

## Effectiveness of proprioceptive neuromuscular facilitation techniques in adhesive capsulitis of shoulder joint: A review

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### Abstract

**Purpose:** The purpose of this study was to review the literature to determine the effectiveness of Proprioceptive neuromuscular facilitation (PNF) treatment techniques in adhesive capsulitis of shoulder joint with effective parameters of treatment for reducing pain, increasing ROM and function in general population.

**Materials and Methods:** No. of different electronic databases were searched limited to adhesive capsulitis, PNF and SPADI including Google Scholar, PubMed, Science Direct, open J gate, published journal articles, book chapters, Observational studies and review articles. Systematic reviews and randomized controlled trials (RCTs) in English language done in patients with adhesive capsulitis with results on pain, ROM and function as outcome measures were included. References related to relevant studies were identified from year 2013 to 2019.

**Results:** According to the selection criteria, 8 full-text articles were included in the review. The most common PNF techniques used by most of the studies were, hold-relax, contract-relax, D2- flexion and extension in upper limb rotation pattern. While some studies used scapular PNF patterns. Among the 8 included studies, most showed that the PNF group is effective in decreasing pain and reducing disability, increasing ROM and improving function compared to conventional physical therapy.

**Conclusion:** AC of shoulder is a common condition, yet its treatment remains challenging. PNF proved to be more effective than other treatment of physiotherapy in the management of adhesive capsulitis of the shoulder joint; however, subjects improved significantly with both treatment strategies, and the differences were small. But more studies needed for more definitive long term outcomes benefits.

**Keywords:** Shoulder, AC, PNF, physiotherapy, functional disability, pain, ROM, SPADI

### Introduction

Adhesive capsulitis is a condition characterized by limitation of motion of the shoulder joint with pain at the extremes of range of motion. It was first described by Putaman in 1882<sup>[1]</sup> and later by Codman<sup>[1,2]</sup>.

### Prevalence

The incidence of adhesive capsulitis is approximately 3 percent in the general population. It is rare in children, peaks between 40 and 70 years of age of person. Women are

more often affected than men. It is common in persons with insulin-dependent and non-insulin-dependent diabetes, and in those with prediabetes (glucose intolerance). Persons with a history of adhesive capsulitis are at increased risk of developing the condition on the contralateral side. Recurrence on the affected side is also possible, especially in patients with diabetes<sup>[3]</sup>.

### Structure and function of shoulder joint

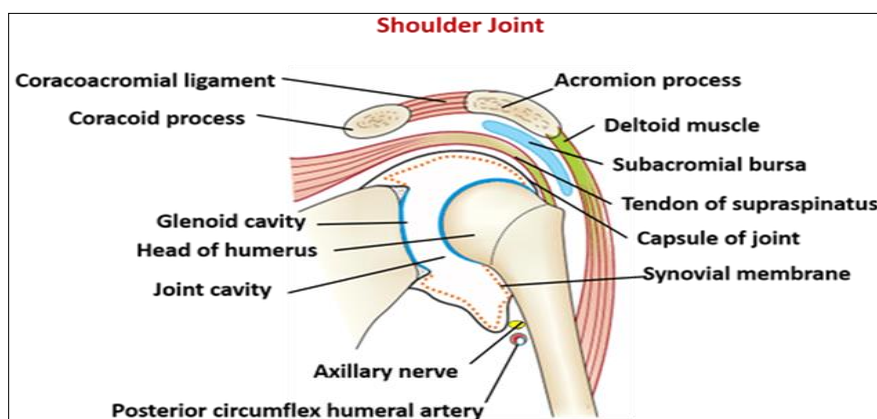
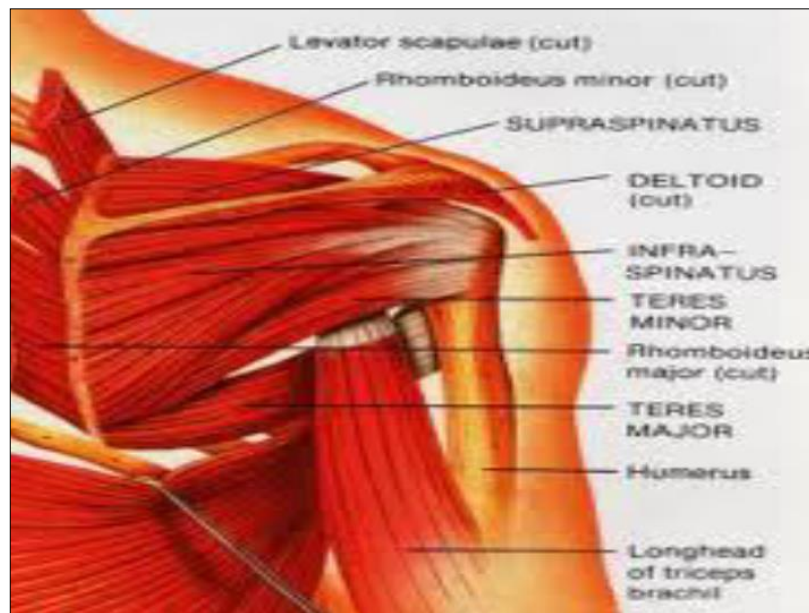


