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Effects of thoracic spine mobilization on chest expansion in patients with chronic mechanical neck pain: a randomized controlled trial

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Abstract

Background and Study Aim Chronic mechanical neck pain significantly impacts the quality of life and functional capacity of individuals, often necessitating long-term management strategies. Traditional stretching exercises are commonly prescribed, but their effectiveness compared to other interventions remains underexplored. The objective of this study was to compare the effectiveness of traditional stretching exercise regimens against thoracic spine and rib mobilization in patients with chronic mechanical neck pain.

Material and Methods This randomized controlled trial included 30 patients aged between thirty and fifty years, all suffering from mechanical neck pain. Patients were randomly assigned to one of two groups, with 15 in each group (Group A: n=15; Group B: n=15). Group A received thoracic spine mobilization coupled with standard passive stretching exercises, whereas Group B underwent a traditional stretching exercise regimen. Both groups were evaluated using the visual analogy scale for pain, active cervical range of motion (ROM), and chest expansion, both before and after a two-week therapy course.

Results Findings from this study were analyzed using a two-way mixed-model multivariate analysis of variance (MANOVA). The results showed no significant differences between Group A (thoracic spine mobilization and standard passive stretching) and Group B (traditional stretching regimen) regarding pain intensity, active cervical range of motion, and chest expansion after the two-week intervention period ($p > 0.05$). However, significant improvements were observed within each group across all measured outcomes, including reductions in pain intensity and increases in cervical range of motion and chest expansion ($p < 0.001$).

Conclusions The study confirms that both passive stretching exercises and thoracic spine mobilization are beneficial interventions for enhancing physical outcomes in patients with mechanical nonspecific neck pain. These approaches are equally effective in improving overall physical functionality, underscoring their value in therapeutic settings for neck pain management.

Keywords: conventional stretching, exercise regimes, thoracic and rib mobility, chronic mechanical neck pain

Introduction

Chronic mechanical nonspecific neck pain is a prevalent condition that disrupts the daily lives of many, especially in middle-aged populations. Its impact on health and productivity highlights the need for innovative and effective management approaches. Among middle-aged individuals, the onset of neck pain is notably high, underscoring the urgent necessity for targeted therapeutic strategies [1]. Various biomechanical factors contribute to this condition, including sensitivities in the cervical spine's ligaments, muscles, zygapophyseal joints, intervertebral discs, and neural tissues [2]. Mechanical dysfunctions in the thoracic or cervical regions can also restrict neck mobility, further exacerbating nonspecific neck pain, while altered functioning of muscles or joints intensifies this ailment [3]. Understanding these diverse biomechanical factors is crucial for developing

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effective treatments. Consequently, accurate diagnosis and management require a comprehensive evaluation, encompassing a detailed medical history, physical examination, and imaging studies to ensure appropriate interventions [2, 3].

Therefore, addressing these multifaceted biomechanical contributors through refined diagnostic and therapeutic approaches is essential. This focus forms the basis for exploring more targeted interventions that could potentially mitigate the adverse effects of chronic mechanical nonspecific neck pain.

The cervical, thoracic, and lumbar spines are strongly interrelated due to their close anatomical and biomechanical links [3]. The thoracic spine, in particular, plays a crucial role in supporting the cervical spine and significantly influences its kinematics [4]. Postural dysfunction of the thoracic spine is recognized as a predisposing factor for cervical spine dysfunction due to impaired mechanical loading [3, 6]. Concurrent motion of the thoracic spine is necessary to facilitate the full range of motion in the cervical spine. Specifically, the upper thoracic spine (T1-T6) contributes approximately 10% to cervical rotation, 25% to cervical flexion/extension, and 14% to cervical lateral flexion [4, 5]. However, limited segmental mobility or postural malalignment of the thoracic spine may restrict cervical spine movement [4, 7]. Additionally, thoracic spine postural impairments can lead to muscle dysfunction around the cervical region, affecting the function of the trapezius, scalene, sternocleidomastoid, levator scapulae, and serratus anterior muscles [8]. Thoracic hyperkyphosis is thought to contribute to the increased prevalence of cervical spine and shoulder joint dysfunctions in older adults [5].

This comprehensive understanding of the interrelations between the thoracic and cervical spine underscores the necessity of addressing thoracic postural dysfunctions in treatments aimed at alleviating neck pain. By focusing on thoracic mobility and alignment, therapeutic strategies may more effectively manage mechanical neck pain, particularly in populations vulnerable to degenerative changes.

