

**EFFECTIVENESS OF NEUROMUSCULAR REDUCTION AND MUSCLE ENERGY
TECHNIQUE OF SUBSCAPULARIS IN SUBJECTS WITH ADHESIVE CAPSULITIS: A
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ABSTRACT**Background and Objective:** Adhesive Capsulitis of Shoulder is characterized by an insidious and progressive pain and loss of active and passive mobility in the glenohumeral joint. A shortened subscapularis muscle has been implicated as cause of limited motion. The objective of this study was to investigate the effectiveness of Neuromuscular Reduction and Muscle Energy Technique of Subscapularis in subjects with adhesive capsulitis.**Methods:** Prospective study design. This study includes 64 Subjects with mean age of 40 to 60 years having a Clinical Diagnosis of Adhesive Capsulitis were randomly allocated in to 2 groups. Group I (n=32) were treated with NMR and Group II (n=32) were treated with MET along in conventional physiotherapy. Participants received the intervention 3 times a week for 6 weeks. The outcome measures of this intervention were measured in VAS for Pain, Universal Goniometer for Shoulder ROM and SPADI for Function. **Results:** Statistical analysis of the data revealed that within group comparison both groups showed significant improvement in all parameters, where as in between groups comparison there is no significant improvement in all parameters. Neuromuscular Reduction and Muscle Energy Technique are equally effective in this condition. **Conclusion:** After 6 weeks of intervention both the subscapularis NMR and MET intervention showed significant improvement on reducing Pain, improving Shoulder ROM, and Function. However, analysis between the groups suggest that both the interventions are equally effective and no exercise is superior to other.**KEYWORDS:** Adhesive Capsulitis, Neuromuscular Reduction, Muscle Energy Technique, Subscapularis Muscle, Shoulder Pain and Disability Index.**INTRODUCTION**

Adhesive Capsulitis (AC), describes a pathologic process during which the body forms excessive connective tissue or adhesions across the glenohumeral joint result in stiffness, Pain and dysfunction. The capsular pattern in the Shoulder is characterized by limitation of passive range.^[1]

The annual incidences are 3% to 5% in the general population and even up to 40% people with diabetes. It mainly affects people between the age of 40 to 60 years, with women are more commonly affected than men.^[2] Prevalence rate of Adhesive Capsulitis in the general population is 2-5% and 10-20% in diabetes.^[3]

According to Neviasser and Hanna fin identified 4 stages of this condition. There are 4 stages of Adhesive Capsulitis. Stage-1 Painful phase: there is a gradual onset of Pain and mild decrease in Range of Motion and these symptoms lasts for <3months. Stage-2 freezing stage:

after the onset with high prevalence of nocturnal Pain and loss of active as well as passive ROM symptoms lasts for 3 to 9 months. Stage-3 frozen stage: there is Pain with end ROM and significant Shoulder stiffness symptoms remain prevalent from 9 to 14 months. Stage-4 thawing stage: minimal Pain with progressive improvement in ROM symptoms occur from 15 to 24 months.^[4]

Adhesive Capsulitis generally subcategorized into primary[or]idiopathic, secondary [or]acquired. There is no specific cause for primary AC, secondary AC associated with recent surgery, immobilization, or trauma and also with systemic, extrinsic, intrinsic disorder. Systemic disorder includes diabetes mellitus and thyroid disorders.^[5] Extrinsic disorder not directly involved to the Shoulder includes cardiopulmonary diseases, Cervical spine pathology, stroke, Parkinson's disease, Humerus fractures. Intrinsic disorder associated to glenohumeral soft tissues and structures includes rotator

cuff pathology, Biceps tendinitis and AC joint arthritis.^[6]

The stability of the humeral head is achieved by supraspinatus, infraspinatus, teres minor and subscapularis, which are commonly called the rotator cuff or SITS muscles. SITS tendon fibers are mixed with the joint capsule and are therefore particularly vulnerable to injury because they are in close proximity to the joint. Subscapularis muscle is a particularly important muscle when considering Shoulder dysfunctions, is almost hidden from palpation. It has a broad attachment to the subscapular fossa and spans the glenohumeral joint to attach to the lesser tubercle of the humerus and the articular capsule. It passes through the anterior joint capsule and lies horizontally between the two almost vertical tendons of the biceps.

