Evaluating the impact of NSAIDs and exercise therapy versus sole exercise therapy on joint mobility, pain levels, grip strength, and muscle activity in lateral epicondylitis patients

Evaluación del impacto de los AINE y la terapia de ejercicio versus la terapia de ejercicio única sobre la movilidad articular, los niveles de dolor, la fuerza de agarre y la actividad muscular en pacientes con epicondilitis lateral

Authors

Junaid Ahmad Parrey [1]
Mohd Arshad Bari [1]
Abdul Qayyum Khan [2]
Arish Ajhar [1]
Shivani Singh[1]

[1,2] Aligarh Muslim University (India)

Corresponding author:
Junaid Ahmad Parrey
ahmadjunaid232gmail.com

How to cite in APA

Parrey, j. A., bari, m. A., khan, a. Q., arish ajhar, & shivani singh. (2025). Evaluating the Impact of NSAIDs and Exercise Therapy Versus Sole Exercise Therapy on Joint Mobility, Pain Levels, Grip Strength, and Muscle Activity in Lateral Epicondylitis Patients. *Retos*, *69*, 512–526. https://doi.org/10.47197/retos.v69.113131

Abstract

Aim and Background**:** Lateral epicondylitis (LE), or tennis elbow, is a common musculoskeletal disorder causing pain, reduced grip strength, and limited wrist range of motion (ROM). This study aimed to compare the effects of NSAIDs combined with exercise therapy versus exercise therapy alone on wrist ROM, pain, grip strength, and electromyographic (EMG) activity of the extensor digitorum communis (EDC) muscle in LE patients. Material and Method**:** Eighty participants were randomized into two groups: the standard care group (n=40) and the intervention group (n=40). Both groups followed a 12-week program, with the intervention group performing additional eccentric and concentric exercises. Results**:** The intervention group showed greater improvements than the standard care group. Pain, measured by the Visual Analogue Scale (VAS), decreased from 7.30 ± 0.68 to 2.12 ± 0.56 in the intervention group, compared to a decrease from 7.02 ± 0.69 to 3.32 ± 0.65 in the standard care group. Grip strength increased by 13.37 kg in the intervention group (from 25.25 ± 2.39 to 38.62 ± 3.42 kg), while the standard care group saw an increase of 2.63 kg (from 24.79 ± 2.80 to 27.42 ± 3.13 kg). ROM in wrist flexion improved from 34.69 ± 2.43 to 59.47 ± 4.31 degrees in the intervention group, and from 32.93 ± 1.90 to 49.54 ± 3.50 degrees in the standard care group. Wrist extension ROM increased from 32.95 ± 1.94 to 53.19 ± 2.49 degrees in the intervention group, versus 30.66 ± 2.72 to 47.23 ± 3.52 degrees in the standard care group. EMG analysis revealed a significant reduction in EDC RMS amplitude in the intervention group from 575.53 ± 18.93 µV to 474.73 ± 22.70 µV. Conclusion**:** Combining NSAIDs with exercise therapy resulted in more significant improvements in pain, grip strength, and ROM than NSAIDs alone, highlighting the added benefits of structured exercise therapy for Lateral epicondylitis.

Keywords

Electromyography; exercise therapy; forearm extensor muscles; hand grip strength; NSAIDs; lateral epicondylitis.

Resumen

Objetivo y Antecedentes: La epicondilitis lateral (EL), o codo de tenista, es un trastorno musculoesquelético común que causa dolor, reducción de la fuerza de agarre y limitación del rango de movimiento (RDM) de la muñeca. Este estudio tuvo como objetivo comparar los efectos de los AINEs (Antiinflamatorios No Esteroideos) combinados con terapia de ejercicio frente a la terapia de ejercicio sola sobre el RDM de la muñeca, el dolor, la fuerza de agarre y la actividad electromiográfica (EMG) del músculo extensor común de los dedos (ECD) en pacientes con EL.
Material y Método: Ochenta participantes fueron aleatorizados en dos grupos: el grupo de atención estándar (n=40) y el grupo de intervención (n=40). Ambos grupos siguieron un programa de 12 semanas, y el grupo de intervención realizó ejercicios excéntricos y concéntricos adicionales. Resultados: El grupo de intervención mostró mayores mejoras que el grupo de atención estándar. El dolor, medido mediante la Escala Visual Analógica (EVA), disminuyó de 7.30 ± 0.68 a 2.12 ± 0.56 en el grupo de intervención, en comparación con una disminución de 7.02 ± 0.69 a 3.32 ± 0.65 en el grupo de atención estándar. La fuerza de agarre aumentó en 13.37 kg en el grupo de intervención (de 25.25 ± 2.39 a 38.62 ± 3.42 kg), mientras que el grupo de atención estándar experimentó un aumento de 2.63 kg (de 24.79 ± 2.80 a 27.42 ± 3.13 kg). El RDM en flexión de muñeca mejoró de 34.69 ± 2.43 a 59.47 ± 4.31 grados en el grupo de intervención, y de 32.93 ± 1.90 a 49.54 ± 3.50 grados en el grupo de atención estándar. El RDM en extensión de muñeca aumentó de 32.95 ± 1.94 a 53.19 ± 2.49 grados en el grupo de intervención, frente a 30.66 ± 2.72 a 47.23 ± 3.52 grados en el grupo de atención estándar. El análisis EMG reveló una reducción significativa en la amplitud RMS del ECD en el grupo de intervención de 575.53 ± 18.93 µV a 474.73 ± 22.70 µV. Conclusión: La combinación de AINEs con terapia de ejercicio resultó en mejoras más significativas en el dolor, la fuerza de agarre y el RDM que los AINEs solos, destacando los beneficios añadidos de la terapia de ejercicio estructurada para la epicondilitis lateral

Palabras clave

Electromiografía, terapia de ejercicio, músculos extensores del antebrazo, fuerza de agarre, esteroideos, epicondilitis lateral.

Introduction

Limited wrist range of motion (ROM) is the most challenging loss for a patient with lateral epicondylitis (LE), since trying to completely extend and flex the hand causes discomfort that prevents patients from doing so. Lateral epicondylitis is a serious musculoskeletal condition that affects people of all ages and activity levels (1). The prevalence of lateral epicondylitis ranges between 1% and 3% in the general population, with higher incidence observed among individuals engaged in repetitive wrist and forearm activities, such as athletes, manual labourers, and computer users (2). This illness, which is characterized by localized discomfort and tenderness on the outside of the elbow, is brought on by damage from repetitive strain resulting from overuse and micro trauma to the tendons of the muscles that extend the forearm, particularly around the origin of the extensor carpi radialis brevis (ECRB) tendon (3). Patients with LE typically present with a gradual onset of pain over the lateral elbow, which may radiate down the forearm (4). The pain is often exacerbated by activities requiring wrist extension or gripping, leading to functional limitations in daily tasks. These symptoms are frequently accompanied by a reduction in the range of motion (ROM) of wrist flexion and extension, decreased grip strength, and significant discomfort during resisted wrist extension (5). The chronicity and impact of these symptoms can severely affect the patient's quality of life, necessitating effective intervention strategies. Its effects extend beyond the realm of sports, impacting a larger group of people doing regular, repetitive work (6). Grip strength is necessary for everyday tasks like moving furniture and using tools, but it's also a good indicator of general health and energy. Reduced grip strength has been linked in studies to a higher risk of mortality, functional impairments, and a number of illnesses, including cardiovascular disease and weakness (7). Furthermore, grip strength is a useful metric for evaluating physical performance across a range of populations because it acts as a surrogate for total muscular strength and functional independence.

