

The effect of McKenzie protocol vs. deep neck flexor and scapulothoracic exercises in subjects with chronic neck pain – a randomized controlled study

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Abstract. – OBJECTIVE: This study investigated the impact of McKenzie exercises against deep neck flexor (DNF) combined with scapulothoracic exercises on improving pain severity, cervical mobility, and functional disability.

PATIENTS AND METHODS: Fifty-five subjects suffering from chronic neck pain participated in this randomized controlled study. They were randomly assigned to three groups; the DNF group, which was treated by traditional physical therapy (i.e., physical therapy agents, stretching, and isometric exercises), combined with DNF, and scapulothoracic exercises; the McKenzie group, treated by traditional physical therapy, combined with McKenzie exercises; and finally, a control group, treated by traditional physical therapy. Before and after 6 weeks of treatment, they were assessed for neck pain severity, cervical range of motion (ROM), and functional disability using a visual analog scale (VAS), a gravity-reference goniometer, and the Copenhagen neck functional disability scale (CNFDS), respectively.

RESULTS: Compared to baseline, all groups showed a significant decrease in neck pain severity and disability ($p < 0.05$), and there was a significant increase in neck flexion/extension, lateral right flexion/left flexion, and right/left rotation ROMs ($p < 0.05$). The improvement of the McKenzie group was significantly higher than the DNF group, and control group. Moreover, the improvement of the DNF group was significantly higher than the control group ($p < 0.05$).

CONCLUSIONS: The McKenzie exercises were better than DNF combined with scapulothoracic exercises to treat neck pain, functional disability, and mobility.

Key Words:

Cervical pain, Deep neck muscles, Exercises, Neck mobility, Strength training.

Introduction

Neck pain is a crucial public health issue that affects the entire population¹. It causes a severe reduction in work and life quality, and it can be a socioeconomic burden on individuals and society². Therefore, to reduce the future burden of neck discomfort, it is necessary to raise public awareness about risk factors and preventive treatments¹. Neck pain is associated with the weakness of muscles in the cervical spine, such as the deep and anterior neck flexors³, which isometric exercises and strength training can alleviate⁴. Multiple cervical spine structures can be the source of pain, which can advance to chronic neck pain.

Inherently, exercises are extensively utilized to increase muscle force, power, elasticity, repair the damaged muscles, and maintain daily activities in subjects suffering from neck pain⁵. It is noteworthy to mention the importance of the deep neck flexor (DNF) muscles in maintaining posture⁶. Accordingly, subjects with chronic neck pain displayed a reduction in the electromyographic activities of DNF muscles (*longus capitis* and *longus colli*)⁷. Besides, they increased the activity of superficial

muscles (sternocleidomastoid and anterior scalene)⁸. People suffering from neck pain are more likely to adopt a forward head position (FHP), which has been attributed to the compressive loading of the cervical tissues⁹.

Retraining the DNF muscles reduces neck pain symptoms and improves its activation level increasing the capability to preserve the cervical vertical alignment¹⁰. The DNF exercises work directly on the DNF musculature¹¹, a dense area with muscle spindles¹². Furthermore, DNF exercises improve the sense of position and motion of the cervical spine, increasing neck stability¹³. They also have a sustainable effect in treating chronic neck pain¹⁴, which may promote a long-term impact in avoiding frequent episodes of neck pain¹⁵.

Conversely, McKenzie exercises increase self-awareness of discomfort concerning posture and spinal movement. It is described as directional preference exercises done throughout the day. This technique may provide additional opportunities to change pain expectations, fear beliefs and rectify functional limitations by altering mechanical, cognitive, and sensory pain perception¹⁶. In patients with spinal pain, conducting repetitive neck retraction exercises significantly reduces the pain and restores the lordosis curve of the cervical spine^{17,18}. Furthermore, McKenzie exercises were found to dramatically reduce neck and back pain in students aged 12-18 years, who were more likely to experience neck and back discomfort¹⁹. It has been reported that the McKenzie exercises are more useful than the isometric strengthening exercises in relieving neck pain²⁰. However, Kim et al²¹ reported no difference between the effects of McKenzie and DNF pain and static DNF muscles strength in adult males and females with FHP.