A greater limitation of glenohumeral external rotation at 45° of abduction when compared to the available external rotation at 90° abduction may have a subscapularis muscle flexibility deficit rather than a glenohumeral capsular restriction in early peri-arthritis. It has been reported in that subscapularis muscle flexibility deficit is responsible for glenohumeral external rotation restriction at 45° of abduction. The common limiters of glenohumeral external rotation are the glenohumeral capsule and the Shoulder internal rotators. Anatomically it is confirmed that subscapularis tendon is intra-articular component of glenohumeral joint capsule.^[6] If subscapular hypertension causes excessive muscle tension, it will persist the humeral head fast to the glenoid fossa creating the pseudo frozen Shoulder. Ultimately however long term reduced mobility and capsular irritation from subscapularis dysfunction may result in Adhesive Capsulitis.^[7]

Godges Joseph et al. (2003) reported that subscapularis muscle flexibility deficit is responsible for glenohumeral external rotation restriction at 45° of abduction. A shortened subscapularis muscle has been implicated as cause of limited motion in patient diagnosed with Adhesive Capsulitis. subscapularis release suggest that subscapularis muscle flexibility deficits are responsible for glenohumeral external rotation limitation in lower ranges of abduction.^[8]

Many treatments are advocated for Adhesive Capsulitis condition, that includes initial conservative management Anti-inflammatory drugs, Intra articular Corticosteroids, Capsular distension injections and Surgical Interventions. Surgical management includes Manipulation under anaesthesia, Arthroscopic release and repair and open release. Physiotherapeutic interventions are routinely used in the treatment for Adhesive Capsulitis such as Mobilizations and Manipulation techniques for Pain free stage and normal use of upper extremity. Some modalities are also suggested for acute Pain that includes Transcutaneous Electrical Nerve Stimulation, Cryotherapy and

Ultrasound.^[9]

The goal of treatment is to alleviate the signs and symptoms of the disease and if possible, to slow progression. The therapeutic spectrum ranges from general measures to Physiotherapy, Orthopaedic Aids, Pharmacotherapy and finally Surgery & Rehabilitation. The goals of treatment, as stated in many of the guidelines are reduction in Pain, improve quality of life, improve mobility and delay in progression of Adhesive Capsulitis. Numerous Physiotherapeutic interventions are routinely used in the treatment for Adhesive Capsulitis. Electrotherapy includes Transcutaneous Electrical Nerve Stimulation, Cryotherapy and Ultrasound. Exercise therapy includes Mobilization, Manipulation techniques used for reducing Pain, Improving Range of Motion and Function.

Recently Neuro Muscular Reduction (NMR) is referred as a vigorous technique which mainly emphasizes the treatment of soft tissue. NMR is a combined technique that uses deep pressure along with muscle origin and insertion with active movement of target area.^[10]

MET is a direct hands-on therapy originally developed by Dr. Fred Mitchell, Sr. Osteopathic Physician. It is a non-invasive technique that can be used to stretch or lengthen muscle and fascia that lack flexibility.^[11]

Muscle Energy Techniques (MET) can help to release and relax muscles, and promote the body's own healing mechanism. MET targets the soft tissues primarily, but it also makes a major contribution towards joint mobilization. MET not only increases ROM of joints, but also increases the extensibility of muscles by means of a mechanism expressed as "increased tolerance to stretch."^[12]

MET is unique in its application as the subject provides the initial effort while the therapist facilitates the process. One of the main uses of this method is to normalize the area of joints, Flexibility and technique can be used for any joint with limited range of motion (ROM).^[13]

Both subscapularis Neuromuscular Reduction and Muscle Energy Technique have been proved effective on Reducing Pain, Improving Range of Motion and Function in Adhesive Capsulitis. However, the available literature for comparison is limited. Hence, the need of the study arises.

MATERIALS AND METHODS

Study design: Prospective study design

Ethical clearance and informed consent: The study protocol was approved by the Ethical Committee of GSL Medical College & General Hospital (Annexure-I), the investigator explained the purpose of the study and given the patient information sheet. The participants were requested to provide their consent to participate in the study (Annexure-II). All the participants signed the

informed consent and the rights of the included participants have been secured.

