A – Research concept
and design
B – Collection and/or
assembly of data
C – Data analysis
and interpretation
D – Writing the article
E – Critical revision
of the article
F – Final approval
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The effectiveness of neural mobilization in addition to conservative physiotherapy on cervical posture, pain and functionality in patients with cervical disc herniation

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Abstract

Introduction: Medical treatment, conservative physiotherapy (CP), exercise, mobilization and prevention methods should be taken into consideration in cervical problems. We aimed to investigate the efficacy of neural mobilization (NM) combined with CP on cervical posture, pain functionality in patients with cervical disc herniation (CDH).

Material and methods: Sixty patients with CDH and radicular pain participated in this randomized controlled study. They were randomly allocated into two groups. The control group (n = 30) received CP (hotpack, transcutaneous electrical nerve stimulation, ultrasound), and the experimental group (n = 30) received CP plus NM on the radial, median and ulnar nerves. Both groups received the CP for three weeks (15 sessions). The experimental group received the neural mobilization technique for three weeks (3 sessions per week). The demographic data, severity of pain (by Visual Analog Scale), cervical active range of motion degree, and cervical posture data (by Tragus to Wall test, Measurement of C7 to Wall Distance) have been recorded. Neck Disability Index (NDI) was applied to all participants for functionality.

Results: The distance between tragus and the wall decreased in the experimental group (p < 0.05), whereas there was not any significant difference in the distance between C7 and the wall (p > 0.05). The scores of pain and cervical active range of motion were found different in favor of the experimental group (p < 0.05). The NDI scores were similar in both groups (p > 0.05).

Conclusion: CP together with NM techniques will provide additional gains in cervical posture, pain, and active range of motion in patients diagnosed with cervical disc herniation.

Keywords: nerve stretching, radiculopathy, rehabilitation

Introduction

Cervical disc herniation (CDH) is the clinical situation which is caused by the displacement of the intervertebral disc or nucleus pulposus towards the cervical spinal canal. Cervical disc herniation occurs especially after the age of forty with disc degeneration, and the deterioration of the natural structure of bones and joints [1,2]. Neck pain is the most common symptom of CDH. Often radiculopathy, with pain radiating to the arm, paresthesia, sensory, motor and reflex changes, is observed [3].

Intervertebral disc pathologies of the cervical region are the second most common of all intervertebral disc diseases after lumbar vertebral disc diseases. Although they can be seen in young adults, their incidence increases in the 45–50 age group, and they are also more common in females [4]. Medical treatment, conservative physiotherapy, exercise therapy, mobilization methods and prevention methods should be taken into consideration in cervical region problems, and the treatment approach to address the problem should be applied using a wide perspective [5]. Neural mobilization, which began to gain popularity in the recent years, consist of movements called neural glides. These techniques gently stretch and mobilize the nerves and surrounding structures. Neural mobilization is believed to ameliorate symptoms by promoting intraneural circulation, axoplasmic flow, and neural viscoelasticity and sensitivity associated with the connective tissue. There are studies in which these techniques have yielded therapeutic success in terms of pain and functionality, particularly in the cervical region and in upper limb disorders where neural mechanosensitivity is increased [6–8].

Neural mobilization is one of the methods used for manual treatment of the peripheral nervous system and tissues surrounding it. Neural mobilization techniques and their underlying mechanisms have been the subject of numerous clinical studies, especially in recent years. Neural mobilization contributes to restoring the ability of neural tissues to stretch, allowing for the re-stimulation of normal physiological function of neural structures [9]. The main goal of neural mobilization is to increase optimal neurophysiological function and reduce extrinsic pressures on nerve tissue by restoring the dynamic balance between the mechanical interfaces surrounding the nerve tissue and the movement thereof [10].

In a study, which neural mobilization and conservative physiotherapy were compared in patients with chronic mechanical neck pain, symptoms such as pain and numbness were significantly reduced in the neural mobilization treatment group when compared to the conservative physiotherapy group [11]. Pain inhibition may be accompanied by postural improvements [12,13]. The studies, which examining the effects of neural mobilization tecniques in addition to conservative treatment, observed more significant improvement in functionality scores was observed in the neural mobilization group [14,15]. The aim of this randomized study was to compare the effects of the routine conservative physiotherapy with and without neural mobilization techniques on cervical posture, pain and functionality in patients diagnosed with cervical disc herniation.