Recent research suggests that improved thoracic kinematics can significantly influence cervical spine function, thereby making thoracic spine mobilization a promising treatment for chronic mechanical nonspecific neck pain [9]. Both thoracic thrust and nonthrust mobilizations have demonstrated beneficial effects in alleviating symptoms associated with nonspecific neck pain, such as reduced pain intensity, increased range of motion, and decreased self-reported disability [9, 10, 11]. Although previous studies have explored the effects of thoracic mobilization on neck pain, there is a notable gap in research examining the combined effects of rib mobilization and traditional stretching exercises, particularly over a two-week period. This gap underscores the need for further studies to assess the impact of such combined interventions on neck pain. Addressing this need will not only contribute to the existing body of knowledge on effective pain management strategies but also enhance understanding of the benefits derived from integrating mobilization and stretching exercises. Consequently, this study aims to evaluate the efficacy of combining traditional stretching exercise training with rib and thoracic spine mobilization in patients suffering from persistent mechanical nonspecific neck pain.

Materials and Methods

Participants

A total of thirty patients, including both males and females, referred by an orthopedic specialist for chronic mechanical nonspecific neck pain (MNP), participated in this study. Eligibility criteria included individuals aged 30 to 50 who had been experiencing neck pain for at least three months. Exclusion criteria were neurological diseases, vertebral fractures, rheumatic disorders, inflammatory or osteo-metabolic diseases, or a history of surgical spinal fixation. After obtaining informed consent, participants were randomly assigned into two groups.

Research Design

This randomized controlled study assessed the efficacy of integrating thoracic and rib mobilization with traditional stretching exercises for treating chronic mechanical nonspecific neck pain. The study was carried out at the Ababa Private Physical Therapy Center in Beni-surf, Egypt, over a period of six months, from January 01, 2021, to June 10, 2021. Participants were randomly divided using index cards into two groups of 15, with a total of 30 index cards used for the random assignment. Group A received both thoracic spine and rib mobilization along with conventional passive stretching exercises, while Group B was treated with a conventional passive stretching exercise program alone. The ethical committee approved the study protocol with reference number P.T.REC/012/003379, conducted in accordance with the 1964 Helsinki Declaration. For visual reference, see Figure 1, which presents a flow diagram illustrating the selection process of participants.

Assessment procedures

Initially, a comprehensive patient history was collected, which included inquiries about the patient's age, sex, occupation, onset, duration, nature, and location of symptoms, as well as the mechanism of injury and activities that might exacerbate or alleviate pain. This was followed by a thorough physical examination. The pre-and posttreatment assessments included:

1. *Visual Analog Scale (VAS).* This employs a 100 mm horizontal line to gauge pain levels at rest, with 0 indicating no pain and 100 representing the highest level of discomfort. Patients were asked to mark the point that corresponded to their current level of pain.
2. *Cervical Active Range of Motion (CAROM).* Measurement was conducted using a tape measure. Patients performed movements in various directions, including flexion, extension, lateral bending (left and right), and rotation (left and right). Measurements were taken three times, and the average for each direction was calculated.
3. *Chest Expansion.* Measurements of upper, middle, and lower chest expansion were performed with the patient seated. Patients were instructed to fully inspire and expire. Measurements were taken at the peak of deep inspiration and the end of full expiration, and the difference was calculated. Measurements were repeated twice, and the average was computed for each level (upper, middle, and lower).

All data were meticulously recorded on an evaluation sheet during the patient's initial or pre-treatment visit to the clinic.

Interventions

Participants in the study were assigned to specific treatment programs with strict instructions to avoid combining these with any pharmacological or other physical treatments.

Group A - Mobilization Techniques:

- *Flexion Mobilization.* Patients sat with hands behind their heads, curling elbows into their groin to induce thoracic flexion. The therapist applied overpressure in cranial and horizontal directions.
- *Extension Mobilization.* From the same starting position as flexion, patients placed one or both feet on a chair to flex the lumbar spine. As patients lifted their elbows upward, the therapist applied overpressure in the direction of thoracic extension.
- *Lateral Flexion Mobilization.* Patients sat with hands behind their heads, directing elbows away from their bodies. During this, the therapist positioned themselves to apply targeted pressure to facilitate lateral flexion.
- *Rotation Mobilization.* Patients sat with arms folded. The therapist, positioned to the side of the patient, facilitated rotation by applying overpressure towards the scapula and pectoral areas, enhancing thoracic mobility.

