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EFFECTIVENESS OF SCAPULAR MUSCLE TRAINING IN IMPROVING GRIP STRENGTH AMONG LATERAL EPICONDYLITIS PATIENT

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ABSTRACT

Background: Overuse injuries including lateral epicondylitis (LE) affect functional activities and quality of life. Medications and Physiotherapy help in reducing pain, and improving muscular imbalance and functional status.

Objective: To determine the effectiveness of scapular muscular training along with conventional physiotherapy in improving the grip strength of patients suffering from lateral epicondylitis.

Methodology: The Randomized control trial was conducted on 56 patients who were selected by using a convenience sampling technique. Patients were randomly divided into two groups Group A (n=28) was treated with conventional physiotherapy treatment and Group B (n=28) was treated with Scapular strengthening and conventional physiotherapy protocol. Modified Sphygmomanometer and Patient Tennis Elbow Evaluation (PRTEE)
were used for assessing grip strength and functional status levels among patients. Data analyzed by using SPSS 26 was presented in the form of mean+S.D and percentage %, frequency tables Paired T-test and Independent T-test were used for within and between the group difference with significant value<0.05.

Result: The results showed that Grip strength and Total PRTEE scoring in the Scapular group were 143.57±7.54 and 56.03±9.37 while in the control group was 135.61±7.02 and 68.03±7.40 respectively with p<0.05 showing that showing that Scapular strengthening was significantly effective than alone Conventional treatment.

Conclusion: The study concluded that Scapular strength training with Conventional Physiotherapy treatment was statistically significant in improving urinary grip strength and functional status in patients who suffered from LE having a p-value <0.05.

Keywords: Grip strength**,** Lateral Epicondylitis, Patient rated Tennis Elbow Evaluation, Scapular Strengthening exercises

INTRODUCTION:

Lateral epicondylitis (LE) or Tennis elbow is a chronic repetitive or overuse injury of the extensor muscles of the forearm caused by forced elbow extension or direct trauma at the lateral epicondyle of the elbow joint (1). Extensors muscles offorearme specially Extensor carpiradialisbrevis is the major muscle affected in this condition leading to pain and swelling at the lateral epicondyle (2). 0.4 to 40% prevalent overuse injury among the 30 to 60 years of age general population (3-5)affecting 5% of tennis players and 12.2% in different occupations affecting 27% of ADLs and 17% of lifting activities that significantly among above 65 years old people (6-8). Furthermore, 2to20%incidence of below 18 years of age players lead to increased elbow injuries to 1.2/1000h especially among women with 1 to 3% prevalent in the dominant hand (9, 10).

Older age, female gender, dominant and, smoking, higher blood glucose level, increased HBA1C, chronic disease, excessive stress, sports (tennis, badminton) and computer usage, rotator cuff injury, De Quervain tenosynovitis, Rheumatoid arthritis, carpal tunnel syndrome, working at any vibratory or intensive working area are major risk factors of developing overloading and micro-trauma, angiofibroblastic degeneration, tendinosis, fibroblastic and vascular events (2, 5, 11). The micro-tearing and strain level of 4-8% at extensor carpi radialis brevis and extensor digitorum communis muscles cause inflammation, failure of collagen fibers, and tendon rupture affecting gripping and twisting activities involving tennis, gardening, computer and wood-related work(12-14).

The intermittent or persistent pain triggering with resisted wrist extension, burning sensations at and around the lateral epicondyle, radiating pain either towards the hand or to the humerus with limited flexion and extension ranges of the affected elbow joint, and weakness in gripping and lifting of objects are the major symptoms in making LE diagnosis (15). Cozen'stest, Mill'stest, and Maudlesy's tests are 91%, 76%, and 66% sensitive diagnostic tests for LE(15, 16)(25, 27). Additionally, the Thomson test, Coffee cup test, and Chair test provide perception in diagnosing of LE along with CT- scan, MRI, and Doppler ultrasound for ruling out tendon and bony pathologies(15, 17, 18). Oral NSAIDs, corticosteroid injections physiotherapy and orthotics are highly recommended non-surgical treatment protocols for managing and treating LE (19, 20).