Materials and methods

Participants

A total of 88 patients were diagnosed by a physician and evaluated in the hospital. The criteria for subject inclusion were the following: Cervical disc herniation at the level of bulging or protrusion (C5-C6-C7-C8) based on clinical presentation and confirmed by magnetic resonance imaging (MRI), age between 20–50 years, cervico-brachial radicular pain for at least six weeks, pain severity at a minimum of level 5 according to the Visual Analog Scale (VAS), sensitivity and numbness in radial, median, ulnar nerve neurodynamic tests, not receiving any other treatment or pharmacological agents. Surgery was not recommended to the participants by the neurosurgeon. Patients with spinal stenosis, rheumatic diseases, previous cervical spine surgery history, severe neurological loss, upper extremity vascular problems, severe osteoporosis, diabetes mellitus and pregnant women were excluded from the study. A total of 71 patients who met the inclusion criteria participated in the study. Patients were randomized into two groups according to their hospital protocol numbers (Study group: 36 patients, Control group: 35 patients) (Fig. 1). The study was conducted between August 2019 and April 2020. Informed consent was obtained from all individuals included in this study.

Ethical approval

The ethical approval was obtained from the ethical committee of Hasan Kalyoncu University (ethics committee decision No: 2019-63, date of approval: 14.06.2019).

Measurements

The demographic information of individuals was recorded. The patients were asked to adopt a painless posture at the hip level while facing straight ahead, feet apart and heels against the wall Tragus-wall distance (cm) and C7-wall distance (cm) were measured [16]. Pain severity of patients was measured on a visual analog scale (VAS), which is a high reliable as well as valid method to assess the severity of pain [17]. The universal goniometer was used to measure the active neck flexion, extension and right and left lateral flexion. The measurements were taken in a sitting position [18]. The Neck Disability Index (NDI) was used to determine the functionality level of the patients [19]. All patients were evaluated blind pre- and post-treatment. The physiotherapists who made the initial assessment and the final assessment were different.

Treatment protocol

A routine conservative physiotherapy protocol applied to the patients in the control group for 3 weeks
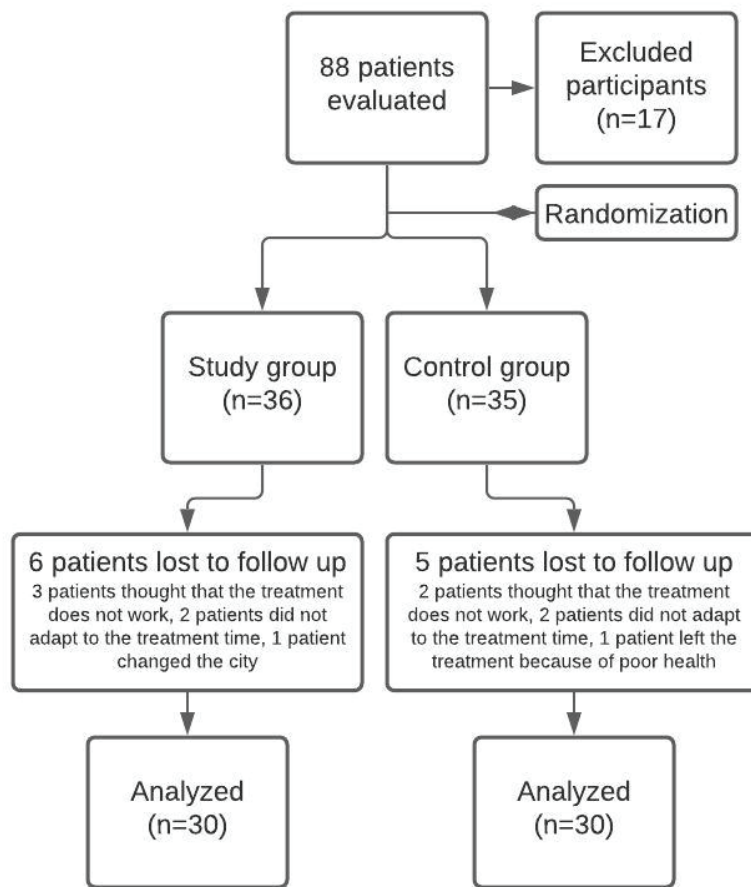
Fig. 1. Flow-chart diagram

