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EFFECTS OF PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION STRETCHING VERSUS JOINT MOBILIZATION ON RANGE OF MOTION AND FUNCTIONAL LEVEL IN ADHESIVE CAPSULITIS PATIENTS

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ABSTRACT

Introduction: *Shoulder pain is ranked third in musculoskeletal disorders causing disability in general population. Physiotherapy plays vital roles in the management of shoulder pain in improving physical condition of patients. The aim of this study was to compare the effectiveness of two techniques Proprioceptive Neuromuscular Facilitation (PNF) stretching and shoulder joint mobilization (JM) on range of motion (ROM) of shoulder and functional level in patients with adhesive capsulitis (AC) or frozen shoulder. Methods: Thirty patients were randomly allocated into two groups of PNF stretching (PNF group: n=15) and JM (JM group: n=15). PNF group received Hold-Relax with Antagonist Contraction (HR-AC) technique, while JM group received Maitland technique with caudal and posterior glide. Conventional treatment was given to both groups, consists of transcutaneous electrical nerve stimulation (TENS) and patient education. Both groups received 8 sessions of treatments within 4 weeks. ROM of shoulder flexion and abduction were evaluated using universal goniometer, and functional level was evaluated using SPADI before and after the treatments. Results: After treatment, significant improvements were observed in the ROM and functional level in both groups (all p <0.05). Both groups were not superior to each other in terms of improving shoulder ROM and also functional level (p <0.05). Conclusion: In addition to conventional physiotherapy treatment, PNF and shoulder JM might be equally effective to increase ROM of shoulder and also functional level in patients with adhesive capsulitis. Hence, it is recommended to add PNF or joint mobilization along with other conventional interventions to optimize the treatment results.*

Keywords: Adhesive Capsulitis; Frozen Shoulder; Joint Mobilization; PNF; Range of motion

1. INTRODUCTION

Adhesive capsulitis (AC) or frozen shoulder is described by gradually onset of shoulder pain and loss of range of both active and passive motion (1). International Classification of Disease (ICD), a system that is created by the World Health Organization (WHO), serves as a global standard for diagnostic health information. Under this system, the term adhesive capsulitis is categorized in ICD-10 and is under diagnosis code M75.0 and was recently revised in October 2022. Adhesive capsulitis can be classified into two categories, primary AC and secondary AC. Primary AC was described as idiopathic shoulder stiffness that happened without any specific trauma or disease (2). There could be some underlying factors that may contribute to the development of the primary AC such as diabetes mellitus, thyroid disorders, and few metabolic disorders (2,3). Second classification, the secondary AC, was described as shoulder stiffness with a known cause. It could be resulted from trauma, post-surgery, inflammatory disease, or infection (2,3).

In the general population, the prevalence of shoulder pain has been reported to be between 2.4% to 26% (4–8). The prevalence of primary AC was reported to affect 2% to 5.3% of the population (9). While the prevalence of AC associated with diabetes mellitus and thyroid disease were reported to be high with 4.3% to 38% of the

population (9–11). When compared by genders, AC affects female more commonly than male (10,12). Adhesive capsulitis also commonly related to age factor. Individuals between age 40 to 65 years old had higher incidence of AC, while the most common incidence occurred between aged 51 to 55, on average (13,14). Individuals with metabolic disorder such as diabetes mellitus (DM) and thyroid disorders are 5 to 7 times higher risk of developing AC (15). In fact, prevalence of AC in diabetes mellitus population is estimated to be up to 40% (10,11,15). Mertens et al. (2022) found that presence of DM will be a prognostic factor for worse improvement of shoulder pain and disability and also shoulder functional level in AC population. (16). Neviaser and Neviaser had described AC progressed into four stages (17). Stage 1 of the AC begin from the onset and may last up to 3 months. In stage 2, pain becomes more persistent and may be more severe. This stage is also known as 'freezing' stage and may last from 3 to 9 months. Stage 3, also known as 'frozen' stage, my last from 9 to 15 months. Final stage is stage 4, which the chronic stage and also referred as 'thawing' stage. Pain begins to resolve, however motion restrictions may persist from 15 to 24 months (17).