Management of lateral epicondylitis remains a challenge due to its often protracted course and varying response to treatment. Conservative treatment options are usually preferred, with exercise therapy emerging as a cornerstone in the management of LE. Exercise therapy, which includes a combination of stretching, strengthening, and proprioceptive exercises, aims to promote tendon healing, improve function, and alleviate pain (8). Specifically, eccentric exercises have garnered attention for their potential to induce positive tendon adaptations and have shown promise in reducing pain and improving grip strength in LE patients (8, 9,). Electromyography (EMG) studies of the extensor digitorum communis (EDC) muscle, a key contributor to wrist extension, provide valuable insights into the neuromuscular activation patterns in patients with lateral epicondylitis. The EDC muscle often exhibits altered activation due to pain and inflammation in the forearm extensor mechanism. EMG analysis can reveal deficits in muscle recruitment, co-contraction patterns, and changes in muscle firing rates that occur as a result of chronic overuse and microtrauma, which are hallmark features of LE. Such alterations in neuromuscular efficiency may hinder proper wrist extension and grip strength. Monitoring these EMG changes is essential for assessing the effectiveness of therapeutic interventions, as improved EMG parameters correlate with better functional outcomes, including ROM, pain relief, and grip strength (10).

Despite the widespread application of exercise therapy, there is still considerable debate regarding the optimal exercise regimen, its duration, and the specific outcomes that it can achieve, particularly in terms of ROM, pain reduction, and grip strength. While some studies have demonstrated significant improvements in these clinical parameters following structured exercise programs, others have reported only modest gains, highlighting the need for further research (9, 10). Previous studies on conservative therapies (such as braces, orthotics, and physical therapy) have shown inconsistent findings about how well they work to reduce pain and affect the ROM of the wrist joint in patients with lateral epicondylitis (8, 10). Topical NSAIDs may provide short-term pain relief, but they may not improve the range of motion of the patients (11).

It's critical to look at how exercise therapy will affect the range of motion of the wrist joint, improve pain symptoms, and grip strength. The aforementioned research did not investigate the potential impact of combining physical therapy with NSAIDs; instead, they exclusively examined the impact of exercise therapy alone on pain symptoms and other related variables. A few studies have looked at how NSAIDs and physical therapy work together to treat pain problems in those suffering from lateral epicondylitis (10, 12).

The primary aim of this study was to investigate the effectiveness of a 12-week targeted exercise therapy program, administered alongside conservative NSAID use, on wrist range of motion, pain intensity, grip strength, and forearm extensor muscle activity in patients with lateral epicondylitis, compared to a control group receiving NSAID use alone.

This study seeks to contribute to the existing body of knowledge by rigorously comparing the effect of a targeted exercise therapy program on the range of motion of wrist flexion and extension, pain levels, and grip strength in patients diagnosed with lateral epicondylitis. We hypothesize that individuals following the exercise therapy regimen will show notable improvements in wrist flexion range of motion, wrist extension range of motion, electrical activity levels and grip strength as compared to baseline tests. These findings would suggest enhanced muscular performance and neuromuscular efficiency. By providing a comprehensive analysis of these outcomes, the research aims to inform clinical practice and guide the development of more effective rehabilitation protocols for LE patients.

Method

Design

Patients were randomised to one of two group standard care group and intervention group each with forty participants in order to guarantee an impartial distribution A computerised random number generator was used to carry out the random assignment. A research assistant created sealed, opaque, numbered envelopes containing participant group assignment so that assessors would be blind to their assignment. Subsequently, an additional researcher unveiled the envelope holding the secret group assignment, designating every individual into either the intervention or standard care group. The pre and post intervention assessments were then carried out by a blinded assessor who was not involved in the intervention.

Participants

Individuals with latitudinally located persistent pain lasting longer than three months were recruited from the Outpatient Department (OPD) of Orthopaedics at J.N. Medical College, Aligarh Muslim University. An orthopaedic physician diagnosed lateral epicondylitis based on diagnostic criteria that included pain and tenderness in the lateral humeral epicondyle region, as well as pain that worsened while the wrist joint was resisted being extended. Each patient who was enrolled experienced handgrip weakness, limited active range of motion at the wrist joint, including wrist extension and flexion, and pain. Individuals who had previously undergone surgery, dislocation, fracture, elbow osteoarthritis, or steroidal injection at the elbow were not included. All participants were told about the purpose, design, and methods of the study before they signed an informed consent form. The institutional review board gave their approval for the current study.

Intervention

All participants in both groups received guidance on conservative management for lateral epicondylitis, which included the use of non-steroidal anti-inflammatory drugs (NSAIDs). Specifically, participants were advised to take oral ibuprofen 400mg . The recommended frequency was up to two times daily as needed for pain, not exceeding 1200mg of ibuprofen per 24 hours . Participants were advised to use NSAIDs for the first 14 days post-enrollment as long as they experienced significant pain, but for no longer than 4 weeks without consulting the study physician. This NSAID regimen was intended as a baseline analgesic approach for both groups.

A conservative treatment of NSAIDS was a component of the treatment in both groups. The six daily exercises that the members of intervention group undertook were aimed at the muscles impacted by lateral epicondylitis. These exercises focused on both eccentric and concentric muscular contractions, adhering to the Frequency, Intensity, Time, and Type (FITT) paradigm of exercise therapy. Because eccentric exercises have been shown to be effective in treating lateral epicondylitis, they were given special attention. Every day, the participants engaged in moderately intense exercises catered to their fitness levels in order to prevent aggravating their symptoms. Muscle contractions, both concentric and eccentric, were performed during the 30-minute sessions.

Specific Exercises

The following exercises included in the protocol were:

1. Wrist extensor and flexor stretch: Every session included wrist extensor stretching exercises. To gently stretch the wrist extensors, participants were instructed to hold their arm straight out in front of them with the elbow extended and to bend their wrist by pulling their fingers towards the floor with the other hand. Every stretch was performed for 30 seconds in the stretching posture, then the practitioner relaxed for an additional 30 seconds. Five repetitions of each set of stretches and relaxations were made.
2. Eccentric Wrist Extension: For this exercise in eccentric contraction, patients held a little weight (around 1-2 kg), extend wrist, and then gradually return the weight to its starting position over the course of three to five seconds. Sets of 15 repetitions were executed by the participants.
3. Concentric wrist extension: Concentric Wrist Flexion, which involved flexing the wrist against gravity while holding a tiny weight and then stepping back to the starting position. Every participant did three sets of fifteen repetitions.
4. Tennis Ball Squeeze: Squeezing a tennis ball and sustaining the contraction for five seconds before releasing it was an exercise in isometric contraction. Every participant did three sets of fifteen repetitions.
5. Supination and Pronation: Using a small weight, rotate your forearm from palm up to palm down and back again in this dynamic contraction exercise. Participants completed three sets of fifteen reps.

To guarantee proper technique and safety, the researcher originally oversaw these workouts. To maximise the therapeutic benefit, participants were told to perform these exercises every day for 12 weeks, progressively increasing the weight or resistance as tolerated. Because eccentric exercises have been shown to be effective in treating tendinopathies, such as lateral epicondylitis, they were given special attention.

