Original Article

The Effects of cervical mobilization and clinical pilates exercises in cervicogenic headache: randomized controlled trial

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ABSTRACT

الأهداف: دراسة آثار تمارين الرقبة (CM) وتمارين البيلاتس السريرية (CPE) في الصداع العنقي (CHA).

المنهجية: أجرينا دراسة بصورة عشوائية على 37 مريضا إلى 3 مجموعات. تم تطبيق CM للمجموعة الأولى، CPE للمجموعة الثانية وCM+CPE للمجموعة الثالثة 3 أيام/أسبوع لمدة 6 أسابيع. قمنا بتسجيل تكرار الألم، وشدة الألم، وعدد المسكنات. أجرينا قياس الوضعية عن طريق تطبيق Posture Screen، ونطاق حركة عنق الرقبة بواسطة جهاز CROM، وتحمل العضلات المثنية العميقة للرقبة بواسطة جهاز الارتجاع البيولوجي المضغوط. تم تطبيق التقييمات مرتين كعلاج ما قبل وبعد.

النتائج: في المقارنة داخل المجموعة، لوحظ انخفاض في معايير الألم، والانحراف الوضعي للرقبة والكتف وزيادة DNFE و CROM في جميع المجموعات (p<0.05). في مقارنة تكرار الألم بين المجموعة، وجدنا اختلاف احصائي مهم في شدة الألم وعدد المسكنات في مجموعات CM وCM+CPE وفقًا لـ CPE (على التوالي، p=0,018، p=0,001، p<0,001). كانت التزوي الرأس والكتف كبيرة في مجموعات CPE وCM+CPE وفقًا لـ CM (على التوالي، p=0,011، p=0.009). كما قمنا بتحديد نطاق الإنحناء الجانبي الأيمن من عنق الرحم للحركة والدوران الأيمن كان بمثابة تغييرات كبيرة في مجموعات CM وCM+CPE وفقًا لـCPE (على التوالي p=0,040، p=0,026). تمت زيادة DNFE بشكل ملحوظ في CM+CPE وفقًا لـ CM وCPE القيمة الإحصائية (p=0.001).

الخلاصة: اظهرت هذه الدراسة فائدة إضافة CM وCPE إلى خطط علاج المرضى الذين يعانون من CHA.

Objectives: To investigate the effects of Cervical Mobilization (CM) and Clinical Pilates Exercises (CPE) in Cervigogenic Headache (CHA).

Methods: The 37 patients were randomized into the 3 groups. The CM for 1st group, CPE for 2nd group and CM+CPE for 3rd group were applied 3 days/a week for 6 weeks. Pain frequency, pain intensity, number of analgesic, were recorded. The posture was measured by Posture Screen application, the cervical range of motion by the CROM device, deep neck flexor muscle endurance by the pressurized biofeedback device. Evaluations were applied 2 times as pre-post treatment.

Results: In within-group comparison a decrease in pain parameters, neck-shoulder postural deviation and an increase DNFE and CROM were observed in all groups (p<0.05). In between-group comparison pain frequency, intensity and number of analgesics were significant changes in the CM and CM+CPE groups according to CPE (respectively p<0,001, p=0,001, p=0,018). Head and shoulder angulation were significant in the CPE and CM+CPE groups according to CM (respectively p=0.009, p=0,011). It was determined that the cervical right lateral flexion range of motion and right rotation were significant changes in the CM and CM+CPE groups according to CPE (respectively p=0,026, p=0,040). DNFE were significantly increased in CM+CPE according to CM and CPE (p=0.001).

Conclusion: This study suggests that it would be beneficial to add CM and CPE to the treatment plans of patients with CHA.