Group B - Stretching Exercise Program:

This group underwent a passive stretching program targeting the inhibition and elongation of over-activated neck muscles such as the sternocleidomastoid, cervical extensors, suboccipital muscles, levator scapulae, and upper trapezius. Treatments were delivered face-to-face, with three weekly sessions of 45 minutes each. Each stretching exercise was held for 30 seconds and repeated four to five times in a clinical setting, strictly isolated from any other treatments.

Statistical Analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) software for Windows, version 25.0. Descriptive statistics, including means, standard deviations, and percentages, were computed for each group both at baseline and after the two-week intervention period. The Chi-square test was utilized to analyze the gender distribution among groups. For comparing the total mean change scores for pain intensity, cervical range of motion, and chest expansion over time, a two-way multivariate analysis of variance (MANOVA) using mixed models was employed. Wilks' lambda was used to calculate the F value for the overall model fit. When MANOVA revealed significant effects ($P < 0.05$), follow-up univariate ANOVAs were performed with Bonferroni adjustments to the p-values to safeguard against Type I errors.

Results

Table 1 confirms that at baseline, there were no statistically significant differences between the groups in terms of age, weight, height, or gender ($P>0.05$), indicating that the groups were well-matched at the study's commencement.

A mixed-design multivariate analysis was conducted to evaluate the differences between the groups in the combined mean change scores of cervical range of motion, chest expansion, and pain outcome measures. The main effects of the groups showed no statistically significant multivariate effect [Wilk's Lambda = 0.51, $F(20,66) = 1.3$, $P = 0.21$, $h^2 = 0.28$]. However, statistically significant multivariate effects were indicated by the interaction between groups and time [Wilk's Lambda = 0.06, $F(20,66) = 10.43$, $P < 0.001$, $h^2 = 0.76$].

Subsequent univariate ANOVAs revealed a significant change in the visual analogy scale (VAS) for pain intensity: $P < 0.001$, $F(2,42) = 10.68$. The proper rotation range of motion (ROM) outcome showed no significant change [$F(2,42) = 0.001$, $P = 0.99$, $h^2 = 0.001$], and there was no significant change in the left rotation ROM outcome. The flexion ROM outcome also showed no significant change, $F(2,42) = 2.01$, $P = 0.15$, $h^2 = 0.05$.

After two weeks of intervention, there were no statistically significant differences between the groups concerning pain intensity, cervical range of motion, or chest expansion outcomes ($P > 0.05$) as detailed in Tables 2 and 3.

