

A Study To Evaluate The Combined Effects Of Muscle Energy Technique And Dynamic Neuromuscular Stabilization Exercises On Pain, Functional Disability And Forward Head Posture Among Subjects With Mechanical Neck Pain

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ABSTRACT

BACKGROUND: Mechanical neck pain is one of the most prevalent musculoskeletal disorders, requiring specialized, evidence-based management interventions. Muscle Energy Technique (MET) and Dynamic Neuromuscular Stabilization (DNS) are widely used in physiotherapy, but limited research studies their combined effect in treating mechanical neck pain. The findings can guide evidence-based practice, on the application of techniques for specific conditions.

AIM: Primary Objective: To study the combined effects of MET and DNS Exercises on Pain, Functional disability, and Forward head posture among subjects with mechanical neck pain.

Secondary Objectives: To study the individual effect of MET and DNS exercises on Pain, Functional Disability, and Forward head posture among Subjects with mechanical neck pain.

MATERIALS AND METHODS: 45 subjects were conveniently selected and divided into three groups A (Control Group), B (Experimental Group 1), and C (Experimental Group 2), 15 subjects in each group. Sample selection is based on inclusion. In the Cross-over study design, Group A was given a Hot pack, Low TENS, and Passive stretching. Group B -conventional treatment along with 1st week MET followed by 2nd week DNS exercises & Group C - 1st week DNS exercises followed by 2nd week of MET along with conventional treatment., 12 treatment sessions 6 times a week for 2 consecutive weeks. Data collection by convenient sampling.

RESULT: Repeated measure ANOVA was done for intra-group analysis. One-way ANOVA and Post Hoc analysis by Tukey were done for inter-group analysis at the value of $p < 0.05$.

CONCLUSION: The combined effect of MET followed by DNS showed significant improvement on mechanical neck pain. Future research should explore the long-term combined effects on diverse populations.

KEYWORDS: Muscle Energy Technique, Dynamic Neuromuscular Stabilization Exercises, Mechanical neck pain.

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INTRODUCTION

Neck pain is a prevalent and debilitating musculoskeletal condition that affects a substantial portion of the global population. It can manifest as pain, fatigue, or tension radiating to the shoulders, upper extremities, or head and is often associated with reduced functional abilities and a lower quality of life. Non-specific neck pain (NsNP) is widespread, with its etiology linked to poor posture, muscle imbalances, repetitive strain, and psychosocial factors such as stress. The prevalence of neck pain ranges widely, with lifetime rates reported to be between 14% and 70% globally, highlighting its significant burden¹.

Muscle Energy Technique (MET) is a manual therapy involving the active contraction of specific muscles against a controlled counterforce applied by the therapist. ⁶ Dr. Fred L. Mitchell Sr., an osteopathic physician, created the Muscle Energy Technique (MET) manual treatment. The voluntary contraction of the patient's muscle in a perfectly regulated direction, at different intensities, against a precisely executed counterforce applied by the operator, is what Greenman defines as MET¹⁴. Either reciprocal inhibition (RI), that affect the antagonists to the tissues that have gone through contraction, or post-isometric relaxation (PIR), which affects the tissues that have been isometrically contracted, was proposed as the mechanism of action of MET¹⁵. MET involves the active contraction of specific muscles against a controlled counterforce and has been shown to improve range of

motion, decrease muscle hypertonicity and reduce pain in patients with chronic musculoskeletal conditions⁵.

Dynamic Neuromuscular Stabilization (DNS) has emerged as a promising rehabilitative approach for addressing neck pain. Developed based on the principles of developmental kinesiology, DNS emphasizes optimizing motor control and activating the deep stabilizing muscles, including the diaphragm, pelvic floor, and cervical spine stabilizers. DNS aims to restore postural stability by improving intra-abdominal pressure and coordinating muscle activation. DNS has also demonstrated potential in reducing pain intensity and disability in patients with chronic neck pain, although further high-quality studies are warranted to confirm its broader applications. Stabilization exercises focus on restoring cervical muscle endurance and coordination, while dynamic exercises aim to enhance muscle strength through progressive-resistive movements¹⁸.

