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Original Article

Effectiveness of PNF Pattern in Regular Physical Therapy Sessions on Functional Mobility in Frozen Shoulder

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ABSTRACT

Frozen shoulder, or adhesive capsulitis, is a musculoskeletal condition that presents with symptoms such as discomfort, nocturnal pain, and limited range of motion. Abduction and external rotation are significantly reduced. **Objective:** To investigate the effectiveness of combining proprioceptive neuromuscular facilitation (PNF) patterns into routine physical therapy sessions for patients with frozen shoulder. **Methods:** A six-week quasi-experimental study was conducted on a total of 30 participants, divided into group A (n=15) and group B (n = 15), selected from the outpatient department (OPD). Pain, disability, and range of motion were evaluated as outcome measures. The group A received proprioceptive neuromuscular facilitation (PNF) patterns in addition to their usual physical therapy sessions, and group B only received conventional physical therapy sessions. Disabilities of the Arm, Shoulder and Hand (DASH), VAS (Visual Analog Scale) and goniometer were used to assess pain, disability and range of motion (ROM). Data were analyzed using SPSS version 23.0. **Results:** Both groups showed a significant reduction in DASH and VAS scores and an increase in ROMs, as group A showed a better result in terms of DASH score and abduction range ($p<0.05$). **Conclusions:** Both the experimental and control groups had statistically significant outcomes. The PNF pattern and Codman exercises both have a positive impact on rehabilitation. However, PNF is more advanced because it involves a combination of movements that are also useful in daily activities. Additionally, PNF helps develop memory for correct patterned movements. On the other hand, Codman exercises are only effective for retaining and improving shoulder ranges.

INTRODUCTION

Frozen shoulder, or adhesive capsulitis, is a musculoskeletal condition characterized by pain, stiffness, and restricted range of motion in the shoulder joint [1]. It predominantly affects individuals aged 40 to 60, with higher incidence among women and those with comorbidities like diabetes or thyroid disorders [2]. The condition progresses through four stages: painful, freezing, frozen, and thawing. The painful stage lasts up to three months, marked by increasing shoulder pain, especially at night, and limited motion [3]. This painful stage transitions into the freezing stage, which lasts for 3 to 9 months. The frozen stage symptoms persist for duration of 9–14 months where stiffness becomes pronounced due to capsule volume reduction. The thawing

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stage, lasting 15 to 24 months, sees gradual improvement in range of motion with little discomfort as the capsule restores [4]. There are two types: primary, with unknown cause, and secondary, triggered by events like trauma or surgery [5]. Pathologically, primary frozen shoulder involves inflammation, fibrosis [6], and capsular contracture [7]. Elevated levels of cyclooxygenases, interleukins, and TNF-α are observed in affected tissues, with pain associated primarily with mild to moderate severity, though some experience severe pain [8]. Neuronal components and increased vascularity are linked to the condition, yet understanding of pain mechanisms remains limited [9]. Proprioceptive Neuromuscular Facilitation (PNF) techniques, pioneered by Dr. Kabat and Margaret Knott, are therapeutic exercises designed to improve neuromuscular function through proprioceptive feedback and movement patterns [10]. Initially developed for conditions like multiple sclerosis and poliomyelitis, PNF has shown effectiveness in treating various neurological, traumatic, and orthopedic disorders [11]. By incorporating spiral and diagonal movement patterns in three planes [12], PNF utilizes stretch and resistance to strengthen muscles and enhance functional movements [13]. In frozen shoulder, which hinders daily activities and impacts psychological well-being, PNF offers potential benefits in reducing pain, improving range of motion, and enhancing functional impairment.

Despite physical therapy being a common initial intervention, the additional benefits of integrating PNF techniques remain uncertain. Therefore, this study aimed to explore the effects of combining PNF with standard physical therapy in treating frozen shoulder, with the goal of improving treatment outcomes and facilitating return to daily tasks.