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A cervicogenic headache (CHA) is defined in the International Classification of Headache Disorders as one of the secondary headache types extending from the back of the head and neck to the ear and zygomatic region and having a unilateral, pressing and sometimes throbbing character. The pain can be triggered by mechanical maneuvers. It can last for weeks, starting from a few days, and can significantly affect the quality of life of those affected.[1]

It has been reported that cervical mobility decreases in CHA and muscle functions of the cervical region are adversely impacted.[2,3] In particular, the weakness of the deep neck flexors comes to the fore, and there are studies reporting the presence of anterior tilt posture of the head.[4,5,6] In headache problems, musculoskeletal changes such as spinal mobility, muscle weakness, muscle stiffness, and posture disorders should be evaluated, and appropriate treatment approaches should be applied in light of the results obtained. It has been reported that not evaluating headache from multiple perspectives may result in dissatisfaction with treatment, and multidisciplinary approaches have been suggested.[7]

Studies on the management of CHA recommend manual therapy approaches.[8] Cervical mobilization or manipulation practices may be beneficial for CHA.[9] Studies have examined the effects of upper segment cervical mobilization such as Mulligan SNAG and Maitland's technique.[10] There are studies showing the effectiveness of Cyriax cervical mobilization (CM) in neck pain. The CHA is a pain originating from the neck and in our study, the effectiveness of CM will be examined in CHA. Considering the effectiveness of exercise in CHA, postural correction exercises for the cervical region,[11] cranio-cervical flexion exercises,[12] cervical stabilization exercises,[13] exercises for the deep neck flexors with biofeedback[14] and exercises for strengthening and stretching the neck region[15] come to the forefront. Pilates includes special movements intended to stabilize the joints, strengthens the deep spinal stabilizing muscles, lengthens the spine, increases mind–body awareness and improves posture.[16] The Australian Physiotherapy & Pilates Institute (APPI) has modified clinical pilates exercises (CPE) so that they can be used in the clinic. This method aims to place five elements: lateral breathing, neutral spine position and centering, shoulder girdle placement, rib cage placement, and head-neck placement.[17] In this context, the Pilates method appears to be an alternative for the treatment of musculoskeletal disorders.[18] It was reported that when individuals with CHA stay in a long-term fixed sitting position, postural compliance in the cervical, thoracic, and lumbar spinal segments is lower than that of healthy individuals and headache is triggered.[19] In light of the studies conducted, it is thought that a holistic exercise approach involving the entire spine, such as clinical pilates method, may be more effective in CHA instead of approaches that only concern the cervical region. There is a case series reporting that the pilates exercise program can induce positive effects on disorders related to tension-type headaches.[20] There are no studies on the effects of the CPE method in CHA. The effect of CPE on the deep muscles of the neck, it is our belief that it will reduce headaches by correcting the neck-shoulder posture. The positive effects of CM and CPE on the cervical structures were considered, our study aimed to investigate the effects of these therapeutic interventions.

We hypothesised that the combined use of CM and CPE would be more effective in patients with CHA. The present study aimed to examine the effects of CM and CPE on pain, neck-shoulder posture, cervical range of motion and deep neck flexor muscle endurance in individuals with CHA.

Methods. *Participants and study design.* This study is a prospective and randomized controlled trial. The study was approved by the Clinical Research Ethics Committee of SANKO University in accordance with the Declaration of Helsinki (Session No:2020/04, Decision No:03). This study was registered at Clinicaltrials.gov gov (ID number: NCT05883319 (March 22,2022)).

Consort flow diagram illustrating the participants in the study is presented in **Figure 1**. Patients who presented to the Neurology Outpatient Clinic of Sani Konukoğlu Practice and Research Hospital and were diagnosed with CHA by a specialist were included in the study. Individuals who signed the voluntary consent form and were included in the study were randomly divided into groups using the minimization method, considering their age, sex, and disease duration. Individuals were grouped into the Cervical Mobilization (CM), Clinical Pilates Exercises (CPE) and Cervical Mobilization (CM) + Clinical Pilates Exercises (CPE) treatment groups.

Patients between the ages of 18 and 65 who had been diagnosed with CHA were included in our study. Based on the headache frequency variable of Jull P et all study, 9 people were determined per group by power analysis,

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with α being 5% and power being 80%.[21] When post-hoc power analysis was examined according to the difference pain frequency in within CM groups, the power of the study was found to be 0.99, in within CPE groups 0. 83, within CM+CPE groups 0.99 (G*Power 3.1, Düsseldorf, Germany). Due to the possibility of data loss, it was planned to include 15 people in each group. In line with the inclusion criteria, 46 patients were included in the evaluation. Three out of 9 patients discontinued treatment due to COVID-19 concerns, and the other six patients due to lack of time. The study was finalized with a total of 37 patients.

