or neurogenic, repetitive wrist extension against resistance appears to be the common pathway for development of lateral elbow pain in sports. In tennis, the backhand groundstroke is thought to be the greatest source of pain generation as it fits the requirement of an extended and radially deviated wrist contracting against the resistance of the ball strike. Adding a rotary moment to this motion to add backspin or topspin by pronating or supinating the extended wrist may serve to exacerbate the traumatic forces.

Personal factors related to the participants of sport may also predispose to developing tennis elbow. Shoulder range of motion and strength have been proposed as contributing factors. Female recreational tennis players with a diagnosis of lateral epicondylitis were found to have weaker trapezius muscle strength, weaker wrist extension strength, and higher shoulder internal to external rotation and wrist flexion to extension strength ratios [9]. This study suggests that imbalance of upper extremity muscle groups, found more commonly in amateur athletes rather than

highly trained athletes, may be a factor. As some evidence suggests, it may be the recreational athlete who is more at risk than the elite player [4].

Tennis specific suggestions for factors that may predispose to tennis elbow include racquet grip size. Nirschl proposed that appropriate grip circumference can be measured on the hand as roughly equal to the distance from the proximal palmar crease to tip of ring finger, with larger grip circumferences thought to be protective. This remains a common recommendation although an EMG study of collegiate tennis players using grips 1/4 inches above and below this guideline showed no significant differences in muscle activity [10].

Factors that serve to increase the force of resistance against the firing muscles of the forearm are also postulated to increase symptom development. In tennis, some of these studied factors include string tension with higher tension leading to greater forces acting on the extensors. This may put amateur players at greater risk as they may opt for a string tension that exceeds their training and performance. With off-center hits, increased grip tightness caused significantly more wrist extension torque which may also contribute to lateral epicondylitis pathology [11].

The string density is another racquet factor that contributes to force generation. A higher string count per unit area will also dampen forces transmitted to the arm. This is a factor related to racquet design and less amenable to aftermarket modification than grip size. Increased racquet weight requires greater force generation to support in a wrist extended position and will put greater stress on the muscles in question. In all sports that require swinging an object, choosing the appropriate size and weight equipment will be protective from injury. In addition, materials that serve to dampen vibratory forces such as graphite and epoxies will lessen the forces transmitted to the extensor origin [1].

Court surfaces have also been implicated in development of tennis elbow. Harder court surfaces conserve greater momentum of the ball, and subsequently increase the force transmitted through the racquet. These surfaces are most cost-effective to maintain in a municipal setting, and thus the most likely available to the average player. Softer court surfaces such as grass and clay courts in the specialty club environment are less accessible to amateur players.

## Other Racquet Sports

The literature about tennis elbow in other racquet sports is minimal. Badminton has been reported to have a “surprisingly low incidence of tennis elbow” [12]. With extremely light racquets and projectile designs, the forces acting across the wrist extensors is likely to be much less than is experienced in other racquet sports. Squash, with a heavier ball and long moment arm acting on the racquet, has also been noted in reports of lateral epicondylitis [13]. Racquetball has been included in lists of sports at risk for development of lateral epicondylitis [1], although specific reports are rare.

## Other Swinging Sports

The non-racquet sports that require swinging an object have similar risk factors to tennis, but fewer reports of epicondylitis are documented.

Golf is known primarily for its association with epicondylitis of the medial side of the elbow, with golfer's elbow, an accepted name for this tendinopathy. Interestingly, arm pain from lateral epicondylitis is the most common upper extremity injury in amateur golfers [14]. Again, these injuries have been noted as more common in amateur and female players [15, 16]. As in the tennis swing, there is vigorous contraction of the extensor muscles to stabilize the wrist. Furthermore, club impact with the ground at the end of the swing places additional stress across the extensors [17]. Like recreational tennis as opposed to baseball or cricket, the majority of participants in this sport are recreational, with a wide variety of skill levels and with varying quality of equipment.

