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Effects of Eccentric Exercises on Pain, Function, Wrist Extensor and Hand Grip Strength in Patients with Chronic Lateral Epicondylitis

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Abstract

Background: Chronic Lateral Epicondylitis (LE) is one of the most frequently observed lesions causing work or sports-related pain disorders.it is a painful condition that leads to reduced hand function, decreased muscle strength and a significant impact on activities of daily living. Eccentric training is an effective therapeutic intervention for improving outcomes in patients with chronic LE.

Purpose: To evaluate the effects of eccentric strengthening exercises on pain, function, wrist extensor and hand grip strength in patients with chronic LE. In addition to evaluating the correlation between these variables post treatment.

Methods: Twenty-three patients of both genders with chronic LE with age range from 16 to 30 years received eccentric strengthening exercises for 12 treatment sessions (3 sessions per week) for 4 weeks, each session included 3 sets of 15 repetitions, with each repetition lasting for 5 seconds and a 30-second rest between sets. The following assessments were used to measure outcomes: pain was evaluated using the Visual Analogue Scale (VAS), function was assessed with the Arabic version of the DASH questionnaire, wrist extensor strength was measured using a Hand-Held Dynamometer (HHD), and hand grip strength was assessed with the Jamar Grip Dynamometer.

Results: Results revealed significant improvement in mean values of VAS, DASH, wrist extensor strength and hand grip strength in patients with LE after receiving eccentric strengthening exercises ($p<0.001$). Pearson correlation analysis revealed a strong positive correlation between values of pain intensity and DASH scores ($r = 0.497$; $p = 0.016$) Furthermore, a very strong positive correlation was observed between wrist extensor strength and hand grip strength ($r = 0.768$; $p < 0.001$). On the other hand, no significant correlation was observed between VAS and wrist extensor strength, VAS and hand grip strength, DASH and wrist extensor strength or DASH and hand grip strength.

Conclusions: The results of this study confirmed the effective role of eccentric strengthening exercises in improving pain, function, wrist extensor and hand grip strength in patients with chronic LE. Additionally, pain was found to have a significant impact on functional improvements. Furthermore, a strong positive correlation was found between wrist extensor strength and hand grip strength.

Keywords: Lateral epicondylitis - Eccentric exercises -DASH questionnaire - Hand held dynamometer.

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Introduction

Lateral epicondylitis is a chronic inflammatory condition caused by repetitive microtrauma and excessive overload of the extensor carpi radialis brevis muscle**.** This is the most common cause of musculoskeletal pain in the elbow, inducing significant pain and limitation of the function of the upper limb. It is frequently seen in sports associated with functional

overload of the elbow[1]. Many patients complain of pain and tenderness in the lateral elbow, Radiation towards the distal forearm, decrease in grip strength and tenderness of the common extensor origin[2].
Lateral Epicondylitis is a relatively prevalent condition, impacting approximately 1% to 3% of the population [1]. It is often linked to work-related or sports-related activities that involve repeated strain on the common extensor muscles. Activities such as repetitive twisting motions of the forearm combined with forceful gripping can contribute to the development of LE [3]. Risk factors for LE are female gender, a history of smoking, older age, a history of diabetes mellitus, and greater involvement of the dominant arm [4].
Conservative management strategies for chronic LE include activity modification, correction of kinetic chain dysfunction, a progressive exercise regimen from isometric to eccentric exercises, corticosteroid injections, platelet-rich plasma injections, and extracorporeal shock wave therapy, all of which have shown evidence in reducing pain [5]. Traditional treatment options consist of both electrotherapeutic and non-electrotherapeutic approaches, which focus on improving function and alleviating pain by stretching and strengthening the affected wrist extensors. eccentric strengthening exercises have increasingly become a first-line conservative treatment for LE [6,7].
Addition of eccentric strengthening exercises to standard physical therapy programs was found to elicit more substantial benefits in reducing pain and improving grip strength in patients with LE and thereby prevent the reoccurrence of the condition [8].
Eccentric graded exercises have been shown to be more effective than concentric graded exercises in reducing pain and increasing muscle strength in chronic LE through several mechanisms: (a) temporary interruption of blood flow in the new blood vessels of the tendon, (b) the generation of a constant mechanical stimulus, which leads to tendon remodeling, and (c) increased collagen synthesis in damaged tendons [9].
The improvement in cases of LE is influenced by various assessment strategies, as indicated in the literature, which include evaluations of pain, function, wrist extensor strength, and hand grip strength. The Visual Analogue Scale (VAS) is recognized as a valid and reliable tool for measuring pain [10]. Several functional scales are available for assessing upper limb conditions, such as the Arabic DASH questionnaire, which consists of 30 items that assess function and has been shown to be a reliable, valid, and responsive tool for Arabic-speaking patients [11]. The reliability of muscle strength assessment using Hand-Held Dynamometry for upper limb muscles is excellent for test-retest [12]. Additionally, the hand grip dynamometer is considered a valid and reliable tool for measuring hand grip strength [13].
Therefore, the aim of this study was to evaluate the effects of eccentric strengthening exercises and examine the relationship between pain, function, wrist extensor strength and hand grip strength after adding eccentric exercises in patients with LE.

