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Effect of adding trunk core training exercise to conventional therapy on patients with chronic mechanical neck pain

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Abstract---Background: One of the most frequent causes of musculoskeletal pain in the general population is cervicalgia, sometimes known as neck pain. Its estimated prevalence ranges from 16.7% to 71.5 percent, and it should be noted that up to 50% of these cases may develop into chronic conditions. In this study, patients with persistent mechanical neck pain were examined to determine the effectiveness of trunk core training exercises on pain, range of motion, functional impairment, and muscle activity. Purpose: The goal of the study was to determine the impact of adding core training to patients' existing conventional treatments for chronic mechanical neck pain. Methods: Twenty male and twenty female patients with persistent mechanical neck pain, ranging in age from 18 to 40, participated in this study. The cases were classified into two equal groups randomly (A and B). Group A has got standard physiotherapy program (Passive stretching of the upper fibers of trapezius, sternocleidomastoid, and scalene muscles, Isometric strengthening exercises of neck muscles, hot pack). Group B has obtained standard physiotherapy program in addition to trunk core training program. Results: When the two groups were evaluated, it was found that both groups had statistically

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noticeable decreases in VAS, NDI, and sternocleidomastoid and scalenus anterior activity after treatment compared to pre-treatment ($p > 0.001$). Both groups' post-treatment upper trapezius activity and total neck range of motion were statistically clearly higher than they were pre-treatment ($p > 0.001$). Following treatment, a comparison between the groups showed a statistically decrease in group B's VAS, NDI, and right and left sternocleidomastoid activity ($p < 0.001$). In favor of group B after treatment, there was a statistically significant increase in neck range of motion and the activity of the right and left upper trapezius ($p < 0.001$). Although there was no statistically significant difference in the activity of the right and left scalenus anterior between the groups ($p > 0.05$). Conclusions: Based on the study's objectives and results, it was determined that core training programs for the trunk, in addition to conventional treatment, were superior to conventional treatment alone in improving VAS, NDI, neck range of motion, right and left sternocleidomastoid activity, and upper trapezius activity in patients with chronic mechanical neck pain.

***Keywords*---**mechanical neck pain, exercise, neck disability index, surface electromyography, core training program, cervical range of motion.

Background

A comprehensive term for neck and/or shoulder pain with mechanical characteristics, mechanical neck pain includes symptoms brought on by prolonged neck flexion posture, extensive neck movement, or palpation of the cervical muscles [1]. One of the most prevalent causes of musculoskeletal pain in the general population is cervicalgia, often known as neck pain, which contributes to one of the major health issues in western culture. It should be noted that up to 50% of these cases could become chronic and that their incidence is estimated to be between 16.7% and 71.5 % percent [2]. Neck pain is frequently caused by awkward work postures, tension, anxiety, heavy lifting, and physically demanding employment [1].

Many exercise plans, including general activity, neck-specific strengthening or control exercises, and sensorimotor activities, have all been studied for their effectiveness in treating neck problems [3]. Exercises for lumbar stabilization are often adopted to increase the neuromuscular control, strength, and endurance of the muscles that are essential for preserving the dynamic stability of the spine and trunk [4].
To obtain optimal lumbar stability throughout regular activities, core stabilization exercises are a popular choice [5, 6, 7]. Exercises for core stabilization include those focused on retraining the deep trunk muscles' function as well as coordination exercises for static, dynamic, and functional tasks [8]. Programs for improving core stability are intended to aid patients in developing functional strength, neuromuscular control, and core muscle endurance [9]. In a previous study, it was figured out that neck pain cases had altered trunk control. The muscular dysfunction associated with neck pain and the trunk muscle dysfunction associated with low back pain are both caused by comparable

mechanisms, according to research, and spinal pain may have similar effects regardless of where in the spine the pain is perceived [33].

A common tool for measuring muscle activity is the electromyography device. Both invasive and non-invasive electrode approaches can be used to record the signals of an electromyography device. Invasive procedures use needle electrodes to capture electromyography signals directly from the muscles. Surface Electromyography, in contrast, captures data using skin-attached surface electrodes. The Surface Electromyography approach offers many advantages over invasive techniques, including the ease with which the Surface Electromyography signal can be located over the skin and the increased patient comfort. As a result, Surface Electromyography detection of muscle function is more favorable [10].

