

Effect of Proprioceptive Neuromuscular Facilitation Technique on Pain, Range of Motion and Quality of Life in Adhesive Capsulitis - An Interventional Study

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ABSTRACT

Background: Adhesive capsulitis is characterized by the development of dense adhesion, capsular thickening and capsular restriction. Proprioceptive Neuromuscular Facilitation (PNF) is an approach to therapeutic exercise that combines functional based diagonal patterns of movement with the technique of neuromuscular facilitation to evoke motor response and improve neuromuscular control and coordinated movements. Proprioceptive Neuromuscular Facilitation (PNF) aims to enhance mobility, movement control and joint coordination.

Method: After approval from the ethical committee, 34 patients were selected and randomly allocated into 2 groups, Group A (control) and Group B (Interventional). Group A (control) received conventional treatment while Group B (Interventional) received conventional plus PNF techniques (5 sessions) for 4 weeks. Pre and post interventional score of NPRS, Range of motion(goniometer) and SPADI scale were measured.

Results: After 4 weeks of intervention, Within Group analysis showed significant improvement on NPRS, range of motion(goniometer) and SPADI scale compared to pre data ($p<0.05$). In between-group analysis, Group B showed significant improvement on score of NPRS, range of motion (goniometer) and SPADI scale than Group A ($p<0.05$).

Conclusion: Group B showed statistically significant improvement on Pain, Range of motion and Quality of life compared to Group A.

Keywords: Adhesive Capsulitis, Proprioceptive Neuromuscular Facilitation

INTRODUCTION

Adhesive capsulitis, peri arthritis, and frozen shoulder are all terms used to describe a painful and stiff glenohumeral joint.⁽¹⁾ Adhesive capsulitis, is characterized by a painful condition with gradual loss of active and passive glenohumeral joint motion with an uncertain etiology.⁽²⁾ Adhesive capsulitis results in limb disability and a reduction in quality of life. Pathological findings of

adhesive capsulitis are mainly thickening and contracture of the glenohumeral joint capsule with adhesion to the humeral head.⁽²⁾ This condition is seen mainly between the age group of 40-65 years and less in younger than 40 years age.⁽³⁾ This condition affects both shoulders in 16% of patients.⁽³⁾ The prevalence of adhesive capsulitis in the normal population is 2% - 5% and 10%-15% in the diabetic population.⁽⁴⁾

PNF is defined as ‘methods of promoting or hastening the response of the neuromuscular mechanism through stimulation of the proprioceptors given by Voss, Jonta, and Meyers (1985).⁽⁵⁾ Proprioceptive Neuromuscular Facilitation (PNF) is a therapeutic method that makes use of auditory, cutaneous, verbal, visual, and proprioceptive input to generate functional recovery in motor output and play a significant part in the treatment of various ailments.⁽⁵⁾ Proprioceptive Neuromuscular Facilitation(PNF) is an approach to therapeutic exercise that combines a functional-based diagonal pattern of movement with the technique of neuromuscular facilitation to evoke a motor response and improve neuromuscular control and coordinated movements.⁽⁵⁾ It consists of multiple planes of movement, making the task more functional and thus helping improve the patient's functional status.⁽⁵⁾ This method activates the proprioceptors found in muscles and tendons, improving muscular performance and promoting postural reflexes.⁽⁵⁾ PNF is a therapeutic idea that enhances the range of motion and muscle activation through four theoretical mechanisms known as autogenic inhibition, reciprocal inhibition, stress relaxation, and gate control theory.⁽³⁾ Using upper extremity patterns, dysfunction brought on by neurological issues, musculoskeletal conditions, or joint constraints is treated.⁽⁶⁾

Adhesive Capsulitis affects Quality of life due to Pain and hypomobility, there are less evidences on the Indian population, hence this study is done to add evidence about the effect of Proprioceptive Neuromuscular Facilitation technique on Pain, Range of motion and Quality of life in Adhesive capsulitis.

So the purpose of this study is to evaluate the effect of PNF technique on Pain, Range of motion and Quality of life in adhesive capsulitis.

The Numeric Pain Rating scale (NPRS) is a valid tool for measuring pain. The NPRS has a 0.95 intraclass correlation value.⁽⁷⁾

Shoulder Range of motion was measured by using a Universal Goniometer and Intraclass correlation values for the Goniometer ranging from 0.80 to 0.99.⁽⁸⁾

The Shoulder Pain and Disability Index (SPADI), a patient-completed questionnaire of 13 items, measures the severity of pain and the degree to which daily activities requiring the use of the upper extremities are made more difficult. There are 5 items on the pain subscale and 8 on the disability subscale. SPADI's intraclass correlation coefficient is >0.90.⁽⁹⁾

MATERIALS AND METHODS

The study comprised patients with adhesive capsulitis. The research design was single-blinded.

The study was approved by the ethical review committee. (Reg No: ECR/1573/Inst/GJ/2021)

Study Design: Interventional study

Study Setting: Physiotherapy College.

Study Duration: 1 year.

Sampling Technique: Randomized sampling (chit method)

Sample Size: 34

Sample size was calculated according to the following formula.

