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EFFECT OF MULTIMODAL APPROACH ON REHABILITATION OF THE PATIENTS WITH LATERAL EPICONDYLITIS: A RANDOMIZED CONTROLLED TRIAL

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Abstract

Background: *Lateral elbow tendinopathy is associated with pain, reduced grip strength, and limitations in daily activities. Exercise and manual therapy are commonly used, but the short-term comparative effect of a multimodal program versus a conventional physiotherapy protocol remains clinically relevant.*

Objective: *To compare a multimodal rehabilitation program with conventional physiotherapy for pain, grip strength, and patient-reported function in adults with lateral epicondylitis.*

Methods: *Clinical trial (NCT06686732) a single-blind randomized controlled trial included 40 participants aged 18–45 years allocated by sealed-envelope method to conventional treatment (n = 20) or multimodal treatment (n = 20). Both groups received 12 treatment sessions over 3 weeks. Outcomes were assessed at baseline and after treatment using a visual analogue scale (VAS), hand-held dynamometry, and the Patient-Rated Tennis Elbow Evaluation (PRTEE). Data were analyzed using SPSS version 25; statistical significance was set at $p < 0.05$.*

Results: *At post-treatment, VAS pain was lower in the multimodal group than in the conventional group (median 1.0 [IQR 0.0] vs 2.0 [IQR 1.0], $p = 0.001$). Grip strength was higher in the multimodal group for the right hand (median 16.0 [IQR 13.5] vs 14.0 [IQR 5.5], $p = 0.032$) and left hand (14.0 [IQR 12.0] vs 12.0 [IQR 4.0], $p = 0.024$). PRTEE scores favored multimodal treatment for pain (12.05 ± 1.93 vs 13.55 ± 2.28, $p = 0.031$),*

usual activities (15.50 ± 1.84 vs 17.75 ± 3.78, p = 0.022), and total score (27.20 ± 3.65 vs 31.40 ± 4.41, p = 0.002); the specific-activities difference was not significant (p = 0.201).

Conclusion: *Both programs were associated with improvement over 3 weeks, while the multimodal program showed better post-treatment results for pain, grip strength, and several PRTEE domains. Interpretation is limited by the small sample and short follow-up, and the statistical analysis should be verified against the raw dataset before submission.*

Introduction

Lateral epicondylitis (LE), clinically referred to as lateral elbow tendinopathy, is a common musculoskeletal disorder characterized by localized pain and tenderness over the lateral epicondyle of the humerus, particularly involving the common extensor tendon (1). The condition predominantly affects the extensor carpi radialis brevis (ECRB) tendon and is associated with impaired tendon structure, reduced load tolerance and functional limitations of the upper extremity (2). Although the term epicondylitis traditionally implies an inflammatory process, histopathological findings indicate that persistent lateral elbow symptoms are more frequently associated with degenerative tendon changes, including collagen disorganization, increased ground substance and abnormal vascular proliferation (3). Consequently, the term lateral elbow tendinopathy is increasingly preferred in contemporary literature to describe the underlying pathological condition (4).

Lateral elbow tendinopathy is frequently associated with repetitive mechanical loading of the wrist extensor muscles and excessive tensile stress on the common extensor tendon (5). Activities involving repetitive gripping, forceful wrist extension, forearm rotation, lifting and manual handling may increase the mechanical demands placed on the tendon (6). Occupational exposure among manual workers, industrial employees and individuals performing repetitive upper-limb activities has been identified as an important contributing factor (7). The condition may also occur among athletes, particularly those participating in racket sports and activities involving repeated wrist and forearm movements. A systematic review examining occupational biomechanical risk factors reported that combined exposure to forceful exertion and repetitive wrist or forearm movements may increase the likelihood of developing elbow tendinopathy, although the available evidence regarding individual occupational exposures remains limited (8).

The clinical presentation of lateral epicondylitis commonly includes lateral elbow pain aggravated by resisted wrist extension, gripping and activities involving loading of the wrist extensor muscles (9). Patients may demonstrate localized tenderness at the lateral epicondyle, reduced pain-free grip strength and impaired upper-limb functional performance (10). Symptoms may extend into the proximal forearm and become more pronounced during repetitive or forceful activities (11). Functional difficulties commonly involve lifting household objects, carrying bags, opening containers, shaking hands and performing occupational tasks requiring sustained gripping. The severity and persistence of symptoms may vary according to tendon loading, duration of symptoms, physical demands and individual clinical characteristics (12, 13).

