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Effect of Scapular Stabilization Exercises Versus Muscle Energy Technique Combined With Posture Correction Exercises on Neck Pain and Forward Head Posture Among College Students: A Comparative Study

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Abstract

Background: Forward head posture (FHP) is a common postural abnormality among college students and may be associated with neck pain and altered cervical alignment. Scapular stabilization exercises (SSE) and muscle energy technique (MET) combined with posture correction exercises are commonly used physiotherapy approaches for managing these impairments.

Objective: To compare the effects of SSE and MET combined with posture correction exercises on neck pain and FHP among college students.

Methods: A comparative experimental study was conducted among 30 college students aged 18–24 years with FHP. Participants were allocated into two groups of 15. Group A received SSE, while Group B received MET combined with posture correction exercises. Both interventions were administered three times per week for four weeks. Craniovertebral angle (CVA) and Numeric Pain Rating Scale (NPRS) scores were assessed before and after the intervention. Within-group changes were analysed using paired t-tests, and between-group changes were analysed using independent t-tests. Statistical significance was set at $p < 0.05$.

Results: Both groups demonstrated significant improvements in CVA and NPRS following the intervention. Group A showed an increase in CVA from 46.87 ± 0.69° to 47.55 ± 1.07° and a reduction in NPRS from 4.13 ± 0.99 to 3.20 ± 0.86. Group B showed an increase in CVA from 46.92 ± 1.03° to 48.24 ± 0.78° and a reduction in NPRS from 4.47 ± 0.52 to 2.53 ± 0.64.

Conclusion: Both SSE and MET combined with posture correction exercises improved cervical posture and reduced neck pain among college students with FHP. The comparative effectiveness of the interventions was determined from the between-group analysis.

Keywords: Forward head posture; Neck pain; Scapular stabilization exercises; Muscle energy technique; Posture correction; Craniovertebral angle.

Introduction

Forward head posture (FHP) is one of the most common postural deviations observed among college students and young adults and is characterised by anterior displacement of the head relative to the cervical spine.[1,4] This postural deviation can alter cervical alignment, increase mechanical stress on cervical structures, and contribute to muscular imbalance.[6,7] Individuals with FHP commonly demonstrate weakness of the deep cervical flexors and scapular stabilisers, accompanied by tightness of the cervical

extensors and pectoralis minor. These muscular alterations may impair normal scapulocervical rhythm and contribute to a reduced craniovertebral angle (CVA).[8–10] Such biomechanical changes have been associated with neck pain, postural dysfunction, and functional limitations.[1,6]

The prevalence of FHP has increased among college students, particularly in association with prolonged smartphone and computer use, sedentary behaviour, poor ergonomics, and sustained faulty postures during academic activities.[11] Previous studies have reported a prevalence of approximately 73% among university students, highlighting FHP as an important musculoskeletal health concern in this population.[12] The craniovertebral angle is a reliable and valid clinical measure for assessing FHP, with lower values indicating greater anterior displacement of the head.[13]

Conservative physiotherapy is commonly used for the management of FHP, with treatment approaches directed towards improving postural alignment, reducing pain, and addressing underlying muscular imbalance. Common physiotherapy interventions include therapeutic exercises, manual therapy, posture correction exercises, ergonomic education, and electrotherapy modalities.[15] Exercise programmes that emphasise strengthening of weakened postural muscles and stretching of shortened muscles have been reported to improve cervical posture and reduce neck pain.[15]

Scapular stabilization exercises (SSE) are widely used to improve scapular alignment and postural control by strengthening muscles including the middle and lower trapezius, rhomboids, and serratus anterior, while reducing excessive activity of the upper trapezius and pectoral muscles.[20,21] Improved scapular alignment may facilitate normal scapulocervical rhythm, enhance postural control, and reduce mechanical stress on cervical structures, thereby contributing to improvements in neck pain and cervical posture.[20,21]

