EFFECT OF A METHOD USING CERTAIN PHYSICAL THERAPY DEVICES TO REHABILITATE INFRASPINATUS MUSCLE FOR HANDBALL PLAYERS

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ABSTRACT

Background. Handball players are prone to injuries to the infraspinatus muscle which is caused by repetitive overhead activity and extreme mechanical stress on shoulder joints during play. Hence, the rehabilitation program should be designed in such a way so that shoulder function can be restored and player can resume training safely after infraspinatus injury. **Objectives.** This research intended to introduce an effective rehabilitation program by using therapeutic devices selected from physical therapy devices and therapeutic exercises for the rehabilitation of handball players with mild tear in infraspinatus muscle.. **Method**. A single-group experimental study was conducted. Sample size of the study was 10 athletes who were elite handball players in Basra Governorate in season 2023 and had mild tear in infraspinatus muscle. Ten selected physical therapy devices were used for the rehabilitation program along with therapeutic exercises which included movements that targeted enhancing shoulder strength, shoulder flexibility and shoulder range of motion. Study variables included explosive power, speed-strength, spinal flexion–extension and rotation, shoulder joint flexibility which were measured during pre-test and post-test. Data were statistically described using descriptive statistics. Significance was tested at $\alpha = 0.05$. **Results.** Results showed a statistically significant difference in explosive power, speed-strength, spinal flexion–extension and rotation, shoulder joint flexibility after performing the rehabilitation program ($P < 0.05$). Explosive power improved from 4.00 to 6.90, speed-strength from 7.60 to 13.60 repetitions, spinal flexion–extension and rotation from 10.60 to 19.60 repetitions and shoulder flexibility from 46.40° to 110.00°. **Conclusion.** Sportsmen who had mild tear in infraspinatus muscle experienced improvements in shoulder strength, shoulder flexibility and shoulder range of motion after performing the selected rehabilitation program. This research introduced new rehabilitation protocol which can be implemented in sports injuries and rehabilitation centers to help athletes recover from their injuries quickly and resume training safely.

Keywords; physical therapy devices, rehabilitation, infraspinatus muscle, handball.

A. INTRODUCTION

Goal of those working in sports field in general, and coach and player in particular, is to achieve sporting achievements. This places a heavy burden on shoulders of athlete, making player vulnerable to many obstacles and difficulties that player must face, whether physical or technical, in order to achieve these achievements. Among these obstacles is exposure to sports injuries that affect different parts of body, each according to nature of their game and sport (Imka et al., 2025; Suryadi et al., 2025).

The shoulder joint is one of most important and largest joints in human body. It is formed by union of three bones: scapula (shoulder blade) from back, clavicle (collarbone), and head of humerus. It is a ball-and-socket joint, and due to its complex anatomical structure and heavy load it bears, shoulder joint is considered one of most significant anatomical and structural components in human body (Dafun JR & Custodio, 2025; Pamungkas et al., 2025). It is remarkably versatile in its functions and movements. Due to its structure, it is an inherently unstable joint because socket in which head of humerus rests is not very deep. Therefore, muscles, tendons, and ligaments cover it. It is only joint that allows for a certain degree of rotation. iliac joint is large and therefore one of most susceptible to injury, whether during daily activities or especially during sports. This joint accounts for a significant percentage of sports injuries among athletes, making it essential to protect its health during various athletic activities (Haidar et al., 2025; Suniga et al., 2025).

Shoulder injuries often involve rotator cuff muscles, particularly infraspinatus muscle, as it is primary and most susceptible to injury among rotator cuff muscles, leading to its injury and tearing. To find appropriate method for rehabilitating partial tears of infraspinatus muscle, researcher resorted to modern treatment and rehabilitation techniques, including use of physical therapy equipment and devices. These techniques have a significant impact on both physical and psychological well-being of injured player, both before and after rehabilitation, in addition to use of exercises (Apriandi et al., 2023; Gunawan et al., 2023; Hardinata et al., 2024). importance of this research lies in its application of a rehabilitation approach combining physical therapy and exercise techniques to rehabilitate partial tears of infraspinatus muscle in injured handball players.

