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Physiotherapy Section

Proprioceptive Neuromuscular Facilitation Techniques versus Closed Kinematic Chain Exercises in Scapular Dyskinesia among Hospital Housekeeping Staff: An Experimental Study

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ABSTRACT

Introduction: Housekeeping staff in the hospitals perform various overhead upper extremity motions. These repeatedly performed movements in turn place high physical load on the shoulder joint causing weakness of the scapulothoracic muscles which in turn may lead to scapular dyskinesia. Scapular Dyskinesia is the alteration in normal position or motions of the scapula during arm movement. Proprioceptive neuromuscular facilitation techniques apply neuro-physiological principles to the sensory and motor system to treat various neuro-musculoskeletal dysfunctions.

Aim: To evaluate the effectiveness of Proprioceptive Neuromuscular Facilitation (PNF) techniques versus Closed Kinematic Chain (CKC) exercises on pain, scapula position and upper extremity work related musculoskeletal disorders in housekeeping staff with scapular dyskinesia.

Materials and Methods: This single blinded experimental study, in which participants were blinded to the treatment allocated was conducted between June 2019 to January 2020, at Dr. D.Y. Patil Vidyapeeth, Pimpri, Pune, Maharashtra, India. Thirty housekeeping staff with scapular dyskinesia, suffering from neck or/and shoulder pain, and aged 18-40 years were randomly assigned to one of the two groups-group A (PNF) or group B (CKC). Both groups received intervention for five days per week for four weeks. Outcome measures were the Numeric Pain Rating Scale (NPRS), Lateral Scapula Slide Test (LSST), Extended Nordic Musculoskeletal Questionnaire (ENMQ) which was assessed pretreatment at 2nd and 4th week of intervention. Data was analysed in PRIMER of biostatistics version 7.0 statistical software. The Friedman Test was used for intra group comparison whereas the Mann-Whitney Rank Sum Test was utilised for intergroup comparison of the results. The statistical difference significance was set at p-value <0.05 for all the tests performed.

Results: The mean age of participants in group A and group B were 35.14±4.73 and 33.08±4.51 years, respectively. All the outcome measures on intragroup analysis showed significant improvements. Intergroup comparison revealed no statistical significant difference in the scores of NPRS on rest and activity between both the groups. The LSST for right side of position 3 (p-value=0.04) and of position 1 (p-value=0.02), 3 (p-value=0.002) on the left side, showed stastically significant difference between both groups. There was also greater improvement in the scores of ENMQ in the participants of group A receiving PNF compared to group B which received CKC Exercises.

Conclusion: The present study proved that both PNF techniques and CKC exercises show significant improvement on pain intensity, increase in the scapular muscle strength and reduction in the upper extremity work related musculoskeletal disorders. However, when compared (LSST and ENMQ), PNF techniques showed statistically greater improvement than CKC exercises.

Keywords: Extended nordic musculoskeletal questionnaire, Lateral scapula slide test, Scapular muscle weakness

INTRODUCTION

The scapula plays a vital role in optimising the function of the shoulder joint therefore any alterations in scapular muscle recruitment may affect many aspects of normal shoulder function. Any variations occurring in the normal position or motions of the scapula during scapular and humeral movements is termed as Scapula dyskinesia. 'Dys' means alteration of and 'kinesis' refers to motion, is a term that reflects the loss of normal control of scapular motion. Overhead athletes are reported to have a greater prevalence of scapula dyskinesia (61%) as compared to non overhead athletes (33%) [1]. There are several bone, soft tissue and nerve related factors that contribute to these abnormal scapula patterns and position. Hypomobility of the short head of biceps or pectoralis minor muscle, altered periscapular muscle activation patterns and distorted scapula muscle force couple co-activation are few of the major soft tissue related causes which lead to the occurrence scapula dyskinesia [2,3].