Muscle energy technique (MET) is an active manual therapy technique involving controlled isometric muscle contractions followed by relaxation. It is used to improve muscle flexibility, restore joint mobility, and reduce muscle tension associated with musculoskeletal and postural dysfunction.[18,30] When combined with posture correction exercises, including chin tuck exercises, scapular bracing, and pectoral stretching, MET may facilitate neuromuscular re-education, improve cervical alignment, increase the craniovertebral angle, and reduce neck pain in individuals with FHP.[18,22]

Although both SSE and MET combined with posture correction exercises have demonstrated beneficial effects in individuals with FHP, direct comparisons between these interventions among college students remain limited. Therefore, the present study aimed to compare the effects of scapular stabilization exercises and muscle energy technique combined with posture correction exercises on neck pain and forward head posture among college students. It was hypothesised that both interventions would improve clinical outcomes, with MET combined with posture correction exercises producing greater improvements in pain reduction and postural alignment.

Materials and Methods

Study Design

A comparative experimental study was conducted in the Exercise Therapy Laboratory of Revathi Institute of Physiotherapy, Avinashi, Tirupur, Tamil Nadu, India, over a period of eight months. The intervention period was four weeks, with three treatment sessions per week, resulting in a total of 12 sessions for each participant. Ethical approval was obtained from the Institutional Ethics Committee (Approval No. RIPR/DT/21/4528). Written informed consent was obtained from all participants before enrolment. The study was conducted in accordance with institutional ethical standards.

Participants

A total of 30 college students aged 18–24 years with forward head posture (FHP) were recruited using convenience sampling. Participants who fulfilled the eligibility criteria were allocated equally into two groups, with 15 participants in each group. Group A received scapular stabilization exercises (SSE), whereas Group B received muscle energy technique (MET) combined with posture correction exercises.

Eligibility Criteria

Inclusion Criteria

Participants were included if they met the following criteria:

- College students aged 18–24 years.
- Craniovertebral angle (CVA) ≤48°.

- Numeric Pain Rating Scale (NPRS) score <8/10.
- Willingness to participate in the study and provide written informed consent.

Exclusion Criteria

Participants were excluded if they had:

- A history of cervical or shoulder surgery.
- Cervical intervertebral disc prolapse.
- Cervical hump.
- Neurological disorders affecting cervical or shoulder movement.
- Other serious cervical pathologies affecting the cervical spine.

Interventions

Group A: Scapular Stabilization Exercises

Participants in Group A underwent a supervised scapular stabilization exercise programme consisting of shoulder flexion with scapular protraction, quadruped alternating arm movements, seated shoulder abduction, and mirror-assisted postural correction. Each exercise was performed for three sets of 10 repetitions per session, three sessions per week for four weeks, resulting in a total of 12 treatment sessions.

Group B: Muscle Energy Technique Combined with Posture Correction Exercises

Participants in Group B received muscle energy technique (MET) targeting the suboccipital and pectoralis minor muscles. The technique consisted of controlled isometric contractions followed by relaxation and was administered for three sets of three repetitions per session. This was followed by posture correction exercises, including chin tuck exercises, scapular bracing, and pectoral stretching. Each exercise was performed for three sets of 12 repetitions per session, three sessions per week for four weeks, resulting in a total of 12 treatment sessions.

Outcome Measures

Outcome measures were assessed at baseline before the intervention and immediately after completion of the four-week treatment programme.

Craniovertebral Angle

Forward head posture was assessed using the craniovertebral angle (CVA). The tragus of the ear and the spinous process of the seventh cervical vertebra (C7) were identified and marked. Standardized lateral photographs were obtained with participants in a relaxed standing position while maintaining a natural forward gaze. The CVA was measured using ImageJ software. A larger CVA indicated better cervical alignment and reduced forward head posture.

Numeric Pain Rating Scale

Neck pain intensity was assessed using the Numeric Pain Rating Scale (NPRS), an 11-point self-reported scale ranging from 0, indicating no pain, to 10, indicating the worst imaginable pain.

Statistical Analysis

Data were analysed using the Statistical Package for the Social Sciences (SPSS), version 24.0. The normality of continuous variables was assessed using the Shapiro–Wilk test. Continuous variables are presented as mean ± standard deviation (SD). Within-group changes from pre-intervention to post-intervention were analysed using the paired *t* test. Between-group differences were analysed using the independent-samples *t* test. Statistical significance was set at $p < 0.05$.