The inclusion criteria were determined as follows: being diagnosed with CHA, being an adult, and not having received medical (excluding analgesic) treatment or physiotherapy for CHA in the last 6 months.

The exclusion criteria were determined as follows: having undergone headache surgery, having a cardiac, neurological, metabolic, orthopedic history that prevents you from exercising, current or previous malignancy history.

Measurements. All evaluations were performed face-to-face by the same physiotherapist under the same conditions. The evaluations made before pre-post treatment.

First, the demographic data of individuals such as gender, age, body weight (kg), height (cm), and body mass index (kg/m^2) and disease duration(years) were also recorded. In the evaluation of the patients' headache frequency of pain (per month), headache intensity and analgesic use (number/month) were recorded. Headache intensity was evaluated with Visual Analogue Scale (VAS).

The PostureScreen Mobile® (PSM) application was used for posture evaluation. This is a valid and reliable application developed to evaluate posture.[22] Head-neck and shoulder angulation translation values measured via the application were recorded as lateral posture analysis.

Cervical range of motion evaluation was performed with a Cervical Range of Motion (CROM) device which has been measured reliability.[23] The device placed around the head measures the normal range of motion of the cervical region with 3 different inclinometers and a magnetic amplifier placed on the neck. The patients were asked to sit in an upright position in the chair with their arms close to the body. The movements were shown and taught to the patient prior to the evaluation The flexion, extension, right-left lateral flexion and the right-left rotation angle of the head was measured with the relevant inclinometer. Each measurement was repeated 3 times, and the average of 3 repetitions was recorded in degrees.

Deep Neck Flexor Endurance (DNFE) was measured using a pressure biofeedback unit (PBU) which intra-rater and inter-rater reliability has been established.[24] The PBU is a pressure-based measurement device used to evaluate the strength and endurance of the stabilizer muscles by giving a value in millimeters of mercury (mmHg). The patients were positioned supine, with the hands by the trunk, knees bent, lips closed, and head in a neutral position. Prior to the measurement, the patient was taught to perform the cranio-cervical flexion movement by extending the neck without using the superficial flexor muscles and bringing the chin slightly closer to the chest. The best value that he/she could hold for 10 sec in 3 evaluations was recorded.

The PostureScreen Mobile® (PSM) application measurement in A, CROM measurement in B and DNFE measurement with PBU in C are shown in **Figure 2**.

Intervention conditions. All treatment methods were applied by the same physiotherapist under the same conditions. Before the treatment, the patients were informed about the treatment method applied.

Cervical mobilization (CM). Cervical mobilization techniques of Cyriax were applied to one group.[25] Prior to applying CM, the patients were placed in the supine position on the treatment bed. The vertebrobasilar artery test was conducted before mobilization. It was observed that the test result of all patients included in the intervention was negative. The 1)bridging technique 2) manual traction (MT) 3)rotation with MT 4)anterior-posterior gliding with MT 5)lateral gliding 6) trapez muscle manual stretching were applied among CM techniques (Figure 3). CM were applied approximately 10 minutes as 8-10 repetition for each technique.

A CPE program was created, selecting from exercises developed by the APPI. The exercise program of all patients in the group was carried out in the presence of a physiotherapist certified as an exercise instructor by the APPI17.

Firstly, the patients were taught the 5 basic elements of lateral breathing, neutral spine position and centering, shoulder girdle placement, rib cage placement and head-neck placement practically. During the exercise sessions, the patients were guided using verbal and tactile stimuli to ensure the continuity of these basic elements. Each exercise was done with 8-10 repetitions in all sessions.

The CPE programme. A) Upper Back Warm-up B) Dumb Waiter C) Chest Stretch D) Corkscrew D) Upper Body Rolls E) Arm Opening Level 1 F) Double leg stretch Level 1 G) Swan Dive Level 1-3 H) Breast Stroke Prep 1 Level 2 İ) Spine Twist J) Cat Stretch K) Active trapezius stretch (**Figure 4**).