Sports injuries have become a major concern for most professionals in sports field, especially those working in treatment and rehabilitation. number of sports injuries is steadily increasing due to high intensity of training and competitions, as well as repetitive nature of difficult movements in certain sports activities that require high intensity and high frequency (Partyka & Waśkiewicz, 2021; W.I. et al., 2018). The researcher observed that most research studies focused on assessing effectiveness of rehabilitation programs in restoring injured joint, muscles, and ligaments. These studies aimed to return athlete or injured person to their pre-injury condition as quickly as possible. Through contact with handball coaches and players, it became clear that shoulder injuries, including simple rotator cuff tears, are among most common. This results in partial tears of tendons and muscles, causing inflammation of shoulder joint and negative effects during injury period. All of these factors contribute to worsening of injury, particularly affecting infraspinatus muscle, which is more susceptible to injury. effectiveness of rehabilitation exercises combined with physiotherapy equipment on these variables increases speed of recovery and restores

athlete to their pre-injury condition, enabling them to perform well in their chosen sport. Therefore, researcher decided to experiment with a rehabilitation program using some physiotherapy techniques and physical exercises to rehabilitate partial tears of infraspinatus muscle. Hence, research problem lies in developing a rehabilitation program using some physiotherapy techniques and physical exercises to rehabilitate partial tears of infraspinatus muscle in injured handball players .

Research Objectives represented by developing a rehabilitation program using some physical therapy methods and physical exercises to rehabilitate partial tears of infraspinatus muscle in injured handball players, identifying effect of rehabilitation program using some physical therapy methods and physical exercises to rehabilitate partial tears of infraspinatus muscle in injured handball players. Sports injuries: A sports injury is defined as a disruption or impairment due to external influences on functioning of various tissues and organs in athlete's body. These influences are often sudden and severe, which may often result in functional (physiological) changes such as bruising and swelling at site of injury, along with changes in skin color and anatomical changes that limit movement of muscle or joint (Cheung et al., 2003; Halperin et al., 2020; Herman et al., 2012)

Physical Therapy Methods: There are many methods of physical therapy used in rehabilitation of many medical conditions in general and sports injuries in particular, and application of these methods is carried out in many ways, including Sports massage, heat therapy, hydrotherapy, electrotherapy, physical therapy with physical exercises. (15:2). Anatomy of shoulder joint: The shoulder joint is a synovial joint of ball -and-socket type, so movements in it are free in all directions (Waugh et al., 2004; Xue et al., 2021; Zotti et al., 2013). That is, it is a joint by virtue of its structure that is unstable due to lack of depth of socket in which head of humerus rests in its natural position in scapula, and it is only joint that allows rotation of 360 degrees (Skutnik et al., 2019). As for ligaments surrounding this joint, they are not tight and are relatively weak, as stability of shoulder joint depends entirely on strength of surrounding muscles to allow it to move with a great degree of unrestricted movement (Dewantara et al., 2024).

Rotator major, rotator minor, supraspinatus-hypoplastic muscle: It originates in form of a feathery group from infraspinatus fossa, occupies it entirely, and muscle passes laterally behind shoulder joint to insert into greater tubercle of humerus. This muscle is supplied by suprascapular nerve.

B. METHOD

Participant

Research sample was selected purposively to include a number of handball players with infraspinatus muscle injuries. sample consisted of (10) players from Al-Minaa Sports Club and Naft Al-Janoub Sports Club (Al-Janoub Club), who had suffered mild to moderate infraspinatus muscle tears. Their ages ranged from (20-25) years, and their training experience ranged from (2-4) years. percentage of research sample was (100%) of original population.

Research Design

The researcher chose experimental method by following pre- and post-measurement method for both experimental and control groups. This was because it was suitable for nature of research, which is a deliberate and controlled change to limited conditions of an event and observing and interpreting resulting changes in event itself.