Physiotherapy (PT), together with other medical management is one of the important treatments component in the AC. PT aims to relief pain, improving ROM, and strengthening of the shoulder (2). Roles of physical therapy in the management of AC include pain reduction management which includes modalities such as heat or ice therapy, and transcutaneous electrical nerve stimulation (TENS). Range of motion (ROM) exercises are important in restoring the lost ROM and preventing further loss of shoulder movement. PT also would prescribe appropriate stretching exercises to target the tight muscles aiming to improve the flexibility and reducing the muscle tension. Roles of PT in adhesive capsulitis management include manual technique such as joint mobilization which employed directly to the restricted joint mobility and increasing the joint surface glides. Appropriate prescription of strengthening exercise is crucial to restore the muscle strength around the shoulder joint once the pain and stiffness improved. Kelley et al. found that shoulder mobilization and stretching exercises combined with medical management are more effective in producing short term (4-6 weeks) pain reduction and improving function (18).

Although multiple studies had explored the effectiveness of joint mobilization technique in AC, there were still dispute on the superior efficacy of over other conservative treatments (19–23). Vermeulen, H.M. et. al (2006) had suggested a further research design where patients should be classified into; treatment groups with physical impairments that best respond to joint mobilization, and where mobilization force is the best matched to the tissue irritability in order to obtain a clear indication of whether mobilization is really beneficial for AC (23).

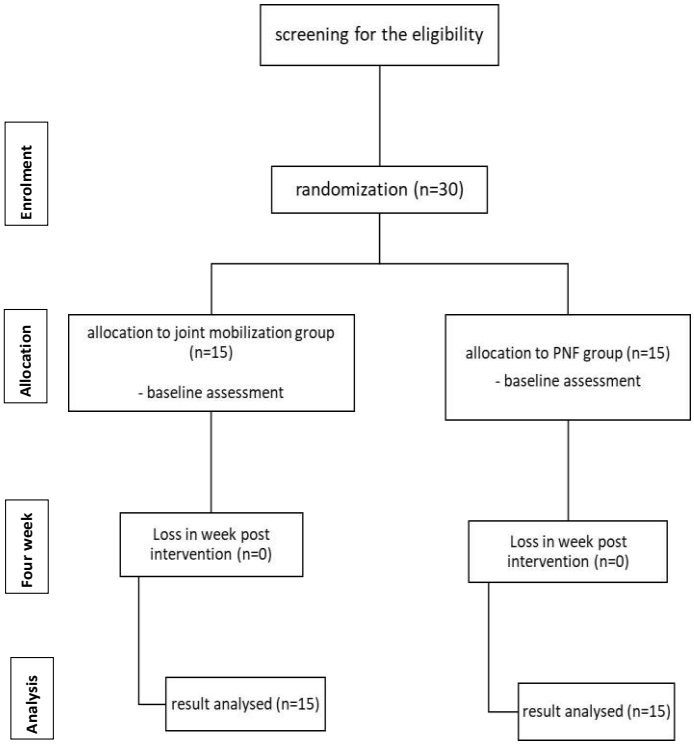
Moreover, current literatures have limited data comparing the effectiveness of both PNF stretching and shoulder mobilization in AC in terms of shoulder ROM. Therefore, this study aimed to compare the effectiveness of PNF stretching and shoulder mobilization on shoulder flexion and abduction range of motion, and also functional level in adhesive capsulitis patients.

