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Information Article

Effect of suggested exercises to rehabilitate injured medial tendons of the elbow joint, based on their electrical activity indicators, for tennis players

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ABSTRACT

This study aims to design a proposed therapeutic exercise protocol for rehabilitating injured medial elbow muscle tendons and to evaluate its neuromuscular efficacy via electromyographic (EMG) indices. The researcher hypothesized statistically significant differences between pre- and post-intervention assessments in joint range of motion (ROM) favoring the post-test. The target population comprised tennis players affiliated with Baghdad sports clubs. The research sample was selected via comprehensive enumeration based on clinical medical diagnoses, totaling (n = 4) injured athletes.

Following variable operationalization, test selection, and pilot testing, pre-intervention baseline measures were recorded. The primary rehabilitation intervention spanned (8) weeks at a frequency of three sessions per week; session duration was (35) minutes for the initial four weeks and advanced to (45) minutes across the final four weeks, utilizing specialized therapeutic and diagnostic instrumentation. Following the post-intervention measurements, datasets were processed statistically.

The researcher concluded that monitoring surface electromyographic indices significantly guides and optimizes the rehabilitation trajectory of medial elbow tendinopathy. The study recommends the routine integration of EMG diagnostics throughout musculoskeletal rehabilitation programs.

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1. Introduction

Specialists in sports injuries have devoted substantial attention to this field, as it represents the fundamental cornerstone upon which athletes rely to return to their various athletic activities. The diversity of rehabilitation modalities has further positioned this discipline at the forefront of medical sciences. Numerous specialists, academics, and physicians have addressed the topic of sports injuries due to its growing importance in achieving optimal athletic performance across all sporting domains, grounded in scientific, practical, and sports-medical principles.

High-intensity athletic performance in terms of speed and power within the skills demanded by sports subjects athletes to significant physical stress aimed at achieving individual or team objectives. This physiological strain and load placed on the body inevitably leads to various types of athletic injuries, regardless of whether they stem from direct contact with sports equipment. In tennis, for instance, players are exposed to substantial physical demands during training and competition, as the requirements of the sport necessitate multi-directional movement and abrupt execution of maneuvers that can result in injury if executed improperly.

Therefore, athletic rehabilitation serves as the decisive factor in facilitating an athlete's return to play in a stronger state than before. It encompasses comprehensive care from the moment an athlete is medically cleared to engage in targeted therapeutic exercises following medical interventions or following injury onset. Athletic rehabilitation constitutes the primary foundation for smart post-injury recovery, aiming to restore physical fitness components—including muscular strength, flexibility, and full motor function—to ensure a safer and stronger return to competitive play and daily activities. Rehabilitation involves progressive phases including immobilization, range-of-motion enhancement, strengthening, and skill-specific training to ensure complete healing and prevent injury recurrence. Post-injury sports rehabilitation is a therapeutic process applied to manage sports-related injuries so that athletes can regain their pre-injury performance levels as expeditiously as possible. Modalities such as physical therapy and therapeutic exercise aim to manage pain, improve joint mobility, and enhance muscular strength. Consequently, post-injury rehabilitation is critical for ensuring full recovery, minimizing time away from sport, and preventing reinjury.

The medial musculature of the elbow joint is frequently susceptible to tears resulting from the mechanical load imposed during forehand and backhand strokes and other tennis-specific skills. Such injuries may also arise from aberrant movement biomechanics or prolonged play, which generates excessive stress on the medial aspect of the joint. Hence, the significance of this research lies in rehabilitating such injuries and ensuring the athlete's optimal return to athletic participation.

Research Problem

Injuries to the tendons of the medial elbow musculature represent a recurring issue among tennis players, as indicated by statistical observations gathered by the researcher through continuous monitoring of players across several Baghdad sports clubs. Based on the researcher's professional background in athletic rehabilitation for racket sports, the researcher sought to investigate this problem, identify its underlying causes, and evaluate electromyographic (EMG) indices before and after rehabilitation utilizing a dedicated battery of therapeutic devices and protocols to ensure the injured athlete's effective return to competitive performance.

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Research Objectives

1. To design proposed therapeutic exercises for the rehabilitation of injured medial elbow musculature.
2. To determine the effect of these exercises on the rehabilitation of the targeted muscles based on electromyographic (EMG) activity indices in tennis players.

Research Hypothesis

1. There are statistically significant differences between the pre-test and post-test measurements of the research sample in range of motion (ROM) in favor of the post-test.

Research Scope

- **Human Domain:** A sample of tennis players suffering from tendon tears of the medial elbow musculature.
- **Temporal Domain:** The period from August 2, 2024, to December 13, 2024.
- **Spatial Domain:** Al-Mansour/Al-Sayd Club tennis courts in Baghdad and the Specialized Center for Therapy and Rehabilitation in Baghdad.

2 Research Methodology and Field Procedures

2.1Research Method

The researcher adopted an experimental design using a single-group pre-test/post-test approach, in accordance with the nature of the research problem.