The most common weak or inhibited muscles of the scapula are the lower stabilisers of the scapula which include the serratus anterior, rhomboids, middle and lower trapezius muscles [4]. Inhibition of these muscles results in a reduced ability of the muscles to exert torque and stabilise the scapula, as well as distort the normal firing patterns of the muscles around the shoulder. The abnormal scapular biomechanics that occur as a result of dysfunction create abnormal scapular positions that decrease normal shoulder function and predispose the shoulder to injury [5]. Various treatment techniques have been used for rehabilitation for scapula muscles, among them the most common treatment techniques used are the Proprioceptive Neuromuscular Facilitation techniques (PNF).

The PNF techniques assist in achieving an optimal state of neurological and musculoskeletal system, and are built on the fact that motor recruitment can be enhanced by appropriately utilising reflexes and proprioceptive inputs which in turn improve the patients postural responses, movement patterns, strength, as

well as muscular endurance [6]. The other most commonly used treatment is the Closed Kinematic Chain exercises (CKC) involves exercises or movements where the distal aspect of the limb is fixed to a stationary object and the proximal segment is free to move. The CKC exercises of the upper extremity cause the muscles around the scapula to co-contract in order to achieve normal scapular position and motion thereby reducing the risk of subacromial impingement, increase rotator cuff efficiency and help in preventing further shoulder injuries [5].

Shankar P et al., reported that scapular stabilisation with closed kinetic chain exercises were effective in reducing pain in participants with scapular dyskinesia [7]. Prasanna KJ et al., concluded that addition of scapular PNF to conventional treatment showed significant reduction in pain intensity, increase in the shoulder range of motion, improvement in scapular dyskinesis and functional activities in subjects with adhesive capsulitis [8]. Housekeeping staff in the hospitals are widely involved in performing repeated activities which may lead to various biomechanical stresses on the musculoskeletal system. Repeated overhead activities performed by them lead to high physical load on the shoulder joint, which may cause scapulothoracic muscle weakness, leading to an altered scapulohumeral rhythm and an abnormal positioning of the scapula (scapular dyskinesia). This in turn increase the risk of work related musculoskeletal disorders or injuries in them. This occupation related musculoskeletal disorders are a major cause of temporary work disability and are widely associated with huge expenses of health cost, reduction in work productivity and reduced quality of life among these workers [9]. To the best of our knowledge there is a lack of literature comparing the individual effects of Proprioceptive Neuromuscular Facilitation techniques (PNF) and Closed Kinematic Chain exercises (CKC) in the treatment of scapular dyskinesia. Therefore, the present study aimed at evaluating the effects PNF techniques versus CKC exercises on pain, scapula position and upper extremity work related musculoskeletal disorders in housekeeping staff with scapular dyskinesia.

MATERIALS AND METHODS

In this single blinded experimental study, participants were blinded to the treatment allocated.The study was conducted between June 2019 to January 2020, at Dr. D.Y. Patil Vidyapeeth, Pimpri, Pune, Maharashtra, India. An Ethical Clearance was obtained from the Institutional Sub-Ethics Committee before the commencement of the study (reference .no. DYPCPT/ISEC/15/2019).

Sample size calculation: Pilot study was conducted to evaluate the prevalence of scapula dyskinesia in housekeeping staff, after which power analysis was done with α error=0.05 and power of 80%. Considering 10% dropouts the sample size was calculated as 30 (15) participants in each group [10].

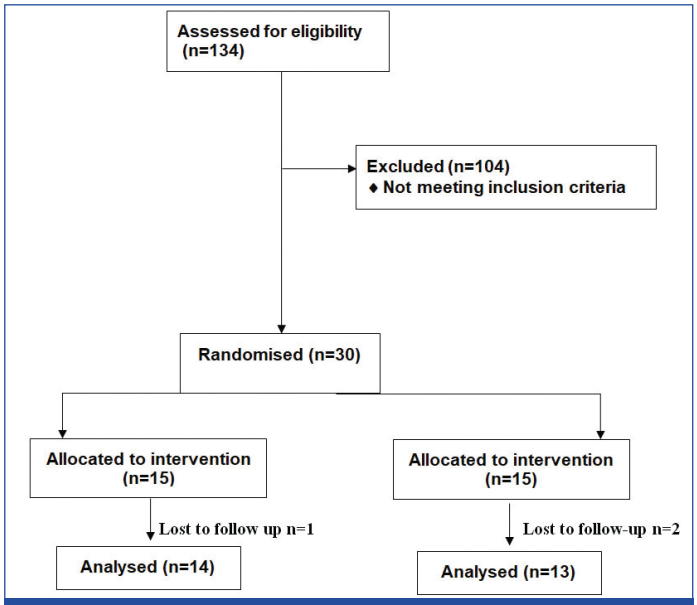
Inclusion criteria: Female hospital housekeeping staff in the age group of 18-40 years with scapula dyskinesia, suffering from neck or/and shoulder pain due to scapular dyskinesia, having a work experience of atleast one year, and those willing to participate in the study were included in the study.