Only CM was applied to the 1st group, only CPE was applied to the 2nd group, and CM and CPE were applied together to the 3rd group. Interventions in all groups were planned three days a week for 6 weeks. All assessments were repeated base line and 6 weeks later.

Statistical analysis. All analyses were conducted using SPSS 25.0 software provided by IBM Corp (Armonk, New York, NY, USA). The normality and homogeneity of the data were evaluated with the Shapiro-Wilk test. Data were expressed as mean ± standard deviation (SD). Categorical variables were presented as percentages. Categorical variables between the groups were compared using the chi-square test. The pre-treatment and post-treatment values within groups were compared with the Wilcoxon test. Changes between the measurement results of evaluation parameters pre-treatment and post-treatment were taken. The Kruskal-Wallis test was used for comparisons between the groups. The level of significance was taken as $p<0.05$ for all analyses.

Results. In line with the inclusion criteria, 46 patients were included in the evaluation. Three patients discontinued treatment due to COVID-19 concerns and the other 6 patients due to lack of time. The study was finalized with a total of 37 patients, 13 in CM group, 12 in CPE group and 12 in the CM+CPE group. As seen in **Table 1**, containing demographic information and disease duration, no difference between the groups was found ($p>0.05$).

Comparisons of outcome measures within and between the groups are shown in **Table 2**.

According to within-group comparison a decrease in pain parameters, neck-shoulder postural deviation and an increase DNFE and CROM were observed in all three groups ($p<0.05$).

Since the baseline values of the individuals differed, pre-post treatment changes were used for comparison between groups.

According to between-group comparison pain frequency, intensity and number of analgesics were found more significant changes in the CM and CM+CPE groups according to CPE (respectively $p<0,001$, $p=0,001$, $p=0,018$). At the same time, head and shoulder angulation were more significant in the CPE and CM+CPE groups according to CM (respectively $p=0.009$, $p=0,011$). It was determined that the cervical right lateral flexion range of motion and right rotation were more significant changes in the CM and CM+CPE groups according to CPE (respectively $p=0,026$, $p=0,040$). The DNFE were significantly increased in CM+CPE according to CM and CPE ($p=0.001$).

Discussion. This study compared the effects of CM and CPE on CHA according to the groups undergoing only CM or CPE. Improvements in headache, posture, CROM and DNFE were observed in all groups after the treatment. However, in the group to which CM and CPE were applied together, it was determined that neck and shoulder postural correctness was achieved more and DNFE increased more.

The results of the present study demonstrated that CM and KPE approaches significantly reduced pain intensity, pain frequency and analgesic use in CHA. It is thought that these approaches relieve headache by reducing stress on cervical structures and increasing blood flow. Primary afferent inputs of the trigeminal nerve and upper cervical nerves converge in the spinal trigeminal nucleus. This anatomical proximity may be the source of CHA. Therefore, reducing the tension on the cervical structures can be effective in reducing headaches.[8]

Guidelines on CHA support the positive impacts of cervical mobilization and manipulation on headaches.[26] Furthermore, there are sources stating that manual and exercise therapy can be used on headache intensity and frequency among patients with cervicogenic headache

Table 1 - Demographics and presence of headache.

	CM (n=13) X±SD	CPE (n=12) X±SD	CM+CPE (n=12) X±SD	p
Age(years)	34.9±9.214	31.75±9.469	30.25±9.016	0.468*
Presence of headache (years)	3.38±2.142	2.67±1.923	3.25±2.454	0.628*
BMI (kg/m^2)	21.432±4.896	24.901±7.1463	20.612±3.946	0.274*
Gender	n (%)	n (%)	n (%)	
Famele	9(%69)	10(%35.7)	9(%75)	0.712†
Male	4(%31)	2(%22.2)	3(%25)	

X:Mean; SD:Standard deviation; BMI: Body mass index; CM: Cervical Mobilization Group; CPE: Clinical Pilates Exercises Group; *Chi-square; †Mann-Whitney U test *p < 0.05

Table 2 - Comparisons of outcome measures within and between groups.

