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Original Research Article

Efficacy of Muscle Energy Technique As Compared to Proprioceptive Neuromuscular Facilitation Technique in Chronic Mechanical Neck Pain: A Randomized Controlled Trial

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ABSTRACT

Background and purpose: Mechanical neck pain provoked by sustained neck posture, neck movement, pain on palpation of cervical musculature without pathologies. Previous study reported that muscle energy technique for upper trapezius and levator scapulae are effective treatment for mechanical neck pain. This study was designed to evaluate the two manual technique i.e. Muscle energy technique (MET) and Proprioceptive neuromuscular facilitation (PNF) technique in subjects with chronic mechanical neck pain.
Methods: 45 subjects of chronic mechanical neck pain were included and randomly allocated in three treatment groups. Group- A received 12 sessions of MET, Group- B received 12 sessions of PNF technique and Group- C received 12 sessions of isometric and self-stretching exercise for four weeks.
Outcome measures: Pain intensity was measured by VAS, ROM was measured by universal goniometer for lateral flexion and rotation of cervical spine and function was evaluated by NDI scale. These parameters were recorded at baseline and at the end of 4 weeks.
Results: There was statistically significant improvement ($p<0.05$) in all the three groups for all the outcomes. In between group comparison the entire outcome showed statistically no significant changes in between Group- A and Group-B.
Conclusion: The present study shows that MET and PNF technique are equally effective in decreasing pain, increasing ROM and improving function in subjects with chronic mechanical neck pain.

Key words: Mechanical neck pain, Muscle energy technique (MET), Proprioceptive neuromuscular facilitation (PNF) technique, Visual analogue scale (VAS), Range of motion (ROM), Goniometer, Neck disability index (NDI).

INTRODUCTION

Mechanical neck pain is also known as nonspecific neck pain. [1] It is also defined as generalized neck pain provoked by sustained neck posture, neck movement, pain on palpation of cervical musculature without pathologies. [2] The annual prevalence of mechanical neck pain ranges in industrial countries from 27% to 48%. Prevalence is high in middle aged people. [3] In the majority of cases, the pathologic basis for the neck pain is unclear and the complaints are labelled as 'nonspecific' or 'mechanical'. [4] Precise prognosis by

clinical examination is problematic because signs and symptoms are frequently nonspecific.[5] Mechanical neck pain commonly seen in people involved in occupation like computer processing, clerical job, students and people with sedentary life style [6,7] awkward occupational posture, heavy lifting and physically demanding work. In a wrong working position, neck extensor muscles would be excessively stretched during a long period of working with forward position of head and neck. [8] According to Janda, postural muscles have a tendency to get shortened, hypertonus, spasmodic and altered proprioceptive input. Therefore common cause of neck pain is muscle tightness in both normal and pathological conditions. Most common muscle is upper trapezius and levator scapulae. [9] The majority of cases of neck pain originate in mechanical factors: repetitive movements, lack of work breaks, static jobs and holding the head and arm position for long period of time. The structures being deformed in mechanical neck pain may be the skin, subcutaneous tissue, capsule of synovial apophyseal joints, longitudinal ligaments, ligamentum flavum, interspinous ligament, and annulus fibrosus of intervertebral disc. [10]

The symptoms of mechanical neck pain include neck pain with limited range of motion of the neck and a feeling of stiffness. Pain is aggravated by neck movements or sustained neck postures [5] and tenderness in neck and shoulder region. [11]

Specific treatment for mechanical neck pain includes moist heat pack, cervical mobilization, cervical manipulation, strength training and postural re-education. [12] Manual therapy is commonly used in the treatment of mechanical neck pain. Manual techniques include positional release technique, muscle energy technique, myofascial release technique, cyriax technique, NAGS and SNAGS, manual pressure release, proprioceptive neuromuscular facilitation and ischemic compression. [1,4]

Muscle energy technique (MET) is a method of treatment that involves the voluntary contraction of subject's muscles in a precisely controlled direction, against a counterforce. MET is commonly useful method for achieving tonus release (inhibition) in a muscle. The approach involves the isometric contraction of the affected muscle producing post isometric relaxation through the influence of the Golgi tendon. [1] MET may be used to decrease pain, stretch tight structures muscle and fascia, reduce muscle tone, improve local circulation, strengthen weak musculature and mobilize joint restriction. [9]