Methods:

Study design: Experimental Correlational Study Design
Sample size calculation: It was performed using G*POWER statistical software (version 3.1.9.2; Franz Faul, University Kiel, Germany) based on data of VAS derived from Kalasva (2018); and revealed that the required sample size for this study would be 19 subjects plus 10% to avoid dropout. So, it would be 21 subjects. Calculation was made with α set at 0.05, power set at 0.95 and effect size set at 0.9
Participants: Twenty-three non athletic patients of both genders with unilateral LE, with age range from 16-30 years. Each patient signed an informed consent before starting the study. All patients were referred by an orthopedic surgeon who diagnosed LE based on clinical and radiological examination. Participants were selected based on the following inclusion criteria: both male and female genders, ages ranging from 16 to 30, unilateral elbow pain, a body mass index between 18.5 and 29.9, and no physical therapy received for the past 6 months [14]. Exclusion criteria included any injury or disease affecting the shoulder, elbow, or wrist on the affected side, any local interventions such as steroid injections within 6 months prior to the study, cervical radiculopathy, a history of fractures in the radius, ulna, or humerus resulting in deformity of the affected limb, or any neurological impairments [15].

Assessment Procedures:
All participants underwent the following assessments before and after physical therapy interventions.

A. **Pain Measurement Using VAS**: which typically consists of a 100 mm line with descriptors at each end representing the extremes of pain intensity (no pain and extreme pain). Patients rated their pain intensity by marking a point on the line that best represented their experience at that moment. A vertical line was drawn through the point that most accurately reflected the patient's pain [16].
B. **Function Measurement Using the Arabic DASH Questionnaire**: which includes 30 items:24 to assess function and disability, and 6 to measure symptoms. Each item is scored on a five-point scale, with scores ranging from 1 ("no difficulty or no symptoms") to 5 ("unable to perform the activity or very severe symptoms"). The total score is calculated by summing the item scores, resulting in a DASH score ranging from 0 to 100, with higher scores indicating greater disability and poorer function [17]. The Arabic version of the DASH has been validated for use in the Arab population [11].
C. **Wrist Extensor Strength Measurement Using HHD (Figure 1)**: Patients were seated with their elbow flexed to 90° and supported on a custom arm rest, with their wrist in a neutral position and forearm pronated, while their feet remained flat on the floor. Force was applied to the dorsal surface of the wrist to assess extension, with resistance

applied perpendicularly to the HHD contact point [18]. The patient was instructed to exert maximal isometric strength on the dynamometer, while the evaluator encouraged the patient with the phrase, "harder, harder, harder." Three attempts were made, with the peak force (in Newtons) recorded for each attempt. Each contraction was held for 5 seconds, followed by a 30-second rest period to reduce fatigue [19].

Figure 1: wrist extensor strength measurement using Hand Held Dynamometer

D. **Hand Grip Strength Measurement Using Jamar Grip Dynamometer (Figure 2)**: Hand grip strength was measured using a Jamar Grip Dynamometer. Patients were seated with their shoulder in a neutral position, arm adducted, elbow flexed to 90°, and the forearm in a neutral position. The wrist and fingers were positioned comfortably on the dynamometer, and the elbow was supported. Patients were instructed to squeeze the dynamometer as hard as possible and hold the position for 5 seconds. No verbal encouragement was provided during the test. Grip strength readings were recorded in kilograms, with each measurement repeated three times. A minimum of 1-minute rest was allowed between attempts to minimize fatigue, and the dynamometer was reset to zero prior to each reading [20].