Results

Participant Characteristics

Thirty-two college students were screened for eligibility. Two participants were excluded from the study, with one excluded due to a cervical hump and one due to cervical intervertebral disc prolapse. The remaining 30 participants met the eligibility criteria and completed the study. Participants were allocated

equally into Group A, which received scapular stabilization exercises, and Group B, which received muscle energy technique combined with posture correction exercises, with 15 participants in each group.

The baseline demographic characteristics of the participants are presented in Table 1, including age, sex, height, weight, and body mass index (BMI). The participant recruitment, allocation, follow-up, and analysis process is presented in Figure 1.

Table 1. Baseline demographic characteristics of participants

Variables	Group A Mean±SD	Group B Mean±SD
Age	21.13 ± 1.35	20.93 ± 1.43
Gender	7/8	6/9
Height	164.27 ± 6.12	165.13 ± 5.84
Weight	60.47 ± 7.26	61.13 ± 6.95
BMI	22.31 ± 2.14	22.46 ± 2.08

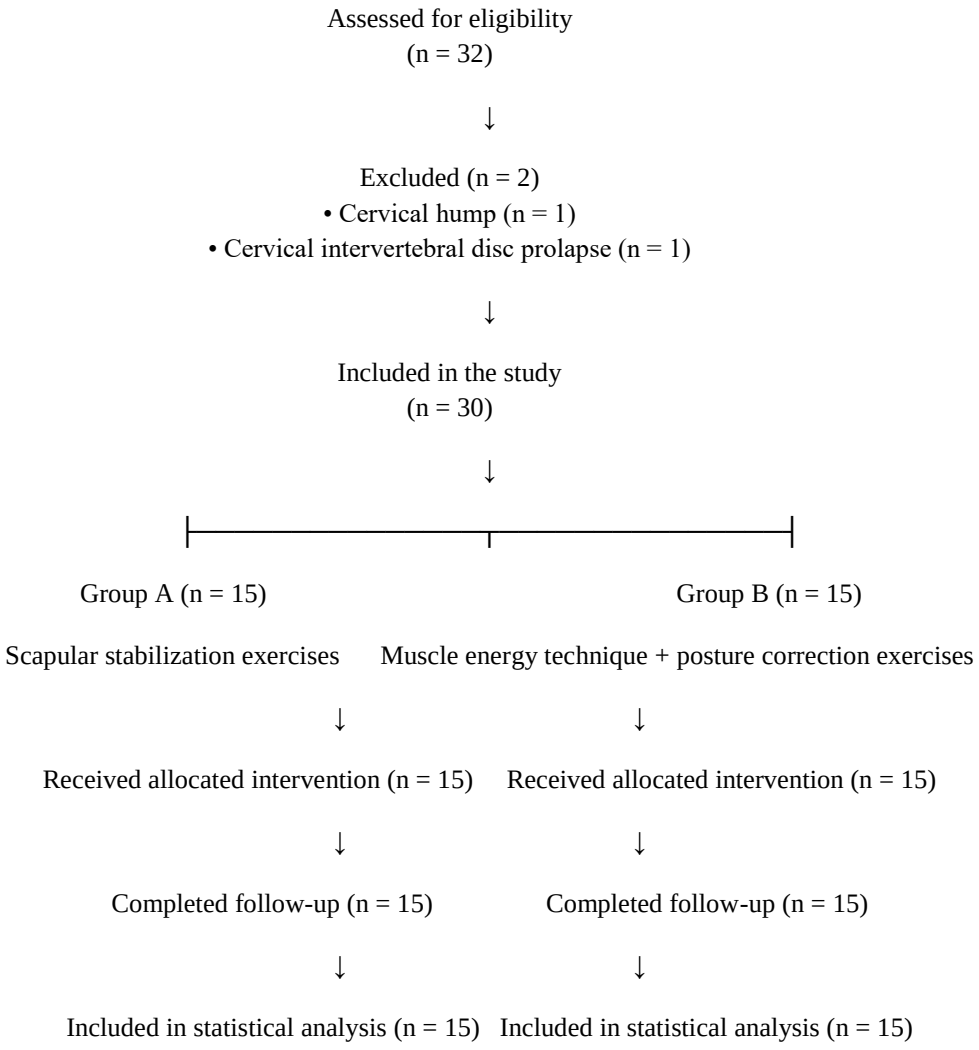


Fig 1. Flow diagram of participant recruitment, allocation, follow-up, and analysis