$N=2SD^2(Z_{a/2}+Z_B)^2/d^2$ where,

SD= Post SD

d=critical difference

$Z_{a/2}$ = level of significance at 95% confidence interval the value is 1.96.

Z_B = Power of study, at 95% power the value is 1.64.⁽¹⁰⁾

INCLUSION CRITERIA

- Willing to participate.
- Both male and female
- Age group between 40 and 65 years.
- Person diagnosed with Adhesive capsulitis by a medical practitioner with more than 3 months duration.
- Unilateral Adhesive capsulitis.
- Patients who understand and follow the verbal and visual commands.
- Patients who were able to read Gujarati and English languages.

EXCLUSION CRITERIA

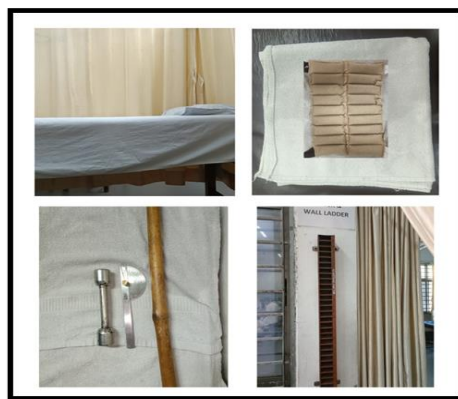
- Any known history to the patient about orthopaedic conditions other than Adhesive capsulitis.
- Any known history to the patient about neurological/cardiopulmonary condition.
- Any contraindication of Proprioceptive Neuromuscular Facilitation (PNF) technique.

WITHDRAWAL CRITERIA

- If pain aggravates.
- If patient wishes to discontinue the treatment.

MATERIALS REQUIRED FOR THE STUDY

- Pen, pencil, paper
- Treatment plinth
- Goniometer
- SPADI scale sheet (Gujarati translated)
- Patient informed consent form
- Assessment form
- Hot pack and towel
- Wall ladder
- Wand stick
- Dumbbell

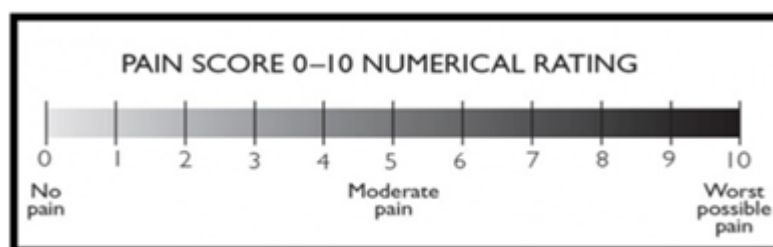


Photograph 1.1 Materials used for the study

OUTCOME MEASURES

1) **NUMERIC PAIN RATING SCALE** - reliability=0.67 to 0.96 and validity=0.86 to 0.95.⁽⁷⁾ The Numerical Pain Rating Scale (NPRS) was used to assess pain intensity. NPRS is an 11-point scale measured using a straight

line, representing numbers 0 through 10. 0 represents “no pain” whereas 10 represents “worst imaginable pain”. The patients were asked to indicate a number on the straight line that is the best indication of their level of pain.⁽⁷⁾



Photograph 1.2 NPRS

2) **SHOULDER ROM** (Universal Goniometer) - Intraclass correlation coefficients ranging from 0.80 to 0.99.⁽⁸⁾