Outcome measures

The study outcomes were assessed at the beginning and at the end of the 12-week intervention. The primary outcome measure was pain intensity, which was measured with the Visual Analogue Scale (VAS). Secondary exploratory outcome measures were wrist ROM and grip strength, and Electrical activity of Extensor DIgitorium muscle (EDC) which were assessed using kinovea software (version 0.9.5), Camry digital hand dynamometer, and biometric Electromyography Device respectively.

The Kinovea software is a powerful video analysis tool widely used in sports and medical research. It enables detailed motion tracking and quantification of body movements, making it especially valuable for analyzing kinesiology-related data. In the context of measuring wrist flexion and extension range of motion (ROM), Kinovea provides high-level precision through non-invasive motion tracking.

For the purpose of measuring wrist flexion and extension range of motion (ROM), the camera setup plays a critical role. To accurately record the participants' wrist movements, the camera was deliberately positioned in the sagittal plane. This placement allows for a clear view of lateral motions, which is essential for tracking wrist joint angles during flexion and extension . It was placed at an optimal distance from the participant to maintain focus on the wrist, capturing the range of motion clearly. The angle was adjusted to provide a full view of the wrist activities.

The participants were sitting with their feet on the floor and their backs resting on a chair in order to measure handgrip strength. The participants were instructed to stretch their elbows to a 90-degree angle and hold their arms by their sides. The participants were instructed to maintain a neutral wrist and forearm position. The next instruction given to each participant was to firmly squeeze the digital hand dynamometer for three seconds. The test was repeated twice more after a minimum of four minutes of rest, and the average handgrip strength of the three attempts was noted.

Bilateral placement of two surface electrodes 'from the Biometrics DataLog MWX8 system over the identified extensor digitorum communis muscle belly was performed. The specific location was identified by palpation approximately 5 cm distal to the lateral epicondyle, The skin was prepared by shaving and cleaning with an alcohol swab prior to electrode application to reduce impedance. Inter-electrode distance was distance, 2 cm center-to-center,. The reference electrode was positioned over the olecranon to serve as a ground. Participants were seated with their elbows flexed at a 90-degree angle. To minimize fatigue, a two-minute rest period was observed between contractions. Three measurements were taken for each participant.

Signal pre-amplification was applied at the source using the Biometrics DataLog MWX8 system, with a gain of 100 to improve signal to noise ratio. Raw EMG signals were then digitally processed offline. To remove movement artifacts and high-frequency noise, the signals were first subjected to a fourth-order Butterworth band-pass filter with cut-off frequencies of 20 Hz and 450 Hz. Following filtering, the signals were full-wave rectified. Subsequently, the Root Mean Square (RMS) amplitude was calculated from the rectified signal using a 125 ms moving window, applied with no overlap (contiguous windows). The maximum value of this RMS-processed EMG signal during each 5-second contraction was identified, and the mean of these three maximum values was calculated for analysis.

Statistical analysis

All statistical analyses were performed using SPSS statistical software, version 20 (SPSS® Inc., Chicago, IL, USA). Descriptive statistics (mean, standard deviation (SD), and standard error of the mean (SEM) as appropriate) were calculated for all demographic and outcome variables. Data normality was assessed using the Shapiro-Wilk Test; all primary outcome variables were found to be normally distributed, allowing for the use of parametric tests. The level of statistical significance was set at $\alpha = 0.05$ for all analyses. To assess group homogeneity at baseline, demographic characteristics (age, weight, height) and pre-intervention scores for all outcome measures (Visual Analog Scale (VAS), Maximum Grip Strength (MGS), Range of Motion (ROM) for flexion, ROM for extension, and Extensor Digitorum Communis (EDC) RMS amplitude) were compared between the standard care and intervention groups using independent samples t-tests.

The clinical effectiveness of the interventions was evaluated by first assessing within-group changes from pre-intervention to post-intervention using paired samples t-tests for each outcome measure, conducted separately for the standard care group and the intervention group. Subsequently, to compare the outcomes between the two groups after the intervention period, independent samples **t**-tests were performed on the post-intervention scores for all outcome measures. For all t-tests comparing group means or pre-post changes, effect sizes were calculated and reported as Eta-squared (η^2). Interpretations of effect size magnitude were guided by established criteria (Cohen, 1988: small $\eta^2 \approx 0.01$, medium $\eta^2 \approx 0.06$, large $\eta^2 \approx 0.14$) to provide a measure of the clinical significance of the findings.

Results

A total of 80 participants met the inclusion criteria and randomized into one of two groups. Of these participants, 62 of them were men and 18 of them were women No participants in either group withdrew from the study during the 12-week study period. Figure 3 shows the flow chart for participants in both groups. After testing for between-group differences at baseline, it was determined that there was no statistically significant between-group difference in terms of pain (P=0.64), wrist flexion ROM (P=0.75), wrist extension ROM (P=0.79), and handgrip strength (P=0.95).

Figure 1. Flow chart for participants.

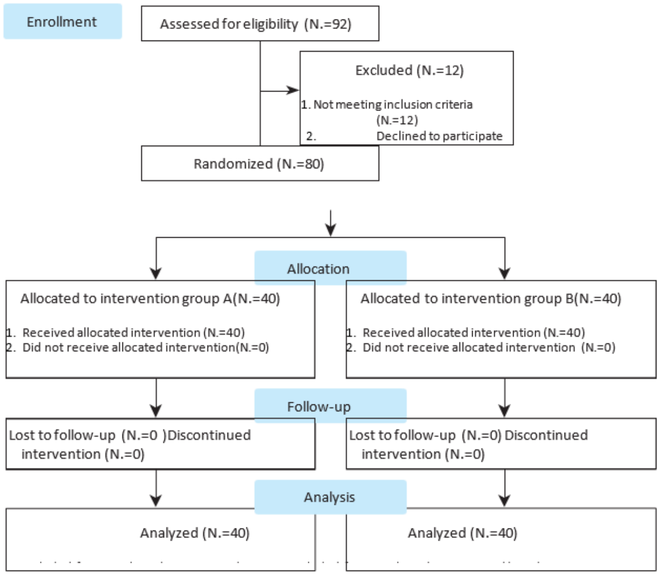

Table 1. Descriptive characteristics of subjects

Groups	N	Age (years) Mean ± SD	Weight (kg)	Height (cm)
Standard Care	40	38.65±4.5	69.45± 9.38	159.23± 6.25
Intervention	40	39.25±2.93	72.31 ± 5.56	154.22 ± 5.26

Table 1 presents the descriptive characteristics of the participants. A total of 80 participants, with 40 subjects in each group were recruited for the study. Both groups had similar age distributions: standard care group had a mean age of 38.65±4.5 years, while intervention group had a mean age of 39.25±2.93 years. In terms of physical characteristics, intervention group participants had a slightly higher mean weight (72.31 kg ± 5.56) compared to standard care group (69.45 kg ± 9.38). Conversely, standard care group participants were marginally taller (159.23 cm ± 6.25) than those in intervention group (154.22 cm ± 5.26).