Both exercise training of neck extensor and DNF muscles can equally alleviate impairment and pain intensity and restore neck posture and muscle strength in patients with chronic neck pain, which was higher than the conventional care control group²². The review study of Blomgren et al²³ compared the effects of DNF training and neck muscle endurance, force, proprioception training, mobility, and stretching exercises on neuromuscular compatibility, muscle girth, and kinesthetic variables. They concluded that the DNF exercises could effectively improve impaired neuromuscular coordination. Conversely, they cannot find changes in the strength or endurance of the neck flexors. Hitherto, no trial has yet compared between McKenzie and DNF exercises in patients with chronic neck pain. Subsequently, this study aimed to compare the effects of McKenzie exercises and DNF

combined with scapulothoracic exercises on cervical mobility, pain severity, and functional disability in those populations.

Patients and Methods

Study Design and Ethics

This study was a randomized controlled trial with a planned duration of 6 weeks. It was conducted at the Faculty of Physical Therapy's outpatient clinic, Cairo University, Egypt, where its ethical committee granted permission to conduct the study (Approval No. P.T.REC/012/003053). Furthermore, it was recorded by ClinicalTrials.gov PRS (NCT04793763) to be conducted according to the Declaration of Helsinki's principles from January 2021 to April 2021. The participants received a detailed clarification of the study evaluation and intervention protocols. Participants were authorized to enroll in the study after signing a written informed consent. The study adhered to the Consolidated Standards of Reporting Trials (CONSORT) guidelines and the Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT)^{24,25}.

Sample Size

G*POWER statistical software was used to calculate the sample size (version 3.1.9.2; Franz Faul, University Kiel, Germany). The optimum sample size for this investigation was N= 54, according to the calculations utilizing $\alpha=0.05$, effect size=0.44, and power=0.80.

Participants

Fifty-five subjects suffering from chronic neck pain of both genders participated in the conducted study. Their ages ranged between 30 and 50 years, while their heights and weights ranged between 152 and 182 cm and between 55 and 90 kg, respectively. Table I illustrates the demographic features of the participants.

The eligibility condition was considered the localized chronic neck pain without an exact etiology with the absence of any arm pain or discomfort that could be replicated by neck mobility or irritant assessment. This pain exists in the dorsal area, between two horizontal lines: the first line passes through the lower half of the occipital area, and the second line runs through the spinous process of the first dorsal vertebra²⁶. The participants were excluded from the study if their neck pain was caused by any other complications, such as a neoplasm, neurological diseases, vascular diseases,