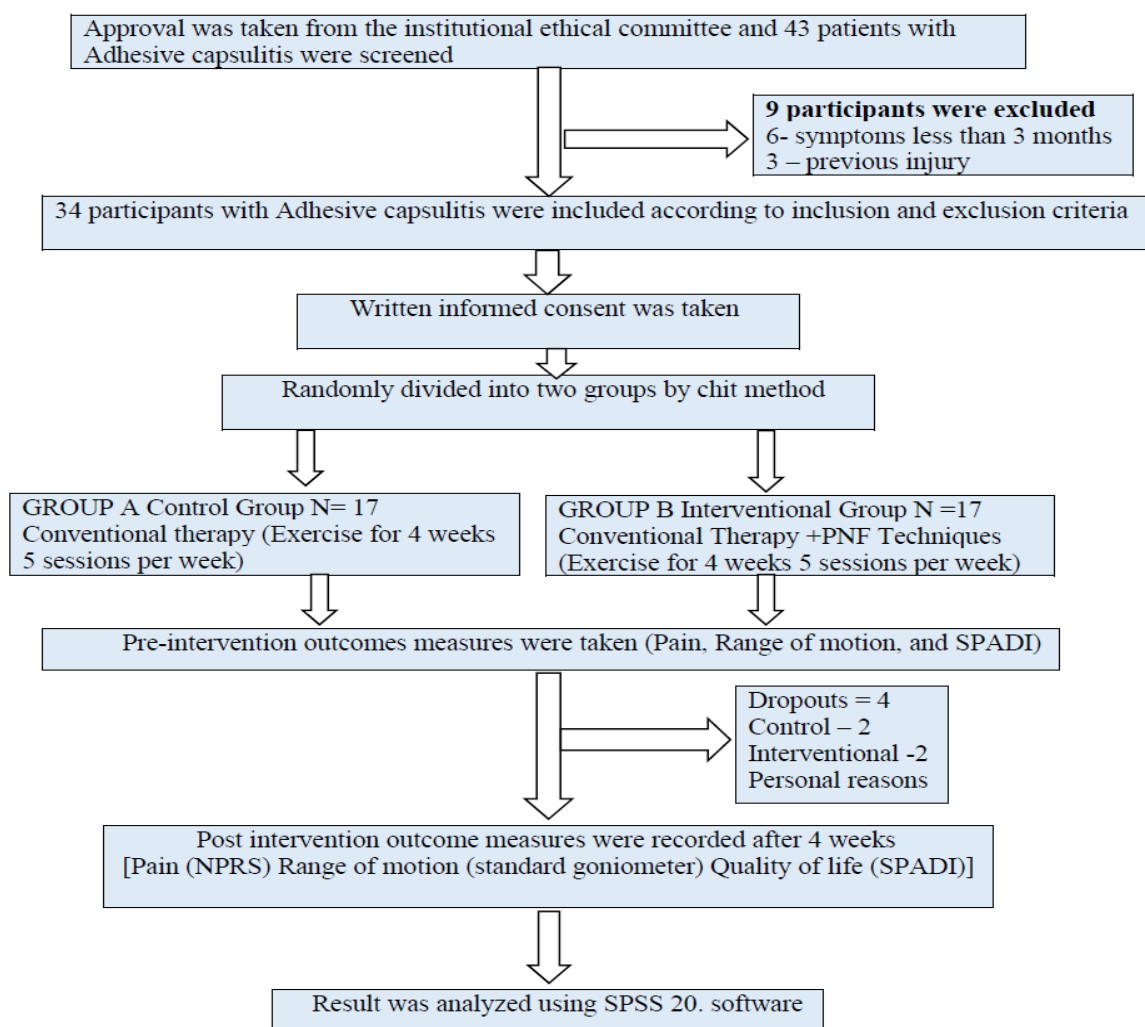
Photograph 1.3 Shoulder ROM

3) **SPADI SCALE** - Intraclass correlation coefficient ≥ 0.90 for SPADI.⁽⁹⁾

The SPADI is a self-measurement tool that measures pain and functional disability in subjects having Adhesive capsulitis. The

subjects were asked to fill in what they considered most appropriate for them. Since all the patients were not well-versed in English, SPADI was used in its Gujarati version.⁽⁹⁾

METHODOLOGY FLOW CHART



Subjects with Adhesive capsulitis was included in the study, based on the inclusion and exclusion criteria. After taking informed, written consent subjects were allocated to two groups, Group A [Control] and Group B [Interventional].

Group A received conventional treatment while Group B received conventional plus Proprioceptive Neuromuscular Facilitation techniques.

Treatment was given for 5 sessions 4 weeks

Group A: Received conventional treatment includes Hot pack, Pendulum exercise, Maitland mobilization, Capsular stretching, and active assisted exercise (wand exercise, wall ladder) ^(11,12,13)

1) Hot Pack: Hot pack was applied for 10 – 15 minutes.



Photograph 1.4 Hot pack

2) Maitland Mobilization – Shoulder joint glides were given to the participants with 10 to 15 repetitions 3 times.



(A)



(B)



(C)

Photograph 1.5 Mobilization [A: Posterior Glide, B: Anterior Glide C: Inferior Glide]

3) Pendulum Exercise - Participants were asked to perform 10 revolutions in each direction once a day. At first, no weight was applied. A weight is added to the hand or wrist cuffs to generate further distracting force after the patient tolerates stretching.



Photograph 1.6 Pendulum exercise

4) Posterior Capsule Stretching: Participants were instructed to use their good arm to lift the affected arm at the elbow, and bring it up and across the body while exerting gentle pressure to stretch the shoulder. Participants were asked to Hold the stretch for 15 to 20 seconds 3 times.

5) Inferior Capsule Stretching: Participants were instructed to use their good arm to lift the affected arm onto a shelf and were asked to exert gentle pressure to stretch the affected shoulder. Participants were asked to Hold the stretch for 15 to 20 seconds 3 times.



(A)



(B)

Photograph 1.7 [A: Posterior Capsular Self Stretching B: Inferior Capsular stretching]

6) **Wall ladder:** Participants were asked to place the affected hands over the ladder at a low level and were asked to slowly start an

upward climb on the finger ladder until it reached the top and then slowly down back to the starting position 10 times a day.



(A)



(B)

Photograph 1.8 [A: Wall ladder exercise for Abduction B: Wall ladder exercise for Flexion]

7) **Wand Exercise:** With the help of a cane or wand stick, active assisted exercise of the shoulder (flexion, extension, abduction, IR & ER) exercises were performed.