Figure 2: Hand grip strength measurement using Hand Grip Dynamometer

Statistical Analysis:

Statistical analysis was conducted using SPSS for Windows, version 26 (SPSS, Inc., Chicago, IL), data were screened for normality assumption, homogeneity of variance, and presence of extreme scores, and the p-value was set at < 0.05. Descriptive statistics would be used to describe the demographic subject characteristics; in the form of mean and standard deviation (SD) of patients' data (age, weight, height, BMI, side affected (left or right) and chronicity of LE. Paired T-test would be used for calculating significant difference. The Pearson correlation test was used to examine the relationship between all dependent variables.

Results:

Twenty-three patients of both gender with chronic LE were included in the current study. Patients received eccentric strengthening exercises in 12 treatment sessions (3 sessions per week) for 4 weeks, each session included 3 sets of 15 repetitions. the dependent outcomes were measured pre-physical therapy (pre) and at the end of the treatment intervention after 4 weeks post-physical therapy (post).

The distribution of females and males was 43.5 % (10) and 56.5 % (13) respectively. The mean and SD of age was 22.96 ± 4.93, The mean and SD of BMI was 27.04 ± 2.27**.** and the mean and SD of symptoms duration was 15±7.988

The mean ± SD of the VAS pre was 7.87±0.801 and the VAS post was 1.952 ±1.125**.** Paired T-test revealed significant differences for the post-intervention assessment of pain intensity (p=0.017*) compared to pre intervention **(Table 1, Figure 3)**. The mean ± SD of DASH pre was 78.004±11.89, and DASH post was 30.961±5.38. Paired T-test revealed significant differences for the post-intervention assessment of functional disability (p<0.001*) compared to pre intervention **(Table 2, Figure 4)**

Table 1: Mean for VAS pre and post.

VAS (cm) $\overline{X}$ **± SD**				
	Pre		**Post**	
	Mean	**SD**	**Mean**	**SD**
	7.870	0.8008	1.952	1.1253

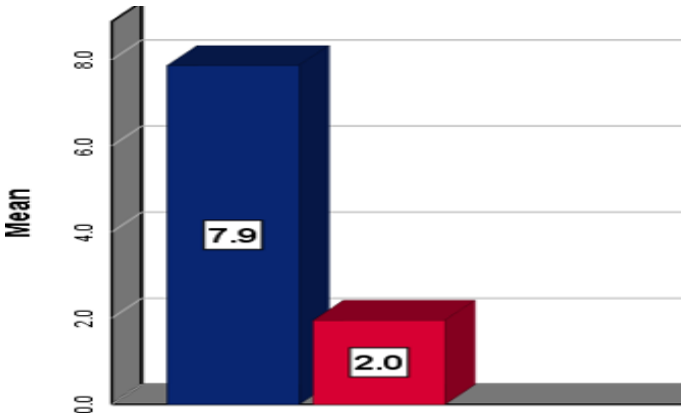

Figure 3: ***Mean VAS pre and VAS post***

Table 2: Mean for DASH pre and post.

DASH (%) $\overline{X}$ **± SD**				
	Pre		**Post**	
	Mean	**SD**	**Mean**	**SD**
	78.004	11.8946	30.961	5.3752

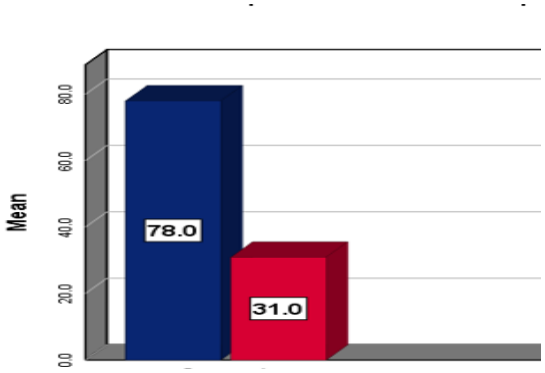

Figure 4: ***Mean DASH pre and post***

The mean ± SD of HHD pre was 42.017±14.35, and HHD post was 49.11±14.91. Paired T-test revealed significant differences for the post-intervention assessment of wrist extensor strength (p<0.001*) compared to pre intervention **(Table 3, Figure 5).** The mean ± SD of the hand grip strength pre in was 20.035±6.059, and the hand grip strength post was 30.109 ±8.42. Paired T-test revealed significant differences for the post-intervention assessment of wrist hand grip strength (p<0.001*) compared to pre intervention **(Table 4, Figure 6).**

