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Effect of PNF and joint mobilization along with ultrasound on abduction and external rotation range of motion and pain in patients with frozen shoulder

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Abstract

Introduction: PNF and Mobilization are the two techniques used in improving Range of motion and reducing pain in patients with frozen shoulder but there is limited evidence for the comparison of PNF movement pattern and Mobilization in the treatment of frozen shoulder**.** Objectives of the study was to compare the effectiveness of PNF movement pattern and mobilization along with ultrasound on abduction and external rotation range of motion and pain in patients with frozen shoulder.

Materials and Methods: 30 clinically diagnosed subjects with frozen shoulder were randomly assigned to either PNF movement pattern with Ultrasound (Group A) and Mobilization technique with Ultrasound (Group B) and were evaluated by measuring passive ROM with the help of Goniometry at baseline, last day of 2nd week and last day of 4th week. Data analysis was performed using SPSS 16**.**

Results: There was significant improvement in ROM and pain after 4 weeks. The result of the study revealed that PNF movement pattern with Ultrasound is better than mobilization technique and ultrasound in improving ROM.

Conclusion: The study showed that both PNF and Joint mobilization along with US are effective in improving shoulder ROM in patients with Frozen shoulder. However subjects treated with PNF showed statistically significant improvement than the subjects treated with joint mobilization.

Keywords: frozen shoulder, ultrasound, PNF, mobilization

Introduction

Frozen shoulder clinically referred to as adhesive capsulitis has been described as a condition of "unknown etiology characterized by gradually progressive, painful restriction of all joint motion with spontaneous restoration of partial or complete motion over months to years [1]. It occurs in the general population with an incidence of approximately 2% and of these 20 to 30% develop the condition bilaterally [2]. The condition is characterized by an insidious and progressive loss of active and passive mobility in the Glenohumeral joint due to joint contracture [3]. It is more common in females, age between 40-60 years [4]. It is commonly observed among peoples in 40–60 yr old, and it is known as "frozen shoulder" [5].

The classic frozen shoulder has 3 stages

1. Stage 1: Painful stage or Freezing phase (Lasts for 2 to 9 months)
2. Stage 2: Stiffness or Frozen phase (Lasts for 4 to 12 months)
3. Stage 3: Thawing phase (Lasts for 6 to 9 months)

Stage 1:- The "freezing" or "painful" stage, in which the patient has diffuse lateral shoulder pain begins gradually and insidiously. Pain is the main initial

Complaint. The pain is worse at night & exacerbated by lying on the affected side,

Stage 2:- The "stiff" or "frozen" stage, in which stiffness with decreased range of motion predominates. Pain, though still present with extreme movement, subsides and loss of movement becomes the patient's chief complaint. Ability to care for oneself and to work might be significantly affected, especially if the patient's dominant arm is involved.

Stage 3:- The "thawing" stage during which, Exacerbations of pain still occur, often because of excessive activity. Gradually pain subsides and movement becomes almost normal [6, 7].

The proprioceptive neuromuscular facilitation (PNF), developed by Knott and Kabat, is a type of therapeutic exercise composed of a pattern of muscular contractions and diagonal movements that are effective on paralyzed muscles and pain of muscles [6]. Proprioceptive neuromuscular facilitation stretch is a technique commonly used in clinical environments to enhance both active and passive ROM with the ultimate goal being to optimize motor performance and rehabilitation [8]. PNF utilizes stretching inhibitory techniques, of these contract relax and hold relax are commonly used. In PNF muscle first lengthened to mild discomfort position and then optimal duration of isometric contraction of 3-6 sec is given, followed by 10 sec of voluntary relaxation of muscle for further elongation of the muscle to new range [9].The isometric contraction causes neural inhibition that reduces reflex activity which then promotes greater relaxation and decreased relaxation to stretch and hence greater ROM [10].

Mobilization technique

Joint mobilization refers to manual therapy techniques that are used to modulate pain and treat joint dysfunctions that limit ROM. Mobilization techniques are applied close to the articular surface in ventral, dorsal and inferior directions of the glenohumeral joint as an intervention for limited joint range of motion [11].