Exclusion criteria: Participants were excluded if they suffered from the following acute pain, degenerative disease of the spine, congenital or traumatic shoulder conditions which may prevent upper limb motion, neurological conditions that affect muscular strength and upper extremity range of motion and participants who were on pain medication.

Total 134 housekeeping staff was screened for scapular dyskinesia after obtaining a written informed consent in the local language, and thereafter were enrolled in the study if they fulfilled the inclusion criteria.

As the maximum number of hospital housekeeping staff of the institute were females, the present study conducted involved 30 female housekeeping staff. They were assigned into either group A (PNF technique) or group B (CKC exercises) with the help of the lottery method by the therapist. For the lottery method, the participants were instructed to select a chit, and were assigned to either group A or group B depending on their choice of selection.

During the study period, three participants were not able to complete their treatment due to health issues and change in job pattern. So, 27 housekeeping staff participated throughout the period of study [Table/Fig-1].



[Table/Fig-1]: Flowchart of procedure.

Group A: Participants in group A received PNF exercise for the scapula and the affected upper extremity. Scapular PNF exercises were performed in side lying position. Rhythmic stabilisation technique of PNF was used to perform scapular pattern which included the following motion- scapular anterior elevation and posterior depression, posterior elevation and anterior depression. Upper extremity PNF pattern included the symmetrical pattern shoulder flexion-abduction external rotation and extension adduction internal rotation, was performed using the slow reversal technique of PNF. Participants performed 2 sets of 10 repetitions each of the scapula and upper extremity PNF exercises for week 1 and 2, progression in the exercises were made by performing three sets of 10 repetitions in week 3 and 4. Intervention was given as one session per day, five consecutive days per week for four weeks period.

Group B: Participants received CKC exercises, which included the following exercises-scapular clock exercises, wall slide exercises wall pushups exercises, standing weight shifts exercises table slide exercises was performed using a wooden table. Participants performed two sets of 10 repetition each of the CKC exercises exercise for week 1 and 2, progression in the exercises were made by performing three sets of 10 repetition in week 3 and 4. Intervention was given as one session per day, five consecutive days per week for four weeks period.

Outcome measures used:

1. Numeric Pain Rating Scale (NPRS) was used to assess change in pain intensity at rest and on activity.
2. The Lateral Scapula Slide Test (LSST) at three positions: position 1(shoulders in neutral position); position 2 (hands resting on hips with thumbs posterior); position 3 (90 degrees shoulder abduction and medial rotation) was used to measure the alteration in the position of the scapula [11].
3. Upper extremity work related disorders were assessed using The Extended Nordic Musculoskeletal Questionnaire (ENMQ), all the outcome measures were assessed pre intervention and at the end of the 2nd and 4th week of intervention respectively [12].

STATISTICAL ANALYSIS

Data was analysed in PRIMER of biostatistics version 7.0 statistical software. The data was not normally distributed as tested by the Shapiro-Wilk normality test. The amount of change in the NPRS, LSST were all evaluated by the Friedman Test for comparing within the groups and Mann-Whitney Rank Sum Test was utilised for comparison of the results in between both the groups. The statistical difference significance was set at p-value <0.05 for all the test performed.

RESULTS

The mean age of participants in group A and group B were 35.14±4.73 and 33.08±4.51, respectively [Table/Fig-2].