Fig 1: Anatomy of shoulder joint (4)

The shoulder joint is considered to be the most mobile joint in the human body. It is better referred to as the shoulder complex, as a number of articulations are necessary to place the humerus in space. Shoulder complex is composed of scapula, clavicle, humerus, and the joints that link these bones into functional entity. These components constitute

one- half of the weight of the entire limb. The three segments scapula, clavicle, and the humerus are joined by three independent linkages: the Sternoclavicular joint (SCJ), the Acromioclavicular joint, (ACJ) and the Glenohumeral (GH) joint. The articulation between the scapula and the thorax is often described as the Scapulothoracic (ST) joint.



**Fig 2:** Muscles of shoulder joint

Muscles of the shoulder, such as trapezius, levator scapulae, and rhomboids, connect the scapula and clavicle to the trunk. Other muscles include pectoralis major, pectoralis minor, latissimus dorsi, teres major and deltoid; connect the clavicle, scapula, and body wall to the proximal end of the humerus. Those Muscles that provide stability and support to the humeral head in the glenoid cavity are supraspinatus, infraspinatus, teres minor and subscapularis, which are commonly known as rotator cuff muscles. The fibers of the tendons blend with joint capsule, makes them especially vulnerable to injuries since they are so closely approximated to the joint [5].

The shoulder complex acts in a coordinated manner to give the smoothest and greatest range of movement possible to the upper limb. The movement available to the Glenohumeral joint (GHJ) alone cannot account for the full elevation (abduction and flexion) of humerus. The rest of the range is supported by the scapula on the thorax through its sternoclavicular and acromioclavicular connection. Scapulohumeral Rhythm (SHR) is defined as the movement relationship between the humerus and the scapula during shoulder flexion and abduction both. During shoulder abduction, there is 120 degrees of movement that occurs at the GH joint, while 60 degrees occurs at the scapulothoracic joint, creating a 2 to 1 ratio (2:1). This movement is known as the SHR of shoulder abduction. The same SHR occurs both during shoulder flexion and shoulder abduction. Reverse SHR makes the scapula move more than the humerus [6, 7].

### **Pathomechanics and clinical features**

Adhesive capsulitis of shoulder joint is a specific pathologic entity [2] which is characterized by development of dense adhesions, capsular thickening [2, 8], capsular restrictions which limits active and passive shoulder Range of Motion

(ROM) with scapular dyskinesia [8] and painful and restricted elevation and external rotation [9].

Cyriax proposed that pathologies involving the GH joint capsule result in a predictable pattern of joint restriction (capsular pattern) with ER most restricted, abduction next most restricted, and medial rotation third most restricted. Possibly faulty postural compensation with protracted and anteriorly tipped scapula elevated with protracted shoulders. Arm swing decreased during gait. General muscle weakness and poor endurance in the glenohumeral muscles with overuse of the scapula muscles leading to pain in the trapezius and posterior cervical muscles. As it is a guarded shoulder motion with substitute scapular motions [5]. The initial symptom is pain, which is generalized and referred to the upper arm, back, and neck. As the pain increases, loss of joint range of motion occurs. The process is generally self-limiting and, in most cases, resolves spontaneously unless there is an underlying problem. There is significant anterior joint/ capsular tenderness and stress pain in a capsular pattern; later there is painless restriction, often of all movements [1].

