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Research Paper Review

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Relationships between biomechanics, tendon pathology and function in individuals with lateral epicondylosis

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ABSTRACT

Study Design

Single-cohort descriptive and correlational study.

Objectives

To investigate the relationships between tendon pathology, biomechanical measures, and self-reported pain and function in individuals with chronic lateral epicondylosis.

Background

Lateral epicondylosis has a multifactorial etiology and its pathophysiology is not well understood. Consequently, treatment remains challenging, and lateral epicondylosis is prone to recurrence. While tendon pathology, pain system changes, and motor impairments due to lateral epicondylosis are considered related, their relationships have not been thoroughly investigated.

Methods

Twenty-six participants with either unilateral (n = 11) or bilateral (n = 15) chronic lateral epicondylosis participated in this study. Biomechanical measures (grip strength, rate of force development, and electromechanical delay) and measures of tendon pathology (magnetic resonance imaging and ultrasound) and self-reported pain and function (Patient-Rated Tennis Elbow Evaluation) were performed. Partial Spearman correlations, adjusting for covariates (age, gender, weight, and height), were used to evaluate the relationship between self-reported pain, function, and biomechanical and tendon pathology measures.

Results

Statistically significant correlations between biomechanical measures and the Patient-Rated Tennis Elbow Evaluation ranged in magnitude from 0.44 to 0.68 (P<.05); however, no significant correlation was

observed between tendon pathology (magnetic resonance imaging and ultrasound) measures and the Patient-Rated Tennis Elbow Evaluation (r = -0.02 to 0.31, P>.05). Rate of force development had a stronger correlation (r = 0.54-0.68, P<.05) with self-reported function score than with grip strength (r = 0.35-0.47, P<.05) or electromechanical delay (r = 0.5, P<.05).

Conclusion

Biomechanical measures (pain-free grip strength, rate of force development, electromechanical delay) have the potential to be used as outcome measures to monitor progress in lateral epicondylosis. In comparison, the imaging measures (magnetic resonance imaging and ultrasound) were useful for visualizing the pathophysiology of lateral epicondylosis. However, the severity of the pathophysiology was not related to pain and function, indicating that imaging measures may not provide the best clinical assessment.

ANALYSIS

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Background Information

Lateral epicondylosis (LE) is one of the most prevalent and costly musculoskeletal disorders. In addition to just simply being painful, the disorder comes with functional deficits that can interfere with occupational tasks and the performance of activities of daily living. Treatment of this particular disorder is challenging, because the exact pathophysiology of LE is not well understood.

LE is characterized pathophysiologically by tendon cellular changes, including an increase in fibroblast proliferation, vascular hyperplasia and disorganized collagen. Additionally, the proximal insertion of the wrist extensors is often thickened, and features increased signal intensity on MRI, mucoid degeneration and neovascularization. The most common, singular signal abnormality is typically found at the origin of the extensor carpi radialis brevis tendon.

The most frequently reported symptom of LE is pain, which can often be recreated clinically through palpation and various orthopedic tests. There are many theories as to the origin of the pain, including neuronal tissue changes, and changes in the nociceptive and non-nociceptive processes (processes which are beyond the scope of this review). Patients can be assessed using pressure pain thresholds and self-reported measures, such as the visual analog scale (VAS) and the Patient-Rated Tennis Elbow Evaluation (PRTEE).

Additionally, pain free grip strength can be measured to assess for any potential motor impairment. Specifically, motor impairments such as reaction time, the rate of force development and electromyographical delay can (and have) been investigated.

The exact relationship between tendon pathology, pain system changes and motor impairments as a result of LE has not been thoroughly investigated. Thus, it was the objective of this study to evaluate the relationships between self-reported pain measures of tendon pathology, biomechanics and imaging in a group of individuals diagnosed with LE.

PERTINENT RESULTS

Patient-Rated Tennis Elbow Evaluation (PRTEE) and Biomechanical Measures

- Statistically, higher PRTEE scores were associated with lower grip strength and rate of force development during gripping.
- Higher PRTEE scores are also associated with higher electromechanical delay in onset of the muscle activation of the extensor carpi radialis.
- Statistically significant partial correlation coefficients between these two variables ranged anywhere between 0.44-0.68, where the most significant correlation was observed between the PRTEE composite score and the rate of force development at 100 msec.

PRTEE and Imaging

- NONE of the 12 partial correlation coefficients performed were statistically significant.

Biomechanical Measures

- A higher rate of force development was found to be associated with higher grip strength.
- The greatest correlation was found between pain free grip strength-(performed using the multi-axis profile dynamometer – MAP) and pain free grip strength-baseline ($r = 0.74$, $P < 0.01$).

Relationships Between Imaging Measures

- The strongest correlation occurred between neovascularity and MRI score ($r = 0.55$, $P < 0.01$).

Biomechanical and Imaging Measures

- No statistically significant association was found between biomechanical and ultrasound imaging measures.
- MRI score was found to be negatively associated with biomechanical measures. All 3 partial correlation coefficients were nominally statistically significant ($P < 0.05$). The strongest correlation was a negative relationship between MRI score and pain free grip strength measured with the MAP ($r= -0.72$).
- Also of note were the negative correlations found between MRI score and pain free grip strength-baseline ($r = -0.52$) and peak rate of force development ($r = -0.47$).