Table 3: Mean for HHD pre and post.

HHD (Nw.m/Kg) $\overline{X}$ **± SD**				
	Pre		**Post**	
	Mean	**SD**	**Mean**	**SD**
	42.017	14.3483	49.113	14.9129

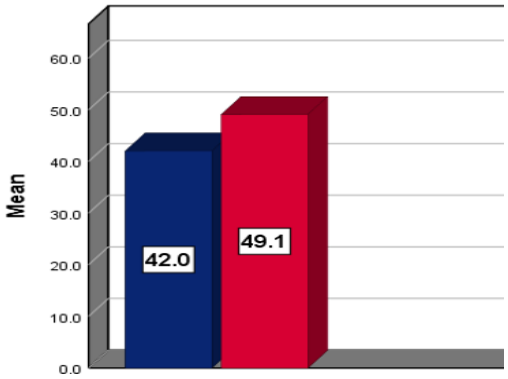

Figure 5: ***Mean HHD pre and post***

Table 4: Mean for hand grip strength pre and post.

Hang grip strength (kg) $\overline{X}$ ± SD				
	Pre		Post	
	Mean	SD	Mean	SD
	20.035	6.0592	30.109	8.4234

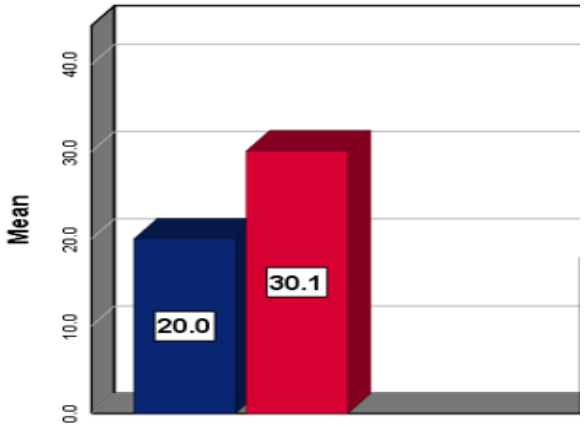

Figure 6: ***Mean HG pre and post***

Correlation:

Pearson correlation analysis revealed a strong positive correlation between values of pain intensity and DASH scores (r = 0.497; p = 0.016). Furthermore, a very strong positive correlation was observed between wrist extensor strength and hand grip strength (r = 0.768; p < 0.001). On the other hand, no significant correlation was observed between the other variables **(Table 5, Figure 7-12)**

Table 5: Pearson correlation analysis for dependent variables

Correlations					
		VAS post	DASH post	HHD post	HG post
VAS post	Pearson Correlation	1	**0.497***	-0.204	-0.256
	Sig. (2-tailed)		**0.016***	0.351	0.238
	N	23	23	23	23

DASH post	**Pearson Correlation**	0.497*	1	-.281	-.354
	Sig. (2-tailed)	0.016		.194	0.097
	N	23	23	23	23
HHD post	**Pearson Correlation**	-0.204	-0.281	1	**0.768****
	Sig. (2-tailed)	0.351	0.194		**<0.001***
	N	23	23	23	23
HG post	**Pearson Correlation**	-.256	-.354	.768**	1
	Sig. (2-tailed)	.238	.097	.000	
	N	23	23	23	23

