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Increased Forward Head Posture and Restricted Cervical Range of Motion in Patients With Carpal Tunnel Syndrome

Carpal tunnel syndrome (CTS) is a complex musculoskeletal disorder usually associated with localized compression of the median nerve at the location of the carpal tunnel. Atroshi et al[1] reported prevalence rates of 3.8% (95% confidence interval [CI]: 3.1%-4.6%) for women and 2.7% (95% CI: 2.1%-3.4%) for men. Bongers et al[2] have recently reported that the incidence rate of CTS was 1.8/1000 (95% CI: 1.7-2.0).

Although the etiology and pathology of CTS is a topic of debate, evidence exists to suggest that CTS is not exclusively a local neuropathy. Zanette et al[35] reported that 45% of patients with CTS exhibited proximal pain, (ie, pain throughout the upper extremity). Chow et al[6] found that neck pain was present in 14% of patients with CTS. Finally, Reading et al[27] determined that symptoms involving the sensory distribution of the median nerve can be related to neck disorders. Therefore, it seems plausible that the cervical region may also be involved in patients with CTS.

Proper posture is considered crucial for musculoskeletal balance and theoretically involves a minimal amount of stress and strain on the body. One of the most common postural abnormalities identified in clinical setting (66%) is a forward head posture (FHP), which implies that the head is anterior to a line

STUDY DESIGN: Case control study.

OBJECTIVES: To compare the amount of forward head posture (FHP) and cervical range of motion between patients with moderate carpal tunnel syndrome (CTS) and healthy controls. We also sought to assess the relationships among FHP, cervical range of motion, and clinical variables related to the intensity and temporal profile of pain due to CTS.

BACKGROUND: It is plausible that the cervical spine may be involved in patients with CTS. No studies have investigated the possible associations among FHP, cervical range of motion, and symptoms related to CTS.

METHODS: FHP and cervical range of motion were assessed in 25 women with CTS and 25 matched healthy women. Side-view pictures were taken in both relaxed-sitting and standing positions to measure the craniovertebral angle. A CROM device was used to assess cervical range of motion. Posture and mobility measurements were performed by an experienced therapist blinded to the subjects' condition. Differences in cervical range of motion were examined using the nonparametric Mann-Whitney *U* test. A 2-way mixed-model analysis of variance (ANOVA) was used to evaluate differences in FHP between groups and positions.

RESULTS: The ANOVA revealed significant differences between groups (F = 30.4; $P<.001$) and between positions (F = 6.5; $P<.01$) for FHP assessment. Patients with CTS had a smaller craniovertebral angle (greater FHP) than controls ($P<.001$) in both standing and sitting. Additionally, patients with CTS showed decreased cervical range of motion in all directions when compared to controls ($P<.001$). Only cervical flexion (r_s = –0.43; P = .02) and lateral flexion contralateral to the side of the CTS (r_s = –0.51; P = .01) were associated with the reported lowest pain experienced in the preceding week. A positive association between FHP and cervical range of motion was identified in both groups: the smaller the craniovertebral angle (reflective of a greater FHP), the smaller the range of motion (r values between 0.27 and 0.45; $P<.05$). Finally, cervical range of motion and FHP were negatively associated with age in the control group but not in the group with CTS.

CONCLUSIONS: Patients with mild/moderate CTS exhibited a greater FHP and less cervical range of motion, as compared to healthy controls. Additionally, a greater FHP was associated with a reduction in cervical range of motion. However, a cause-and-effect relationship cannot be inferred from this study. Future research should investigate if FHP and restricted cervical range of motion is a consequence or a causative factor of CTS and related symptoms (eg, pain). *J Orthop Sports Phys Ther 2009;39(9):658-664. doi:10.2519/jospt.2009.3058*

KEY WORDS: *CROM, CTS, neck*

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passing through the center of gravity of the body.[12] FHP has been previously identified in patients with neck pain,[13] temporomandibular disorders,[7] postconcussion headache,[31] cervicogenic headache,[34] chronic tension-type headache,[8] and migraine.[10] In addition, restricted cervical range of motion has also been found in patients with tension-type or cervicogenic headache.[36]