Study population: Subjects clinically diagnosed as Adhesive Capsulitis by an Orthopedician.

Study setting: The study was conducted at out Patient Department of Physiotherapy, GSL Medical College and General Hospital, Rajamahendravaram, Andhra Pradesh, India.

Study duration: The study was conducted during the period between July 2020 and June 2021.

Sampling method: Systematic Random Sampling.

Intervention duration: 3 sessions a week for 6 weeks.

Sample size: A total of 120 Subjects based on prevalence were screened in that 64 Subjects were recruited who are willing to participate in the study. Recruited participants were explained the purpose and relevance of the study. Those willing to participate voluntarily be included in the study after obtaining informed consent. All the eligible Participants were randomized in to either Neuromuscular Reduction Group or Muscle Energy Technique Group with 32 in each group.

INCLUSION CRITERIA: Participants with diagnosis of Adhesive Capsulitis having symptoms of Pain and at least 4 features of the following items. Subjects with age of 40 – 60 years, Shoulder Range of Motion reduced, Shoulder Pain more than 3 months and Stage II and stage III Adhesive Capsulitis.

EXCLUSION CRITERIA: Any surgical procedures of Shoulder joints.

Rotator cuff tear and other Shoulder ligament injuries, Shoulder related arthritis, Malignancy, Peri Arthritic Shoulder secondary to Fracture, Dislocation, Reflex Sympathetic Dystrophy, Any neurological disorder related Shoulder, Post Fracture Stiffness, Tendinitis.

OUTCOME MEASURES

1. Visual Analogue Scale (VAS) was used to measure Pain at baseline and at the end of 6 weeks.
2. Universal Goniometer is used to measure the Range of Motion in Shoulder abduction and external rotation and at the end of 6 weeks.
3. Shoulder Pain and Disability Index (SPADI) was used for Functional measurement and at the end of 6 weeks.

MEASUREMENT OF PAIN SEVERITY (VAS)^[14]

The VAS scale is a reliable, valid, responsive and frequently used Pain outcome measure. The instrument used consists of horizontal lines, 10cm long with anchor points of 0 (no Pain) and 10 (severe Pain). It is located at either end of the line. Patients are instructed to draw a vertical mark on the line indicating their Pain level. The severity of Adhesive Capsulitis was evaluated by VAS.

Note how severe you feel your disease state is with a mark (|) on the line below.



Universal Goniometer (UG) for Shoulder ROM^[15]

The Universal Goniometer (UG) is a reliable, valid, responsive, and frequently used for Cervical Range of Motion outcome measure. The full-circle Goniometer or Universal Goniometer is a versatile device for recording measurements of Peripheral joint ROM in Subjects. The UG is a 360° Protractor Goniometer by aligning this within the axis of a Joint, the degree of motion can be measured in a single Plane.

It contains of mainly three parts.

- 1: Axis
- 2: Stable arm
- 3: Movable arm

procedure for measuring shoulder abduction

The subject position was in supine lying to Active Shoulder abduction was measured, with both the Shoulders flat against the table. The fulcrum of the goniometer is placed over anterior to the acromion process, immovable arm is placed parallel to the midline of the sternum and movable arm is placed at the midline of the humerus. The subject was then asked to elevate the affected arm up to complain Pain and the movable arm move along with the subject arm then taken the active abduction ROM.

Procedure for Measuring Shoulder external rotation

The Active Range of Motion of External Rotation is measured with the subject in supinely. Then the affected Shoulder is abducted to 90° and the elbow is kept in 90° of flexion, the forearm is in neutral position. The humerus is supported horizontally by the table to maintain a neutral horizontal position. Goniometer fulcrum is placed over the Olecranon process of the ulna, immovable Arm is placed perpendicular to the floor, and Moving Arm is aligned parallel to the ulna pointing toward the styloid process. The subject is asked to move the arm into External rotation up to complain of Pain.

SPADI for Function^[16]

The Shoulder Pain and Disability Index (SPADI) is a self-administered questionnaire that consists of two dimensions, one for Pain and the other for Functional activities. The Pain dimension consists of five questions regarding the severity of an individual's Pain. Functional activities are assessed with eight questions designed to measure the degree of difficulty an individual has with various activities of daily living that require upper-extremity use. The SPADI takes 5 to 10 minutes for a patient to complete and is the only reliable and valid region-specific measure for the Shoulder.