(A)



(B)

Photograph 1.9 [A: Wand exercise for Flexion B: Wand exercise for Rotation]

Group B: Received conventional treatment plus PNF diagonal pattern ^(14,15,16)

PNF TECHNIQUES

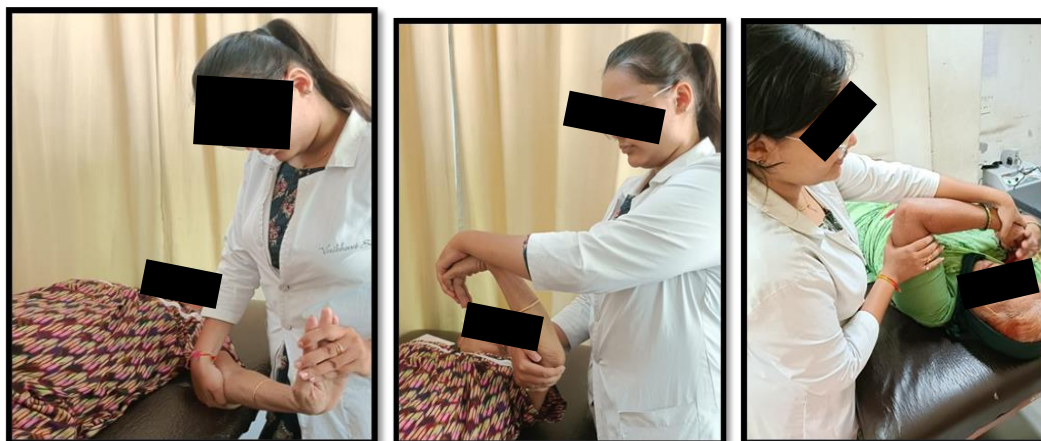
Patients were positioned in supine lying. Firstly, the therapist gave preparatory instructions.

Upper limb D1 – D2 pattern flexion-extension with hold and relax techniques were applied as per the patient's pain tolerance and shoulder ROM limitations.

Antagonistic muscles were resisted in isometric contraction followed by relaxation. Participants were asked to

perform an isometric contraction of the opposing muscle or pattern. The resistance was given by the therapist which was gradually raised. After sufficient contraction, the therapist instructed the patient to relax. Gradually, the patient and the therapist both relaxed.

All Patterns were performed with 5 repetitions with no. of 2 sets.



Photograph 1.10 PNF Technique D1 pattern



Photograph 1.11 PNF Technique D2 pattern

STATISTICAL ANALYSIS

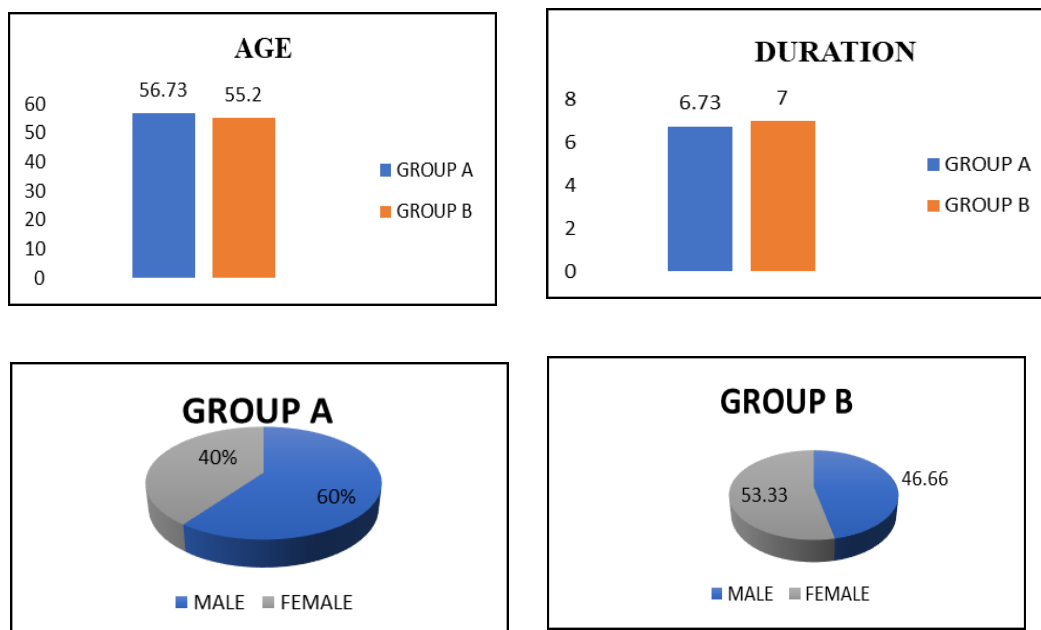
The result was analyzed by using the SPSS 20.0 version. The Shapiro-Wilk test was performed to examine the normal distribution of the data. The level of significance was kept at 5% and the confidence interval (CI) at 95%. Data of NPRS at activity, Range of motion, and SPADI were normally distributed, so the parametric test was applied. The data of NPRS at rest was not normally distributed,

so the nonparametric test was used. Within-group and between-group analyses were done for the outcome of NPRS, range of motion, and SPADI. A paired t-test was used for within group and the Unpaired t-test was used for between groups in which data were normally distributed. The Wilcoxon test was used for within group and the Mann-Whitney U test was applied for the data which were not normally distributed.