It has been reported that there is a significant correlation between cervical spine arthritis and the presence of CTS.[14] Hurst et al[14] reported that the presence of arthritis in the cervical spine may result in compression of the cervical nerve roots, predisposing patients to developing CTS via the "double-crush syndrome." The double-crush syndrome refers to the coexistence of dual compressive lesions along the course of a nerve.[29] This concept hypothesizes that impingement of a peripheral nerve of the upper extremity, for instance the median nerve, may result in a complex clinical presentation in which a single lesion in the course of the proximal portion of a nerve predisposes that nerve to a second lesion further along its distal portion, particularly when it passes through a narrow anatomical canal (eg, carpal tunnel). In agreement with this hypothesis, Pierre-Jerome and Bekkelund[25] demonstrated that patients with CTS experienced a higher incidence of narrowing of the cervical foramen when compared to healthy controls. These authors hypothesized that the compromised neural foramen could potentially lead to nerve compression and possibly a double-crush syndrome in patients with CTS.[25] Accordingly, it is possible that a FHP may compromise cervical nerve roots, rendering the subject more susceptible to developing CTS.

To our knowledge, no researchers have previously investigated the possible connection among FHP, cervical range of motion, and the symptoms associated with CTS. The main purpose of this study was to investigate differences in both FHP and cervical range of motion between patients with CTS and healthy controls. Additionally, a second aim was to investigate the possible relationship among FHP, cervical range of motion, and clinical variables quantifying the intensity and temporal profile of pain due to CTS. Finally, because range of motion has been shown to decrease with age,[20] we also investigated if cervical range of motion and FHP were correlated with age in patients with CTS.

METHODS

Subjects

Consecutive patients diagnosed with CTS presenting to the Neurology Department of the Fundación Hospital Alcorcón were screened for eligibility criteria. Inclusion criteria included both clinical and electrophysiological findings of CTS.[4] A clinical examination was conducted by an experienced neurologist, whereas the electrophysiological findings were assessed by an experienced neurophysiologist. To be included in the current study, patients had to exhibit at least 4 of the 5 following clinical signs during the physical examination: pain and paresthesia within the median nerve distribution for at least 6 months, increasing symptoms during the night, positive Tinel sign reproducing patients' symptoms, positive Phalen sign reproducing patients' symptoms, or self-perceived hand strength deficits.

Additionally, an electrodiagnosis study was performed according to standardized protocols.[23] The following neurophysiologic tests were conducted on both upper extremities of each potential participant: median nerve distal motor latency from wrist to thenar eminence and median nerve sensory conduction velocity from thumb to wrist and from the third finger to the wrist. As suggested by the American Association of Electrodiagnostic Medicine, the American Academy of Neurology, and the American Academy of Physical Medicine and Rehabilitation guidelines,[15] patients with normal standard electrodiagnostic tests (median nerve distal motor latency or median nerve sensory conduction velocities) underwent further comparative (median/ulnar) tests.[22] Sensory and motor conduction studies of radial and ulnar nerves were conducted to rule out radial or ulnar nerve involvement. Patients diagnosed with either moderate (abnormal median nerve sensory latency and abnormal median nerve distal motor latency) or mild (abnormal median nerve sensory latency and normal median nerve distal motor latency) CTS were included in the study. A median nerve distal sensory latency greater than 3.60 milliseconds and a median nerve distal motor latency greater than 4.20 milliseconds were considered as abnormal.[15]

Patients were excluded if they exhibited any of the following: (1) extreme or severe CTS, (2) any sensory or motor deficit for either the ulnar or radial nerve, (3) age older than 65 years, (4) a history of wrist, upper extremity, or cervical spine trauma (whiplash), (5) previous wrist, upper extremity, or cervical surgery, (6) previously received a steroid injection, (7) multiple diagnoses for the upper extremity, (8) a history suggesting systemic disease causing CTS (eg, diabetes mellitus, thyroid disease), (9) pregnancy, (10) a concomitant medical condition (eg, rheumatoid arthritis, fibromyalgia), or (11) involved with or seeking litigation at the time of the study.