2. MATERIALS AND METHODS

The study design used in this study is a randomized-trial design. The inclusion selection criteria were healthy men and women aged between 30 to 60 years old. 1) diagnosed with frozen shoulder or adhesive capsulitis by the medical doctors and were referred to physiotherapy department. 2) presented with reduced shoulder active range of motion of the abduction and flexion, at least half of the range. The participants were excluded if they experienced shoulder pain related to trauma, had history of shoulder surgery and dislocation, presented with history of cervical radiculopathy, diagnosed with tendinitis or rotator cuff injury, and patients with diabetes mellitus and thyroid disorders. This study was conducted in the physiotherapy department in hospital in Alor Setar, Kedah. This study was reviewed and approved by the Ethical Committee Board of AIMST University, Kedah with the reference AUHEC/FAHP/13/07/2023/MPT-PT-B1-002. A total of 30 patients, 19 female and 11 males participated in this study. All of the subjects were divided into two groups using the systematic sampling method. The sample size was determined using the G-power-3.1.9.7 software with specific parameters provided in the software interface. The level of significance (α) is kept at; power ($1-\beta$) = 0.8 and effect size 0.8. The total sample size recruited in this study was 30 subjects with 15 subjects per group with three outcome measures were used. All the participants gave their written informed consent and were notified of the confidentiality of the

information given. They had the right to withdraw from the study at any given time. The flow of recruitment of the participants was described in the Figure 1 below.

Figure 1: Flow of patients throughout the course of the study



Data Collection Procedure

Three outcome measures were taken for this study which were active range of motion (ROM) of shoulder flexion and abduction, and shoulder disability level using Shoulder Pain and Disability Scale (SPADI). Active ROM of flexion and abduction of the shoulder will be measured by using goniometer measurement (18,24). Measurements of shoulder ROM using standard goniometer had demonstrated ICC ranging from 0.80 to 0.99 (Riddle et al., 1987). Kelley et al. (2013) had described the most ideal position and placement of the goniometry to measure the ROM of the shoulder flexion and abduction. Flexion of the shoulder was measured with the patient positioned in supine with arm by the side, with the axis of the goniometer on the greater tuberosity, the stationary arm was aligned to the midline of trunk, and movable arm was aligned with the lateral epicondyle. To measure abduction, patient was positioned in supine with arm at the side, with the axis of the goniometer was on the head of the humerus, the stationary arm was aligned parallel to the midline of the sternum, and the movable arm was aligned with the midshaft of the humerus (18). Measurements for the active ROM were recorded before and after the treatment session.

Shoulder disability level was evaluated by using SPADI as recommended by (25–27). SPADI is two domains, 5 pain items, and 8 disability items. It is a 13-item patient self-report tools with each domain score is weighted equally for the total score (28). The score ranges from 0 to 100 as the maximum score, with 0 score indicates no pain nor difficulty and 100 means the most severe disability. Roy et al. (2009) stated that SPADI has reliability coefficient of ICC $\geq$ 0.89 in variety of patient populations. Researches of SPADI had showed adequate measurement qualities (26,29) . Minimum detectable change (MDC) at the 90% confidence level has been reported to be 18.1 (30), and the MDC at the 95% confidence level was reported as 18.0. In recent study by Staples et al. (2010) found that SPADI had better responsiveness compared to DASH in evaluating AC patients (27).

Interventions

In the PNF group, Hold-Relax with antagonist contraction (HR-AC) technique was performed as it was proved to be better than other PNF stretching technique. The duration of the procedure was be 10-second of contraction (31,32), followed by 20-second for relaxation, and was be repeated for 5 sets (31).

Shoulder mobilization with caudal and posterior glide to improve shoulder abduction and flexion and was conducted following the Maitland mobilization grades (33–35). Agarwal et al. (2016) & Yang et al. (2007) reported for each set, ten repetitions with 1 oscillation per second with total treatment time for 20 minutes will be beneficial to the patients. In a study conducted by Vermeulen et al. (2006), both high-grade and low-grade mobilization technique (HGMT) were found to be effective in increasing glenohumeral joint mobility and decreasing disability compared to low-grade mobilization technique (LGMT). Hence, in this study, high-grade mobilization technique was conducted for the patients.