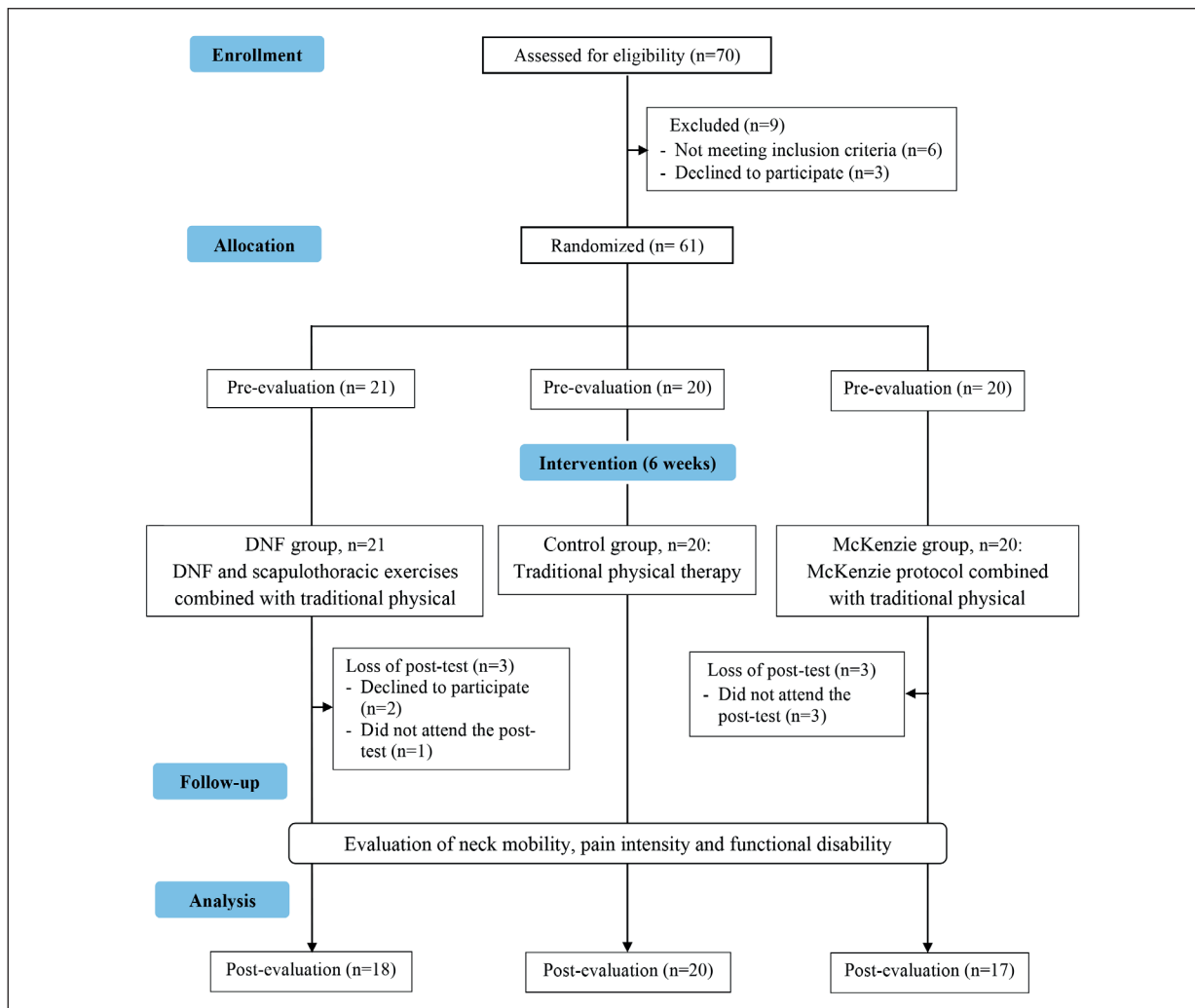


Figure 1. Flowchart of the study processes. DNF; deep neck flexors.

history of neck injury or surgery, neurologically deficient radiculopathy, inflammatory arthritis, or if they had experienced pain in the scapula, upper extremities, lumbar spine or hip joints which developed regional instability.

Randomization, Allocation, and Blinding

Seventy participants were examined for their eligibility by a research coordinator. Six participants did not meet the eligibility requirements, and three declined participations. The final number of patients was 61 participants. Following the study inclusion, the participants were randomly assigned to one of three groups (i.e., DNF group, n=21; McKenzie group, n=20; and Control group, n=20), based on a computer-generated minimization technique that considers the patient’s age

and the intensity of neck pain. After allocation, three participants were excluded from the DNF group, and three were exempted from the McKenzie group.

Consequently, the DNF group consisted of 18 patients treated by traditional physical therapy (physical therapy agents, stretching, and isometric exercises), combined with scapulothoracic and DNF exercises. The McKenzie group consisted of seventeen patients treated by traditional physical therapy, accompanied by McKenzie exercises. Finally, the control group comprised twenty patients treated by traditional physical therapy. The final number of participants was fifty-five, only one more than the previously calculated number. The intervention lasted six weeks (five days a week). Figure 1 elucidates the study’s stages and progress.



Figure 2. Deep neck flexor muscles strengthening exercises.

Interventions

Physical therapy agents

Intellect Advanced device (REF2773MS; Chattanooga: Mexico) was used to supply transcutaneous electrical nerve stimulation (TENS) for 30 minutes (frequency; 80 Hz, and intensity; 10-30 mA). This intensity was selected to provide a stinging feeling that has been just about 2-3 times the subject's sensation threshold. It consisted of four surface electrodes, each measuring 25 cm², positioned over the neck region. Ultrasound therapy (US); a Metron Accusonic Plus (Metron Medical, Australia Pty Ltd. Carrum Downs Victoria Australia 3201) was used to deliver a continuous ultrasound (frequency; 1 MHz, and intensity; 1.5 W/cm²) for 10 minutes using, over the painful area of the neck¹⁴. Infrared Irradiation (R 125, 250 watts, Philips; 126597: Australia) was applied to the neck region for 20 minutes at a distance of 40 cm.

Stretching and isometric exercise

The stretching exercises were performed in the following order: stretch the upper trapezius to lateral flexion, the scalene to ipsilateral flexion and rotation, and the extensor muscles to flexion, holding each exercise for 30 seconds. Each exercise was performed three times from a standing position in a single session that lasted around 10 minutes^{27,28}. From the sitting position, the isometric exercises consisted of 3 sets of exercises repeated 10 times in each set and 6 seconds hold in flexion, extension, rotations, and side flexion on both right

and left sides through applying resistance to the forehead^{14,29,30}.

