

## Pain Modulation in Frozen Shoulder – Electrotherapy Versus Exercise Therapy

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### Abstract

This study was done to evaluate the efficacy of pain alleviation in frozen shoulder using a combination of electrical modalities as TENS, Ultrasound and hot packs versus exercise comprising of glenohumeral mobilization and stretching exercises. Sample (n = 30; 16 female, 14 male) was selected through random sampling. Middle aged male and female with primary idiopathic frozen shoulder were included in the study, the subject's pain was assessed both pre and post study on visual analogue scale (VAS). Electrotherapy was found to be more effective than exercise therapy alone for pain modulation in frozen shoulder.

**Keywords:** Frozen Shoulder, electrotherapy, stretching exercise, glenohumeral mobilization.

### Introduction

Dupleix is the man who first described the pain and stiffness of the shoulder joint as Humeroscapular Periarthritis in 1872, while Codman in 1934 used the term Frozen Shoulder and in 1945 Neviasser gave the name of Adhesive Capsulitis for the same pain and stiffness of the shoulder joint. Grey used the term Periarthritis for Idiopathic Frozen Shoulder in 1978.

A frozen shoulder means significant loss of its range of motion in all direction (capsular pattern). It's a result of inflammation, scarring, thickening and shrinkage of the capsule that surrounds the normal shoulder joint.

Idiopathic frozen shoulder is characterized by the development of dense adhesion and capsular restrictions, especially in the dependant fold of the capsule, rather than the articular changes in the cartilage and bone, as seen with rheumatoid arthritis or osteoarthritis.

Frozen shoulder is of two types: Primary and Scondary; Primary frozen shoulder has insidious onset usually occurs between the age of 40 and 60 years without known etiology, while secondary frozen shoulder is said to be when the problem or cause is already mentioned in which there is a period of pain and/ or restricted motion such as with rheumatoid arthritis and osteoarthritis, trauma or immobilization may also lead to secondary frozen shoulder.

The shoulder or glenohumeral joint is a ball and socket synovial joint with three degree of freedom. The articulation is made up of large head of the hume-

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rus and the small glenoid fossa. It has a capsule and several associated ligaments and bursae. The glenohumeral joint has sacrificed congruency to serve the mobility needs of the hand. Saha A. in 1961 described that the fossa is greater in the frontal plane (length) than in the sagittal plane (width) with substantial variability in the curvature. The proximal articular surface is somewhat enhanced by an accessory structure known as Glenoid Labrum. The labrum is loosely attached superiorly, whereas the inferior portion is firmly attached and relatively immobile. The articular surface of humeral head is invariably larger than that of the proximal surface, forming one third to one half of a sphere. The head faces medially, superiorly and posteriorly with respect to the shaft and condyles of humerus. The glenohumeral joint is surrounded by a large, loose capsule that is taught superiorly and slack anteriorly and inferiorly. When the humerus is abducted and laterally rotated on the glenoid, the capsule twists itself and tightens, making it the close packed position for the glenohumeral joint, whereas a thin area of capsule between the superior and middle glenohumeral ligament is a particular point of weakness known as Foramen of Weitbrecht. There are four ligaments to stabilize the glenohumeral joint, in these four, three are glenohumeral ligaments and one is coracohumeral ligament. The three glenohumeral ligaments are superior, middle and inferior. Superior glenohumeral ligament passes from the superior glenoid labrum and base of the coracoid process to the upper neck of the humerus. It contributes most to stability when the arm is at side. Inferior glenohumeral ligaments also known as Inferior Glenohumeral ligament Complex because of its three portions and these are Anterior Band, Posterior Band and Axillary Pouch in between anterior and posterior band. The complex contributes most to stability when the glenohumeral joint is at 90° or more. Coracohumeral ligament originates from the coracoid process and insert through two bands. The first band insert into the edge of supraspinatus and onto the greater tubercle, where it joins the superior glenohumeral ligament, whereas the second band insert into the subscapularis and lesser tubercle. Coracohumeral arch also known as Suprahumeral Arch and formed by the coracoid process, the acromion and the coracoacromial ligament that spans the two bony projections. It covers the head of the humerus and forms a space within which the sub-acromial bursa, the supraspinatus tendon and tendon of the long head of biceps lie. The arch prevents the head of the humerus from superior dislocation.

Jonathen Cluett in 2010 defined the following risk factors responsible in the development of frozen shoulder:

1. **Age and Gender:** Most commonly affects patients between the age of 40 and 60 years and it is twice common in women than in men.
2. **Endocrine Disorders:** Patients with diabetes are at particular risk for developing frozen shoulder. Other endocrine disorders such as thyroid can also lead to this condition.
3. **Shoulder Trauma or Surgery:** Patient who sustained a shoulder injury or underwent surgery on the shoulder can develop a frozen shoulder. When surgery or injuries followed by prolonged joint immobilization, risks of developing frozen shoulder are highest.
4. **Other Systemic Condition:** Systemic conditions such as heart and Parkinson's disease have also been found to be associated with an increased risk for developing a frozen shoulder.

