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Exploring the Link Between Comorbidities, Tobacco Usage, and Surgical Intervention in Medial Epicondylitis

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Keywords: sports medicine, injury, tobacco, golfer's elbow

Posted Date: May 29th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9171804/v1

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Additional Declarations: No competing interests reported.

Version of Record: A version of this preprint was published at Scientific Reports on October 7th, 2026.
See the published version at https://doi.org/10.1038/s41598-026-74810-y.

Abstract

Introduction: Medial epicondylitis (ME) can be painful and debilitating. Risk factors for ME include forceful work, continuous bending, or repetitive use of the common flexor tendon, such as in golf, tennis, and baseball. Current literature analyzing epicondylitis of the forearm focuses predominantly on lateral epicondylitis, or “tennis elbow”. Typically, ME is effectively treated non-operatively, though serious cases require surgical intervention. The purpose of this study was to elucidate the connection between common comorbidities and the diagnosis and prevalence of ME and the need for subsequent surgery, with secondary analysis on the specific effect of tobacco use disorder on this condition.

Methods: An insurance claims database was retrospectively analyzed from 2007 to 2015 using ICD-9 and ICD-10 codes. Patients with a history of tobacco use were queried for tobacco use disorder, and a separate matched group of patients without a history of tobacco use was created. This created two matched cohorts by age, alcohol use, diabetes mellitus, gender, hyperlipidemia, hypertension, and obesity, isolating tobacco use as an independent variable. Prevalence of ME in the total database population was separately identified using ICD-9 code: 726.31, and ICD-10 code: M7700. A group of patients with ME and tobacco use disorder from the original query was created and matched to patients with ME in the non-tobacco use disorder group. Surgical intervention in these groups was identified using CPT codes 24358 and 24359. Logistic regression was used to calculate odds ratios. Primary analysis was performed for demographics, comorbidities, setting of diagnosis, and surgical intervention. Patient records were deidentified, and the study was exempt from IRB Approval.

Results: The final query yielded 10,884 patients with ME, of which 5,584 belonged to the tobacco use disorder group and 5300 belonged to the non-tobacco use group. 158 tobacco users and 98 non-tobacco users in total underwent subsequent surgical intervention. Tobacco users had an increased odds of diagnosis of ME (OR:1.05; 95%CI: 1.01 – 1.10, p = 0.006). and odds of undergoing surgical intervention for ME (OR:1.62; 95%CI: 1.25 – 2.08, p=0.0002). ME was most common in patients aged 60 – 69, followed by age groups 50 – 59, and 40 – 49. The most common comorbidities overall were hypertension and hyperlipidemia, followed by diabetes mellitus and tobacco use. History of tobacco use and hypertension were significantly higher in patients with ME who underwent surgical intervention (p=0.009, p=.048). Diagnoses of ME and subsequent surgical intervention have increased substantially from 2007 to 2015.

Conclusion: Patients with a history of tobacco use have increased odds of developing ME and undergoing surgical intervention, suggesting a role of sequelae of tobacco use on the development and management of ME. This is supported by the current understanding of the pathophysiology of tobacco use on the musculoskeletal system and impaired healing capacity. The results demonstrate that even when controlling for a significant number of other common comorbidities, tobacco use independently has a significant effect on the diagnosis of ME and subsequent surgical intervention. Furthermore, the results show that the majority of these diagnoses of ME occur in the community setting, and further, there has been an increase in diagnoses of ME and subsequent surgical intervention from 2007 to 2015.

INTRODUCTION

Medial epicondylitis (ME), or golfer's elbow, is a relatively common musculoskeletal pathology that affects the common flexor tendon in the forearm. (Descatha et al. 2003; Shiri et al. 2006) ME is characterized by the development of pain over the proximal insertion site of the common flexor tendon. Sequelae of the pain associated with this condition included reduced functionality, work productivity, and athletic performance. Risk factors for ME include forceful work, repetitive bending or twisting of the wrist joint, and cyclic use of the common flexor tendon in golf, tennis, or baseball.(Descatha et al. 2003; Shiri et al. 2006)