Strengthening exercises, Acupuncture, Deep transverse frictional massage, Cyriax technique, Mill's manipulation, Myofascial Release techniques, Ultrasound, Short wave Diathermy, Laser therapy, Iontophoresis, eccentric and concentric strengthening of extensor muscles are major physiotherapy treatment techniques used for managing LE(14, 21-23). However, Scapular muscle strengthening is one of the treatment techniques used to manage the strengthening of weakened rotator cuff muscles, serratus anterior, and abnormal imbalance of scapular muscles. This helps in treating the abnormal shoulder elbow and wrist kinetics that lead to overuse of elbow joints and improving functional status and grip strength (14, 24). Fazal et al (2023) mentioned the activation and strengthening of scapular muscles efficient role in relieving pain and improving the functional status among the patient within four weeks in lateral epicondylitis patients (25). Additionally, Srinivas et al (2022) strengthening of middle and lower trapezius muscles helps in improving scapular position and kineatics eventfully leading to pain, grip- strength, and muscular strength among athletes suffering from lateral epicondylitis and it should be part of conventional physiotherapy program (26).

Bhalara et al (2020) reported a marked reduction in muscular strength and endurance in the middle and lower trapezius muscle and serratus anterior observed in LE patients affecting wrist movements and grip strength (21). Lee et al (2018) stated shoulder and scapular stabilization exercises improve the tenderness threshold in upper extremity muscles, especially in the trapezius muscle for improving pain in lateral epicondylitis (27). Limited studies focus on improving the grip strength of the patient's affected hand by scapular strengthening exercises that involve upper, middle, and lower trapezius muscles and serratus anterior muscles. Therefore; the current study was conducted to improve the grip strength of muscles by strengthening the upper, middle, and lower trapezius along with serratus anterior.

Material & Method:

The Randomized Control trial was conducted in Physiotherapy department of Fatima Medical Center after receiving the Ethical permission from the Ethical committee of Superior University Lahore. A total of fifty-six patients were selected through the non-probability convenience sampling technique. The sample size was calculated through The G power 3.1.9.4 having [Mean I 39.03, Mean II 28.26,1-β err prob of 80%, CI of 95%, and α err prob of 0.05] (28). Patients aged 20-50 of age with reported pain on the lateral epicondyle, having > 4 VAS scoring and positive Tomson test, Mill's test, Cozen's sign, and Maudsley's test were included in the study (24, 29). The participants excluded from the study had a history of neurological/ Radiculopathy signs in the upper limb, Cervical pain, Bilateral elbow pain, elbow or wrist surgery, and Receiving any corticosteroid injection within the last 6 months(24, 29).

The selected patients were completely blinded by the treatment protocol provided to the corresponding group by the therapist. The patients were further randomly allocated into their groups through the lottery method. In this method, the patient had to hand-pick the chit from the box containing a total of fifty-six chits, which were mentioned with the group title names A and B. The box contains equal twenty-eight chits mentioned by Group A and twenty-eight chits mentioned by Group B for preventing any error in the allocation of patients.

The patients in **Group A** were managed by using conventional physiotherapy. Initially, each patient received the Pulsed ultrasound that was applied at the lateral epicondyle having 2 W/cm2 intensity and 3MHz applied for 3-5 mins. After Pulsed Ultrasound, a proper deep friction massage was applied around the lateral epicondyle in the form of deep circles with firm pressure through the fingertips for approximately 5 to 10 minutes. Finally, the patient was guided to perform therapeutic exercises including eccentric and concentric exercises of the forearm and wrist isometrics of all movements with 10 repetitions of 3 sets with 10-second intervals (3).

Group B was managed with a combination of conventional physiotherapy along Scapular strengthening exercises. Initially, each patient received the Pulsed ultrasound that was applied at the lateral epicondyle having 2 W/cm2 intensity and 3MHz applied for 3-5 mins. After Pulsed Ultrasound, a proper deep friction massage was applied around the lateral epicondyle in the form of deep circles with firm pressure through the fingertips for approximately 5 to 10 minutes. Finally, the patient was guided to perform therapeutic exercises including eccentric and concentric exercises of the forearm and wrist isometrics of all movements with 10 repetitions of 3 sets with 10-second intervals (3).

After receiving conventional treatment, patients were guided to perform interventional exercises such as Scapular Strengthening exercises. Primarily; the patient was positioned in a prone lying position and advised to push the body away from the floor with an extended elbow and maintain the position for 10 seconds. Then, the patient was moved to a side-lying position carrying dumbbells of 1 to 2 kg in their hands. From the relaxing arm, the patient had to extend their arm for the activation of the middle trapezius muscle while carrying dumbbells in their hands. This exercise was performed with 10 repetitions of 3 sets with 20 seconds interval of rest(30).