RESULT

Table 2.1: shows baseline data comparison

CHARACTERISTIC	GROUP A CONTROL GROUP [MEAN ±SD]	GROUP B INTERVENTIONAL GROUP [MEAN± SD]	P VALUE
AGE [YEARS]	56.73 ± 4.73	55.26 ± 7.55	0.515
DURATION [MONTHS]	6.73 ± 1.56	7.0 ± 2.48	.728



Graph 3.1 (A) Age Distribution (B) Duration Of adhesive capsulitis (C) Gender Distribution of Control group (D) Gender distribution of Interventional group

Table 2.2. Comparing Mean values for measured outcomes pre-treatment for both groups

Characteristic	Control group [Mean± Sd]	Interventional Group [Mean ± Sd]	z value	P - value
Pain at rest [NPRS]	1.75 ± 0.79	0.86 ± 0.63	-0.204	0.870

Characteristic	Control group [Mean ± Sd]	Interventional group [Mean ± Sd]	t value	P - value
Pain at activity [NPRS]	5.0 ± 1.25	5.33 ± 1.23	-.734	0.46
Flexion	131.4 ± 25.62	141.86 ± 21.79	-1.205	0.23
Extension	27.4 ± 3.97	29.26 ± 3.081	-1.437	0.16
Abduction	91.06 ± 25.21	106.0 ± 24.81	-1.113	0.11
External rotation	43.33 ± 20.28	41.26 ± 15.43	0.314	0.75
Internal rotation	41.93 ± 11.70	48.0 ± 17.12	1.13	0.26
SPADI total score	52.66 ± 11.78	53.93 ± 10.98	-.304	0.76

WITHIN GROUP ANALYSIS

GROUP A (CONTROL GROUP)

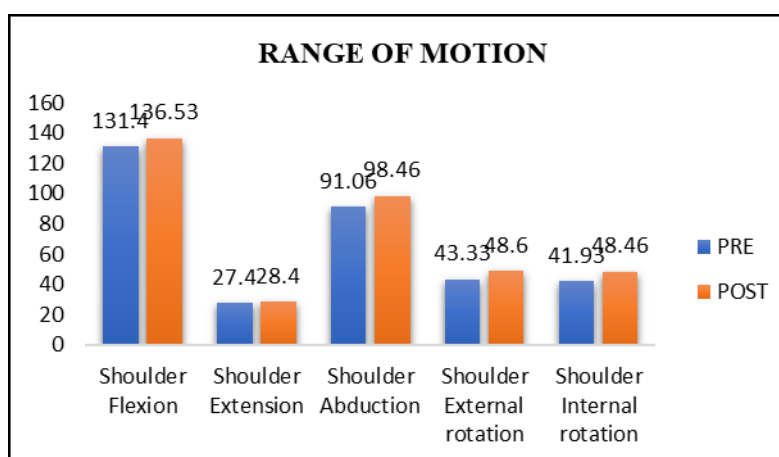
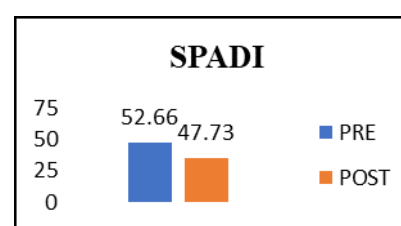
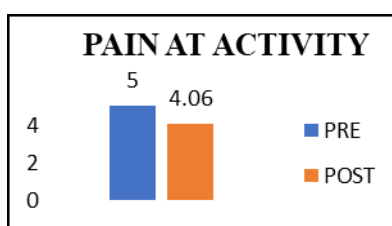
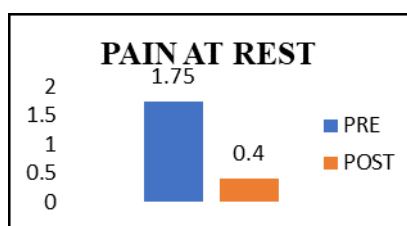
Control group Pre and post 4-week data analysis showed statistically significant difference i.e., $p < 0.05$

Table 2,3 shows within group analysis

Variables	Pre data [Mean ± Sd]	Post 4 weeks data [Mean ± Sd]	Z Value	p Value	Significance
Pain At Rest [NPRS]	1.75 ± 0.79	0.4 ± 0.5	-2.838	0.00	Significant

Variables	Pre data [Mean ± Sd]	Post 4 weeks Data [Mean ± Sd]	t Value	p Value	Significance
Flexion	131.4 ± 25.62	136.53 ± 25.03	-8.783	0.00	Significant
Extension	27.4 ± 3.97	28.46 ± 2.29	-1.524	0.15	Not significant
Abduction	91.06 ± 25.21	98.46 ± 25.26	-4.478	0.00	Significant
External Rotation	43.33 ± 20.28	48.6 ± 16.92	-2.835	0.01	Significant
Internal Rotation	41.93 ± 11.70	48.46 ± 3.31	-2.321	0.03	Significant

Variables	Pre data [Mean ± Sd]	Post 4 weeks data [Mean ± Sd]	t Value	p value	Significance
Pain at activity [NPRS]	5.0 ± 1.25	4.06 ± 1.16	14.0	0.00	Significant
SPADI total	52.66 ± 11.78	47.73 ± 12.88	4.296	0.00	Significant



Graph 3.2 shows Mean of GROUP A (a) Pain at rest pre and post 4 weeks (b) pain at activity pre and post 4 weeks (c) SPADI pre and post 4 weeks (d) ROM pre and post 4 weeks.

