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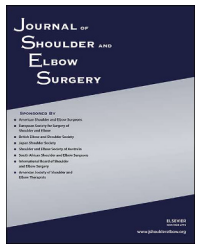

Clinical diagnosis of lateral-sided elbow pain: predictors for recognizing a diagnosis other than tennis elbow

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ABSTRACT

Background: Lateral elbow pain (LEP) is most commonly caused by lateral elbow tendinopathy (LET), a diagnosis typically made based on clinical symptoms and physical examination, without the need for additional diagnostic imaging in the initial workup. However, recent research suggests that at least 11% of LEP cases are misdiagnosed as LET. Several other conditions can mimic LET, making awareness of the full differential diagnosis essential to ensure accurate diagnosis and initiate the appropriate treatment. This study aims to identify factors of patient characteristics, history taking, and physical examination that aid clinicians in distinguishing LET from other causes of LEP.

Methods: A prospective cohort of 170 consecutive patients with LEP presenting in the outpatient orthopedic clinic of 3 large teaching hospitals were included. All patients were assessed using a standardized diagnostic protocol. Bivariable analysis and multivariable binary logistic regression with a stepwise backward selection procedure were performed to identify variables associated with a diagnosis other than LET.

Results: In this cohort, 46.5% of the patients received a diagnosis other than LET. Independent predictors of an alternative diagnosis included age $\leq$30 years ($P < .001$), acute symptom onset ($P = .045$), joint locking ($P < .001$), presence of joint effusion (hydrops) ($P < .001$), a positive instability test ($P = .013$), and a negative Maudsley test ($P < .001$).

The study was deemed exempt from formal ethical approval by the local ethics committees and the Central Committee on Research Involving Human Subjects (CCMO).

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Conclusion: Nearly half of patients presenting with lateral elbow pain are diagnosed with conditions other than LET. The identification of age ≤30 ($P < .001$), acute onset ($P = .045$), locking ($P < .001$), hydrops ($P < .001$), any positive instability test ($P = .013$), and a negative Maudsley test ($P < .001$) as independent predictors for a diagnosis other than LET has practical implications. Recognizing these factors enables clinicians to consider alternative diagnoses, potentially preventing misdiagnosis and treatment delay.

Level of evidence: Level III; Diagnostic Study

Keywords: Elbow; lateral; tendinopathy; tennis elbow; lateral epicondylitis; diagnosis; test

Lateral elbow pain (LEP) is most frequently attributed to lateral elbow tendinopathy (LET), also known as tennis elbow, lateral epicondylitis, or tendinopathy of the extensor carpi radialis brevis (ECRB). The diagnostic gold standard for LET relies on a combination of history and physical examination, without requiring additional imaging during the initial assessment.

However, a variety of conditions produce similar symptoms as LET, including radial nerve compression, synovial fringe impingement (radio-capitellar or posterolateral synovial plica), posterolateral rotatory instability (PLRI), annular ligament injury or hypertrophy, osteochondritis dissecans (OCD), Panner's disease, distal biceps tendinopathy, degenerative or inflammatory arthropathy of the radiocapitellar joint, occult fractures or referred pain from pathology in surrounding joints or cervical spine.[2,5,8,12] Recognizing this broad differential diagnosis is critical, as recent evidence suggests that at least 11% of the LEP cases are misdiagnosed as LET.[3]

Although conventional radiographs are routinely used in adults with LEP, they often fail to rule out other pathologies and may create a false sense of diagnostic certainty.[13] In cases of persistent diagnostic uncertainty, additional imaging modalities, such as ultrasound, computed tomography (CT), or magnetic resonance imaging (MRI) may be warranted, depending on the suspected pathology. However, thorough history taking and physical examination remain low-cost, non-invasive, and time-efficient tools for differentiating LET from other diagnoses that may require different management strategies.

Despite the importance of accurate clinical assessment, no studies have systematically evaluated the diagnostic accuracy of history-taking for patients with LEP. Research on physical examination tests is also scarce, with 1 study assessing LET using a grip strength dynamometer and 2 small studies (each involving 8 patients) evaluating 4 different tests for PLRI.[1,7,14] To date, no studies have investigated the diagnostic accuracy of clinical tests for other LEP-related conditions.

