Chapter 1
Tennis Elbow: Definition, Causes, Epidemiology

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Introduction

The diagnosis of lateral epicondylitis was first made by Runge in 1873, in which the author described lateral humeral condylar tenderness and difficulty in writing [28]. In 1882, Morris coined the term "lawn tennis elbow" as he found the condition was associated with the tennis backhand stroke [17]. Over time, this entity became known as "tennis elbow" or lateral epicondylitis. It is important to realize that the term "tennis elbow" is a misnomer as golfers, baseball players, clothing pressers, salesmen carrying grips, violinists, blacksmiths, telephone operators, and homemakers are all susceptible to this condition. Patients afflicted with this condition typically experience pain at the origin of the extensor muscle, pain with resisted wrist extension, and tenderness with palpation of the tendinous origin of the muscles at the lateral humeral epicondyle. The condition can be very difficult to treat.

Definition

The elbow is a trocho-ginglymus joint with articulations between the humerus, ulna, and radius [25]. A series of musculotendinous units cross the elbow joint and function to position the arm and hand in space. The lateral epicondyle of the humerus has been described as a pyramid-shaped bony prominence from which the anco-

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neus, extensor carpi radialis brevis (ECRB), extensor digitorum communis (EDC), and extensor carpi radialis longus (ECRL) originate [7]. Among these, the ECRB has been implicated most often in lateral epicondylitis, with additional involvement of the EDC 35–50 % of the time [26, 27]. The ECRB originates from the anterior face of the lateral epicondyle, is located deep to the other extensors, and is characteristically tendinous at this location.

The term "epicondylitis" falsely implies an inflammatory reaction. Excised ECRB tendon in patients with lateral epicondylitis has shown the normal tissue of ECRB invaded by immature fibroblasts and nonfunctional vascular buds, with disorganized surrounding and hypercellular tissue. This finding led Nirschl et al. to coin the term "angiofibroblastic tendinosis" [11, 27]. Despite the absence of inflammation, patients with lateral epicondylitis complain of pain, particularly during activities requiring wrist extension. Elevated levels of substance-P, calcitonin gene-related peptide, and glutamate have been found within the ECRB tendon in patients with chronic tennis elbow, thus offering another etiology for pain [2, 23].

Etiology

The cause of pain and disability in lateral epicondylitis is unknown. It is likely to be multifactorial with an emphasis on repetitive microtrauma and overuse in genetically predisposed individuals.

Some authors have proposed that the rate of lateral epicondylitis is lower in those with two-handed backstrokes vs. single-handed backstrokes, as the nondominant arm helps offload the forces seen by the leading arm [12]. While in theory this might make sense, no clinical studies have proven this to be true. In fact, one investigation found no difference in electromyography (EMG) profiles of ECRB activity between one- and two-handed backstrokes [12]. Similarly, grip size and the use of dampeners to reduce vibration of the strings of racquets have not been shown to affect the rate of lateral epicondylitis [15, 22, 32]. Hennig et al. did find that the more experienced tennis players experienced less vibration and had decreased EMG [16] firing in the wrist extensors during backhand stroke compared with novice players, lending credence to improper technique as a likely cause of developing lateral epicondylitis. Supporting this idea, Kelley et al. showed increased activity in the wrist extensors and pronator teres on EMG and high-speed film during ball impact and early follow-through in tennis players with lateral epicondylitis compared with the control group [18].

Lanz and Wachsmuth [21] described seven bursae, including the radiohumeral bursa located deep to the common extensor tendon and superficial to the radiohumeral joint capsule. Some authors have postulated that these bursae are a potential cause of lateral epicondylitis as repetitive wrist extension with the arm pronated inflamed these structures [8, 24].

Others have evaluated the vascularity of the lateral epicondylar region to help understand the etiology of tennis elbow. Schneeberger and Masquelet studied the

arterial anatomy of the ECRB in cadavers and consistently found an avascular zone at the undersurface of the extensor tendon origin [29]. Others noted hypovascular zones at the lateral epicondyle and 2–3 cm distal to the extensor insertion [3]. Another possible mechanism maybe the autonomic nervous system, which controls vasoconstriction and vasodilatation of the blood vessels surrounding the ECRB. Smith et al. showed abnormal sympathetic vasomotor response in 40 patients with lateral epicondylitis compared with the contralateral unaffected side using a laser Doppler flowmeter to measure dermal blood flow velocity [31].

Laban et al. stressed the importance of examining the shoulder, as unrecognized shoulder pathology may place elevated stress across the common extensor muscle group. In 19 patients with decreased internal rotation, the authors showed that they used increased wrist flexion to compensate for the loss of arc of motion in the shoulder [20].

Bunata et al. studied the anatomical relationship between the ECRB and lateral edge of the capitellum in 85 cadaveric elbows. The authors found that the ECRB undersurface is vulnerable to friction wear as the ECRL compresses the ECRB against the lateral edge of the capitellum [6].