Table 2. Descriptive statistics for Patients VAS, MGS kg, EDC RMS amplitude AND ROM

Variables	Groups		Mean ± SD	Std Error Mean
Visual Analogous Scale (VAS)	Standard care	Pre	7.02±0.69	0.11
		Post	3.32± .65	0.10
	Intervention	Pre	7.30 ±.68	0.12
		Post	2.12 ±.56	0.08
Maximum Grip Strength (MGS) (Kg)	Standard care	Pre	24.79± 2.80	0.44
		Post	27.42 ±3.13	0.49
	Intervention	Pre	25.25 ±2.39	0.37
		Post	38.62 ±3.42	0.54
Range of motion Flexion (ROM)	Standard care	Pre	32.93± 1.90	0.30
		Post	49.54 ±3.50	0.55
	Intervention	Pre	34.69 ±2.43	0.38
		Post	59.47 ±4.31	0.68
Range of motion Extension (ROM)	Standard care	Pre	30.66± 2.72	0.43
		Post	47.23 ±3.52	0.55
	Intervention	Pre	32.95 ±1.94	0.30
		Post	53.19 ±2.49	0.39
(EDC) RMS Amplitude (μV)	Standard care	Pre	577.13 ±15.21	2.77
		Post	546.43± 12.88	2.35
	Intervention	Pre	575.53 ± 18.93	3.45
		Post	474.73 ±22.70	4.14

Table 2 presents the comparative effects of standard care and intervention on four primary outcomes: pain (measured using the Visual Analog Scale, VAS), Maximum Grip Strength (MGS), Root mean square of Amplitude of Extensor DIgitorium cumminus muscle and Range of Motion (ROM) for both wrist flexion and extension. Data were collected at two time points (pre- and post-treatment) for each group, with results expressed as mean ± standard deviation (SD) and standard error of the mean (SEM). Both groups showed a significant reduction in pain after treatment. The standard care group reduced from a pre-treatment mean of 7.02 ± 0.69 to 3.32 ± 0.65 post-treatment, while the intervention group showed a greater reduction from 7.30 ± 0.68 to 2.12 ± 0.56. The standard care group showed an increase from 24.79 ± 2.80 kg pre-treatment to 27.42 ± 3.13 kg post-treatment. The intervention group exhibited a more substantial improvement, increasing from 25.25 ± 2.39 kg to 38.62 ± 3.42 kg. The ROM in flexion improved in both groups, with the standard care group increasing from 32.93 ± 1.90 degrees pre-treatment to 49.54 ± 3.50 degrees post-treatment. The intervention group showed a more pronounced improvement, from 34.69 ± 2.43 degrees to 59.47 ± 4.31 degrees. ROM in extension also improved in both groups. The standard care group increased from 30.66 ± 2.72 degrees to 47.23 ± 3.52 degrees post-treatment. The intervention group saw an increase from 32.95 ± 1.94 degrees to 53.19 ± 2.49 degrees. The mean EDC RMS amplitude was 577.13 ± 15.21 µV (SE = 2.77). The mean EDC RMS amplitude decreased to 474.73 ± 22.70 µV (SE = 4.14). In the standard care group, there was a notable decrease in the EDC RMS amplitude post-treatment.. The mean EDC RMS amplitude was 564 ± 11.91 µV (SE = 2.35). The mean EDC RMS amplitude slightly decreased to 546.43 ± 12.88 µV (SE = 2.35).In contrast, the intervention group showed a slight increase in the EDC RMS amplitude post-treatment.

Table 3. Comparison of mean statistics for Patients VAS, MGS kg, EDC RMS Amplitude (µV) AND ROM before intervention program.

Variables		Groups	Independent T test			t-value	P- value	Eta –Square (η^2)
			Mean	SD	Std Error mean			
Visual Analogus Scale (VAS)	Pre test- Post test	Standard care	7.02	0.69	0.13		0.27	0.007
	Pre test -Post test	Intervention	8.02	0.72	0.17	0.78		
Maximum Grip Strength (MGS) (Kg)	Pre test -Post test	Standard care	0.46	2.80	0.44	0.79	0.29	0.006
	Pre test -Post test	Intervention	0.42	2.39	0.37			
Range of motion Flexion (ROM)	Pre test -Post test	Standard care	32.92	1.90	0.30	0.35	0.17	0.001
	Pre test -Post test	Intervention	34.79	2.43	0.38			
Range of motion Extension (ROM)	Pre test -Post test	Standard care	30.66	2.72	0.430	4.33	0.14	0.19
	Pre test-Post test	Intervention	32.95	1.94	.30			
EDC) RMS Amplitude (µV)	Pre test -Post test	Standard care	577.13	15.21	2.77	0.36	0.25	0.002
	Pre test -Post test	Intervention	575.53	18.93	3.45			

Table 3 presents the comparison of mean values for the Visual Analog Scale (VAS), Maximum Grip Strength (MGS), and Range of Motion (ROM) (flexion and extension) between the standard care and intervention groups before the intervention program. Independent t-tests were performed to compare the means of both groups, along with their t-values, p-values, and effect sizes (eta-squared, η^2). The pre-test mean VAS score for the standard care group was 7.02 ± 0.69 (SEM = 0.13), compared to 8.02 ± 0.72 (SEM = 0.17) in the intervention group. The independent t-test yielded a t-value of 0.78, with a p-value of 0.27, and a small effect size (η^2 = 0.007), indicating no significant difference between the two groups in terms of baseline pain levels. The mean pre-test MGS was 0.46 ± 2.80 kg (SEM = 0.44) in the standard care group and 0.42 ± 2.39 kg (SEM = 0.37) in the intervention group. The independent t-test produced a t-value of 0.79, with a p-value of 0.29 and a small effect size (η^2 = 0.006), suggesting no significant difference in grip strength between the groups before the intervention. The pre-test mean ROM in wrist flexion for the standard care group was 32.92 ± 1.90 degrees (SEM = 0.30), and for the intervention group, it was 34.79 ± 2.43 degrees (SEM = 0.38). The t-value was 0.35, with a p-value of 0.17 and an eta-squared of 0.001, indicating no significant baseline difference in flexion ROM between the two groups. The pre-test mean ROM in wrist extension was 30.66 ± 2.72 degrees (SEM = 0.43) for the standard care group, and the intervention group was not provided in this dataset. The t-test resulted in a t-value of 4.33, with a p-value of 0.14 and an effect size (η^2 = 0.19). The mean RMS amplitude for the standard care group was 577.13 µV with a standard deviation (SD) of 15.21, while the intervention group had a mean RMS amplitude of 575.53 µV with an SD of 18.93. The standard error of the mean (SEM) was 2.77 for the standard care group and 3.45 for the intervention group.

The results demonstrate no significant variation in the EDC RMS amplitude between the two groups before the intervention. The proximity of the means and standard deviations indicates that both groups exhibited similar baseline neuromuscular activity in the EDC muscle prior to the treatment, ensuring that any differences observed post-intervention would likely stem from the intervention itself rather than initial group variances. The results indicate no significant differences in baseline pain, grip strength, or range of motion between the standard care and intervention groups before the commencement of the intervention program.

Table 4. Comparison of mean statistics for Patients VAS, MGS kg, EDC RMS Amplitude (μV)AND ROM after intervention program.