A structured diagnostic approach to patients presenting with LEP helps to identify underlying causes other than LET. Therefore, the aim of this study is to identify patient characteristics, history, and physical examination items that predict a diagnosis other than LET in patients with lateral elbow pain.

Methods

Patient selection

A prospective cohort study was conducted, including 170 consecutive patients presenting with LEP to the outpatient clinics of 3 large teaching hospitals between January 2017 and July 2022. A comprehensive follow-up process was implemented to establish the definitive diagnosis (eg, after imaging or surgery), which was completed by April 2024. Patients were eligible for inclusion if they presented with LEP as their primary complaint. Exclusion criteria were penetrating trauma or fractures, insufficient proficiency in Dutch or English, and significant cognitive impairment that interfered with the diagnostic process or informed consent. All patients received standard care, and no additional interventions were performed beyond routine diagnostic and clinical procedures. As such, the study was deemed exempt from formal ethical approval by the local ethics committees and the Central Committee on Research Involving Human Subjects (CCMO), in accordance with Dutch regulatory guidelines.[6]

Data collection

Patients underwent a standardized diagnostic protocol performed by 1 of 3 experienced upper extremity orthopedic surgeons (B.T., D.E., and M.B.). The protocol included the collection of patient characteristics, relevant history items, and a structured set of physical examination tests (Table I). Motion restriction was defined as 10 degrees less compared to reference values.[16] The selection and execution of these tests were based on previously published literature and are detailed in the Supplementary File S1.[15]

Reference test

A clinical diagnosis of lateral elbow tendinopathy (LET) was established when patients demonstrated tenderness over the ECRB or common extensor origin and met at least 2 of the following 3 criteria:

(1) Pain with resisted wrist extension (Cozen test[11]),
(2) Pain with resisted middle finger extension (Maudsley test[7]),
(3) Pain with the elbow extended and the wrist flexed and pronated (Mills test[7]).

As part of standard care, all patients underwent conventional anteroposterior and lateral radiographs of the elbow. Additional imaging was performed at the discretion of the treating orthopedic surgeon, based on clinical suspicion. Ultrasound or MRI (with or without arthrography) was used to assess soft-tissue conditions. Computed tomography (CT) was employed when bony pathology was suspected. When

Table I – Protocol including patient characteristics, history items and physical examination tests

Patient characteristics and history items	Physical examination tests
Gender	Alignment
Age (yr)	Motion restriction
Duration of complaints (mo)	Joint effusion
Dominant hand affected	Grip & grind (G&G) test passive/active in 90°
Manual labor	One of the following instability tests: Varus stress test, Stand-up test, Table top relocation test, Drawer test, Pivot shift test
Hand/arm related sports	Palpitation capitellum (pain)
Onset: acute (with or without trauma)/ gradual	Palpation lateral epicondyle (pain)
Locking	Mills test
Crepitations	Maudsley test
Neurologic symptoms	Cozen test

available, imaging findings were considered more definitive than clinical criteria in establishing the diagnosis of LEP.

In patients who underwent surgery, the intraoperative diagnosis took precedence over both clinical and imaging-based diagnoses. Surgical indications and intraoperative assessments were conducted by the aforementioned 3 experienced upper extremity orthopedic surgeons.

Statistical analysis

Data-analysis was conducted using Microsoft Excel 2010 (Microsoft Corp. Redmon, WA, USA) and Statistical Package for the Social Sciences 29 (IBM Corporation, Armonk, NY, USA). Descriptive statistics were calculated as follows: median and range for non-normally distributed continuous variables, mean and standard deviation for normally distributed continuous variables, and frequencies and percentages for categorical variables. Missing data from incomplete observations were handled using listwise deletion.[9] Bivariable analysis was performed to assess if any variables within patient characteristics, history items and physical examination were associated with the definitive diagnosis other than LET. A χ 2 test was used for categorical variables, and items with 5 or fewer items were removed.

Subsequently, variables with a P value <.1 entered a multivariable binary logistic regression with a stepwise backward selection procedure. At each step, the variable with the largest P value was eliminated. This process was repeated until all variables in the equation reached a P value < .05. Multivariable binary logistic regression was limited to 10 events per variable.