On a cellular level, ME is caused by microtears and inflammation of the muscles that make up the common flexor tendon. (Armstrong et al. 1993) These include the flexor digitorum superficialis, pronator teres, flexor carpi radialis, palmaris longus, and flexor carpi ulnaris. Collectively, these muscles function to pronate, flex, and adduct the wrist and flex the elbow. (Netter, MD 2018) Recurrent microtears lead to collagen remodeling, resulting in decreased collagen strength, scar tissue formation, tendon thickening, and subsequent pain and limited function.(Kiel and Kaiser 2018)

Much of the current literature centers on ME's counterpart, lateral epicondylitis, or "tennis elbow". Less common than lateral epicondylitis, ME accounts for approximately 10–20% of all diagnoses of epicondylitis, with 75% of cases being in the dominant arm. (Shiri et al. 2006) Prevalence in the normal population is thought to be near 0.4%, while reports range from 3.8% to 8.2% in specific populations of manual laborers. (Descatha et al. 2003; Shiri et al. 2006; Ritz 1995)While ME is often associated with sports such as golf, baseball, tennis, and throwing, over 90% of all cases are non-sport related.(Shiri et al. 2006; Chen et al. 2001; Grana 2001; Jobe and Ciccotti 1994; Severson et al. 2005; Shaffer and Huttman 2014) Most cases of ME are occupation-related, with forceful, repetitive use involving the common flexor tendon being the main risk factor. (Shiri et al. 2006) Other risk factors include obesity, tobacco use, and high psychosocial work demands.(Descatha et al. 2003; Wolf et al. 2010)

Most cases of ME are treated non-surgically, although more severe cases can be treated successfully with surgical intervention when conservative modalities fail. (Han et al. 2016; Vangsness and Jobe 1991) Surgical intervention often entails a release of the common flexor tendon at the medial epicondyle and debridement of pathological tissues.(Vinod and Ross 2015) Risk factors for requiring surgical intervention after failed non-operative therapy include age (< 65), diabetes mellitus, peripheral vascular disease, and tobacco use.(Degen et al. 2017) Tobacco use specifically has well-described effects on the musculoskeletal system, affects rates of development of tendinopathy, and impairs healing processes. (Petersen et al. 2007; Al-Bashaireh et al. 2018; Galatz et al. 2006; Jorgensen et al. 1998)

ME accounts for up to 20% of all epicondylitis; however, there has been limited focus on demographics, comorbidities, initial setting of diagnosis, conservative treatment outcomes, or surgical intervention in patients with ME.(Descatha et al. 2003) The primary purpose of this study is to investigate the influence that tobacco use disorder has on diagnoses of ME and the need for surgical intervention due to tobacco's known effects on tendinopathy and healing. (Abate et al. 2013; Rom et al. 2015; Committee on

the Public Health Implications of Raising the Minimum Age for Purchasing Tobacco Products et al. 2015)Additionally, we seek to describe the baseline demographics, comorbidities, initial setting of diagnosis, prevalence, and incidence of ME, and surgical intervention in our total population of patients with ME.

METHODS

Database:

This retrospective study did not require IRB review because it uses a public data set. A retrospective review of a Humana patient population was retrospectively analyzed from 2007 to 2015 using the PearlDiver (Pearl Diver Technologies, Fort Wayne, Indiana) supercomputer. PearlDiver is a Health Information Portability and Accountability ACT (HIPAA) compliant public database that contains several million patient records indexed in a de-identified format. Patients and diagnoses were queried using International Classification of Disease, 9th Revision (ICD-9) and 10th Revision (ICD-10) codes.

Patients who used tobacco were identified using ICD-9 and ICD-10 codes 305.1 and F17.2, respectively. Patients who used tobacco were then matched to non-tobacco user controls in a 1:1 ratio according to age, gender, alcohol use, diabetes mellitus, hyperlipidemia, hypertension, and obesity (BMI>30kg/m^2), isolating tobacco use as an independent variable (Fig. 2.).