Proprioceptive Neuromuscular Facilitation (PNF) involves stretching, resisted movement, traction and approximation to ameliorate muscle decline, disharmony, atrophy and joint movement limitation. It is very effective in improving flexibility, strength and range of motion. Recently, it has been used in orthopaedic diseases of bones and PNF Technique is based on movement pattern to facilitate and correct sensory motor function it has been suggested that PNF correct the impaired impulses emerging from proprioceptive receptors in the muscle. Therefore, it decreases pain and desires to improve the strength of muscles. [13]

There is lack of literature comparing the Muscle energy technique with proprioceptive neuromuscular facilitation technique on chronic mechanical neck pain. Therefore, the purpose of present study is to compare that which of the two techniques i.e. Muscle energy technique and the proprioceptive neuromuscular facilitation technique is better to decrease pain, improve ROM and improve function in subjects with chronic mechanical neck pain.

MATERIALS AND METHODS

We recruited 45 subjects from NIOH, Kolkata. Subjects with chronic mechanical neck pain were included in the study. Criteria for inclusion were age of 18-45 years, both males and females. Duration of pain at least 3 months. VAS score

between 5 to 8 cm. Complaint of neck pain without radiation. Neck disability index score more than 10 points on 0-50 scales. Dull aching pain increased by sustained postures, neck movement and palpation of cervical musculature. Neck pain with limitation of side flexion and rotation range of motion. Pain is always felt at end range. Stiffness on turning the head and neck in the morning.

Exclusion criteria included subjects spinal infection. History of neck surgery in the past 12 months. Diagnosed cases of central cervical canal stenosis, torticollis, and scoliosis. Neck pain with radiation to the arm and upper extremity. Trauma of the neck. Nerve root involvement. Diagnosed with serious pathology like malignancy, infection and inflammatory disorders. Frequent migraine. History of cervical degenerative joint disease.

The subjects were randomly assigned in the three treatment groups (group A) MET along with isometric exercises and stretching exercises for neck, groups (group B) PNF along with isometric exercises and stretching exercises for neck, groups (group C) isometric exercises and stretching exercises for neck. Total 12 sessions thrice in a week for 4 weeks.

Procedure

MEASUREMENT OF OUTCOME PARAMETERS

Measurement of pain intensity: Pain intensity was measured using Visual Analogue Scale. Which is a 10cm horizontal line, with 0 presenting "no pain" and 10 representing "worst pain imaginable"? It is reliable, valid and sensitive to change.

Measurement of cervical spine (C.S) lateral flexion

(Universal goniometer was usedto measure the cervical lateral flexion ROM.)The fulcrum of the goniometer was placed over C-7 spinous process, stationary arm was positioned with the spinous process of the thoracic vertebrae and movable arm was positioned with the dorsal midline of the head.

Measurement of cervical rotation

Universal goniometer was used to measure the cervical rotation ROM. The fulcrum of the goniometer was placed over the centre of the cranial aspect of the head, proximal arm parallel to an imaginary line between the two acromion process and distal arm with the tip of the nose.

Neck disability index scale

Neck disability index consists of 10 questions addressing functional activities. There are 6 potential responses for each item, ranging from no disability (0) to total disability (5). The NDI is scored from 0 to 50, with higher score indicating greater disability.

PROCEDURE

Study an approved by the Institutional Ethical Committee (IEC). The subjects who were diagnosed and referred as a case of chronic mechanical neck pain from Assessment clinic (ASC), NIOH were approached with the proposal of the study. They were screened according to the inclusion and exclusion criteria. The subjects were allocated to treatment

Group- A (Muscle energy technique + supervised & home exercise program (HEP)), Group-B (Proprioceptive neuromuscular facilitation technique + supervised and HEP) and Group -C (Supervised and HEP) by simple random sampling method consisting of 15 subjects in each group. For each subject, demographic and baseline data of the outcome measures (pain intensity, ROM and function) were taken. Then interventions were given thrice in a week (total=12 sessions) for four weeks. After completion the therapeutic sessions of 4 weeks, post-intervention data of the outcome measures were taken. (Table 1)

Fig 1: MET for upper trapezius

Fig 2: MET for levator scapulae

Statistical analysis

Data was computed and analysed using SPSS (Statistical Package for Social Sciences) software version 23. Mean and standard deviation were calculated for Pre and 4thweeks Post treatment data for the entire outcome measures in all the groups.

