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PNF, Rotator Cuff, Rotator Cuff Tear

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The Effect of Proprioceptive Neuromuscular Facilitation (PNF) Stretching Exercises on the Rehabilitation of Partial Rotator Cuff Tendon Tears in Some Swimmers

Abstract

The purpose of the present study was to determine what PNF (Proprioceptive Neutral Facilitation) stretching exercises contribute to recovery from partial tears of the rotator cuff tendons among swimmers. In order to realise the aims set for it, the study adopted an experimental design of the single-group type with a pre-measurement and a post-measurement. Ten (10) swimmers presenting with partial tears of the rotator cuff tendons formed the sample.

A rehabilitative programme built upon PNF stretching exercises was prepared by the researchers. It extended over (8) weeks at a rate of (3) rehabilitative units weekly, each unit occupying between (25–30) minutes and organised so that the principle of gradually rising load in rehabilitation matched the functional condition of the injured swimmers. A group of measurements was relied upon: mobility of the shoulder in flexion, extension, abduction, horizontal abduction, horizontal adduction, internal rotation and external rotation, together with the strength of the musculature governing the shoulder and the level of pain, taken both before and after the rehabilitative programme.

Statistically significant progress was registered across every variable of the study when the two measurements were set against each other. Mobility of the shoulder widened in every direction, the musculature surrounding the joint grew stronger, and the level of pain fell. Every difference lay on the side of the post-measurement, which points to the efficiency of the rehabilitative programme built upon PNF exercises in restoring partial rotator cuff tears among swimmers.

The study recommends that these exercises be adopted within the rehabilitative programmes prepared for injured swimmers, and that further investigations be undertaken to set them against other rehabilitative approaches across varied age categories and sample sizes.

INTRODUCTION

Swimming belongs to the activities that depend in the first place upon proprioceptive neuromuscular facilitation together with repeated work of the body's joints, the shoulder above all. Injuries of the shoulder are widespread throughout every sport that loads the upper limbs. Because this joint moves about several axes, in more than one direction and across wide ranges, it is at the same time more exposed to injury than the remaining joints; its treatment extends over a long period and is attended by considerable pain for the injured person. The shoulder carries a decisive share in producing propulsive force and in obtaining smoothness of performance while swimming. The overhead movements repeated without interruption during swimming place the joint under heavy mechanical loading from which a variety of injuries may arise, foremost among them injuries of the rotator cuff tendons and particularly partial tears, which markedly weaken the functional efficiency of the joint. The outcome is pain, a narrower range of movement and reduced muscular strength, all of which act negatively upon the physical and technical level of the swimmer.

Contemporary sports rehabilitation draws upon a variety of therapeutic approaches whose purpose is to return the joint to its normal function, to raise the level of motor performance and to shorten the period of return to training and competition. Among these approaches stand the stretching exercises of proprioceptive neuromuscular facilitation (PNF), counted with the therapeutic techniques most frequently applied in the rehabilitation of athletes, since they raise flexibility, widen the mobility of the joint and arouse the sensory and nervous receptors. The technique proceeds by carrying the limb as far as its range of movement permits and fixing it there, after which a continuous contraction is produced in the stretched muscles, followed by relaxation and by further stretching towards an additional limit of movement. A number of earlier investigations have treated subjects of this kind, among them (Yildirim et al., 2007; (Hashem, et al., 2022) Their study, entitled "Comparing the Effect of PNF Proprioceptive Neuromuscular Facilitation Stretching Technique and Weight Training for Patients with Neuromuscular Disorders," was applied to 48 persons distributed over two groups: the first was given PNF therapeutic exercises and the second weight-training exercises. The therapeutic regime ran for 8 weeks and ended with a rise in the levels of strength within both groups, the difference between the two experimental groups carrying no statistical significance. (Al-Fartousi, 2013) carried out a study entitled "Using Proprioceptive Neuromuscular Facilitation (PNF) Exercises to Rehabilitate Some Shoulder Muscle Injuries in Handball Players" upon 12 players drawn from first-class handball clubs in Baghdad. Rehabilitation of the experimental group extended over six weeks at three units weekly, and the findings established that PNF exercises widen the mobility of the shoulder, raise the strength and the mass of the muscles governing it, and lessen pain in the affected region.