Research Test Questionnaire Form: The researcher nominated a number of tests related to physical variables, and then presented these tests to a number of experts and specialists in field of research to seek their opinions. The researcher relied on percentage law in accepting tests that had a percentage of agreement on more than (75%) and neglected tests that had a percentage of agreement on less than that , as shown in Table (5).

Table 1. Percentage Of Agreement Among Experts And Specialists In Nominating Suitable Tests

No.	Test types	Candidate tests	Percentage
1	Explosive force	Medicine ball throwing test (3) kg from a seated position in a wheelchair	100%
2	Power characterized by speed	From a front support position, bend and extend your arms for 15 seconds.	100%
3	Spine range and rotation	Bottom and side touch	100%
4	Shoulder joint flexibility	Stick test	100%

Physical Tests

Test of throwing a medicine ball weighing (3) kg with both hands over head: Objective: To measure explosive power of arms, 5 cm apart, or a measuring tape is fixed to starting line from zero to a few meters towards throwing area. Examiner stands behind starting line facing throwing area, holding medicine ball with both hands above their head, and then throws it by swinging their arms slightly backward. Conditions: The player must throw ball, not push it. Ball must be thrown towards throwing area. Each examiner has two attempts; better one counts. Attempt with furthest distance from starting line is recorded.

Test Front support for (15) seconds: Measuring speed-strength characteristic of arms. Performance Specifications: From a prone position, subject bends their arms until their chest touches or nearly touches ground within 15 seconds, repeating as many times as possible. Conditions: No stopping is permitted during test. Maintain a straight torso throughout performance. Ensure chest touches or nearly touches ground during performance. Each subject is allowed only one attempt. Test Management: A timer signals start and calculates time taken to complete test. A recorder calls out names of subjects and records results. Recording: Number of repetitions in 15 seconds.

Test Bottom and side touch: Objective: To measure flexion, extension, and rotation of spine. Performance specifications: Draw an (X) mark on two points: On floor between lab's feet. On wall behind back of lab (in middle). Upon hearing start signal, subject bends their torso forwards and downwards to touch ground with their fingertips at (X) mark between their feet. They then extend their torso upwards while rotating to left to touch (X) mark

behind their back with their fingertips. Next, they rotate and bend their torso downwards to touch (X) mark between their feet again. Finally, they extend their torso while rotating to right to touch (X) mark behind their back. This action is repeated as many times as possible within thirty (30) seconds, ensuring that marks behind back are touched once from left and once from right.

Test Gymnastics sticks (63:5): Objective: To measure flexibility of shoulder joint: Test specifications: reading will be either positive or negative. tools Gymnastics stick, cylindrical, 2 cm diameter, 120 cm long, measuring tape divided into centimeters. How to perform test : subject stands holding stick with both hands in middle , so that hands are close together. subject tries to raise both arms forwards and behind body as high as possible, taking care not to bend elbows. As stick passes behind body with arms extended, subject has to separate hands to perform movement correctly. Test procedure: Measure distance between hands with stick held firmly behind body. flexibility index is calculated as follows: Shoulder Flexibility Index = Distance between hands (cm) Shoulder width (cm) Shoulder Flexibility Index Shoulder width in centimeters.

Calendar: Distance is an indicator of flexibility.

Exploratory Experiment

In order to determine correct and scientific methods for applying tests and measurements used in research, researcher conducted exploratory experiment on Wednesday , June 4 , 2025 , at ten o'clock in morning in laboratory and halls of College of Physical Education and Sports Sciences to determine correct time to carry out range of motion tests, as well as muscle strength tests used, in addition to taking height and weight measurements and ensuring that support staff were proficient in their duties regarding application of tests and their instructions, and recording information of tests used for each player in research sample, as well as knowing necessary and accurate time for players to arrive at place of conducting tests in order for researcher to confirm ability of injured players to apply exercises used in proposed rehabilitation program.