METHODS

A quasi-experimental study was conducted in both the public and private sectors over duration of 6 weeks, from November 2023 until December 2023. Purposive sampling was employed with a sample size of 30 individuals, divided into two groups: experimental (Group A, n = 15) and control (Group B, n = 15). For this quasi-experimental study, the sample size calculation was conducted using Rasoft software, ensuring that the study had sufficient statistical power to detect meaningful effects. The study focused on variables including pain, disability, and shoulder range of motion (ROMs), with an alpha value of 0.05 and a confidence interval of 95%. The study population comprised regular outpatient department (OPD) patients meeting the inclusion criteria: male and female individuals aged 45 to 60, diagnosed with adhesive capsulitis, and experiencing limited ROMs of 50%. Exclusion criteria encompassed acute trauma, fractures, bony deformity, glenohumeral joint pathology, acromioclavicular joint pathology, and rotator cuff disorder. SPSS version 23.0 was used to analyze the data. The Disability of the Arm, Shoulder, and Hand (DASH) questionnaire, the Visual Analogue Scale (VAS) for pain assessment, and a goniometer were utilised to measure disability index, pain levels, and range of motion (ROMs), respectively. Shapiro Wilk test was used to analyze the distribution of data: the p- value was kept at >0.05 which indicated that data were normally distributed and parametric test (independent sample t-test for between groups and paired sample t test for within groups) was applied. In this study, control group received treatment regimen comprised transcutaneous electrical nerve stimulation (TENS), application of a heating pad, ultrasonic therapy, Codman exercises, and range of motion (ROM) exercises. We administered this comprehensive treatment approach to the control group under investigation. We used TENS therapy and heating pad for stimulation and to facilitate muscle relaxation and vasodilation to the targeted areas, aiming to relieve pain and promote muscle relaxation. Ultrasonic therapy with high-frequency sound waves aided tissue healing and reduced inflammation. Codman and Range of motion exercises focusing on specific shoulder movements, improve joint mobility and strength. The study used a structured protocol, with each control group participating in 40-minute sessions five days a week. While in experiment group we utilized PNF patterns along with ultrasonic and heating pad. The therapist used proprioceptive neuromuscular facilitation (PNF) techniques, specifically using the hold-relax method followed by the D2 pattern of flexion-extension movements. Participants underwent active-to-passive movements up to their end range of motion, followed by resistance training comprising 15 repetitions and 3 sets. The researchers administered this regimen five days per week for duration of six weeks.

RESULTS

Figure 1 shows the age distribution of the patients N=30 with mean of 52.43 and standard deviation 4.46.

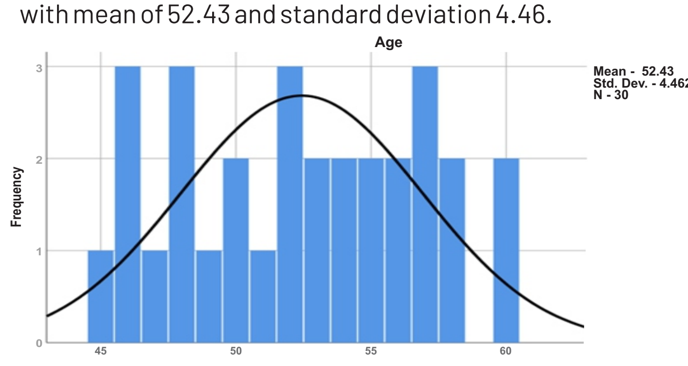

Figure 1: Age Distribution of Patients

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Figure 2 shows frequency distribution of gender in which 20(66.67%) females and 10(33.33%) males were included.

