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The effect of rehabilitation exercises using elastic ropes of different resistances in improving the range of motion and muscle strength of patients with frozen shoulder joint

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Abstract

The purpose of this paper is to preparing rehabilitation exercises using rubber ropes with different resistances for those suffering from frozen shoulder joint, identifying the effect of rehabilitation exercises in improving the range of motion and strength of the muscles working on the shoulder joint, and identifying the effect of rehabilitation exercises in reducing the severity of pain for those suffering from frozen shoulder joint. The experimental method was used with a single-group design with pre-test and post-test due to its suitability and the nature of the research problem. The sample was chosen intentionally and they are from the reviewers of the specialized center for physical therapy and physical rehabilitation located in Wasit and their number was (6) injured people aged (35-45) years. One of the most important results reached by the researcher is that: Rehabilitation exercises using rubber ropes of different resistances had a positive effect on frozen shoulder injury, and rehabilitation exercises using rubber ropes contributed to improving muscle flexibility and increasing their strength in patients with frozen shoulder joint. One of the most important recommendations recommended by the researchers is that: Based on the results of this study, it is recommended to include elastic rope exercises with different resistances as an essential part of rehabilitation programs for patients with frozen shoulder joint and conduct further studies to determine the most appropriate resistances and optimal programs to achieve maximum benefit from elastic rope exercises in improving muscle and joint function in patients with frozen shoulder.

Keywords: Frozen shoulder, rehabilitation exercises, rubber ropes

Introduction

When talking about freedom of movement, this word has many moral connotations that bring comfort and hope to the soul, but losing this freedom or part of it requires more patience, sacrifice and enduring severe pain. This condition is very similar to the freedom of movement enjoyed by some joints in the body, including the shoulder joint, as this joint has multiple axes of movement and in different directions, and a large range of movement, which makes it vulnerable to injury and the chance of injury is higher compared to other joints in the body.

Although the vast majority of these injuries and inflammations are simple and easy to treat with medication and rest, there is a category of patients in whom the condition develops into a disease known as (Frozen shoulder), which is an annoying condition that may lead to partial disability and affect the patient's life and daily activities.

Frozen shoulder is a disease that affects the shoulder, causing pain in this area, resulting in a lack of shoulder movements, which forces the patient to stop using his hands. This disease was named this because the patient, due to the severity of the pain, cannot use his arm normally and feels that his shoulder is frozen and cannot move his arm normally. It is a painful and annoying condition that may last for several months with the patient.

Frozen shoulder injury causes a disability in the range of motion of the joint, which occurs as a result of weakness in the muscles of the shoulder girdle, whether the muscles working on the joint or near it, and this is accompanied by a deficiency in blood circulation, which results in a decrease in the viscosity of the synovial fluid, especially at night.

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Symptoms of the injury appear in the form of a slight pain that moves to the upper arm above the joint, and this pain is accompanied by a deficit in the motor function of the arm. Frozen shoulder joint injury occurs as a result of suffering from severe pain and inflammation and it is not possible to obtain full movement, because the scapula becomes unable to rotate, causing the movement of the joint to be limited outward and upward. The inability of the scapula to rotate is due to the joint freezing, adhesion, and fixation of the humerus, which leads to difficulty in performing daily tasks and continuous pain that increases and intensifies when trying to move the joint. This is what prompted the researcher to conduct this study as a serious attempt to improve the range of motion and strength of the muscles working around the frozen shoulder joint by using rubber ropes with different resistances.

Research objective

- Preparing rehabilitation exercises using rubber ropes with different resistances for those suffering from frozen shoulder joint.
- Identifying the effect of rehabilitation exercises in improving the range of motion and strength of the muscles working on the shoulder joint.
- Identifying the effect of rehabilitation exercises in reducing the severity of pain for those suffering from frozen shoulder joint.

Research hypotheses: There are statistically significant differences between the pre and post-tests in improving the range of motion and strength of the muscles working on the shoulder joint and reducing the severity of pain for patients with frozen shoulder joint, in favor of the post-test.