A study entitled "The Effect of Peripheral Neuromuscular Facilitation (PNF) Stretching Exercises on Ankle Injury Rehabilitation in Athletes" was conducted by (Al-Khafaji & Al-Masoodi, 2023) upon eight injured athletes at the National Center for Sports Talent Development, distributed as two basketball players, two volleyball players, two handball players and two swimmers. The PNF rehabilitative exercises were applied across six weeks at three units weekly, and the findings established the efficiency of these exercises in restoring ankle injuries among athletes, those of basketball, volleyball, handball and swimming in particular: the strength of the muscles governing the ankle rose, the mobility of the joint widened appreciably, ankle pain diminished and healing was hastened.

From this the significance of the present study arises, namely the preparation of rehabilitative exercises capable of widening the mobility of the shoulder, of strengthening the musculature that governs it and of lowering the level of pain among swimmers carrying partial tears of the rotator cuff, by means of PNF (Physio-Neutral Facilitation) stretching exercises, in service of our injured athletes and in assistance of coaches and of those engaged in the field of training and rehabilitation.

Through their work as teachers of sports physiology, of swimming and of the rehabilitation of sports injuries, and through their reading of the scientific literature and of the rehabilitative programmes applied in treatment centres and sporting clubs, the researchers noticed that the greater part of these programmes concentrates upon restoring movement and muscular strength by means of modern apparatus, whereas PNF stretching exercises are not drawn upon to a sufficient degree in spite of the favourable findings recorded by earlier studies regarding the improvement of joint function. The problem therefore rests in supplying an answer to the following question:

Do Proprioceptive Neuromuscular Facilitation (PNF) stretching exercises exert a positive effect upon the rehabilitation of partial rotator cuff tendon tears among some swimmers?

Definitions:

- Proprioceptive Neuromuscular Facilitation (PNF): a technique employed in physical therapy and in flexibility training which proceeds through the contraction and the relaxation of the muscles so as to stimulate the nerves and to retrain the body upon movement.
- Rotator Cuff: four muscles together with their tendons, encircling the shoulder joint (supraspinatus, infraspinatus, teres minor and subscapularis). What they chiefly do is to hold the head of the humerus firmly inside the socket of the shoulder and to allow movement to proceed smoothly.
- Rotator Cuff Tear: a rupture occurring in one or more of the tendons belonging to the four muscles that form the rotator cuff of the shoulder. Under injuries of the rotator cuff falls every form of irritation or of excessive use affecting these muscles or their tendons (Rotator Cuff Injury Definition - Diseases and Conditions, 2025); such injuries rank among the conditions most frequently met with in the shoulder joint (William et al., 2004).

Method and Procedures:

Research Methodology:

The experimental method, in its design of pre-measurement and post-measurement, was employed by the researchers, being the design that answered to the nature of the problem under study.

Research Sample:

Swimmers carrying shoulder injuries, specifically partial tears of the rotator cuff (supraspinatus tendon), were chosen by the deliberate method, ten (10) in number, from among those attending the Specialized Center for Physical Therapy and Rehabilitation of Injured Swimmers, College of Physical Education and Sports Sciences, University of Baghdad. Diagnosis of the injury, of its degree and of the medical history was undertaken by the specialist physician of the centre, and magnetic resonance imaging (MRI) served to confirm it.

The homogeneity of the study sample in the variables under investigation is presented in Table (1).

Variables		Unit	Mean	Median	Standard Deviation (SD)	Skewness
Height		cm	181.300	180.000	8.631	0.477
Weight		kg	75.500	76.300	6.283	0.433
Age		Years	22.833	21.500	2.772	0.028
Shoulder Range of Motion (ROM)	Shoulder Flexion	Degree	132.000	131.050	15.216	0.299
	Shoulder Extension	Degree	41.800	40.775	5.910	0.455
	Shoulder Abduction	Degree	130.751	129.009	10.256	0.388
	Shoulder Horizontal Abduction	Degree	65.500	64.871	11.667	0.185
	Shoulder Horizontal Adduction	Degree	35.881	34.500	4.610	0.654
	Shoulder Internal Rotation	Degree	44.517	43.955	3.996	0.200
	Shoulder External Rotation	Degree	55.427	54.388	5.177	0.295

Means, Instruments and Devices Employed in the Study:

The following were relied upon: a goniometer for the measurement of the range of movement, a scale for body weight, a measuring tape, a stopwatch, elastic bands, a set of graded weights, forms for recording and transcribing data, the internet, and Arabic and foreign sources.