The usual and typical symptoms of frozen shoulder include usually a dull, aching pain, limited ROM especially external rotation, difficulty with activities such as brushing hair, putting on shirts/ bras, pain when trying to sleep on the affected shoulder.

Three stages of frozen shoulder have been described: **Painful / Freezing Stage:** is the most painful stage, motion is restricted, but the shoulder is not stiff. This painful stage typically lasts 6 to 12 weeks. **Frozen Stage:** pain usually eases out, but the stiffness worsens. This stage lasts 4 to 6 months. **Thawing Stage:** gradually motion improves over a lengthy period of time, lasts more than a year.

Frozen shoulder is suspected during examination when the shoulder range of motion is significantly limited, with either the patient or the examiner attempting the movement. Underlying diseases involving the shoulder joint can be diagnosed with the history, examination, and blood testing and x-ray examination of the shoulder joint. Inflammation of the shoulder joint (arthritis) or the muscles around the shoulder can cause swelling, pain, or stiffness of the joint that can mimic the range of motion limitation of the frozen shoulder. Injury to individual tendons around the shoulder (tendons of the rotator cuff) can limit shoulder joint range of motion, but usually not in all directions. The treatment of frozen shoulder usually requires an aggressive combination of anti-inflammatory medications, cortisone injections in to the shoulder joint, and physical therapy. Without aggressive treatment, a frozen shoulder can be permanent. Diligent physical the-

rapy is often key and can include ultrasound, electric stimulation, and range of motion exercise maneuvers, ice packs, and eventually strengthening exercises. Most patient find relief with exercise and stretching, moist heat, anti-inflammatory medications, cortisone injection, and manipulation under anesthesia. Physical therapy can take weeks to months for recovery, depending on the severity of the scarring of the tissues around the shoulder. Sometimes frozen shoulder is resistant to treatment. Patients with resistant frozen shoulder can be considered for release of the scar tissue by arthroscopic surgery or manipulation under anesthesia. It is very important for patients that undergo manipulation to partake in an active exercise program for the shoulder after the procedure. It is only with continued exercise of the shoulder that mobility and function optimized.

It is very important for people with a frozen shoulder to avoid reinjuring the shoulder tissues during the rehabilitation period. These individuals should avoid sudden jerking motions, heavy lifting with affected shoulder.

## Literature Review

Morgan B. et al (1996) found that the transcutaneous electric nerve stimulation (TENS) is a safe and simple form of analgesia but is little used as an adjunct to local anesthesia during routine procedures. This trial investigates the use of TENS in the radiology department using distension shoulder arthrography for ‘frozen shoulder’, a moderately painful procedure, as a model. Sixty patients with a clinical diagnosis of ‘frozen shoulder’ were randomized to receive high-intensity TENS, low – intensity TENS or to act as controls. A standard procedure was then performed. Following the procedure patients completed a visual analogue pain scale. Mean recorded pain levels were lower in the TENS groups with a 50% difference between the high – intensity group and a 38% difference between the low – intensity group as compared to control (difference statistically significant  $P < 0.01$  and  $P < 0.05$ ,

respectively). TENS was well tolerated by patients. The 50% reduction in mean pain levels supports the use of TENS for routine painful procedures.

Craig J. A. et al (1996) assessed the hypoalgesic efficacy of transcutaneous electrical nerve stimulation (TENS) upon acute stage (72 h) experimentally induced delayed onset muscle soreness (DOMS). TENS naive subjects ( $n = 48$ ; 24 male and 24 female) were recruited, screened for relevant pathology and randomly allocated to one of four experimental groups: control, placebo, low TENS (200  $\mu$ sec; 4 Hz) or high TENS group (200  $\mu$ sec; 110 Hz). DOMS was induced in a standardized fashion in the non-dominant elbow flexors of all subjects by repeated eccentric exercise. Subjects attended on three consecutive days for treatment and measurement of elbow flexion, extension and resting angle (Universal goniometer). Mechanical Pain Threshold/tenderness (algometer) and pain (Visual Analogue Scale (VAS)) on daily basis, plus McGill Pain Questionnaire on the third day only. Measurements were taken before and after treatment under controlled double blinded conditions. Analysis of results using repeated measures analysis of variance (ANOVA) and post hoc tests showed some inconsistent isolated effects of high TENS (110 Hz) compared to the other conditions upon resting angle and flexion scores; no significant effects were found for any of the other variables. These results provide no convincing evidence for any measurable hypoalgesic effects of TENS upon DOMS-associated pain at the stimulation parameters used here. Ishaque F. (2008) stated that mobilization techniques improve the normal extensibility of the shoulder capsule and stretch the tightened soft tissues to induce beneficial effects.