Research fields

- **Human field:** A sample of visitors to the Specialized Center for Physiotherapy and Physical Rehabilitation.
- **Time field:** (20/11/2023) to (15/2/2024).
- **Spatial field:** Specialized Center for Physiotherapy and Physical Rehabilitation.

Research methodology and field procedures

Research Methodology

The experimental method was used with a single-group design with pre-test and post-test due to its suitability and the nature of the research problem.

Community and sample research

The sample was chosen intentionally and they are from the reviewers of the specialized center for physical therapy and physical rehabilitation located in Wasit and their number was (6) injured people aged (35-45) years.

Sample homogeneity

The sample was homogeneous among themselves in the variables of height, weight, age and duration of injury.

Table 1: Shows the homogeneity of the research sample in the variables of height, weight and age

No.	Variables	Measuring unit	Sample	Mean	Std. Deviations	Median	Skewness
1.	Length	Cm	6	175.17	2.229	175.00	0.991
2.	Weight	Kg		65.50	2.345	65.50	-0.349
3.	Age	Year		40.83	2.317	40.00	-0.568
4.	Duration of injury	days		12.33	2.338	12.00	0.245

From Table (1) it is clear that the values of the variables of the torsion coefficient are limited between (± 1) and this indicates that the sample individuals are homogeneous.

Tools, methods and devices used in the research

1. Arabic and foreign sources and references.
2. Individual form to collect information.
3. Italian-made rhytometer to measure weight and height.
4. Genometer to measure angles.
5. Electronic dynamometer to measure muscle strength.
6. Rubber bands of different resistance.

Shoulder joint range of motion tests (Reiman & Robert, 2009) [20]

- Raising the arm up.
- Pushing the arm back.

Muscle strength tests (Reiman & Robert, 2009) [20]

- Measuring muscle strength (Pulling from top to bottom)
- Measuring muscle strength (Pulling from bottom to top)
- Measuring muscle strength (Pulling from right to left)
- Measuring muscle strength (Pulling from left to right)

Pain level test (Richard & Carrie, 2010) [21]

The visual analog scale was used to measure the degree of pain, as this scale is widely used in many studies due to its ease of use, when a correct and quick report is required

about the pain felt by the patient. This scale is a paper divided into ten units (cm) so that zero indicates the absence of pain, while ten indicates the maximum intensity of pain that the person cannot tolerate. The patient is required to put a mark on the line from (0-10) cm, where he gives an index number for the severity of the pain or the decrease or end of the pain.

Exploratory experiment

It was conducted on a sample of (2) injured people within the original sample and its aim was as follows:

- Training on how to take measurements for range of motion and strength of shoulder joint muscles and test the degree of pain.
- Identifying the time taken to perform the tests.
- Identifying the ease and difficulty of the tests for the injured.
- Identifying the validity of the test tools used.
- Identifying the accuracy of the measurement tools used.
- Identifying the appropriate time for the rehabilitation unit and its impact on the injured.
- Identifying the correct method of performance by the assistant team.
- Identifying the suitability of the exercises prepared by the researcher for the injured.
- Identifying any difficulties that the researcher may face during the application.

It was applied on Wednesday, 22/11/2023 at 5 pm.

Pre-tests

They were conducted on Saturday 26/11/2023 on the main research sample at 5 pm and included tests of range of motion, muscle strength, and visual symmetry to measure the degree of pain.