INTERVENTIONS

The study consists of 6 weeks of intervention which includes Subscapularis Neuromuscular Reduction in (Group- I) and Muscle Energy Technique in (Group- II). The Outcome measures were measured by using Visual Analogue Scale for Pain, Universal Goniometer for Shoulder Range of Motion (ROM) and SPADI for Function. All the eligible participants were consecutively randomized in to either Group- I or Group –II.

GROUP I: subscapularis neuromuscular reduction [NMR]^[17]

The Subjects were asked to perform intervention 3 times a week for 6 weeks under supervision of Physiotherapist. The therapist on the contralateral side, leaning over the subject and contacting the vertebral border of the scapular over the most medial and superior portion of the muscle belly. The therapist then adducts the arm and lets his or her thumb sink into the muscle going as far medial and superior as is comfortably possible for the patient. Next, the therapist abducts the patient's arm parallel to the floor as his or her inferior hand pulls on the muscle from superior to inferior while going deeper and deeper with each subsequent stroke within the patient's tolerance.^[10]

The subject was instructed that the subscapularis NMR procedure was to be Pain free, if any Pain was perceived during the application of treatment, it must be ceased immediately.

The procedure was performed 15 minutes and conventional Physiotherapy 45 min duration in every session. The treatment procedure was performed 3 sessions in a week for 6 weeks.

GROUP-II: Muscle Energy Technique (MET)^[18]

A single application of MET was applied to the GHJ horizontal abductors, the subject was in a supine position on the table. The therapist stabilized the scapula at the lateral border and with the elbow flexed, the subject's Shoulder was horizontally adducted to the first barrier of motion. The subject was instructed to perform a 5 second isometric contraction at approximately 25% maximal effort in the direction of horizontal abduction, against opposing force provided by the examiner at the distal humerus. Following the contraction, the participant was instructed to pull his arm across his body, as the therapist applied a 30 second active assisted stretch. The subject was instructed to relax and a new movement barrier was then engaged by the examiner.

A single application of MET was applied to the GHJ external rotators, the subject was in a supine position on the examination table. With the humerus supported and the Subjects Shoulder and elbow in 90° of abduction and flexion, respectively, the therapist passively moved the humerus into internal rotation until the first barrier of motion was reached. The subject was then instructed to perform a 5 second isometric contraction of

approximately 25% maximal effort in the direction of external rotation, against an opposing force provided by the therapist at the distal forearm. Following the contraction, the subject was instructed to internally rotate the arm towards the ground as a 30second active assisted stretch was applied. The subject was instructed to relax, and a new movement barrier was then engaged by the examiner.

The MET were given to the Subjects for 3 sets per session with 5 repetitions in 15 minutes along with 45 minutes of conventional exercises. The treatment procedure was performed 3 sessions in a week for 6 weeks.

Conventional Physiotherapy^[19]

Both the groups receive conventional Physiotherapy which includes the Shoulder wheel, Over Head Pully, Codman's Exercises, finger ladder and home programme.

Pully Exercises^[20]: Over an iron beam pass a skipping rope. Holding the two ends of the rope on either side, swing the rope alternatively up and down, this helps improve the flexion and extension movements of the Shoulder. Do this for 5 to 10 minutes everyday.

Pendulum Exercises^[21]: Subjects stand at the edge of a table or cot in forward loop position. Slightly bend forward and support the table with the normal hand. Now slowly rotate the stiff Shoulder in all the directions in a circular motion. Repeat this for 5 to 10 times.

Finger ladder Exercises: Stand facing a ladder hanging on the wall Place the affected hands over the ladder at a low level. Now slowly start an upward climb over the ladder until it reached the top and then slowly lower it down back to the starting position.

Shoulder Wheel Exercises: subject stands facing towards the wheel and hold the handle of the wheel with affected hand in order to rotate the wheeling in clockwise and anticlockwise directions till the allowed Range of Motion unless until the Subjects complain the Pain.

After 6 weeks of intervention, all Subjects were evaluated for their decreasing Pain by VAS and Functional disabilities by using SPADI, and measuring abduction and external rotation Range of Motion by using Universal Goniometer.