	CM X±SS	p†	CPE X±SS	p†	CM+CPE X±SS	p†	Z	p‡
Pain / Frequency(times month)								
Pre-treatment	13.38±7.54	0.001*	11.17±4.609	0,003*	17.08±10.71	0.002*		
Post-treatment	3.62±2.78		7.92±3.315		3.58±2.99			
Change	9.769±5.433		3.250±1.912		13.5±8.969		15.681	0.000*
İntensity(cm)								
Pre-treatment	5.81±1.18	0.001*	6.15±1.09	0,002*	7.43±1.04	0.002*		
Post-treatment	1.74±1.41		3.75±0.89		1.88±1.14			
Change	4.072±1.076		2.40±0.968		5.55±1.720		20.998	0.001*
Number of analgesic (per month)								
Pre-treatment	12.23±10.94	0,001*	8±4.51	0,002*	13.75±12.70	0.002*		
Post-treatment	2.62±3.30		5.17±3		2.42±2.39			
Change	9.615±8.713		2.833±2.480		11.33±11.36		8.045	0.018*
Posture / Head translation								
Pre-treatment	4.27±3.03	0.002*	3.34±2.74	0.008*	2.66±2.11	0.008*		
Post-treatment	3.38±2.45		1.35±1.54		1.35±2.06			
Change	0.89±0.84		1.98±1.57		1.40±1.10		2.582	0.275
Head angulation								
Pre-treatment	14.62±9.95	0.001*	9.62±6.24	0.002*	12.10±5.03	0.002*		
Post-treatment	12.16±8.24		4.55±3.27		7.63±4.42			
Change	2.45±2.59		5.06±3.37		5.55±3.14		9.405	0.009*
Shoulder translation								
Pre-treatment	2.48±1.61	0.002*	1.43±1.61	0.012*	2.07±1.81	0.008*		
Post-treatment	1.65±1.42		0.425±0.777		1.08±1.17			
Change	0.670±0.428		1.00±0.954		1.39±1.20		2.011	0.366
Shoulder angulation								
Pre-treatment	2.60±1.10	0.001*	1.32±1.36	0.008*	2.72±1.07	0.002*		
Post-treatment	1.11±1.55		0.323±0.482		1.44±1.02			
Change	0.767±0.407		1.00±0.936		1.52±0.563		9.061	0.011*
CROM° /Flexion								
Pre-treatment	37.30±6.84	0.003*	33.33±7.04	0.016*	34.5±6.86	0.011*		
Post-treatment	44.61±5.56		41.92±4.94		44±2.55			
Change	7.307±3.682		8.58±6.41		9.50±6.62		0.284	0.867
Extension								
Pre-treatment	57.46±10.88	0.004*	56.83±9.19	0.026*	58.75±7.41	0,011*		
Post-treatment	64.92±9.4		63.25±7.11		67.33±3.11			
Change	7.46±5.44		6.41±4.83		8.58±5.56		1.297	0.523
R lateral flexion								
Pre-treatment	29.53±4.55	0.003*	32.17±3.88	0.018*	26.83±5.82	0.007*		
Post-treatment	36.30±4.76		37.50±2.27		37.08±2.02			
Change	6.76±2.04		5.33±3.62		10.25±5.67		7.263	0.026*
L lateral flexion								
Pre-treatment	31.38±3.88	0.003*	30.33±3.77	0.002*	27.75±5.73	0.005*		
Post-treatment	36.92±4.40		36.58±2.23		36.41±3.23			
Change	5.53±2.50		6.25±4.474		8.66±5.67		2.019	0.364
R rotation								
Pre-treatment	51.30±6.88	0.003*	52.42±7.66	0.011*	52.91±7.34	0.002*		
Post-treatment	62.53±5.12		59.25±7.32		64.08±3.39			
Change	11.23±5.34		6.83±2.58		11.16±5.06		6.442	0.040*
L Rotation								
Pre-treatment	52.53±5.23	0.002*	54.75±8.04	0.018*	53.16±8.81	0.012*		
Post-treatment	61.76±3.1		61.67±6.86		63.5±3			
Change	9.23±5.68		6.91±4.46		10.33±6.91		1.941	0.379
DNFE(mmhg)								
Pre-treatment	10.77±3.11	0.003*	11.33±4.11	0.008*	10.83±2.32	0.002*		
Post-treatment	16.62±3.30		16.50±4.01		19.83±2.75			
Change	5.84±2.76		5.16±1.58		9±2.17		14.134	0.001*