(5 days per a week). Twenty minutes of heat application with hotpack, 20 minutes of conventional TENS for pain (Pulse duration: 50 μs, frequency: 100 Hz) and 5 minutes of continuous mode ultrasound for deep heating (at a frequency of 1 MHz, and intensity of 1.5 W/cm^2) were applied to the cervical region. Exercises were comprised of upper-back strengthening (lower and middle trapezius muscles) and upper extremity stretching exercises, isometric neck exercises for cervical flexors, extensors and rotatores, chin-nod for activation of deep cervical flexors, serratus anterior muscle strengthening that were performed for 5 s with 10 repetitions (Rest interval: 3 sec) for both experimental and study groups. Patients performed the exercises 5 days a week during the 3-week intervention period. A neural mobilization treatment protocol was applied to the study group in addition to conservative physiotherapy for 3 weeks (3 days per a week and 4 days in the last week, 10 sessions in total, 10 times for each of three nerves in each sessions). The patients were asked if they had symptoms or not during the nerve mobilization tests. Each neural mobilization was applied for 10 seconds.

Radial nerve mobilization: Elbow extension, shoulder internal rotation, wrist, thumb and fingers flexion and ulnar deviation were performed with the depression of the shoulder girdle while the patient was in the supine position [20] (Fig. 2A).

Median nerve mobilization: Ninety degrees shoulder abduction with shoulder girdle depression, elbow extension, wrist and fingers extension with ulnar deviation were applied while the patient was lying supine position [20] (Fig. 2B).

Ulnar nerve mobilization: Ninety degrees shoulder abduction was performed with shoulder depression while the patient in the supine position, Then, the patient's elbow was brought to 90° flexion, the hand was brought to the ear while the head was rotated the opposite side, and radial deviation movement was applied with the extension of the wrist [20] (Fig. 2C).

Statistical analysis

The SPSS Package Program was used for the statistical analyses (SPSS 23.0 for Windows, Chicago, IL, USA). Normality distribution of the data was analyzed. The numerical data were given as arithmetic mean and

Fig. 2. Application of neural mobilization technique; A: Radial nerve mobilization, B: Median nerve mebolization, C: Ulnar nerve moblization

standard deviations (X±SD). The intra-group comparisons before and after the treatment were analyzed with Paired Sample t-test. In the inter-group comparisons analysis was done by using one way ANOVA test and Bonferroni correction were used to determine the differences amongst the interventions. The statistical significance was set at p < 0.05 [21].

Results

Thirty one (51.6 %) of the individuals were male, and twenty nine (48.4 %) were female. Mean age of all participants was 47.23 ± 12.17 years. Demographic and anthropometric characteristics of both groups are presented in Tab. 1. There were no significant differences in demographic and anthropometric characteristics between the two groups (p > 0.05).

In the study group, it was observed that the tragus-wall and C7-wall distances were significantly decreased after the treatment when compared to the results before the treatment (p < 0.05). The distances were similar in the control group before and after the treatment (p > 0.05). The groups had similar values before the treatment in terms of the tragus-wall and C7-wall distances (p > 0.05). After the treatment, there was a significant difference observed between the groups in terms of tragus-wall distances in favor of the study group (p < 0.05). However, there was no difference in terms of C7-wall distance between the groups after the treatment (p > 0.05) (Tab. 2).

In a comparison of the subjective pain values of the groups before and after the treatment, it was observed that the pain values were decreased in resting, sitting and lying positions, and in all neck movements in both groups (p < 0.05). Pre-treatment pain values didn´t differ significantly in both groups (p > 0.05). After the treatment, it was reported that the pain relief in the study group was more than control group (p < 0.05) (Tab. 3).

It was seen that neck mobility in all directions was increased in both groups before and after the treatment (p < 0.05). Prior to treatment values in neck extension and right rotation active joint mobility were different between groups (p < 0.05). The other active joint movement ranges didn´t differ significantly (p > 0.05). There was no difference between the groups in

Tab. 1. The demographic characteristics of groups

	SG (n = 30) X ± SD	CG (n = 30) X ± SD	F	p
Age (years)	47.17 ± 12.54	47,30 ± 12.02	0.002	0.967
Height (cm)	165.63 ± 7.03	166.50 ± 7.25	0.221	0.640
Weight (kg)	76.73 ± 8.67	78.90 ± 8.87	0.916	0.343
Body mass index (kg/m²)	28.10 ± 4.06	28.61 ± 4.08	0.236	0.629

p < 0.05 is statistically significant, One-way ANOVA, SG: Study group, CG: Control group, X: Mean, SD: Standard deviation.