All statistical analysis was done by using SPSS software version 21.0 and Microsoft excel-2007. Descriptive data was presented in the form of mean ± standard deviation and mean difference Percentages were Calculated and Presented. Paired Student "t" test was performed to assess the statistical difference within the groups for Pain, Range of Motion and Function from Pre-test and Post-test values. Independent student "t" test was performed to assess the statistically significant difference in mean value between the groups for Visual Analogue

Scale Pain, Universal Goniometer for Shoulder Range of Motion Shoulder Disability and Index for Function. For all statistical analysis, $P < 0.05$ was considered as statistically significant.

Improved Function on SPADI. The consort flow chart of the study showed the study organization in terms of Subjects Screening, Random allocation and analysis following the Intervention.

RESULTS

The results of this study were analysed in terms of Pain relief and increased Shoulder abduction and external rotation Range of Motion on Universal Goniometer,

COMPARISON OF MEAN SCORE OF VAS IN BETWEEN THE GROUPS

GROUPS	VAS	Mean	SD	P-value	Inference
GROUP I	PRE	6.27	1.721	1.000	In Significant
GROUP II		6.27	1.721		
GROUP I	POST	3.30	1.179	0.741	In Significant
GROUP II		3.20	1.157		

COMPARISON OF MEAN SCORE OF SPADI DISABILITY IN BETWEEN THE GROUPS

GROUPS	SPADI	Mean	SD	P-value	Inference
GROUP I	PRE	68.033	9.4302	0.9064	In Significant
GROUP II		68.3	8.0006		
GROUP I	POST	39.133	7.2717	0.9275	In Significant
GROUP II		39.3	6.8639		

COMPARISON OF MEAN SCORE OF SHOULDER ABDUCTION IN BETWEEN THE GROUPS

GROUPS	ROM	Mean	SD	P-value	Inference
GROUP I	PRE	70.433	11.4008	0.195	In Significant
GROUP II		74.033	9.813		
GROUP I	POST	99.1	14.045	0.135	In Significant
GROUP II		94.233	10.598		

COMPARISON OF MEAN SCORE OF ROM EXTERNAL ROTATION IN BETWEEN THE GROUPS

GROUPS	ROM	Mean	SD	P-value	Inference
GROUP I	PRE	29.17	8.313	0.874	In Significant
GROUP II		29.50	7.917		
GROUP I	POST	43.83	7.273	0.669	In Significant
GROUP II		43.00	7.724		

DISCUSSION

The Aim of the study was to compare the Effectiveness of Subscapularis Neuromuscular Reduction (Group -I) and Muscle Energy Technique (Group - II) on Pain, Range of Motion and Function in Adhesive Capsulitis. In this study Subjects were assessed for Pain using VAS, Function by SPADI and ROM by Goniometer respectively.

In this study Subjects were assessed for Adhesive Capsulitis underwent either subscapularis NMR or Muscle Energy Technique which are performed for six weeks the parameters were assessed before and after exercise training.

In this study (Group-I) Subscapularis NMR with conventional exercises have showed statistically significant difference within the groups from pre-test to post-test values in Reducing Pain, Improving Function in Subjects with Adhesive Capsulitis.

In this study (Group-II) Muscle Energy Technique with conventional exercises have showed statistically significant difference within the groups from pre-test to post-test values in Reducing Pain, Improving Function & ROM in Subjects with Adhesive Capsulitis.

In subscapularis Neuromuscular Reduction is a vigorous technique which mainly emphasizes the treatment of soft tissue. NMR is a combined technique that uses deep pressure along the origin and insertion of a muscle combined with active movement. This technique attempts to release muscular and fascial adhesions. the gentle forces applied to the fascial restrictions will elicit vasomotor response and increase blood flow to the affected area, thereby enhancing lymphatic drainage of toxic metabolic wastes. It also realigns the fascial planes, and most importantly resets the soft tissue proprioceptive sensory mechanism. These adhesions pull us out of a three- dimension a orientation with gravity as a muscle/tendon begins to stretch and encounters an

adhesion, the muscle contracts to prevent any further stretching and to protect the area involved by this, it reprograms the central nervous system, enabling a normal Functional Range of Motion without eliciting the old pain pattern.^[23] Barnes claimed that, there is change in the viscosity of the ground substance of the muscle and fascia which can restore proper alignment of the muscle fiber and increase joint mobility. who explained the Subscapularis Neuromuscular Reduction improves the vertical alignment and lengthens the body providing more space for proper Functioning of osseous structures, nerves, muscles, blood vessels and organs which improves the Function. Our study supported by Madiha Ali, 1 Sehrish Ali, 2 Abdul Ghafoor Sajjad, et al, that Subscapularis Neuro Muscular Reduction (NMR) with conventional Physiotherapy is more effective in Improving the Pain, ROM in patients with Adhesive Capsulitis.