Several biomechanical, occupational and individual factors contribute to the development and persistence of lateral elbow tendinopathy. Repetitive wrist extension, forceful gripping, sustained forearm positioning and inadequate recovery between loading activities may increase cumulative tendon stress (14). Individual characteristics, including age, physical capacity and previous musculoskeletal symptoms, may also influence clinical presentation and recovery (15). The interaction between mechanical loading and the biological capacity of the tendon to adapt is particularly important. Excessive or repeated

loading beyond the tendon's current capacity may contribute to impaired tissue adaptation and persistent symptoms. Therefore, the condition should be understood as a multifactorial tendinopathy rather than an isolated inflammatory disorder (16).

Lateral epicondylitis can substantially affect occupational performance, physical functioning and health-related quality of life. Pain during gripping and lifting may interfere with professional responsibilities, household activities, sports participation and other activities requiring upper-limb strength and coordination (17). Individuals engaged in manual occupations may experience reduced work capacity, activity modification and occupational absenteeism (18). The clinical practice guideline published by Lucado et al. (2022) identifies pain, muscle performance impairments and functional limitations as important clinical considerations in the assessment and management of lateral elbow tendinopathy. Although the condition is frequently described as self-limiting, symptoms may persist for several months, with recurrence and incomplete recovery reported in a proportion of affected individuals (9).

Conservative management is generally recommended as the initial treatment strategy for patients with lateral epicondylitis. Physiotherapy interventions aim to reduce pain, improve tendon loading capacity, restore wrist extensor strength and facilitate the recovery of functional activities (19). Common rehabilitation strategies include progressive resistance exercises, eccentric and concentric strengthening, isometric exercises, stretching, manual therapy, mobilization with movement and patient education (20). Progressive loading exercises are particularly relevant because they target the functional capacity of the wrist extensor musculature and facilitate adaptation to mechanical demands (21). Manual therapy techniques may also be incorporated to address pain and movement-related impairments (22). The 2022 clinical practice guideline by Lucado et al. recommends resisted wrist extensor exercise and selected manual therapy interventions as components of impairment-based management for lateral elbow tendinopathy (9).

A multimodal rehabilitation approach integrates different therapeutic interventions within a structured treatment programme to address the multiple clinical impairments associated with lateral epicondylitis (23, 24). Such an approach may combine manual therapy, therapeutic exercises, stretching, soft tissue techniques and other clinically indicated physiotherapy interventions (25). The rationale for combining these techniques is to address different dimensions of the condition, including pain, muscular performance, tendon loading tolerance and functional disability. Manual therapy, particularly mobilisation-with-movement, may provide short-term pain modulation and facilitate the performance of therapeutic exercises. In contrast, progressive strengthening exercises aim to improve wrist extensor muscle strength, endurance and tolerance to repetitive mechanical loading. Integrating these interventions within a structured rehabilitation programme may therefore address both symptom-related impairments and functional limitations associated with lateral elbow tendinopathy (23, 26, 27).

Previous clinical research has investigated the application of multimodal physiotherapy interventions in patients with lateral elbow tendinopathy. Dunning et al. (2024) conducted a multicentre randomized clinical trial involving 143 participants to investigate the effects of adding percutaneous electrical dry needling and thrust manipulation to a multimodal physiotherapy programme comprising exercise, mobilization and ultrasound. Their findings demonstrated significantly greater improvements in pain and disability in the group receiving the additional interventions compared with multimodal physiotherapy alone at three months (28). These findings provide clinical evidence supporting further investigation of combined rehabilitation strategies. However, the effects of individual treatment components and their contribution to overall clinical improvement require further consideration.

Furthermore, the 2024 Cochrane systematic review by Wallis et al. evaluated manual therapy and prescribed exercise for lateral elbow pain. The review included randomized and quasi-randomized clinical trials and concluded that these interventions may produce slight short-term improvements in pain and disability compared with minimal or no intervention; however, the certainty of evidence was low and the benefits were not consistently maintained during longer-term follow-up (26). Similarly, Campos et al. (2024), in a systematic review and meta-analysis of 47 randomized trials investigating non-invasive interventions, reported that the available evidence for many conservative treatment approaches remained uncertain, particularly regarding improvements in pain, maximum grip strength and disability (19).

Despite the availability of several conservative treatment options, uncertainty remains regarding the most appropriate combination of physiotherapy interventions for managing lateral epicondylitis. Differences in treatment protocols, intervention duration, exercise progression and outcome assessment may contribute to variations in reported treatment effects. Therefore, evaluating a structured multimodal rehabilitation programme through a randomized controlled trial is important to establish its clinical effects and provide further evidence for physiotherapy practice.