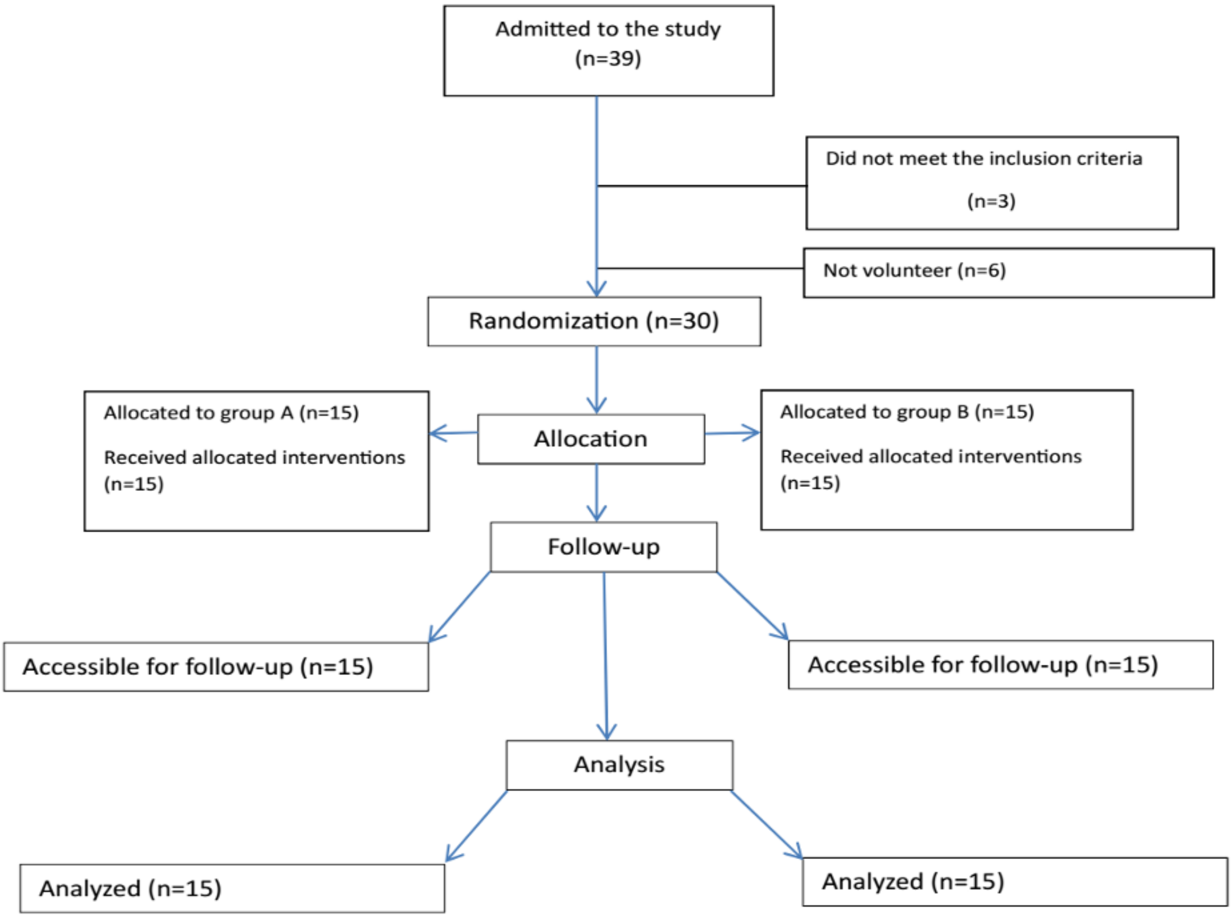

Figure 1. Flow diagram showing participants' selection

Table 1. General characteristics of the patients in the two groups (A&B)

Characteristics	Group A (n=15)	Group B (n=15)	F-Value	P-Value
Age(years)	38.3±11.0	39.4±9.98	0.1	0.9
Weight(kg)	77.67±10.44	78.2±8.12	0.06	0.94
Height(cm)	167.1±5.06	168.8±4.95	0.87	0.43
Sex, n(%)				
Male	5(33.3%)	6(40%)	X2=0.57	0.76
Female	10(66.7%)	9(60%)		
VAS (mm)	76.67±9.76	74.67±11.87	0.16	0.85
Flex (cm)	9.93±3.95	8.8±3.12	0.52	0.6
Ext.(cm)	15.8±1.61	14.47±2.75	1.2	0.31
RLF (cm)	14.47±3.83	14.6±3.66	0.14	0.87
LLF (cm)	14.67±3.02	14.47±3.6	1.14	0.33
RR (cm)	15.27±2.34	15.2±2.73	1.98	0.15
LR (cm)	16.27±2.52	15.8±2.91	2.36	0.11
L. Chest(cm)	1.6±0.51	1.8±0.68	0.51	0.6
Up. Chest(cm)	1.87±0.64	1.6±0.63	0.79	0.46
M. Chest(cm)	1.27±0.46	1.53±0.64	1.6	0.21

Visual Analogue Scale (VAS); Flex (Flexion); Extension (Ext); Right Rotation (RR); Left Rotation (LR); Right Lateral Flexion (RLF); Left Lateral Flexion (LLF); Lower (L); Upper (Up); Medium (M); Mean Difference (MD); Confidence Interval (CI); Probability Value (p). * Data are mean± SD; * P-Value < 0.05 indicates statistical significance.