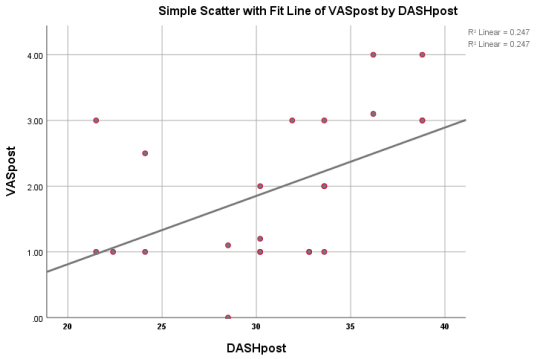

Figure 7 Scatter plot for the correlation between VAS and DASH

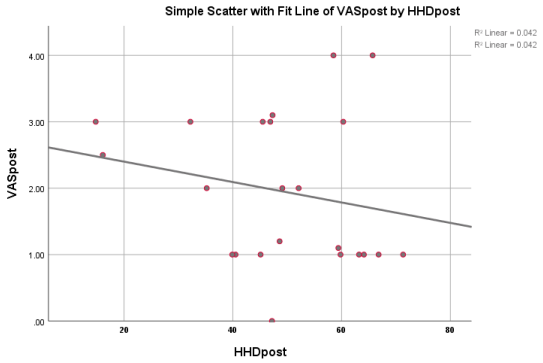

Figure 8 Scatter plot for the correlation between VAS and HHD

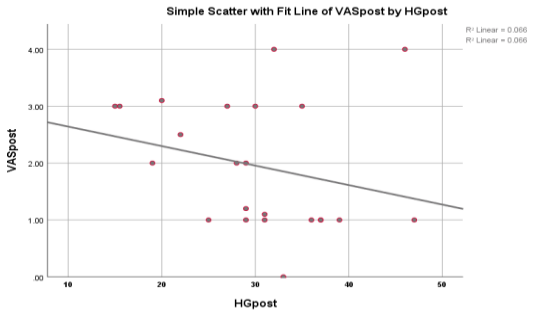

Figure 9 Scatter plot for the correlation between VAS and HG

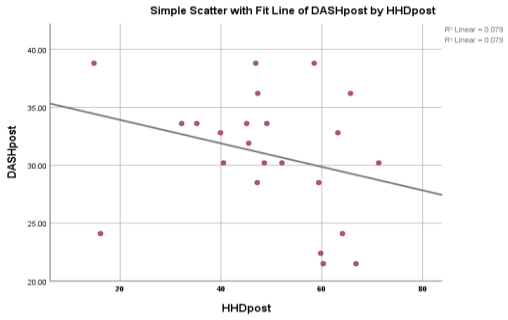

Figure 10 Scatter plot for the correlation between DASH and HHD

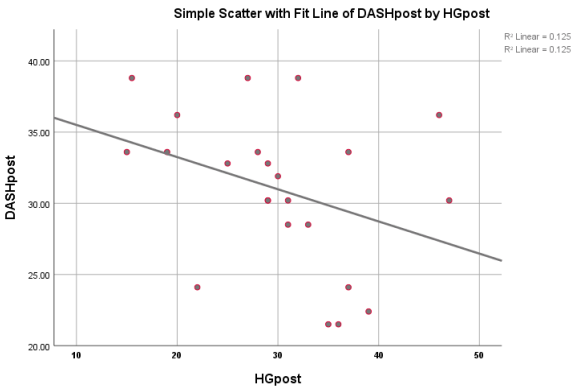

Figure 11 Scatter plot for the correlation between DASH and HG

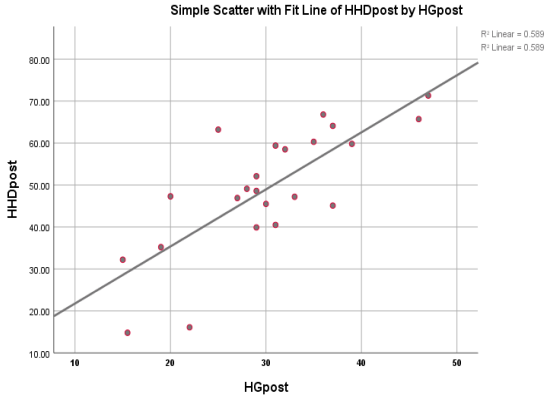

Figure 12 Scatter plot for the correlation between HHD and HG

Discussion:

The results of this study showed significant improvement in mean values of VAS, DASH, wrist extensor strength and hand grip strength after receiving eccentric exercises as compared with the corresponding mean values before treatment. The results of this study came into agreement with an RCT conducted by [21]. They evaluated the effects of eccentric exercises on 34 patients with LE. Patients were divided into 2 groups, Group A received eccentric exercises in addition to low-level laser therapy, Group B received muscle energy technique in addition to low-level laser therapy. Pain was assessed using a pain pressure algometer. They concluded that eccentric exercises were more effective than muscle energy technique on pain in patients with LE.