Within-Group Comparison

Both intervention groups demonstrated statistically significant improvements in craniovertebral angle (CVA) and Numeric Pain Rating Scale (NPRS) scores following the four-week intervention.

In Group A, the mean CVA increased from 46.87 ± 0.69° at baseline to 47.55 ± 1.07° post-intervention, with a mean increase of 0.68° (95% CI: 0.24 to 1.12; p = 0.005). The mean NPRS score

decreased from 4.13 ± 0.99 to 3.20 ± 0.86, with a mean reduction of 0.93 points (95% CI: −1.26 to −0.60; $p < 0.001$).

In Group B, the mean CVA increased from 46.92 ± 1.03° at baseline to 48.24 ± 0.78° post-intervention, with a mean increase of 1.32° (95% CI: 0.99 to 1.65; $p < 0.001$). The mean NPRS score decreased from 4.47 ± 0.52 to 2.53 ± 0.64, with a mean reduction of 1.93 points (95% CI: −2.26 to −1.60; $p < 0.001$). The within-group changes in CVA and NPRS are illustrated in Figures 2 and 3, respectively.

Table 2. Within-group comparison of craniovertebral angle and Numeric Pain Rating Scale scores before and after the intervention

Outcome measure	Group	Pre-intervention (Mean ± SD)	Post-intervention (Mean ± SD)	Mean Difference (95% CI)	*t* value	*p* value
Craniovertebral angle (°)	Group A	46.87 ± 0.69	47.54 ± 1.07	0.68 (0.24 to 1.12)	3.32	0.005*
	Group B	46.92 ± 1.03	48.23 ± 0.78	1.32 (0.99 to 1.65)	8.64	<0.001*
Numeric Pain Rating Scale	Group A	4.13 ± 0.99	3.20 ± 0.86	−0.93 (−1.26 to −0.60)	−6.09	<0.001*
	Group B	4.47 ± 0.52	2.53 ± 0.64	−1.93 (−2.26 to −1.60)	−12.61	<0.001*

Abbreviations: SD, standard deviation; CI, confidence interval.

Statistically significant at p < 0.05.

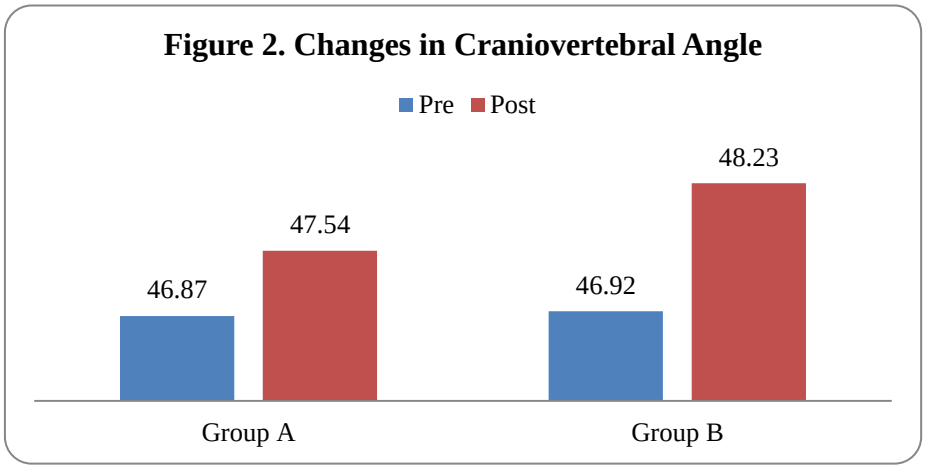


Fig 2. Changes in craniovertebral angle before and after the intervention in Group A and Group B.