Conventional physiotherapy interventions included Transcutaneous Electrical Nerve Stimulation (TENS) and patient education. TENS help to reduce the level of irritability of the joint. TENS activates inhibitory mechanisms to reduce central excitability in the central nervous system (36). Participants were provided with educational information related to their natural course of the disease, encouraging functional, pain-free range of motion by teaching activity modification, and matching the stretch intensity to the participant's level of irritability at the time (18). All treatment regimens were carried out for two days per week and were continued for four weeks as recommended by (18,31,37) A total of three assessments were performed as the baseline (day one), and at week four (at the end of the study).

Statistical Analysis

All data analysis was performed using Statistical Package for the Social Science (SPSS) version 29.0. Results for descriptive analysis were documented as frequency, mean, and standard deviation (SD). Statistical tests analysis such as paired t-test and independent t-test were used in this study. The level of statistical significance was set as p-value of less than 0.05.

3. RESULTS

Sociodemo Graphic Data

Demographic data that were analysed included age and gender, and were reported as mean (M) and standard deviation (SD). A total of 30 participants were recruited and included in the analysis. No drop out and important harm reported. The characteristics are shown in Table I. No group difference between characteristics measures was observed. Mean age for the participants was 51.5 years old. Majority of the participants were females (n = 19, 63.3%) compared to males (n = 11, 36.7%). Most of the subjects were Malay (n = 21, 70%), followed by Indians (n = 5, 16.7%), and Chinese (n = 4, 13.3%).

Table 1: Demographic Data of Participants (n=30)

Variables	Frequency, n (%), mean (SD)
Age(years), mean (SD)	51.5 years ± (5.46)
Gender, n (%)	
Male	11 (36.7%)
Female	19 (63.3%)
Race, n (%)	
Malay	21 (70%)
Chinese	4 (13.3%)
Indian	5 (16.7%)

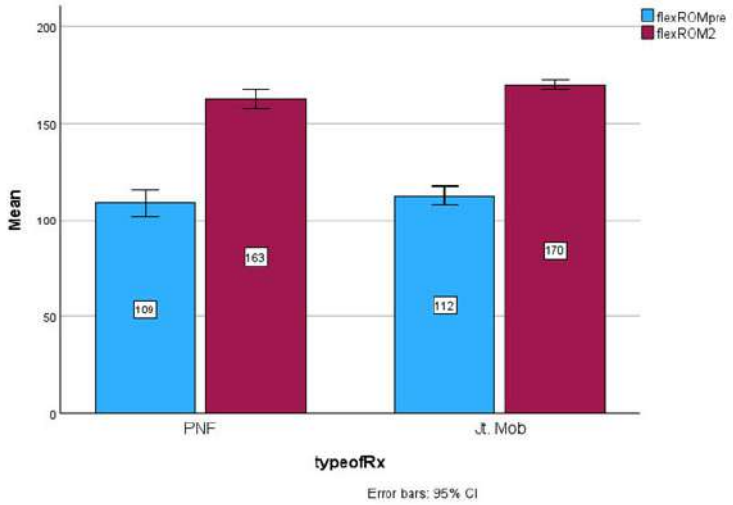
Effects of PNF and Jt. Mob on Range of Motion of Shoulder Flexion.

The means (SD) of the flexion ROM for pre and post interventions for both groups were shown in Table II and Fig. II. Difference between groups was analysed using the independent t-test as well as 95% confidence intervals (CI) for the mean difference. The results showed that IN PNF group the mean ROM increased from 107.9° to 162.7° with difference of 54.8°. In joint mobilization group, the mean ROM increased from 112.5° to 170.8° with difference of 58.3°. P-values for both groups were recorded less than 0.001 which indicate that both are significant. However, no significant group difference was observed in flexion ROM pre and post intervention for both groups (p = 0.33) and indicates both groups are equally effective in increasing shoulder flexion ROM.