Furthermore, Isometrics of elbow extensors were performed by patients with 90-degree flexion of shoulder, extended elbow, and wrist in a neutral position and the patient performed exercises with a towel. Twisting motion of elbow from extension to flexion while maintaining 90-degree flexion of shoulder, extended elbow, and writs in neutral position (3). All these exercises were performed with 10 repetitions of 3 sets with 20-second intervals for consecutive 4 weeks.

After selection, each patient was assessed pre-treatment and post-assessment at 4^{th} weeks through the selecting tools as strength was assessed by using a Modified Sphygmomanometer and disability by PRTEE scale.

Patient-rated Tennis Elbow Evaluation (PRTEE) is a self-evaluated questionnaire that is used for the evaluation of patients' pain and disability from a score between 0-100. The greater the scoring; the greater will be the pain and disability among patients. It is a highly reliable and valid tool with AUC=0.90, MDC =11 MCID= 20, and ICC =0.89-0.96 (30, 31). Grip strength was assessed by using a modified sphygmomanometer which it first inflated to 100 mmHg with a closed valve. The

pressure was reduced to 20mmHg and the movement of wrist extension will be resisted and the pressure will be recorded. It is a reliable tool with excellent inter-rater reliabilityICCof0.72-0.94 and test-retest reliability of 0.64-9.94 (32).
SPSS 26.0 version was used for data analysis in which parametric tests were used within and across the group analysis. The within-group analysis was determined by a Paired T-test and the group analysis was determined through an Independent t-test with a p-value <0.05.

Results:
The results of the study were described in tabulated form in which quantitative variables were represented in mean ± standard deviation and qualitative variables in frequency (%). Table 1 provides results of age as the mean age of the Control group (n=28) patients was 33.64± 7.99 while the mean age in the Scapular group was 36.25±8.33 with a minimum age of 20 years to a maximum age of 50 years respectively in both groups. The gender distribution in both groups is described in Table 1 in the Control group (n=28) patients 13 (46.4%) were male and 15 (53.6%) were female. Similarly; the in Scapular group (n=28); 16 (57.1%) were male and 12 (42.9%) were female.
The frequency (%) of Patients' Marital status and affected side of the elbow was mentioned in Table 1. According to Table 1; in the Control group (n=28); 12 (42.9%) were single, 13 (46.4%) were married and 3 (10.7%) were widows. Similarly; the marital status of the Scapular group (n=28) was 12 (42.9%) were single, 15 (53.6%) were married and 1 (3.6%) was a widow. Moreover; in Table 1 Out of 56 patients; in the Control group (n=28) patients; 11 (39.3%) had a left affected side and 17 (60.7%) had a right affected side. Similarly; the in Scapular group (n=28); 14 (50%) had the left affected side and 15 (50%) had the right affected side of the elbow.
The normality of data was analyzed by Kolmogorov–Smirnov test and having p-value >0.05 confirmed that data was normally distributed and parametric tests would be used for within and between group analysis having significance (p) value <0.05. The within-group analysis of Group A (the control group) is mentioned in Table 2. The grip strength was mentioned as the Pre-treatment mean Grip strength was 135.61±7.02 while post-treatment was 138.96±7.02 with p=0.00. The pain and functional scoring of PRTEE was described with pre-treatment pain scoring of PRTEE section was 37.35±6.19 while post-treatment mean pain scoring was 34.36±6.17 and Pre-treatment mean functional status scoring of PRTEE section was 36.64±6.05 while post-treatment mean functional status scoring was 33.67±6.13. Additionally; the Total PRTEE scoring mentioned in Table 7 as the Pre-treatment mean of Total PRTEE score was 74.00±7.49 while the post-treatment mean Total PRTEE score was 68.03±7.40 with p=0.00 confirming Conventional Physical therapy was effective in improving grip strength and disability level.
The within analysis of Group B (Scapular muscle training) is described in Table 2. Grip strength mentioned was Pre-treatment mean Grip strength was 134.60±7.51 while post-treatment mean Grip strength was 143.57±7.53. Moreover; the Pain and functional scoring of PRTEE as Pre-treatment mean pain scoring of PRTEE was 37.39±5.88 while the post-treatment mean pain scoring of PRTEE was 28.46±5.95 and Pre-treatment mean functional status scoring of PRTEE was 36.32±5.96 while post-treatment mean functional status scoring was 27.57±6.92. The Total PRTEE scoring as Pre-treatment mean Total PRTEE score was 73.71±9.43 while post-treatment mean Total PRTEE score was 56.03±9.37 with p=0.00 showing that Scapular muscle training in combination with Conventional physical therapy group was significantly effective in improving disability level among lateral epicondylitis patients.
Furthermore; the comparative group analysis is mentioned in Table 3. Table 3 showed that Post-treatment means Grip strength in the Control group was 135.61±7.02 while in the Scapular group was 143.57±7.54 p=0.002. Similar results were obtained for the Pain and Functional section of the PRTEE scoring tables as Post-treatment mean pain scoring of PRTEE in the Control group was 34.35±1.16 while in the Scapular group was 28.46±5.95 and Post-treatment mean functional status scoring of PRTEE section in the group was 33.67±1.15 while in Scapular group was 27.57±6.92 with p-value 0.00.
The Total PRTEE scoring mentioned in Table 3 showed Post-treatment mean Total PRTEE score in