DNF exercise

It was performed without using a biofeedback system³¹. From a supine position with the cervical spine in a neutral posture, the participant was asked to nod his head to flatten the cervical curve. This posture was maintained for 10 seconds (10 times) (Figure 2). The sternocleidomastoid muscles were monitored during the DNF muscle contraction to ensure they were not contracting.

Scapulothoracic exercise

It is (a) strengthening exercise of the serratus anterior muscle, as well as the middle and inferior fibers of the trapezius muscle³². Serratus anterior exercises consisted of two steps. Step 1: the participant stood up facing the wall, and hands rested on the wall with an equal distance to shoulder width. Step 2: the participant did a "push-up with a plus" exercise by pushing his body away from the wall until his elbows became completely extended, which completely protracted the scapulae (Figure 3).

To train the lower and middle fibers of the trapezius muscle, the participant assumed a prone position, then he horizontally abducted the shoulder with depression, adduction, and upward rotation of the scapulae. These exercises were carried out in a 120-135° abduction for the lower trapezius muscle. These exercises were conducted at about a 90° abduction for the middle trapezius muscle. The shoulder was laterally rotated, allowing the thumb to point to the ceiling, and the scapula did not rise



Figure 3. Serratus anterior muscle strengthening exercises.

in the direction of the head. The participant's neck was positioned in a comfortable position (Figure 4). If the participant could not rotate his body, a pillow was mounted under the superior part of the chest to retain the neck's neutral position, with the participant's forehead resting on his contralateral forearm. Participants were requested to complete their exercises on a habitual basis during each session and perform them twice a day at home.

McKenzie exercises

The following are the exercises' descriptions, according to Hefford³³, for extension dysfunction. The participant was in a comfortable sitting posture with a proper back support, then, he was asked to pull the head back as far as possible, keeping the head forward-facing, without up or down inclinations (10 to 15 times). Then, he restored the neutral sitting posture, and at the end of the range of motion (ROM), he exerted an extra force by pushing the chin with his fingers (10 to 15 times). Subsequently, the participant was requested to return to the original position, while the therapist one hand's forefinger was placed alongside the participant's mandible (to stabilize the head at full retraction position), and the heel of the other hand was placed on the first or second dorsal vertebra (to provide posterior-anterior force). The exercises were then repeated five or six times (Figure 5A).

About rotation dysfunction, from the aforementioned same sitting position, the participant was asked to partially retract his head and rotate it to the pain side as much as possible for a second before returning to the original position. This motion was repeated 10 to 15 times in a rhythmic pattern. The participant was then advised to repeat the identical retraction and active rotation movements. Each participant was instructed to place his right hand behind his head with his fingertips touching his left ear and his left hand under his chin for left rotation, then return to the original position after a second. The participant was then seated in a comfortable, relaxed position with his head slightly retracted and his back supported. The therapist's right hand rested on the right trapezius of the participant while standing behind him. The left hand of the therapist carried the participant's head. Then, the participant was asked to twist his head as far as he could go within his range. The therapist generated more rotation force by spinning the head with the left arm. The participant was asked to swivel his head to the end of ROM while using his right hand to apply reverse force to the vertebrae below (spinous process). Then, the head was returned to the original posture after keeping the position for one or two seconds. The exercises were then repeated five or six times (Figure 5B).



Figure 4. Trapezius muscle strengthening exercises.

For lateral flexion dysfunction, the participant was asked to flex his head laterally and retract it towards the painful side from the sitting position mentioned earlier. Then, he was instructed to return to the original position after a brief period in this position. This action was repeated 10 to 15 times in a rhythmic pattern from the same position. Then, the participant was asked to place his left hand above his head with his fingers contacting the right ear and pull the head down to his shoulder. He was directed to return to the upright position after a second in that position. The identical actions were executed 10 to 15 times in a rhythmic pattern.

The therapist then stood at the participant's back with his head relaxing on the therapist's chest, with slight head retraction. Then, the therapist's right hand was put in opposition to the right side of the participant's head, the elbow resting on the clavicle, the therapist's forearms were parallel to each other, and the fingertips were put on the participant's head. The participant was asked to slightly do retraction of his head before lateral flexing it to the end of the ROM. After movement completion, the therapist applied downward force on the side of the head with his right hand, and the thumb applied an opposing force on the spinous process.