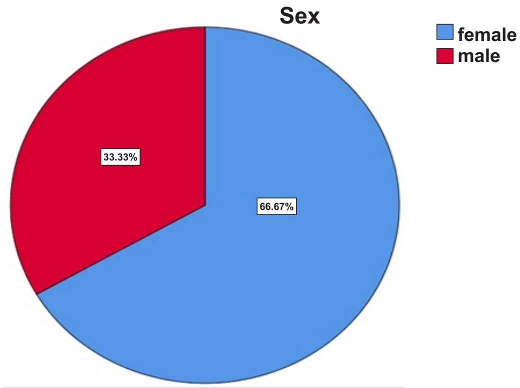

Figure 2: Gender Distribution

For within group difference, paired sample t-test was used. Table 1 shows the experimental group (group A) within group paired analysis and Table 2 shows control group paired analysis. For Group A, the DASH scores showed a paired difference of 32.46 with a standard deviation difference of 6.772, yielding a significant p-value of 0.000. Similarly, VAS scores exhibited a paired difference of 1.53, a standard deviation difference of 0.105, and a significant p-value of 0.001. In terms of shoulder mobility, external rotation had a paired difference of 5.20, a standard deviation difference of 0.704, and a significant p-value of 0.003. Abduction showed a substantial paired difference of 43.00, a standard deviation difference of 5.238, and a highly significant p-value of 0.000. Internal rotation demonstrated a paired difference of 7.20, a standard deviation difference of 2.956, and a significant p-value of 0.003. Flexion had a paired difference of 39.73, a standard deviation difference of 1.173, and a significant p-value of 0.000. For Group B, the DASH scores displayed a paired difference of 13.27, with a standard deviation difference of -8.706, resulting in a significant p-value of 0.007. VAS scores exhibited a paired difference of 1.00, a standard deviation difference of 0.662, and a significant p-value of 0.010. Shoulder mobility, external rotation had a paired difference of 3.13, a standard deviation difference of 4.892, and a significant p-value of 0.003. Abduction showed a paired difference of 15.26, a standard deviation difference of 14.979, and a significant p-value of 0.002. Internal rotation demonstrated a paired difference of 4.86, a standard deviation difference of 3.361, and a significant p-value of 0.004. Flexion had a paired difference of 50.74, a standard deviation difference of 12.203, and a highly significant p-value of 0.000.

Table 1: Paired T-Test within Groups Analysis

Groups	Variables	Time of Measurements		p-value
		Pre-Treatment	Post-Treatment	
		Mean ± SD	Mean ± SD	
Group A	DASH	67.93 ± 6.105	35.47 ± 12.877	0.000
	VAS	4.33 ± 1.302	2.80 ± 1.407	0.001
	External Rotation	11.87 ± 1.710	17.07 ± 2.414	0.003
	Abduction	100.00 ± 10.154	143.00 ± 15.392	0.000
	Internal Rotation	28.40 ± 2.610	35.60 ± 5.566	0.003
	Flexion	118.07 ± 4.978	157.80 ± 6.151	0.000
Group A	DASH	70.87 ± 4.511	57.60 ± 13.217	0.007
	VAS	4.13 ± 1.759	3.13 ± 1.971	0.010
	External Rotation	12.27 ± 1.552	15.40 ± 5.444	0.003
	Abduction	100.67 ± 13.229	115.93 ± 28.208	0.002
	Internal Rotation	29.67 ± 5.779	34.53 ± 9.140	0.004
	Flexion	115.73 ± 7.968	166.47 ± 20.171	0.000

Table 2 and 3 showed between group comparison before and after treatment. Independent sample t-test shows there is no statically significant difference before treatment between experimental and control groups. A statically significant difference was observed only in DASH disability index of arm, shoulder and hand, and shoulder abduction ($p<0.05$).

Table 2: Between Group Analysis at Baseline (Independent t-test)

Groups		Mean ± SD	N	T	p-value
Group A	DASH at Baseline	67.93 ± 4.511	15	-1.497	.146
Group B	DASH at Baseline	70.87 ± 6.105	15		
Group A	VAS at Baseline	4.33 ± 1.759	15	.354	.726
Group B	VAS at Baseline	4.13 ± 1.302	15		
Group A	External Rotation at Baseline	11.87 ± 1.552	15	-.671	.508
Group B	External Rotation at Baseline	12.27 ± 1.710	15		
Group A	Abduction at Baseline	100.00 ± 13.229	15	-.155	.878
Group B	Abduction at Baseline	100.67 ± 10.154	15		
Group A	Internal Rotation at Baseline	28.40 ± 5.779	15	-.774	.446
Group B	Internal Rotation at Baseline	29.67 ± 2.610	15		
Group A	Flexion at Baseline	118.07 ± 7.968	15	.962	.344
Group B	Flexion at Baseline	115.73 ± 4.978	15		