Patients affected by ME were separately identified using ICD-9 code: 726.31, and ICD-10 code: M7700. Patients with lateral epicondylitis were excluded using the exclusion filter command. Using Boolean command operators “AND’, “OR’. “NOT”, the inclusion criteria for the study group were patients with ME with a history of tobacco use disorder prior to the index ME diagnosis. This created our study cohort of patients diagnosed with ME with a history of tobacco use disorder prior to their ME diagnosis. A comparison cohort was then created within the previous population of matched non-tobacco users in a 1:1 ratio. Patients undergoing surgical intervention were subsequently identified using CPT codes 24358 and 24359.

Ethics Statement

This study utilized a publicly available, de-identified insurance claims database (PearlDiver Technologies, Fort Wayne, Indiana, USA). As all patient information in the PearlDiver database is de-identified and compliant with the Health Insurance Portability and Accountability Act (HIPAA), this study did not involve direct human subject interaction and was exempt from Institutional Review Board (IRB) approval.

Informed consent

was not required for this study because the dataset contained no identifiable patient information and did not involve direct patient contact. The need for informed consent was waived in accordance with

national regulations governing research involving de-identified datasets.

All methods were carried out in accordance with relevant guidelines and regulations for research using de-identified healthcare databases.

Data Availability Statement

The data that support the findings of this study are available from PearlDiver Technologies (Fort Wayne, Indiana, USA). These data were obtained from a publicly available, de-identified administrative claims database and are available from the authors upon reasonable request and with permission from PearlDiver Technologies. Access to the database requires a license from PearlDiver Technologies.

Website: https://www.pearldiverinc.com

Primary Assessments and Data Analysis

Patients with a history of tobacco use disorder and who were diagnosed with ME served as our primary study population. Primary data analyzed included: demographics, comorbidities, initial setting of diagnosis, diagnoses of ME, and surgical intervention.

Appropriate descriptive statistics were used where necessary. Odds ratios were calculated for association using PearlDiver computing software. Significance was set at a p-value less than 0.05. Due to using a public database as well as the deidentification of patient data, the study was exempt from Institutional Review Board (IRB) review.

RESULTS

The Humana patient population, containing 8,000,000 patients, was queried. An initial query of this total population (TP) was performed for patients with a history of tobacco use disorder, yielding 1,657,810 patients. This cohort was then matched according to age, gender, and medical comorbidities to non-tobacco users in a 1:1 ratio, isolating tobacco use as the independent variable. The results of the matching process yielded two groups with similar distributions in terms of age, gender, and medical comorbidities, indicating a successful match. The matched cohorts yielded 3,315,620 patients. A separate query of the TP for diagnoses of ME was then performed, yielding 23,572 patients diagnosed with ME. Of these 23,572 patients, 5584 patients were identified with a history of tobacco use, and were matched to 5300 patients within the non-tobacco use cohort. 525 patients within the TP eventually underwent surgery for ME, with 158 and 98 of the patients belonging to the tobacco use and non-tobacco use cohorts, respectively. (Fig. 1)

ME and Baseline Patient Demographics:

Within the 23,573 patients queried in the insurance claims database, ME was most prevalent in patients ages 60 to 69 (25.64%), followed by ages 50 to 59 (23.08%), and 40 to 49 (17.26%). ME was the least common in patients under 10 (n = 22; 0.09%). Incidence of ME was greater in males (n = 12,366; 52.46%) than in females (n = 11,207; 47.54%). Diagnoses of ME have increased from 2007 to 2015, and surgical interventions per year have more than doubled since 2007. (Fig. 2)

Comorbidities of patients with ME:

Comorbidities assessed within the ME patient population included: hypertension (58.66%), hyperlipidemia (56.98%), diabetes mellitus (n = 6,182; 26.22%), tobacco use (23.69%), obesity (16.57%), and alcohol abuse (2.93%) (Table 4). Comorbidities in patients with ME who underwent primary index surgery (PI) were compared with those of the total population of patients with ME. Diagnosis of tobacco use disorder and hypertension was significantly higher in patients with ME who underwent surgical intervention (p = 0.009). Additionally, there was a statistically significant history of hypertension within the surgical group compared to the TP with ME (p = 0.048). Patients who used tobacco had increased odds of being diagnosed with ME (OR:1.05; 95%CI: 1.01–1.10, p = 0.006) and undergoing surgical intervention (OR: 1.62; 95%CI: 1.25–2.08, p=.0002). (Table 1)

Initial Setting of Diagnosis:

Reported incidence of ME increased 68% from 2007 to 2015 (Fig. 1). ME was most commonly diagnosed in physicians' offices (n = 21,030; 89.21%), followed by outpatient hospitals (n = 1,272; 5.40%), and urgent care facilities (n = 297; 1.26%). ME was least commonly diagnosed in inpatient hospital (n = 33; 0.14%) and rural health clinic (n = 26; 0.11%) settings (Table 2.).