GROUP B (INTERVENTIONAL GROUP)

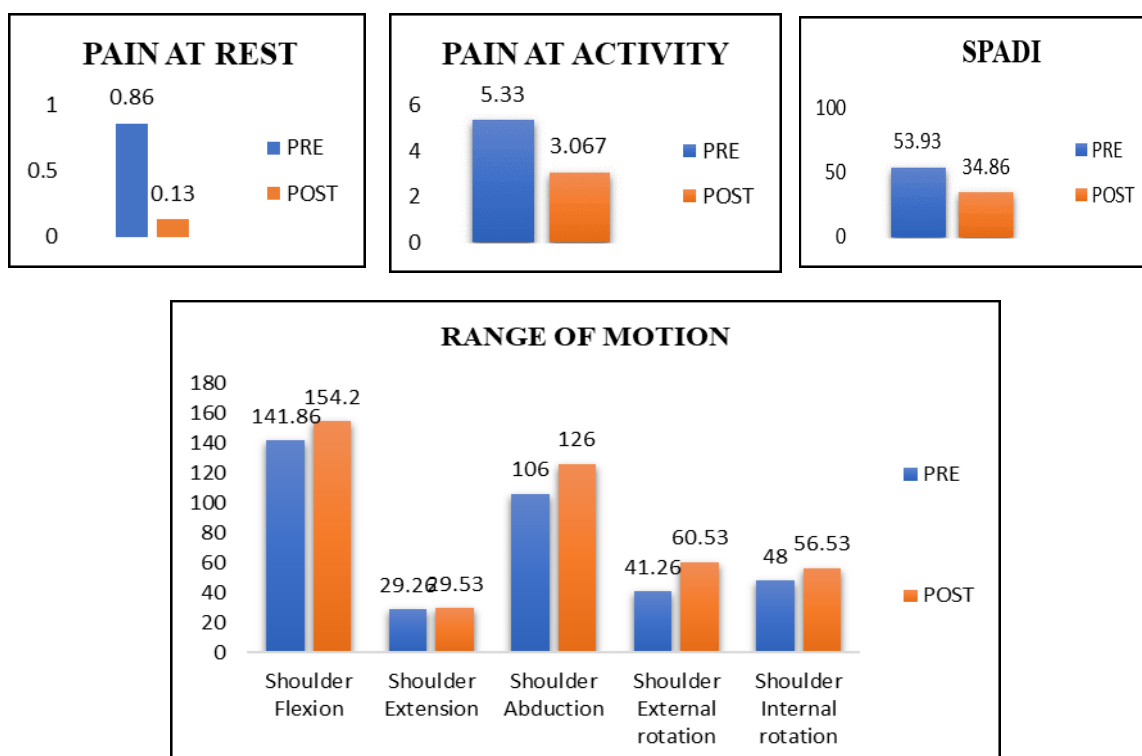
In Interventional group Pre and post 4-week data analysis showed statistically significant difference i.e., $p < 0.05$

Table 2.4 shows within group analysis (Interventional group)

Variables	Pre data [Mean ±Sd]	Post 4 weeks data [Mean ±Sd]	z value	p value	Significance
Pain at rest [NPRS]	0.86 ± 0.63	0.13 ± 0.35	-3.051	0.00	Significant

Variables	Pre data [Mean ±Sd]	Post 4 weeks data [Mean ± Sd]	t Value	p value	Significance
Pain at activity [NPRS]	5.33 ± 1.23	3.06 ± 0.96	14.789	0.00	Significant
SPADI total	53.93±10.98	34.86 ± 10.96	15.981	0.00	Significant

Variables	Pre data [Mean ± Sd]	Post 4 weeks Data [Mean ± Sd]	t value	P Value	Significance
Flexion	141.86 ± 21.79	154.2 ± 21.24	-4.118	0.00	Significant
Extension	29.26 ± 3.081	29.53 ± 2.61	-3.81	0.70	Not significant
Abduction	106.0 ± 24.81	126.6 ± 35.31	-3.38	0.00	Significant
External Rotation	41.26 ± 15.43	60.53 ± 10.68	-10.327	0.00	Significant
Internal Rotation	48.0 ± 17.12	56.53 ± 13.46	-5.924	0.00	Significant



Graph 3.3 shows Mean of GROUP A (a) Pain at rest pre and post 4 weeks (b) pain at activity pre and post 4 weeks (c) SPADI pre and post 4 weeks (d) ROM pre and post 4 weeks.

