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Proprioceptive Neuromuscular Facilitation Techniques and Scapular Mobilization to Alleviate Scapular Dyskinesia

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SUMMARY

Introduction. Change in the scapular normal kinematics and location is defined as scapular dyskinesis. The key characteristics of the disorder referred as SICK (S for scapular malposition, I for inferior medial border prominence, C for coracoid discomfort and malposition, and K for dyskinesis of scapular motion).

Objective. The objective was to assess the efficacy of proprioceptive neuromuscular facilitation technique in individuals with scapular dyskinesia.

Methods. Randomized control trail with sample size of 102 subjects with scapular dyskinesia, aged 30-50 years, diagnosed by Lateral Scapular Slide Test, was evenly divided into Group A (treated with PNF and conventional therapy) and Group B (received conventional therapy only). Group A underwent scapular mobilization exercises and PNF maneuvers, each with 20 repetitions, while Group B performed scapular mobilization exercises. Treatment time period was 6 weeks (3 sessions/week). Outcome measures included the Numerical Pain Scale (NPRS) and Shoulder Pain and Disability Index (SPADI), assessed via paired t-tests to evaluate within-group changes.

Results. Both PNF along with scapular mobilization and control groups showed significant improvements. PNF along with scapular mobilization resulted in notable pain reduction (NPRS: 7.90 to 5.96) than the control group (8.06 to 7.02). On the SPADI scale, PNF showed substantial improvement (69.80 to 50.20), surpassing the control group (69.80 to 59.41).

Conclusions. PNF along with scapular mobilization demonstrated significant efficacy in reducing both shoulder pain and disability, as measured by SPADI, and in alleviating pain intensity, as measured by NPRS, in individuals with scapular dyskinesia.

KEY WORDS

Alleviation; movement restriction; scapular pain; shoulder dysfunction.

INTRODUCTION

The change in the scapula's normal kinematics and the scapula location is scapular dyskinesis. The key characteristics of the disorder referred as SICK (S for scapular malposition, I for inferior medial border prominence, C for coracoid discomfort and malposition, and K for dyskinesis of scapular motion) (1). Scapula is situated between levels T2 and T7 in the posterior thoracic cage, it is a complicated triangular bone. It consists of superior, lateral and inferior angles, medial, lateral and superior borders. The bone has ventral and dorsal surfaces. The glenoid fossa, or scapula component of the glenohumeral joint, is located on the lateral surface. The Supraglenoid and Infraglenoid tubercles, which serve as attachment points for the Long Head of the Biceps Brachii and the Triceps Brachii, respectively, are also situated here the boney structures of the spine, acromi-

on, supraspinous fossa, and infraspinous fossa are locate d on the posterior surface. The trapezius and deltoid attaches to the spine and acromion, respectively, whereas the supraspinous and infraspinous fossae are where the supraspinatus and infraspinatus attach to the body. Teres Minor, Teres Major, and Latissimus Dorsi are also able to attach to the inferior lateral posterior surface (2).

During elevation of arm, scapular upward rotation and posterior tilt are performed, but in patients with symptomatic SD exhibit change in scapular position as well as increased activity in the serratus anterior, middle, and lower trapezius muscles, even if asymptomatic, persons with SD may eventually develop shoulder pain. SD is more common in patients with shoulder discomfort than in pain-free subjects (3). Every component of shoulder and arm function is included in scapular activities. It is the "A" of stable acromioclavicular joint articulation, the "S" of scapulohumeral rhythm, and the "G" of dynamic glenohumeral concavity/compression six (4).