Comorbidities and Risk Factors in ME/Surgical Intervention:

Of the 23,573 patients who had been diagnosed with ME, 525 subjects had undergone surgical intervention (2.23%). 158 tobacco users had a diagnosis of ME and subsequently underwent surgical intervention, with 98 patients in the matched non-tobacco user cohort also undergoing surgery. While only 98 of the ME non-tobacco users' group underwent surgical intervention (2.83 vs. 1.85%). Rates of surgical intervention were most common in patients ages 50 to 59 (n = 192; 36.57%), followed by ages 40 to 49 (n = 150; 28.57%) and 60 to 69 (n = 94; 17.90%) (Table 3). Reported incidence of surgical intervention has increased substantially, with a 127% growth from 2007 to 2015 (Fig. 1).

Comorbidities assessed within the surgical intervention patient population included: hyperlipidemia (n = 278; 52.95%), hypertension (n = 265; 50.58%), tobacco use (n = 158; 30.10%), diabetes mellitus (n = 116; 22.20%), obesity (n = 77; 14.67%), and alcohol abuse (n = 23; 4.38%) (Table 3).

DISCUSSION

Tobacco use is among the most preventable causes of illness, with almost 1 billion tobacco users globally.(West 2017) While several countries have made advancements in reducing tobacco use, it remains a global health issue.(Jatoi et al. 2009) In the United States alone, tobacco use is prevalent in approximately 25% of the population, with cigarette consumption being the most common method of use, followed by cigars and chewing tobacco.(King et al. 2012) Tobacco, in fact, is one of the most commonly used drugs of choice, with over 25% of adults using tobacco in the United States.(King et al. 2012) The damaging effects of tobacco encompass a multiplicity of biochemical processes, including healing of the musculoskeletal system, and thus, orthopedic surgery outcomes.(Abate et al. 2013; Committee on the Public Health Implications of Raising the Minimum Age for Purchasing Tobacco Products et al. 2015; Rodriguez-Merchan 2018)

Additionally, tobacco use appears to be relatively common in competitors and highly active individuals, populations that are primarily at risk for ME. (Henninger et al. 2015; Mündel 2017)In a review of 6 years' worth of survey data, Severson *et al.* found that 36% of major league baseball competitors were using smokeless tobacco (ST).(Severson et al. 2005) Similarly, Marclay *et al.* demonstrated that prevalence of tobacco use was higher in athletes compared to the average American population (25%).(Marclay et al. 2011)

Not only is tobacco use prevalent, but its usage is also linked to poorer athletic performance and functionality. In a 12-month longitudinal study involving 41 participants, Rom *et al*. established that smoking cessation increased lean body mass and led to higher predicted strength of handgrip, chest press, and leg press.(Rom et al. 2015) The described results are likely attributed to the decrease in protein synthesis and metabolic performance found in tobacco users.(Petersen et al. 2007) Other mechanisms by which tobacco use may increase the risk of ME injury and the rate of subsequent surgical repair are likely multifactorial in nature. Nicotine has several deleterious effects on the musculoskeletal system. These include cartilage damage, decreased circulation, compromised healing, and reduced muscle mass and strength.(Abate et al. 2013; Al-Bashaireh et al. 2018)

Estimates of ME prevalence in certain labor-intensive occupations can be up to 8%.(Descatha et al. 2003; Ritz 1995)While our study did not investigate this specific subset of population, our finding of (insert percentage of Humana patients diagnosed with ME) is consistent with previous reports within the adult population.(Descatha et al. 2003; Shiri et al. 2006) Additionally, this study demonstrated that the majority of ME diagnoses in our population occurred in patients aged 40 to 69 (Table 3). These findings are consistent with the current literature. In a Finnish study consisting of 4,783 subjects, Shiri *et al.* found most of the subjects with medial epicondylitis were aged 45–64.(Shiri et al. 2006) Similarly, in a retrospective review utilizing "*The Defense Medical Epidemiology Database*", Wolf *et al*. found that the majority of ME diagnoses in military personnel occurred over the age of 40.(Wolf et al. 2010)