### **Types**

Adhesive capsulitis is classified into two types: (1) primary, which is insidious OR idiopathic and (2) secondary, which is generally due to trauma or subsequent immobilization. Those with primary adhesive capsulitis generally have a very gradual onset and progression of symptoms, with no known precipitating event that can be identified. These symptoms may progress so slowly that the patient does not even seek medical attention until ROM and pain severely limit their daily living activities. The person affected with a secondary adhesive capsulitis who usually notices their symptoms soon after a fall or inciting trauma as their ROM does not appear to improve as expected after the pain from

the harmful event should no longer limit ROM<sup>[10]</sup>. Many conditions can produce symptoms mimicking to those of adhesive capsulitis. These include full and partial-thickness rotator cuff tears, calcific tendinitis, glenohumeral or acromioclavicular arthritis, and cervical radiculopathy<sup>[2]</sup>. Common functional limitations or disabilities are inability to reach overhead, behind head, out to the side and behind back that create difficulty in dressing (such as putting on a jacket or coat or women fastening under garments behind their back), reaching hand into back pocket of pants, self-grooming and bring eating utensils to the mouth. Difficulty lifting weighted objects and reduce ability to sustain repetitive activities also seen in AC<sup>[2, 5]</sup>. ADL and occupational activities decrease depends on which shoulder is involved, for instance, self-care, grooming, combing hair, eating and dressing are impaired if right shoulder is involved for right-handed person, on the other hand dressing and perineal care are hampered if left shoulder is involved<sup>[1]</sup>.

### Stages and diagnostic criteria

It is commonly believed that AC is an idiopathic, self-limiting syndrome divided into four consecutive stages lasting approximately 24 months in total. The formal diagnostic criteria include: 1. Painful and stiff shoulder for at least 4 weeks. 2. Severe shoulder pain that interferes with activities of daily living or work. 3. Night pain. 4. Painful restriction of both passive and active shoulder range of motion (elevation <100°, external rotation >50% restriction) and 5. Normal appearance<sup>[11]</sup>.

Shoulder motion must be assessed and documented carefully and consistently to obtain an accurate and ongoing measure of the efficacy of a given treatment. Both active and passive motion range must be recorded and compare. A compensatory increase in scapulothoracic motion can create additional symptoms, described by the patient as discomfort medial to the scapula<sup>[12]</sup>. Information about musculoskeletal pain is obtained through the use of appropriately designed, self-assessment questionnaires, which collect specific information and are also used as patient-reported outcome measures (PRO). More than 30 different questionnaires about pain in the shoulder area have been described in the literature. The most commonly used are the DASH (Disability of the Arm, Shoulder and Hand) Questionnaire, the Shoulder Pain and Disability Index (SPADI), the American Shoulder and Elbow Surgeons (ASES) Society standardized shoulder assessment form, the Shoulder Disability Questionnaire (SDQ), and the Western Ontario Shoulder Instability Index (WOSI), as well as the Simple Shoulder Test (SST), Oxford Shoulder Test (OST)<sup>[13]</sup>, LSST, VAS and NPRS<sup>[14]</sup>.

### Treatment

A considerable proportion of patients with adhesive capsulitis are treated with NSAIDs - nonsteroidal anti-inflammatory drugs, intra-articular corticosteroid injections and physical therapy<sup>[15]</sup>. In persistent cases, more aggressive interventions, such as hydro dilatation, arthroscopic release or manipulation under anesthesia have been used. With respect to physical therapy a variety of interventions are used<sup>[16]</sup>, various conservative methods available for treating adhesive capsulitis of shoulder including capsular stretching, Shoulder ROM exercises, pendulum exercise, scapular thoracic strengthening

exercises, Proprioceptive neuromuscular facilitation (PNF) and mobilization techniques to relieve pain, improve glenohumeral ROM and shoulder functional activities of patient. Electrotherapy modalities like hot pack, ultrasound (US), interferential therapy, transcutaneous electrical nerve stimulation, short wave diathermy and LASER are also used<sup>[14, 16, 17, 18]</sup>.

Scapulohumeral rhythm is playing an important role in increasing shoulder ROM. For that reason evaluation of the position of the scapula is very important in the pathologies of the shoulder because these pathologies are responsible for the second and third most common causes of musculoskeletal pain<sup>[8]</sup>. The disturbance in the Scapulohumeral rhythm creates the alterations in alignment of scapula and interferes with the function of upper limb. It is evident that the most effective techniques for adhesive capsulitis with scapular dyskinesis are Scapular Proprioceptive Neuromuscular Facilitation (PNF) and Scapular Mobilization with Movement (MWM). For proper functioning of the upper limb, the position of the scapula upon thorax and movement synchronization is mandatory. The scapular patterns of PNF will facilitate and synchronize with Upper limb function of shoulder movements<sup>[8, 14]</sup>. PNF has been reported to be effective in relieving pain and improving functional abilities among therapeutic approaches<sup>[14]</sup>.