Healthy controls were recruited from volunteers who responded to a local newspaper announcement and were excluded if they exhibited a history of upper extremity or head/neck pain, fractures, or any neurological disorder. Healthy controls were matched on the basis of age, hand dominance, and occupation. Matching for age was achieved by individually selecting the control subject with the closest available match for age of the patient with CTS. Hand dominance was controlled by matching the dominant arm, which was defined as the hand that the participants used for writing. Finally, occupation was matched by individually selecting the healthy control with the same occupation to the patient with CTS.

The study was supervised by the Department of Physical Therapy, Occupational Therapy, Rehabilitation, and Physical Medicine of the Universidad Rey Juan Carlos. The project was approved by the local Human Research Committee. All participants signed an informed consent prior to participation.

Self-Report Measures

A numerical pain rating scale[16] (NPRS), with 0 as no pain and 10 as maximum pain, was used to assess the current, worst, and best level of pain experienced in the preceding week. Patients were asked to draw the distribution of their hand pain on an anatomical map.[17] The pain area was calculated (arbitrary units) with a digitizer (ACECAD D9000; Ace Cad Enterprise Co, Ltd, Taipei Hsien, Taiwan).

Further, the Spanish-adapted version[28] of the Boston Carpal Tunnel Questionnaire[19] (BCTQ), a self-report measure of functional limitation and symptom severity, was also used. This questionnaire evaluates 2 domains: (1) the functional status scale, which assesses the ability to perform 8 common hand-related tasks, and (2) the symptom severity scale, which includes 11 items assessing hand pain severity, numbness, and weakness at night and during the day. Each question is answered on a 5-point scale (1, no complaint; 5, very severe complaint), with higher scores indicating greater severity. Each BCTQ score (range, 1-5) is calculated from the average of the score of the individual questions included in each subscale, with higher scores indicating greater severity.[19] The BCTQ has been shown to be valid, reliable, and responsive for patients with CTS.[18]

Cervical Range-of-Motion Assessment

Cervical range of motion was assessed following previously published guidelines[8,10] and measured with a CROM device (Performance Attainment Associates, St Paul, MN). Previous publications have reported intratester reliability ranging from 0.7 to 0.9 and intertester reliability ranging from 0.8 to 0.87 when making measurements using the CROM.[4,24] More recently, intratester reliability ranging from 0.87 to 0.96 and standard error of measurements between 2.3° and 4.1° were reported for measurements on subjects with and without neck pain.[13] Tousignant et al[30] determined that the CROM device showed excellent validity for measurements of cervical rotation when compared to an optoelectronic system (Optotrak; Northern Digital Inc, Waterloo, Ontario, Canada).

Cervical range of motion was recorded in a single direction (flexion/extension, lateral flexion ipsilateral/contralateral to the side of the CTS, and rotation ipsilateral/contralateral to the side of the CTS), as well as the total range of motion for the 3 planes of movement (flexion/extension, lateral-flexion, and rotation), by an experienced therapist blinded to the subjects' condition. Cervical range of motion was evaluated in a relaxed sitting position. Participants were asked to sit comfortably on the chair with both feet flat on the floor, hips and knees in 90° of flexion, and buttocks positioned against the back of the chair. The CROM device was placed on the top of the subject's head with the neck in a neutral position. Subjects were asked to move the head as far as they could without pain in a standard fashion: forward (flexion), backward (extension), right and left lateral flexion, and right and left rotation.[8,10] Two measurements were recorded for each motion, and the mean was used in the statistical analysis.

Forward Head Posture (FHP) Examination

One of the most commonly used methods for assessing FHP is taking a picture of the lateral view of the subject.[9] The base of the camera was set at the height of the subject's shoulder. The tragus of the ear was marked, and a plastic pointer was taped to the skin overlying the spinous process of the C7 vertebra. Once the picture was obtained, it was used to measure the craniovertebral angle (ie, the angle between the horizontal line passing through C7 and a line extending from the tragus of the ear to C7) (**FIGURE 1**). A smaller craniovertebral angle indicates a greater FHP. Raine and Twomey[26] have reported the reliability of this technique to be excellent (ICC = 0.88).