Comorbidities were assessed in patients with ME regardless of whether surgical intervention was performed. Incidence of hypertension was greatest, followed by hyperlipidemia, diabetes mellitus, and

tobacco use. In a prospective study of 1,824 patients, Hegmann *et al*. demonstrated a strong relationship between lateral epicondylitis and modified Framingham Heart Study CVD risk scores, which included tobacco use, diabetes mellitus, hyperlipidemia, and hypertension.(Hegmann et al. 2017) Similarly, Shiri *et al*. found that smoking [OR: 2.5; 95%CI: 1.3–4.7], obesity [OR: 1.9; 95%CI: 1.0–3.7], and diabetes mellitus type 2 [OR: 3.3; 95%CI: 1.4–7.9] increase risk of developing ME.(Shiri et al. 2006) These reports are consistent with the findings of our study.

An upward trend of both ME diagnosis and ME surgical intervention was observed in the study. Reported diagnoses of ME and surgical intervention have increased by 68% and 127% during our study period. The results of our analysis demonstrate that tobacco use led to increased odds of surgical intervention [OR: 1.62; 95% CI 1.25–2.08, *p*=. 0002]. Degen *et al*., reported similarly that tobacco use is a significant risk factor for surgical intervention in patients with ME [OR: 2.01; 95%CI: 1.32–3.08, *p* = 0.017].(Degen et al. 2017) This increased incidence of surgical intervention is likely related to tobacco's role in reducing collagen production, impairing musculoskeletal healing, and decreasing vascularity.(Abate et al. 2013; Galatz et al. 2006; Jorgensen et al. 1998) Patients aged 50–59 had the highest incidence of surgery in our study, followed by ages 40–49 and 60–69 (Table 3). Vinod and Han et. al reported similar findings in their analyses, where the incidence of surgical intervention was highest at a mean age of 52.5 and 51.6 years, respectively.(Han et al. 2016; Vinod and Ross 2015) The overall incidence of surgical treatment of ME demonstrated in our study is similar to that previously reported in the literature.(Degen et al. 2017)

While our study is characterized by a pool of over 3 million patients and controlled for confounding factors by matching the cohorts, there are limitations to acknowledge. The patient record database relies on ICD-9 and ICD-10 procedural and diagnosis codes, which are not intended to be employed for research. (Yoshihara and Yoneoka 2014) Additionally, this may not be a true cross-sectional representation of tobacco use and ME injuries, as data were retrieved from a single insurance claim database.(Burrus et al. 2015) Furthermore, due to the nature of ICD-9 diagnosis and procedural coding, we could not establish the severity of damage or tobacco use, limiting our ability to generalize the findings of our analysis. Despite these limitations, to our knowledge, this study is one of the few to analyze the relationship between former and current tobacco use and ME diagnoses, and the first to describe its association with subsequent surgical intervention.

CONCLUSION

Patients with a history of tobacco use have an increased risk of developing ME and a requirement for subsequent surgical intervention. Tobacco use may increase the severity of ME and likely impairs the healing and remodeling processes that occur with repetitive use of the medial common flexor tendon. Furthermore, the results show an increase in the diagnosis of ME and subsequent surgical intervention from 2007 to 2015. Although they remain relatively low, the prevalence and incidence of ME and surgical intervention have increased year over year from 2007 to 2015. The harmful effects of tobacco usage are well known. It is imperative for the treating physician to counsel patients on their increased risk for the development of this pathology and their subsequent need for surgical intervention. Future studies would

be needed to investigate the impact of tobacco use on the outcomes of conservative and operative interventions with regard to treatment success or need for revision surgery in operative patients. Further analysis is needed to describe the economic impact of smoking as it relates to this condition, increased health care usage, and costs associated with operative intervention. Future investigation is critical to validate causality between tobacco use and ME and subsequent surgical procedure.