Despite the growing utilization of DNS and MET, direct comparisons between these techniques in managing neck pain are scarce. Preliminary evidence suggests that while both approaches can improve pain and functionality, their mechanisms of action differ. DNS works on improving neuromuscular coordination and postural alignment, whereas MET focuses on alleviating muscle tension and enhancing joint mobility. Understanding the unique and complementary benefits of these therapies could guide clinicians in optimizing treatment plans for patients with neck pain.

This paper aims to evaluate the combined effects of MET and DNS on neck pain, functional disability and forward head posture, providing a comprehensive analysis of their therapeutic benefits and potential applications. By consolidating recent evidence and identifying gaps in current research, this study seeks to contribute to the development of more effective, patient-centered interventions for neck pain management.

METHODS

This study employed a single-blinded randomized controlled clinical trial design, registered with CTRI with reg. number CTRI/2023/03/050962. A consecutive sampling technique was used to recruit participants for the study as they became available. The subjects were screened to determine whether they met the inclusion criteria for the study. The participants for this study were patients with sub-acute and chronic neck pain, aged between 18-45 who were able to comprehend instruction in English, Hindi, or Punjabi language, and who were not involved in any other form of exercise training during the study.

The following categories of patients were excluded from the study: Patients with co-morbidities that influence overall well-being, for example, AIDS, Patients with specific disorders of the cervical spine, such as; disk prolapse, spinal stenosis, postoperative conditions, history of severe trauma, spasmodic torticollis, impaired skins conditions, malignancy, spinal infections, frequent migraine, fibromyalgia, shoulder diseases, inflammatory rheumatic diseases and psychiatric illness, Patients with obvious spinal deformity or neurological disease, Patients with a reported history of cardiovascular diseases contraindicated to exercise.

They were recruited from the OPD. The consented participants were randomly allocated into the three study groups viz. Group A contained stretching exercises of the upper trapezius and levator scapulae with low TENS, and hot pack (Control gp; n= 15); Group B conventional treatment along with 1st-week muscle energy technique + 2ndweek dynamic neuromuscular stabilization exercises (Expt gp 1; n = 15); or Group C 1st week Dynamic neuromuscular stabilization exercises + 2ndweek muscle energy technique along with conventional therapy (Expt gp 2; n = 15). Forty-five participants completed the study: Control gp; n = 15, Expt gp 1; n = 15, Expt gp; n = 15 as shown in Figure 2 flow chart. Total 12 treatment sessions were given to each group 6 times a week for two consecutive weeks. Neck pain was measured by NPRS score, functional disability by the NDI score, and craniocervical angle by the Apecs smartphone application as shown in Fig 1.



Figure 1: Measuring Forward Head Posture

Ethical approval for the study was sought and obtained from the Institutional Ethics Committee.

| | |
|---------|--|
| GROUP A | Hydro Collator + Low TENS Frequency 1-20 Hz and duration 20 mins + Passive Stretching 20 second hold 10 second relax 5 repetitions |
| GROUP B | Hydro Collator+ Low TENS Frequency 1-20 Hz and duration 20 mins+ 1 st week muscle energy technique + 2 nd week dynamic neuromuscular stabilization exercises |
| GROUP C | Hydrocollator+ Low TENS Frequency 1-20 hz and duration 20 mins + 1 st week Dynamic neuromuscular stabilization exercises + 2 nd week muscle energy technique |

Figure -2: Protocol FlowChart

Procedure:

Hydrocollator pack for 20 min on neck, Low TENS: Frequency- 1-20 Hz, pulse width-150µs-300µs Duration 20 mins. Passive Stretching was done Upper Trapezius and Levator scapulae muscle.