the Control group was 68.03±7.40 while in the Scapular group was 56.03±9.37 with p=0.00 showing that Scapular muscle training in combination with Conventional physical therapy group was combatively and significantly effective than Conventional physical therapy in improving grip strength among lateral epicondylitis patients.

Table 1: Demographic variable of Groups:

Variables		**Control group** (n=28)	**Scapular Group** (n=28)
Age		33.64± 7.99	36.25±8.33
Gender	**Male**	13 (46.4%)	16 (57.1%)
	Female	15 (53.6%)	12 (42.9%)
Marital Status	**Single**	12 (42.9%)	12 (42.9%)
	Married	13 (46.4%)	15 (53.6%)
	Widow	3 (10.7%)	1 (3.6%)
The affected side of the Elbow	**Left**	11 (39.3%)	14 (50%)
	Right	17 (60.7%)	15 (50%)

Table 2: Within Groups analysis of Grip strength & PRTEE of groups:

Variables		**Control Group**				**Scapular Group**		
		Pre-treatment	**Post-treatment**		**p-value**	**Pre-treatment**	**Post-treatment**	**p-value**
		Mean ± S.D	Mean ± S.D			Mean ± S.D	Mean ± S.D	
Grip strength		135.61±7.02	138.96±7.02		0.00	134.60±7.51	143.57±7.53	0.00
PRTEE	**Pain**	37.35±6.19	34.36±6.17	0.00	37.39±5.88	28.46±5.95	0.00	
	Functional status	36.64±6.05	33.67±6.13	0.00	36.32±5.96	27.57±6.92	0.00	
	Total	74.00±7.49	68.03±7.40	0.00	73.71±9.43	56.03±9.37	0.00	

Table 3: Between Groups analysis of Grip strength & PRTEE of groups:

Variables		**Post-treatment**		
		Control Group	**Scapular Group**	**p-value**
		Mean ± S.D	Mean ± S.D	
Grip strength		135.61±7.02	143.57±7.54	0.022
PRTEE	**Pain**	34.35±1.16	28.46±5.95	0.001
	Functional status	33.67±1.15	27.57±6.92	0.000
	Total	68.03±7.40	56.03±9.37	0.000

DISCUSSION:

The study was designed to compare and determine the effectiveness of scapular muscle training in combination with conventional physical therapy in improving grip strength and functional status among patients suffering from Lateral epicondylitis. The results reported a significant difference in grip strength and functional status with a p-value <0.05 among the patients managed with scapular training as compared to the control group confirmed scapular muscle training had a significant role in managing grip strength and functional status of patients.

The grip strength and functional status were assessed by using a Modified sphygmomanometer and Patient Rated Tennis elbow scale respectively. Grip strength and PRTEE showed marked improvement in both control and scapular muscle training confirming physical therapy is an effective protocol for managing LE. However; on comparison; grip strength was 143.57±7.54 improved by Scapular training as compared to 135.61±7.02 in the control group with p-value <0.05 showing Scapular muscle training is highly effective in improving grip strength among LE.

Similarly; PRTEE scores showed a significant reduction in patients managed through Control and Scapular muscular training. While on comparison; pain, functional and total PRTEE were

statistically improved in the Scapular training group with 28.46±5.95, 27.57±6.92and 56.03±9.37in comparison to 34.35±1.16, 33.67±1.15 and 68.03±7.40 of Control group ($p < 0.05$). This significant improvement was further confirmed by Kirithika et al (2024) concluded scapular strengthening and eccentric exercises played a signification reduction in pain and improvement in grip strength and functional status of LE patients within five weeks. These exercises decrease distal joint loading and extensor carpi radial inflammation by improving the proximal muscular imbalance (28). This is concurrent with the current study as grip strength and functional status were highly improved by scapular training within 4 weeks of the treatment protocol.