The present study aims to investigate the effect of a multimodal rehabilitation approach on pain, muscle performance and functional outcomes in patients with lateral epicondylitis through a randomized controlled trial. By assessing changes in relevant clinical and functional parameters following rehabilitation, the study intends to determine the extent to which the combined intervention influences recovery and functional performance. The findings may contribute to the existing evidence regarding conservative management and support the development of evidence-based rehabilitation strategies for patients with lateral epicondylitis.

Materials and method

Study Design

The study design was Randomized Controlled Trial.

Study Setting

Data was collected from Riphah International Hospital, Sihala, Muzaffar Khan Hospital, barrier No. 2 Wah Cantt and DSK Physio & Rehab, Bahria Town Phase 7.

Selection Criteria

Inclusion Criteria

- Age from 18-45 years (29)
- Point tenderness at the lateral epicondyle (30)
- Positive Cozen test, Mill's test and Maudsley's test (31)
- Consenting to participate in the study

Exclusion Criteria

- History of fracture in elbow, wrist or hand(31)
- History of surgery in elbow, wrist or hand region
- Elbow conditions other than lateral epicondylitis
- Cognitive deficits and not giving consent

Intervention/Protocol

Group A: Conventional Group

Group A was conventional treatment group that was given the detailed conventional treatment including heating pad for 10 mins on elbow, stretching of ECRB, AROM Exercises, Wrist strengthening Exercises, Maitland mobilizations in 12 sessions for 3 weeks.

Group B: Multimodal Group

Group B was multimodal treatment group that was given the detailed multimodal treatment including heating pad for 10 mins on elbow, in cervical spine passive stretching of trapezius and levator scapulae and upper limb (ECRB, ECRL, ECU, Extensor Digitorum, Extensor Digiti Minimi, Eccentric Exercises for muscle strengthening, Neuromuscular rehabilitation

Exercises, movement with mobilization in 12 sessions for 3 weeks.

Variables/Outcome Measure

The following tools were used for the 'Pre' & 'Post' assessment in this study.

Digital Hand-Held Dynamometer

CAMRAY Hand Held Digital Dynamometer was used to check hand grip strength. Hand Grip Strength values were recorded in kilograms, with one-kilogram equating to 2.2046 pounds. The CAMRY dynamometer used for measurements has a maximum capacity of 90 kg, and its accuracy is limited to 0.1 kg.

Participants sat comfortably at chair, they were instructed to grasp the dynamometer initially with their right hand, maintaining fully extended elbows. They were to stand upright with their feet positioned shoulder-width apart during this process then same procedure was reported with left hand, and the strength values was measured for three times. Participants were verbally encouraged to exert their full grip strength by squeezing the handle for five seconds before the initiating the test. Subjects were prohibited from swinging their arms, intermittently gripping the handle, squatting, or contacting the dynamometer with other parts of the body. Grip strength of both hands were measured three times with gap of 15 seconds, and the average value were mainly recorded and analyzed. Normal reference values of handgrip were taken in kg according to age and sex matched data.

For the use of dynamometer, the studies have found excellent scores for inter and intra-rater reliabilities (ICC ≥ 0.855). For measurement of maximal isometric strength done during primary upper limb movements, there is strong validity and reliability for the low-cost digital dynamometer.(32) The hand grip strength in kg was categorized based on following category: (33).



Measurement of grip strength using dynamometer

Visual Analogue Scale

One of the tools for measuring pain is the Visual Analogue Scale (VAS). Studies have found higher scores of test-retest reliabilities in educated patients ($r = 0.94$, $p<0.01$) as compared to individuals not having an educational background ($r = 0.71$, $p<0.01$). For rating acute abdominal pain, VAS has high reliability with ICC of 0.99(34). For assessment of disability and chronic pain of the musculoskeletal origin, VAS has shown good reliability.

Since there is no golf standard set for measurement of pain, criterion validity of VAS cannot be found. While it has a high construct validity as found out in patients with different rheumatic diseases. It is also highly correlated with numeric rating scale with coefficients ranging from 0.62 to 0.91.(35) As far as the vertical and horizontal orientations of VAS are concerned, both are found to be highly correlated (0.99).(36)

Patient-rated Tennis Elbow Evaluation (PRTEE)
PRTEE measures the degree of difficulty associated with elbow which a patient has had during their past week. It is scored on the range of 0 to 10, with 0 indicating no pain and difficulty and 10 indicating the maximum amount of pain and difficulty.
For the functional assessment of upper limb in LE, questions regarding specific activities are asked whether or not the individual had difficulty performing movements or not.(37) Due to high reliability of PRTEE in assessment of LE among individuals as well as tennis athletes, it has the potential of becoming standard tool used in LE research.(38)

Sample Size
Sample size was calculated using G-power 3.1. Total 40 Patients were randomly allocated into Group A (conventional protocol) and Group B (Multimodal protocol), each having 20 participants.