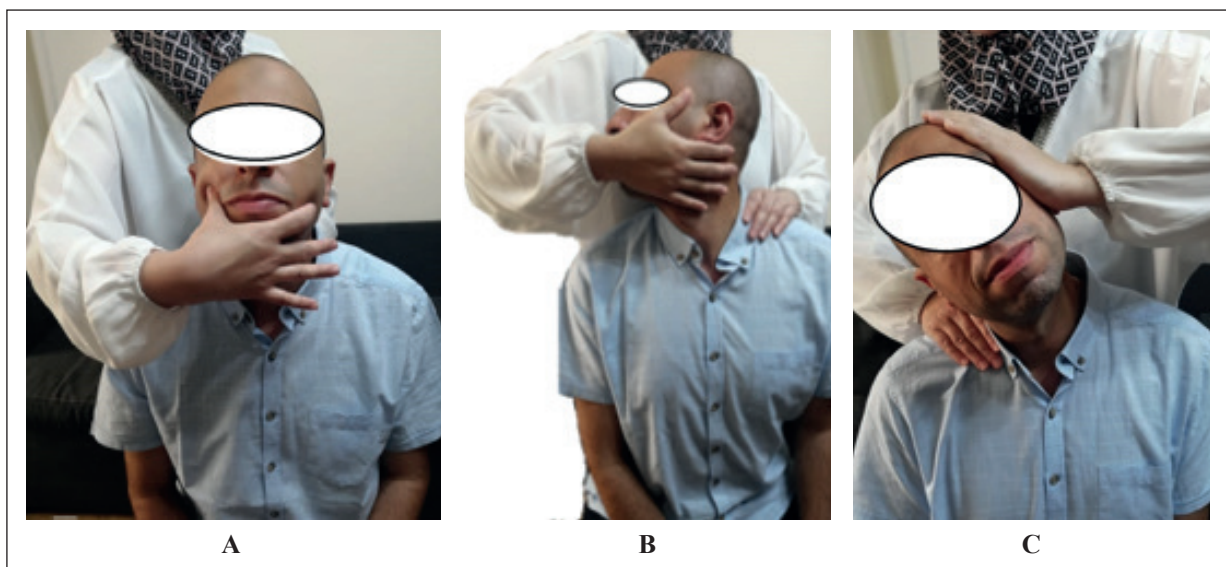


Figure 5. McKenzie exercise; **A**, extension dysfunction, **B**, rotation dysfunction, and **C**, lateral flexion dysfunction.

Before returning to the upright posture, the participant kept the position for one or two seconds. The exercises were then repeated five to six times (Figure 5C).

Assessment Procedures

Measurement of the cervical ROM

A Myrin gravity reference goniometer (Rehab Co. AN LIC-Company, S-17183 Solna, Sweden) was used to measure the gross mobility limitation of a person having cervical dysfunction and objectively assess the effectiveness of a rehabilitation program. Likewise, it was a reliable mean to assess neck motion³⁴. The neck mobility was examined while the participant was sitting on a chair, with the buttocks aligned against the back of the chair, the sole of the feet completely in contact with the floor, and his hip and knee joints at a right angle. Then, the strap was used to set up the device over a participant's head who was asked to move his head to the full, active ROM for each of the six neck motions (Figure 6); the sagittal plane motion (flexion/extension), frontal plane (right/left lateral flexion), and transverse plane (right/left rotation)³⁵.

Evaluation of pain intensity

A visual analog scale (VAS) was used to evaluate the pain intensity; it is a 100-mm-long, smooth line with word descriptions at each end. The participant's impression was placed where he believed the best expression about his current condition was. The distance in millimeters from the line's left end to the point marked by the participant determined the VAS score, which was widely regarded as a valid and reliable device for estimating pain³⁶.

Assessment of the neck functional activity level

It was evaluated using the Copenhagen neck functional disability scale (CNFDS)³⁷, a self-administered questionnaire applied to determine the degree of practical incapacity in subjects with neck pain³⁸. The questionnaire asked about headaches, rest and thinking abilities, and everyday activities. There were also psychological issues, such as social communication, passionate relations, and future mental conditions. They have all been given the green light and appear to be reliable³⁹.

The CNFDS is a tool that allows persons who are receiving physical therapy for neck pain to assess their progress. Patients between the ages of 20 and 75 are eligible to enroll in the survey⁴⁰. These questions are either answered with a "yes", "at times", or "no" response. If the patient answers



Figure 6. Measurement of the cervical range of motion.

"yes" to all the questions, he has a reasonable degree of ability. Answering "no" to six questions out of fifteen indicates a high degree of ability. A considerable ability receives a zero, a low ability receives a score of two, and the answer "incidentally" consistently receives a score of one³⁸.