Dellon et al. described a neuroma of the posterior cutaneous nerve of the forearm as a potential source of pain in the area of the lateral epicondyle, particularly after surgical treatment of lateral epicondylitis [9]. This is an important consideration in patients with recalcitrant pain following surgical treatment. In a small series of nine patients, Dellon reported eight patients had excellent pain relief and one patient had good pain relief when the neuroma was excised with implantation of the proximal nerve end into the brachioradialis. Additionally, Dellon showed statistically significant greater improvement in pain relief and faster return to work in patients who underwent denervation of the lateral epicondyle compared to patients who received an epicondylectomy [5].

Epidemiology

Lateral epicondylitis affects 1–3 % of adults in the general population each year [1, 34]. However, the incidence may differ depending on the population of interest as more than 50 % of amateur tennis players reported having been affected with lateral epicondylitis at some point in their career [19]. Typically, adults in the fourth or fifth decade of life are affected. Males and females are affected equally [10, 30], and oftentimes it is the dominant arm that is symptomatic.

Manual laborers, smokers, and those who repetitively bend/straighten their elbow for more than 1 h/day and have poor social support have been associated with higher rates of lateral epicondylitis [10, 14, 30, 35] (Table 1.1). The burden on the economic system is substantial, with 5 % of the affected working-age subjects reporting work absence because of elbow symptoms in the past 12 months [35]. In addition, comorbid conditions, including rotator cuff pathology, DeQuervain's disease, carpal tunnel syndrome, and oral corticosteroid therapy, have been shown

Table 1.1 Reported risk factors for lateral epicondylitis

Age 30–50 years
Manual labor
Smoking
DeQuervain's tenosynovitis
Carpal tunnel syndrome
Oral corticosteroid therapy
Repetive activities > 1 h/day
Poor social support
Poor tennis mechanics

to be independent risk factors for developing lateral epicondylitis. The exact mechanism for this is unclear [33].

The workers' compensation (WC) population can be a difficult subpopulation to treat. Balk compared surgical outcomes of ECRB tendon release between patients filing for WC and those who had no work-related issues. At a mean follow up of 51 months, both groups were found to be equally satisfied with their results and pain relief. However, fewer WC patients returned to their original or similar work status compared with non-WC patients (65% vs. 77%, respectively). Furthermore, 24% of WC patients changed jobs because of persistent symptoms, versus only 4% of non-WC patients [4]. Similarly, Grewal et al. reported on a cohort of 36 patients treated with arthroscopic release for tennis elbow, in which 23 were WC claimants. After surgery, WC patients took twice as long to return to work (24.5 weeks vs. 10.3 weeks), scored lower on American Shoulder and Elbow Society (ASES) scores, Mayo Elbow Performance index, Patient Rated Tennis Elbow Evaluation, Medical Outcomes Study 12-Item Short Form, and Work Limitation Questionnaire [13].

Within the military population, it appears that female gender, age greater than 40 years, and white race are risk factors for developing lateral epicondylitis [36].

Conclusions

Lateral epicondylitis is a condition primarily occurring in adults between the ages of 30 and 50 years. Although the name "lateral epicondylitis" implies an inflammatory reaction, histologic evidence suggests that this condition is more reflective of a chronic angiofibroblastic tendinosis. While many theories exist as to the true cause of lateral epicondylitis, no single explanation is sufficient to elucidate the true cause. There are many risk factors for developing lateral epicondylitis, and one should not falsely assume that only tennis players are susceptible.