Randomization
Randomization was done using sealed envelope method to randomly allocate the participants into conventional and multimodal group.

Blinding
This study was single blinded RCT in which the assessor were blinded and were not aware which treatment group they were being assessed to.

Data Collection Procedure
After obtaining permission from concerned hospitals and physiotherapy OPDs, informed consent was taken from patients with lateral epicondylitis having explained the procedure. Patients were randomly allocated into two groups. Patients received a total of 12 sessions such that 4 sessions per week for a total of 3 weeks in alternate days.
Patients were assessed for baseline measurements against outcome measures. The base line demographic, clinical and disability data were collected through structured questionnaire. Patients were re-assessed at completion of treatment. Patient's assessment of pain was done on baseline, and at the end of 3rd week. Grip strength and PRTEE was taken at baseline and end of 3rd week.

Intervention protocol
Both groups received 12 sessions over 3 weeks, scheduled four times per week on alternate days according to the thesis. The exact session schedule should be checked because four sessions weekly and alternate-day scheduling may not align consistently across a three-week period.
Conventional treatment included a heating pad applied to the elbow for 10 minutes; stretching of the extensor carpi radialis brevis (15-second holds, four repetitions); active range-of-motion exercises for wrist flexion/extension and elbow flexion/extension and forearm pronation/supination (10 repetitions × 3 sets); manually resisted wrist-extensor strengthening (10-second holds, five repetitions, three sets); and Maitland mobilization of the proximal radioulnar, humeroradial, and humeroulnar joints (four sets, with one minute of rest between sets; Grades III–IV).

Group A (Conventional protocol)	Group B (Multimodal protocol)
HEATING PAD	
Heating pad will be used for 10 minutes over the elbow region.	Heating pad will be used for 10 minutes over the elbow region.

STRETCHINGS	
Extensor carpi radialis brevis stretching (hold for 15 seconds x 4 reps	Passive stretching exercises in cervical spine (trapezius and levator scapulae) and upper limb (ECRB, ECRL, ECU, Extensor Digitorum, Extensor Digiti Minimi) – stretching kept for 1 min each.
STRENGTHENING EXERCISES	
Wrist strengthening exercises: Manually resisting wrist extensors (10 second hold x5 reps x 3 sets)	**Muscle strengthening:** Ten repetitions of three sets are done. 1kg load is used to do eccentric exercise of the extensor muscles, associated with mobilization with movement and done with moderate resistance TheraBand.
EXERCISE TRAINING	
ROM exercises: Active ROM of wrist flexion and extension (10 reps x 3 sets) Active ROM of elbow flexion, extension, supination and pronation (10 reps x 3 sets)	**Neuromuscular Rehabilitation:** All excersies will be performed 12x3 on every session and guided to patient as home exercise plan. Finger Flexion and Extension ,Grip Strengthening Balls,Thumb Opposition,Finger Pinch,Hand Grippers,Finger Tapping,Wrist Flexion and Extension,Finger Stretching,Grip Strengthening Putty
DEEP TRANSVERSE FRICTION MASSAGE THERAPY	
	Transverse massage: Transverse masssage is done in the wrist extensors tendons for 2 minutes and inhibition of tension points in the bellies of extensor muscles is done.
MOBILIZATION	
Maitland mobilization: 4 sets of Maitland elbow joint mobilization with 1 min of rest between sets. Grade 3 and 4 were given Mobilizations Proximal Radioulnar Mobilizations,Humeroradial Mobilizations, Humeroulnar Mobilization	**Mobilization with movement:** Mobilization with movement is done in wrist extension initially and then in neutral position and finally in wrist flexion. A sustained lateral glide was given at the humeroradial joint. 6 reps x 3 sets