### Proprioceptive neuromuscular facilitation

Kabat and Knott developed PNF treatment method in early 1950s<sup>[19]</sup>. All the techniques of PNF are accomplished as per basic procedures; among them performing rotational patterns of movement is one of the chief components. Different techniques, such as rhythmic initiation, repeated contractions, rhythmic stabilization, combination of isotonic, dynamic reversals, hold-relax, and contract-relax can be applied to improve muscle strength and flexibility, respectively. Hold-relax, contract-relax techniques are based on the neurophysiology of reciprocal innervations, post-isometric relaxation (autogenic inhibition) and stress relaxation, that enhance range of motion and muscle activation. Proprioceptive neuromuscular facilitation methods, particularly those involving reciprocal activation of the agonist and antagonist to the desired motion provide the greatest potential for muscle functioning<sup>[16]</sup>. Based on diagonal patterns of movement to improve neuromuscular control, pain and function<sup>[14]</sup>.

Proprioceptive neuromuscular facilitation (PNF) techniques are designed to enhance the response of neuromuscular mechanism by stimulating proprioceptors. The pattern of PNF exercise has a spiral, diagonal direction, and the performance of these patterns is in line with the topographic arrangement of the muscle being used. The performance of movements in PNF pattern may permit muscles to act in a way that are close to the actions and movements. PNF stretching quickens neuromuscular responses by stimulating neural proprioceptors. Proprioceptors are nerve endings found in muscles, tendons and joints which are sensitive to changes in tension. One of these proprioceptors is the Golgi Tendon Organ (GTO) which is sensitive to an increase tension in muscles. When a patient's muscle is stretched and<sup>[14]</sup> the patient contract the muscle isometrically, it is thought that the GTO's reflexes are stimulated which inhibiting or relaxing the muscle (Contract-Relax method), then through

reflex inhibition, the agonist muscle will further relaxed. At this point the muscle can be passively stretched to a new position. PNF stretching is very advanced technique and involves a variety of strategies to provide many results. The contract-relax method is the most effective of the PNF methods. This method uses a muscle contraction followed by passive stretching. It is usually repeated several times. It is also recommended to mildly stimulate the opposing muscle group in order to return neuromuscular balance [5]

## Materials and methods

### Search Duration

Articles published from 2013-2019

### Study population

person suffering with AC

### Search Database

Studies were identified from following database.

- Google scholar
- Pubmed
- science Direct
- Open J gate

### Study Design

A review of literature.

### Study Duration

6 months

### Inclusion Criteria

- Language of articles in English only
- Observational studies, review articles with the full texts and Studies with the full texts from the reference list of articles available in search database from the year 2013 to 2019
- Studies which have included participants who are diagnosed with AC and outcome measures were pain, ROM and function.
- The encompassed studies should have used PNF alone or combined as the main treatment and compared to conventional physical therapy.

### Exclusion Criteria

- Studies with the diagnosis of shoulder impingement syndrome, rotator cuff tears, shoulder instability, fractures, osteoporosis, Neurological abnormalities and cervical pathology were excluded.

### Procedure

The study has been approved by the research advisory committee. A review has been done on effectiveness of PNF in AC of shoulder in general population with effective parameters of treatment for reducing pain, increasing ROM and function. Articles published between the years 2013 to 2019 have been taken for the study. 43 articles of AC and PNF have been searched. Out of these, 8 articles have been selected as per the inclusion criteria. No. of different electronic databases were searched limited to adhesive capsulitis, PNF and SPADI including Google Scholar,

Pubmed, Science Direct, open J gate, published journal articles, book chapters, Observational studies and review articles. Randomized and non-randomized controlled trials, systemic review studies were selected for this review Adhesive capsulitis, PNF and ROM, SPADI and functional disability were some of the key words used to search these articles. Selected articles have been scrutinized for the AC, PNF intervention types, and treatment parameters with pain, ROM and function as outcome measures.

### Data analysis and results

Eight studies were identified using the selection criteria mentioned. Out of those, 2 were from Turkey and 6 from India.

### Characteristics of the included studies

The numbers of participants included in these studies ranged from 20 to 60. Five studies included both male and female participants [5, 16, 18, 24, 27], two studies that included only male participants [23, 25] and one included only female participants. (8) Two studies including individuals with mean age groups of 50 years [23] and 56 years. [24] Six studies examining specific age groups of 40-60 years, [5, 16] 40-70 years [8, 18, 25], and one study included age groups of above 40 years [27].