The association of baseball and epicondylitis primarily revolves around the medial sided elbow pathology that is common in overhead throwers due to repetitive valgus loads. Concern for lateral sided elbow injuries is largely absent from the volumes of data that have been accumulated on baseball injuries, and exist primarily as theoretical injury patterns. The lead arm in the batting motion supports a heavy object with a wrist extended and radially deviated position, often with a supination motion at contact and follow-through against a heavy projectile moving with significant velocity. Furthermore, many swing patterns involve a single-handed follow-through, mimicking the single handed tennis backhand that is considered to be the greatest offender of the tennis swing for development of lateral epicondylitis. Perhaps it is because the absolute number of recreational baseball and softball players are much less than the number of recreational tennis players, or that the frequency of play and number of swings per exposure are much less that this pathology is not reported. However, by mechanism alone, the baseball swing may put a player at risk and this pathology should be suspected in the baseball or softball player who presents with lateral elbow pain.

In much the same way as baseball, the cricket swing can be expected to place forces across the wrist extensors subjecting them to injury and development of lateral epicondylitis. Cricket also has a small footprint on the lateral epicondylitis literature and receives only passing mention [8]. Unlike baseball, a cricket batsman remains at bat until retired and may be required to swing many more times than a baseball player in a match.

## Olympic Sports

A consistent theme through the discovery of lateral epicondylitis in sport is that the amateur participants with less refined techniques or equipments place themselves at greater risk than the highly trained professional athlete. However, archery is one pursuit that defies this logic. Archery is an Olympic sport, although more often practiced by the amateur in the realm of hunting and outdoor activity rather than

competition. In the process of the shot, the wrist extensor musculature of the bow arm is subjected to significant force as the wrist holds an extended posture to counteract the force of string pull. The faulty technique of the amateur is to hold the bow in a flexed wrist posture, which is protective of the lateral epicondylar insertion [18]. Thus, it may be the elite competitive archers, rather than the beginners that present with this complaint. Furthermore, this may be exacerbated at higher levels of competition where string tensions may be increased.

Martial arts disciplines have also been identified as a source of tennis elbow symptoms. In the performance of these techniques, certain postures and movements demand prolonged contraction of forearm and wrist musculature. One case report detailed a fulltime karate instructor with lateral epicondylitis of both upper extremities as the result of this training [19]. This clearly represents a provocative activity with overtraining or repetition of an action beyond a physiologic threshold. This union can be extrapolated to any of the sporting activities discussed.

Swimming is an excellent form of nonimpact aerobic exercise and is recommended to many orthopaedic patients as a way to avoid injury or degeneration to weight-bearing joints. This is likely the same population who is at risk for lateral epicondylitis resulting from pool work. In swimmers, this condition is recognized in athletes who are typically greater than 30 years old and can frequently be associated with training errors or faulty stroke techniques [20]. As is the case with many other sports, proper technique and avoidance of overtraining can be preventative.

Rowing as a competitive sport has fewer overall participants; however, rowing machines are ubiquitous in gyms, and popular for cardiovascular exercise. Lateral epicondylitis has been recognized as an upper extremity complaint in rowers, and understanding of basic rowing biomechanics and techniques has been advocated for providers to more effectively recognize and treat patients in this population [21].

## Other Sports

Increasing in popularity with the advance of indoor facilities is the sport of rock climbing or bouldering. This sport is uniquely demanding of upper extremity strength and endurance, and overuse tendinopathies of the elbows are common. The forces required of the muscles crossing the wrist and elbow are significant, especially for very demanding routes which may include reverse inclines or overhangs. In a survey of Austrian climbers, 29.6% of all men and 13.4% of women reported occurrence of lateral epicondylitis [22]. In fact, lateral epicondylitis trailed only annular ligament strains of the fingers for the most commonly reported injury. The investigators also noted that lateral elbow tendinopathy was more common in men with increased age and increased climbing stress.

A population that is sometimes overlooked in sport injury discussions is the disabled athlete, including the wheelchair athlete. The use of the upper extremities for force generation in a competitive setting lends itself to overuse injuries and tennis elbow is recognized as being prevalent in wheelchair users [23]. Wheelchair racing including

distance racing has been considered a high-injury risk sport and in an evaluation of the British Wheelchair Racing Association, overuse injuries were common and recurred more often than other types of injuries [24]. In a study of wheelchair fencers, elbow strains were the predominant musculoskeletal complaint [25]. With the rapidly growing availability of wheelchair sports, physicians should be aware of the associated musculoskeletal injuries and be prepared to offer appropriate treatment.