Tab. 2. The comparison of groups in terms of tragus-wall distance and C7-wall distance before and after the treatment

	Study group (n = 30)		Control group (n = 30)		F		P_b	
	BT X ± SD	AT X ± SD	BT X ± SD	AT X ± SD	BT	AT	BT	AT
Tragus-wall distance	13.20 ± 1.73 $P_{a= 0.001}$	11.57 ± 2.40	13.00 ± 1.51 $P_{a= 0.054}$	12.60 ± 1.45	0.228	4.064	0.635	0.048*
C7-wall distance	7.73 ± 2.02 $P_{a= 0.001}$	6.27 ± 1.20	6.87 ± 1.25 $P_{a= 0.051}$	6.43 ± 1.28	4.001	0.271	0.051	0.605

p < 0.05 is statistically significant, BT: Before treatment, AT: After treatment, X: Mean, SD: Standard deviation, P_a: Paired Sample t-test, P_b: Results from One-way ANOVA test.

Tab. 3. The comparison of groups in terms of neck pain before and after the treatment

	Study group (n = 30)		Control group (n = 30)		F		P_b	
	BT X ± SD	AT X ± SD	BT X ± SD	AT X ± SD	BT	AT	BT	AT
RP	4.77 ± 1.19 $P_{a= 0.001}$	1.93 ± 0.98	5.00 ± 1.23 $P_{a= 0.001}$	3.07 ± 1.20	0.555	16.025	0.475	0.000*
SP	4.83 ± 1.12 $P_{a= 0.001}$	1.93 ± 0.94	4.83 ± 1.23 $P_{a= 0.001}$	2.97 ± 1.13	0.001	14.785	1.000	0.001*
LP	3.67 ± 1.56 $P_{a= 0.001}$	0.90 ± 0.84	4.00 ± 1.36 $P_{a= 0.001}$	1.93 ± 0.98	0.775	19.128	0.382	0.001*
F	4.60 ± 1.67 $P_{a= 0.001}$	1.87 ± 1.14	5.03 ± 1.40 $P_{a= 0.001}$	3.27 ± 1.44	1.182	17.519	0.281	0.001*
E	5.97 ± 1.75 $P_{a= 0.001}$	2.80 ± 1.19	6.10 ± 1.47 $P_{a= 0.001}$	3.83 ± 1.42	0.102	9.387	0.751	0.003*
RLF	4.80 ± 1.30 $P_{a= 0.001}$	2.07 ± 1.14	5.27 ± 1.48 $P_{a= 0.001}$	3.30 ± 1.32	1.682	15.010	0.200	0.001*
LLF	4.70 ± 1.39 $P_{a= 0.001}$	1.77 ± 1.28	5.30 ± 1.47 $P_{a= 0.001}$	3.30 ± 1.34	2.641	20.523	0.110	0.001*
RR	4.03 ± 1.47 $P_{a= 0.001}$	1.43 ± 1.01	4.43 ± 1.30 $P_{a= 0.001}$	2.63 ± 1.22	1.239	17.320	0.270	0.001*
LR	4.03 ± 1.27 $P_{a= 0.001}$	1.30 ± 1.12	4.37 ± 1.38 $P_{a= 0.001}$	2.67 ± 1.27	0.948	19.586	0.334	0.001*

*p < 0.05 is statistically significant, BT: Before treatment, AT: After treatment, X: Mean, SD: Standard deviation, RP: Resting position, SP: Sitting position, LP: Lying position, F: Flexion, E: Extension, RLF: right lateral flexion, LLF: Left lateral flexion, RR: Right rotation, LR: Left rotation, P_a: Paired Sample t-test, P_b: Results from One-way ANOVA test.

Tab. 4. The comparison of groups in terms of joint mobility before and after the treatment

	Study group (n = 30)		Control group (n = 30)		F		P_b	
	BT X ± SD	AT X ± SD	BT X ± SD	AT X ± SD	BT	AT	BT	AT
F	31.53 ± 5.42 $P_{a=0.001}$	37.20 ± 4.86	30.83 ± 5.80 $P_{a=0.001}$	33.30 ± 6.29	0.233	7.227	0.631	0.009*
E	30.57 ± 7.79 $P_{a=0.001}$	35.33 ± 7.05	26.87 ± 5.49 $P_{a=0.001}$	29.10 ± 5.62	4.517	14.327	0.038*	0.001*
RLF	30.90 ± 6.76 $P_{a=0.001}$	36.57 ± 6.11	29.23 ± 5.39 $P_{a=0.001}$	32.13 ± 5.32	1.114	8.986	0.296	0.004*
LLF	32.90 ± 6.06 $P_{a=0.001}$	38.30 ± 5.98	30.23 ± 5.91 $P_{a=0.001}$	32.67 ± 5.88	2.974	13.527	0.090	0.001*
RR	53.87 ± 9.56 $P_{a=0.001}$	61.60 ± 9.73	57.37 ± 8.21 $P_{a=0.001}$	62.33 ± 8.17	2.315	0.035	0.134	0.852
LR	54.27 ± 10.90 $P_{a=0.001}$	62.70 ± 11.20	59.97 ± 9.67 $P_{a=0.001}$	63.00 ± 8.59	4.591	0.014	0.036*	0.908