The overall score was calculated by combining all the inquiry scores. This total score might be anywhere between zero and thirty. It reflects the degree of utility incompetence, with higher values indicating more incapacity. A score of zero indicates that the patient's neck is free of protests, whereas a score of thirty indicates that dissent has significantly hampered the patient's neck. Rehashed scores could be compared to raw scores or expressed as a percentage difference from the (unique) benchmark result.

Statistical Analysis

The acquired data were analyzed using the Statistical Package for Social Sciences for Windows version 20.0 (SPSS, IBM Corp., Armonk, NY, USA). To detect if there was a noteworthy difference between the age, weight, height, or BMI of the three groups, the analysis of variance (ANOVA) test was used, and the Chi-square test was done to detect if there was a significant differ-

Table I. Demographic characteristics of subjects

	DNF group, n=18 Mean ± SD	McKenzie group, n=17 Mean ± SD	Control group C, n=20 Mean ± SD	p-value
Age (year)	43.06 ± 8.68	41.24 ± 7.82	41.60 ± 8.99	0.798 ^a
Weight (kg)	70.83 ± 5.92	72.18 ± 5.74	71.75 ± 6.39	0.797 ^a
Height (cm)	169.53 ± 8.40	1.64 ± 7.37	1.67 ± 7.56	0.482 ^a
Body mass index (kg/m ²)	25.18 ± 1.77	26.28 ± 1.64	25.60 ± 1.72	0.174 ^a
Sex (male/female)	11/7	10/7	12/8	0.991 ^b

SD: Standard deviation, **p*-value < 0.05 indicates a significant difference, a; ANOVA test, b; Chi-square test.

ence in gender between groups. It was important to check the data normality before proceeding with the parametric data analysis. So, the Shapiro-Wilk test (normality test) verified that it was normally distributed ($p > 0.05$). Furthermore, the homogeneity of variances between the groups was examined using Levene's test, which showed that the data were homogenous. The three groups' variations in neck mobility, pain intensity, and functional level were investigated using multivariate ANOVA. For the ensuing multiple comparisons, post-hoc testing with the Bonferroni correction was used. The level of significance was deposited at (α) of 0.05.

Results

There were no noteworthy differences in age, weight, height, BMI, or gender between the three groups ($p > 0.05$), as illustrated in Table I. There was no significant difference between-subjects effect (groups; $F=1.73$, $p=0.055$), significant difference within-subjects effect (time; $F=1.62$, $p=0.001$), and the interaction effect (time*group; $F=5.54$, $p=0.001$). Following that, several pairwise comparisons were conducted.

Regarding the pre-values of the sagittal plane motion (flexion/extension), frontal plane (right/left lateral flexion), and transverse plane (right/left rotation), VAS, and CNFDS, there were no significant differences amongst the three groups ($p=0.563$, 0.535 , 0.540 , 0.512 , 0.916 , 0.929 , 0.829 , 0.670 respectively). The post-test values of neck flexion/extension, lateral right flexion/left flexion, right/left rotation were substantially greater than the pre-test values ($p=0.001$). The post values of VAS and CNFDS were extensively lower than the pre values ($p=0.001$), as demonstrated in Table II.

McKenzie group had significantly greater post values for neck flexion/extension, lateral right flexion/left flexion, and right/left rotation than the

DNF group ($p=0.033$, 0.034 , 0.022 , 0.006 , 0.047 respectively), and the control group ($p=0.001$). The DNF group had substantially higher post values for neck flexion/extension, lateral right flexion/left flexion, right/left rotation than the control group ($p=0.042$, 0.031 , 0.015 , 0.003 , 0.033 , 0.37 respectively). The VAS and CNFDS post values of McKenzie group were considerably lower than those of the DNF group ($p=0.014$, 0.035 respectively) and the control group ($p=0.001$). The post values of VAS and CNFDS of McKenzie group were considerably lower than those of the control group ($p=0.006$, 0.034 respectively).

Discussion

The present study disclosed that both DNF, and scapulothoracic exercises combined with traditional physical therapy and McKenzie exercises combined with traditional physical therapy were effective in improving cervical mobility, decreasing pain intensity, and reducing disability compared to traditional physical therapy in chronic neck pain. The McKenzie exercises were more effective than the DNF combined with scapulothoracic exercises, and both were more effective than the traditional physical therapy alone.