Characteristics	Group A (n=14) Mean±SD	Group B (n=13) Mean±SD	p-value (t-test)
Age (years)	35.14±4.73	33.08±4.51	0.095
Work experience (years)	2.75±1.75	3.69±2.03	0.082

[Table/Fig-2]: Demographic data of the participants.
p-value <0.05 considered significant

[Table/Fig-3] indicates values on the NPRS on rest and on activity assessed at pre intervention, two weeks and four weeks post intervention in group A and group B, the scores suggest a reduction in pain intensity from pretreatment at the end of four weeks of intervention in both the groups. However, intergroup comparison reveal no statistical significant difference in the scores of NPRS on rest and activity between both the groups.

NPRS	Group A Mean±SD	Group B Mean±SD	p-value
NPRS on rest			
Pretreatment	3.64±0.63	3.76±1.23	0.96
After 2 weeks of treatment	2±0.96	2.61±1.19	
After 4 weeks of treatment	0.57±0.93	0.61±0.86	
NPRS on activity			
Pretreatment	6.35±0.84	6.53±0.96	0.25
After 2 weeks of treatment	4.35±0.84	4.92±1.15	
After 4 weeks of treatment	2.87±1.16	2.53±1.19	

[Table/Fig-3]: Comparison of Numeric Pain Rating Scale (NPRS) on rest and on activity between group A and group B.
p-value <0.05 to be considered significant (calculated using Mann-Whitney rank sum test)

[Table/Fig-4,5] indicates intragroup comparisons of thescores of LSST for group A and B, respectively. The score reveal that there were statistically significant changes in the scores of LSST for all three positions at the end of 4th week of intervention in both group A and group B.

Lateral scapula slide test	Group A			
	Mean±SD	p-value	Mean±SD	p-value
	RT 1		**LT 1**	
Pretreatment	8.93±1.64	<0.001*	7.50±1.71	0.002*
After 2 weeks of treatment	8.6±1.60		7.46±1.72	
After 4 weeks of treatment	8.47±1.61		7.37±1.68	
	RT 2		**LT 2**	
Pretreatment	8.94±1.62	<0.001*	7.51±1.66	0.008*
After 2 weeks of treatment	8.70±1.54		7.43±1.67	
After 4 weeks of treatment	8.54±1.56		7.37±1.66	
	RT 3		**LT 3**	
Pretreatment	8.52±1.6	0.002*	7.16±1.65	0.005*
After 2 weeks of treatment	8.37±1.62		7.10±1.69	
After 4 weeks of treatment	8.18±1.59		7.07±1.64	

[Table/Fig-4]: Pretest and Post-test values of LSST for Right (RT) and Left (LT) side of position 1, 2 and 3 at pre, post 2 weeks and post 4 weeks of intervention in group A.
*p-value <0.05 to be considered significant (Friedman test)

Lateral scapula slide test	Group B			
	Mean±SD	p-value	Mean±SD	p-value
	RT 1		**LT 1**	
Pretreatment	9.90±1.27	<0.001*	8.29±1.24	0.035*
After 2 weeks of treatment	9.66±1.20		8.15±1.22	
After 4 weeks of treatment	9.42±1.14		8.07±1.21	
	RT 2		LT 2	
Pretreatment	9.97±1.29	0.004*	8.33±1.22	<0.001*
After 2 weeks of treatment	9.87±1.28		8.25±1.21	
After 4 weeks of treatment	9.53±1.15		8.13±1.23	
	RT 3		LT 3	
Pretreatment	9.50±1.23	<0.001*	7.98±1.19	0.002*
After 2 weeks of treatment	9.24±1.13		7.84±1.17	
After 4 weeks of treatment	9.05±1.11		7.71±1.18	

[Table/Fig-5]: Pretest and Post-test values of LSST for Right (RT) and Left (LT) side of position 1, 2 and 3 at pre, post 2 weeks and post 4 weeks of intervention in group B.

[Table/Fig-6,7] indicates intergroup comparisons of the scores of LSST between group A and B. The scores reveal better outcomes in group A on the right side for position 3 and for position 1 and 3 on the left side as compared to group B.