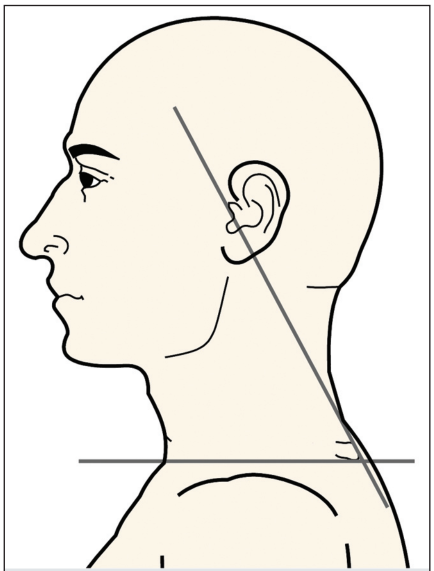

FIGURE 1. Measurement of the craniovertebral angle.

As in previous studies, FHP was assessed in both a relaxed sitting and a standing position.[8,10] For assessing FHP in sitting, participants were asked to sit comfortably on a high-backed chair with both feet flat on the floor, hips and knees at 90° angles, and buttocks positioned against the back of the chair. Subjects were asked to rest their hands on their laps and to keep their shoulders against the back of the chair. They were also instructed to visually focus on a point on the wall directly in front of them. The visual point was confirmed by the examiner after the subject had assumed a comfortable sitting position that would minimize the tendency towards flexion or extension of the neck, while maintaining a relaxed head position. For assessing FHP in standing position, subjects were asked to stand comfortably with their arms resting at the side of the body. Subjects were then instructed to visually focus on a point on the wall directly ahead of them. A picture of the lateral view of each participant was taken in both positions by an experienced

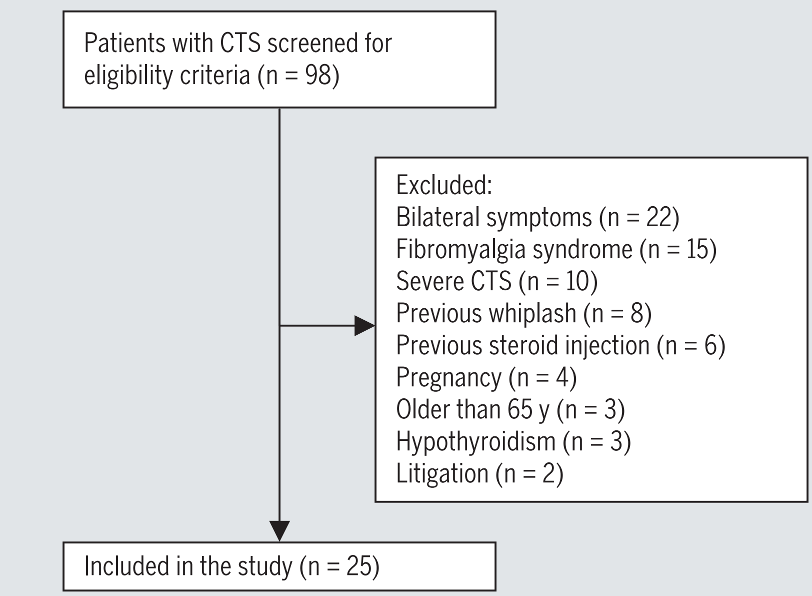

FIGURE 2. Diagram of recruitment of patients with carpal tunnel syndrome (CTS).

physical therapist blinded to the subjects' condition.

Statistical Analysis

Data were analyzed with SPSS, Version 14.0. The distribution of quantitative data was assessed with the Kolmogorov-Smirnov test ($P>.05$). Variables without a normal distribution of data (pain history, pain area, current, less, and worst level of hand pain in the preceding week, and cervical range of motion) were analyzed with nonparametric tests, whereas data with a normal distribution (craniovertebral angle and age) were analyzed with parametric tests.