Variables		Groups	Independent T test			t-value	P- value	Eta –Square (η^2)
			Mean	SD	Std Error mean			
Visual Analogus Scale (VAS)	Pre test- Post test	Standard care	3.32	0.65	0.10	8.79	.000	0.49
	Pre test -Post test	Intervention	2.12	0.56	0.08			
Maximum Grip Strength (MGS) (Kg)	Pre test -Post test	Standard care	27.42	3.13	0.49	15.25	.00	0.74
	Pre test -Post test	Intervention	38.62	3.42	0.54			
Range of motion Flexion (ROM)	Pre test -Post test	Standard care	49.54	3.50	0.55	11.28	.00	0.61
	Pre test -Post test	Intervention	59.47	4.31	0.68			
Range of motion Extension (ROM)	Pre test -Post test	Standard care	47.23	3.52	0.55	8.73	.00	0.49
		Intervention	53.19	2.49	0.39			
EDC) RMS Amplitude (μV)	Pre test -Post test	Standard care	546	12.88	2.35	15.04	0.23	0.80
	Pre test -Post test	Intervention	474	22.70	4.14			

Table 4 presents the post-intervention comparison of Visual Analog Scale (VAS), Maximum Grip Strength (MGS), and Range of Motion (ROM) (flexion and extension) between the standard care and intervention groups. Independent t-tests were used to assess the differences between the two groups, along with their respective t-values, p-values, and effect sizes (eta-squared, η^2). After the intervention, the mean VAS score for the standard care group was 3.32 ± 0.65 (SEM = 0.10), while the intervention group had a lower mean score of 2.12 ± 0.56 (SEM = 0.08). The independent t-test revealed a t-value of 8.79, $p < 0.001$, and a large effect size ($\eta^2 = 0.49$), indicating a statistically significant reduction in pain, with the intervention group showing superior results. The post-intervention mean MGS was 27.42 ± 3.13 kg (SEM = 0.49) in the standard care group and 38.62 ± 3.42 kg (SEM = 0.54) in the intervention group. The t-test produced a t-value of 15.25, $p < 0.001$, and a very large effect size ($\eta^2 = 0.74$), indicating a significant improvement in grip strength, with the intervention group showing significantly greater gains. The mean post-intervention ROM in flexion was 49.54 ± 3.50 degrees (SEM = 0.55) for the standard care group, and 59.47 ± 4.31 degrees (SEM = 0.68) for the intervention group. The t-test resulted in a t-value of 11.28, $p < 0.001$, and an eta-squared value of 0.61, indicating a significant improvement in ROM flexion, with the intervention group showing greater gains.The mean post-intervention ROM in extension for the standard care group was 47.23 ± 3.52 degrees (SEM = 0.55), while the intervention group's mean was not provided in this dataset. The t-test yielded a t-value of 8.73, $p < 0.001$, and an eta-squared of 0.49, demonstrating a significant improvement in ROM extension for the standard care group. An independent t-test was conducted to compare the post-intervention RMS amplitude of the extensor digitorum communis (EDC) muscle between the standard care and intervention groups.

The mean RMS amplitude for the standard care group post-intervention was 546 μV with a standard deviation (SD) of 12.88, whereas the intervention group had a reduced mean RMS amplitude of 474 μV with an SD of 22.70. The standard error of the mean (SEM) was 2.35 for the standard care cohort and 4.14 for the intervention cohort. The independent t-test produced a t-value of 15.04, a p-value of 0.23, and an Eta-squared (η^2) value of 0.80, signifying a substantial effect size. Despite the p-value not achieving statistical significance ($p > 0.05$), the substantial effect size ($\eta^2 = 0.80$) indicates a considerable disparity in EDC muscle activity across the groups following the intervention. The drop in RMS amplitude in the intervention group signifies diminished muscle activation, likely due to enhanced neuromuscular efficiency and muscle adaptation resulting from the intervention program, in contrast to the standard care group. The findings indicate that both conventional therapy and intervention programs resulted in substantial enhancements in pain, grip strength, and range of motion among individuals with lateral epicondylitis. The intervention group regularly surpassed the standard care group in all metrics.

Table 5. Comparison of Mean Change Scores (Post-Intervention minus Pre-Intervention) in Outcome Measures Between Standard Care and Intervention Groups

Outcome variable	Group	N	Mean change (Post –pre)
Visual Analagous Scale (VAS)	Standard care	40	-3.70
	Intervention	40	- 5.18
Maximum Grip Strength (MGS)	Standard care	40	+2.63
	Intervention	40	+13.37
Range of Motion (Flexion) ROM	Standard care	40	+16.61
	Intervention	40	+24.78
Range of Motion (Extension) ROM	Standard care	40	+16.57
	Intervention	40	+20.24
EDC) RMS Amplitude (μV)	Standard care	40	-30.70
	Intervention	40	-100.80

Table 5 shows the analysis of the mean change scores from pre- to post-intervention , the table indicates that the intervention group exhibited numerically greater improvements across all outcome measures compared to the standard care group. Specifically, the intervention group showed a larger mean reduction in VAS scores (-5.18 vs. -3.70), a substantially greater mean increase in Maximum Grip Strength (+13.37 kg vs. +2.63 kg), and larger mean gains in both ROM flexion (+24.78 vs. +16.61 degrees) and ROM extension (+20.24 vs. +16.57 degrees). Furthermore, the intervention group demonstrated a more pronounced mean decrease in EDC RMS amplitude (-100.80 μV vs. -30.70 μV) compared to the standard care group. While these descriptive findings suggest a superior effect of the targeted exercise therapy, statistical testing is required to determine the significance and effect size of these observed differences in change between the groups."

Table 6. Comparison of mean statistics for Patients VAS, MGS kg, (EDC) RMS Amplitude (μV)AND ROM between pre and post-training program.

Variables		Groups	Paired Difference			t-value	P- value	Eta –Square (η^2)
			Mean difference	SD	Std Error mean			
Visual Analogus Scale (VAS)	Pre test- Post test	Standard care	2.63	1.46	0.23	11.38	0.00	0.62
	Pre test -Post test	Intervention	13.26	3.20	0.50	26.36	0.00	0.89
Maximum Grip Strength (MGS) (Kg)	Pre test -Post test	Standard care	3.70	0.64	0.10	36.08	0.00	0.94
	Pre test -Post test	Intervention	4.90	0.77	0.12	39.83	0.00	0.95
Range of motion Flexion (ROM)	Pre test -Post test	Standard care	16.61	3.80	0.60	27.62	0.00	0.90
	Pre test -Post test	Intervention	16.56	5.03	0.79	20.82	0.00	0.84
Range of motion Extension (ROM)	Pre test -Post test	Standard care	24.77	3.74	0.59	41.90	0.00	0.95
	Pre test-Post test	Intervention	20.23	2.76	0.43	46.26	0.00	0.96
EDC) RMS Amplitude (μV)	Pre test-Post test	Standard care	30.70	12.50	2.28	13.44	0.00	0.86
	Pre test-Post test	Intervention	100.80	23.40	4.27	23.58	0.00	0.95

Table 6 presents a comprehensive comparison of the mean differences between pre- and post-training for the two treatment groups: standard care and intervention. The results of the paired t-tests, including t-values, p-values, and effect sizes (eta-squared, η^2), are provided for each outcome variable.