Results

A total of 170 patients with lateral elbow pain (LEP) were included in the study, of whom 91 (53.5%) were male. The median age was 45 years (range: 9-79 years), and 26 patients (15.3%) were under the age of 18. The median duration of symptoms was 12 months (range: 1-240 months). In 62.4% of the cases (n = 106), the dominant arm was affected.

Table II – Final diagnosis

Diagnosis	N	% of total
Lateral elbow tendinopathy (LET)	91	53.5
Other diagnosis	79	46.5
Osteochondritis dissecans (OCD)	36	21.2
Posterolateral rotatory instability (PLRI)	18	10.6
Arthrosis	9	5.3
Supinator syndrome	7	4.1
Synovial fringe	4	2.4
Distal biceps tendinopathy	4	2.4
No orthopedic diagnosis (referred to rheumatologist)	1	0.6
Total	170	100

Regarding occupational and recreational activities, 41.8% of patients (n = 71) participated in hand-intensive sports, while 75.9% (n = 129) reported engaging in manual labor or desk-based work. Most patients had received prior treatment before visiting the orthopedic clinic: 101 (59.4%) had undergone physiotherapy, and 35 (20.5%) had received one or more corticosteroid injections.

Further diagnostic evaluation, through imaging and/or surgical exploration, was performed in 97 patients (57.1%). The remaining 73 patients were diagnosed based solely on standardized clinical examination protocol described in the methods section.

Ninety-one patients (53.5%) were diagnosed with lateral elbow tendinopathy (LET). The remaining 79 patients (46.5%) received a different diagnosis, as summarized in Table II. Notably, all 26 patients under the age of 18 were diagnosed with osteochondritis dissecans (OCD), occasionally in combination with posterolateral rotatory instability (PLRI). Furthermore, OCD was exclusively observed in patients aged 30 years or younger and was the most frequent diagnosis within this age group.

Bivariable analysis of patient characteristics, history-taking elements, and physical examination findings identified several factors associated with a diagnosis other than LET. These included age ≤30 years, symptom duration ≤12 months, participation in hand- or arm-intensive work or sports, acute symptom onset, locking, crepitus, malalignment, joint effusion (hydrops), restricted flexion or extension, a positive passive Grip & Grind (G&G test), a positive result on any instability test, pain on palpation of the capitellum, absence of pain on palpation of the epicondyle, and negative Mills, Maudsley, and Cozen tests (Table III).

Multivariable analysis further identified age ≤30 years, acute onset, locking, hydrops, a positive result on any instability test, and a negative Maudsley test as independent predictors of a diagnosis other than LET (Table IV).

In a subgroup analysis including only patients ≥18 years, bivariable analysis identified the same factors associated with a diagnosis other than LET as in the total sample, with the addition of neurologic complaints. However, multivariable analysis in this subgroup did not identify neurologic complaints as independent predictor of a diagnosis other than LET.

Table III – Bivariable analysis of patient characteristics, history items and physical examination