Methods

Aims

Since the spine is made up of continuing vertebral segments, it is logical to suppose that experiencing pain in one part of the spine may result in experiencing pain in another part. This is demonstrated by the co-occurrence of neck and low back pain as well as a highly substantial positive association between the cervical and lumbar spines' degenerative alterations [11]. This study was done to determine the effectiveness of trunk core training exercises in treating patients with chronic mechanical neck pain in terms of pain, range of motion, functional impairment, and muscle activity.

Design

As for the design of the experimental research; a pre-and-post-randomized two-factorial study design was adopted successfully.

Ethical approval

The Faculty of Physical Therapy at Cairo University in Egypt's Institutional Ethics Committee gave the study their approval with no. of (P.T.REC/012/002963).

Setting

Participants were chosen carefully from the orthopedic outpatient clinics, Faculty of Physical Therapy, Modern University for Technology and Information. Persistent mechanical neck pain cases were referred by a neurologist or an orthopedic surgeon. They were between the ages of 18 and 40. Equal numbers of patients (20) were split into two groups (A and B). Traditional treatment was given to Group A (in the form of a hot pack, manual isometric strengthening exercises for cervical extension, flexion, bilateral side bending, and bilateral rotation, and passive stretching of the upper fibers of the trapezius, sternocleidomastoid, and scalene muscles), while Traditional treatment was given to Group B along with a core strengthening program for the trunk. The chosen program was administered to each patient for a total of 12 sessions [12].

- **To be eligible** to take part in the current study, cases should meet the following criteria: Patients who have had neck pain for longer than three months; Patients who are prepared and capable of participating in an exercise program safely; Patients who do not have cognitive impairments that might limit their contribution.
- **Patients were excluded in case having** Neurologic problems, and severe trauma is indicators of significant spinal disease; any balance-affecting vestibular, ocular, or neurological disorders; symptoms currently radiating (and/or a neurological impairment); history of malignancies, fractures, or spinal surgery; Herniated disc, ankylosing spondylitis, and spondylolisthesis are three examples of specific neck discomfort [12].

Evaluation procedure

- **Visual Analogue Scale (VAS)** The visual analog scale (VAS) is a straight line with a typical length of 10 cm that ranges from zero to the worst pain a person may experience (10) [13].
- **Neck Disability Index (NDI)** It is the most widely used and well-validated tool for determining the level of self-rated disability in neck pain patients. It has been successfully utilized to address this extremely prevalent issue in both clinical and research settings [14].
- **Cervical Range of Motion device (CROM).** This device consists of a system of inclinometers with a gravity reference that can measure head protrusion and retraction as well as the cervical spine's flexion, extension, and rotation in the sagittal, frontal, and transverse planes. [15].

Fig 1. CROM (32)

- **Surface Electromyography (SEMG).** By evaluating the timing and amplitude of muscle activation, muscular activation patterns in musculoskeletal diseases can be evaluated [16]. A 1 cm inter-electrode distance Myomonitor Wireless EMG system (DE 2.3 EMG sensor, Delsys, Inc., USA) was utilized to measure the myoelectric activity of muscles. It is a portable, dual-mode data collecting system for physiological and EMG signals with eight channels. Experiments can be carried out in locations that are inaccessible to conventional systems thanks to the portable design.

Fig 2. EMG

Treatment procedures

- **Hot pack**
  Moist hot, on a towel, (60x30) for 15 minutes.
- **Passive stretch**
  Upper fibers of the trapezius, sternocleidomastoid, and scalene muscles will be passively stretched (it will be held for 30 seconds, and the stretch will be repeated three times in each session) [17].
- **Isometric strengthening exercises of neck muscles**
  For cervical extension, flexion, bilateral side bending, and bilateral rotation perform isometric strengthening exercises (hold each position for 10 seconds, then repeat the exercise 10 times).
- **Trunk core training program**
  Exercises for core stability include abdominal hollowing and simultaneous contractions of the multifidus and abdominal muscles in a variety of positions, including lying on one's back, being on one's stomach, standing, sitting, and bridging. As the exercise progressed, the patients were instructed to maintain the neutral curve of the lumbar spine while adding motions to the program. The program's final levels included Swiss balls and balance boards [18].