CLINICAL APPLICATION & CONCLUSIONS

Biomechanical measurements of grip strength and rate of force development are associated with self-reported pain measurements and function as measured by the PRTEE. No statistically significant relationship was found between ultrasound and MRI imaging measures, or measurement of self-reported pain. The results of this study also indicate that the rate of force development may have a greater role in the functional assessment of patients with LE, compared to maximum grip strength, as it has a greater correlation with the PRTEE. This is significant, as the performance of daily activities requires a certain threshold of strength. Strength beyond this threshold is likely not necessary to improve function. However, a greater rate of force development may help in reaching the strength threshold level more quickly, and may have a greater contribution toward function.

Additionally, electromechanical delay was significantly correlated with the PRTEE questionnaire, but not with the pain subscale. The delay represents the initial stages of force production, which may be the explanation for why previous studies have found a decrease in reaction time in patients with LE (1, 2).

These results are important for physical/manual therapy interventions for this disorder. While it is important to address a deficit in grip strength in a rehabilitation setting, simply improving grip strength may not address the deficits in the rate of force development. Improving the rate of force development require exercise that incorporate a velocity-dependent component (i.e. neuromuscular or power training).

The severity of ultrasound and MRI findings for LE are not correlated with symptom severity and function. The authors recommend that imaging be used for a specific diagnosis of disease, rather than for the assessment of disease severity.

In short, biomechanical measures have the potential to be used as clinical outcome measures in individuals with LE, while imaging measures were only useful for identifying the pathophysiology of LE, not the severity.

STUDY METHODS

Twenty-nine subjects diagnosed with LE were recruited. *The diagnostic criteria for LE included:*

1. Lateral elbow pain for more than 3 months.
2. Tenderness to palpation over the lateral epicondyle and/or the common extensor tendon.
3. Pain with at least 2 of the following provocation tests: Cozen's test, Mill's test, and resisted supination.

Exclusion criteria consisted of:

- Current or previous history of rheumatoid or any other inflammatory arthritis
- Diabetes mellitus
- Chronic pain
- Pregnancy
- Systemic nervous disease
- Neuropathy
- Acute trauma to the wrist or hands
- Prior or concurrent upper extremity injury

- Unresolved litigation
- Any other comorbidity that would interfere with participation.

Self-Reported Outcome Measures:

All included patients completed the Patient-Rated Tennis Elbow Evaluation (PRTEE), which contains a 5-item pain subscale and 10-item function subscale. A composite score, ranging from 0-100 is recorded, with 0 being the best score, and 100 being the worst. The patients also filled out a visual analog scale (VAS), where they rated the average lateral elbow pain intensity for the previous week.

Biomechanical Factors

- *Pain free grip strength*: Participants were seated in a chair with the elbow in an extended position and asked to squeeze the dynamometer 3 separate times, holding for 5 seconds each time, avoiding discomfort.
- *Rate of force development*: Participants were seated in a chair with the elbow in an extended position. Participants were instructed to squeeze the handle as quickly and hard as possible without pain 3 separate times, holding for 5 seconds each time, upon receipt of a randomly timed visual stimulus. The rate was calculated by taking the derivative of the force signal, measured in 30, 50 and 100 milliseconds from the onset of contraction
- *Electromechanical delay*: Raw EMG data from the extensor carpi radialis (ECR) muscle was collected. Electrodes were placed proximally on the ECR, exactly one-third of the distance measured between the lateral epicondyle and the distal radius. The time between the onset of the muscle activation based on the change in EMG signal and the onset of contraction as measured by the dynamometer is considered to be the electromechanical delay.

Only data from the affected arm were reported in the statistical analysis for this paper. In any case where the symptoms were bilateral, results from the most symptomatic arm as determined by VAS were used.

Tendon Pathology Measures were performed via magnetic resonance imaging (MRI) and ultrasound. Grading of the tendon pathology via MRI was performed using the following criteria:

- *Grade 0*: normal common extensor tendon
- *Grade 1*: mild tendinopathy in the common extensor tendon
- *Grade 2*: moderate tendinopathy
- *Grade 3*: severe tendinopathy

Grading of the tendon neovascularity and hypoechogenicity using ultrasound was performed using these criteria:

- *Grade 0*: no neovessels; normal hypoechogenicity
- *Grade 1*: mild (1-2 neovessels); mild focal hypoechogenicity
- *Grade 2*: moderate (3-4 neovessels); moderate focal hypoechogenicity
- *Grade 3*: severe (more than 4 or diffuse neovessels); severe diffuse hypoechogenicity

STUDY STRENGTHS / WEAKNESSES

General Considerations

- The individuals included in this study all had chronic LE. As such, the conclusions of this study cannot necessarily be applied to those with acute LE.
- Assessors were not blinded as to which individuals had LE, but they were blinded to the results of the outcome measures.
- There was no control group.

Additional References

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