Table 2. Clinical Characteristics of Subjects following a Two-Week Intervention (N=30*)

Characteristics	Group I ((n=15)	Group II (n=15)	F-Value	P-Value
VAS (mm)	41.13±14.07	41.0±11.46	10.68	0.0002
Flex (cm)	7.53±3.14	6.47±2.67	2.01	0.15
Ext.(cm)	12.67±1.76	11.87±2.61	2.27	0.12
RLF (cm)	11.67±3.2	11.8±3.17	0.74	0.48
LLF (cm)	11.73±2.58	11.6±2.67	0.12	0.89
RR (cm)	12.27±2.71	12.27±3.28	0.001	0.99
LR (cm)	12.87±2.8	12.2±2.88	0.25	0.78
L. Chest (cm)	2.6±0.51	2.8±0.68	10.48	0.0002
Up. Chest (cm)	2.93±0.7	2.67±0.72	3.62	0.04
M. Chest (cm)	2.2±0.56	2.47±0.52	5.98	0.005

VAS, Visual Analogue Scale; Flex, Flexion; Ext, Extension; RR, Right Rotation; LR, Left Rotation; RLF, Right Left Lateral Flexion (LLF); L stands for lower; Up for upper; M for medium; MD for mean difference; CI for confidence interval; and p for probability value. * P-Value < 0.05 indicates statistical significance; mean ± standard deviation is presented. * P-Value < 0.05 indicates statistical significance; mean ± standard deviation is presented.

Table 3. Between Groups Effects after two weeks of intervention

Outcomes	GI Versus G2		Partial Eta Squared
	MD (95% CI)	P-Value	
VAS (mm)	-0.07 (-1.09, 0.95)	0.99	0.34
Flex (cm)	1.13 (-1.78, 4.04)	0.99	0.09
Ext.(cm)	0.8 (-1.47, 3.07)	0.99	0.1
RLF (cm)	-0.13 (-3.14, 2.87)	0.99	0.03
LLF (cm)	0.13 (-2.35, 2.62)	0.99	0.01
RR (cm)	0.01 (-2.83, 2.83)	0.99	0.001
LR (cm)	0.67 (-2.03, 3.36)	0.99	0.01
L. Chest (cm)	-0.2 (-0.82, 0.42)	0.99	0.33
Up. Chest (cm)	0.27 (-0.36, 0.89)	0.87	0.15
M. Chest (cm)	-0.27 (-0.75, 00.22)	0.53	0.22

VAS, Visual Analogue Scale; Flex, Flexion; Ext, Extension; RR, Right Rotation; LR, Left Rotation; RLF, Right Left Lateral Flexion (LLF); L stands for lower; Up for upper; M for medium; MD for mean difference; CI for confidence interval; and p for probability value. * P-Value < 0.05 indicates statistical significance; mean ± standard deviation is presented. * P-Value < 0.05 indicates statistical significance; mean ± standard deviation is presented.

However, after two weeks of treatment in each group, there were statistically significant differences in all outcome measures (p<0.01), as shown in Table 4 comparing groups.

Discussion

This study aimed to compare the effects of thoracic mobilization versus a routine regimen of stretching exercises on individuals with chronic mechanical nonspecific neck pain, focusing on chest expansion and active cervical range of motion. Although significant improvements were observed within both groups in terms of pain intensity, cervical range of motion, and chest expansion, no significant differences were found between the groups after two weeks of intervention. This suggests that while both interventions are effective in improving the measured outcomes, one is not superior to the other in the short-term context of this study.

Previous studies have primarily focused on the effects of thoracic mobilization on neck pain. For instance, research has shown that thoracic spine mobilization can significantly reduce pain and improve function in patients with neck pain [10, 13]. However, the combined effects of rib mobilization

Table 4. Within-group changes after two weeks of intervention

Variables	Group A (n=15)		Group B (n=15)	
	Change from baseline to 2 weeks		Change from baseline to 2 weeks	
	MD (95% CI)	P-Value	MD (95% CI)	P-Value
VAS (mm)	35.33(28.82, 41.85)	0.0001	32.67(26.15, 39.18)	0.0001
Flex (cm)	2.4(1.89, 2.91)	0.0001	2.33(1.83, 2.85)	0.0001
Ext.(cm)	3.13(2.74, 3.53)	0.0001	2.6(2.2, 3.0)	0.0001
RLF (cm)	2.8(2.21, 3.39)	0.0001	2.8(2.21, 3.39)	0.0001
LLF (cm)	2.93(2.42, 3.45)	0.0001	2.87(2.35, 3.39)	0.0001
RR (cm)	3.0(2.44, 3.65)	0.0001	2.93(2.37, 3.49)	0.0001
LR (cm)	3.4(2.85, 3.96)	0.0001	3.6(3.05, 4.16)	0.0001
L. Chest (cm)	-1.0(-1.11, -0.89)	0.0001	-1.0(-1.11, -0.89)	0.0001
Up. Chest (cm)	-1.07(-1.25, -0.88)	0.0001	-1.07(-1.25, -0.88)	0.0001
M. Chest (cm)	-0.93(-1.11, -0.76)	0.0001	-0.93(-1.11, -0.76)	0.0001