Table II: Comparison flexion ROM within groups PNF and Jt. Mobilization

Flexion ROM (°)	Pre	Post	Difference	p-value	
PNF stretching (n=15) M ±SD	107.9 ± 13.86	162.7 ± 8.67	54.8 ± 11.40	0.001	0.33
Joint Mobilization (n=15) M ±SD	112.5 ± 8.93	170.8 ± 5.44	58.3 ± 8.91	0.001	

Figure II: Pre and Post Flexion ROM Between Two Groups



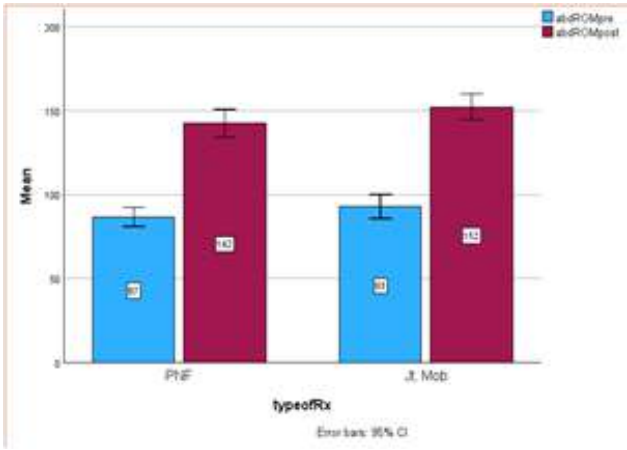
Effects of PNF and Jt. Mob on Range of Motion of Shoulder Abduction.

The means (SD) of the abduction ROM for pre and post interventions for both groups were shown in Table III and Fig III. Interaction effect between group and time was analysed using the independent t-test as well as 95% confidence intervals (CI) for the mean difference. The results showed that in PNF group, the mean ROM increased from 86.7° to 142.4° with difference of 55.7°. In joint mobilization group, the mean ROM increased from 92.9° to 152.2° with difference of 59.3°. P-values for both groups were recorded less than 0.001 which indicate that both are significant. However, no significant group difference was observed in abduction ROM pre and post intervention for both groups (p = 0.39) and indicates both groups are equally effective in increasing shoulder abduction ROM.

Table III: Comparison abduction ROM within groups PNF and Jt. Mobilization

Abduction ROM (°)	Pre	Post	Difference	*p*-value	Overall
PNF stretching (n=15) M ±SD	86.7± 10.38	142.4 ± 15.04	55.7± 10.21	0.001	0.39
Joint Mobilization (n=15) M ±SD	92.9± 12.87	152.2 ± 13.87	59.3± 12.09	0.001	

Figure III: Pre and Post Abduction ROM Between Two Groups



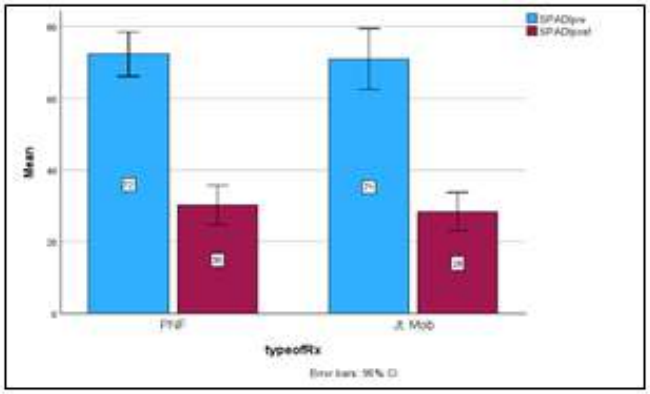
Effects of PNF and Jt. Mob on Shoulder Functional Level

For the third outcome measure, which is the functional level using SPADI score, the means (SD) of the scores for pre and post interventions for both groups were described in Table IV and Figure 4. Interaction effect within groups was analysed using the paired t-test as well as 95% confidence intervals (CI) for the mean difference. when compared between pre and post for within groups, it was found that both groups had significant improvement in increasing shoulder abduction ROM. In PNF group, the mean SPADI score reduced from 72.4 to 30.27 with difference of 42.13. In joint mobilization group, the mean score reduced from 71.00 to 28.4 with difference of 42.6. P-values for both groups were recorded less than 0.001 which indicate that both are significant. It was found that no significant group difference was observed in flexion ROM pre and post intervention for both groups (p = 0.89) and indicates both groups are equally effective in reducing shoulder functional disability. However, no significant group difference was observed in SPADI score for both groups and indicates both groups are equally effective in reducing shoulder disability.