BETWEEN GROUP ANALYSIS (GROUP A AND GROUP B)

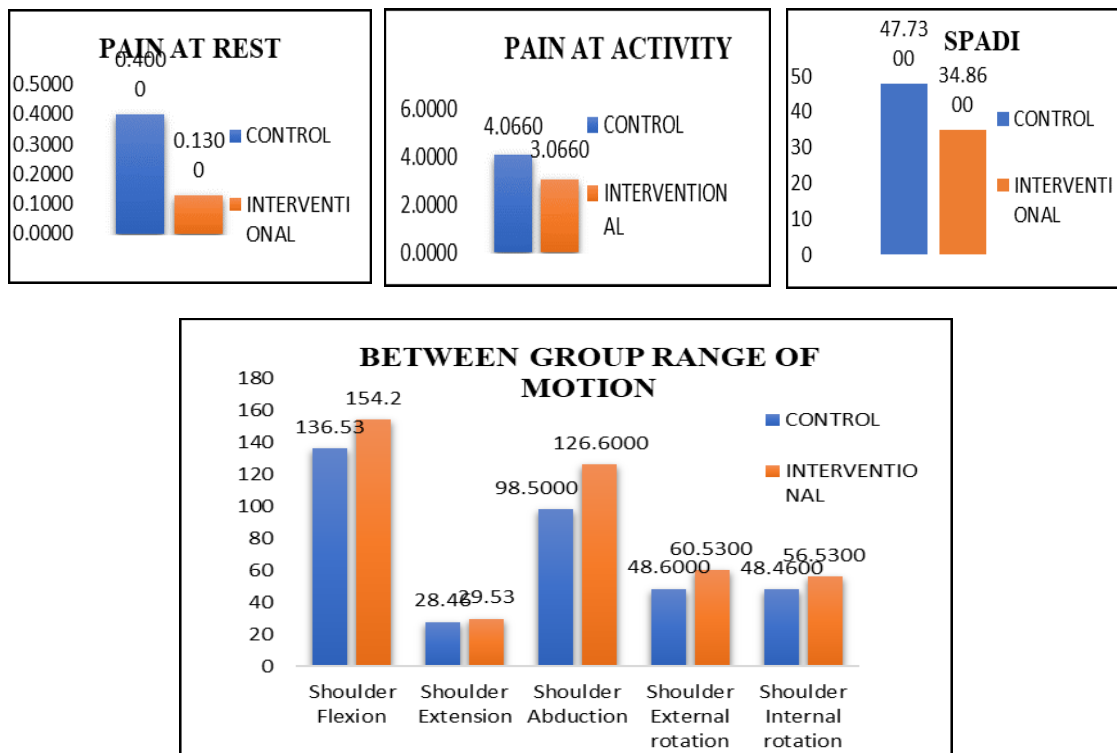
Comparison of pain (NPRS), ROM and QOL (SPADI) between two groups (Group A & Group B) after 4 weeks of Intervention showed significant values i.e., $p < 0.05$

Table 2.5 shows between group analysis

Variables	Group A [Mean ± Sd]	Group B [Mean ± Sd]	Mann Whitney U test	P value	Significance
Pain at rest [NPRS]	0.4 ± 0.5	0.13 ± 0.35	82.5	0.21	Not significant

Variables	Group A [Mean ± Sd]	Group B [Mean ± Sd]	t value	P value	Significance
Pain at activity [NPRS]	4.06 ± 1.16	3.06 ± 0.96	2.567	0.01	Significant
SPADI total	47.73 ± 12.88	34.86 ± 10.96	2.945	0.006	Significant

Variables	Group a [Mean ± Sd]	Group b [Mean ± Sd]	t Value	P value	Significance
Flexion	136.53 ± 25.03	154.2 ± 21.24	-2.084	0.04	Significant
Extension	28.46 ± 2.29	29.53 ± 2.61	-1.187	0.24	Not significant
Abduction	98.46 ± 25.26	126.6 ± 35.31	-2.5096	0.01	Significant
External rotation	48.6 ± 16.92	60.53 ± 10.68	-2.309	0.02	Significant
Internal Rotation	48.46 ± 3.31	56.53 ± 13.46	2.252	0.03	Significant



Graph 3.4 shows Mean of (a) Pain at rest post 4-week (b) Pain at activity post 4-weeks (c) SPADI post 4 weeks between groups (d) ROM post 4 weeks between groups.

Statistically Null hypothesis is rejected, As Group B (Interventional) showed a more significant effect than Group A (Control). Between groups."(Group A and Group B) analysis of pain at activity ($p = 0.01$), shoulder flexion ($p = 0.04$), abduction ($p = 0.01$), ER ($p = 0.02$) and IR ($p = 0.03$), and QOL ($p = 0.006$) post 4 weeks of intervention showed significant difference ($p < 0.05$).

Effect size (Cohen's effect size) of pain at rest ($r =$ small effect), pain at activity ($d =$ small to medium effect), shoulder flexion ($d =$ medium to large effect), extension ($d =$ small to medium effect), abduction ($d =$ large effect), ER ($d =$ large effect) and IR ($d =$ large effect), QOL ($d =$ large effect)

DISCUSSION

The present study was designed to study the Effect of Proprioceptive Neuromuscular Facilitation technique on Pain, Range of Motion and Quality of life in Adhesive capsulitis.

Total 30 patients with adhesive capsulitis were taken after screening according to inclusion and exclusion criteria and divided into two groups randomly by using the chit method and given interventions for 4 weeks; pre-post outcome measures were taken and analysis was done by using SPSS 20 software.

Following the intervention in within groups, the results demonstrated a statistically significant improvement in both the control and interventional groups.

In between group analysis Group B which received the PNF Technique in addition to conventional physical therapy showed statistically significant improvement in Pain at activity, flexion, abduction, IR, ER, and SPADI in compared to the control group.