Heijden G. J. M. G. et al (1999) conducted a Randomized placebo controlled trial with a two by two factorial design plus an additional control group in 17 primary care physiotherapy practices in the south of the Netherlands. Patients with shoulder pain and / or restricted shoulder mobility, because of soft tissue impairment without underlying specific or generalized condition, were enrolled if they had not recovered after

Morgan B. et al  
(1996)  $n = 60$ .

Tool	Outcome Scale	Effect	Result
High Intensity TENS	VAS	50% improved compare to control group	50% reduction in pain supports the use of TENS
Low Intensity TENS	VAS	38% improved compare to control group	

Craig J. et al (1996) n=48 (24 males, 24 females).

Tool	Outcome Scale	Effect	Result
Low TENS (200µsec; 4Hz)	Mechanical Pain Threshold, VAS, Mc Gill Pain Questionnaire	Inconsistent effects of High TENS (200µsec; 110Hz)	No convincing evidence for any measureable hypoalgesic effects of Tens upon DOMS associated pain
High TENS (200µsec; 110Hz)			

Yang J. I. et al (2007)

Tool	Outcome Scale	Effect	Result
End Range Mobilization (ERM)	Mobility and Functional Ability	Significant improvement in ERM	ERM and MWM are more effective than MRM
Mobilization With Movement (MWM)		MWM corrected scapulohumeral rhythm significantly than ERM	
Mid Range Mobilization (MRM)		MRM less effective than ERM and MWM	

Vermeulen H. M. et al (2000), n=7 (4 men, 3 women), Mean age: 50.2 years. Disease duration: 8.4 months.

Tool	Outcome Scale	Effect		Result
		Arom	Prom	
End Range Mobilization (ERM)	Joint Mobility	Flexion from 113 to 147 degree; Abduction from 91 to 151 degree; Lateral Rotation from 13 to 31 degree	Flexion from 120 to 154 degree; Abduction from 96 to 159 degree; Lateral Rotation from 21 to 41 degree	4 patients rated excellent improvement, 2 patients rated good improvement, 1 patient rated moderate improvement.

six sessions of exercise therapy in two weeks. They were randomized to receive (1) active ET plus active US; (2) active ET plus dummy US; (3) dummy ET plus active US; (4) dummy ET plus dummy US; or (5) no adjuvant. Additionally, they received a maximum of 12 sessions of exercise therapy in six weeks. Measurements at baseline, 6 weeks and 3, 6, 9, and 12 months later were blinded for treatment. Outcome measures: recovery, functional status, chief complaint, pain, clinical status, and range of motion After written informed consent 180 patients were randomized: both the active treatments were given to 73 patients, both the dummy treatments to 72 patients, and 35 patients received no adjuvants. Prognosis of groups appeared similar at baseline. Blinding was successfully maintained. At six weeks seven patients (20%) without adjuvants reported very large improvement (including

complete recovery), 17 (23%) and 16 (22%) with active and dummy ET, and 19 (26%) and 14 (19%) with active and dummy US. These proportions increased to about 40% at three months, but remained virtually stable thereafter. Up to 12 months follow up the 95% CI for differences between groups for all outcomes include zero.

Yang J. I. et al (2007) compared the use of 3 mobilization techniques—end – range mobilization (ERM), mid-range mobilization (MRM), and mobilization with movement (MWM)—in the management of subjects with frozen shoulder syndrome (FSS). They found that subjects in both groups improved over the 12 weeks. Statistically significant improvements were found in ERM and MWM. Additionally, MWM corrected scapulohumeral rhythm significantly better than ERM did. They also conclude that subjects with FSS, ERM and

MWM were more effective than MRM in increasing mobility and functional ability. Movement strategies in terms of scapulohumeral rhythm improved after 3 weeks of MWM.