The results of a study conducted by [22] came into agreement with our results. They compared the effectiveness of eccentric exercises versus concentric exercises on improving function measured by Patient Rated Tennis Elbow Evaluation Scale (PRTEE) on 68 patients aged 18-45 years with LE. Results showed significant improvement in function in the eccentric training group. They concluded that eccentric exercises were more effective than concentric exercises for improving function in patients with LE.

In line with prior research, this study findings provide further confirmation of the established results in the literature done by [9]. They investigated the clinical and functional efficacy of eccentric exercises for chronic LE patients.120 patients were divided into 2 groups. The first group was given eccentric exercises, while the second was given concentric exercises. Wrist extensor strength was assessed by HHD before and after intervention. They concluded that eccentric exercises increased muscle strength in chronic LE more effectively than concentric exercises.

Our suggestion was supported by [15] to assess the effects of eccentric exercises on hand grip strength in patients with LE. patients were divided into 3 groups. Group A received eccentric exercises in addition to conventional treatment, Group B received concentric exercises in addition to conventional treatment, Group C received conventional treatment only. Hand grip strength was measured using a Jamar grip dynamometer. Results showed significant improvement of grip strength in the group that received eccentric exercises.

Our findings document the unique contributions of VAS to DASH scores. We found that pain contributed to changes in function, this finding was expected because complain of pain results in disability and affects activities of daily living [23]. On the other hand, a strong positive relationship was found between HHD and hand grip dynamometer which means that improvements in wrist extensors strength improves hand grip strength.

In agreement with this research, An RCT provided evidence supporting the correlation between pain relief and improved physical function after 8 weeks of treatment with diclofenac sodium gel in patients with hand osteoarthritis. This can be due to that pain inhibits physical function and influences severity of disease [24]. Similarly, [25] found that a pain management program led to functional improvements in a pediatric population with joint hypermobility, further reinforcing the connection between pain reduction and enhanced physical performance.

As with previous research, the results obtained in this study are in harmony with earlier findings of a cohort study conducted on 615 patients undergoing knee arthroplasty explained that patients with high levels of pain exhibited low physical function [26]. [27] confirmed our result by showing that patients with chronic pain had more negative impact on physical function.

The results of our analysis are in agreement with the results of previous studies including [28], who investigated the link between pain and disability in patients with chronic musculoskeletal pain. Moreover, our findings align with those of [29], who identified the significant role of pain, stiffness, and disease duration in determining disability levels in knee osteoarthritis patients.

Our study findings highlight the strong correlation between wrist extensor strength and hand grip strength. This finding is supported by [30] who investigated that the fatigue of wrist extensor muscles effectively decreased grip strength and lateral pinch. This agreement could be attributed to the fact that grip strength is produced not only by forearm flexor activation, but also the simultaneous activation of the extensors as synergists. Therefore, they suggested that the wrist extension should be considered as a therapeutical strategy to enhance grip strength and to prevent forearm muscle fatigue [31].

To the best of our knowledge, this is the first study to examine the correlation between VAS and DASH scores, as well as the relationship between wrist extensor strength and hand grip strength following an eccentric exercise program in patients with LE.

Conclusion:

The results of this study confirmed the effective role of eccentric exercises on improving pain, function, wrist extensor and hand grip strength in patients with LE. Additionally, pain was found to have a significant impact on functional improvements. Furthermore, a strong positive correlation was found between wrist extensor strength and hand grip strength.

Recommendations:

- Further studies should be performed with longer follow up period.
- Further studies are needed to explore the correlation between various measured variables and treatment interventions in LE patients.
- Further studies are needed to compare the effects of different manual therapy techniques in the treatment of LE.

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national research This research was not funded by any external source.

Conflict of interest:

The authors declare no conflicts of interest.

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