Main experiment

The main research experiment was applied to the research sample during the period (28/11/2023 to 13/2/2024) for a period of (10) weeks divided into (3) stages, each stage includes (3) weeks with (3) rehabilitation units per week, except for the first stage, which included (4) weeks. The rehabilitation units were applied at the Specialized Center for Physiotherapy and Physical Rehabilitation in Wasit Governorate. The researcher set some points when implementing the rehabilitation units, including that the exercises in the first (4) units be applied to the research sample with static negative exercises, then positive moving exercises, and include a progression from simple exercises to complex exercises, taking into account that these exercises are performed until the beginning of feeling pain, taking into account the psychological state of the injured person and working to gain the patient's confidence in returning to the condition he was in before the injury compared to the healthy limb. The rehabilitation units were divided into three stages as follows:

First: The first stage: Aims to activate blood circulation and flexibility of the shoulder joint, increase its range of motion, and activate the nerves and muscles surrounding the shoulder joint. The duration of this stage is (4) weeks. This stage contains a set of exercises with a fixed rhythm to reduce pain and improve the muscle groups of the muscles working on the shoulder joint, in a comprehensive and balanced manner and to try to reduce swelling. It also contains some exercises for the positive range of motion of the affected muscles at the end of the stage. The number of repetitions ranges from (10-20) repetitions, and the rest period between each group ranges from (30 seconds - 1 minute). The duration of the rehabilitation unit in this stage is (25-30 minutes).

Second: The second stage: aims to stimulate blood circulation and strengthen the muscles working on the

shoulder joint and its duration is (3) weeks, and the focus is on increasing the strength and size of the muscles and the range of motion of the injured shoulder joint through the exercises used by the researcher (as shown in Appendix 1), as it included strength and resistance exercises with rubber ropes, in which she took into account the use of gradual resistance from easy to difficult and from simple to complex, as these ropes included three levels of difficulty (yellow color equals 1 kg, blue color equals 2 kg, and red color equals 3 kg). More than one color can be used in the same exercise, noting that the rubber rope reaches the maximum elasticity allowed at the end of the range of motion for the exercise. Resistance exercises using rubber ropes aim to strengthen the muscles that have weakened as a result of the injury, and these exercises must be performed slowly at first and with complete control of the muscles until the movement reaches its full range. The number of repetitions in this stage ranges from (8-12) repetitions, and the rest periods range from (15 seconds) between each exercise and the rehabilitation unit time in this stage is (40-45 minutes).

Third: The third stage: aims to restore the full range of motion of the shoulder joint in addition to restoring the muscle strength of the muscles surrounding the joint and ensuring that the individual reaches his normal state before the injury occurred and its duration is (3) weeks, and the number of repetitions is (10), and the rest periods range from (120 seconds) with a note during the rest that he performs stretching exercises for the muscles working on the shoulder joint.

Post-tests

The post-tests were conducted on Sunday, February 15, 2024 at 5 pm. The researcher took care to conduct these tests under the same conditions in which the pre-tests were conducted in terms of place, time, tools used in measurement, and the assistant work team.

Statistical methods

The search data was processed through the Statistical Package for the Social Sciences (SPSS).

Results and Discussion

First: Presentation and discussion of the results of shoulder joint flexibility tests for the research sample

Table 2: Shows the results of the pre- and post-test for the variables under study (The range of motion of the shoulder joint)

Variables	Pre-test		Post-test		Arithmetic mean of difference	Standard error of the mean difference	T value calculated	Degree of freedom	Level Sig	Type Sig
	Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation						
Raise arm up	107.83	5.456	160	6.356	29.167	9.538	-7.491	5	0.001	Sig
Push arm back	38.83	5.307	61.33	4.633	-15.5	7.893	-4.810	5	0.005	Sig

Statistically significant at a significance level of $\geq (0.05)$, at a degree of freedom ($n - 1$).

The results in Table (2) showed significant differences between the pre- and post-tests in the shoulder joint range of motion variable tests in favor of the post-tests, and that the improvement rate in this variable was high. The researcher attributes the reason for this improvement to the effectiveness of the exercises applied to the sample members using rubber ropes with different resistances, as these exercises were elastic for the muscles and had a

positive effect on the joint's range of motion. The exercises used gave effective results in improving the research variables in general and the range of motion in particular, as the injury to the shoulder joint directly affects the movement, which leads to weakening the muscles surrounding the joint, and leads to limiting the range of motion.

