CONTINUING EDUCATION

# "Tennis Leg"

## A State-of-the-Science Review

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**Abstract:** *Background:* Tennis leg (TL), a musculotendon injury to the gastrocnemius, has been associated with the eponymous sport since 1883. This article examines the historical context of TL as a sports compared with an occupational injury. This was juxtaposed with the history of tennis elbow, a tendon injury to the upper extremity also associated with sport. *Methods*: Bibliometric databases (PubMed, Web of Science [WOS], Hathi Trust) were keyword-searched; relevant citations were investigated in depth. *Results*: The search yielded 71 citations for TL (PubMed). The majority ($n$ = 43) were key word linked to sport terms; only one was linked to work-related search terms. Furthermore, none of the top four cited publications (Web of Science) alluded to work-related risk factors in TL in full textual analysis. Hathi Trust yielded the earliest work-related case, reported in a non-biomedical source. Tennis elbow was more frequently reported ($n$ = 189 citations in PubMed) and more frequently linked ($n$ = 193; 9.7%) to occupational search terms. *Conclusion/Application to Practice*: The history of TL, juxtaposed with tennis elbow, demonstrates how nosology can influence but does not wholly explain disease attribution, potentially to the detriment of taking into account occupational causality. The lack of recognition of occupational factors revealed in this literature search was notable because TL occurred most commonly in males of working age. By providing perspective on how historical context and nosology can affect the conceptualization of disease, this review may help inform prevention, treatment, and regulatory policy.

**Keywords:** tennis leg, lawn tennis leg, tennis calf, coup de fouet, whiplash leg, colpo di frusta, sport, athletic, athlete, occupational, work-related, tennis elbow, lateral epicondylitis

## Background

Two prominent orthopedic conditions utilize the term tennis in both lay persons' and even common medical nomenclature. One term is tennis leg, sometimes referred to as tennis calf, and the second is tennis elbow. The history of the nosology of these two conditions provided insights into how constructs of disease impact understandings of etiology and, through this, influences attribution of causality. This was particularly relevant to the recognition of potential work-related factors in injury, which in turn, influenced occupational history taking, work restrictions, and, ultimately, compensation and disease prevention.

In the case of tennis leg, this article traced more than a century of biomedical case reports and series that may have expanded to include other pastimes beyond lawn tennis, but consistently excluded almost any mention of any occupational etiologies, even in professional athletes. In contrast, over the same period of time tennis elbow, which is medically termed lateral epicondylitis, has been linked not only with tennis, but also with various manual occupations, such as using hammers and other hand tools. Exploring the history of these two conditions and the differences in how they have been perceived sheds light more broadly on the inter-relationships between nomenclature and occupational attribution in musculoskeletal injury.

## Methods

This review was conducted using a systematic search of PubMed for tennis leg utilizing the following search terms: "tennis leg, OR tennis calf, OR coup de fouet (Martorell, 1955) AND leg or calf." To clarify whether or not citations included consideration of a potential work-related etiology, the search was repeated adding AND work-related OR occupational OR occupation. Citations identified were reviewed along with their corresponding reference lists to explore additional resources, whether other journal articles or textbooks. This process was repeated until references were exhausted and duplicated information was occurring consistently with further searches.

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A parallel approach in PubMed and Web of Science was undertaken for tennis elbow with the following search terms: "tennis elbow OR lateral epicondylitis" followed by a repeated search also adding the same work-related key words as was performed for tennis leg.

Because much of the relevant literature likely appeared in years prior to consistent coverage by PubMed, Index Cumulative Medicus and Hathi Trust Digital Library (Hathi Trust) supplemented the search and also provided a basis to track the appearance of tennis leg and tennis elbow as approved subject headers in the former system and in sources other than biomedical journals or trade journals and texts, in the latter. The Hathi Trust was searched utilizing the terms tennis leg and lawn tennis leg. Time periods were then searched by decade and the following number of citations were found: 1910–1919, 98 citations; 1920–1929, 64 citations; 1930–1939, 12 citations; and 1940–1949, 19 citations.

All identified journal publications were categorized by the following specialties: sports medicine, general orthopedics, radiology, and occupational medicine. Finally, 47 major orthopedic text books were identified from a review of Hathi Trust spanning the original 1900–2000. These textbooks were selected to ascertain how tennis leg and tennis elbow were described in terms of potential occupational etiology.