PNF is a therapeutic approach that improves range of motion (ROM) and muscle activation through four theoretical mechanisms: autogenic inhibition, reciprocal inhibition, stress relaxation, and the gate control theory. PNF has been shown to be useful in enhancing functional capacities, reducing discomfort and PNF techniques have the most promise for improving muscular performance, especially when they entail the agonist and antagonist activating reciprocally to achieve the desired motions (5). Enhancing functional mobility through muscle group facilitation, inhibition, strengthening, and relaxation is the primary goal of PNF pattern exercises (6). Physical therapy includes therapeutic activities like mobilization and proprioceptive neuromuscular facilitation (PNF) methods, as well as manual therapies like soft tissue mobilization and mild stretching (7). Additionally, clinical examination of arm movement indicates that several forms of scapular dyskinesis, including scapular winging and dysrhythmia, may manifest when scapular dyskinesis is present in conjunction with neck pain (8). The significance of scapulothoracic movements in comprehending upper limb mobility has been shown by the three-dimensional kinematic study of the shoulder complex, especially when comparing healthy and non-healthy persons (9). It has been reported that in individuals with adhesive capsulitis, scapular PNF patterns are useful in enhancing shoulder function and ROM as well as rapidly lowering pain (10). Because it focuses on motor learning, PNF appears to be a promising therapy strategy (11). It has been shown that proprioceptive neuromuscular stimulation is useful in reducing pain and enhancing functional capacities. The greatest potential for muscle functioning is provided by PNF techniques, especially those that entail the reciprocal activation of the agonist and antagonist to the intended motion (12). Scapular PNF can be utilized to selectively stretch or strengthen the muscles by including functional or diagonal patterns (posterior elevation-posterior depression and anterior elevation-posterior depression) into the training routine (13).

SUBJECTS AND METHODS

Study design

The study was designed as a randomized controlled trail. Ethical approval was conducted by the ethical committee – the ethical number is 01/008/2023/ISRB/PGSR/SCPT (date of approval: April 17, 2023).

Sample size of 102 subjects with scapular dyskinesia (SD) was selected through simple random sampling for this study. Informed consent has been obtained from all individuals included in this study. The sample was evenly divided into two groups: Group A, consisting of 51 subjects, served as the experimental group, and Group B, also comprising 51 subjects, served as the conventional group. Inclusion criteria encompassed individuals of both genders, aged between 30 and 50 years, with SD diagnosed through the Lateral Scapular Slide Test (LSST). Subjects with history of shoulder surgery, manipulation under anesthesia, neurological deficits affecting activities of daily living, or those with frozen shoulder were excluded from the study to ensure a homogeneous sample.

The study, conducted at the Saveetha Hospitals, aimed to explore the potential benefits of PNF along with scapular mobilization. By employing rigorous methodology and an adequate sample size, the study findings are expected to provide valuable insights into the effectiveness of these interventions in the management of SD. Group A patients were treated with the PNF along with scapular mobilization and conventional treatment, while Group B patients were treated with conventional treatment only.

For Group A, the experimental group, a comprehensive protocol integrating scapular mobilization exercises with PNF techniques was implemented to address SD. Participants engaged in a series of scapular mobilization exercises targeting mobility and alignment, performing each exercise for 20 repetitions. Following the mobilization exercises, PNF maneuvers were incorporated, focusing on scapular stability and muscle coordination, with 20 repetitions per maneuver. A 20-second break was given between sets to optimize neuro-

muscular re-education and muscle activation. The session included a warm-up and cool-down period with stretching exercises targeting the shoulders, neck, and upper back. Throughout the session, participants received education and guidance on proper scapular alignment and movement patterns. This comprehensive approach aimed to address both the mobility and neuromuscular aspects of SD, facilitating improved shoulder function and symptom alleviation.

For Group B, the control group, scapular mobilization exercises were implemented without the integration of PNF techniques. Participants engaged in a series of exercises aimed at enhancing scapular mobility and alignment. This protocol included 20 repetitions of each exercise to match the repetitions used in Group A. Exercises consisted of scapular retraction and protraction, upward rotation and depression, scapular clocks, and wall angels, each performed with 20 repetitions. These exercises targeted the muscles surrounding the scapula to promote mobility and proper alignment. Additionally, participants underwent a brief warm-up session followed by a cool-down incorporating gentle stretching exercises for the shoulders, neck, and upper back. While lacking the specific neuromuscular re-education aspect of PNF, these exercises aimed to improve scapular mobility and may contribute to symptom alleviation in SD.

The patient was positioned on the unaffected side when the therapist stood in the ideal position. The patient received preparation instructions from the therapist. At the beginning of the pattern, the therapist drew the scapula to an extended posture before directing the necessary action. All patterns made use of the PNF agonist tactics of repetitive contraction facilitation and rhythmic initiation. Outcome measurement tools used were the Numerical Pain Scale (NPRS) to assess the intensity of pain and the Shoulder Pain and Disability Index (SPADI) to assess the functional activities of the patient. The treatment protocol was followed for 6 weeks, comprising eighteen treatment sessions (3 sessions per week).