p < 0.05 is statistically significant, BT: Before treatment, AT: After treatment, X: Mean, SD: Standard deviation, F: Flexion, E: Extension, RLF: Right lateral flexion, LLF: Left lateral flexion, RR: Right rotation, LR: Left rotation, P_a: Paired Sample t-test, P_b: Results from One-way ANOVA test.

Tab. 5. The comparison of groups in terms of Neck Disability Index scores before and after the treatment

	Study group (n = 30) X ± SD		Control group (n = 30) X ± SD		F		P_b	
	BT X ± SD	AT X ± SD	BT X ± SD	AT X ± SD	BT	AT	BT	AT
NDI	18.93 ± 6.43 $P_{a=0.001}$	11.33 ± 6.10	18.93 ± 5.10 $P_{a=0.001}$	13.37 ± 5.74	0.001	1.767	1.000	0.189

p < 0.05 is statistically significant, BT: Before treatment, AT: After treatment, X: Mean, SD: Standard deviation, NGGYA: Nottingham Extended Activities of Daily Living scale, NDI: Neck Disability Index, P_a: Paired Sample t-test, P_b: Results from One-way ANOVA test.

the right and left rotation of active neck movements after the treatment (p > 0.05). It was observed that there was a significant difference in the values of other movements of the neck, and the ranges increased more in the study group when compared to the control group (p < 0.05) (Tab. 4).

An improvement was observed in the intra-group comparisons of study and control groups in terms of NDI scores before and after the treatment (p < 0.05). There was no difference in comparisons of both groups (p > 0.05) (Tab. 5).

Discussion

In this study, in which we investigated the effects of a conservative physiotherapy protocol in addition to neural mobilization treatment on cervical posture, pain, and functionality in patients diagnosed with cervical disc herniation, the positive effect of the treatment on cervical posture, reduction in pain and increase in active range of motion was determined.

The prevalence of cervical disc herniation increases with the degeneration in vertebrae especially after the

age of 40 [22]. Williams et al. stated that neck pain is caused by the degeneration of the discs in individuals of working age [23]. Suzuki et al. evaluated cervical intervertebral discs on the magnetic resonance images of 1059 participants who had neck pain, and they reported that disc degeneration increases with age [24]. In the study conducted by Kim et al., it is argued that cervical disc herniation may result from aging, increased muscle tension and intense work tempo [25]. The average age of the individuals in our study is 47.23 ± 12.17, which is similar to the average age of patients with CDH, mentioned in the literature.

Postural changes in the cervical region due to the pathology or that predispose to pathology are natural. In a study, researchers investigated the anterior tilt, and normal range of motion of the neck in patients with cervical disc herniation. In the study, cervical lordosis between C2-C7 was measured, by means of radiological images, to compare the normal range of motion of cervical rotation, flexion and extension in healthy individuals with the same measurements in individuals with cervical disc herniation. It was reported that the patients with cervical disc herniation had significantly reduced neck range of motion, and increased head anterior tilt when compared to the healthy individuals [26]. Sharma et al. stated in their study, that the postural changes in the cervical region are known to negatively affect the mobility and flexibility of the peripheral nervous system, while neural mobilization can relieve tensions in the myofascial muscle chains to gain normal functionality [13]. In our study, we used tragus-wall distance measurement and C7-wall distance measurement methods to evaluate the cervical posture. After the treatment, the lack of difference in C7-wall distance measurements in both groups may be related to the occurrence of postural changes with longer-term treatments. However, we believe that the decrease in tragus-wall distance in the study group is due to the decrease in pain, the application of stresses at the muscular level during neural mobilization techniques, and that these stresses may contribute to the flexibility of the muscles in this area.