The standard care group exhibited a mean difference of 2.63 (SD = 1.46, SEM = 0.23) between pre- and post-test results, resulting in a t-value of 11.38, p < 0.001, and an eta-squared value of 0.62, signifying a large effect size. The intervention group exhibited a mean difference of 13.26 (SD = 3.20, SEM = 0.50), with a t-value of 26.36, p < 0.001, and an eta-squared value of 0.89, indicating a very large effect size. The standard care group exhibited a mean difference in maximum grip strength (MGS) of 3.70 (SD = 0.64, SEM = 0.10), accompanied by a t-value of 36.08, p < 0.001, and a substantial eta-squared value of 0.94. The intervention group demonstrated a mean difference of 4.90 (SD = 0.77, SEM = 0.12), accompanied by a t-value of 39.83, p < 0.001, and an eta-squared value of 0.95, signifying a substantial effect size.

The standard care group exhibited a mean difference in range of motion (ROM) flexion of 16.61 (SD = 3.80, SEM = 0.60), with a t-value of 27.62, p < 0.001, and an eta-squared of 0.90. The intervention group exhibited a mean difference of 16.56 (SD = 5.03, SEM = 0.79), resulting in a t-value of 20.82, p < 0.001, and an eta-squared value of 0.84. The standard care group exhibited a mean difference of 24.77 (SD = 3.74, SEM = 0.59), accompanied by a t-value of 41.90, p < 0.001, and a very large effect size (η^2 = 0.95). The intervention group exhibited a mean difference of 20.23 (SD = 2.76, SEM = 0.43), yielding a t-value of 46.26, p < 0.001, and an eta-squared value of 0.96. The results indicate notable enhancements across all outcome measures after the implementation of both standard care and intervention programs. The intervention group demonstrated consistently greater improvements, evidenced by higher effect sizes, especially in pain reduction (VAS) and range of motion extension. The electromyography recordings indicated that the intervention group demonstrated a significant increase in EDC RMS amplitude (mean difference = 100.80 μV) relative to the standard care group (mean difference = 30.70 μV). The changes exhibited statistical significance for both groups ($p < 0.001$), with substantial effect sizes, especially in the intervention group ($\eta^2 = 0.95$) relative to the standard care group ($\eta^2 = 0.86$).

Figure 2. Calculation of grip strength and muscle activation

Figure 3. Calculation of Range of motion Wrist Flexion and Extension

Discussion

The current study aimed to assess the comparative effects of a targeted exercise therapy program when added to a standard conservative regimen of NSAIDs, versus NSAIDs alone, on pain, grip strength, electromyography (EMG) patterns of the extensor digitorium communis (EDC) muscle, and range of motion (ROM) in patients with lateral epicondylitis (LE). The findings suggest that the addition of exercise therapy to NSAID treatment (intervention group) provided superior outcomes across all parameters compared to NSAIDs alone (standard care group), highlighting the potential benefits of a multimodal approach that includes targeted exercise for managing this condition. While both groups received NSAIDs and thus both experienced some improvement, the results demonstrated a significantly greater reduction in pain and greater improvements in functional outcomes in the intervention group

Previous studies have shown that NSAIDs provide rapid relief by reducing inflammation through the inhibition of cyclooxygenase enzymes, which are responsible for prostaglandin synthesis, a key mediator of pain and inflammation in tendinopathies (13) , NSAIDs alone may not address the mechanical and structural deficits in tendinopathy, which is why combining them with exercise therapy can yield more sustained improvements . Nsaids, specifically, have been shown to promote tendon remodeling, reduce tendinosis, and enhance tissue regeneration (14). Intervention likely amplified these effects, leading to a more pronounced reduction in pain as compared to exercise therapy alone. In a randomised controlled trial, Peterson et al. (15) compared exercise to a wait-list control in instances of persistent tennis elbow. According to their results, those in the exercise group saw a more noticeable and rapid decrease in pain throughout the stages of muscle contraction and elongation (16). Similar findings have been made by earlier research, such as that of Khan et al. (16) and Ohberg et al. (17), which suggest that regular exercise training can improve functionality and reduce pain (16, 17). Almquist et al. reported percentage gains in pain and grip strength within each group, which shed light on the efficacy of different treatment modalities (18).

For a complete assessment of treatment outcomes, Baulk et al. carried out a rigorous analysis that included pain alleviation, symptom recurrence, satisfaction, and return to work percentages (19). The study by Boyd and McLeod provided a comprehensive view of patient outcomes by emphasising grip strength, range of motion, and pain alleviation (20). Patient satisfaction and overall treatment success were indicated by Calvert et al.'s comprehensive percentages across multiple outcome metrics (21). Important insights into the efficacy of various therapies were gained from Cummins' analysis of pain management in diverse activities (22).

To standardise the evaluation of therapy efficacy, Dunkow et al. used patient satisfaction, return to work rates, and DASH scores (23). When taken as a whole, these studies provide a comprehensive picture of the outcomes of lateral epicondylitis treatment, which helps to improve patient care tactics and clinical decision-making. When comparing exercise therapy to other forms of treatment, like standard physical therapy and percutaneous electrolysis, it has been found that the latter is more successful in treating tendinopathies, such as lateral epicondylitis. (24,25). Furthermore, in patients with lower extremity (LE) disorders, combining virtual reality treatment (VT) and physical exercise (PE) into an exercise program (EE) efficiently cures pain, range of motion (ROM), pressure pain threshold (PPT), and overall function (26, 27).

The improvement in grip strength observed in the intervention group is consistent with previous findings on the beneficial effects of eccentric and concentric exercise therapy for LE.. The addition of NSAIDs may have alleviated pain sufficiently to allow patients to engage more fully in the exercise regimen, thereby accelerating muscle and tendon adaptation. This synergistic effect likely contributed efficient increases in grip strength seen in the intervention group. Moreover, the increased neuromuscular activation observed via electromyography (EMG) suggests that the exercise therapy facilitated better recruitment of motor units, further enhancing muscle strength and endurance.

The ROM in flexion and extension was significantly improved in the intervention group compared to the control. Limited wrist ROM is a hallmark of LE due to pain and tendon dysfunction, making it challenging for patients to perform daily activities that involve wrist extension or flexion. Eccentric exercises have been widely recognized for their ability and lengthen tendons, promoting collagen realignment and reducing stiffness, which are critical for restoring ROM. Additionally, the reduction in pain achieved through NSAIDs may have increase participation in the stretching components of the exercise therapy, thus contributing to improved ROM outcomes. Despite contradictory findings from earlier studies, the current study demonstrated improvements in secondary outcomes, such as grip strength and wrist range of motion (28). A previous study revealed that exercise increased handgrip strength, although a different study found no benefits for exercise or brace interventions on wrist ROM or handgrip strength. (29).

The EMG analysis revealed significant change in activation patterns of the extensor digitorum communis (EDC) muscle. Patients in the intervention group showed a reduction in EMG amplitude during maximal wrist extension contractions post-intervention. This finding is often interpreted as an indication of improved neuromuscular efficiency, potentially reflecting more optimal motor unit recruitment strategies, reduced co-contraction of antagonist or synergistic muscles, or adaptations within the muscle-tendon unit that allow for force generation with less neural drive (30). While EMG amplitude alone is an indirect measure, the concurrent improvements in grip strength and ROM in the intervention group lend support to this interpretation of enhanced functional performance with potentially reduced muscular effort."