- **Muscle Energy Technique was applied for the Trapezius and Levator scapulae muscles-**

The patient was asked for the light resistance effort (20% available strength) by taking the shoulder towards the ear and the ear towards the shoulder. This double movement is necessary for muscle contraction from both ends. This contraction was held for 7-10 seconds while the therapist gently took the head/neck into the gained range of side flexion and stretched the shoulder towards the feet. Stretching is maintained for 30 seconds.

- **Dynamic Neuromuscular stabilization exercise protocol-**

DNS exercises involved 5 5-minute warm-up, 20 20-minute DNS exercise, and 5 min cool-down

- **Warm-up:** By static cycling for 5 minutes.
- **DNS Exercises: 20 min**
 - **Supine position :** Shavasana pose, chin tuck in, palms open, patient performed Diaphragmatic Breathing exercise, 3 times. Hip and knee flexed to 90 degrees with hip slightly abducted and externally rotated. Hip and knee flexed, the patient raised his hands to touch his knees first and then his ankle
 - **Prone lying with forearm support**
 - Quadruped position- Patient moved his one extremity forward by flexing the hip and knee like a baby crawling
 - Head up, chin tucked in, elbow flexed, palms open, fingers flexed (like catching a ball).Baby-rock, prone, rolling, side-lying, oblique-sit, tripod, kneeling, squat, and Czech Get up (CGU)
 - Exercise with Theraband: The Patient held the Theraband with both hands. Gradually stretch the band by opening arms against resistance. Participants started with the Thera-band with the least resistance, coloured red, and progressed to those with increasingly greater resistance, green, then blue.
 - Swiss ball exercise- Quadruped position, patient placed his/her ball below the hips and lifted the arm and legs.

Cool down: 05 minutes stretching,30-sec hold,3 repetitions, 2 sets.

Frequency: Dynamic Stabilization exercise and Muscle Energy Technique, along with conventional treatment sessions, were held six times a week for two weeks each, lasting approximately 45 minutes. Altogether, each participant had 12 treatment sessions.

Data Analysis: Descriptive statistics of mean, standard deviation, median, interquartile range, and percentages were used to summarize all data obtained from the participants. Analysis of Variance (ANOVA) was used to compare pain intensity, functional disability and forward head posture at baseline, sixth day (post-treatment), and twelfth day(post-treatment)of the study in the three groups – Control Group A, Experimental Group B and Experimental Group C. Repeated measure ANOVA was done for intra-group analysis comparison of the effects of the Control Group A, Experimental Group B, and Experimental Group C on pain intensity, functional disability and forward head posture. One-way ANOVA and Post Hoc analysis by Tukey were done for inter-group analysis. The Level of significance selected for the study was p<0.05. The data analyses were carried out using the SPSS version 18.0.

RESULTS

Demographic data: Sixty participants were recruited for this study. Forty-five of the participants completed the two-week program. Demographic details are shown in Table 1.

Table 1. Participants Socio-demographic Characteristics

| Variable | n | % |
|---------------|---|---|
| Gender | | |

| | | |
|-----------------------|----|------|
| Male | 42 | 47.7 |
| Female | 46 | 52.3 |
| Marital status | | |
| Single | 18 | 20.5 |
| Married | 70 | 79.5 |

Educational qualification

| | | |
|--------------------|----|------|
| Nil | 6 | 6.8 |
| Primary/ Secondary | 55 | 62.5 |
| Tertiary | 27 | 30.7 |

Employment

| | | |
|---------------------|----|------|
| Unemployed | 19 | 21.6 |
| Self-employed | 47 | 53.5 |
| Government employed | 22 | 25.0 |

Income per month

| | | |
|---------------|----|------|
| Low/Middle | 41 | 46.6 |
| Moderate/High | 47 | 53.4 |

Key (N=frequency of variables,%-Percentage)

Within-group comparison

Pain intensity

With the aid of repeated measures ANOVA, within-group comparisons of participants' numeric pain rating scores in different groups were made across the baseline, sixth day (post-treatment), and twelfth day(post-treatment) of the study, as shown in Table 2.