Among the 8 studies, two were RCTs and six were experimental design. All the studies had two comparison groups, except one in which there were three comparison groups [24]. Out of 8 studies, only two [8, 23] used isolated PNF as an intervention in the experimental group. However, the remaining six studies combined other physical therapy treatments like joint mobilization, stretching, wax therapy, transcutaneous electrical nerve stimulation, ultra sound, hot pack, pendulum exercise, myofascial release and muscle energy techniques with the PNF techniques. Pendulum/Codman exercise wall and wand exercises had been given as a home program for both groups in one study [25].

The PNF techniques used were the hold-relax and contract-relax for the muscles of the shoulder. Rhythmic initiation and repeated contractions for scapular patterns were other techniques used in some studies. The most common upper limb pattern facilitated was Diagonal 2 – flexion and extension. Two studies used rhythmic initiation and repeated contractions for all scapular patterns. One study used rhythmic initiation for anterior elevation and posterior depression of scapular pattern [24]. Number of the repetitions ranged from five to twenty. The dosage of treatment per week ranged from 2 to 5 times per week. Total treatment duration ranged from 1 to 6 weeks. Out of the 8 studies, only one study was conducted as single treatment sessions [24]. However, one study did not mention the details of the sessions per week [18]. The common outcome measures used in the studies were ROM, pain, and functional performance. ROM for all shoulder movements were measured by using a goniometer in degrees. The pain was measured by VAS, SPADI or Pennsylvania shoulder score. Disability and function were evaluated by SPADI, LSST or a Simple Shoulder Test. Out of 8 studies, 6 studies concluded that both groups are effective in improving outcome measures, but PNF groups are more effective and statistically significant in improving outcomes. One study concluded equal effect [8] and one study found no significant effect except in pain [24]. The characteristics of the included studies in this review were provided in Table 1.

**Table 1:** Characteristics of the included studies

Sr.no	Author and year	Number of total participants	Age group	Country	Study design	Type of intervention	PNF technique	Treatment frequency	Out come	Impact of PNF	Conclusion
1	Dr. Dravya M Mistry et.al. <sup>(8)</sup> 2019	20/Female	40-70 years	India	Experimental	Group A: PNF Group B: MWM	Scapular D1 and D2 diagonal pattern	20 repetitions with 20 seconds rest for 3 times/1week	VAS, ROM and simple shoulder function test	Equal	Reduction in pain, improving ROM and functional activity
2	Dr.Neeti Mishra et. al. <sup>(16)</sup> 2018	30/ Male and Female	40-60 years	India	Experimental	Group A: PNF+ conventional treatment Group B: Control method: conventional treatment	scapular Rhythmic initiation and repeated contraction	20 repetition, 3sets/3days /week for 6 weeks	VAS,SPADI	Significant	Reducing pain and disability
3	K Jothi Prasanna et.al. <sup>(18)</sup> 2017	24/ Male and Female	40-70 years	India	Experimental	Group A: PNF, wax, stretching and mobilization Group B: Control method: wax, stretching and mobilization	scapular Rhythmic initiation and repeated contraction	20 repetition for 6 weeks	VAS, LSST, ROM, Simple shoulder test	Significant	Reduction of pain and improvement of shoulder ROM, Scapular dyskinesis and functional activities
4	Hariharasudhan ravichandran et.al. <sup>(23)</sup> 2015	60/Male	Mean age Of 50	India	Experimental	Group A: PNF Group B: MET	D2 PNF pattern of flexion and extension.	16 repetitions 5 days/ week for 2 weeks	ROM, University of Pennsylvania shoulder score	Significant	Relieving pain, restoration of ROM and function
5	Nilay Comuk Balci et. al. <sup>(24)</sup> 2015	53/ Male and Female	Mean age of 56	Turkey	RCT	Group A: PNF, physiotherapy modality Classic ex. Group B: classic ex. physiotherapy modality Group C: Control group: only physiotherapy modality	Scapular Anterior elevation and posterior depression , posterior elevation anterior depression, rhythmic initiation and repeated contraction	20 repetition in one session only	VAS,LSST, ROM and Simple shoulder test	Not significant -	Relieving pain
6	Eda AKBA et. al. <sup>(25)</sup> 2015	36/Male	20-70 years	Turkey	RCT	Group A: Control group: home exercise Group B: PNF, home exercise	D2Flexion pattern and hold-relax	15 sessions 5time/week	VAS,LSST,ROM,SPADI	significant	Reduction of pain, improvement of shoulder ROM and function
7	Mahendran P. <sup>(27)</sup> 2013	30/ Male and Female	Above 40 years	India	Experimental	Group A: joint mobilization Group B: PNF and joint mobilization	D2Flexion pattern Contract-relax	10-15 repetition, 5days/ week for 4 weeks	VAS,ROM	significant	significant improvement in ROM and reduction of shoulder pain
8	Ranjitha.L <sup>(5)</sup> 2013	50/Male and Female	40-60 years	India	experimental	Group A: PNF,CHL stretching and pendulum exercises Group B: Pendular exercises.	Contract -relax	5 repetitions, 2times/week in 4 weeks	VAS, ROM,SPADI	Significant -	effective in improving pain, ROM & function