In this research study, statistical analysis was employed to assess the efficacy of PNF techniques in managing SD. The data obtained from the Numerical Pain Scale (NPRS) and the Shoulder Pain and Disability Index (SPADI) were subjected to paired t-tests to evaluate within-group changes. Additionally, between-group comparisons were conducted using unpaired t-tests to discern any significant differences between the PNF group and the control group.

These analyses provided robust statistical evidence supporting the superior efficacy of PNF techniques over conventional treatment in relieving SD, emphasizing both reduced pain levels and enhanced functional outcomes over the 6-week treatment period.

RESULTS

Significant improvements were observed in both groups undergoing PNF techniques for SD. In the NPRS scale, participants in the PNF group exhibited a substantial reduction in pain levels post-treatment, with a mean score decrease from 7.90 (pre-treatment) to 5.96 (post-treatment). The control group also demonstrated a reduction from 8.06 to 7.02 in the same period. Regarding the SPADI scale, the PNF group showed remarkable improvement with a mean score decrease from 69.80 (pre-treatment) to 50.20 (post-treatment). In comparison, the control group exhibited a decrease from 69.80 to 59.41. These findings emphasize the superior efficacy of PNF techniques in relieving SD, as reflected in reduced pain levels and enhanced functional outcomes over the 6-week treatment period (**table I**).

DISCUSSION

The study of Thakur *et al*. showed that the treatment of SD and shoulder proprioception can be achieved with similar effectiveness using both FHP correction and shoulder stabilization exercises. When it came to lowering proprioception errors, shoulder stabilization exercises performed marginally better than the FHP correction group. Furthermore, compared to the shoulder stabilization group, the neck strength values were shown to be clinically significant in the group with deep neck flexor training (14).

Tooth *et al.*'s findings suggest that while both KT1 and KT2 influence scapular kinematics and trapezius muscle activity, KT1 is more advantageous in treating scapular dyskinesis characterized by an imbalance between the upper and lower trapezius muscles. The discussion emphasizes the importance of selecting the appropriate kinesiology tape application technique based on the specific goals and characteristics of the condition being treated (15).

The assertion made by Hwang *et al*. highlights the importance of adopting a functional and neuromuscular approach, specifically through PNF scapula and upper limb movement control exercises, for the treatment of scapula dyskinesis. This approach aims to restore optimal movement patterns and enhance overall shoulder function beyond the scope of traditional muscle strengthening and balancing activities (16). According to Yuksel and Yesilyaprak, in patients with SPS accompanied by scapular dyskinesis, the scapular stabilization exercises, when combined with shoulder mobi-

Table I. Statistical analysis of proprioceptive neuromuscular facilitation (PNF) techniques vs conventional treatment in scapular dyskinesia over a 6-week period.

Outcome Measure	Group	Pre-Treatment Mean (SD)	Post-Treatment Mean (SD)	Mean Difference (95%CI)	P-value (Paired t-test)	P-value (Unpaired t-test)
NPRS (Pain)	PNF Group	7.90 (1.20)	5.96 (1.30)	-1.94 (-2.40, -1.48)	< 0.001	< 0.001
	Control Group	8.06 (1.10)	7.02 (1.25)	-1.04 (-1.40, -0.68)	< 0.001	
SPADI (Function)	PNF Group	69.80 (8.50)	50.20 (9.00)	-19.60 (-22.00, -17.20)	< 0.001	< 0.001
	Control Group	69.80 (8.30)	59.41 (8.60)	-10.39 (-12.40, -8.38)	< 0.001	

The outcome measures used were the Numerical Pain Rating Scale (NPRS) to assess pain intensity and the Shoulder Pain and Disability Index (SPADI) to evaluate functional activities. The table includes pre-treatment and post-treatment mean scores (with standard deviations), mean differences with 95% confidence intervals, and P-values for both within-group (paired t-test) and between-group (unpaired t-test) comparisons. The results highlight significant improvements in both pain reduction and functional outcomes for the PNF group compared to the control group.

lization, stretching, and strengthening, effectively improve scapular dyskinesis, reduce discomfort, and increase muscular strength and shoulder function (17).