Subjects suffering from chronic neck pain demonstrated the weakness of the DNF muscles⁸. As a result, the current conclusion was consistent with prior research that found that craniocervical flexor training decreased pain severity in those patients. The craniocervical flexor exercises increased the DNF muscles' capacity and neuromuscular control, such as the *longus colli*, and *longus capitis*, which lowered the pain severity in subjects with neck pain^{10,41-44}. In the same context, O'Leary et al⁴⁵ stated that both craniocervical flexion and traditional neck flexion exercises improved the isometric craniocervical flexor muscle function, with-

Table II. The values of cervical range of motion (ROM), Visual analog scale (VAS), Copenhagen neck functional disability scale (CNFDS) score before and after intervention.

		DNF group, n=18 Mean ± SD	McKenzie group, n=17 Mean ± SD	Control group C, n=20 Mean ± SD
Flexion	Pre	4.99 ± 0.81	5.27 ± 0.93	5.03 ± 0.84
	Post	6.17 ± 0.87	6.91 ± 0.83	4.48 ± 0.80
	<i>p</i> -value	0.001*	0.001*	0.001*
Extension	Pre	4.39 ± 0.98	4.28 ± 1.17	3.97 ± 1.40
	Post	5.82 ± 1.34	7.03 ± 1.14	4.65 ± 1.54
	<i>p</i> -value	0.001*	0.001*	0.001*
Lateral right flexion	Pre	3.11 ± 0.45	2.92 ± 0.48	2.99 ± 0.60
	Post	3.88 ± 0.61	4.48 ± 0.62	3.28 ± 0.67
	<i>p</i> -value	0.001*	0.001*	0.001*
Lateral left flexion	Pre	3.17 ± 0.50	2.96 ± 0.51	3.05 ± 0.58
	Post	4.05 ± 0.44	4.64 ± 0.61	3.44 ± 0.54
	<i>p</i> -value	0.001*	0.001*	0.001*
Right rotation	Pre	5.42 ± 0.91	5.32 ± 7.41	5.28 ± 0.88
	Post	6.63 ± 1.07	7.41 ± 0.81	5.86 ± 0.85
	<i>p</i> -value	0.001*	0.001*	0.001*
Left rotation	Pre	5.36 ± 0.90	5.38 ± 1.10	5.27 ± 0.72
	Post	6.64 ± 0.73	7.47 ± 0.70	5.97 ± 0.91
	<i>p</i> -value	0.001*	0.001*	0.001*
VAS	Pre	6.28 ± 1.79	6.47 ± 1.84	6.15 ± 1.08
	Post	3.47 ± 1.22	2.38 ± 0.98	4.63 ± 1.05
	<i>p</i> -value	0.001*	0.001*	0.001*
CNFDS	Pre	15.39 ± 2.36	15.76 ± 3.99	14.75 ± 3.86
	Post	9.17 ± 1.72	7.06 ± 2.11	11.20 ± 3.04
	<i>p</i> -value	0.001*	0.001*	0.001*

SD: Standard deviation, **p*-value < 0.05 indicates a significant difference.

out differences in muscle achievement between the two exercises regimens.

Furthermore, Tsiringakis et al⁴⁶ recently reported that motor control training of the DNF is more beneficial than strength-endurance training of the cervical muscles in reducing pain intensity and functional disability in patients with neck pain. Moreover, the DNF exercises may benefit to reestablish the cervical region sensorimotor control and enhance its neuromuscular function⁴⁷. As one probable explanation for exercise's pain-relieving impact, mechanoreceptors such as the muscle spindle, Golgi tendon organ, and joint proprioceptors are stimulated during training. Signals from these receptors release endogenous opioids and trigger the pituitary gland to generate endorphins^{48,49}.

According to Jull et al⁴¹, the DNF exercises provided more neck pain and function benefits than simple neck flexion exercises. Likewise, Lee et al⁵⁰ stated that the DNF exercises reduced neck pain and improved the neck and shoulder posture in high school students' neck and shoulder posture. Furthermore, Dusunceli et al⁵¹ used neck extension exercises and DNF exercises for subjects with

neck pain. They reported that the subjects who had completed 12-months of DNF exercises exhibited improved pain and functional level, which was aligned with the current findings. Suvarnato et al²² reported that six weeks of neck extensors and DNF training have restored the neck stability, reduced pain severity, and improved the strength of neck muscles in patients with chronic neck pain. The extensor strength was gained in the semispinalis group, while flexor strength was grasped in the deep cervical flexor group.

Kjellman and Oberg⁵² showed that the McKenzie exercises were more beneficial than general exercises and ultrasound in the control group, with faster neck pain relief during the first three weeks. Protective muscular spasms are frequently associated with neck pain, resulting in ischemia, increased pain, and incorrect neck position due to the pressure within the homonymous muscle. They discovered that correcting one's posture aided in alleviating neck pain and muscle spasms. The postural correction has been revealed in alleviating sternocleidomastoid spasm⁵³, which supports the current finding

about the functional work of McKenzie exercises to correct the posture.