The tests for normal range of motion of shoulder joint were carried out for research sample and for two groups (experimental and control) on Sunday, June 1, 2025 , at ten o'clock in morning, with help of assistant staff, in laboratory of College of Physical Education and Sports Sciences. On following day, corresponding to 2/6/2025, physical tests were conducted for research sample and for experimental and control groups at ten o'clock in morning with help of support staff in hall of College of Physical Education and Sports Sciences.

The researcher prepared a proposed rehabilitation program by reviewing scientific references and sources related to sciences of (sports medicine, sports training physiology, handball) , in addition to personal interviews with experts and specialists in field of research, who played an effective role in guiding researcher to enable to extract idea of proposed rehabilitation program for rehabilitation of partial tear of infraspinatus muscle in handball players. This was done by preparing a rehabilitation program that includes a number of physical exercises by following a method of gradually increasing exercises from easy to difficult. program begins first with use of physical exercises preceded by physical

therapy devices. first weeks included cooling device (cryotherapy) only for a period of two weeks , starting from 15/6/2025 until 27/6/2025, with three rehabilitation units per week Sunday, Tuesday, Thursday at ten o'clock in morning.

The rehabilitation unit included static and dynamic contraction exercises and some movement exercises. physical exercises were organized and sequential, progressing from easy to difficult. rehabilitation units were implemented in laboratories and halls of College of Physical Education and Sports Sciences. exercises used weight of injured part , then exercises using resistance bands and some weights, in addition to aerobic exercises, and finally some exercises specific to handball. This was done to give body sufficient time to prepare before returning to any physical activity that requires a certain level of intensity, while taking into account gradual progression of physical exercises from easy to difficult.

1. Week 1: A set of static contraction exercises were applied, as well as some simple movements to give joint ability to regain normal range of motion that was determined after injury, in addition to use of cryotherapy device.
2. Week 2: A set of static contraction exercises were applied, as well as some arm movement exercises to help restore normal range of motion of joint , along with some simple exercises using resistance bands and cryotherapy equipment.
3. Week three: A. Using some physical exercises B. Using body weight in addition to using resistance band exercises with ultrasound and electrical stimulation devices.
4. Week 4: Some aerobic exercises and resistance band exercises were used, along with some arm exercises. Light weights, two ultrasound devices, and an electrical stimulation device.
5. Week 5: Using some strength exercises Light weights , in addition to two ultrasound devices and an electrical stimulation device.
6. Week 6: All exercises this week were specialized in handball with electrical stimulation and ultrasound devices.

The tests for normal range of motion of shoulder joint of experimental research sample were carried out on day of 7/30/2025 AD at ten o'clock in morning with help of assisting staff in laboratory of College of Physical Education and Sports Sciences. On following day, corresponding to 7/31/2025, physical tests for experimental research sample were conducted at ten o'clock in morning with help of support staff in hall of College of Physical Education and Sports Sciences.

Statistical Methods

The researcher used Statistical Package for Social Sciences (SPSS Version 20).

A. RESULTS

The researcher presented results obtained in tables and discussed them, in order to determine their validity and conformity with research objectives and hypotheses.

Table 1. Mean, Standard Deviation, And Standard Error Of Differences, As Well As Statistical Significance And Importance Of Pre- And Post-Tests For Normal Range Of Motion Tests And Physical Variables Of Shoulder Joint For Experimental Group, Are Shown.

Variables	Measurement unit	Pre-test		Post-test		St. error	Sig. level	Sig. type
		M.	St.d	M.	St.d			
Explosive force	M.	4,000	0.696	6,900	0.857	0.228	0004,0	Sig.
Power characterized by speed	Rep.	7,600	2.302	13,600	1.140	0.547	0007,0	Sig.
Flexion, extension, and rotation of spine	Rep.	10,600	2.408	19,600	1.140	1.095	001,0	Sig.
Shoulder joint flexibility	Deg.	46,400	26.359	110,000	10,000	10.047	003,0	Sig.