2.2Population and Sample

The research population comprised tennis players from Baghdad clubs. Through a comprehensive survey of these clubs, the researcher purposively selected players diagnosed with tendon tears of the medial elbow musculature, totaling four (N (4= injured athletes based on medical reports obtained from the players. To verify the diagnosis and severity of the injury, the researcher presented the sample to a specialist physician. Following precise clinical and diagnostic examinations using medical equipment, all cases were confirmed as mild (first-degree) tendon tears of the medial elbow musculature. The researcher verified the homogeneity of the research sample, as presented in Table 1.

Table 1. Homogeneity of the Research Sample

No.	Variables	Mean	Standard Deviation (SD)	Median	Skewness
1	Height (cm)	177.3	3.79	179.6	0.60
2	Body Mass (kg)	59.23	2.92	61.88	0.90
3	Age (years)	20.56	2.89	22.5	0.67

2.3Instruments, Equipment, and Tools Used in the Study

2.3.1Data Collection Tools

1. Scientific sources and references.
2. Internet resources.
3. Systematic observation.

2.3.2Devices and Equipment Used in the Study

1. Therapeutic ultrasound device.
2. Infrared radiation device.
3. Electromyography (EMG) device.
4. HP laptop (manufactured in Korea).
5. Standard goniometer.
6. Sony camera (manufactured in Malaysia).
7. Resistance bands / elastic tubing.
8. Dumbbells.

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9. Gymnasium / rehabilitation hall.

2.4 Research Procedures

2.4.1 Research Variables

Relevant scientific literature and references were reviewed to identify the research variables. Based on the researcher's specialization in athletic rehabilitation, the primary variables were established as the proposed exercise program and the corresponding electromyographic (EMG) activity indices, guided by previous literature (Khudair & Mal Allah, 2024).

2.4.2 Research Tests

To select standardized tests appropriate for the sample and variables, the researcher utilized validated protocols documented in scientific literature, including:

2.4.2.1 Range of Motion (ROM) Measurement (Hassan Saad Al-Jejakli, 2006, p. 70)

- **Test Name:** Range of Motion (ROM) Measurement.
- **Purpose:** To measure flexion and extension ranges of the elbow joint.
- **Unit of Measurement:** Degrees (°).
- **Equipment Used:** Goniometer.
- **Testing Procedure:** The participant is seated with the arm hanging naturally alongside the torso, or positioned supine with the palm facing upward (supinated). The axis (fulcrum) of the goniometer is aligned over the lateral epicondyle of the humerus.
    - *Stationary arm:* Positioned parallel to the longitudinal midline of the lateral aspect of the humerus.
    - *Movement arm:* Positioned parallel to the lateral midline of the radius, pointing toward the radial styloid process.
    - *Extension movement:* The return movement from full flexion; participant posture and goniometer placement remain identical to flexion measurement.
- **Scoring:** The maximum degree attained by the participant is recorded. Total range of motion in this measurement is calculated by subtracting the extension angle from the flexion angle to determine the total ROM of the elbow joint.

2.4.3 Pilot Study

The researcher conducted a pilot study on the sample members to identify potential obstacles that might arise during the main intervention, verify the operational efficiency of the testing instruments, and assess the participants' compliance and readiness for the testing protocols.

2.4.4 Pre-test Assessment

The researcher administered the pre-tests to the research sample under standardized conditions to ensure measurement accuracy, while assessing the participants' physical readiness for testing.

2.4.5 Main Intervention

The main intervention was conducted over an 8-week period at a constant frequency of three weekly sessions (Sunday, Tuesday, Thursday). Each rehabilitation session lasted 45 minutes, incorporating dedicated therapeutic devices and modalities suitable for this injury type. The intervention was divided into two distinct 4-week phases. The researcher utilized an EMG device to monitor neuromuscular activity, assess progressive improvements over the intervention period, evaluate motor unit

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recruitment patterns in the torn muscle fibers, and obtain accurate indices from the start to the completion of the program.

The intervention structure was organized as follows:

Phase One (Weeks 1–4):

1. Application of therapeutic ultrasound.
2. Application of infrared radiation therapy.
3. Joint pain alleviation.
4. Progressive enhancement of elasticity in muscles crossing the elbow joint.
5. Stimulation of muscle tone in the affected musculature.
6. Stretching of joint-stabilizing muscles.
7. EMG monitoring.
8. Session duration: 30–53 minutes.

Phase Two (Weeks 5–8):

1. Enhancement of joint biomechanics and mechanics.
2. Expansion of elbow joint range of motion.
3. Strengthening of muscles acting on the elbow joint.
4. Progressive resistance exercises.
5. Repeated elbow flexion and extension drills.
6. Utilization of functional rehabilitation tools to enhance muscular strength and ROM.
7. EMG monitoring.
8. Restoration of normal elbow range of motion (∘15–∘0for functional flexion and ∘0for extension).
9. Session duration: 40–45 minutes.

2.4.6 Post-test Assessment

The researcher conducted the post-tests under identical environmental, procedural, temporal, and instrumental conditions established during the pre-test phase.

2.4.7 Statistical Analysis

Statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS) to analyze the study data.