Similarly; In a pre-posttest study; Espinoza et al (2024) concluded scapular training exercises with conventional physical therapy improve functional status, pain, and grip strength in LE patients within 6 weeks and maintained for 1 year (33). This further supported current study results as within 4 weeks remarkable improvement was observed while it contradicts with current study results for lack of collecting data for prolonged follow-up. Similarly, Yuksel et al (2024) reported that scapular strengthening exercises played an essential role in improving muscular strength and managing the abnormal position of the scapula that increases the disturbance in the muscular activation and coordination of the upper limb producing extra loading on the distal joints(34). The positional and strength enhancement helps in improving pain and disability among the patients which highly supported current results as LE patients showed marked improvement in the PRTEE scoring ($p < 0.005$) and grip strength ($p < 0.005$) of the patients.

A randomized control study reported by Raithatha et al (2024) stated combination of scapular exercises with ultrasound and wrist extensor strengthening played significant role in improving pain, grip strength, and PRTEE scoring (7). It is highly concurrent with recent results as the patients managed with Scapular exercises showed significant improvement in grip strength and PRTEE confirming the importance of Scapular strengthening. However, the previous literature was in contrast to current results to some extent in non-significant improvement in disability that is significantly improved in current results making the current study a significantly strong study. Additionally; Mostafaee et al (2022) reported shoulder and scapular muscular training in combination with conventional physical therapy helps enhance the grip strength and functional status of LE patients. These exercises focus on improving the biomechanical imbalance, restoration of kinetic chain energy, and reducing the over activity with compensatory work of wrist muscles (24). This literature highly supported the current study as grip strength and PRTEE functional scoring were improved by both conventional and scapular training. However; scapular training improved grip strength with a p-value <0.05 by improving the scapular instability.

Day et al (2021) concluded scapular training with conventional therapy improves functional status with a remarkable increase in grip strength for approximately 12 months of follow-ups. Scapular training is highly effective in managing proximal muscular and biomechanical deficits and helps in reducing the overexertion of distal muscles in acute and bilateral LE (31). Substantially; Day et al (2015) reported, that in LE, scapular training helps in reducing the increased kinetic energy observed on the elbow and hand joints associated with the weakening of shoulder external rotators, abductors, and scapular retractors muscles. Scapular exercises manage muscular weakness and scapular instability to reduce the compensated over-activity of wrist extensors and cause overuse injuries including lateral epicondylitis (35). These studies support the current study results as Scapular muscle training is effective in producing remarkable improvement in pain and functional scoring of PRTEE by reducing the compensatory activity of wrist extensor muscles.

Bhalrar et al (2020) reported people who suffered from lateral epicondylitis had significantly weaker upper, middle, and lower trapezius muscles along with serratus anterior. The reduction in scapulothoracic strength and endurance leads to over-activity and micro-trauma of wrist extensor muscles that need to be assessed and managed through treatment (10). This supports the current study's aim of using scapular muscle training in managing over-activity and micro-traumatic events at the lateral side of the elbow. Ramteke et al (2020) supported the slow and reduced rotation of the trunk and external rotators with increased flexion of the elbow producing excessive valgus elbow torque leading to repetitive contraction of external carpi and grip strength reduction among LE

patients that effectively managed by resisted exercises of serratus anterior, trapezius and rotator cuff muscles (36) confirming the improvement of PRTEE scoring and grip strength among patients managed by capsular strengthening in study.

Stasionpoulos et al (2019) and Lee et al (2018) concluded scapulothoracic imbalance managed by eccentric and isometric contraction of scapular muscles eventually improves grip strength by improving proprioception and motor function of shoulder and elbow joints. This proprioceptive activation helps to reduce the inflammatory condition by increasing blood flow and neovascularization (27, 37). This further supports the current study results as comparative grip strength was markedly improved in the scapular muscle training group. Moreover, Kachanathu et al (2019) supported that scapular strengthening helps to reduce the gripping effort of hand muscles. The tightness of the posterior muscle group of the shoulder and the overdevelopment of internal rotators lead to excessive stress on capsular ligaments and translation of the anterior segment of the humeral head. This proximal instability causes the production of increased muscular effort in the griping of the hand (38). This highly supported currents study results as LE patients reported significant improvement in grip strength by a marked reduction in pain section with improvement in functional scoring of PRTEE scale ($p<0.05$).