- Paired t- test and ANOVA test were used to compare the data. Level of significant was set up $p<0.005$.SPSS version 23 software used for analysis of collected data.
- Test of normality was done using "Shapiro- Wilk" test which revealed that data was normally distributed ($p>0.05$) thus parametric test were used for analysis of continuous data.
- Demographic data (age, duration of symptoms) and baseline characteristics of the data between the three groups for homogeneity were measured using "One way ANOVA".
- "Paired sample t-test" were used to see the differences within the group at baseline and after the completion of treatment protocol.
- "One way ANOVA" and Post Hoc-Tukey's test for multiple comparisons were used to see the differences between the groups. Multiple comparisons of the mean difference i.e. difference of mean of pre-data and mean of post-data were used for comparison among the groups.
- The tests were applied at 95% confidence interval.
- The results were considered significant at p value ≤ 0.05.

FLOW CHART OF STUDY

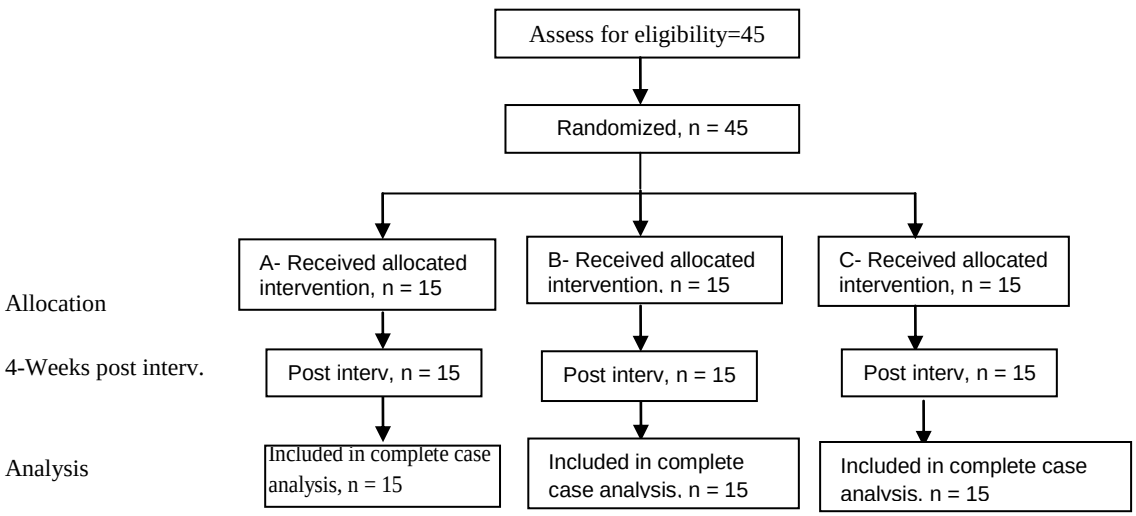

Table 1: Interventions of different groups

Therapy Type/ Intervention	Description
Manual Therapy Group A-MET	**for upper trapezius (fig. 1)** • Subject- supine lying • Therapist- stabilized the shoulder of affected side with one hand and other hand at the ear and mastoid area of the affected side. • Then flexed neck fully side bent in unaffected side and slight rotation towards the affected side. • Subject was introduces a slight resisted effort (20% of available strength) to take the stabilized shoulder towards the ear (a shrug movement) and ear towards the shoulder. • Isometric contraction for 7-10 seconds with appropriate breathing. • This position was maintained for 30 seconds (post isometric relaxation). **for levator scapulae (fig 2)** • Subject - supine lying. • Therapist- one hand supports the head and other hand on the affected side shoulder. • Then therapist's forearm lift the neck into full flexion and head turned fully into side flexion and rotation on unaffected side. • asked the subject to take the head backwards towards the table against the therapist's unmoving resistance, while at the same time a slight (20% of available strength) shoulder shrug. • Isometric contraction was held for 7-10 seconds with appropriate breathing. This position was maintained for 30 seconds (post isometric relaxation). • 3 to 5 repetition • 3 sessions/week for 4 weeks. [8,10] [Isometric exercise and self-stretching for neck muscles was given as supervised as well as home exercise programdescribed in group- C]
Group- B (PNF)	Two physiotherapists for simultaneous neck and arm (PNF) patterns. Slow reversal technique of PNF was used. **Methods:** The following movement patterns were performed:- a) Head and neck flexion with rotation to right b) Head and neck extension with rotation to left c) Left upper extremity- extension, adduction, internal rotation with elbow straight(simultaneously perform with head and neck flexion with rotation to right) d) Left upper extremity- flexion, abduction, external rotation with elbow straight (simultaneously perform with head and neck extension with rotation to left) Same pattern repeated in other direction with right upper extremity. Movement pattern in one direction have been described below **a) Head and neck flexion with rotation to right** • Patient's position - Supine lying and head and neck out of plinth. • Starting position- extension of the head and neck with rotation to left. • Therapist's position – Standing, one hand on the occiput and other hand on the mandible. • Commands- 'pull your chin up towards the sternum'. • Movement- flexion of the head and neck with rotation to the right with normal timing. Facilitation through appropriate verbal commands and manual contact. **b) Head and neck extension with rotation to left** • Patient's position- same as above • The starting position- head and neck flexion with rotation to right. • Therapist's position – Standing, one hand on the occiput and other hand on the mandible. • Commands-'push and look to the left'. • Movement- Extension of the head and neck with rotation to the left with normal timing. Facilitation through appropriate verbal commands and manual contact.