Lateral scapula slide test	Group A Mean±SD	Group B Mean±SD	p-value (Mann-Whitney rank sum test)
RT 1			
Pretreatment	8.93±1.64	9.90±1.27	0.19
After 2 weeks of treatment	8.6±1.60	9.66±1.20	
After 4 weeks of treatment	8.47±1.61	9.42±1.14	
RT 2			
Pretreatment	8.94±1.62	9.97±1.29	0.20
After 2 weeks of treatment	8.70±1.54	9.87±1.28	
After 4 weeks of treatment	8.54±1.56	9.53±1.15	
RT 3			
Pretreatment	8.52±1.6	9.50±1.23	0.04*
After 2 weeks of treatment	8.37±1.62	9.24±1.13	
After 4 weeks of treatment	8.18±1.59	9.05±1.11	

[Table/Fig-6]: Comparison of LSST for right (RT) side of position 1, 2 and 3 at pre, post 2 weeks and post 4 weeks of intervention in group A and group B, p-value <0.05 to be considered significant.
*p-value <0.05 was considered as significant

LSST	Group A Mean±SD	Group B Mean±SD	p-value (Mann-Whitney rank sum test)
LT 1			
Pretreatment	7.50±1.71	8.29±1.24	0.02*
After 2 weeks of treatment	7.46±1.72	8.15±1.22	
After 4 weeks of treatment	7.37±1.68	8.07±1.21	
LT 2			
Pretreatment	7.51±1.66	8.33±1.22	0.13
After 2 weeks of treatment	7.43±1.67	8.25±1.21	
After 4 weeks of treatment	7.37±1.66	8.13±1.23	
LT 3			
Pretreatment	7.16±1.65	7.98±1.19	0.002*
After 2 weeks of treatment	7.10±1.69	7.84±1.17	
After 4 weeks of treatment	7.07±1.64	7.71±1.18	

[Table/Fig-7]: Comparison of LSST for right (RT) side of position 1, 2 and 3 at pre, post 2 weeks and post 4 weeks of intervention in group A and group B.
*p-value <0.05 to be considered significant; LSST: Lateral scapula slide test

[Table/Fig-8] indicates the responses on the ENMQ used to evaluate the work related upper extremity disorders, which reveal

that less number of participants experienced discomfort after four week of intervention in group A as compared to group B. Thereby suggesting superior outcomes in the scores of ENMQ in group A as compared to group B.

ENMQ	Group A (n=14)	Group B (n=13)
Neck pain	7 (50%)	8 (61.5%)
Shoulder pain	10 (71.4%)	7 (53.8%)
Back pain	3 (21.4%)	1 (7.6%)
Knee pain	1 (7.1%)	0
Hospitalisations	0	0
Changed jobs	6 (42.8%)	7 (53.8%)
Discomfort in past 4 weeks	13 (92.8%)	12 (92.3%)
Discomfort today (pretreatment)	14 (100%)	13 (100%)
Discomfort today (at 2 weeks post treatment)	13 (92.85%)	12 (92.3%)
Discomfort today (at 4 weeks post treatment)	9 (64.2%)	10 (76.9%)
Prevented from working in last 12 months	12 (85.7%)	11 (84.6%)
Visited a doctor in last 12 months	9 (64.2%)	8 (61.5%)
Taken pain medication in last 12 months	10 (71.4%)	8 (61.5%)
Taken sick leaves in last 12 months	1 (7.1%)	1 (7.1%)

[Table/Fig-8]: Responses for the Extended Nordic Musculoskeletal Questionnaire (ENMQ) in group A and group B.

DISCUSSION

The purpose of the present study was to evaluate the effectiveness of PNF compared to CKC exercises on pain, scapula position and upper extremity work related musculoskeletal disorders in housekeeping staff with scapular dyskinesia. In the current study, evaluation of the pain scores at rest and activity suggested that both PNF technique as well as CKC exercises is effective in reducing pain. Lee Y et al., stated that shoulder stabilisation exercises along with conventional exercises had evident effects on reduction in pain intensity, improvement in functional outcomes and also showed improvement in the quality of life in patients with neck pain [13].