The mechanical improvement may be attributed to treating the adaptive muscle shortening of the neck region, resulting in limited uncomfortable movement and reduced spinal mobility necessitating activities that promote the rebuilding process. Normal tissue function was only reestablished with the use of loading tactics like the McKenzie method⁵⁴. McKenzie exercises are also a very useful treatment method because they often rely on the force created by the patient in the direction that relieves his chronic neck pain symptoms⁵⁵. It is an active therapy with an educational component that involves repeated movements or sustained positions to reduce pain and disability and improve spine mobility. Furthermore, it helps patients moving their spine in the least detrimental direction for their problem, minimizing movement restrictions caused by kinesiophobia or pain⁵⁶.

Concerning the cervical region, there have been studies affirming the McKenzie protocol's efficacy in treating neck pain and according with this study's findings⁵⁷. Abdulwahab and Sabbahi¹⁸ reported that the neck retraction exercises released the compression on the cervical root in subjects with cervical radiculopathy and extended the lower cervical region, which recovered the normal neck posture. The McKenzie group showed improvement in physical performances, which may be due to the noticeable alteration in the awareness of pain. McKenzie's exercises decreased anxiety caused by pain anticipation and fear from achieving certain physical motions, which increased self-confidence⁵⁸.

According to the present findings, the McKenzie exercise is more advantageous than the isometric strengthening exercise, as Neeraj and Shiv²⁰ discovered. Moreover, Garcia et al⁵⁹ found that the McKenzie protocol was more effective than the Back School technique in improving physical function in patients with lower back problems. They discovered no reduction in pain intensity, although the amount of this impact was minor and may be of questionable therapeutic significance. The McKenzie technique and DNF exercises were compared to the management of spine problems in the only study. McKenzie method, alone or in combination with DNF exercises, was proven to be more beneficial in young people with FHP than DNF exercises alone⁶⁰.

Lee and Seo⁶¹ reported that to increase the efficiency of DNF muscles, activation should inhibit the activity of sternocleidomastoid and anterior scalene muscles, which can be achieved

through stretching exercises of these muscles⁶², which also correct the neck posture in subjects suffering from chronic neck pain. These findings could explain the McKenzie and DNF groups' greater improvement than the control group, who received only traditional physical therapy and physical therapy agents. Furthermore, the control group's improvement was only attributed to the mechanical effect of isometric exercises and stretching training. The review study of Price et al⁶³ reported that exercise training programs reduce neck pain intensity and functional disability, and Kang et al⁶⁴ recently found that stretching exercises stimulate motor nerves, improving inhibition of muscular activity, muscle contraction delay, and muscle pathological conditions. However, Martimbianco et al⁶⁵ stated that there are inadequate reports supporting the use of TENS in subjects suffering from neck pain, because there is very low-certainty clinical support of an existing difference between TENS and placebo TENS on neck pain, and adding the US to traditional electrotherapy-based physical therapy offered no significant effect for neck pain⁶⁶.

The following were some of the research's limitations: First, the sample size was quite tiny. As a result, the findings cannot be applied to other situations. Second, the participants' daily activities were not totally under control, which was difficult to overcome. Third, there were no psychological outcomes that could be measured. Fourth, it is possible that patients did not follow the home exercises routine. Fifth, the nature of jobs and working hours were not considered while selecting the sample, which may have influenced the current findings. Sixth, head posture and neck angles were not assessed during the inclusion criteria or before and after the intervention to examine their influence on body alignment. Finally, there was no follow-up assessment to realize the treatment's long-term effects, which should be considered in future investigations. Furthermore, the participants' inclusion criteria comprised the classification of the severity of neck pain, such as mild, moderate, or severe pain, which impacted the measured outcomes' scores. More investigation is required to evaluate the impact of current therapies on muscle strength, everyday endurance activities, and psychological well-being.

Conclusions

This study reported that a combined treatment of McKenzie exercises and traditional physical

therapy was more effective than DNF and scapulothoracic exercises, combined with traditional physical therapy, or traditional physical therapy alone, for managing pain, functional disability, and cervical mobility in subjects with chronic neck pain. Moreover, the DNF and scapulothoracic exercises, combined with traditional physical therapy, were more effective than the traditional physical therapy alone.

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Conflict of Interest

This research work has no conflicts of interest.

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Authors' Contribution

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