Table IV: Comparison functional disability within groups PNF and Jt. Mobilization

SPADI	Pre	Post	Difference	*p*-value	Overall
PNF stretching (n=15) M ±SD	72.4 ± 11.21	30.27 ± 9.92	42.13 ± 6.99	0.001	0.89
Joint Mobilization (n=15) M ±SD	71.00 ± 15.36	28.40 ± 9.64	42.60 ± 11.46	0.001	

Figure IV: Pre and Post SPADI score Between Two Groups



4. DISCUSSION

The aim of this study was to compare the effectiveness of two techniques, PNF stretching and joint mobilization on shoulder flexion and abduction range of motion, and also level of disability in patients with adhesive capsulitis. Participants included in this study had similar baseline values for dependent variables indicating that both groups had homogenous distribution of patient. After four weeks of interventions, significant improvement was recorded in active flexion ROM for both groups. Similarly, for active shoulder abduction ROM, both groups also showed significant improvement for PNF and joint mobilization groups. However, there were no significant differences recorded when comparing the outcomes between groups, suggesting that PNF or joint mobilization were not superior to each other in improving active shoulder range of motion. This can be supported with a study by (38), who found that both joint mobilization and PNF were similarly effective in improving range of motion and reducing pain in shoulder impingement patients.

Functional levels also were greatly improved in both groups post treatment. This could be related to the simultaneously increased range of motion and muscle strength of the shoulder after the treatments. When the range of motions of the shoulder improved and the pain level had reduced, the individuals may perform other functional activities that previously they could not perform due to the pain and also restricted mobility of the shoulder such as reaching overhead and backward. In a study conducted by Griggs et al. (2000), they had recommended adding a more aggressive treatment such as manual therapies to conventional stretching exercise in order to improve functional activities in idiopathic AC patients (39).

There were several potential limitations to this study. First, this study was conducted as a Master of Physiotherapy thesis work, hence, there was limited time allocation for an extended follow-up period and the number of participants involved in this study were relatively small. Next, there was no control group allocated in this study which may provide a better comparison and outcomes. However, the similar distribution of gender and age groups within both groups might be counted as the strengths of this study. This study may provide guide and support for the therapists in the management of adhesive capsulitis to further optimize patient's ability to achieve full range of motion, depending on the patient's stage of condition. Therefore, researchers might take into considerations of these limitations and strengths when conducting similar study like this in the future.

5. CONCLUSION

Conventional physiotherapy interventions such as hot packs, ultrasound, and TENS are undeniably preferred for the treatment of the patients with AC. However, present study had showed that by adding PNF stretching or joint mobilization together with other conventional treatments significantly improve shoulder ROM and also functional level as both are equally effective within short time of period in the management of adhesive capsulitis.

This research also helps healthcare professionals and practitioners make informed decisions regarding the treatment options. Besides that, the results of the study can contribute to developing personalized treatment plans

for patients with adhesive capsulitis. By gaining insight into which treatments brought better results, healthcare professionals can customize their therapeutic strategies according to each person's specific requirements and goals. This approach enhances outcomes while minimizing pain and functional constraints.

The implementation of effective interventions has the potential to improve the condition, enhance functional and social activities and thus improve the quality of life. Furthermore, providing a more effective treatments within shorter period of time will have positive implications for healthcare costs. By identifying the most efficacious interventions, healthcare resources can be allocated more efficiently, potentially reducing the financial burden of managing adhesive capsulitis.

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