(Phil Page. 2011) ^[18] add that rubber ropes are used in stretching programs, performing stretching through the pre-stretching contraction technique makes the stretching more

effective, when the muscle contracts against the resistance of the rope followed by a slow stretch, this leads to increased muscle stretch and full range.

(Jay Hoffman, 2014) ^[16] believes that rubber ropes work to strengthen the muscles, but there are properties of rubber ropes such as (Rebound) and this produces the additional benefit of training the muscles working on the muscles that assist in movement in addition to the opposing muscles, as it not only leads to improvements in muscle strength in general but also leads to improvements in joint stability.

The researcher believes that the correct gradation of the exercises set, regular repetitions and rest periods led to significant differences between the pre- and post-tests. Sources indicate that rehabilitation exercises provide four basic benefits, which are (Improving and stimulating blood circulation, strengthening ligaments, tendons and working muscles, improving muscle tone, and increasing flexibility), in addition to using resistance exercises using rubber ropes that improve the previously mentioned benefits better.

In addition, paying attention to rehabilitation exercises and using them in a scientific way preserves the human body and restores the normal function of the injured or sick tissue, which is what was indicated by (Khalil *et al.*, 1997) ^[5].

This was also confirmed by (Mervat Al-Sayed Youssef, 1998) ^[11] that "range-of-motion exercises such as flexion, extension, adduction, abduction and rotation are standard

exercises for the process of restoring the natural shoulder position, and that each exercise works on a specific muscle or group of muscles that helps stabilize the shoulder joint and thus obtain a wide range of motion." This is confirmed by (Mohammed Hassan Alawi, 1992) ^[8] that therapeutic exercises lead to improving the flexibility of the shoulder and arms by preparing the muscles to press on the joints located near them to improve flexibility, as short muscles, inflexibility and fibrosis are among the most important factors affecting joint flexibility. Accordingly, therapeutic exercises must be used to get rid of fibrosis in the joint and increase muscle elasticity, thus emphasizing the group of exercises related to flexibility and strength exercises in order to achieve balanced development of the joint. The researcher believes that the effectiveness of rehabilitation exercises contributed to overcoming the movement limitations and what they gain for the joints, ligaments and muscles in terms of flexibility, as the researcher considers the ranges of movement (flexion, extension, adduction, abduction) to be among the very important variables that must be focused on, as the movement of the joint in different directions is what represents the entire joint.

Second: Presentation and discussion of the results of the shoulder joint muscle strength tests for the research sample

Table 3: Shows the results of the pre- and post-test for the variables under study (Muscle strength)

Variables	Pre-test		Post-test		Arithmetic mean of difference	Standard error of the mean difference	T value calculated	Degree of freedom	Level Sig	Type Sig
	Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation						
Muscle strength measurement (Pull from top to bottom)	5.667	0.5164	10	1.0488	-4.33	1.2910	-8.222	5	0.000	Sig
Muscle strength measurement (Pull from bottom to top)	4.667	0.6055	9	1.0488	-5.33	1.2111	-10.787	5	0.000	Sig
Muscle strength measurement (Pull from right to left)	3.250	0.5244	5.5	0.7071	-2.75	0.5244	-12.845	5	0.000	Sig
Muscle strength measurement (Pull from left to right)	3.750	0.5244	5.083	0.5845	-2.33	1.0328	-5.534	5	0.003	Sig

Statistically significant at a significance level of $\geq (0.05)$, at a degree of freedom ($n - 1$).

The results in Table (3) showed significant differences between the pre- and post-tests in muscle strength tests in favor of the post-tests. The researcher attributes the reason for the improvement to the rehabilitation exercises using rubber ropes with different resistances, which contributed to improving the strength of the muscles working on the shoulder joint among the research sample members, in addition to the sample members' commitment to applying all the unit components and their commitment to attending the rehabilitation units.