Ultrasound therapy (UST), one of the modalities used to treat frozen shoulder which elevates tissue temperature to depths of more than 5 cm causing increased collagen tissue extensibility,

pain threshold, and enzymatic activity. It also changes nerve conduction velocity, contractile activity of the skeletal muscle [12] To our knowledge, there is a dearth of evidence that PNF, Ultrasound and Mobilization is effective in treating frozen shoulder. Hence the purpose of the present study was to compare the effectiveness of PNF stretch combined with movement pattern and Mobilization along with ultrasound on passive range of motion in patients with frozen shoulder.

Materials and Methods

Study Design

Pretest, posttest experimental group design was carried out with sample of 30 patients with frozen shoulder. Subjects were randomly allocated using sealed envelope method to receive either PNF stretch combined with movement pattern and ultrasound or Mobilization with ultrasound. Informed consent was taken from all the participants included in the study. All the participants who meet the inclusion criteria were evaluated thoroughly using screening Performa.

Source of Data

Uma Sanjivani hospital, Gurgaon, Haryana.

Inclusion and Exclusion criteria

Participants with frozen shoulder were selected and were included in the study after meeting the following inclusion criteria: Symptomatic subjects between the age group of 40-60 (both male and female).Subjects having stiff and painful shoulder for more than 1 month.

Minimum 50% of restriction in abduction and external rotation of shoulder joint.

Unilateral involvement, Diabetic and non-diabetic patient. Subjects with following conditions were excluded from the study with history of recent shoulder trauma in and around shoulder joint, Rotator cuff injuries or previous surgery, Intrinsic gleno- humeral pathology such as glenohumeral arthritis [12].

Interventions

Ultrasound was given in sitting with a pulse ratio of 1:4 and an intensity of 1.5 W/cm2 for 10 minutes [13].

Group A was treated with PNF stretch combined with movement pattern and ultrasound thrice a week. Group B was treated with mobilization with ultrasound thrice a week.

PNF stretch with movement pattern

The subject was placed in supine lying. In supine position, the subject's head and neck was placed in comfortable position. The involved upper extremity was positioned in shoulder extension, adduction and internal rotation; elbow extension; forearm pronation; wrist and finger flexion with forearm lying across the umbilicus. PNF hold-relax technique was applied to antagonist muscle for 10 seconds followed by voluntary relaxation the arm was then passively moved into the new range. This was repeated 5 times per session. Treatment was given 3 times a week for 4 weeks [14].

Mobilization

Joint mobilization refers to manual therapy techniques that are used to modulate pain and treat joint dysfunctions that limit ROM.

Grades of mobilization:

1. **Grade 1:** Small amplitude rhythmic oscillations are performed at the beginning of range.
2. **Grade 2:** Large amplitude rhythmic oscillations are performed within the range not reaching the limit.
3. **Grade 3:** Large amplitude rhythmic oscillations are performed up to the limit of the available motion and are stressed into the tissue resistance.
4. **Grade 4:** Small amplitude rhythmic oscillations are performed at the limit of the available motion and are stressed into the tissue resistance.

The subject was placed in supine lying.

Mobilization was given to improve abduction and external rotation thrice a week for 4 weeks, three sets of 10 to 15 repetitions with 1 minute rest was given. Total duration of intervention was 30 minutes [8].

Outcome and Measurements

Pain was measured using Visual Analog Scale and Range of Motion was measured by Universal Goniometer. All the outcome measurements were taken at the baseline, 2nd week and then after 4th week in both the groups.

Statistical analysis

Data analysis was performed with software package SPSS 16 for window version. Mean and standard deviations for all the variables were calculated. Comparison of effect of treatment within the group for all the variables was done by using Paired t test Comparison between the groups for all the variables on day 1, 2nd week and 4th week was done using unpaired t test. Significance level was kept at 95% ($p<0.05$) SThere is no statistically significant difference in the baseline VAS score and initial ranges of shoulder.

Results

The results revealed a significant difference between Group A and Group B at the end of the study depicting that PNF stretch with movement pattern was more effective than Mobilization when combined with ultrasound in increasing Range of motion and decreasing pain of shoulder joint.