The results of the current study showed that both techniques are effective in treating grip strength and functional status in LE patients. However, most studies supported that Scapular muscle training are more effective in improving muscular imbalance causing an increase in strength and functional status of wrist extensors that help in reducing pain and improving grip and functional status of wrist and elbow joints that is not significantly managed with only Conventional physical therapy. Having defined strengths; the still study had its limitations. Initially, the study collected data from a single hospital setting which limited the generalization study Therefore; a further study should be conducted on collecting data from multiple clinical setups. Secondly, the study mentioned and treated scapular instability with Scapular strengthening. However, comparing the effects of training with conventional treatment protocol limits its efficacy. Therefore a future study needed to be conducted in which scapular strengthening was compared with shoulder exercises or elbow exercises to design a better program.

CONCLUSIONS

Overuse of elbow injuries including Lateral epicondylitis is common among the general population. The study concluded combination of conventional physiotherapy with Scapular muscle training significantly improved grip strength and functional status among LE patients compared with general conventional physical therapy. Therefore; a combination of scapular muscle training with conventional physiotherapy should be considered in managing Lateral epicondylitis patients.

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References:

1. Tarpada, S. P., Morris, M. T., Lian, J., & Rashidi, S. (2018). Current advances in the treatment of medial and lateral epicondylitis. *Journal of Orthopedics, 15*(1), 107-110. https://doi.org /10.1016/j.jor.2017.11.009
2. Bazancir, Z., & Fırat, T. (2019). A potential factor in the pathophysiology of lateral epicondylitis: The long sarcomere length of the extensor carpi radialis brevis muscle and implications for physiotherapy. *Medical Hypotheses, 130*, 109278. https://doi.org /10.1016/j.mehy.2019.109278
3. Bisset, L. M., & Vicenzino, B. (2015). Physiotherapy management of lateral epicondylalgia. *Journal of Physiotherapy, 61*(4), 174-181. https://doi.org/10.1016/j.jphys.2015.08.004
4. Coombes, B. K., Bisset, L., & Vicenzino, B. (2015). Management of lateral elbow tendinopathy: One size does not fit all. *Journal of Orthopaedic & Sports Physical Therapy, 45*(11), 938-949. https://doi.org/10.2519/jospt.2015.5986