Group- C (control group)	**c) Left upper extremity- extension adduction, internal rotation with elbow straight** • Patient's position- supine lying • The starting position will be flexion, abduction, and external rotation of the shoulder, elbow flexion, supination of the forearm, extension of the wrist with radial deviation and extension of the fingers and thumb. • Therapist's position- standing, palm of left hand into the palm of the patient's left hand and grasp the palm and exert pressure on the dorsum of the patient's hand. • Commands- Instruct the patient to grip my hand and pull down'. • Movement- Flexion of fingers, opposition of the thumb, flexion of the wrist with ulnar deviation, pronation of the forearm, extension, adduction and medial rotation of the glenohumeral joints. d) **Left upper extremity – flexion, abduction, external rotation with elbow extension** • Patient's position- supine lying • Starting position- extension, adduction, and internal rotation of the shoulder with elbow straight, pronation of the forearm, flexion and ulnar deviation of the wrist, flexion of the finger and flexion and opposition of the thumb. • Therapist's position- standing .The therapist's right hand over the lateral epicondyle and the point of the elbow to encourage extension and with the left hand grips the patient hand for the basic pattern. • Commands- 'push'. After the movement has started the therapists places the finger of her right hand on the extensors surface of the patient's wrist at the radial side. And resistance will be given by the hand on the wrist for facilitate these movements. • Movement- Extension of the thumb and finger, extension of the wrist with radial deviation, supination of the forearm, elbow flexion and shoulder flexion, abduction and external rotation. [8-12 repetitions 3 times a week for 4 weeks. [7,12] Isometric exercise and self-stretching for neck muscles described in Group C]

	Stretching exercises **For neck extensor stretch:** • Gently bend the neck forward • Holdfor 10 seconds and repeat 5 times. **For neck flexor stretch:** • Gently bend the neck backward • Hold for 10 seconds and repeat 5 times. **For neck side flexor stretch:** • Gently bend the neck on right/left side • Hold for 10 seconds and repeat 5 times. **For neck lateral rotation stretch:** • Gently turn the neck on right/left side • hold the position for 10 seconds and repeat 5 times **ISOMETRIC EXERCISE FOR NECK MUSCLES** • Isometric flexion- • Dominanthand on the forehead • Firmly pushes the forehead against the hand • For 10 seconds and repeat 5 times. **Isometric extension-** • Hand behind their head • Firmly pushes the head against the hand • For 10 seconds and repeat 5 times. **Isometric side flexion-** • Hand on right/left side of the head • Firmly pushes the head against the hand • For 10 seconds and repeat 5 times. **Isometric neck rotation-** • Hand on the right/left cheek. • firmly turn the face against the hand • hold for 5 seconds and repeat 5 times. [10,13] [Patient was instructed to attend the supervised session thrice in a week for 4 weeks]

RESULTS

Demographic Data

45 subjects (Female=28 and Male=17) were evaluated and randomly assigned into three different groups-Group-A (n=15), Group- B (no=15), Group- C (n=15). Their age, duration of symptoms was recorded. These variables showed statistically insignificant difference between the three groups ($p>0.05$) at baseline. (Table-2)

Within group analysis of VAS shown significant differences between pre and post intervention data ($p<0.05$) in all the three groups. In between group comparison, the mean difference of VAS i.e. mean of VAS_Pre and mean of VAS_Post differences (VAS_Diff) is found to be statistically significant between the three groups. (Table-3)