Mean±Standard deviation (SD), *p<0.05 for p† (within the group) by Wilcoxon test and p‡ (between groups) by Kruskal-Wallis test. CM: Cervikal Mobilization Group; CPE: Clinic Pilates Exercises Group; R: right; L: left; CROM: Cervical Range of Motion; DNFE: Deep Neck Flexor Endurance

The effectiveness of manual and exercise therapy for CHA was evaluated in a systematic review. Studies include exercise methods such as stretching, low load endurance exercises for cervico-scapular muscle, low load and mobility exercise program for the cervical spine, postural correction intervention, ROM home exercises, cranio-cervical exercise.[27] The CPE is an exercise approach based on neutral spine and core stabilization. Especially, neck stabilization is provided by deep neck flexor activation. Scapular stabilization is ensured by activating the rhomboids, trapezius middle-lower part and serratus anterior in the shoulder girdle. In the meantime, the trapezius upper part and pectoral muscles are kept in a long position. This proper posture is tried to be maintained throughout the exercise period. There is no study in the literature in which CPE, an exercise method that takes whole body alignment and posture approach, is used specifically for headaches. Our study will contribute to the literature in this respect. In the present study, a significant improvement was observed in terms of headache parameters with CPE. The results suggest that postural correction with CPE is effective in reducing headache. This study concluded, in line with the literature, that using exercise and mobilization together in the treatment of CHA would be more beneficial.

Forward head posture (FHP) is a common postural problem in individuals with CHA. Protraction in the shoulder girdle is usually observed together with FHP. It is known that these postural deviations result in shortening and muscle weakness in cervical extensors (suboccipital, semispinalis, splenius, and upper trapezius), flexors (longus colli, longus capitus, rectus capitis anterior), sternocleidomastoid and pectoral muscles. Furthermore, the study by Abaspour et al.[28] examined the weakness of deep neck flexor muscles in individuals with CHA by US and showed that the muscle thickness was less.[28] The duty of deep neck flexor muscles in neck stabilization is also important to ensure postural correctness. A study comparing postural changes in the spine after 30 minutes of laptop use in individuals with CHA. Habitual spinal posture degrees of the cervical, thoracic and lumbar spine were analysed using 3D-Vicon motion analysis. It was found that optimal postural adaptation was less in individuals with CHA compared to healthy individuals. It was interpreted that this would increase the rate of encountering musculoskeletal problems.[19] The results of this study show that the head and shoulder posture improve due to the preservation of spinal alignment along the CPE and better activation of the deep neck flexors. Our study results provide an alternative to approaches to correct poor head posture in CHA.

Patients with CHA were reported to have inadequate cervical mobility with a decrease in CROM due to muscle shortening and weakening.[2] In one study, dry needling was applied to the upper trapezius, suboccipital, and SCM regions in patients with CHA versus the group given classical physiotherapy and craniocervical flexion exercises. It was concluded that dry needling might be more successful in reducing the frequency of headaches and increasing CROM and DNFE.[29] Another study in which Mulligan's SNAG mobilization was applied versus cervicoscapular strengthening exercises to patients with CHA reported that SNAG mobilization might be more effective on head and neck pain, but there was no significant difference between the two interventions for CROM.[30] The current studies reported that manual approaches and exercise methods increased the decreased CROM. In parallel with the literature, a significant increase in CROM was obtained with CM and CPE applications in our study. However, it was observed that Cyriax CM was more effective in increasing CROM. According to the results of this study, to increase CROM in CHA, it is recommended to first loosen the soft tissues with CM and then apply CPE.