Vermeulen H. M. et al (2000) describes the use of end-range mobilization techniques in the management of patients with adhesive capsulitis. They conducted their gliding on Four men and 3 women (mean age = 50.2 years, SD = 6.0, range = 41 – 65) with adhesive capsulitis of the glenohumeral joint (mean disease duration = 8.4 months, SD = 3.3, range = 3 – 12) were treated with end – range mobilization techniques, twice a week for 3 months. Indexes of pain, joint mobility, and function were measured by the same observer before treatment, after 3 months of treatment, and at the time of a 9 – month follow-up. In addition, arthrographic assessment of joint capacity (i.e., the amount of fluid the joint can contain) and measurement of range of motion of glenohumeral abduction on a plain radiograph were conducted initially and after 3 months of treatment. After 3 months of treatment, there were increases in active range of motion. Mean abduction increased from 91 degrees (SD = 16, range = 70 – 120) to 151 degrees (SD = 22, range = 110 – 170), mean flexion in the sagittal plane increased from 113 degrees (SD = 17, range = 90 – 145) to 147 degrees (SD = 18, range = 115 – 175), and mean lateral rotation increased from 13 degrees (SD = 13, range = 0 – 40) to 31 degrees (SD = 11, range = 15 – 50). There were also increases in passive range of motion: Mean abduction increased from 96 degrees (SD = 18, range = 70 – 125) to 159 degrees (SD = 24, range 110 – 180), mean flexion in the sagittal plane increased from 120 degrees (SD = 16, range = 95 – 145) to 154 degrees (SD = 19, range = 120 – 180), and mean lateral rotation increased from 21 degrees (SD = 11, range = 10 – 45) to 41 degrees (SD = 8, range = 35 – 55). The mean capacity of the glenohumeral joint capsule (its ability to contain fluid) increased from 10 cc (SD = 3, range = 6 – 15) to 15 cc (SD = 3, range = 10 – 20). Four patients rated their improvement in shoulder function as excellent, 2 patients rated it as good, and 1 patient rated it as moderate. All patients maintained their gain in joint mobility at the 9 – month follow-up.

Blanchard V. et al (2009) found in a review of literature of 6 studies were deemed eligible for inclusion in the final review. All had evidence of random allocation to either an injection group or a physiotherapeutic intervention group. There were some differences between the studies with regard to both the corticosteroid injections and physiotherapeutic interventions. Stan-

darized mean differences and effect estimates were calculated for three of the included studies at various follow-up periods. There was a medium effect for corticosteroid injections compared with physiotherapeutic interventions for the outcomes of pain, passive external rotation and shoulder disability at 6 weeks. There was only a small effect in favor of corticosteroid injections for pain, passive external rotation and shoulder disability at 12 to 16 weeks and 26 weeks, and pain and shoulder disability at 52 weeks.

## Material and Method

### Study Design

Divided the population (n = 30; 16 female, 14 male) into two groups, one is called experimental and other the control group. Experimental group exposed to electrotherapy (US 1MHz, continuous at 2w / cm<sup>2</sup> for 4 minutes; preset low rate high intensity TENS for 20 minutes; hot packs for 10 minutes) while the control group to the exercise therapy (glenohumeral mobilization and stretching) protocols. Simple Random Sampling Technique was adapted to collect the samples from the population of frozen shoulder. Every alternate or second member, who came to the department of physical therapy with the complaint of frozen shoulder, was selected for the experimental group and every third member selected for the control group.

### Inclusion Criteria

- Middle aged male and female.
- Having unilateral, idiopathic primary type of frozen shoulder.
- Persisted for 2 months.
- Having pain that hindered the ADLs and restricted ROM especially external rotation and abduction.

### Exclusion Criteria

- Young and old individuals.
- Secondary frozen shoulder.
- Recent history of trauma.
- Post CABG patients.
- Patient with mastectomy.
- Patient with acute cervical spondylosis.

SOAP method was used to collect the data for analysis. The procedure involved the assessment at two levels, first at day one or before treatment and second at day fourteen (pre and post assessment). The assessment was based on the single outcome tool that is, Visual Analogue Scale (VAS) for pain. The treatment between these two assessments involved the electrotherapy (ultrasound of continuous mode at 1 MHz, 2 w/cm<sup>2</sup> for 4 minutes to shoulder joint, preset low rate high intensity TENS for 20 minutes and hot packs for 10 minutes) in the control group, glenohumeral mobilization and stretching exercises to the shoulder soft tissue were done in the experimental group.

## Result

Thirty patients (male 14, female 16) of middle aged (mean 52.5 years, 40 – 65), with primary idiopathic frozen shoulder were monitored for the comparison between electrotherapy and exercise therapy. After 14 days of physical therapy sessions, found that the electrotherapy is more effective (42.77%) than exercise therapy (31.66%) by using the un-related t-test on the data ( $t = 1.701$ ,  $p = 0.10$ ,  $df = 28$ ). The result was found to be significant at  $p > 0.05$  for one tail hypothesis. This means that electrotherapy is more effective than exercise therapy alone in frozen shoulder for pain modulation.

During comparison, electrotherapy found to be effective more than exercise therapy for pain modulation in frozen shoulder patients. The results are similar to the results of Morgan B. et al (1996), as they found the efficacy of TENS in distended shoulder arthrography.

## Recommendation

With the above experience, the author shall recommend ultrasound of continuous mode at 1 MHz, 2 w/cm<sup>2</sup> for 4 minutes to shoulder joint, preset low rate high intensity TENS for 20 minutes and hot packs for 10 minutes for pain alleviation only in frozen shoulder.

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