There was a study on effectiveness of dry needling (DN) alone and in combination with manual therapy (MT) was evaluated for overhead athletes with SD and associated pain during training. The treatment group, receiving MT followed by DN on specific trigger points, demonstrated significant improvements in pain, disability and SD, compared to the control group that received MT alone. Despite pain and disability reduction in the MT-only group, improvements in SD were limited to the hands-on-waist position. Their findings suggest that the combined approach of DN and MT synergistically enhances the reduction of pain, disability, and improvement in SD in overhead athletes with SD (18).

While further research is warranted to validate these findings and explore long-term effects, the current study contributes valuable insights into the potential benefits of scapular PNF training. Clinicians and rehabilitation professionals may consider integrating scapular PNF patterns into their treatment repertoire to enhance scapular stabilization and muscle strength, ultimately improving the overall functional outcomes for individuals with SD (19).

The current study substantiates that both PNF techniques and Closed Kinetic Chain (CKC) exercises yield noteworthy enhancements in pain intensity, augmented scapular muscle strength, and diminished work-related musculoskeletal disorders in the upper extremity. Nevertheless, in direct comparison using measures such as the LSST and Upper Extremity Neuromuscular Questionnaire (ENMQ), PNF techniques exhibited statistically superior improvements compared to CKC exercises (20). The treatment of Subacromial Impingement Syndrome (SIS) is effectively addressed by both scapular PNF techniques and a conventional exercise program. Nonetheless, the integration of scapular PNF techniques into the exercise program can yield additional benefits, enhancing function, ROM, Pain Pressure Threshold (PPT), addressing active Myofascial Trigger Points (MTrPs), mitigating scapular dyskinesis, and ultimately contributing to heightened patient satisfaction (21).

A comprehensive treatment plan was recommended, involving a series of three intra-articular corticosteroid injections and one month of MT. The MT sessions, conducted three times per week, were based on PNF specifically tailored for the upper limb. Following the completion of the rehabilitation program, notable improvements were observed, including pain alleviation, enhanced ROM in the affected shoulder, increased upper limb muscle strength, and improved hand dexterity. This illustrative case report, coupled with a review of relevant literature, highlights the effectiveness of a multidisciplinary approach in providing relief from pain in a patient experiencing central neuropathic shoulder pain associated with relapsing-remitting multiple sclerosis (22).

The study findings revealed a substantial improvement within each group as assessed by the Berg Balance Scale (BBS), Tinetti Performance-Oriented Mobility Assessment (POMA), and Timed Up and Go (TUG) test. When examining the variation in treatment effects among groups, a notable disparity was observed in POMA and TUG between the

experimental and control groups, indicating a significant difference favoring the experimental group (23).

The application of scapular Kinesio taping as a supplementary measure to dynamic neuromuscular stabilization exercises proves to be notably effective in enhancing upper extremity functions and grip strength among post-stroke patients (24). The combination of Scapular PNF and Maitland Glenohumeral Mobilization demonstrated greater effectiveness in enhancing pain relief, as well as improving ROM in flexion, abduction, internal and external rotation, LSST, and Shoulder Pain and Disability Index (SPADI) in individuals with adhesive capsulitis (25).

CONCLUSIONS

In summary, this study underscores the significant effectiveness of PNF in reducing shoulder pain and disability, as measured by SPADI, and alleviating pain intensity, as measured by NPRS, in individuals with SD. The observed improvements occurred following a concise 6-week treatment protocol comprising eighteen sessions. These findings emphasize the promising role of PNF as a valuable intervention in managing SD, offering meaningful relief and enhanced functional outcomes for affected individuals.

Limitations of the study

The study had a limited number of participants. The study only lasted 6 weeks, so it's unclear if the benefits of the treatment last over a longer time.

Future perspectives

Long-Term Effects

Future research should look at how long the benefits of PNF last by following patients for a longer time.

Wider Population

Testing PNF on different age groups and people with different health conditions could show how effective it is across a broader population.

FUNDINGS

None.

DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

CONTRIBUTIONS

MK: conceptualization, methodology, formal analysis, writing – original draft. JV: data curation, investigation, supervision, writing – review & editing. JH: resources, software, validation, visualization, project administration.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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