Change in Rom

The measurement of ROM in degree was done at baseline, 2nd week and 4th week.

Table 1: Comparison of abduction range of Group A

Group A	Abduction		P value
	Mean± SD	Mean± SD	
0-2 wks	95.7333±7.20582	1.2860±8.06934	.047^{NS}
2-4 wks	128.60±8.06934	1.6933±7.35495	.003*
0-4 wks	95.7333±7.20582	1.6933±7.35495	0.001*

NS: Not significant, *: Significant, Group A: PNF

Within group analysis showed that there was highly significant improvement in abduction ROM in group A on 2nd and 4th week ($p< 0.005$)

Table 2: Comparison of External rotation range of Group A

Group A	External Rotation		P value
	Mean± SD	Mean± SD	
Baseline	24.667±2.74246	54.600±6.00952	.082[NS]
2nd week	54.600±6.00952	81.1333±2.69568	.014[*]
4th week	24.667±2.74246	81.1333±2.69568	0.002[*]

NS: Not significant, *: Significant, Group A: PNF,

Within group analysis showed that there was a significant improvement in External rotation ROM in group A on 2nd and 4th week (p< 0.005)

Within group analysis showed that there was a significant improvement in abduction ROM on group B in 2nd and 4th week (p< 0.005)

Table 3: Comparison of abduction range of Group B

Group B	Abduction		P valuable
	Mean± SD	Mean± SD	
baseline	95.2000±4.26280	1.1600±8.41767	.034[NS]
2nd week	1.1600±8.41767	1.6020±2.62624	.012[*]
4th week	95.2000±4.26280	1.6020±2.62624	0.002[*]

Table 4: Comparison of External rotation range of Group B

Group B	External Rotation		P value
	Mean± SD	Mean± SD	
0-2 wks	24.000±1.08584	48.800±1.69930	.0377[NS]
2-4 wks	48.800±1.69930	72.0667±1.55063	.0142[*]
0-4 wks	24.000±1.08584	72.0667±1.55063	0.003[*]

NS: Not significant, *: Significant, Group B: joint mobilization

Within group analysis showed that there was a significant improvement in External rotation ROM in group B on 2nd and 4th week (p< 0.005)

Table 5: Comparison of VAS scores between Group A and Group B

Variable (VAS)	Group A mean ± standard deviation	Group B mean ± standard deviation	T value	P value
baseline	6.79±0.76	7.25±0.90	1.208	0.261[NS]
2nd week	4.20±0.85	5.09±0.85	3.019	0.006*
4th week	2.08±0.65	3.10±0.60	2.732	0.004*

NS: Not significant, *: Significant, Group A: PNF, Group B: joint mobilization

Between group analysis showed that there was a significant reduction in VAS score in Group A and group B on 2nd and 4th week (p< 0.00.

Table 6: Comparison of abduction range between Group A and Group B

Comparison	Abduction		P value
	Mean± SD Group A	Mean± SD Group B	
baseline	95.7333±7.20582	95.2000±4.26280	.0365[NS]
4th week	169.33±7.35495	160.20±2.62624	.014[*]

NS: Not significant, *: Significant, Group A: PNF Group B: joint mobilization

Between group analysis showed that there was significant improvement in abduction ROM in group A and Group B on 4th week (p< 0.005)

Table 7: Comparison of external Rotation between group A and Group B

Comparison	External Rotation		P value
	Mean± SD Group A	Mean± SD Group B	
baseline	24.667±2.74246	24.000±1.08584	.0647[NS]
4th week	81.1333±2.69568	72.0667±1.55063	.011[*]

NS: Not significant, *: Significant, Group A: PNF Group B: joint mobilization

Between group analysis showed that there was significant improvement in External rotation ROM in Group A and Group B on 4th week (p< 0.005)

Discussions

Results of the study showed that PNF movement pattern is more effective technique than joint mobilization in reducing pain (measured by VAS) and increasing ROM (measured by Goniometer)

Subjects included in this study had similar baseline values of all dependent variable selected suggesting that both groups had homogeneous distribution of patients. The VAS and ROM of both groups came out to be non-significant at baseline when compared using 't' test.