Measurements Adopted in the Study:

First: Measurement of the Shoulder's Range of Movement (Klaus, 2004)

Movement of the shoulder was measured across seven different directions: shoulder flexion, shoulder extension, shoulder abduction, shoulder adduction, shoulder medial rotation and shoulder lateral rotation.

Second: Measurement of Shoulder Joint Muscle Strength (Lucille & Cathrein, 1986)

Muscular strength was assessed through the resistance offered by the patient to the person conducting the test. This is a standard medical test for evaluating the strength of the muscles, and the assessment rests upon five points, the first standing for the least strength and the fifth for the greatest.

Third: Assessment of the Level of Pain (Al-Fartousi, 2013)

Pain was assessed by means of a defined scale composed of four levels. The first level stands for the absence of pain and carries the score (0). The second level stands for pain attended by resistance during movement and carries the score (1). The third level stands for pain attended by resistance during movement and carries the score (2). The fourth level stands for pain unattended by resistance during movement and carries the score (3).

Pilot Study:

On Sunday, 15 February 2026, an exploratory experiment was carried out upon three patients suffering partial tears of the rotator cuff tendons, drawn from the same sample. It began at nine o'clock in the morning within the Specialized Center for Physical Therapy and Rehabilitation, College of Physical Education and Sports Sciences, University of Baghdad. With the help of the assisting team, the researchers used this experiment to acquaint themselves with the apparatus and the tools intended for the main study and to verify their readiness for work. A second exploratory experiment followed at the same place in order to establish how far the participants were able to perform stretching exercises by peripheral neuromuscular facilitation (PNF) for the rehabilitation of partial rotator cuff tendon tears; its aim was to determine how far the exercises suited the group, the time each exercise demanded, and what obstacles or difficulties might confront the researchers while the rehabilitative approach was being applied.

Pre-testing:

On Tuesday, 17 February 2026, at nine o'clock in the morning, the pre-measurements were taken from the study sample within the Specialized Center for Physical Therapy and Rehabilitation of Injured Individuals, College of Physical Education and Sports Sciences, University of Baghdad. They covered the mobility of the shoulder, the strength of the musculature governing it, and the level of pain in that region.

Main Experiment:

A rehabilitative programme of 8 weeks was designed by the researchers, comprising 3 rehabilitative units weekly, 24 units in all, each unit occupying between 25 and 30 minutes.

Table (2) show the structure of the rehabilitation unit for PNF exercises.

Section	Duration	Content
Warm-up	5 minutes	Warm compresses (heat packs) or light arm ergometer, pendulum exercises, and simple shoulder mobility exercises.
Main Phase	18–20 minutes	Proprioceptive Neuromuscular Facilitation (PNF) stretching exercises, therapeutic exercises, and progressive muscle strengthening.
Cool-down	3–5 minutes	Light stretching, breathing exercises, and cold packs (ice packs) as needed.

Table (3) shows the progression of the load during the rehabilitation program using the (PNF) technique.

Phase	Intensity	Repetitions	Contraction Duration	Rest Interval	Resistance
1–2	40–50%	3	6 seconds	20 seconds	No resistance
3–4	50–60%	4	6–8 seconds	20 seconds	Light resistance band
5–6	60–70%	5	8 seconds	25 seconds	Medium resistance band + light weight
7–8	70–80%	5–6	8–10 seconds	30 seconds	Moderate resistance + swimming-specific simulation

The pre- and post-tests (PNF) were administered on Thursday, February 19, 2026, and completed on Thursday, April 16, 2026.

Post-test:
On Sunday, 19 April 2026, the post-measurements were taken from the study sample, the researchers holding to the same conditions of time and place that had governed the pre-measurements.

Statistical methods:
The researchers used the Statistical Package for the Social Sciences (SPSS).

Results:
The arithmetic means and the standard deviations of the two measurements for the range of movement of the joint are presented in Table (4).