(Allan- Kuifi, 2006) ^[13] confirm that the rehabilitation program leads to an increase in the size and strength of the muscles surrounding the injured joint. Rehabilitation also works to prevent recurrence of injuries in the future and helps to return the normal functions of the muscles working on the injured shoulder joint, represented by increasing muscle strength.

The researcher emphasizes the importance of muscle strength and its impact on movement, so it must be maintained and worked on to return it to what it was before the injury. This is done by practicing regular muscle strength, which greatly improves muscle strength, muscle tone, and ligament strength, thus increasing the strength of

both (Tendons and joints). The researcher attributes this result in improving the muscle strength of the shoulder joint to the rehabilitation exercises that led to maintaining muscle strength as much as possible and preventing muscle atrophy and paying attention to the muscle strength of the muscles working on the injured shoulder joint, which leads to rapid movement of the injured limb. Rubber ropes are effective tools for performing strength training, and like any strength training, these ropes work to strengthen muscles and bones by providing them with resistance, but there are properties of rubber ropes such as (Rebound), which produces an additional benefit for training the muscles working on the muscles that help in movement in addition to the opposing muscles. It not only leads to improvements in muscle strength in general, but also leads to improvements in joint stability (Lee E Brown, 2007) ^[17].

This study agrees with (Mustafa Abdel Aziz, 2005 and Bashar Binwan Hassan, and Amin Atta Hassan, 2022) ^[9, 4] which proved the role of rehabilitation and therapeutic exercises and their impact on increasing muscle strength by strengthening the muscles and ligaments surrounding the joints and bringing the injured to the highest physical and functional level.

The researcher followed the rule of gradual increase in the difficulty of the exercises using rubber ropes of different

resistance, which led to a state of adaptation to work gradually to ensure the safety of the rehabilitation process according to gradual stages from simple to complex. This is what (Ashraf Al-Dessouki and Magdy Mahmoud, 1999) [3] indicated to the importance of taking into account the gradualness of the exercises set from easy to difficult,

especially exercises that aim to improve the range of motion and muscle strength.

Third: Presentation and discussion of the results of the pain level test for the research sample

Table 4: Shows the results of the pre- and post-test for the variables under study (Pain level test)

Variables	Pre-test		Post-test		Arithmetic mean of difference	Standard error of the mean difference	T value calculated	degree of freedom	Level Sig	Type Sig
	Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation						
Pain level test	4.67	0.816	0.92	0.492	3.750	1.173	7.833	5	0.001	Sig

(*) Statistically significant at a significance level of $\geq (0.05)$, at a degree of freedom $(n - 1)$.

The results in Table (4) showed significant differences between the pre-test and post-test in the pain level test in favor of the post-test. The researcher attributes the reason for the improvement to the rehabilitation exercises using rubber ropes of different resistance, which contributed to improving the pain level among the research sample members. The rehabilitation program contributed to rehabilitating the shoulder joint after injury and returning it to its normal state by reducing the severity of pain, restoring range of motion, and restoring muscle strength.

This is consistent with what was indicated by (Ahmed Abdel Aziz, 2004) [1], (Wael Sahwan, 2000) [12] that the rehabilitation program helps to eliminate pain and also has a major role in restoring the injured organ to its normal state.

The study of (Qadri Bakri, 2009) [7] also confirms that balanced and integrated physical therapy has a positive effect on strengthening muscles, stimulating blood circulation, improving muscle tone, reducing the level of pain, returning the injured part to its normal position, and improving the psychological state.

This is consistent with what (Osama Riad, 2002) [2] indicated that practicing rehabilitation exercises leads to reducing and improving the level of pain sensation.

This is consistent with the results of the study of (Abdel Halim Kamel, 2005) [6], which confirms that rehabilitation exercises contribute to alleviating pain resulting from various sports injuries.

This is also consistent with what was indicated by the study of (Mona Fahal, 2002) [10] that rehabilitation exercises are one of the best and safest types of physical therapy for alleviating pain and increasing the range of motion.