For the main aim of the study, a 2-way mixed-model analysis of variance (ANOVA) was used to evaluate differences in FHP, with position (sitting or standing) as the within-subject factor and group (patients or controls) as the between-subject factor. In addition, differences in cervical range of motion between groups were assessed with the nonparametric Mann-Whitney *U* test.

Further, the Spearman rho (r_s) test was used to analyze the association between the craniovertebral angle or cervical range of motion and the pain clinical variables (pain history, pain area, and current, lowest, and worst level of pain) within the patient group. Further, the Pearson correlation test (r) was used to analyze the association between FHP and cervical range of motion for each direction in both groups. Finally, the Pearson correlation test (r) was again used to investigate the association between age and both the cervical range of motion and FHP within each study group. In general, a *P* value of less than .05 was considered statistically significant; however, when 2 related comparisons were conducted (flexion/extension, ipsilateral/contralateral lateral-flexions, and ipsilateral/contralateral rotations), a corrected *P* value of less than .025 was used as threshold for significance (Bonferroni correction).

RESULTS

Demographic and Clinical Data

Ninety-eight consecutive patients with CTS between January 2008 and October 2008 were screened for eligibility criteria. A total of 25 women between 22 and 62 years of age (mean ± SD, 41 ± 10 years) satisfied the eligibility criteria and agreed to participate. The reasons for ineligibility can be found in **FIGURE 2**, which provides a flow-diagram of patient recruitment. In addition, 25 matched healthy women without upper extremity symptoms between 21 and 60 years of age (mean ± SD, 41 ± 7 years) were recruited to participate in the study. All participants were right-hand dominant. Current occupations were similar between both groups: desk work (patients, n = 9; controls, n = 10), housewife (patients, n = 5; controls, n = 4), cleaning lady (patients, n = 5; controls, n = 5), and teacher (patients, n = 6; controls, n = 6).

Fourteen patients (56%) presented with right-sided CTS, 5 (20%) with left-sided CTS, and the remaining 6 (24%) had bilateral symptoms. For data analysis we considered the most painful side from patients with bilateral symptoms. Consequently, 4 additional patients were considered to have right-sided CTS and the remaining 2 left-sided CTS. The mean duration of pain was 3.2 years (95% CI: 1.6-4.7), and the pain area was 35.2 arbitrary units (95% CI: 27.0-43.3). The mean current level of pain was 5.2 (95% CI: 4.6-5.8). For level of pain experienced in the preceding week the worst was 7.5 (95% CI: 7.1-7.9) and the lowest was 2.4 (95% CI: 1.8-2.9). Finally, the mean BCTQ functional status scale score was 2.7 (95% CI: 2.4-3.0), and the mean BCTQ symptom severity scale score was 2.9 (95% CI: 2.7-3.1).

Significant positive correlations between duration of symptoms and current pain, worst and lowest level of hand pain experienced in the preceding week, and pain area were identified (all: r_s = 0.8, $P<.001$). No significant correlation between either scale of the BCTQ and clinical pain features was found.

FHP and Cervical Range of Motion

The ANOVA revealed significant differences between groups (F = 30.4, $P<.001$) and between positions (F = 6.5, $P<.01$) for FHP assessment. Patients with CTS had a smaller craniovertebral angle (greater FHP) in both sitting and standing positions compared to healthy controls ($P<.001$). Additionally, the craniovertebral angle was smaller in the sitting position when compared to the standing position for both groups ($P<.01$). Patients with CTS also showed decreased cervical range of motion when compared to controls for all directions ($P<.001$), and also for total range of motion for flexion-extension, rotation ($P<.001$), and lateral-flexion ($P = .02$). The **TABLE** shows the craniovertebral angle and the cervical range-of-motion measurements for both groups.