Within group analysis of L.FROM shown significant differences between pre and post intervention data ($p<0.05$) in all the three groups.In between group comparison, the mean difference of L.F ROM i.e. mean of L.F ROM_Pre and mean of L.F ROM_Post differences (L.F ROM_Diff) is found to be statistically significant between the three groups. (Table-4)

Within group analysis of ROT.ROM shown significant differences between pre and post intervention data ($p<0.05$) in all the three groups. In between group comparison, the mean difference of ROT. ROM i.e. mean of ROT. ROM_Pre and mean of ROT. ROM_Post differences (ROT. ROM_Diff) is found to be statistically significant between the three groups. (Table-2)

Within group analysis of NDI shown significant differences between pre and post intervention data ($p<0.05$) in all the three groups.

In between group comparison, the mean difference of NDI i.e. mean of NDI_Pre and mean of NDI_Post differences (NDI_Diff) is found to be statistically significant between the three groups.

Table 2: Demographic and Baseline Data

VARIABLES	Group- A (Mean±SD)	Group- B (Mean±SD)	Group- C (Mean±SD)	One-way ANOVA	
				F-value	p-value
Demographic Data					
AGE	31.53±10.06	35.53±8.39	34±8.77	0.73	0.48
DURATION	4.33±2.46	4.20±1.32	4.06±0.88	0.09	0.91
Baseline Data					
VAS	6.01±0.68	5.76±0.74	6.20±0.68	1.12	0.33
NDI	28.66±0.97	28±2.39	29.2±2.48	1.26	0.29
ROM(L.F)	32.26±2.28	33.36±2.52	32.2±2.70	0.96	0.39
ROM(ROT)	43.86±4.06	47.4±3.97	44.46±3.94	3.35	0.04

Table 3: within & between group comparison of VAS

Groups	Mean±SD	Pre-Post diff Mean±SD	Paired t test		Multiple comparison
			t-value	p-value	
A	VAS0- 6.01±0.68 VAS4- 1.80±0.40	4.14±0.62	25.73	0.000	A vs. C- 0.000
B	VAS0- 5.82±0.74 VAS4- 2.12±0.28	3.75±0.78	18.50	0.000	B vs. C- 0.000
C	VAS0- 6.20±0.68 VAS4- 3.28±0.27	5.33±1.44	20.72	0.000	A vs. B- 0.18

Abbreviations: VAS- Visual analogue scale, Group A- Muscle energy technique, Group B- Proprioceptive neuromuscular facilitation, Group C- Control group, VAS0- Baseline data of VAS, VAS4- Post intervention of VAS

Table 4: Within& between group comparison of LFROM

Groups	Mean±SD	Pre-Post diff Mean±SD	Paired t test		Multiple comparison
			t-value	p-value	
A	LFROM0-32.26±2.28 LFROM4-40.46±1.40	8.20±2.07	15.29	0.000	A vs. C- 0.000
B	LFROM0-33.33±2.52 LFROM4-41.33±1.58	8.0±2.13	14.49	0.000	B vs. C- 0.000
C	LFROM0-32.20±2.70 LFROM4-37.53±2.26	5.33±1.44	14.27	0.000	A vs. B- 0.55

Abbreviations: LFROM- Lateral flexion range of motion, Group A- Muscle energy technique, Group B- Proprioceptive neuromuscular facilitation, Group C- Control group, LFROM0- Baseline data of lateral flexion ROM, LFROM4- Post intervention data of lateral flexion ROM

Table 5: Within & between group comparison of Rot.ROM

Groups	Mean±SD	Pre-Post diff Mean±SD	Paired t test		Multiple comparison
			t-value	p-value	
A	ROTROM0-43.86±4.06 ROTROM4-73.20±5.07	29.33±6.83	16.63	0.000	A vs. C- 0.000
B	ROTROM0-47.40±3.97 ROTROM4-74.00±2.61	26.60±3.33	30.90	0.000	B vs. C- 0.000
C	ROTROM0-44.46±3.94 ROTROM4-55.93±3.39	11.46±4.86	9.12	0.000	A vs. B- 0.88

Abbreviations: ROTROM- Rotation range of motion, Group A- Muscle energy technique, Group B- Proprioceptive neuromuscular facilitation, Group C- Control group, ROT.ROM0- Baseline data of Rotation ROM, ROT.ROM4- Post intervention data of Rotation ROM