## Results

We derived the number of medical citations for tennis leg based on our key word searches from PubMed, Web of Science, and Index Medicus. For PubMed there were 71 citations. Web of Science there were 87 citations (16 in addition to the 71 in PubMed), and none for Index Medicus. In total, 87 citations analyzed for tennis leg. For tennis elbow, the PubMed search yielded 1986 citations with the earliest in 1928, while was reduced to 193 (9.7%) citations when we added the work-related search terms. Manual review of the Index Medicus (1945–1951) yielded one citation for tennis elbow in the 1949 edition.

### The Earliest Citations

The term tennis leg was described by R.W. Powell in 1883 as lawn tennis leg. Powell emphasized a typical scenario of acute pain onset while in the midst of the eponymous game of sport. Hood, in 1884, added to this etiology and stated it was a "name given to an accident which has long been known to surgeons" (Hood, 1884). He described two incidents, one involving the Honorable Spencer Pansonby Fane who had an accident of unknown cause in November 1864 from which "he was crippled until June 1866." The second injury Hood described was of a Dr. W. G. Grace, who suffered an injury while playing cricket. Dr. Grace came to see Dr. Hood for "having had the characteristic feeling of having been smartly struck on the calf on the previous evening." From 1883, for the next 8 years, tennis leg in medical literature was attributed to various sports-related causes, including, but not strictly limited to, tennis.

By the 1960s, a tennis leg injury was sometimes referred to as "the old ladies carriage muscle" because it occurred in a woman who was alighting a bus with only the toes on the step, resulting in excessive flexion of the foot (Morhous, 1961). The same report also described two other cases of women getting out of automobiles "following a long, tiring ride" and another woman injured when walking "to the bathroom after nine hours of sleep." Of note, even in the more recent biomedical literature, embarking and disembarking from transportation continues to be a causative factor for tennis leg. For example, Tao and his team presented a case of a nonathlete patient who presented with an unusual case of acute compartment syndrome secondary to tennis leg after disembarking from a truck without any other trauma noted (Tao et al., 2016).

The mechanics of the traumatic injury were attributed to the knee being in extension while the ankle was forcefully dorsiflexed. The pain and symptomology related to this condition often took the injured person out of the implicated activity for a few days to weeks, but was typically followed by a return to previous activities with a complete recovery in 6 weeks (Arner & Lindholm, 1958; Brickner, 1997; Delgado et al., 2002; Hutchinson et al., 1995). Nonetheless, some cases have been reported to experience recalcitrant pain continuing up to 19 months post injury (Christopher, 1927).

### Occupational Health Connection

It was remarkable that although tennis leg occurred in sports, the implicated mechanism of injury could be work-related as well (Goldberg & Comstock, 1944; Koulouris et al., 2007; Kulund et al., 1979; Kwak et al., 2006; United States, 1927). Tennis leg, then and now, most commonly occurred in males in their mid-forties, a demographic consistent with not only leisure sport, but also well within the range of labor force participation, and a variety of work roles. For example, consider the occupational implications of tennis leg in professional sports. Professional athletes may even mistakenly be considered protected from injury because they were thought to be more expert, physically fit, and well-trained (Kuettner, 1922). At least one early 20th-century review of the subject alluded to cases in boxers, dancers, and baseball players who engaged in certain movements that would lend themselves to stretching or injuring the gastrocnemius, without ever mentioning work-relatedness or compensation for medical treatment or work disability (Gilcreest, 1933). Even a fictional text of the time (Ransohoff, 1921) mentions the condition of tennis leg along with golf arm as being due to an avocation, in the case of amateur sport fishing.

### Establishing Occupational Etiologies

Although over time the construct of tennis leg was expanded beyond sports, clinicians seldom ventured into the workplace to identify sources of injury. During the mid-20th century, a presumed increased frequency of cases was attributed to greater leisure time and a compulsion for fresh air, sunshine, and increased physical activity and exertion. Throughout this period,

orthopedic texts emphasized the classic symptom description and a corresponding sports causation (Henderson, 1963; Keen & Da Costa, 1921; Lewin, 1940; Mercer, 1983; Whitelocke & Anglin, 1910). The first case in the biomedical literature that might possibly be considered work-related appeared in 1912 (Western Medical Review, 1912). This report describes a case of "a very large, heavy man of 45, [who] jumped from the street to the curb and felt something snap in the calf of his leg. He kept about his work, was considerably lame," and went to see a medical provider a few days after the incident occurred. The diagnosis was a ruptured plantaris tendon, which early on, was wrongly believed to be the proximate cause of tennis leg. Given the context and the allusion that the patient "kept about his work," this seemed implicitly an on-the-job event, but that was never stated directly. The three other cases with possible work-related causation were included in a broader review of the subject published 20 years later, briefly summarizing a number of cases, dominantly from avocational activities as noted previously (Gilcreest, 1933). Three cases possibly related to salaried employment were never stated explicitly as such. These include a 30-year-old man whose foot became tangled in the rungs of a ladder leading to a 12-foot fall; a 38 year-old man injured when he fell 3 feet while carrying a weight of 105 pounds on his shoulder; and the third a 24 year-old man injured while lifting a 300 pound block of ice over the edge of a truck. All scenarios involved misplacement of the lower extremity. Although the author does state that "occupation is always a factor in the production of ruptures," this could easily be intended to mean a generic activity (e.g., occupation in the sense of a nonsalaried activity) and not a vocational duty. This omission is all the more notable because Gilcreest was at one time the executive medical officer of an industrial hospital under the aegis of the University of California, San Francisco (Gilcreest, 1921).