TABLE — Differences in Neck Mobility and Forward Head Posture in Patients With Carpal Tunnel Syndrome (CTS) and Healthy Controls*

	Patients With CTS	Healthy Controls
Flexion/extension		
Flexion†	47 (44-50)	62 (59-65)
Extension†	66 (62-70)	80 (77-83)
Total†	114 (108-119)	142 (138-146)
Lateral flexion		
Ipsilateral/right†‡	35 (30-39)	40 (37-44)
Contralateral/left†	38 (33-42)	44 (43-45)
Total†	72 (64-81)	84 (80-89)
Rotation		
Ipsilateral/right†	72 (66-77)	81 (77-84)
Contralateral/left†	71 (65-76)	81 (77-85)
Total†	147 (138-154)	162 (155-170)
Craniovertebral angle		
Sitting†	39 (35-43)	48 (45-52)
Standing†	44 (41-47)	52 (49-54)

* *Values are mean (95% confidence interval) degrees.*
† *Significant differences between patients and controls (P<.001).*
‡ *Ipsilateral and contralateral to the side of CTS for those with CTS.*

Correlation Between FHP, Cervical Range of Motion, and Clinical Pain Features

Within the group of patients with CTS, FHP was not associated with any hand pain feature ($P>.3$). Significant negative correlations between the lowest pain experienced in the preceding week and cervical flexion ($r_s = -0.45$, $P = .02$) or lateral flexion contralateral to the side of the CTS ($r_s = -0.51$, $P = .01$) were identified. The range of motion for other cervical movements was not correlated with hand pain clinical features.

Correlation Between FHP and Cervical Range of Motion

Combining the data from both groups, a positive correlation between the craniovertebral angle in the sitting position and cervical range of motion in all directions was found: flexion ($r = 0.3$, $P = .02$), extension ($r = 0.45$, $P<.001$), contralateral lateral flexion ($r = 0.39$, $P = .004$), ipsilateral lateral flexion ($r = 0.27$, $P = .043$), and both rotations ($r = 0.41$, $P = .002$). The smaller the craniovertebral angle, the lower the cervical range of motion. In addition, similar correlations between the craniovertebral angle in the standing position and cervical range of motion were found.

Correlations Between Age, FHP, and Cervical Range of Motion

In patients with CTS, FHP and cervical range of motion were not correlated with age. Conversely, within the control group, FHP was positively correlated with age in both sitting ($r = 0.6$, $P = .02$) and standing ($r = 0.65$, $P<.001$) positions. For the control group, there was a negative correlation between age and cervical flexion ($r = -0.4$, $P = .03$), extension ($r = -0.5$, $P<.01$), and both lateral flexions ($r = -0.4$, $P<.01$; $r = -0.35$, $P<.01$). Age did not seem to influence cervical rotation.

DISCUSSION

The results of our study demonstrated that patients with moderate CTS had a greater FHP and decreased cervical range of motion when compared to healthy subjects. FHP was associated with cervical range of motion, with greater FHP being related to a lower amount of cervical range of motion. However, neither FHP nor cervical range of motion were related to clinical pain features due to CTS.

The results of our study are similar to those that have identified the presence of FHP and restricted cervical range of motion in other populations with musculoskeletal disorders. FHP has been previously identified in patients with different types of headaches. Watson and Trott[34] reported that patients with cervicogenic headaches had a smaller craniovertebral angle (greater FHP) than healthy subjects (mean ± SD, 44.5° ± 5.5° versus 49.1° ± 2.9°; $P<.001$). Treleaven et al[31] found that patients with postconcussion headaches also had a smaller craniovertebral angle (mean ± SD, 46.7° ± 2.8°) than healthy controls (50.7° ± 7.9°). Additionally, Fernández-de-las-Peñas et al[8] reported that patients with chronic tension-type headache exhibited a smaller craniovertebral angle (mean ± SD, 45.3° ± 7.6°) when compared to healthy subjects (54.1° ± 6.3°; $P<.001$). We have also previously identified that the craniovertebral angle was smaller in patients with unilateral migraine (mean ± SD, 42.2° ± 6.4°) when compared to controls (52.6° ± 7.2°; $P<.001$).[10] Our group of patients with CTS also showed a smaller craniovertebral angle, confirming than FHP is present in patients with CTS. Because FHP is also related to other pain conditions,[7,8,10,13,31,34] the change of head posture may be a consequence (ie, an antalgic posture in trying to reduce pain, rather than a possible etiologic factor). This is supported by the fact that neither FHP nor cervical range of motion was found to be related to function nor symptom severity due to CTS in this study. Therefore, a cause-and-effect relationship cannot be established with the current study. Whether FHP and restricted cervical range of motion is a consequence of the pain or a causative factor in patients with CTS requires further investigation.