Variable	LET (%)	Other diagnosis (%)	Total (% of group)	P value
Patient characteristics and history items				
Sex			170 (100)	.146
Male	47	32	79 (46.4)	
Female	44	47	91 (53.5)	
Age			170 (100)	<.001*
≤30	4	50	54 (31.8)	
>30	87	29	116 (68.2)	
Duration			170 (100)	<.001*
≤12 mo	66	38	104 (61.2)	
>12 mo	25	41	66 (38.8)	
Affected side			170 (100)	.935
Dominant	57	49	106 (62.4)	
Non-dominant	34	30	64 (37.6)	
Work			170 (100)	.069
Hand/arm related	64	65	129 (75.9)	
hand/arm related	27	14	41 (24.1)	
Sport/hobby			170 (100)	.029*
Hand/arm related	31	40	71 (41.8)	
Not hand/arm related	39	60	99 (58.2)	
Onset			170 (100)	.003*
Acute	18	32	50 (29.4)	
Gradual	73	47	120 (70.6)	
Locking			170 (100)	<.001*
Yes	0	48	48 (28.2)	
No	91	31	122 (71.8)	
Crepitus			170 (100)	<.001*
Yes	2	16	18 (10.6)	
No	89	63	152 (89.4)	
Neurology			170 (100)	.109
Yes	16	22	38 (22.4)	
No	75	57	132 (77.6)	
Physical examination				
Alignment			170 (100)	<.001*
Varus/valgus malalignment	1	16	17 (10)	
Normal alignment	90	63	153 (90)	
Hydrops			170 (100)	<.001*
Yes	0	32	32 (18.8)	
No	91	47	138 (81.2)	
F/E motion			170 (100)	<.001*
Restricted	5	45	50 (29.4)	
Normal	86	34	120 (70.6)	
G&G passive			131 (77.1)	<.001*
Positive	4	22	26 (19.8)	
Negative	70	35	105 (80.2)	
G&G active			131 (77.1)	.475
Positive	41	28	69 (52.7)	
Negative	33	29	62 (47.3)	
Any instability test			167 (98.2)	<.001*
Increased laxity	0	21	21 (12.6)	
Stable	89	57	146 (87.4)	
Pain on palpitation capitellum			167 (98.2)	<.001*
Positive	12	44	56 (33.5)	
Negative	77	34	111 (66.5)	
Palpation lateral epicondyle			170 (100)	<.001*
Positive	84	20	104 (61.2)	
Negative	7	59	66 (38.8)	
Mill's test			170 (100)	<.001*
Positive	64	12	76 (44.7)	
Negative	27	67	94 (55.3)	
Maudsley test			170 (100)	<.001*
Positive	82	12	94 (55.3)	
Negative	9	67	76 (44.7)	
Cozen test			170 (100)	<.001*
Positive	78	15	93 (54.7)	
Negative	13	64	77 (45.3)	

LET, lateral elbow tendinopathy; F/E, flexion/extension; G&G, Grip & Grind.

* $\chi 2$ test was significant at $P < .05$.

Table IV – Multivariable Logistic Regression Analysis of patient characteristics, history, and physical examination items

Variable	Odds ratio for other diagnosis (95% CI)	P value
Age ≤30	37.5 (12.5-112.9)	<.001
Acute onset	2.8 (1.4-5.5)	.045
Locking	3.9 (2.9-5.3)	<.001
Hydrops	2.9 (2.3-3.7)	<.001
Positive instability test	2.6 (2.1-3.1)	.013
Negative Maudsley test	50.9 (20.2-128.0)	<.001

CI, confidence interval.

Discussion

This study identified patient characteristics, history-taking elements, and physical examination findings that predict pathology other than lateral elbow tendinopathy (LET) in patients with lateral elbow pain (LEP). In our prospective cohort of 170 patients, a standardized diagnostic protocol revealed that nearly half (46.5%) received a diagnosis other than LET. Multivariable analysis identified 6 independent predictors for a diagnosis other than LET: age ≤30 years, acute symptom onset, locking, joint effusion (hydrops), a positive instability test, and a negative Maudsley test. These findings have clinical implications, enabling clinicians to consider alternative diagnoses in the diagnostic process and potentially preventing delays in appropriate treatment.

A recent study focusing on patients with persistent symptoms despite nonoperative treatment for presumed LET reported similar predictors for alternative diagnoses, including young age, swelling, instability, and mechanical symptoms such as locking.[3] Compared to that study, our cohort was broader and more representative of clinical reality, as it included all patients presenting with LEP, regardless of prior treatment. As such, our findings may better reflect the diagnostic challenges faced in daily orthopedic practice.

An important observation is the strong age-related diagnostic pattern. None of the 26 patients under 18 years were diagnosed with LET. Instead, all were diagnosed with

osteochondritis dissecans (OCD), sometimes in combination with posterolateral rotatory instability (PLRI). Moreover, OCD was not observed in patients older than 30 years. This finding underscores the importance of age as a diagnostic filter. In young patients with LEP, clinicians should not assume LET but must actively consider alternative diagnoses such as OCD.