5. Sayampanathan, A. A., Basha, M., & Mitra, A. K. (2020). Risk factors of lateral epicondylitis: A meta-analysis. *The Surgeon, 18*(2), 122-128. https://doi.org/10.1016/j.surge.2019.10.002
6. Sandhu, K., Kahal, K. S., Singh, J., Singh, J., & Grewal, H. (2020). A comparative study of activated platelet rich plasma versus local corticosteroid injection for the treatment of lateral epicondylitis: A randomized study. *International Journal of Orthopaedics, 6*(1), 1274-1276. https://doi.org/10.18044/jioh.6.1.1274
7. Raithatha, K., Khant, A., & Ved, V. (2018). Effectiveness of scapular muscle strengthening in management of lateral epicondylalgia. *International Journal of Advance Research, Ideas and Innovations in Technology, 4*(3). Retrieved from [URL]
8. Degen, R. M., Conti, M. S., Camp, C. L., Altchek, D. W., Dines, J. S., & Werner, B. C. (2018). Epidemiology and disease burden of lateral epicondylitis in the USA: Analysis of 85,318 patients. *HSS Journal, 14*(1), 9-14. https://doi.org/10.1007/s11420-018-9698-7
9. Pluim, B. M., Clarsen, B., & Verhagen, E. (2018). Injury rates in recreational tennis players do not differ between different playing surfaces. *British Journal of Sports Medicine, 52*(9), 611-615. https://doi.org/10.1136/bjsports-2017-098805
10. Bhalara, A. S., & Sheth, M. S. (2020). Comparison of scapular muscle strength and endurance in subjects with lateral epicondylitis and healthy individuals. *International Journal of Health Sciences & Research, 10*(2), 43-48. https://doi.org/10.52403/ijhsr.20200206
11. Park, H. B., Gwark, J. Y., Im, J. H., & Na, J. B. (2021). Factors associated with lateral epicondylitis of the elbow. *Orthopaedic Journal of Sports Medicine, 9*(5), 23259671211007734. https://doi.org /10.1177/23259671211007734
12. Johns, N., & Shridhar, V. (2020). Lateral epicondylitis: Current concepts. *Australian Journal of General Practice, 49*(11), 707-709. https://doi.org/10.31128/AJGP-10-20-5706
13. Lenoir, H., Mares, O., & Carlier, Y. (2019). Management of lateral epicondylitis. *Orthopaedics & Traumatology: Surgery & Research, 105*(8), S241-S246. https://doi.org /10.1016/j.otsr.2019.07.002
14. Pathan, A. F., Sharath, H., & Sharath, H. (2023). A review of physiotherapy techniques used in the treatment of tennis elbow. *Journal of Clinical Rehabilitation, 15*(10).
15. Ma, K. L., & Wang, H. Q. (2020). Management of lateral epicondylitis: A narrative literature review. *Pain Research and Management, 2020*. https://doi.org/10.1155/2020/2835681
16. Zwerus, E. L., Somford, M. P., Maissan, F., Heisen, J., Eygendaal, D., & Van Den Bekerom, M. P. J. (2018). Physical examination of the elbow: What is the evidence? A systematic literature review. *British Journal of Sports Medicine, 52*(19), 1253-1260. https://doi.org /10.1136/bjsports-2018-099187
17. Scher, D. L., Wolf, J. M., Owens, B. D., & Maj, M. C. (2009). Lateral epicondylitis. *Orthopedics, 32*(4). https://doi.org/10.3928/01477447-20090401-25
18. Di Giacomo, G., Ellenbecker, T. S., & Kibler, W. B. (2019). *Tennis medicine: A complete guide to evaluation, treatment, and rehabilitation*. Springer. https://doi.org/10.1007/978-3-030-23835-7
19. Bateman, M., Titchener, A. G., Clark, D. I., & Tambe, A. A. (2019). Management of tennis elbow: A survey of UK clinical practice. *Shoulder & Elbow, 11*(3), 233-238. https: //doi.org/10.1177/1758573219835693
20. Coombes, B. K., Connelly, L., Bisset, L., & Vicenzino, B. (2016). Economic evaluation favors physiotherapy but not corticosteroid injection as a first-line intervention for chronic lateral epicondylalgia: Evidence from a randomized clinical trial. *British Journal of Sports Medicine, 50*(22), 1400-1405. https://doi.org/10.1136/bjsports-2016-096971
21. Bhalara, A. S., & Sheth, M. S. (2020). Comparison of scapular muscle strength and endurance in subjects with lateral epicondylitis and healthy individuals. *International Journal of Health Sciences & Research, 10*(2), 43-48. https://doi.org/10.52403/ijhsr.20200206
22. Weber, C., Thai, V., Neuheuser, K., Groover, K., & Christ, O. (2015). Efficacy of physical therapy for the treatment of lateral epicondylitis: A meta-analysis. *BMC Musculoskeletal Disorders, 16*, 1-13. https://doi.org/10.1186/s12891-015-0683-5