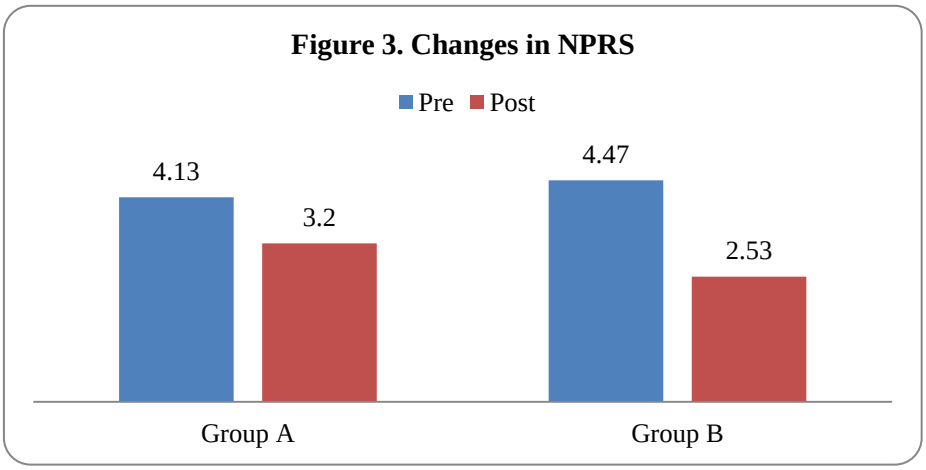


Fig 3. Changes in Numeric Pain Rating Scale (NPRS) Before and After the Intervention

Between-group comparison

Between-Group Comparison

There was statistically significant baseline differences between the two groups for the outcome measures.

Following the four-week intervention, the mean post-intervention CVA was 47.55 ± 1.07° in Group A and 48.24 ± 0.78° in Group B. Analysis of the change scores demonstrated a statistically significant between-group difference in CVA improvement, with Group B showing a greater change than Group A (mean difference in change: −0.64°; 95% CI: −1.16 to −0.12; $t(28) = -2.51$; $p = 0.018$; Cohen's $d = -0.92$).

For NPRS, the mean post-intervention score was 3.20 ± 0.86 in Group A and 2.53 ± 0.64 in Group B. Analysis of the change scores demonstrated a statistically significant between-group difference in pain reduction (mean difference in change: 1.00 point; 95% CI: 0.56 to 1.44; $t(28) = 4.61$; $p < 0.001$; Cohen's $d = 1.68$). The between-group comparison of outcome measures is presented in Table 3.

Table 3. Between-group comparison of changes in craniovertebral angle and Numeric Pain Rating Scale scores following the intervention

Outcome measure	Group A: Mean change	Group B: Mean change	Mean Difference in change (95% CI)	*t* value	*p* value
Craniovertebral angle (°)	0.68	1.32	−0.64 (−1.16 to −0.12)	−2.51	0.018*
Numeric Pain Rating Scale	−0.93	−1.93	1.00 (0.56 to 1.44)	4.61	<0.001*

Abbreviations: SD, standard deviation; CI, confidence interval.

Statistically significant at $p < 0.05$.

Discussion

The present study compared the effects of scapular stabilization exercises (SSE) and muscle energy technique (MET) combined with posture correction exercises on forward head posture (FHP) and neck pain among college students. Both intervention groups demonstrated statistically significant improvements in craniovertebral angle (CVA) and Numeric Pain Rating Scale (NPRS) scores following four weeks of treatment. Between-group analysis of change scores demonstrated significantly greater improvement in CVA and greater reduction in neck pain in the group receiving MET combined with posture correction exercises compared with the SSE group.