Table 2. Comparisons of mean numeric pain rating scores among participants across the 3-time points of the study by treatment group

| Group | Baseline | 6 th day | 12th day | F-ratio | P |
|-------------------|-------------------------|----------------------|-----------------------|---------|---------|
| | $\bar{X} \pm SD$ | $\bar{X} \pm SD$ | $\bar{X} \pm SD$ | | |
| control | 6.00 ± 1.195* (n=15) | 5.8±1.6# (n=15) | 4.47±1.62\$ (n=15) | 35.83 | (<0.05) |
| Experimental gp 1 | 5.67±0.97* (n=15) | 3.13±1.72# (n=15) | 3.6±2.02\$ (n=15) | 9.17 | (<0.05) |
| Experimental gp 2 | 6.13±1.26* (n=15) | 6.6±1.8# (n=15) | 3.73±1.9\$ (n=15) | 41.95 | (<0.05) |

Alpha level was set at 0.05

Superscripts (*, #, \$) for a particular variable: Mean values with different superscripts are significantly different; Mean values with the same superscripts are not significant different. Key NPRS=Numeric pain rating scale, n=number of participants in group

Functional disability

A within-group comparison of functional disability using the neck disability index scores of participants in the different groups was done with the aid of repeated measure ANOVA across the baseline, sixth day (post-treatment), and twelfth day(post-treatment) of the study, as shown in Table 3

Table 3. Comparison of median neck disability index scores among participants across the 3 time points of the study by treatment group

| Group | Baseline | 6 th day | 12th day | F-ratio | P |
|-------------------|-------------------------|-----------------------|-----------------------|---------|---------|
| | $\bar{X} \pm SD$ | $\bar{X} \pm SD$ | $\bar{X} \pm SD$ | | |
| control | 25.2 ± 10.49* (n=15) | 24.6±10.07# (n=15) | 22.2±9.7\$ (n=15) | 7.4 | (<0.05) |
| Experimental gp 1 | 22.0±11.38* (n=15) | 15.2±9.6# (n=15) | 16.2±10.9\$ (n=15) | 137.16 | (<0.05) |
| Experimental gp | 23.6±10.77* (n=15) | 24.4±9.4# (n=15) | 15.4±8.01\$ (n=15) | 16.79 | (<0.05) |

(n=15) (n=15) (n=15)

Alpha level was set at 0.05. Superscripts (*, #, \$) for a particular variable: Median values with different superscripts are significantly different; Median values with the same superscripts are not significantly different. Key number of participants

Forward Head Posture

A within-group comparison of functional disability using the craniocervical angle scores of participants in the different groups was done with the aid of repeated measure ANOVA across the baseline, sixth day (post-treatment), and twelfth day (post-treatment) of the study, as shown in Table 4

Table 4. Comparison of median craniocervical angle scores among participants across the 3 time points of the study by treatment group

| Group | Baseline | 6 th day | 12th day | F-ratio | P |
|-------------------|------------------------|------------------------|---------------------------|---------|---------|
| | $\bar{X} \pm SD$ | $\bar{X} \pm SD$ | $\bar{X} \pm SD$ | | |
| control | 45.6 ± 3.15* (n=15) | 46.4 ± 2.02# (n=15) | 46.6 ± 3.68\$ (n=15) | 0.800 | (<0.05) |
| Experimental gp 1 | 44.8 ± 3.73* (n=15) | 49.8 ± 3.07# (n=15) | 49.5 ± 3.18\$ (n=15) | 35.5 | (<0.05) |
| Experimental gp 2 | 43.07 ± 5.3* (n=15) | 43.07 ± 4.9# (n=15) | 47.33 ± 6.008\$ (n=15) | 26.38 | (<0.05) |

Alpha level was set at 0.05 Superscripts (*, #, \$) for a particular variable: Mean values with different superscripts are significantly different; Mean values with the same superscripts are not significantly different. Key n=number of participants.