Table (1) shows arithmetic mean, standard deviation, and standard error of differences, statistical significance, and significance in pre-test and post-test for experimental group for tests of normal range of motion and physical variables of shoulder joint. We find that arithmetic mean for variable (explosive power) in pre-test was (4.000) with a standard deviation of (0.696), while we find that arithmetic mean in post-test was (6.900) with a standard deviation of (0.857), while standard error of differences appeared with a value of (0.228). Since statistical significance is (0.0004), which is less than significance level of (0.05), this indicates that there are significant differences between pre-test and post-test in favor of post-test.

While we find that arithmetic mean of variable (speed-characterized strength) in pre-test was (7.600) with a standard deviation of (2.302), while we find that arithmetic mean in post-test for same variable was (13.600) with a standard deviation of (1.140), while standard error of differences appeared with a value of (0.547). Since statistical significance is (0.0007), which is less than significance level of (0.05), this indicates that there are significant differences between pre-test and post-test, in favor of post-test.

While we find that arithmetic mean for variable (flexion and extension of spine) in pre-test was (10.600) with a standard deviation of (2.408), while we find that arithmetic mean in post-test for same variable was (19.600) with a standard deviation of (1.140), while standard error of differences appeared with a value of (1.095). Since statistical significance is (0.001), which is less than significance level of (0.05), this indicates that there are significant differences between pre-test and post-test, in favor of post-test.

While we find that arithmetic mean for variable (shoulder joint flexibility) in pre-test was (46.400) with a standard deviation of (26.359), while we find that arithmetic mean in post-test for same variable was (110.000) with a standard deviation of (10.000), while standard error of differences appeared with a value of (10.047). Since statistical significance is (0.003), which is less than significance level of (0.05), this indicates that there are significant differences between pre-test and post-test, in favor of post-test.

Discussion

The researcher finds , through reviewing results of Table (1), that there are differences in arithmetic means between pre-test and post-test in tests of (explosive power, speed-strength, spinal flexion and rotation, shoulder joint flexibility) for experimental group, in favor of post-test compared to pre-test. researcher attributes these differences to proposed rehabilitation program, in which researcher took into account rest periods between exercises and sets, as "progress in level of physical fitness elements is achieved as a result of correct exchange between work and rest, since load placed on individual leads to a temporary decrease in functional capacity of body's internal organs, and during rest period body produces a greater amount of energy than it consumes during effort, meaning that energy present in body after recovery period is greater than energy that was present in body before start of effort (F. et al., 2013; Hamm, 2006; R. et al., 2012). Likewise , use of physical exercises in conjunction with physical therapy sessions led to effective application of exercises with maximum possible effort by injured player, which in turn led to development of muscle strength, since " physical exercises in all their forms and types work to affect muscles responsible for movement in body, and it is known that exercising muscles by using physical exercises leads to special adaptations that work to develop level of muscle performance in terms of strength and flexibility (Conneely & Yu, 2019; Wasser et al., 2021).

In addition to nature of exercises and gradual increase in level of rehabilitation exercises, it played a role in gradually increasing strength of muscles working on shoulder joint in line with capabilities of injured players, i.e. without player reaching point of feeling pain. rehabilitation program also focused on rehabilitating and strengthening muscles working on shoulder joint.

B. CONCLUSION AND RECOMMENDATIONS

Proposed rehabilitation program has an effect through restoring normal range of motion and flexibility of shoulder joint in research sample. Test results showed that there was an improvement in level of explosive power and speed-strength of shoulder joint muscles through effect of proposed rehabilitation program. Proposed rehabilitation program has a positive effect on muscle groups working on shoulder joint. The researcher recommends necessity of using proposed rehabilitation program to treat and rehabilitate infraspinatus muscle injury of shoulder joint in sports injury treatment and rehabilitation centers. Need to conduct studies similar to researcher's study, but on other muscles in shoulder joint. Necessity use of therapeutic and assistive methods for muscle injury rehabilitation in implementing rehabilitation program, in a manner appropriate to level of injury.

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D. AUTHOR CONTRIBUTION STATEMENT

The sole author is responsible for all content of the manuscript and completion.

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