All patients in group B were under the following exercise

- Teach the patient how to independently contract the Transversus abdominis and the Multifidus muscle from a variety of positions.


Fig 3. activate Transversus abdominis

- Transversus abdominis and multifidus muscles contraction at the same time from sitting and standing positions.

Fig 4. Isolated movement of adjacent body areas maintaining lumbar spine stability

- Isolated movement of adjacent body parts while maintaining lumbar spine stability
- Stabilizing muscle isometric co-contractions with the addition of external load to the lumbar spine.
- Sitting on an unstable base of support and 3-plane movement, co-contractions during normal-speed walking and other activities
- Bridging exercise

Fig 5. Bridging exercise

- Exercising with and without unstable base of support while bridging on two legs; alternately extending your arms and legs while lying down or kneeling in a 4-point stance; Lifting the arms and legs while seated on a Swiss ball; functional co-contractions.

Fig 6. Bridging exercise on an unstable surface

- Single-leg bridging exercise with an unstable base of support; Simultaneous arm and leg movements from supine; and Functional co-contractions during walking

Fig 7. Functional co-contractions

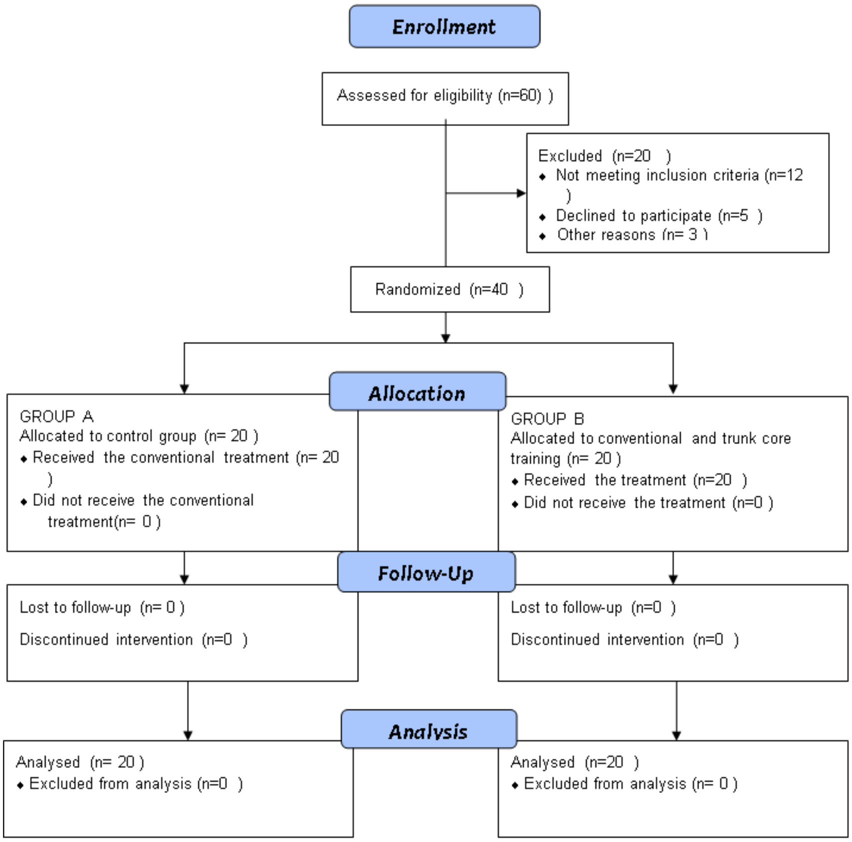

Fig 8. Flow Chart

Statistical analysis

An unpaired t-test was used to compare the ages of the groups. The distribution of sex within groups was compared using the Chi-squared test. The Shapiro-Wilk test was used to verify that the data had a normal distribution. The homogeneity between groups was examined using Levene's test for homogeneity of variances. To determine how the therapy affected the sternocleidomastoid, upper trapezius, and scalenus anterior EMG and VAS, mixed MANOVA was used. The Bonferroni correction was applied in posthoc tests for future multiple comparisons. All statistical tests had a significance threshold of p 0.05. The statistical program for social studies (SPSS) version 25 for Windows was used for all statistical analysis (IBM SPSS, Chicago, IL, USA).