Table 3: Between Group Analysis after Treatment (Independent t-test)

Groups		Mean ± SD	N	T	p-value
Group A	DASH After Treatment	35.47 ± 13.217	15	-4.645	.000
Group B	DASH After Treatment	57.60 ± 12.877	15		
Group A	VAS After Treatment	2.80 ± 1.971	15	-.533	.598
Group B	VAS After Treatment	3.13 ± 1.407	15		
Group A	External Rotation After Treatment	17.07 ± 5.444	15	1.084	.292
Group B	External Rotation After Treatment	15.40 ± 2.414	15		
Group A	Abduction After Treatment	143.00 ± 28.208	15	3.262	.004
Group B	Abduction After Treatment	115.93 ± 15.392	15		
Group A	Internal Rotation After Treatment	35.60 ± 9.140	15	.386	.703
Group B	Internal Rotation After Treatment	34.53 ± 5.566	15		

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Group A	Flexion After Treatment	157.80 ± 20.171	15	-1.592	.130
Group B	Flexion After Treatment	166.47 ± 6.151	15		

DISCUSSION

The findings of this study suggest that incorporating proprioceptive neuromuscular facilitation (PNF) patterns into regular physical therapy sessions significantly impacts functional mobility in individuals with frozen shoulder [14]. The results revealed significant improvements in various outcome measures, including Disability of Arm, Shoulder, and Hand (DASH) scores, Visual Analog Scale (VAS) scores for pain, and shoulder mobility parameters such as external rotation, abduction, internal rotation, and flexion. Both groups showed a noticeable reduction in the disability index (DASH score), indicating a significant improvement in their functional ability for routine tasks [15]. Moreover, recent research has shown the efficacy of proprioceptive neuromuscular facilitation (PNF) approaches in improving joint mobility and flexibility [16]. The findings of a comparative study provide valuable evidence supporting the use of proprioceptive neuromuscular facilitation (PNF) stretching as an effective intervention for improving range of motion, reducing shoulder pain, and enhancing functional outcomes in patients with adhesive capsulitis [17]. A single case study; on 46-year female who diagnosed with adhesive capsulitis, revealed the combined effectiveness of PNF with deep breathing exercises. After 11 sessions result showed VAS improvement from 6 to 2 and the post-exercise shoulder flexion and abduction improved from 100 degree to 160 degree, internal rotation from 25 degree to 55 degree, and external rotation from 40 degree to 60 degree [18]. A prior study has provided evidence supporting the effectiveness of proprioceptive neuromuscular facilitation (PNF) approaches in managing chronic back pain [19]. The between-groups analysis demonstrated that the experimental group demonstrated significant improvement in DASH score and abduction range, which corresponds to the findings of a study conducted to examine the impact of proprioceptive neuromuscular facilitation (PNF) exercise on the range of motion (ROM), pain, and functional activity of patients who received total knee arthroplasty (TKA). The exercise resulted in significant changes in VAS and TUG scores within and between the experimental and control groups ($p<0.01$)[20]. However, it is important to acknowledge a few restrictions of the study, which include the relatively small sample size and the lack of long-term monitoring to assess the long-term effects of the improvements observed. Further research including a larger sample size and extended periods of observation is required to gain a better understanding of the continuous efficacy of PNF pattern therapy in the treatment of frozen shoulder.

CONCLUSIONS

The study found that the combination of proprioceptive neuromuscular facilitation patterns, Codman exercises, and electrotherapy resulted in statistically significant benefits. Both the PNF pattern and Codman exercises have a beneficial effect on rehabilitation. However, PNF is considered to be better due to its use of the combination of movements that have common uses for routine activities. In addition, PNF helps in the improvement of memory for correct patterned movements. However, Codman exercises are mainly effective for retaining and improving shoulder mobility.

Authors Contribution

Conceptualization: JA
Methodology: MF
Formal analysis: MA
Writing-review and editing: SG, SURB, HS, TAS, HABA, SA

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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