References

1. Allander E. Prevalence, incidence, and remission rates of some common rheumatic diseases or syndromes. Scand J Rheumatol. 1974;3:145–53.
2. Alredson H, Ljung B-O, Thorsen K, et al. In vivo investigations of ECRB tendons with microdialysis technique-no signs of inflammation but high amounts of glutmate in tennis elbow. Acta Orthop Scand. 2000;71:475–9.
3. Bales CP, Placzek JD, Malone KJ, Vaupel Z, Arnoczky SP. Microvascular supply of the lateral epicondyle and common extensor origin. J Shoulder Elbow Surg. 2007;16:497–503.
4. Balk ML, Hagberg WC, Buterbaugh GA, Imbriglia JE. Outcome of surgery for lateral epicondylitis (tennis elbow): effect of worker's compensation. Am J Orthop. 2005;34(3):122–6.
5. Berry N, Neumeister MW, Russell RC, Dellon AL. Epicondylectomy versus denervation for lateral humeral epicondylitis. HAND. 2011;6(2):174–8.
6. Bunata Robert E, Brown DS, Capelo R. Anatomic factors related to the cause of tennis elbow. J Bone Joint Surg Am. 2007;89:1955–63.
7. Calfee RP, Patel A, Dasilva MF, Akelman E. Management of lateral epicondylitis: current concepts. J Am Acad Orthop Surg. 2008;16:19–29.
8. Carp L. Tennis elbow caused by radiohumeral bursitis. Arch Surg. 1932;24:905–22.
9. Dellon AL, Kim J, Ducic I. Painful neuroma of the posterior cutaneous nerve of the forearm after surgery for lateral humeral epicondylitis. J Hand Surg Am. 2004;29(3):387–90.
10. Dimberg L. The prevalence and causation of tennis elbow (lateral humeral epicondylitis) in a population of workers in an engineering industry. Ergonomics. 1987;30(3):573–9.
11. Faro F, Wolf JM. Lateral epicondylitis: review and current concepts. J Hand Surg. 2007;8:1271–7.
12. Giangarra CE, Conroy B, Jobe FW, et al. Electromyographic and cinematographic analysis of elbow function in tennis players using single-and double-handed backhand strokes. Am J Sports Med. 1993;21:394–9.
13. Grewal R, MacDermid JC, Shah P, King GJ. Functional outcome of arthroscopic extensor carpi radialis brevis tendon release in chronic lateral epicondylitis. J Hand Surg Am. 2009;34(5):849–57.
14. Haahr JP, Andersen JH. Physical and psychosocial risk factors for lateral epicondylitis: a population based case-referent study. Occup Environ Med. 2003;60:322–9. doi:10.1136/oem.60.5.322.
15. Hatch GF III, Pink MM, Mohr KJ, et al. The effect of tennis racket grip size on forearm muscle firing patterns. Am J Sports Med. 2006;34:1977–83.
16. Hennig EM, Rosenbaum D, Milani TL. Transfer of tennis racket vibrations onto the human forearm. Med Sci Sports Exerc. 1992;24:1134–40.
17. Jobe FW, Ciccotti CM. Lateral and medial epicondylitis of the elbow. J Am Acad Orthop Surg. 1994;2:1–8.
18. Kelley JD, Lombardo SJ, Pink M, Perry J, Giangarra CE. Electromyographic and cinematographic analysis of elbow function in tennis players with lateral epicondylitis. Am J Sports Med. 1994;22:359–63.
19. Kitaie E, Itay S, Ruder A, Engel J, Modan M. An epidemiological study of lateral epicondylitis (tennis elbow) in amateur male players. Ann Chir Main Memb Super. 1986;5:113–21.
20. Laban MM, Iyer R, Tamler MS. Occult periarthrosis of the shoulder: a possible progenitor of tennis elbow. Am J Phys Med Rehabil. 2005;84:895–8.
21. Lanz T, Wachsmuth W. Praktische anatomie. Berlin: Springer; 1959.
22. Li FX, Fewtrell D, Jenkins M. String vibration dampers do not reduce racket frame vibration transfer to the forearm. J Sports Sci. 2004;22:1041–52.
23. Ljung B-O, Forsfren S, Frieden J. Substance P and calcitonin gene related peptide expression at the extensor carpi radialis brevis mucle origin: implications for the etiology of tennis elbow. J Orthop Res. 1999;17:554–9.
24. McVay CB. Surgical anatomy, vol 2, 6th ed. Philadelphia: Saunders; 1984.

25. Morrey BF. The elbow and its disorders, 4th ed. Philadelphia: Saunders; 2009.
26. Nirschl RP, Ashman ES. Elbow tendi-nopathy: tennis elbow. Clin Sports Med. 2003;22:813–6.
27. Nirschl RP, Pettrone FA. Tennis el-bow: the surgical treatment of lateral epicondylitis. J Bone Joint Surg Am. 1979;61:832–9.
28. Runge F. Zur genese und behandlung des schreibekramfes. Berl Klin Wochenschr. 1873;10:245.
29. Schneeberger AG, Masquelet AC. Arterial vascularization of the prioximal extensor carpi radialis brevis tendon. Clin Orthop Relat Res. 2002;46:3–12.
30. Shiri R, Viikari-Juntura E, Varonen H, Heliovaara M. Prevalent and determinants of lateral and medial epicondylitis: a population study. Am J Epidemiol. 2006;164(11):1065–74.
31. Smith RW, Papadopolous E, Mani R, Cawley MI. Abnormal microvascular responses in a lateral epicondylitis. Br J Rtheumatol. 1994;33:1166–8.
32. Stroede CL, Noble L, Walker HS. The effect of tennis racket string vibration dampers on racket handle vibrations and discomfort following impacts. J Sports Sci. 1999;17:379–85.
33. Titchener AG, Fakis A, Tambe AA, Smith C, Hubbard RB, Clark DI. Risk factors in lateral epicondylitis (tennis elbow): a case-control study. J Hand Surg Eur Vol. 2013;38:159–64.
34. Verhaar JA. Tennis elbow: anatomical, epidemiological and therapeutic aspects. Int Orthop. 1994;18:263–7.
35. Walker-Bone K, Palmer KT, Reading I, Coggon D, Cooper C. Occupation and epicondylitis: a population-based study. Rheumatology. 2012;51:305–10.
36. Wolf JM, Mountcastle S, Burks R, Sturdivant RX, Owens BD. Epidemiology of lateral and medial epicondylitis in a military population. Mil Med. 2010;175(5):336–9 (4).