23. Menta, R., Randhawa, K., Cote, P., Wong, J. J., Yu, H., Sutton, D., & others. (2015). The effectiveness of exercise for the management of musculoskeletal disorders and injuries of the elbow, forearm, wrist, and hand: A systematic review by the Ontario Protocol for Traffic Injury Management (OPTIMa) collaboration. *Journal of Manipulative and Physiological Therapeutics, 38*(7), 507-520. https://doi.org/10.1016/j.jmpt.2015.04.008
24. Mostafaee, N., Divandari, A., Negahban, H., Kachooei, A. R., Moradi, A., Ebrahimzadeh, M. H., & others. (2022). Shoulder and scapula muscle training plus conventional physiotherapy versus conventional physiotherapy only: A randomized controlled trial of patients with lateral elbow tendinopathy. *Journal of Rehabilitation Research and Development, 38*(9), 1153-1164. https://doi.org/10.1682/JRRD.2021.03.0023
25. Fazal, A. I. A., Kibria, M. G., Akter, S., Salek, S., & Rahman, M. M. (2023). Activation of middle and lower trapezius and strengthening of serratus anterior muscle for the rehabilitation of a patient with chronic lateral epicondylalgia: A case report. *European Journal of Physical and Rehabilitation Medicine, 9*, 1-7. https://doi.org/10.23736/S1973-9087.23.08273-8
26. Srinivas, M. R., & Babu, J. H. K. (2022). The effect of middle and lower trapezius strengthening on hand grip strength in athletes with chronic lateral epicondylitis. *Journal of Physical Therapy Science, 6*(9), 4231-4243. https://doi.org/10.1298/jpts.2022.4223
27. Lee, J.-H., Kim, T.-H., & Lim, K.-B. (2018). Effects of eccentric control exercise for wrist extensor and shoulder stabilization exercise on the pain and functions of tennis elbow. *Journal of Physical Therapy Science, 30*(4), 590-594. https://doi.org/10.1589/jpts.30.590
28. Kirithika, G., Kamalakannan, M., Ramana, K., & Anitha, A. (2024). Efficacy of scapular strengthening exercise and eccentric forearm exercise on functional recovery in subjects with lateral epicondylitis. *Indian Journal of Physiotherapy & Occupational Therapy, 18*. Retrieved from [URL]
29. Raithatha, K., Khant, A., & Ved, V. (2018). Effectiveness of scapular muscle strengthening in management of lateral epicondylalgia. *International Journal of Advance Research, Ideas and Innovations in Technology, 4*(3). Retrieved from [URL]
30. Farzad, M., MacDermid, J. C., Shafiee, E., Beygi, A. S., Vafaei, A., Varahra, A., & others. (2022). Clinimetric testing of the Persian version of the Patient-Rated Tennis Elbow Evaluation (PRTEE) and the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaires in patients with lateral elbow tendinopathy. *Journal of Rehabilitation Research and Development, 44*(12), 2902-2907. https://doi.org/10.1682/JRRD.2022.03.0030
31. Day, J. M., Lucado, A. M., Dale, R. B., Merriman, H., Marker, C. D., & Uhl, T. L. (2021). The effect of scapular muscle strengthening on functional recovery in patients with lateral elbow tendinopathy: A pilot randomized controlled trial. *Journal of Sport Rehabilitation, 30*(5), 744-753. https://doi.org/10.1123/jsr.2020-0142
32. Silva, B. B., Venturato, A. C., Aguiar, L. T., Luiz Filho, F., Faria, C. D., & Polese, J. C. (2019). Validity and reliability of the modified sphygmomanometer test with fixed stabilization for clinical measurement of muscle strength. *Journal of Bodywork and Movement Therapies, 23*(4), 844-849. https://doi.org/10.1016/j.jbmt.2019.03.010
33. Gutiérrez-Espinoza, H., Estrella-Flores, E., Cuyul-Vásquez, I., Jorquera-Aguilera, R., Francisco López-Gil, J., & Araya-Quintanilla, F. (2024). Effects of a conventional treatment plus scapular exercises program in patients with chronic lateral elbow tendinopathy: A pre–post single-group study. *Journal of Sport Rehabilitation, 33*(2), 106-113. https://doi.org/10.1123/jsr.2023-0104
34. Yuksel, E., & Yesilyaprak, S. S. (2024). Scapular stabilization exercise training improves treatment effectiveness on shoulder pain, scapular dyskinesis, muscle strength, and function in patients with subacromial pain syndrome: A randomized controlled trial. *Journal of Bodywork and Movement Therapies, 37*, 101-108. https://doi.org/10.1016/j.jbmt.2024.02.003
35. Day, J. M., Bush, H., Nitz, A. J., & Uhl, T. L. (2015). Scapular muscle performance in individuals with lateral epicondylalgia. *Journal of Orthopaedic & Sports Physical Therapy, 45*(5), 414-424. https://doi.org/10.2519/jospt.2015.5828

36. Ramteke, S., & Samal, S. (2020). To study the effect of rotator cuff exercises on tennis elbow. *Indian Journal of Public Health Research & Development, 11*(3), 610-614. https://doi.org/10.37506/ijphrd.v11i3.11612
37. Stasinopoulos, D. (2019). The role of proprioception in the management of lateral elbow tendinopathy. *Journal of Hand Therapy, 32*(1), e2-e3. https://doi.org/10.1016/j.jht.2018.11.007
38. Kachanathu, S. J., Zedan, A. M. E., Hafez, A. R., Alodaibi, F. A., Alenazi, A. M., & Nuhmani, S. (2019). Effect of shoulder stability exercises on hand grip strength in patients with shoulder impingement syndrome. *Somatosensory & Motor Research, 36*(2), 97-101. https://doi.org /10.1080/08990220.2019.1619637