Declarations

Disclosures: None

Funding: The Study Received no Funding

Disclosure: None of the Authors has any Conflicts of Interest to Disclose

Consents

No human subjects were used in this research manuscript and thus, no IRB approval is needed.

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Tables

Tables 1 to 4 are available in the supplementary files section

Figures

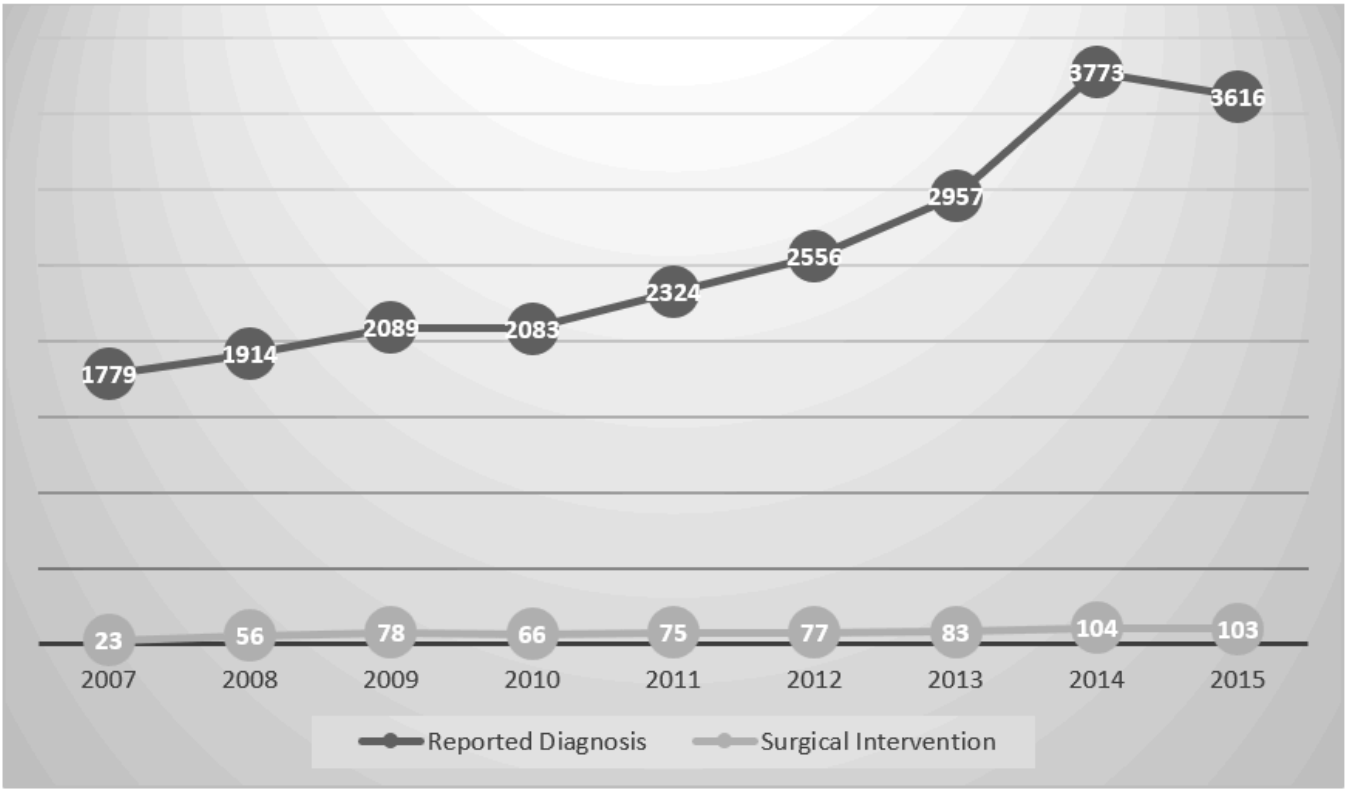


Figure 1

Trends Among Reported Diagnosis of Medial Epicondylitis and Surgical Intervention of Medial Epicondylitis Within the Humana Population.

Image not available with this version

Figure 2

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Supplementary Files

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