Central Range of Motion Variables	Unit of Measurement	Pre-test		Post-test	
		Mean	SD	Mean	SD
Shoulder Flexion	Degree	132.000	15.216	166.153	5.338
Shoulder Extension	Degree	40.800	5.910	56.912	3.426
Shoulder Abduction	Degree	130.751	10.256	160.535	6.971
Horizontal Shoulder Abduction	Degree	65.500	11.667	88.756	5.334
Horizontal Shoulder Adduction	Degree	35.881	4.610	44.660	2.933
Shoulder Internal Rotation	Degree	44.517	3.996	56.333	3.544
Shoulder External Rotation	Degree	55.417	5.177	75.583	2.628

The differences in arithmetic means, the standard deviations, the calculated (T) value, the level of error, the significance of the differences and the percentage of improvement between the two measurements in the variables of shoulder mobility are presented in Table (5).

Central Range of Motion Variables	Unit of Measurement	Mean Difference	SD of Differences	Calculated t-value	Sig. (p-value)	Statistical Significance
Shoulder Flexion	Degree	34.153	13.224	16.500	0.000	Significant
Shoulder Extension	Degree	15.112	4.611	10.523	0.000	Significant
Shoulder Abduction	Degree	29.784	10.159	5.833	0.000	Significant
Horizontal Shoulder Abduction	Degree	23.256	8.753	10.738	0.000	Significant
Horizontal Shoulder Adduction	Degree	8.774	2.581	4.215	0.000	Significant
Shoulder Internal Rotation	Degree	11.816	3.263	8.335	0.000	Significant
Shoulder External Rotation	Degree	20.156	6.502	9.771	0.000	Significant

Significant at an error level of 0.05 when the value of the error level falls below 0.5, the degree of freedom being 10-1=9. The arithmetic means and the standard deviations of the two measurements for muscular strength and for the level of pain are presented in Table (6).

Measurements	Unit of Measurement	Pre-test		Post-test	
		Mean	SD	Mean	SD
Actual Strength	Degree	2.561	0.480	4.810	0.451
Pain Score	Degree	3.000	1.228	1.017	0.334

The mean of ranks, the sum of ranks, the Z value of the Wilcoxon test, the level of error and the significance of the differences between the two measurements in muscular strength and in the level of pain are presented in Table (7).

Measurements	Unit of Measurement	Rank	N	Mean Rank	Sum of Ranks	Calculated Z-value	Sig. (p-value)	Statistical Significance
Muscle Strength	Score	Negative Ranks	0	0.000	0.000	3.558	0.001	Significant
		Positive Ranks	10	5.50	67.000			
		Ties	0					
Pain Score	Score	Negative Ranks	2	2.500	8.500	2.000	0.045	Significant
		Positive Ranks	7	5.930	44.500			
		Ties	1					

Significant at an error level of 0.05 when the value of the error level falls below 0.05, on the basis of the negative values:

- Negative = Post-test less than pre-test
- Positive = Post-test greater than pre-test
- Equal = Post-test equal to pre-test
- The Wilcoxon signed-rank test is calculated based on negative values.

Discussion:

Tables (4) and (5) present the measurements of shoulder mobility, where differences of statistical significance appear between the two measurements on the side of the post-measurement in the variables of flexion, extension, abduction, horizontal abduction, internal rotation and external rotation of the shoulder. The researchers ascribe this progress to the efficiency of (PNF) stretching exercises in restoring partial rotator cuff tendon tears among some swimmers, as is evident from the marked widening obtained in the movement of the joints working within the shoulder region. Such widening proceeds from the greater flexibility acquired by the muscles of that region, which renders the movement of the joint easier. Among what stretching exercises yield is a wider range of movement, since the parts of the body are placed in defined positions and the muscles are thereby lengthened in a natural manner; muscular tension then falls and the natural range of movement grows considerably. This growth of the range is translated into a longer distance traversed, so that the joint moves with ease and possible injuries of muscle or tendon are avoided (Walker, 2007). The functional effects of flexibility exercises issue in a wider range of movement within the joint owing to changes in the flexion and in the capacity for adaptation of the tendons, the muscle fibres and the connective tissues (Mousa, 2023). This confirms that therapeutic exercises by PNF (Physical Flexibility) raise muscular flexibility and, in consequence, the range of movement of the joint (Sabbar et al., 2023). The use of PNF has furthermore weakened the stretch reflex which opposes alteration in the length of the muscle, through adaptation occurring in the sensory receptors, in the muscle spindles and in the Golgi bodies. Stretching by PNF is conceived as carrying the limb across the whole range of movement available to it, fixing it there for a period, and then contracting the muscles to the limit of their range (Mondher, 2023), whereby a nervous adaptation is induced. Within the sensory receptors in particular, the stretch receptors of the muscle spindles adapt so that greater elongation meets with less resistance. The tension generated by a constant muscular contraction held for a period arouses the Golgi bodies of the tendon, and these in their turn set the process of muscular contraction at work, so that elongation of the muscle finally increases and flexibility improves (Al-Hazza, 2009). Many studies confirm that sound and suitable stretching exercises greatly raise the capacity of the ligaments and the tendons to lengthen and thereby increase the flexibility of the joint (Al-Bashtawi & Al-Khawaja, 2005). Preparing stretching exercises by proprioceptive neuromuscular facilitation of the sensory receptors (PNF) for the rehabilitation of partial rotator cuff tendon tears among some swimmers according to defined foundations, and adopting the principle of gradual load within the rehabilitative exercises, bore in addition a clear effect upon the improvement of movement in the variables of the study. This was reached by applying exercises suited to the capacities of the injured swimmers and by guarding against complications of the injury, the principle of gradual load standing as a preventive measure against internal disturbances in the joints and the tendons (Al-Mandalawi & Al-Shati, 1987). Applying PNF exercises across 8 weeks at 3 rehabilitative units moreover raised the adaptation of the neuromuscular apparatus, which indicates a rise in neuromuscular coordination that led to a wider range of movement and to greater flexibility through the nervous adaptation obtained. With the coordinated work of the agonist and the antagonist muscles, and with the mechanical adaptation issuing from stretching exercises (PNF), it is held that the improvement of joint flexibility observed after a period of stretching returns to a mechanical adaptation followed by a nervous one. (Al-Hazzaa, 2009a; Al-Hazzaa, 2009b)

What the study reached agrees with earlier investigations indicating that PNF stretching exercises act positively upon the rehabilitation of the muscles governing the shoulder joint and upon widening its range of movement, as the studies of (Kesiktas et al., 2021;Al-Fartousi , 2013) have shown.

Tables (6) and (7) present the measurement of strength in the musculature governing the shoulder, where differences of statistical significance appear between the two measurements on the side of the post-measurement in the variable of muscular strength. The researchers ascribe this progress to the efficiency of neuromuscular facilitation (PNF) stretching exercises in restoring partial rotator cuff tendon tears among some swimmers, as is evident from the marked rise obtained in the strength of the muscles working upon the shoulder. Rehabilitative exercises demand a force of contraction that draws in a greater quantity of muscle fibres, owing to the resistance met while the movements are performed, and this adds to the recruitment of those fibres. Strength training acts upon the central nervous apparatus and upon the processes of inhibition, so that the capacity to recruit muscle fibres grows (Hossam El-Din, 1993); and the more fibres that share in the work, the greater the force the muscle is able to produce (Allawi & Radwan, 1994). PNF exercises, furthermore, bring together more than one technique, strength and flexibility (muscular stretching) alike, whether static or dynamic, both being elements of exercise, which means the performance of compound muscular exercises against resistance. Binding stretching exercises to strength training is indispensable if the musculoskeletal apparatus is to develop in a balanced manner and the development of a single aspect alone is to be avoided (Al-Bashtawi & Al-Khawaja, 2005). This confirms that returning the muscle to its strength and to its natural form assists in raising its capacity for stretching, which is reached through stretching exercises by tightening and lengthening the muscle under an internal or an external stimulus continued for a certain period until the desired level is attained (Hussein& Nasif, 1987). Obtaining a greater muscular contraction through recruitment of the muscle rests, moreover, upon a group of factors, some belonging to the nervous and muscular apparatus and others working in differing directions within each of them. The PNF (Physical Neural Network) method of training nevertheless affords a strength of contraction beyond that of other methods, among its means the nervous impulses of high frequency (Sabbar et al., 2023) together with the energy added through stimulation of the tissues. The flexibility of the ligaments, the joints and the tendons, and this energy itself,

contribute to relative rises in the output of maximal forces, whereby the efficiency of the muscle in lifting weights increases (Jafeer et al., 2023).