It is noted from the results of this study that the decrease in the level of pain had a major role in improving the level of functional capabilities of the shoulder joint, which was reflected in improving the functional efficiency of the joint in terms of flexibility and strength. All of the above variables are related to each other, and the impact of the rehabilitation program falls on all of these variables according to scientific standards in rehabilitation and is carried out under the supervision of specialized cadres and is applied in specialized centers that had a positive impact in achieving balanced development in all of these variables, which led to the disappearance of pain after undergoing the rehabilitation program.

Conclusion and Recommendations

Conclusion

- Rehabilitation exercises using rubber ropes of different resistances had a positive effect on frozen shoulder injury.

- Rehabilitation exercises using rubber ropes contributed to improving muscle flexibility and increasing their strength in patients with frozen shoulder joint.
- The results show that using different resistances of rubber ropes can lead to varying benefits, as high resistances increase strength and endurance, while low resistances contribute to improving tissue flexibility.
- Rehabilitation exercises using rubber ropes of different resistances improved the flexibility of the shoulder joint and increased its range of motion.
- Rehabilitation exercises using elastic ropes of different resistances improved the muscle strength of the shoulder joint.
- Rehabilitation exercises using elastic ropes of different resistances reduced the degree of pain in the shoulder joint.

Recommendations

- Based on the results of this study, it is recommended to include elastic rope exercises with different resistances as an essential part of rehabilitation programs for patients with frozen shoulder joint.
- Conduct further studies to determine the most appropriate resistances and optimal programs to achieve maximum benefit from elastic rope exercises in improving muscle and joint function in patients with frozen shoulder.
- Use rehabilitation exercises designed to treat frozen shoulder injury and generalize them to rehabilitation and physiotherapy centers.
- Pay attention to the psychological aspect when performing these exercises in order to achieve acceptance of the patients for treatment and interaction and adaptation to it during the treatment stages, which ensures the success of the rehabilitation process.
- Prepare similar programs that rely on therapeutic methods such as hydrotherapy in water pools.

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Appendix (1)

Rehabilitation exercises

- Shoulder abduction exercise to the side: Raise the arm to the side and extend it fully beside the body, and the palm of your hand points down while holding the elastic band from one end with the hand to the side and

the other end holding the leg, and the torso is straight. Start raising the arm until you feel muscle tension.

- Shoulder abduction exercise to the front: Raise the arm to the front and extend it fully in front of the body, and the palm of your hand points down while holding the elastic band from one end with the hand in front and the other end holding the leg, and the torso is straight. Start raising the arm forward until you feel muscle tension.
- Shoulder push back exercise: Push the arm back and extend it fully behind the body, and the palm of your hand points up while holding the elastic band from one end with the hand behind and the other end holding the leg, and the torso is straight. Start pushing the arm backward until you feel muscle tension.
- Hold an elastic rope behind the back and then pull it up to the highest point possible.
- Hold the elastic rope with both hands in front and pull them to the side.
- From a standing position, place an elastic rope between the hands, move the injured hand to the side with the shoulder rotating outward while the other is fixed.
- From a standing position, place the elastic rope on the edge of the door and work on moving the injured hand so that the shoulder rotates inward.
- Place the hands behind the back from standing and hold the elastic rope and move it to the sides with the hands extended.
- Facing the wall and holding the elastic rope from both ends and pulling them outward by separating the hands.
- Hold the elastic band and the injured arm behind the back, then pull the arm up to the highest point that can be reached.
- Hold the elastic band in front and lift it high and work on pulling it, i.e. creating resistance for both arms and holding the position, then return to the normal position.
- Hold one end of the elastic rope in front of the body with one hand and work on pulling the other end of the band backwards with the other hand.
- Repeat the same previous exercise but by exchanging arms once to the right and once to the left.

Appendix (2)

Explains the range of motion and muscle strength tests used in the research