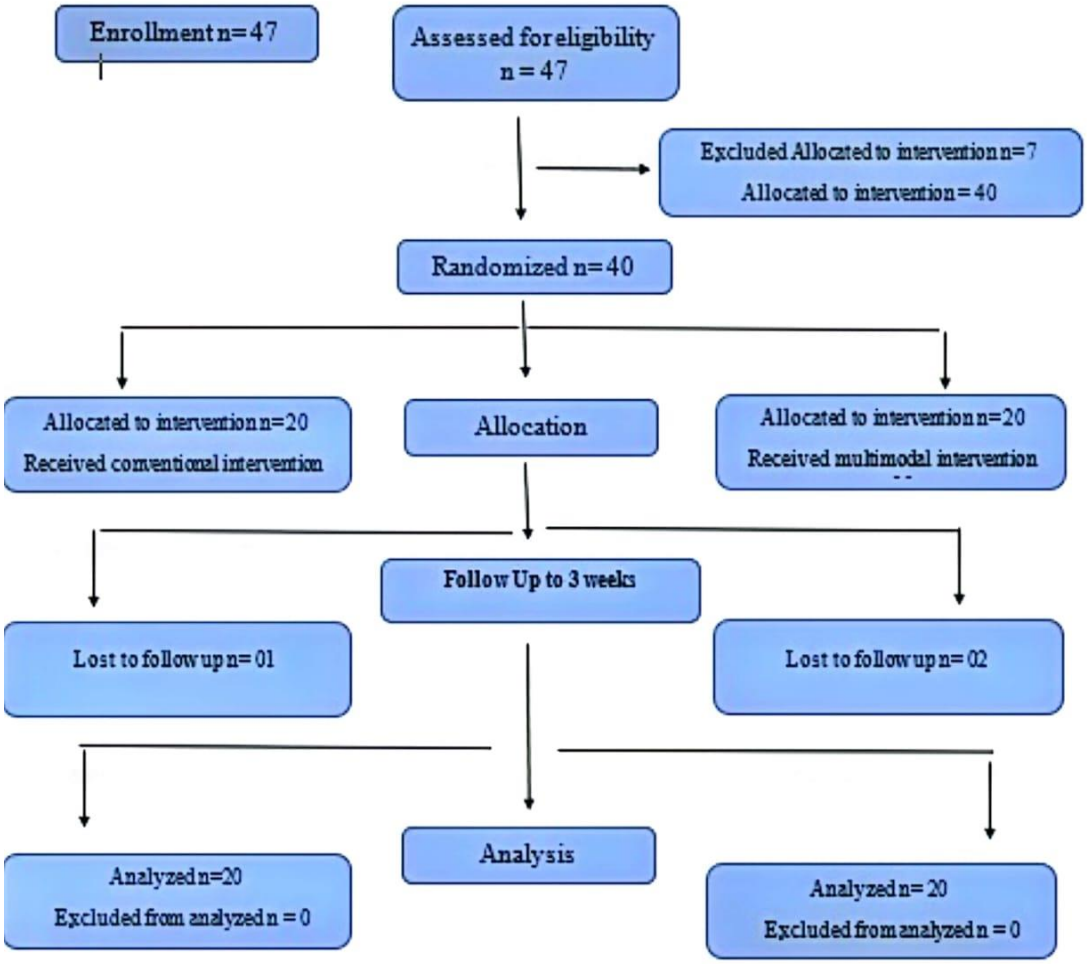
Conventional Treatment Group



Multimodal Treatment Group

Ethical Considerations

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the institutional Research Ethics Committee of Ripha Internatona University Islamabad before the commencement of data collection. All participants were informed about the purpose, procedures, potential benefits, and possible risks of the study, and written informed consent was obtained before participation. Participants were assured of the confidentiality and anonymity of their personal information and were informed of their right to withdraw from the study at any stage without any consequences. The trial was registered with ClinicalTrials.gov under registration number NCT06686732.



CONSORT Diagram

Results

Data was analyzed using SPSS version 25. Shapiro-Wilk test was used to assess the normality of the data. Parametric and non-parametric tests were used to analyze the outcome variables. P-value of 0.05 was considered significant.

Table 1: Normality analysis

Tests of Normality			
Variables	**Group**	**Shapiro-Wilk**	
		Statistic	**p-value**
VAS baseline	Conventional group	0.887	0.023
	Multimodal group	0.809	0.001
Grip right baseline	Conventional group	0.901	0.043
	Multimodal group	0.811	0.001
Grip left baseline	Conventional group	0.858	0.007
	Multimodal group	0.820	0.002

PRTEE pain baseline	Conventional group	0.945	0.292
	Multimodal group	0.968	0.708
PRTEE specific activities baseline	Conventional group	0.948	0.333
	Multimodal group	0.861	0.008
PRTEE usual activities baseline	Conventional group	0.923	0.113
	Multimodal group	0.914	0.077
PRTEE total baseline	Conventional group	0.953	0.416
	Multimodal group	0.953	0.415

Shapiro-Wilk test concluded the variability in the normality of the data distribution between variables at baseline for both groups. For VAS and grip strength of both hands, in both conventional and multimodal group, it shows significant deviation from normality ($p<0.05$) the pain in PRTEE shoes normal distribution in both groups ($p = 0.29$ and $p = 0.70$). Meanwhile, PRTEE usual activities and total scores are normally distributed ($p > 0.05$). Moreover, the specific activities for PRTEE demonstrates the non- normality in multimodal group ($p = 0.00$) but normality in the conventional group ($p = 0.33$).