No statistically significant difference with small effect was seen on pain at rest in between groups, which can be due to low NPRS score at rest in post-intervention assessments in both groups.

In both groups, the affection of Extension was less pre intervention. So, the difference of post intervention measures compared to pre intervention was less in both the groups. That can be possible reason for no significant difference were noted in within and between groups.

At the end of the treatment, it is noticed that pain in activity significantly decreased. It may be due to Superficial heating generated analgesia and increased circulation and metabolism by causing vasodilatation. When elevated heat in connective tissue combines with stretching, the viscoelasticity increases. This might cause patients to perform exercises easily and thus, increase painless joint motion and decrease the intensity of pain during activities of daily living.⁽¹⁴⁾

The gate control theory could explain the likely mechanism of pain reduction in PNF approaches. According to pain gate hypothesis, during PNF activities, afferent inputs from the muscle spindles, joints, tendons, and capsule may block the transmission of pain at the dorsal grey horn laminae of the spinal cord.⁽¹⁵⁾

Four theoretical physiological mechanisms of PNF are there: autogenic inhibition, reciprocal inhibition, stress relaxation, and the gate control theory (Hindle et al).⁽¹⁷⁾

In order to find out how PNF affects patients with adhesive capsulitis in terms of the scapula and upper extremities, Eda Akbaş et al. conducted a study in 2015 and concluded effectiveness on pain.⁽¹⁸⁾

Nilay Comuk Balc et al. (2016) concluded that PNF methods, conventional exercises, and modalities by themselves have an

instant impact on patients' Pain, range of motion, and functional capacities which supports our study.⁽¹⁹⁾

When the opposing muscle contracts voluntarily, the TM experiences reciprocal inhibition, which manifests as decreased neural activity. According to Rowlands et al. (2003) the neurons in the stretched TM continue to fire, inhibiting the TM's electrical activity. As a result, the force of the TM continuing to receive signals to contract would oppose and lessen the contraction of the antagonist muscles.⁽²⁰⁾

Afferent fibers enter the spinal cord at the spinal level and produce collateral branches that interact with spinal neurons, which subsequently transmit signals to the alpha-motoneuron in the TM's GTOs. This connection has an inhibitory effect that makes the TM relax. (Sharman et al 2006).⁽²¹⁾

The mechanism that contributes to improving shoulder function is that the proprioceptive neuromuscular facilitation technique is aimed at relaxing tense muscles and restricted joints to make quick gains in ROM.⁽¹⁵⁾

Ping Lin¹, Moudan Yang¹, et al. reported that compared with traditional manual therapy, the PNF technique can better stimulate the body's proprioceptors, promote the relevant neuromuscular responses, and enhance the contraction ability of the corresponding muscles. Meanwhile, by adjusting the abnormal excitability of the sensory nerves, the muscle tension can be changed, and the muscle spasm can be relieved and made it move in a normal way. It is expected to be more helpful in relieving pain in patients with frozen shoulder and improving joint ROM.⁽²⁾

Gisele Ostermari Meneghini 2021 concluded that PNF approaches produced encouraging results in the beginning and also reported statistically significant results of PNF techniques on scapular dyskinesis and improving ROM.⁽²²⁾

A similar result was carried out in 2019 Jaya Shanker, Tedla and Devika Rani Sangadala,

who carried out a meta-analysis, the PNF technique works better than standard physical therapy. ⁽¹⁵⁾

Ine Santia et al in 2019, studied the correlation between the limitations of the joint ROM and the functional ability of patients with Adhesive capsulitis and the result showed that there is a positive correlation between limited ROM and the functional ability of the shoulder joint in patients with Adhesive capsulitis. ⁽²³⁾

Marcos Rassi Fernandes studied to determine the correlation between functional disability and the quality of life of patients with adhesive capsulitis and the result highlights the link between a lower quality of life and the person who reports the greatest shoulder disability. ⁽²⁴⁾

Min Zhang et al in 2022 studied a linear relationship between QOL and functional disability, thus improvement in function can lead to improvement in quality of life. Due to this quality of life improves as the functional ability of the shoulder improves. ⁽²⁵⁾

In 2015, Hariharasudhan Ravichandran and Janakiraman Balamurugan examined the effectiveness of PNF in relation to muscle energy techniques for the treatment of pain and disability in individuals with AC and demonstrated the superiority of PNF technique over other pain management methods for AC patients, improved range of motion and functional ability. Their findings concur with those of the current investigation. ⁽²⁶⁾

These findings are also supported by the current study's results, which showed that the PNF group improved more than the routine PT group.

Hence, this outcome of the study is also supported by other scientific evidences.

CONCLUSION

This study with 4 weeks of intervention on 30 patients with Adhesive capsulitis, showed a statistically significant effect on Pain, Range of motion, and Quality of life, hence it can be concluded from this study that Proprioceptive Neuromuscular

Facilitation Technique along with conventional protocol reduces Pain, improved Range of motion and Quality of life in Adhesive capsulitis.

Declaration by Authors

Ethical Approval: Approved (Reg No: ECR/1573/Inst/GJ/2021)

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Conflict of Interest: The authors declare no conflict of interest.

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