## Discussion

AC joint of shoulder is one of the most prevalent shoulder conditions affecting the general population. Our main objective for this study is to perform a review to find out the effectiveness of PNF techniques applied in AC joint of shoulder and to determine effective parameters of treatment for reducing pain, increasing ROM and function in general population. Articles published between the years 2013 to 2019 have been selected for the study. Total 8 articles have been selected for the review.

The results of the review had shown that, the most common PNF techniques were effective in AC were the hold-relax and contract-relax for the muscles of the shoulder, rhythmic initiation and repeated contractions for scapular patterns and Diagonal 2 – flexion and extension in upper limb patterns. A variety of outcome measures were utilized in eight studies and almost all studies used more than one outcome measure (Table 1). The most commonly used outcome measures in the reviewed studies were VAS, ROM and various functional outcome measures such as Shoulder Pain and Disability Index Score (SPADI), University of Pennsylvania shoulder score, Lateral scapular slide test (LSST) and simple shoulder function test. Pain intensity was assessed on a visual analogue scale, Range of shoulder movements (ROM) were measured by a universal goniometer. Lateral Scapular Slide Test was used for evaluation of the scapula. Functional performance was assessed by Shoulder Pain and Disability Index (SPADI), University of Pennsylvania shoulder score, and simple shoulder function test. All the functional outcome measures used in the reviewed articles have been reported to be valid and reliable.

Our results are similar from a previously published study that involved the same screening <sup>[19]</sup>. When compared to other groups the group which received PNF technique was found to have increased functional activities and range of motion along with the reduction in pain. The results of the review had shown that, the PNF techniques were effective in AC, though in one study by Nilay, Comuk Balci *et al* <sup>[24]</sup>, which conducted a single session and demonstrated that there is no significant difference between groups except pain relief, however, all the groups had shown significant differences after a single session of treatment interventions and other study by Dr. Dravya, M Mistry *et al* <sup>[8]</sup>, demonstrated that both the groups shown equal improvement.

Proprioceptive Neuromuscular Facilitation (PNF) techniques help in improving range of motion as it elongates the Golgi tendon organ that facilitates relaxation of the antagonist muscles. Contract-relax PNF procedures involving reciprocal activation of the agonist and antagonist to the desired motion, provide the greatest potential for muscle lengthening and hold-relax technique is based on isometric contractions against maximum resistance using for improving passive ROM and decreasing pain.

Limitation of our reviewed studies published between the years 2013 to 2019 is that we have found a substantial variation in the conventional physiotherapy treatment given in AC. There is limited literature on the effectiveness of specific exercise regimen for the treatment. While there were few studies addressing the effects of therapeutic exercises, no identical exercise regimen was followed in any of the studies. Additionally, the intensity, frequency, duration of exercises and the use of physical therapy modalities varied across studies. Both the lack of use of

identical Exercises and varied physical therapy modalities in different studies limit the ability to generalize these findings in order to treat patients with AC of shoulder.

Therefore, further studies are needed to establish the effectiveness of each treatment strategy with randomization. Future reviews should try to combine a single type of studies, isolated techniques of PNF and long-term follow-up to see the effectiveness on AC of shoulder joint. Future research into the effectiveness of specific exercises for pain relief, ROM improvement and improved functional status is needed to determine the optimal dose of different exercises such as the intensity, frequency, and duration of exercises for patients with AC of shoulder joint.

However, our findings support the need for further research to establish the effectiveness of specific PNF techniques in general population of different countries using validated outcome measures in population-based samples. This information should assist health-care practitioners who treat patients with this disorder.

## Conclusion

AC of shoulder is a common condition, yet its treatment remains challenging. PNF proved to be more effective than other treatment of physiotherapy in the management of adhesive capsulitis of the shoulder joint; however, subjects improved significantly with both treatment strategies, and the differences were small. But more studies needed for more definitive long term outcomes benefits.

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