The earliest clear documentation that explicitly documents a case of tennis leg from work-related causation was not in a biomedical publication, but rather in a trade journal in the Law Reports section of The Builder. (Law Reports: . . ., 1917). In December, 1917 Judge Graham of the Bow County Court of the United Kingdom rendered a decision which had far-reaching consequences. A British Act had recently passed as an addition to the Workmen's Compensation Act, called the War Additions Act 1917 (Parliamentary Papers, 1918) that allowed an extra 25% on award for total incapacity. This law was addended in this manner due to the increased cost of living coinciding with World War One. The claim before the court was made by a male builder's laborer asking for compensation under this act from his employer who was a master builder and contractor. The alleged accident occurred on August 22, 1917. An area of town had recently been bombed and this contractor/employer had the rebuilding arrangements. His men were engaged in work between two buildings. The workers had to constantly go under a steam pipe pushing a wheel barrow. As the heap they had to walk over gradually increased in size and height they had to stoop lower. The claimant stooped very low one time and "felt a very sharp pain in the back of his leg, which he first attributed to somebody throwing something at him for fun." He arose and then collapsed after the incident. The pain became so severe that colleagues bound the leg up and transported the worker to the hospital. He was diagnosed with rupture(s) of some of the fibers of the principal muscles of the calf. Treatment consisted of bedrest that he maintained for weeks. Up to the point of the court date, the worker had not been paid. Therefore, he was asking for pay according to the initial Act and the updated addendum to the Act as he was incapable of returning to his ordinary work and "did not think he could return for months." The judge awarded the worker benefits and wages back to the date of the injury and the date of the passing of the Act. Therefore, this case was clearly work-related causation of a tennis leg diagnosis and stands as the first true documented case of work-related tennis leg. Ironically, the trade journal source, which was identified in the search of the Hathi Trust, was unlikely to have been read or cited by clinicians.

More than 100 years elapsed before the next work-related case of tennis leg came to be published, appearing in an occupational nursing journal in 2019 (Domeracki et al., 2019). This publication reviewed two cases which occurred in a hospital setting. The first incident occurred while a linen worker was loading and offloading a linen cart when he described an onset of symptoms similar to those reported by Powell in 1883. The second case was a Human Resource staff member climbing stairs and felt a pop when his foot dorsiflexed and knee hyperextended, again, a mechanism of injury classic to the reported literature.

## Connection Between Tennis Leg and Tennis Elbow

Tennis elbow, in comparison with tennis leg, has a history parallel in time but divergent in its occupational context. Tennis elbow was initially described in 1873 by Runge (Runge, 1873). The closely related name lawn tennis elbow first came into use in 1882 by Morris (Morris, 1882), only a year before lawn tennis leg first appeared. Tennis elbow is a relatively common condition but may be difficult to treat. It occurs most commonly in males between the ages of 30 and 50 years, which is an age range overlapping that of tennis leg. Tennis elbow was classically associated with the motion of a tennis backhand stroke. Playing tennis, however, was only one of many types of upper-extremity activities that was associated with this condition. Typically, those affected experienced pain at the origin of the extensor muscle, pain with resisted wrist extension, and tenderness with palpation of the tendinous origin of the muscle at the lateral epicondyle of the elbow.