Only a limited number of studies have examined individual physical examination tests for LEP-related conditions.[1,7,14] For LET, grip strength testing shows moderate sensitivity and specificity but is rarely used in routine clinical care.[7] For PLRI, a few small studies have evaluated tests such as the pivot shift test, table-top relocation test, stand-up and push-up tests, with promising sensitivity but unknown specificity due to limited sample sizes and lack of controls.[1,14] Notably, no studies have yet reported on the diagnostic accuracy of physical examination tests for other potential causes of LEP, such as radial nerve compression, synovial fringe, osteochondritis dissecans (OCD), Panner's disease, or degenerative or inflammatory arthropathy. Our study helps address this gap by integrating physical examination findings with patient history and demographics, rather than evaluating tests in isolation.

The main strength of our study lies in the comprehensive design. Rather than focusing solely on the diagnostic value of individual physical examination tests for a single condition, we integrated demographic and historical factors, thereby utilizing all the relevant information provided by the patient. Moreover, we included a relatively large cohort of patients with various causes of lateral elbow pain (LEP) that may mimic lateral elbow tendinopathy (LET). As a result, we believe our findings offer valuable insights that can be directly applied to clinical practice.

Our study has several limitations. First, since LET is a clinical diagnosis, defining an absolute reference standard remains challenging. Currently, no superior alternative to history-taking and physical examination has been proposed in the literature. Nevertheless, this approach is widely accepted and has been used in many high-quality randomized controlled trials and cohort studies. Imaging modalities such as ultrasound and MRI offer variable diagnostic accuracy and should be interpreted with caution, particularly in LET.[10] To maximize reliability, we employed a previously described and validated clinical protocol for diagnosing LET,[7] supplemented by imaging or intraoperative findings when available.

Second, all physical examinations were performed by experienced upper extremity orthopedic surgeons, which may limit generalizability. Less experienced examiners, such as general practitioners or residents, might achieve lower diagnostic accuracy. However, many of predictive factors identified in this study, including age, symptom onset, and Maudsley's test, are simple and commonly used in clinical practice. Furthermore, our study population consisted of referred patients, either from general practitioners or as a second opinion by another orthopedic surgeon, resulting in a certain degree of preselection.

Finally, despite the prospective study design, some variables had missing data, likely due to the large number of parameters recorded per patient. As described in the methods section, we used listwise deletion for handling missing values. Notably, all final predictors had complete data, ensuring the robustness of our key findings.

One key question that remains is the clinical utility of diagnostic tests. While we identified predictive factors for alternative diagnoses, an ideal study design would assess whether applying these predictors improves treatment outcomes.[4] For LET, this may be limited. Conservative treatment (eg, physiotherapy, NSAIDs, time) is widely used, and evidence suggests most patients improve regardless of the specific intervention. Therefore, the value of accurately diagnosing LET lies more in ruling out other conditions than in directing specific treatment. Future studies could investigate whether diagnostic accuracy directly improves patient outcomes across this spectrum.

A promising development in diagnostic decision-making is the potential integration of artificial intelligence (AI). These technologies could assist clinicians in synthesizing complex patterns in demographics, symptoms, and physical findings to support the prediction of the most likely diagnosis. In the context of LEP, AI could help identify patients at higher risk for alternative diagnoses, potentially guiding referral decisions or imaging strategies. Importantly, AI is not intended to replace clinical expertise but could serve as an additional tool to reduce the risk of misdiagnosis and improve outcomes for patients. Although our study provides a solid foundation of predictive variables, future research could explore the practical application and diagnostic accuracy of AI-based models in this context.

The results of our study represent an initial step in the development of a clinical prediction model for identifying diagnoses other than LET in patients with LEP. Validation of these predictors in external cohorts and evaluation of their effect on patient management and treatment outcomes are important next steps. Ultimately, improving diagnostic accuracy should lead to more personalized care, faster recovery, and more efficient use of healthcare resources.

Conclusion

Nearly half (46.5%) of all the patients presenting with lateral elbow pain receive a diagnosis other than lateral elbow tendinopathy (LET). Independent predictors for an alternative diagnosis included age $\leq$30, acute onset, locking, joint effusion (hydrops), any positive test for lateral instability, and a negative Maudsley test. Recognizing these clinical signs may be crucial for medical professionals, as distinguishing LET from other conditions enables timely and appropriate treatment, especially in children were LET was not found.

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Supplementary data

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