Table 6: Within & between group comparison of NDI

Groups	Mean±SD	Pre-Post diff Mean±SD	Paired t test		Multiple comparison
			t-value	p-value	
A	NDIO-28.66±0.97 NDI4-13.20±2.80	15.46±2.77	16.63	0.000	A vs. C- 0.000
B	NDIO-28±2.39 NDI4-14.13±2.66	13.86±2.66	30.90	0.000	B vs. C- 0.000
C	NDIO-29.20±2.48 NDI4-19.33±1.89	9.86±2.19	9.12	0.000	A vs. B- 0.88

Abbreviations: NDI- Neck disability scale, Group A- Muscle energy technique, Group B- Proprioceptive neuromuscular facilitation, Group C- Control group, NDI0- Baseline data of NDI, NDI4- Post intervention data of NDI

DISCUSSION

With the technique of MET there is decrease in pain, via the production of joint movement, or a stretching of joint capsule, may be capable of reducing pain by inhibiting the stronger diameter nociceptive

neuronal input at the spinal cord level. [14] The possible mechanism for the reduction in pain intensity in the MET group can be attributed to the hypoalgesic effect. This can be explained by the inhibitory golgi tendon reflex, activated during the isometric contraction that leads to reflex relaxation of the muscle and activation of the muscle and joint mechanoreceptors leads to sympatho excitation evoked by somatic efferents and localised activation of periaqueductal gray matter that play a role in decreasing modulation of pain. Nociceptive inhibition then occurs at the dorsal horn of the spinal cord, as simultaneous gating takes place of nociceptive impulses in the dorsal horn, due to mechano-receptor stimulation. [8,11]

PNF technique involves different patterns of movements that are rotational, multi-axial, and multidirectional and provide proper neuromuscular function via the stimulation of proprioceptive function. These movements are more effective and are used to decrease pain, increase the range of motion and improve the function. PNF position renders greater amount of sensory input coming from the periphery than that in the neutral position. This induces changes in the excitability of the pyramidal tract, the final motor pathway leading to stronger excitation of the cortical area leading to better recruitment of the muscle. It has also been indicated that proper function of proprioceptive system has an important role in the maintenance of correct head and neck posture, and improve the ability to maintain a correct posture. [8,9] The level of pain decreased by isometric exercises due to increase endorphins that occurs usually after training and better neuromuscular control. The strong muscle contractions happen during isometric exercise which activates muscles stretch receptors. These afferent from these receptors cause endogenous opoids to be released and also cause the release of beta endorphins from the Pituitary gland, these secretions may cause decrease pain. [15]

The reduction in the pain following stretching can be explained on the basis of inhibitory effects of GTO (which causes dampening effects on the motor neuronal discharges, thereby causing relaxation of the musculotendinous unit by resetting its resting length) and Pacinian corpuscle modification. These reflexes will allow relaxation in musculotendinous unit tension and decreased pain perception. [4]

Range of motion

MET improves the cervical which mainly works on reducing spasm or tightness of muscle by first resetting the muscle spindle and inhibits the muscles by activating the Golgi tendon. [16] Proposed mechanism by which passive manual stretch facilitates the laying down of collagen and regain of muscle length are a direct viscoelasticity changes from decreased act in myosin cross bridging. This would then allow for increased joint ROM. The possible explanation of the increased in ROM relies on the effect of autogenic inhibition. [17]

The effect of MET for increase in range of motion can be explained on the basis of physiological mechanisms behind the changes in muscle extensibility- reflex relaxation, viscoelastic changes and changes to stretch changes. Combination of contractions and stretches might be more effective for producing viscoelastic changes because the forces could produce increased viscoelastic change. [11,18]

The effect of PNF for increase in ROM, according to (Alter 1996), PNF is a technique involving combinations of alternating contraction and stretches. Whose goal is facilitation of agonist muscle thereby increase the recruitment of additional motor neurons or increase the excitability of the motor neurons. [7,12]

Neck Disability Index (NDI): The improvement is the resultant of combined findings of pain reduction and increasing ROM. PNF group also showed an improvement in function ability could be seen as a direct result of flexibility and endurance improvement. [7]

CONCLUSION

From the present study it can be concluded that Muscle Energy Technique and Proprioceptive Neuromuscular Facilitation Technique are both equally effective in reducing pain, improving ROM and function in subjects with chronic mechanical neck pain. Control group also showed statistical significant improvement in reducing pain, improving ROM and function at the end of 4th week. There was no statistical significant difference between Group - A and Group - B.

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