Although commonly arising out of athletic activities, very early in its history it was appreciated that tennis elbow could be associated with one's occupation and the tasks therein. By 1896, Bernhardt considered this condition to be an occupational neuralgia, a now obsolete construct (Bernhardt, 1896). Over the years that followed, examples of occupational causes of tennis elbow noted in the biomedical literature have included gripping of hand or power tools, such as carpenters with constant hammer use, de-seamers who grasp an oxyacetylene torch, bricklayers who grasp a trowel and lift bricks, or chippers who manipulate pneumatic chipping hammer (Mills, 1928; Sinclair, 1965). Mills, in 1928, included in his article on the subject that

tennis elbow was initially limited to "tennis players, golfers and workers in certain trades which involve the constant use of a hammer" (Mills, 1928). By 1951, a review of tennis elbow stated that early treatment by an industrial clinic greatly reduced the period of disability and lost work time (MacGregor & Lanfear, 1951). By 1965, another review noted that "tennis elbow occurs quite frequently in industry" (Sinclair, 1965). This review by Sinclair also described treatment measures to be utilized in well-equipped industrial medical departments.

## Conclusion

This investigation into the nosology and occupational recognition of tennis leg and tennis elbow raises more questions than answers. For tennis leg, there is a paucity of clearly identified occupationally related cases in biomedical literature as compared with tennis elbow. This contrasts with scenarios in which tennis leg was attributed to sports (Leach et al., 1985; Lee et al., 2012; Touliopolous & Hersham 1999) or even everyday activities such as getting off a bus. The name of a condition or disorder alone may impact common conceptions of etiology, but was unlikely to be the sole explanation for the paucity of occupational attribution documented in the biomedical literature concerning tennis leg as such. Were this to be the case, tennis leg and tennis elbow, both with the same implicit sports etiology imbedded in the name and both being identified initially in the latter part of the 19th century, would have behaved in the same manner in terms of recognized attribution, which clearly, they did not. This divergence is further underscored by tennis elbow being glossed in a definitive etymologic reference, while tennis leg does not appear there (Oxford English Dictionary Online, n.d.).

With non-sport–related scenarios of these two conditions, there are other key aspects to consider. One aspect was that tennis elbow reflects repetitive trauma, whereas tennis leg represents an acute traumatic event. In terms of an acute event, the latter was more trivial in nature and therefore may evoke bias against malingering from the industrial or occupational medicine perspective. In addition, tennis leg had been associated with activities that could occur as part of almost any job, for example, a clerical worker going up a flight of stairs. In contrast, the work activities associated with tennis elbow are identifiably related to particular job tasks, especially manual labor using tools.

One limitation of this analysis was the lack of qualitative data that might emerge from open-ended interviews with practitioners who diagnose tennis leg and tennis elbow. Another potential source of information that was beyond the scope of this investigation would be administrative data sets such as insurance claims data. Such data could provide incidence estimates over time for the two conditions based on work attribution (i.e., workers' compensation claims) and in general claims data independent of attribution. The broad search strategy employed, however, was a strength of this investigation, going beyond PubMed to identify a wider range of relevant materials in both time and type.

## Implications for Occupational Health Nursing Practice

Education on nomenclature and common versus medical terminology is imperative for occupational health nursing practice in both the academic and practice settings to avoid misdiagnosis, subsequent treatment, and preventive measures. The continued focus on evidence-based practice and literature reviews in clinical practice are essential in learning more about different conditions and their possible work-related causation. The research for this article was an outgrowth of a prior tennis leg manuscript by this author and colleagues (Domeracki et al., 2019) which was based on two diagnosed cases of tennis leg in a hospital-based occupational medicine clinic with a third rule out case in a matter of a 6-month span. This led to recognition of the gaps in literature regarding tennis leg and its potential occupational causation and the need for a comprehensive review. In light of the literature on tennis leg discussing that this was a common condition related to the gastrocnemius, it was fascinating to find how few authors alluded to work-relatedness even when they or their colleagues had sustained such injuries. From a tort or litigation standpoint, it is valuable for nurse clinicians and the insurers to whom they submit claims to recognize the work-related risk factors that may be causally associated with tennis leg, regardless of its name.

Finally, and most importantly, this investigation demonstrated how the history of a condition such as tennis leg influences nosology and the ways in which attribution of disease can be perceived, to the detriment of taking into account a potential occupational attribution. Perhaps more occupational nursing and medicine publications and education would behoove the addition of historical perspectives on conditions when appropriate in giving more depth to the process of differential diagnosis, treatment planning, and prevention measures.

### In Summary

- Tennis leg is a common condition that, in the literature, is mostly attributed to non-work-related, sports causation.
- Compared to tennis leg, tennis elbow is more frequently related to occupational causation and with work-related attribution early on from the time the term was coined.
- As with this example of tennis leg, the history of a condition demonstrated how nosology influences the ways in which attribution of disease can be perceived, to the detriment of taking into account a potential occupational attribution.
- Health science historical reviews of conditions allow occupational health clinicians to more completely understand the complexity, nature, and challenges of accurate diagnostic processes related to differential diagnosing.

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