In a meta-analysis, Chen et al[5] reported the following normative values for cervical range of motion: flexion/extension, 150°-116° (flexion, 69°-48°; extension, 93°-61°); lateral flexion, 108°-76° (1 side, 49°-38°); rotation, 186°-136° (1 side, 93°-70°). Based on these data, most of the subjects (n = 24 [96%]) within the control group were in the upper 50% of the normative values and most of the patients with CTS (n = 22 [88%]) were below normative values. Therefore, we conclude that our healthy control group presented with normal cervical range of motion, and that most of our individuals in the patient group exhibited a decrease in cervical range of motion. Nevertheless, cervical range of motion of 3 patients with CTS (12%) falls within the lower value of 95% CIs of the normative values.

Additionally, cervical range of motion has been shown to decrease with age.[20] We found that cervical range of motion decreased with age in our healthy control group, but not in the patients with CTS. Because the groups were age matched, age cannot explain the decreased in cervical range of motion found in patients with CTS.

A statistically positive correlation was found between FHP and cervical range of motion for all directions: subjects with a greater FHP (ie, smaller craniovertebral angle) showed less cervical range of motion. Our results are in agreement with previous studies which also found that FHP was inversely correlated with the amount of cervical range of motion.[21,33] This is expected, as FHP may lead to compression on the facet joints affecting the biomechanics of the head/neck. However, it should be recognized that, although the correlations were statistically significant, they were low to moderate (0.25-0.45).

Considering the increased FHP and restricted neck range of motion in our sample of patients with CTS, we hypothesize that perhaps treatment directed at the cervical spine may enhance the outcomes of patients with CTS. Preliminary evidence suggests that a therapeutic approach including interventions targeted at the neck region may be helpful in reducing pain and improving function in CTS. Valente and Gibson[32] have reported the outcomes of a patient with CTS who was treated with a multimodal approach including techniques directed at the cervical spine. After 12 treatments, the patient exhibited improvements in grip strength and a normalization of motor and sensory latencies of the median nerve.[32] However, a cause-and-effect relationship cannot be inferred from a case report. Hence, future clinical trials should investigate the effects of treatment directed at the cervical spine in patients with CTS.

There exist a few limitations to the current study. First, we used a relatively small sample size from 1 specialized hospital. Future studies with larger sample sizes should continue to investigate abnormalities of FHP and cervical range of motion and their association with clinical pain features of CTS. Additionally, the results of our study do not allow us to make inferences regarding the clinical relevance of FHP and restricted cervical range of motion in the natural course of CTS. Future trials should investigate if physical therapy management directed at the cervical spine changes the symptoms and severity of CTS.

CONCLUSIONS

Patients with mild or moderate CTS exhibited greater FHP and greater restrictions in cervical range of motion as compared to matched healthy controls. Additionally, FHP was correlated with cervical range of motion: the greater the FHP, the lesser the range of motion. Neither FHP nor cervical range of motion was related to clinical pain features due to CTS. Further research is needed to clearly define the potential role of both FHP and restricted cervical range of motion in both the etiology and the perpetuation of CTS.

KEY POINTS

FINDINGS: Patients with mild or moderate CTS exhibited a greater FHP and less cervical range of motion compared to matched healthy controls. A more pronounced FHP was associated with reduced cervical range of motion. Neither FHP nor cervical range of motion was related to clinical pain features due to CTS.

IMPLICATIONS: Treatment directed at correction of FHP and limitations of cervical range of motion may be worth considering as part of the treatment for individuals with CTS.

CAUTION: We used a relatively small sample size from 1 specialized hospital. The study design does not allow us to make inferences about a cause-and-effect relationship between CTS, FHP, and cervical range of motion.

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