Participant characteristics

The study included 40 participants, with 20 in each treatment group. Mean age was 34.15 ± 6.09 years in the conventional group and 33.15 ± 7.55 years in the multimodal group. The overall mean age was reported as 33.65 ± 6.79 years. The involved side was right in 15 participants (75%) in each group. Symptom duration was distributed across acute, subacute, and chronic categories in both groups. Occupational categories differed somewhat between groups.

Table 2: Participant characteristics

Characteristic	Conventional (n=20)	Multimodal (n=20)
Age, years, mean ± SD	34.15 ± 6.09	33.15 ± 7.55
Right-side involvement, n (%)	15 (75%)	15 (75%)
Left-side involvement, n (%)	5 (25%)	5 (25%)
Acute symptoms (<1 month), n (%)	4 (20%)	5 (25%)
Subacute symptoms (1–3 months), n (%)	8 (40%)	7 (35%)
Chronic symptoms (>3 months), n (%)	8 (40%)	8 (40%)

Within-group analysis of PRTEE

PRTEE scores for pain, specific activities, usual activities, and total scores between the multimodal and conventional groups at baseline and post-intervention. At baseline, the PRTEE pain score for conventional (20.500 ±3.96) and multimodal group (20.05 ± 2.16) was no significant differences were observed in pain ($p = 0.366$), At post intervention scores shows significant improvement with multimodal group reducing to (12.05 ± 1.93) comparison with 13.55 ± 2.28 in the conventional group. For specific values at baseline scores were comparable (23.60 ± 2.52 vs. 23.10 ± 4.14, $p = 0.823$ and $p = 0.214$, respectively), and post intervention there was reduction to 16.20 ± 2.19 in the multimodal group compared to the 17.30 ± 3.07 in the conventional group. In Usual activities at baseline the scores were slightly higher in the conventional group (24.15 ± 3.42 vs. 22.95 ± 3.08, $p = 0.002$), comparable in the post intervention the multimodal group show the reduction (15.50 ±

1.84) compared to the conventional group (17.75 ± 3.78). At baseline PRTEE scores were close (43.50 ± 3.68 for multimodal vs. 43.75 ± 6.37 for conventional, p = 0.740 and p = 0.006, respectively), but the post intervention results shows that the multimodal group (27.20 ± 3.65) over the conventional group (31.40 ± 4.41).

Table 3: Within-group analysis of PRTEE

Variables	Assessments	Conventional Group		Multimodal Group	
		Mean ±SD	p value	Mean ±SD	p value
PRTEE Pain	Baseline	20.500 ±3.96	0.305	20.05 ± 2.16	0.366
	Post	13.550 ± 2.28		12.05 ± 1.93	
PRTEE Specific Activities	Baseline	23.100 ± 4.14	0.214	23.60 ± 2.52	0.823
	Post	17.300 ± 3.07		16.20 ± 2.19	
PRTEE Usual Activities	Baseline	24.150 ± 3.42	0.002	22.95 ±3.08	0.893
	Post	17.750± 3.78		15.50 ±1.84	
PRTEE Total	Baseline	43.750±6.37	0.006	43.50 ± 3.68	0.740
	Post	31.400± 4.41		27.20 ± 3.650	

International Journal of Advanced Research

Within-Group Analysis

Results demonstrated the evaluation of different variables by comparing two groups, Conventional and Multimodal, at baseline and post-intervention. VAS showed significant improvement from baseline to post-intervention. The baseline median score for both groups is 6.0 (IQR 1.0), with a Z-value of -4.008 and p-value < 0.001, indicating a significant reduction in pain. At post-intervention, the Conventional group shows a median score of 2.0 (IQR 1.0) and the Multimodal group a median of 1.0 (IQR 0.0). Grip Strength data reveal similar trends: at baseline, the Conventional group's right grip strength median is 12.5 (IQR 5.0) with a Z-value of -3.714 (p < 0.001), and the Multimodal group's right grip strength median is 14.0 (IQR 12.0) with a Z-value of -3.874 (p < 0.001). Both groups show post-intervention improvements, with the Conventional group reaching 14.0 (IQR 6.0) and the Multimodal group reaching 16.0 (IQR 14). For left grip strength, the baseline median for the Conventional group is 11.0 (IQR 5.0) with a Z-value of -3.169 (p < 0.001), and for the Multimodal group, it's 13.0 (IQR 11.0) with a Z-value of -3.508 (p < 0.001). Post-intervention, the Conventional group shows a median of 12.0 (IQR 4.0), while the Multimodal group reaches 14.5 (IQR 12).