Results

Subject characteristics

Table (1) shows the subject characteristics of groups A and B. Found that there was no significant difference between the groups in age and sex distribution ($p > 0.05$).

Table 1
Comparison of subject characteristics between the group A and B

	Group A	Group B	p-value
	Mean ±SD	Mean ±SD	
Age (years)	31.5 ± 5.49	29.4 ± 4.63	0.19
Sex, N (%)			
Females	10 (50%)	10 (50%)	1
Males	10 (50%)	10 (50%)	

SD, Standard deviation; p-value, the Probability value

Effect of treatment on VAS, NDI, neck ROM and EMG of sternocleidomastoid, upper trapezius, and scalenus anterior

Mixed MANOVA revealed a noticeable interface effect of treatment and time ($F = 11.41$, $p = 0.001$). There was a clear key effect of treatment ($F = 6.67$, $p = 0.001$). There was a significant key effect time ($F = 300.47$, $p = 0.001$).

Within group comparison

Both the groups showed a clear decrease in VAS and NDI post-treatment compared with the pre-treatment ($p < 0.001$). The percentage of the decrease in VAS and NDI of group A was 50.31 and 50.95% respectively and that in group B was 62.03 and 64.53% respectively. (Table 2). There was a clear increase in all neck ROM post-treatment in both groups in comparison to that pretreatment ($p < 0.001$). The percentage of increase in flexion, extension, right bending, left bending, right rotation and, left rotation in group A was found to be 25.45, 34.34, 73.03, 54.14, 51.5 an, 47.16% respectively and in group B it was 48.37, 58.9, 87.91, 69, 77.46 and 72.78% (Table 3). There was an apparent decrease in sternocleidomastoid and scalenus anterior activity and a clear increase in upper trapezius activity post-treatment in both groups compared to pre-treatment groups ($p < 0.001$). The percentage of change in right sternocleidomastoid, left sternocleidomastoid, right scalenus anterior, left scalenus anterior, right upper trapezius and left upper trapezius of group A was 14.62, 14.43, 16.42, 17.16, 18.29 and 17.27% respectively and that in group B was 30.95, 29.79, 20.58, 22.26, 32.37 and 34.73% (Table 4).

Between-group Comparison

It was found no clear variance between the groups pre-treatment ($p > 0.05$). The comparison among groups post-treatment a clear decrease in VAS and NDI of group B when compared with group A ($p < 0.001$). There was a noticed increase in neck ROM of group B compared with that of group A post-treatment ($p < 0.001$). (Table 2-3). There was a noticed decrease in right and left sternocleidomastoid activity of group B when compared with that of group A post-treatment ($p < 0.001$). While there was an evident increase in right and left upper trapezius activity of group B when compared with that of group A post-treatment ($p < 0.01$). no significant difference was found in right and left scalenus anterior activity between the groups ($p > 0.05$). (Table 4).

Table 2
Mean VAS and NDI Pre-and post-treatment of the group A and B

	Pre-treatment	Post-treatment			
	Mean ±SD	Mean ±SD	MD	% of change	p-value
VAS					
Group A	8.15 ± 0.87	4.05 ± 0.88	4.1	50.31	0.001
Group B	7.9 ± 1.02	3 ± 0.64	4.9	62.03	0.001
MD	0.25	1.05			
	p = 0.41	*p = 0.001*			
NDI (%)					
Group A	44.85 ± 14.71	22 ± 3.43	22.85	50.95	0.001
Group B	44.4 ± 14.73	15.75 ± 2.04	28.65	64.53	0.001
MD	0.45	6.25			
	p = 0.92	*p = 0.001*			