What the study reached is consistent with earlier investigations indicating that the use of stretching exercises (PNF) acts positively upon raising the muscular strength of the musculature governing the shoulder joint, as the studies of (Al-Fartousi, 2013; Kesiktas et al., 2021;Abdulhassan et al., 2022) have shown.

Tables (6) and (7) present the measurement of the level of pain, where differences of statistical significance appear between the two measurements on the side of the post-measurement. It is likewise observed that pain fell appreciably, and the researchers ascribe this to the use of stretching by neuromuscular facilitation of the sensory receptors (PNF) in restoring partial rotator cuff tendons among some swimmers, whereby the pain borne by the injured was lessened. (Susan et al., 2008) affirm that stretching exercises (PNF) lower the level of pain; and among what muscular stretching yields is the relief of aches and pains within the muscle (Nelson & Kokkonen, 2009). Stretching is besides an effective and economical means of soothing, which relieves such pains by lengthening the individual muscle fibres and improving the circulation of blood, so that accumulated wastes and useless substances are carried away. A fall in pain serves as an indicator of recovery, since it permits the patient to perform movements within ranges close to the natural ones, whereas its presence points to an underlying disorder, pain standing in the way of effective and coordinated muscular work and possibly signalling damage to come (Susan et al., 2008). The use of PNF exercises stimulates in addition the injured region and improves the circulation of blood there, so that debris is removed, nourishment of the affected area rises, and recovery together with the lowering of pain is at length obtained.

What this study reached agrees with earlier investigations such as (Kesiktas et al.,2021;Al-Fartousi, 2013), which demonstrated the considerable effect of PNF exercises upon lowering pain.

Recommendations:

1. Adopt stretching exercises by neuromuscular facilitation (PNF) within the rehabilitative programmes prepared for swimmers carrying partial rotator cuff tears, since these exercises widen the mobility of the shoulder joint, strengthen the musculature governing it and lower pain in that region.
2. Hold instructional courses for coaches and swimmers on the value of applying PNF techniques within preventive programmes, so as to contribute to lowering the likelihood of the injury recurring.
3. Conduct further studies to apply PNF techniques to other shoulder and ankle injuries in athletes from different sports and disciplines.
4. Utilize the results of this study in rehabilitation programs at treatment centers.

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Appendix (1) Stretching Training Methodology using the (PNF) Technique

Phase	Weeks	Objectives	Exercises	Training Dose
Phase I	1–2	• Reduce pain • Increase range of motion (ROM) • Prevent joint stiffness	PNF Exercises: Contract–Relax, Hold–Relax.Target muscles: Internal and external rotators, deltoid, pectoralis major, and latissimus dorsi.Additional exercises: Pendulum exercise, Wall Walk, wooden stick exercises to improve ROM, and sponge ball squeezing.	• 3 repetitions per exercise • 6-second isometric contraction • 15-second relaxation • 20-second stretching
Phase II	3–4	Increase flexibility	PNF Exercises: Contract–Relax, Hold–Relax, Slow Reversal.Strength exercises: Light resistance band, internal rotation, external rotation, scapular abduction, scapular retraction, and ball press against the wall.	• 4 repetitions • 6–8-second contraction • 20-second stretching
Phase III	5–6	Increase muscular strength and stability	PNF Exercises: Slow Reversal Hold, Rhythmic Stabilization.Strength exercises: Medium-resistance elastic band, 1–2 kg dumbbell, front raise, lateral raise, internal and external rotation, and scapular stabilization exercises.	• 5 repetitions • 8-second contraction • 25-second stretching
Phase IV	7–8	Restore shoulder function and gradually return to swimming	PNF Exercises: D1 Flexion/Extension, D2 Flexion/Extension.Advanced exercises: Higher-resistance elastic bands, light medicine ball throws, swimming movement simulation exercises, and light swimming using a kickboard with gradual progression of training load.	• 5–6 repetitions • 8–10-second contraction • 30-second stretching