Table 3: Within Group Analysis

Variables	Assessment	Conventional Group				Multimodal Group		Z Value	P – value
		Median (IQR)	MR	Z value	P value	Median (IQR)	MR		
VAS	Baseline	6.0 (1.0)	0.00	-4.008	<0.001	6.0(2.0)	0.00	-4.008	<0.001
	Post	2.0(1.0)	10.5			1.0(0.0)	10.5		
	Baseline	12.50(5.0)	9.0	-3.714	<0.001	14.0(12)	10.0	-3.874	<0.001

Grip Strength Right	Post	14.0(6.0)	0.00			16.0(14)	0.00		
Grip Strength left	Baseline	11.0(5.0)	6.5	-3.169	<0.001	13.0(11)	8.0	-3.508	<0.001
	Post	12.0(4.0)	0.00			14.5(12)	0.00		

Between-group Analysis at Baseline and Post Intervention

The Conventional and Multimodal groups on pain (VAS) and grip strength, presenting medians, IQRs, mean ranks (MR), U-values, and P-values. For VAS, at baseline it was not shown statistically significant (P > 0.05), statistically significant improvements were seen at post-intervention (P = 0.001) in the Multimodal group, with lower median scores and MR values reflecting reduced pain. Grip strength comparisons showed no significant baseline differences for the right (P = 0.221) or left hand (P = 0.054). However, post-intervention results demonstrated significantly greater grip strength improvements in the Multimodal group for both the right (P = 0.032) and left hand (P = 0.024). These findings suggest that for reduction of pain and improvement of grip strength, the Multimodal approach was more effective than the Conventional group.

Table 4: Between Group Analysis

Variables	Assessment	Conventional Group		Multimodal Group		U -Value	p value
		Median (IQR)	MR	Median (IQR)	MR		
VAS	Baseline	6.0(1.0)	23.18	6.0(1.7)	17.83	146.50	0.127
	Post	2.0 (1.0)	25.70	1.0 (0.0)	15.30	96.00	0.001
Grip Strength Right	Baseline	12.50(4.5)	18.25	14.0(12.0)	22.75	155.00	0.221
	Post	14.0(5.5)	16.55	16.0(13.5)	24.45	121.00	0.032
Grip Strength Left	Baseline	11.0(4.75)	16.98	13.0(11.2)	24.03	129.50	0.054
	Post	12.0(4.0)	16.35	14.0(12.0)	24.65	117.00	0.024

DISCUSSION

The present study demonstrated that both conventional and multimodal therapy approaches significantly improved pain reduction, functional outcomes, and maximal grip strength in patients with lateral epicondylitis (LE). However, the combination of progressive strengthening exercises with conventional therapy yielded superior subjective and objective outcomes. These findings align with existing literature emphasizing the efficacy of multimodal approaches in addressing the multifactorial nature of LE.

Lateral epicondylitis, commonly characterized as an overuse injury, results in tendon structural weakening, impairing daily activities. The PRTEE questionnaire and VAS were utilized as outcome measures. Grip strength, responsive to intervention, was also assessed due to its strong association with pain on palpation and functional outcomes. The study results within 3 weeks demonstrated significant improvement in the multimodal group compared to the conventional group covering the multiple variables.

The age range (18–45 years, mean age 33.65 ± 6.788) in this study aligns with Sada et al., who reported LE prevalence between 30 and 50 years.(39) Age-related tendon flexibility and collagen alterations, as noted by Heales et al., may affect recovery rates, particularly in chronic cases.(40) Occupational factors also play a

significant role, as demonstrated by Descatha et al. and Haahr and Andersen, who highlighted repetitive manual tasks as primary contributors to LE.(41, 42) The current study corroborates these findings, with 35% of participants in the multimodal group and 45% in the conventional group being housewives or laborers. The multimodal group showed superior outcomes in reducing VAS ($p = 0.001$) and improving PRTEE scores ($p = 0.002$), emphasizing the importance of interventions targeting mechanical stressors.