As per [Table/Fig-3], intergroup analysis for pain indicated that both PNF and CKC exercises are equally effective in reducing pain at the end of four weeks of intervention. PNF stimulates the proprioceptive myoreceptors of the muscles and tendons, that lead to activation of the golgi tendon organs which further cause reflex inhibition of the muscle thereby reducing pain. The PNF techniques also help in normalising muscle tone and increase the circulation of blood as well as tissue fluid which in turn contribute to further relief of pain [8]. The CKC exercises stimulate the proprioceptive system to initiate and control muscle activation patterns, also they reduce the shear forces acting on the joint while adding comprehensive forces on the joint which in turn enhance joint stability. Rezasoltani A et al., performed a study and concluded that exercises using PNF patterns were more effective than traditional exercise therapy increase neck muscles strength and decrease neck pain among bank workers suffering [6]. Exercises based on proprioceptive patterns correct impaired proprioceptive signals, improve cervicocephalic kinaesthesia and the ability to improve the head and neck posture thereby reduce pain and discomfort in these patients with chronic neck pain.

As per [Table/Fig-6,7], both PNF and CKC exercises are effective in improving the strength of the scapula muscles over a period of four weeks of intervention. This occurs due to the neural adaptation which occurs after a period of four weeks of strength training. PNF exercises cause a decrease in CNS inhibition, reduced sensitivity of the golgi tendon organ and changes at the myoneural junction of the motor unit. These factors lead to an increase in the recruitment, rate and synchronisation of the firing of motor units thereby improving motor learning and co-ordination [14]. Upper extremity CKC exercises promote co-activation of the stabilisers of the scapula and the glenohumeral joint and thus, improve the dynamic stability of the glenohumeral complex, leading to stimulation of the mechano-receptors and augment sensory impulses for the control of movement being performed [15].

The above results are consistent with the results of Kotteeswaran K and Balaji M, who showed that patients with periarthritis shoulder having scapula dyskinesia benefited addition of scapula exercises to conventional treatment [16]. Turgut E et al., concluded that addition of scapula stabilisation exercises to shoulder girdle stretching and strengthening treatment protocol produced better results with respect to scapula kinematics after six weeks and 12 weeks of training [15]. Intergroup comparison between both the study groups in the present study indicated comparison of LSST for right side of position 3 (p-value=0.04) and of position 1 (p-value=0.02), 3 (p-value=0.002) on the left side, revealed that PNF technique proved to be more effective than CKC exercises. This may be due to the fact that PNF training changes muscle fiber distribution and cross sectional area of the muscle. The PNF leads to changes in the distribution of the muscle fiber type leading to a unidirectional pattern of transformation of fast twitch fibers to slow twitch fibers. Irradiation occurring due PNF exercises produces an activation of the weaker muscles by stimulating the stronger group of muscles thereby improving their strength [14].

The [Table/Fig-8] depicts the scores on the ENMQ which was applied as a screening tool for musculoskeletal pain and related events, the scores reveal that, 64.2% of participants of group A and 76.9% of participants in group B experienced pain after four weeks of intervention. Better outcomes were observed in the scores of group A, thereby stating that group A receiving PNF techniques, proved to be more effective in reducing upper extremity work related musculoskeletal disorders as compared to the participants treated with the CKC exercise, thereby suggesting that PNF techniques proved to be more economically effective than CKC exercises.

Limitation(s)

The LSST which was used to measure the position of the scapula was performed using a measuring tape instead of a vernier caliper which may reduce the accuracy of the readings obtained due to human error.

CONCLUSION(S)

The present study conducted among female housekeeping staff with scapula dyskinesia undergoing treatment involving PNF techniques and CKC exercises both demonstrated significant improvement in pain intensity on rest and activity, increase in the scapular muscle strength thereby improving the position of the scapula and reduction in the upper extremity work related musculoskeletal disorders, however participants receiving PNF techniques showed greater statistical significant results as compared to participants receiving CKC exercises. Further studies can utilise Electromyography (EMG) an assessment tool to analyse the recruitment of the scapula muscles.

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