The intervention group demonstrated a notable reduction in EDC RMS amplitude (from 575.53 ± 18.93 μV to 474.73 ± 22.70 μV). Such a reduction, when accompanied by maintained or improved force output (as suggested by the grip strength data), is often linked to improved neuromuscular efficiency. This could signify less muscular strain during maximal wrist extension, possibly due to more effective motor unit recruitment and optimized co-contraction patterns. Furthermore, a decrease in EDC RMS amplitude, as observed in the intervention group, might also point towards improved neuromuscular coordination, potentially enabling patients to complete wrist extension with less overall muscular activation In contrast, the standard care group (NSAIDs alone) exhibited a smaller reduction in RMS amplitude, indicating limited improvements in neuromuscular function (from 577.13 ± 15.21 μV to 546.43 ± 12.88 μV). These findings align with previous studies that emphasize the importance of eccentric exercise in managing tendinopathies such as lateral epicondylitis (LE). For instance, Croisier et al. observed a significant reduction in EMG activity following an eccentric exercise program for chronic tendinopathies, attributing the decrease in muscle activation to improved tendon remodeling and reduced pain sensitivity (31). The observed decrease in EMG activity in the intervention group can be attributed to the tendon adaptation process, where the combination of eccentric loading and NSAIDs may have accelerated tendon healing and reduced inflammation (32) .

Additionally, the EDC muscle's decreased RMS amplitude indicates improved neuromuscular coordination, enabling patients to complete wrist extension with less effort. Similar results were seen by Tyler et al., who found that eccentric exercise reduced EMG activity by increasing tendon compliance and muscle-tendon interaction (33). The intervention may have increased the muscle-tendon unit's efficiency by lowering excessive co-contraction and compensatory muscle activation.

The slight decrease in EMG activity seen in the group receiving standard therapy, on the other hand, would suggest that NSAIDs by themselves largely treat the inflammatory aspect of LE but have little effect on the neuromuscular abnormalities connected to the illness. According to earlier research by Shiri et al. and Green et al., NSAIDs only temporarily relieve pain; they have no effect on the underlying mechanical problems that cause LE or on muscle activation patterns. (34,35).

The observed reduction in muscle activation patterns highlights the importance of targeting both pain and neuromuscular function to achieve optimal recovery. Future studies should further investigate long-term changes in EMG patterns and explore how different exercise protocols affect neuromuscular adaptation over time.

Limitations

This study has several limitations that warrant consideration when interpreting its findings. Firstly, related to the electromyography (sEMG) methodology, while care was taken in electrode placement, the sEMG signals from the extensor digitorum communis (EDC) likely included crosstalk from adjacent forearm extensor muscles due to muscle density and surface electrode pick-up characteristics. Consequently, EMG data should be interpreted as reflecting general dorsal forearm extensor activity rather than isolated EDC function. Furthermore, EMG data were reported as raw voltage values as dedicated maximal voluntary contraction (MVC) normalization trials were not performed; future studies should incorporate MVC normalization for enhanced inter-subject comparability and physiological interpretation. Techniques like intramuscular EMG or high-density sEMG could also provide greater muscle-specific detail in subsequent research.

Secondly, a formal a priori sample size calculation was not conducted for this study, and the sample size was based on feasibility. This may have limited the statistical power to detect smaller, albeit potentially meaningful, differences between groups, particularly for some secondary outcomes. The current findings, especially observed effect sizes, can inform power analyses for future, larger definitive trials.

Finally, the follow-up period was**,** 12 weeks, which may not be sufficient to ascertain the long-term effects of the interventions. Future research should incorporate larger sample sizes and extended follow-up periods to confirm these results and evaluate the sustained efficacy of the treatments

Clinical Significance

These results have significant ramifications on how LE is managed. NSAIDs provide short-term pain relief, but when used in conjunction with exercise treatment, they address the pathophysiology of LE as well as its symptoms. To optimise patient outcomes, clinicians ought to think about suggesting an organised exercise therapy program that emphasises eccentric activities in particular.

Conclusions

This study showed that when NSAIDs are used in conjunction with exercise therapy specifically, eccentric exercises patients with lateral epicondylitis experience significant improvements in pain, grip strength, range of motion, and neuromuscular efficiency. Along with significant improvements in grip strength and wrist function, the intervention group also displayed higher decreases in pain and EMG activity. These results emphasise how crucial it is to combine NSAIDs and exercise therapy for the best possible care of LE. Long-term impacts and the possibility of additional medicines to improve results should be investigated in future study.

Acknowledgements

The authors are grateful to the Aligarh Muslim University, Aligarh (U.P.) India 202002.

Financing

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

References

Abbas, L., Leiros-Rodríguez, R., Marques-Sanchez, M. P., de Carvalho, F. O., & Maciel, L. Y. (2023). Efficacy of percutaneous electrolysis for the treatment of tendinopathies: A systematic review and meta-analysis. *Clinical Rehabilitation,37*(6), 747–759. https://doi.org/10.1177/02692155221147781

Alizadehkhaiyat, O., Fisher, A. C., Kemp, G. J., Vishwanathan, K., & Frostick, S. P. (2007). Upper limb muscle imbalance in tennis elbow: A functional and electromyographic assessment. *Journal of Orthopaedic Research, 25*(12), 1651–1657. https://doi.org/10.1002/jor.20468

Almquist, E. E., Necking, L., & Bach, A. W. (1998). Epicondylar resection with anconeus muscle transfer for chronic lateral epicondylitis. *The Journal of Hand Surgery, 23*(5), 723–731. https://doi.org/10.1016/S0363-5023(98)80061-0

Balk, M. L., Hagberg, W. C., Buterbaugh, G. A., & Imbriglia, J. E. (2005). Outcome of surgery for lateral epicondylitis (tennis elbow): Effect of worker's compensation. *American Journal of Orthopedics, 34*(3), 122–126.

Bisset, L., Paungmali, A., Vicenzino, B., & Beller, E. (2005). A systematic review and meta-analysis of clinical trials on physical interventions for lateral epicondylalgia. *British Journal of Sports Medicine, 39*(7), 411–422. https://doi.org/10.1136/bjsm.2004.016170

Calvert, P. T., Macpherson, I. S., Allum, R. L., & Bentley, G. (1985). Simple lateral release in treatment of tennis elbow. *Journal of the Royal Society of Medicine, 78*(11), 912–915. https://doi.org/10.1177/014107688507801106

Croisier, J. L., Foidart-Dessalle, M., Tinant, F., Crielaard, J. M., & Forthomme, B. (2007). An isokinetic eccentric program for the management of chronic lateral epicondylar tendinopathy. *British Journal of Sports Medicine, 41*(4), 269–275. https://doi.org/10.1136/bjsm.2006.033334

Cullinane, F. L., Boocock, M. G., & Trevelyan, F. C. (2014). Is eccentric exercise an effective treatment for lateral epicondylitis? A systematic review. *Clinical Rehabilitation, 28*(1), 3–19. https://doi.org/10.1177/0269215513491597

Cummins, C. A. (2006). Lateral epicondylitis: In vivo assessment of arthroscopic debridement and correlation with patient outcomes. *The American Journal of Sports Medicine, 34*(9), 1486–1491. https://doi.org/10.1177/0363546506288016

Dunkow, P. D., Jatti, M., & Muddu, B. N. (2004). A comparison of open and percutaneous techniques in the surgical treatment of tennis elbow. *The Journal of Bone and Joint Surgery. British Volume, 86*(5), 701–704. https://doi.org/10.1302/0301-620X.86B5.14