Coombes et al. suggested that multimodal techniques applying along with manual therapy techniques and exercises yield greater results for chronic state. As studies showed chronic stages have long-term functional impairment as angio-fibroblastic hyperplasia and other histological alteration have been connected to chronicity.(43) The current research that enrolled participants for 3 weeks also encountered the participants with chronic stage of lateral epicondylitis and they had a high score on baseline of all outcome measures. The participants showed improvement in terms of pain and functional status. (41, 43)

According to research by Descatha et al., 4.9% of workers especially housewives and laborers were subjected to repeated wrist motions.(41) Similarly, Haahr and Andersen demonstrated manual job tasks to be strongly linked with the lateral epicondylitis,(44) such as manufacturing, emphasizing that women had a significant incidence of discomfort and decreased functional activity, especially while rolling (43.3%), carrying bags (26%), and turning knobs (30.7%), among other domestic tasks.(45)

Pain reduction, assessed using the Visual Analog Scale (VAS), showed significant improvement in both groups. The multimodal therapy group (Group B) demonstrated a greater reduction in pain (MR = 15.30, $p = 0.001$) compared to the conventional group (Group A, MR = 25.70). These results are consistent with a retrospective study that reported multimodal therapies reduce pain by 30–60% over 4–6 weeks, while conventional treatment shows slower progress, typically achieving a 20–40% reduction ($p < 0.05$) within the same period (46, 47). Sharma et al. also highlighted significant pain reductions over six weeks ($p < 0.001$), emphasizing the added benefits of combining stretching exercises, manual therapy, and other pain-relief modalities.(48)

Functional improvements were assessed using the PRTEE questionnaire. Group B exhibited superior functional recovery ($p = 0.002$) compared to Group A, aligning with findings from Mansuri et al., who reported significant PRTEE score reductions with physiotherapy interventions ($p < 0.05$).(49) Kim et al. demonstrated the effectiveness of manual therapy, strengthening exercises, and deep friction massage in reducing PRTEE scores ($p < 0.05$).(50) Moreover, a systematic review showed that eccentric strengthening of wrist extensors and manual therapy significantly improved PRTEE scores over 12 weeks ($p < 0.05$).(51) While the present study's duration was three weeks, the observed improvements (pain, $p = 0.366$; specific activities, $p = 0.823$; usual activities, $p = 0.893$; total scores, $p = 0.740$) support the efficacy of multimodal therapy for rapid functional enhancement.

A cross-sectional research by Akbar H. et al. found a substantial correlation between the afflicted side and hand dominance, with up to 72.2% of instances affecting the dominant hand ($p<0.05$).(52, 53) Another cross sectional study by Patil MD et. al. has revealed that 48% of the housewives had pain in their right elbow while 20% experienced pain in their left hand, and only 26% experiences pain in both hands.(54) This relationship, likely indicates the mechanical stress on ECRB during tasks like fine motor control and powerful grasp.(55, 56) Epicondylitis is also interlinked to increase elbow carrying angle as it contributes to the tendon tension. (57) In comparison, various therapies such as manual therapy and mobilizations are useful in addressing both functional and arrangement factors to the disease.(58)

Grip strength is a critical indicator of functional recovery in LE. This study demonstrated significantly greater improvements in grip strength for both dominant ($p = 0.032$) and non-dominant hands ($p = 0.024$) in the multimodal group compared to the conventional group. These

findings align with Li et al., who reported a 20–49% improvement in grip strength with blood flow restriction (BFR) training compared to conventional strengthening training ($p < 0.001$).(53) Similarly, Vicenzino et al. observed grip strength increases from 20.4 ± 5.1 kg to 30.2 ± 6.3 kg with Multimodal therapy,(46) and Sharma et al. noted a rise from 19.8 ± 3.2 kg to 29.6 ± 4.8 kg within four weeks ($p < 0.05$).(48) These results highlight the enhanced efficacy of multimodal approaches in improving forearm muscle function and grip strength.

Chronic stages of LE, characterized by angiofibroblastic hyperplasia and histological alterations, pose significant treatment challenges.(40) Participants in this study with chronic LE showed high baseline scores across outcome measures but achieved substantial improvements in pain, grip strength, and functional outcomes with multimodal therapy. These results are consistent with Vicenzino et al. and Sharma et al., who highlighted the effectiveness of combining manual therapy, strengthening exercises, and other modalities in chronic LE cases.(46, 48)

CONCLUSION

The Study conclude that Both conventional physiotherapy and multimodal rehabilitation were associated with significant improvements in pain and grip strength among patients with lateral epicondylitis. Post-intervention comparisons favored the multimodal group for pain reduction and right- and left-hand grip strength. However, the comparative effect on functional disability requires clarification because the PRTEE results are inconsistently reported. Further studies with larger sample sizes and longer follow-up periods are recommended to establish the sustained effectiveness of multimodal rehabilitation.

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