The improvement observed in the SSE group may be attributed to enhanced activation and strengthening of the scapular stabilizing musculature, including the middle and lower trapezius, rhomboids, and serratus anterior. Improved scapular control may contribute to better scapulocervical alignment and postural control, potentially reducing excessive mechanical loading on the cervical region. Scapular stabilization exercises may also influence the activity of muscles involved in maintaining head and neck posture, thereby contributing to improvements in cervical alignment and neck pain. Previous literature has reported beneficial effects of therapeutic exercise on CVA and pain in individuals with FHP, supporting the use of exercise-based interventions for postural and symptomatic improvement.[20,21]

Participants who received MET combined with posture correction exercises demonstrated greater improvement in CVA and greater reduction in NPRS compared with the SSE group. The effects of MET may be associated with post-isometric relaxation, changes in muscle flexibility, and alterations in neuromuscular control. When combined with posture correction exercises, MET may address restrictions in shortened musculature, while corrective exercises reinforce improved postural alignment and motor control. This combined approach may have contributed to the greater changes observed in cervical alignment and neck pain in the present study. Previous literature has also reported beneficial effects of manual therapy and postural corrective exercise approaches in individuals with FHP and mechanical neck pain.[18,22,30]

The findings of the present study are consistent with previous literature indicating that exercise-based and manual therapy approaches can contribute to improvements in FHP and associated neck pain. A systematic review of treatment programmes for chronic neck pain associated with FHP reported beneficial effects of both exercise-based and manual therapy interventions on pain and disability.[1] A recent systematic review and meta-analysis also reported that therapeutic exercise may improve CVA and reduce pain intensity in individuals with FHP and neck pain.[2] These findings provide support for the improvements observed in both intervention groups in the present study.

The greater improvement in CVA observed in the MET combined with posture correction group may reflect the potential benefit of addressing both muscle flexibility and postural control within the same

intervention. Similarly, the greater reduction in NPRS observed in this group suggests that the combined intervention produced greater short-term changes in pain than SSE alone within the present sample. However, these findings should be interpreted in the context of the study design, small sample size, convenience sampling, and relatively short intervention period. The findings demonstrate a between-intervention difference within the study sample and should not be interpreted as definitive evidence that one intervention is superior for all individuals with FHP.

The findings have clinical implications for physiotherapy practice. Both SSE and MET combined with posture correction exercises produced statistically significant improvements in CVA and neck pain over four weeks. The greater between-group changes observed with MET combined with posture correction exercises indicate that an intervention addressing both muscle flexibility and postural correction may be a useful treatment approach for college students with FHP and associated neck pain. Nevertheless, treatment selection should consider individual presentation, treatment goals, therapist expertise, and patient preferences.

This study has several strengths. A standardized intervention protocol was followed for both groups, objective and self-reported outcome measures were used to assess cervical posture and pain, and all participants completed the intervention without loss to follow-up. The study also directly compared two physiotherapy approaches commonly used in the management of FHP. However, several limitations should be acknowledged. The sample size was relatively small, participants were recruited using convenience sampling, and the intervention period was limited to four weeks. Long-term follow-up was not performed; therefore, the sustainability of the observed treatment effects remains unknown. In addition, potentially relevant psychological, ergonomic, physical activity, and lifestyle factors that may influence neck pain and posture were not assessed.

Future studies should include larger samples, more rigorous allocation procedures, multicentre recruitment, longer intervention periods, and long-term follow-up. Further research should investigate whether the observed benefits of MET combined with posture correction exercises are maintained over time and whether similar effects are observed in different age groups and occupational populations. Comparative studies incorporating other evidence-based physiotherapy interventions and additional outcomes such as neck disability, muscle endurance, ergonomic exposure, and quality of life may provide a more comprehensive understanding of the effects of these interventions.

Conclusion

Both scapular stabilization exercises and muscle energy technique combined with posture correction exercises were effective in improving craniovertebral angle and reducing neck pain among college students with forward head posture. However, muscle energy technique combined with posture correction exercises produced significantly greater improvement in craniovertebral angle and a significantly greater reduction in neck pain compared with scapular stabilization exercises.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this study.

Author Contributions

Radhakrishnan V: Conceptualization, Methodology, Participant recruitment, Data collection, Formal analysis, Manuscript drafting.

Dr. Nithya V: Supervision, Methodology validation, Critical revision of the manuscript, Final approval of the manuscript.

Dr. P. Bright Alwin Victor: Research guidance, Manuscript review, Administrative support, Final approval of the manuscript.

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Data Availability Statement

The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

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