Garg, R., Adamson, G. J., Dawson, P. A., Shankwiler, J. A., & Pink, M. M. (2010). A prospective randomized study comparing a forearm strap brace versus a wrist splint for the treatment of lateral epicondylitis. *Journal of Shoulder and Elbow Surgery, 19*(4), 508–512. https://doi.org/10.1016/j.jse.2009.08.006

Sánchez-Gómez, Ángela., Domínguez, R., Sañudo, B., & San Juan, A. F. (2023). Efectos de 8 semanas de ejercicio excéntrico y terapia de ondas de choque extracorpóreas sobre el tejido tendinoso, dolor percibido, potencia y fuerza muscular en atletas diagnosticados con tendinopatía rotuliana: un estudio longitudinal (Effects of 8 weeks of eccentric exercise and extracorporeal shockwave therapy on tendon tissue, perceived pain, and muscle power and strength in athletes diagnosed with patellar tendinopathy: A longitudinal study). *Retos*, *47*, 1–11. https://doi.org/10.47197/retos.v47.93378

Gongora-Rodriguez, J., Rosety-Rodriguez, M. A., Rodriguez-Almagro, D., Martin-Valero, R., Gongora-Rodriguez, P., & Rodriguez-Huguet, M. (2024). Structural and functional changes in supraspinatus tendinopathy through percutaneous electrolysis, percutaneous peripheral nerve stimulation, and eccentric exercise combined therapy: A single-blinded randomized clinical trial. *Biomedicines, 12*(4), Article 771. https://doi.org/10.3390/biomedicines12040771

Green, S., Buchbinder, R., Barnsley, L., Hall, S., White, M., & Smidt, N. (2002). Non-steroidal anti-inflammatory drugs (NSAIDs) for treating lateral elbow pain in adults. *Cochrane Database of Systematic Reviews, 2002*(2), Article CD003686. https://doi.org/10.1002/14651858.CD003686

Irie, K., Yokota, J., Takeda, M., Mukaiyama, K., Nishida, Y., Sato, M., & Aoyama, T. (2022). Comparison of forearm muscle activation and relationship with pressure distribution in various grip patterns. *Asian Journal of Occupational Therapy, 18*(1), 31–37. https://doi.org/10.11596/ajot.2021-0021

Khan, K. M., Cook, J. L., Bonar, F., Harcourt, P., & Astrom, M. (2000). Overuse tendinosis, not tendinitis: A new paradigm for a difficult clinical problem. *The Physician and Sportsmedicine, 28*(5), 38–48. https://doi.org/10.3810/psm.2000.05.890

Luginbühl, R., Brunner, F., & Schneeberger, A. G. (2008). No effect of forearm band and extensor strengthening exercises for the treatment of tennis elbow: A prospective randomised study. *Chirurgia degli Organi di Movimento, 91*(1), 35–40. https://doi.org/10.1007/s12306-007-0007-1

Molaee, F., Shahmir, M., Oliveira, R., Nia Samakosh, H. M., Hajrezaee, B., Sarvari Far, B., & Badicu, G. (2024). ¿Puede el entrenamiento de oscilación y movilización aguda beneficiar el sentido de la posición articular y la fuerza de los músculos del manguito rotador en jugadores de tenis jóvenes? *Retos, 58*, 271-280. https://doi.org/10.47197/retos.v58.106208

Nilsson, P., Thom, E., Baigi, A., Marklund, B., & Mansson, J. (2007). A prospective pilot study of a multidisciplinary home training programme for lateral epicondylitis. *Musculoskeletal Care, 5*(1), 36–50. https://doi.org/10.1002/msc.117

Nirschl, R. P., & Ashman, E. S. (2003). Elbow tendinopathy: Tennis elbow. *Clinics in Sports Medicine, 22*(4), 813–836. https://doi.org/10.1016/S0278-5919(03)00016-5

Ohberg, L., Lorentzon, R., & Alfredson, H. (2001). Neovascularisation in Achilles tendon with painful tendinitis but normal tendon: An ultrasonographic investigation. *Knee Surgery, Sports Traumatology, Arthroscopy, 9*(4), 233–238. https://doi.org/10.1007/s001670000189

Pérez Espallargas, L., Ayuso Pablo, A., Abdelkader Mohamed, K., Pinto Redondo, A., & López González, L. (2024). Efectos del ejercicio de fuerza escapular para pacientes con epicondilalgia lateral: Ensayo clínico aleatorizado. *Retos, 56*, 357–364. https://doi.org/10.47197/retos.v56.103988

Peterson, M., Butler, S., Eriksson, M., & Svardsudd, K. (2011). A randomized controlled trial of exercise versus wait-list in chronic tennis elbow (lateral epicondylosis). *Upsala Journal of Medical Sciences, 116*(4), 269–279. https://doi.org/10.3109/03009734.2011.600476

Rodriguez-Huguet, M., Cabrera-Martos, I., Valenza, M. C., Pastor-Moreno, G., Calvo-Lobo, C., & Romero-Garcia, M. (2022). Current trends of dry needling for tendinopathy: A systematic review and meta-analysis. *Journal of Clinical Medicine, 11*(6), Article 1674. https://doi.org/10.3390/jcm11061674

Shiri, R., Viikari-Juntura, E., Varonen, H., & Heliövaara, M. (2006). Prevalence and determinants of lateral and medial epicondylitis: A population study. *American Journal of Epidemiology, 164*(11), 1065–1074. https://doi.org/10.1093/aje/kwj316

Smidt, N., Lewis, M., Van Der Windt, D. A., Hay, E. M., Bouter, L. M., & Croft, P. R. (2002). Lateral epicondylitis in general practice: Course and prognosis. *The Clinical Journal of Pain, 18*(2), 92–97. https://doi.org/10.1097/00002508-200203000-00003

Smidt, N., Van Der Windt, D. A., Hay, E. M., Bouter, L. M., & Croft, P. R. (2006). Lateral epicondylitis in general practice: Course and prognostic indicators of outcome. *The Journal of Rheumatology, 33*(10), 2053–2059.

Söderberg, J., Grooten, W. J., & Äng, B. O. (2012). Effects of eccentric training on hand strength in subjects with lateral epicondylalgia: A randomized-controlled trial. *Scandinavian Journal of Medicine & Science in Sports, 22*(6), 797–803. https://doi.org/10.1111/j.1600-0838.2011.01323.x

Stasinopoulos, D., & Johnson, M. I. (2005). "Physiotherapy and rehabilitation for lateral epicondylitis: A systematic review." *British Journal of Sports Medicine* has been removed as it was a duplicate of Bisset et al. with incorrect author attribution.

Tyler, T. F., Thomas, G. C., Nicholas, S. J., & McHugh, M. P. (2010). Addition of isolated wrist extensor eccentric exercise to standard treatment for chronic lateral epicondylosis: A prospective randomized trial. *Journal of Shoulder and Elbow Surgery, 19*(6), 917–922. https://doi.org/10.1016/j.jse.2010.04.041

Authors' and translators' details:

Junaid Ahmad Parrey	ahmadjunaid232@gmail.com	Author
Mohd Arshad Bari	arshadbari.bari@gmail.com	Author
Abdul Qayyum Khan	drabdul762@gmail.com	Author
Arish Ajhar	khanarishazhar@gmail.com	Translator
Shivani Singh	shivanischolar21@gmail.com	Author