Pain intensity was measured at 2nd week and 4th week with mean difference of 2.59, 2.12 for Group A and 2.25, 1.89 for Group B which was significant p≤0.05, Abduction and External rotation ROM for Group A was measured at baseline and 4th week with mean difference of 73.50 and 56.47 as shown in Table No- 1 and 2. Abduction and External rotation ROM for Group B was measured at baseline and 4th week with mean difference of 65.00 and 48.06, as shown in Table No- 3 and 4. Between group analysis between Group A and B comparing Pain, Abduction and External Rotation as shown in Table No- 5, 6 and 7.

Luís Viveiros [15] *et al* 2004 found that Stretching import physiological changes such as remodeling of elastin and collagen molecules, these changes may be associated with alterations on the muscle tendon units and fascia, caused by increase on tissue elasticity. In other words, the range of motion would be influenced by the increase on the length of the tissue.

In another study by Funk DC 2003 [16] had concluded that PNF stretching shows greater ROM gains than static stretching. Panjabi M [17] *et al* studied that proprioceptive neuromuscular technique demonstrated significant improvement in terms of pain relief, restoration of ROM and early return to ADL. The mechanism by which proprioceptive neuromuscular technique caused improvement in shoulder ROM and function could be elongation of tissues, which could be the probable reason helping to improve ROM and function. Panjabi explains that every movement segment depends on three subsystems; the passive, the active and the neural subsystem, which stresses the diagonal pattern of movement in PNF technique. Maitland 1983 said that mobilization mainly consists of rhythmic oscillatory movements which stimulate the type-2 dynamic mechanoreceptors and by this way can inhibit the type-4 nociceptive receptors and also has an effect on circulatory perfusion and has an effect on fluid flow as blood flow in the vessels supplying the nerve fibres and synovial fluid flow surrounding the avascular articular cartilage. Mobilization causes a reversal of the ischemia, oedema, and inflammation

cycle and reduces joint effusion and relieves pain by reducing the pressure over the nerve endings

Vermeulen HM *et al* [3] also opined that mobilization (Maitland "Grade 3-4") plays a major role to get optimum movement of shoulder in conditions associated with frozen shoulder. Mangus, B.C [18] *et al* 2002 concluded that Joint mobilization techniques induce neurophysiologic effect which is based upon the stimulation of the peripheral mechanoreceptors and inhibition of nociceptors. Bialosky [19] *et al* (2009) suggested that manual therapy (MT) is effective in the treatment of musculoskeletal pain. Donatelli and Wooden [12], 2004 studied the mechanical changes which include breaking up adhesions, realigning of collagen or increasing fiber glide when specific movement stress the specific part of the capsular tissue. Robertson VJ [20] *et al* reported the usage of ultrasound therapy (UST) clinically in rehabilitation of patients with frozen shoulder. According to him, active therapeutic ultrasound is used for treating people with pain and musculoskeletal injuries to promote soft tissue healing. Both thermal and nonthermal effects of UST are proven beneficial in reducing inflammation and improve tissue extensibility, pain threshold, and enzymatic activity. The increased pliability of the tissue along with the reduction of inflammation as a part of thermal effects of UST paves way for aggressive mobilization of shoulder with low perception of pain. The non-thermal effects of UST have shown to reduce the recurrence of the symptoms also reducing the in-house rehabilitation duration mobilization. Clinical relevance of the study was to provide useful information about the effect of PNF and mobilization along with ultrasound in improving shoulder ROM thus providing a better approach for frozen shoulder treatment. It can be successfully included in conditioning and training program to improve performance. Future research can be done with large group of sample including subjects with different age group. The merits associated with long term effect of PNF stretching and joint mobilization for improving ROM with same treatment period were not examined in this study due to time constraints so future research may include a follow up of 2- 4 months so as to verify the long term effect of treatment program which may be beneficial for patients of frozen shoulder.

Conclusion

Result of the study showed that both PNF and joint mobilization along with US are effective in improving shoulder ROM in patients with frozen shoulder. However subjects treated with PNF showed statistically significant improvement than the subjects treated with joint mobilization.

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