In Muscle Energy Techniques (MET) can help to release and relax muscles, and promote the body's own healing mechanisms. MET targets the soft tissues primarily, but it also makes a major contribution towards joint Mobilization. MET not only increases ROM of joints, but also increases the extensibility of muscles by means of a mechanism expressed as "increased tolerance to stretch. The current study also demonstrated that the beneficial effect of improving Range of Motion after applying Muscle Energy Technique.^[24] Sibby et.al, reported that this improvement in the Range of Motion may be due to Muscle Energy Technique which mainly works on decreasing the spasm or tightness of muscle by first resetting the muscle spindle and inhibiting the muscles by activating the Golgi tendon organ. This phenomenon is called post isometric relaxation in which there is period of a relative hypotonicity during which a stretch of the involved muscle is more easily achieved than before contraction. After application of MET, musculotendinous junction acts in a viscoelastic manner and leads to the properties of creep and stress relaxation.^[25] Therefore this technique which indicate the strength training leads to decreasing pain. A decrease in pain leads to an improvement in ROM and Function. Our study supported by Swaraj S. Shetty 1, Ruchita R. Shah 2 et al Muscle Energy Techniques (MET) with Conventional Physiotherapy is more effective in improving the Pain, ROM in patients with Adhesive Capsulitis.^[26]

This study shows that subscapularis muscle involvement is one of the causes in Adhesive Capsulitis, with restriction in Shoulder Range of Motion and increase disability. Individually both Neuromuscular Reduction and Muscle Energy Technique were found to be effective in different conditions. In the present study, both the NMR and MET are individually effective in pre and post comparison to decrease Pain and increase Range of Motion in Adhesive Capsulitis.

When coming to comparison between the groups

Subscapularis NMR with conventional exercises and Muscle Energy Technique with Conventional exercises shows statistically significant improvement in post test values to decrease Pain, increase ROM and Function. The result of the study shows there is no significant change to Improve the Pain, ROM and Function. None of the technique is superior to the other on decreasing Pain and improving ROM, Functional and ability of Shoulder in Subjects with Adhesive Capsulitis. However, in comparison between NMR and MET no group is superior to one another.

This study proved that Subscapularis NMR and Muscle Energy Technique with Conventional Physiotherapy were equally effective to treat the subscapularis muscle in Subjects with Adhesive Capsulitis. These exercises are Effective in reducing Pain, Improving Range of Motion, Function in Shoulder. Thereby it increases the Quality of life.

Hence, we can conclude that Subjects with Adhesive Capsulitis can achieve significant results using subscapularis NMR and Muscle Energy Technique addition to Conventional Physiotherapy.

LIMITATIONS

- Small Sample size.
- Only Certain age group (40-60).
- Lack of Control group.
- No blinding of evaluators.
- Lack of follow-up in the present study.

RECOMMENDATIONS FOR FURTHER RESEARCH

- Sample size can be increased with inclusion of a greater number of Subjects to generalize the effects of these techniques in larger population.
- In the present study only, Adhesive Capsulitis was taken. Hence in further studies other musculoskeletal conditions that affect the Subscapularis can be studied.
- The duration of study can be increased by 8 weeks or 12 weeks.

CONCLUSION

The present study concluded that six weeks of Interventions of Neuromuscular Reduction and Muscle Energy Technique were shown significant improvement in reducing Pain, improving Range of Motion and Function. However, analysis between the groups suggest that both the interventions are equally effective.

From the findings of the current study, it can be recommended that the Neuromuscular Reduction and Muscle Energy Technique protocol may be opted as a treatment of choice for reduction of subscapularis muscle to decrease Pain, enhancing the shoulder Range of Motion and improve the Function in subjects with Adhesive Capsulitis.

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