The military athlete is another population that deserves mention. The active-duty military population is known for high levels of physical activity, continuous physical fitness, and strenuous job-related demands placed on their upper extremities. In a focused study of this population, female gender, age greater than 40, and Caucasian race were found to have higher incidence risk ratios of tennis elbow [26]. As with the general and athletic populations, in the military, lateral epicondylitis was found to be more common than medial epicondylitis.

## **Other Recreational Pursuits**

While not technically a sport, professional musicians often have demanding, repetitive motions that can be physically demanding and result in musculoskeletal injury. Percussionists, keyboard players, and stringed instrument players all have repetitive flexion and extension of the wrist, which predisposes to lateral epicondylitis. Furthermore, this is an activity that may involve hours of dedicated practice several times a week or even daily for dedicated players. While percussion or keyboard may be equilateral in terms of their presentation, string players will more commonly present with pathology in their fingering hand [27]. Musicians tend to have vague pain localized to the lateral epicondyle thought to be more typical of the occupational injury rather than the athlete; however, treatment recommendations and surgical indications are felt to be similar [28].

## **Treatment, and Return to Sport**

Sport specific reports of treatment are rare, but there are some studies that give reference for evaluation of treatment in athletes as compared to the general population.

Counterforce bracing, and wrist extension bracing for lateral epicondylitis symptoms, are relatively simple and inexpensive methods to initiate treatment. Correct placement of the counterforce brace should be directed to the athlete. Placement just distal to the lateral epicondyle has been found to reduce loads greater than placement directly over the lateral epicondyle [29]. Wrist extension braces place the arm in a position of rest for lateral epicondylar muscles. Specific outcomes for return to activity are not well reported.

More intensive intervention may involve utilization of physical therapists or athletic trainers in the treatment of these patients. A consecutive group of nine rock

climbers presenting with lateral epicondylitis diagnoses were treated with a program of cervical spine manipulation, mobilization treatments to the elbow, manipulation of the wrist, dry needling, and kinesio tape. They were followed with measures of the patient-related tennis elbow evaluation as well as pain pressure threshold testing to ECRB and ECRL, brachioradialis and supinator muscles. At 2 and 6 months, all patients showed improvement [30]. This study suggests that a variety of nonoperative treatments should be explored and can be expected to give some improvement to patients with these conditions.

Corticosteroid injections are common in the treatment of lateral epicondylitis that is refractory to noninvasive means of treatment. The risks of steroid injection include tendon rupture, fat necrosis, and skin discoloration and should be weighed against conflicting data on efficacy [31, 32]. These risks may be more concerning in a high-level athlete or in the setting of chronic treatment.

Another nonoperative treatment option is extracorporeal shock wave treatment. This has been trialed on athletes including a study of effects in tennis players. In a study of 78 players with at least 12 months of symptoms a placebo-controlled trial was performed with weekly treatments over 3 weeks. In the treatment group, 65% of players had improved symptoms at 3 months compared with 28% in the placebo treatment group, which was statistically significant [33]. However, a similar study in a general population did not show any difference in treatment versus placebo group [34].

Surgical treatment has been well described in the patient refractory to conservative management; among athletes, open versus arthroscopic techniques have been debated. Although there are no head-to-head studies in athletes there is some consideration that in the appropriate patient arthroscopic treatment may allow more rapid return of the athlete to sport activities [35].

Although there are many excellent outcomes reported with a variety of surgical modalities, not all athletes will be able to return to their previous level of sporting competition. In a series of 19 patients treated with open extensor release and origin reattachment found that 18 of 19 patients were “better,” yet six (60%) of those playing high-demand sports and two (15%) of those with high-demand employment changed sports or jobs postoperatively [36]. All athletes that are contemplating surgical intervention for this condition should be counseled that they may not return to their previous level of competition.

## Summary

Lateral epicondylitis is a diagnosis that has a special relationship with sport. It derives from motion patterns that are ubiquitous in upper extremity competition whether swinging a racquet or not. The fact that it is also a source of occupational morbidity only increases the importance of physician awareness and knowledge of treatment options. Sport participation is an important link to lifetime fitness and has innumerable benefits to patient health. For many patients, return to sport may be as



important to them as return to work. For the physician practice that treats athletes of all skill levels, it is important to understand that tennis elbow is more than just tennis.

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