SD, Standard deviation; MD, Mean difference; p-value, the Probability value

Table 3
Mean neck ROM pre and post-treatment of the group A and B

ROM (degrees)	Pre-treatment	Post-treatment			
	Mean ±SD	Mean ±SD	MD	% of change	p-value
Flexion					
Group A	55 ± 11.47	69 ± 6.61	-14	25.45	0.001
Group B	53.75 ± 11.79	79.75 ± 3.43	-26	48.37	0.001
MD	1.25	-10.75			
	p = 0.73	*p = 0.001*			
Extension					
Group A	41.5 ± 7.79	55.75 ± 4.06	-14.25	34.34	0.001

Group B	40.75 ± 6.12	64.75 ± 5	-24	58.90	0.001
MD	0.75	-9			
	p = 0.73	*p = 0.001*			
Right bending					
Group A	22.25 ± 3.79	38.5 ± 2.35	-16.25	73.03	0.001
Group B	22.75 ± 3.43	42.75 ± 2.55	-20	87.91	0.001
MD	-0.5	-4.25			
	p = 0.66	*p = 0.001*			
Left bending					
Group A	23.25 ± 4.94	37 ± 3.76	-13.75	59.14	0.001
Group B	25 ± 4.29	42.25 ± 2.55	-17.25	69.00	0.001
MD	-1.75	-5.25			
	p = 0.23	*p = 0.001*			
Right Rotation					
Group A	41.75 ± 10.29	63.25 ± 6.13	-21.5	51.50	0.001
Group B	43.25 ± 8.31	76.75 ± 7.12	-33.5	77.46	0.001
MD	-1.5	-13.5			
	p = 0.61	*p = 0.001*			
Left rotation					
Group A	44 ± 5.52	64.75 ± 4.72	-20.75	47.16	0.001
Group B	45 ± 7.07	77.75 ± 5.49	-32.75	72.78	0.001
MD	-1	-13			
	p = 0.62	*p = 0.001*			

SD, Standard deviation; MD, Mean difference; p-value, the Probability value

Table 4
Mean EMG of sternocleidomastoid, upper trapezius, and scalenus anterior pre and post-treatment of the group A and B

%MVIC	Pre-treatment	Post-treatment			
	Mean ±SD	Mean ±SD	MD	% of change	p-value
Right sternocleidomastoid					
Group A	75.25 ± 10.69	64.25 ± 8.77	11	14.62	0.001
Group B	73.5 ± 8.9	50.75 ± 5.2	22.75	30.95	0.001
MD	1.75	13.5			
	p = 0.57	*p = 0.001*			
Left sternocleidomastoid					
Group A	74.5 ± 6.66	63.75 ± 5.34	10.75	14.43	0.001
Group B	73 ± 7.67	51.25 ± 4.83	21.75	29.79	0.001
MD	1.5	12.5			
	p = 0.51	*p = 0.001*			
Right scalenus anterior					
Group A	68.5 ± 6.51	57.25 ±	11.25	16.42	0.001

		5.72			
Group B	69.25 ± 6.74	55 ± 6.07	14.25	20.58	0.001
MD	-0.75	2.25			
	p = 0.72	*p = 0.23*			
Left scalenus anterior					
Group A	67 ± 7.5	55.5 ± 6.04	11.5	17.16	0.001
Group B	68.5 ± 5.15	53.25 ± 5.68	15.25	22.26	0.001
MD	-1.5	2.25			
	p = 0.46	*p = 0.23*			
Right upper trapezius					
Group A	61.5 ± 9.33	72.75 ± 5.95	-11.25	18.29	0.001
Group B	60.25 ± 9.1	79.75 ± 7.69	-19.5	32.37	0.001
MD	1.25	-7			
	p = 0.67	*p = 0.003*			
Left upper trapezius					
Group A	62.25 ± 8.02	73 ± 8.49	-10.75	17.27	0.001
Group B	59.75 ± 8.18	80.5 ± 6.66	-20.75	34.73	0.001
MD	2.5	-7.5			
	p = 0.33	*p = 0.004*			