Between-groups comparison

Pain intensity

With the aid of the One-way ANOVA table 5 shows the comparison of pain intensity of participants in the Control gp, Experimental gp 1, and Experimental gp 2 at the baseline and at the end of the 6th and 12th day of the study.

Table 5. Comparison of participants mean pain intensity scores using the Numeric Pain rating Scale by treatment group at baseline, 6th day and 12th day of the study.

| Group | Baseline | 6 th day | 12th day | F-ratio | P |
|-------------------|-----------------------|------------------------|-----------------------------------|---------|---------|
| | Mean + SD | Mean + SD | Mean + SD | | |
| control | 6 ± 1.195* (n=15) | 5.8 ± 1.6# (n=15) | 4.47 ± 0.661 1.642\$ (n=15) | | (<0.05) |
| Experimental gp 1 | 5.6 ± 0.9* (n=15) | 3.13 ± 1.72# (n=15) | 3.6 ± 2.02\$ (n=15) | 16.00 | (<0.05) |
| Experimental gp 2 | 6.13 ± 1.2* (n=15) | 6.6 ± 1.8# (n=15) | 3.73 ± 1.9\$ (n=15) | 0.93 | (<0.05) |

Alpha level was set at 0.05. Superscripts (*, #, \$) for a particular variable: Mean values with different superscripts are significantly different; Mean values with the same superscripts are not significantly different. Key: n = number of participants in the groups, SD = standard deviation

Functional disability

With the aid of the One-way ANOVA table 5 shows the comparison of neck disability index score of participants in the Control gp, Experimental gp 1, and Experimental gp 2 at the baseline and at the end of the 6th and 12th day of the study.

Table 6. Comparison of median neck disability scores of participants by treatment group at 0, 6th day and 12th day of the study.

| Group | Baseline | 6 th day | 12th day | F-ratio | P |
|-------|----------|---------------------|----------|---------|---|
|-------|----------|---------------------|----------|---------|---|

| | Mean + SD | Mean + SD | Mean + SD | | |
|-------------------|-------------------------|------------------------|-------------------------|-------|---------|
| control | 25.2 ± 10.49* (n=15) | 24.6 ± 10.0# (n=15) | 22.2 ± 9.7\$ (n=15) | 0.324 | (<0.05) |
| Experimental gp 1 | 22 ± 11.3* (n=15) | 15.27 ± 9.6# (n=15) | 16.2 ± 9.6\$ (n=15) | 4.529 | (<0.05) |
| Experimental gp 2 | 23.6 ± 10.7* (n=15) | 24.4 ± 9.4# (n=15) | 15.4 ± 8.07\$ (n=15) | 2.239 | (<0.05) |

Alpha level was set at 0.05 Superscripts (*, #, \$) for a particular variable: Median values with # superscripts are significantly different; Median values with the *, \$ superscripts are not significantly different. Key: n = number of participants in the groups, SD = standard deviation

Forward Head Posture

Inter-group analysis by One-way ANOVA table 7 shows the comparison of craniovertebral angle degree of participants in the Control gp, Experimental gp 1, and Experimental gp 2 at the baseline and at the end of the 6th and 12th day of the study.

Table 7. Comparison of craniovertebral angle scores of participants by treatment group at 0, 6th day and 12th day of the study.

| Group | Baseline | 6 th day | 12th day | F-ratio | P |
|-------------------|------------------------|-------------------------|-------------------------|---------|---------|
| | Mean + SD | Mean + SD | Mean + SD | | |
| control | 45.6 ± 3.15* (n=15) | 46.4 ± 2.02# (n=15) | 46.5 ± 3.6\$ (n=15) | 1.506 | (<0.05) |
| Experimental gp 1 | 44.8 ± 3.73* (n=15) | 49.8 ± 3.07# (n=15) | 49.5 ± 3.18\$ (n=15) | 13.250 | (<0.05) |
| Experimental gp 2 | 43.07 ± 5.3* (n=15) | 43.07 ± 4.99# (n=15) | 47.3 ± 6.00\$ (n=15) | 1.817 | (<0.05) |