It has been reported that they reduce the symptoms of edema, and demyelination resulting from root pressure of nerve and dysfunction of microcirculation by restoring homeostasis between the neural tissue and surrounding structures. Studies have shown that neural mobilization reduced intraneural edema, increased intercellular fluid flow, reduced hyperalgesia, and induced the immune response. Also, it has been known that neural mobilization techniques are safer and more target-specific compared to tensioning techniques [27–29].

Beneciuk et al. reported that if a specific stretching technique was performed on the median nerve it had a hypoanalgesic effect on pain. The researchers noted that neural mobilization may be effective in reducing pain by inhibition in the dorsal horn [30]. Savva et al. investigated the effect of neural mobilization on pain, functionality, grip strength, and active joint range of motion in the neck. Forty-two patients were divided into two groups, median nerve mobilization was applied in addition to cervical traction, and the control group was not given any treatment. They noted that neural mobilization plus cervical traction improved pain, functionality, grip strength, and neck normal joint range of motion [31]. In a review article about the effectiveness of neural mobilization in neuromuscular disorders Basson et al. noted that neural mobilization affects lower back, neck and arm pain along with nerve root damage, and it is not effective for carpal tunnel syndrome [15]. Kim et al. observed that the effectiveness of the treatment increased when they applied neural mobilization techniques together with another treatment (manual cervical traction) in patients with cervical radiculopathy. They stated increase in pain, joint range of motion, endurance of the deep flexor muscles, and improvement in the endurance scores of the patients [6]. As can be seen in previous studies, neural mobilization technique contributes to the improvement in parameters such as pain, functionality, active joint range of motion. Also in the studies, neural mobilization in addition to conservative physiotherapy increased the effectiveness of the treatment. In our study, similar to the findings in the literature, healings in pain and active joint range of motion were observed in both groups. All other neck movements, except rotational movements, showed improvement in the study group. We believe that longer-term treatments and manual joint therapy methods may be required to gain more range of motion in rotational movements.

Khan et al. compared the effectiveness of neck mobilization and neural mobilization in patients with cervico-brachial pain. At the end of the treatment, there was significant healing in pain values and NDI score in both groups [32]. Ragonese conducted a study in which he compared manual therapy (cervical lateral glide, neural mobilization, thoracal mobilization) with therapeutic exercises (deep neck flexor, trapezius, and serratus anterior muscle strengthening) in patients with cervical radiculopathy. The pain score of the manual treatment group and the score of the NDI were significantly reduced when compared to the therapeutic exercise group. He stated that neural mobilization, which is applied in addition to therapeutic exercises in patients with cervical radiculopathy, will be more effective on pain [33]. Anwar et al. have investigated the effectiveness of cervical treatment. A conservative treatment protocol consisting of cervical traction, hot pack and

isometric neck exercises were applied to both groups. Neural mobilization therapy was applied in addition to the individuals in the study group. The functional status of the participants was measured by the NDI. At the end of the study, there was a significant difference in the NDI score in favour of the neural mobilization group [34]. In fact, the findings of studies confirm that the addition of neural mobilization to the conservative treatment provide a significant benefit for functionality in patients with cervical radiculopathy. However, our study only included short-term measurements. We think that long-term follow up may have revealed significant differences.

It can be said that, 3-week routine conservative physiotherapy protocol applied together with 10 sessions neural mobilization in patients with cervical disc herniation has a positive effect on the cervical posture and pain. These treatment protocol improves the active range of motion of the neck. Therefore, this approach may be used as self-practice to complement standard physiotherapy treatment programs for patients with CDH.

Limitations of the study

Lack of a satisfaction questionnaire for participants that evaluated the applied treatment methods, and the results after the treatment could be recognized as a limitation of our study, and should be considered for future research. There is a gap of a consensus in the literature regarding the frequency and number of repetitions of neural mobilization techniques. In the future studies, we recommend that treatment protocols could be designed by cervical traction, which is most probably would increase the effect of treatment.

Conclusions

In the light of the findings of our study a significant healing score in the NDI scores was observed in both groups if we consider matters in terms of before and after the treatment, while there was no difference in the NDI scores when the groups were compared with each other. This finding was unlike similar studies in the literature. In conclusion, it can be considered that neither of the treatments are superior to each other in terms of functionality. A decrease in NDI scores in both groups may be due to a decrease in pain after the treatment in both groups. Although it is not possible to homogenize patient groups and symptoms completely, the positive effects of neural mobilization on treatment are clear.

Funding

Conflict of interest
The authors declare no conflict of interest.

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