VAS, Visual Analogue Scale; Flex, Flexion; Ext, Extension; RR, Right Rotation; LR, Left Rotation; RLF, Right Lateral Flexion; LLF, Left Lateral Flexion; L, lower; Up, upper; M, medium; MD, mean difference; CI, Confidence interval; p, probability value. * P-Value < 0.05 denotes statistical significance; data are mean± SD. * P-Value < 0.05 denotes statistical significance; data are mean± SD

with traditional stretching exercises, as investigated in this study, are less documented. While studies such as those by authors in [12] and [14] have noted improvements in cervical range of motion and muscle strength through various physical therapy techniques, the specific contribution of rib mobilization remains underexplored.

Our findings align with those of [10] and [13], which reported improvements in similar clinical outcomes following thoracic mobilization. However, the unique aspect of our study—the inclusion of rib mobilization—did not show additional benefits when compared to traditional stretching alone. This could suggest that the specific techniques of mobilization may not be as critical as previously thought, or that the duration of intervention in our study was too brief to detect any differential effects.

Further research is needed to explore these findings over longer intervention periods and with varied techniques to fully understand the potential differential impacts of thoracic versus rib mobilization in conjunction with traditional stretching exercises.

The findings of this study underscore the effectiveness of thoracic spine mobilization integrated within a passive stretching regimen, which improved resting pain intensity, active cervical range of motion, and chest expansion in patients with chronic mechanical nonspecific neck pain. These results align with previous research which suggests that therapeutic exercises combined with thoracic mobilization can treat symptoms of chronic mechanical nonspecific neck pain more effectively than exercises alone [15].

Thoracic mobilization specifically targets enhancements in chest expansion and respiratory function, both of which are often compromised in patients with chronic neck pain [11]. Our study supports existing literature by demonstrating that thoracic and rib mobilization not only improves thoracic kinematics and segmented thoracic mobility but also positively impacts cervical function, postural alignment, and overall respiratory function [9]. Furthermore, both thrust and nonthrust mobilizations of the thoracic spine have been documented to alleviate symptoms, decrease neck pain intensity, and enhance range of motion, ultimately reducing self-reported disability [10, 11].

Our findings suggest that the addition of rib mobilization could potentially open new therapeutic possibilities by further enhancing thoracic kinematics and cervical function. This approach appears promising in managing chronic mechanical nonspecific neck pain by improving the overall functional and postural alignment of the thoracic and cervical regions.

The utility of thoracic mobilization as a treatment for mechanical neck pain is well-documented, with systematic reviews generally affirming its positive impact [16, 17]. Despite this, there remains some discrepancy in the literature, as other reviews have noted mixed results regarding the effectiveness of thoracic spine treatments in managing neck pain [18]. This suggests that while thoracic mobilization is beneficial, factors such as treatment protocols, patient selection, and outcome measures might influence its efficacy.

Further emphasizing the potential of thoracic treatments, a study highlighted improvements in lower trapezius muscle strength following thoracic manipulation [8]. Similarly, conventional stretching exercises have been consistently beneficial, not only in reducing pain intensity but also in improving cervical range of motion and overall quality of life for patients with persistent, nonspecific mechanical neck pain [14, 18, 19]. These benefits align with findings from Jari Ylinen et al., who reported that manual therapy combined with stretching exercises effectively reduces short-term pain intensity in chronic mechanical neck pain sufferers [20].

Our findings contribute to this body of evidence by suggesting that integrating thoracic mobilization with conventional stretching might offer additional benefits. This underscores the potential of a multimodal approach in treating chronic mechanical neck pain, which could lead to more comprehensive management strategies. However, the relatively small sample size of our study limits the generalizability of these results. Future research with larger cohorts is essential to validate and expand upon our findings, potentially establishing more definitive evidence for the efficacy of combined treatment modalities.

Conclusions

This study demonstrates that thoracic mobilization combined with passive stretching exercises significantly reduces pain intensity, enhances active cervical range of motion, and improves chest expansion in individuals suffering from chronic mechanical nonspecific neck pain. These findings suggest that integrating thoracic mobilization into treatment regimens may offer considerable benefits for this patient population.

Conflict of interest

The authors declare no conflicts of interest related to this work.

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