SD, Standard deviation; MD, Mean difference; p-value, the Probability value

Discussion

In our study pain, neck disability index, range of motion, and muscle activity in patients with mechanical neck pain, the effectiveness of adding a trunk core training program to conventional treatment (passive stretching of the upper fibers of trapezius, sternocleidomastoid, and scalene muscles, isometric strengthening exercises of neck muscles for flexion, extension, side bending for both sides, and rotation for both sides, hot pack) has been examined. This study showed that both groups post-treatment VAS, NDI, sternocleidomastoid, and scalenus anterior activity decreased statistically from pre-treatment levels. Both groups' upper trapezius and total neck range of motion were statistically and noticeably higher post-treatment than they were pre-treatment. Comparisons between groups post-treatment showed that group B had a clear decrease in VAS, NDI, and right and left sternocleidomastoid activity. In comparison to group A, group B's post-treatment neck range of motion and upper trapezius activity increased clearly. Between groups, there was no apparent difference in the activity of the right and left scalenus anterior.

It has been discovered that strengthening exercises for the neck and shoulder are quite helpful at ending the pain cycle [19] and enhancing motor control [20; 21]. Numerous investigations [22, 23] have shown that neck pain and neck muscular atrophy are closely connected. The inhibiting effect of pain and alterations in muscle architecture may both contribute to a decline in muscular strength [24]. A meta-analysis showed that core stability training is more effective at reducing pain than general exercise and may, in the near term, improve physical function in people with chronic LBP [25]. The normal function requires a pain-free range of motion. The Neck Disability Index (NDI) subscales are inversely correlated with patient pain. The improvement in ROM and decrease in discomfort may have contributed to the decrease in NDI scores that was observed across all subjects. The NDI is sensitive to change and has a good correlation with VAS, as demonstrated by Vernon and Mior [26].

In the clinical trial conducted by Albornoz-Cabello et al., the experimental group improved more than the control group (clinical pain decreased clearly by 3.86 points on a scale of 10; big effect) (control group). The variations between the groups following therapy were also seen in terms of neck impairment. The degrees of disability did, however, noticeably improve for both groups [27]. These findings are supported by earlier research [30]. The global sample also demonstrated improved active and passive right neck rotation as evaluated by a goniometer (angular measurement). The experimental group, however, significantly outperformed the control group in this cervical range of motions. The improvement in stretch tolerance and mechanical structural changes that followed interferential current therapy and workouts can serve as illustrations of these outcomes [28]. These changes were likely brought on by a change in the viscoelastic properties of the cervical muscles.

The findings of our study is closely related to results from a study that was investigating the effectiveness of combining Pilates and conventional therapy on mechanical neck pain cases. That study's findings showed a clear significant reduction in pain intensity in both groups, with the Pilates group experiencing a pain reduction of 81 % and the conventional group experiencing a reduction of 23 %. Finally, the muscle amplitude of the superficial flexors and extensors was evaluated by normalized RMS by EMG, and it was reduced in both groups, favoring the Pilate group [29]. In addition, Alsultan discovered that patients with neck pain moved their trunks less when doing a dual task (cervical rotation) gait than did healthy people, even if there was no statistically significant difference between the groups when performing a single gait task [30].

Recommendation

- A treatment process based on a classification system for the reasons of neck pain has to be developed in the future. This will improve the capacity to identify neck pain patient subgroups, which will help make better clinical decisions and increase the success of treatment by matching cases with the most effective interventions.
- Additional research adopting core training exercises is required to determine whether patients with persistent mechanical neck pain have improved functioning and daily living skills.
- Additional research should be done to utilize various muscle performance measurement techniques, like biofeedback or cervical muscular performance assessments. More research work should be carried out to determine the long-term effects of core training on pain and functional disability, as well as perhaps additional research into the impact of core training on elderly individuals. To provide more trustworthy evidence for future investigations, this paper demonstrated the effectiveness of treating neck pain using core stability exercises.

Limitations

As for the limitations of the study, the current study has involved a limited number of patients. A minimal number of cases were recruited, and none dropped out.

Conclusions

Based on the study's objectives and results, it was determined that a core training program for the trunk, along with conventional treatment, helped patients with chronic mechanical neck pain improve their VAS, NDI, neck range of motion, and the activity of their right and left sternocleidomastoid and upper trapezius muscles.

Conflicts of interest

The authors declare the absence of conflicts of interest.

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