Alpha level was set at 0.05 Superscripts (*, #, \$) for a particular variable: Median values with different superscripts are significantly different; Median values with the same superscripts are not significantly different. Key: n = number of participants in the groups, SD = standard deviation

DISCUSSION

This study investigated the combined effects of Muscle energy technique and Dynamic Neuromuscular Stabilization exercises on neck pain, functional disability, and forward head posture among subjects with mechanical neck pain. The age of the participants ranged from 18 to 45 years, an age range consistent with those of patients affected by neck pain in most epidemiological studies(86,87,88). The dependent variables of this study were NPRS, NDI, and CVA.

The results of the study highlight the Effective Combination of two advanced techniques, Muscle Energy Technique and Dynamic Neuromuscular Stabilization exercises. It revealed that applying Muscle Energy Technique (MET) in the 1st week, followed by Dynamic Neuromuscular Stabilization (DNS) exercises in the 2nd week, produced significantly better outcomes than the reverse sequence. Improvement is observed in Pain reduction, a Decrease in functional disability, and Correction of forward head posture. It supports the alternative hypothesis (H₁) and emphasizes the importance of sequencing interventions for optimal therapeutic outcomes. Mechanism for the effectiveness of 1st Week MET Followed by 2nd Week DNS can be explained by the physiological and biomechanical effects of each technique and how their specific Technique (MET) as a Priming Phase i.e, in the first week, MET relieves restrictions and improves range of motion, preparing the body for subsequent neuromuscular retraining. Relaxed and lengthened muscles respond more effectively to stabilization exercises in the second phase. MET involves isometric contractions followed by passive stretching, which reduces muscle tension and relaxes hypertonic muscles, improves joint mobility by releasing restrictions in the surrounding tissues and restores muscle balance and addresses asymmetry. Dynamic Neuromuscular Stabilization (DNS) as a Strengthening and Stabilizing Phase in 2nd week creates synergistic progression in second phase. After MET reduces restrictions and pain, DNS reinforces functional movement patterns and stabilizes the corrected posture. Without initial priming from MET, DNS might struggle to address deeper structural issues effectively. DNS focuses on activating deep core and stabilizer muscles through specific movement patterns, which enhances motor control and postural stability, promotes neuromuscular coordination by engaging underactive

stabilizing muscles (e.g., deep cervical flexors) and corrects faulty movement patterns contributing to forward head posture. order amplifies their benefits. Muscle Energy Joshi R, Poojary N showed Effectiveness of Muscle Energy Technique and Posture Correction Exercises on Pain and Function in Patients with Non-specific Chronic Neck Pain Having Forward Head Posture—a Randomized Controlled Trial. The result of their study showed that Group which includes MET and posture correction exercises showed better significant improvement in reduction of pain, improving the range of motion and the disability⁸⁰. The Golgi tendon reflex activates a neuro-physiological mechanism that inhibits the alpha motor neuron, causing reflex muscle relaxation and a reduction in pain. This mechanism explains why applying MET to the sub-occipital muscles helps to reduce hyper-activation. Different types of movement in the central body, breathing, diaphragm, upper and lower limbs, and other areas were included in the DNS exercises. Bae WS, Lee KC, Lee DY conducted a study on The Effects of DNS on FHP and Spine Posture. When summed up, dynamic neuromuscular stabilization exercise is a suitable training technique for enhancing forward head posture. DNS exercise appeared to affect the structure of the shoulder and neck region although it did not directly mediate the mobility of neck bone by supporting the trunk by raising intraperitoneal pressure with the use of diaphragm-assisted breathing.

CONCLUSION

The result of the study concluded that the application of 1st week Muscle Energy Technique followed by 2nd week Dynamic Neuromuscular Stabilization exercises showed better result than 1st week Dynamic Neuromuscular Stabilization exercises followed by 2nd week Muscle Energy Technique on pain, functional disability and forward head posture among subjects with neck pain. It provide evidence for the use of effective combination of two approach on treatment of neck pain.

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