Deep neck flexor biofeedback and traditional exercise methods were applied to patients with CHA and it was observed that the group to which pressure biofeedback was applied had a significant decrease in pain frequency compared to the control group.[14] Whereas it was reported that mobilization and cervical correction exercises could be used to manage head and neck pain in CHA,[31] it was also stated that craniocervical exercises were effective in correcting neck posture.[32] These studies have demonstrated the effectiveness of exercise approaches that specifically target the deep neck flexors. Our study results similarly showed that CPE increased DNFE. It is thought that with Cyriax mobilization, it becomes easier to activate the deep neck flexors by relaxing the tense muscles. Therefore, in individuals with CHA, DNFE increased more when CM and CPE were administered together in our study.

In the case report we presented earlier, we observed the acute effect of CM on blood flow, muscle stiffness and CROM. In line with the positive results we obtained, we stated that there was a need for randomized controlled trials on the subject.[33] We also observed the positive effects of CM after 6 weeks of treatment with this study. Additionally, by adding CPE to the study, we demonstrated the additive effect of CPE and CM together on neck-shoulder posture and DNFE.

There are studies about neck suggesting the use of CPE in patients with neck pain and sagittal cervical disorientation, but their number is very small. Picak et

al[34] reported that in patients with chronic nonspecific neck pain, CPE is a safe and effective method to improve pain and disability, DNFE, posture, ROM, and proprioception. Hurer et al[35] compared the effectiveness of CPE and home exercises in sagittal cervical disorientation. CPE have been found to provide clinically significant improvements in craniovertebral, head tilt, cervicothoracic angles and strength and DNFE. The clinical effects of pilates exercises on forward head posture were examined by Lee et al. Pilates exercises were found to be more effective in terms of postural correctiveness, neck range of motion and neck muscle fatigue compared to the control group exercise program.[36] This study, which shows effectiveness of CPE on neck-shoulder posture in CHA, a headache of neck origin, contributes to the literature. Leite et al[20] in a case series, it was reported that the clinical pilates program can induce positive effects on pain intensity, daily life function, negative emotional states related to tension type headaches. Studies examining the effect of CPE on headaches are quite limited. Our study is the first study to examine the efficacy of CPE in CHA with secondary headache. More studies examining the efficacy of CPE in headache are needed.

In conclusion, it is impossible to ignore the increase in neck and neck-related diseases due to the use of technological tools. The increase in the amount of analgesics used, especially with chronic pain, also puts a significant burden on the healthcare sector. Additionally, considering the adverse effects of long-term use of analgesics, it is important for human health to develop alternative approaches to reduce pain. Our study contributes to the literature by examining the effect of CM and CPE on pain management and musculoskeletal system effects in CHA. It also offers solutions to some musculoskeletal problems in patients with CHA. Reducing musculoskeletal symptoms in CHA is clinically important. Our study offers alternative approaches to prevent the increase and chronicity of complaints in CHA. There is a need for studies in which long-term results are monitored for these approaches.

In summary, it was found that CM and CPE reduced pain intensity, pain frequency, analgesic use, neck-shoulder posture deviation and increased CROM and DNFE in patients with CHA. It was concluded that CPE applied together with CM might additionally be more effective in achieving neck-shoulder postural correctness and increasing DNFE. It was thought that it would be beneficial to add these physiotherapy approaches to the treatment plans of patients with CHA.

The main limitation of our study is that there was no follow-up for the sustainability of the effectiveness of the interventions. Therefore, it was determined that long-term follow-up studies were needed. Although there is no difference in terms of gender between the groups of individuals included in the study, the unequal gender distribution within the group is one of the limitations of the study. Since our study was conducted in a single center, we were able to reach a limited number of individuals diagnosed with CHA. This is an important limitation of our study. Parametric tests could not be used in statistical analysis due to the small number of individuals with whom the study was completed. Studies with a larger population are needed to demonstrate the efficacy of CM and CPE on CHA. It is also recommended to evaluate the effects of CM and CPE on parameters such as neck pain, neck muscle stiffness, blood flow, and quality of life in future studies on individuals with CHA.

Conclusions. This study showed that the use of CM and CPE alone was effective for the management of CHA. However, it was reported that CPE applied together with CM may be more effective in reducing headache complaints, improving neck-shoulder posture, and increasing DNFE. These applications can be used in patients with CHA.

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