3. Presentation, Analysis, and Discussion of Results

3.1Presentation and Analysis of Results

Table 2. Means, Standard Deviations, and Calculated t-values for Pre- and Post-test Range of Motion (ROM)

No.	Variables	Sub-variable	Unit	Pre-test (X(¯	Pre-test (±SD(	Post-test (X(¯	Post-test (±SD(	Mean Diff. (Md(	Calculated t-value	p-value (Sig(	Significance
1	Range of Motion	Flexion	Degrees	56.22	3.23	28.36	2.52	27.86	2.33	0.001	Significant
2	Range of Motion	Extension	Degrees	127.13	4.13	144.58	2.29	17.45	3.27	0.002	Significant

Statistically significant at the α 0.05=significance level with degrees of freedom)df=n.(3=1−

3.2 Discussion of Results

Table 2 demonstrates statistically significant differences between the pre-test and post-test measurements for range of motion (ROM) in favor of the post-test. The researcher attributes these differences to the application of therapeutic modalities designed to alleviate pain resulting from tendinous tears of the medial musculature. Among these devices was therapeutic ultrasound, which facilitates dynamic tissue and

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tendon evaluation during movement and contraction, enabling the researcher to monitor healing progression in the torn tendons. High-resolution ultrasound is an advanced, non-invasive imaging modality providing detailed visualization of muscles, tendons, ligaments, joints, nerves, and surrounding soft tissues. The transducer transmits acoustic waves into biological tissues, which propagate and reflect back depending on tissue density and structural architecture. This device utilizes high-frequency acoustic waves without ionizing radiation, making it one of the safest diagnostic and monitoring tools for repeated or longitudinal evaluation (Lanza, 2015). The researcher applied this modality following light therapeutic exercise at the conclusion of each rehabilitation session during the first week of the intervention.

During the second week, infrared radiation therapy was introduced to stimulate localized microcirculation and alleviate muscle hypertonicity. Infrared modalities transmit radiant thermal energy captured by optical/thermal detectors and convert it into therapeutic deep heat, thereby reducing muscular spasm and pain. Optical energy stimulates targeted cellular repair within the injured region without inducing procedural discomfort, unlike other painful interventions. Radiant heat stimulates the release of endothelial nitric oxide (NO), enhancing vasodilation and localized blood perfusion in the affected area by delivering thermal energy into deeper tissue layers (Shang-Ru, 2017). The researcher utilized infrared therapy to reduce inflammation, manage pain, increase local blood flow, alleviate nociceptive input, and accelerate collagen repair and tendon healing.

The subsequent two weeks incorporated tailored therapeutic exercises using varied rehabilitative tools to strengthen the muscular structures surrounding the injured area. Elastic resistance bands were utilized as versatile and effective tools for enhancing muscular strength and flexibility, providing progressive accommodating resistance that mimics free weights while reducing joint compressive stress. The researcher integrated electromyography (EMG) during these exercises to evaluate action potential transmission to the active musculature. Motor neurons controlling skeletal muscles transmit action potentials that trigger coordinated muscle contraction and relaxation cycles (ryn Farnsworth, 2021).

During the final four weeks, the program prioritized expanding joint range of motion and strengthening the periarticular musculature. Bodyweight exercises were initially employed, followed by progressive resistance training adhering to scientific principles of progressive overload, intensity adjustment, and structured recovery intervals. These exercises promote glycogen resynthesis, reduce glycogen-bound water content, enhance connective tissue tensile strength, accelerate ligamentous and tendinous healing, and improve muscular strength around the elbow joint, thereby preventing vascular adhesions and lowering mechanical pressure on sensory nerve endings responsible for nociceptive pain transmission. Consequently, these exercises improved movement mechanics regulated by the surrounding musculature (Farhan & Al-Moamen, 2025). Mechanoreceptors and sensory organs within muscles and tendons transmit afferent neural signals, including pain perception, relative to the mechanical stress exerted on the nervous system. The researcher diversified the exercise regimen across difficulty levels; multi-planar and multi-directional movement variations enhance movement fluidity, implement control, and neuromuscular coordination and balance (Al-Badrani, 2020). The researcher emphasized static (isometric) and dynamic (isotonic) muscular contractions during the final weeks utilizing medicine balls to

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enhance muscular strength in the forearm and brachial musculature. Furthermore, structured stretching exercises increased tendon excursion and range of motion, reflected through varied movement patterns across flexion, extension, and pronation/supination of the forearm relative to the humerus, representing functional motor richness under requisite dynamic force requirements.

4. Conclusions and Recommendations

4.1 Conclusions

- Electromyographic (EMG) indices demonstrated a substantial positive reflection on the rehabilitation process of medial elbow muscle tendons.
- Significant improvements were observed in elbow joint range of motion (ROM) resulting from the integrated use of therapeutic medical devices.
- The rehabilitative tools and progressive exercises yielded positive outcomes in enhancing muscular strength and joint range of motion.

4.2 Recommendations

- Continuous utilization of electromyography (EMG) throughout athletic rehabilitation protocols.
- Conducting similar studies across other muscle groups and athletic disciplines.

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