CERVICO-OCCIPITAL POSTURE IN WOMEN WITH MIGRAINE: A CASE-CONTROL STUDY

Gabriela Natália Ferracini[a*], Fabíola Dach[b], Thais Cristina Chaves[c], Carina Ferreira Pinheiro[d], Débora Bevilaqua-Grossi[e], César Fernández-de-las-Peñas[f],José Geraldo Speciali[g]

1)* Doctoral Student, Department of Neurosciences and Behavioral Sciences/Faculty of Medicine of RibeirãoPreto, University of São Paulo – FMRP-USP. Ribeirão Preto, São Paulo, Brazil.

2)Professor, Department of Neurosciences and Behavioral Sciences/Faculty of Medicine of RibeirãoPreto, University of São Paulo - FMRP-USP/Responsible for the Headache and Craniofacial Pain Outpatient Clinic, University Hospital, Faculty of Medicine of Ribeirão Preto, Ribeirão Preto, São Paulo, Brazil.

3)Professor, Department of Neurosciences and Behavioral Sciences/Faculty of Medicine of Ribeirão Preto, University of São Paulo-FMRP-USP / Postgraduate Program of Rehabilitation and Functional Performance. Ribeirão Preto, São Paulo, Brazil.

4)Masters Student, Department of Neurosciences and Behavioral Sciences/Faculty of Medicine of Ribeirão Preto, University of São Paulo – FMRP-USP/Postgraduate Program of Rehabilitation and Functional Performance. Ribeirão Preto, São Paulo, Brazil.

5)Professor, Department of Neurosciences and Behavioral Sciences/Faculty of Medicine of Ribeirão Preto, University of São Paulo – FMRP-USP/Postgraduate Program of Rehabilitation and Functional Performance. Ribeirão Preto, São Paulo, Brazil.

6)Professor, Department of Physical Therapy, Occupational Therapy, Physical Medicine and Rehabilitation of Rey Juan Carlos University, Alcorcón, Spain

7)Senior Professor, Department of Neurosciences and Behavioral Sciences/Faculty of Medicine of Ribeirão Preto, University of São Paulo – FMRP-USP. Ribeirão Preto, São Paulo, Brazil.

*** Corresponding author:** Department of Neurosciences and Behavioral Sciences. Faculty of Medicine of Ribeirão Preto, University of São Paulo.Avenida dos Bandeirantes, 3900 - 14048-900. Ribeirão Preto, SP, Brasil. Tel: +55 16 99750-8011

E-mail adressess: gabiferracini@hotmail.com; fabioladach@yahoo.com.br; thaiscchaves@hotmail.com; carinafp@hotmail.com;deborabg@fmrp.usp.br;

josespeciali@yahoo.com.br; cesarfdlp@yahoo.com.es

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ABSTRACT

Study design: Case-control study.

Objective: To determine the differences in head extension posture between women with migraine and healthy women assessed by radiographic and photographic measures.

Background: Previous studies have assessed forward head posture in patients with migraine using photographs. To date no study has compared postural differences using both radiographs and photographs.

Methods: Thirty-three women (age 32±11.3 years) with migraine and 33 matched controls (age 33±12.6) years old participated. High cervical angle (HCA: the angle formed between the most inferior line from the occipital surface to the posterior portion of C1 and the posterior surface of the odontoid process of C2) and the vertical distance between C0 and C1 (C0-C1) were measured with radiographs, whereas the cranio-vertebral (CV) angle was assessed with photographs using K-Pacs® and Corporis Pro 3.1® software, respectively.

Results: None of the outcomes differed significantly between women with migraine (HCA: 66.8°, 95%CI 64.2-68.1; CV: 46.1°, 95%CI 45.0-47.1; C0-C1: 8.6mm 95%CI 7.7-9.2) and controls (HCA: 67.9°, 95%CI 66.5-69.3; CV: 44.5°, 95%CI 43.2-45.7; C0-C1: 8.7mm, 95%CI 7.9-9.4). Different relationships between the frequency (r=-0.42; P=0.01, R2= 10%) of migraine and the HCA were found.

Conclusion: This study demonstrated that women with migraine did not exhibit forward head posture compared to women with no history of headache in either radiographic or photographic postural analysis. However, there was a weak

association of the frequency of migraine attacks with a variation in the high cervical angle as assessed by radiographs.

Level of Evidence: Differential diagnosis/symptom prevalence, Level 4

Key-words: Headache; Photography; Radiography; Posture.

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Introduction

Posture analysis is usually the first assessment performed by physical therapists[29] in patients with musculoskeletal pain disorders[35] such as mechanical neck pain.[30,36,41] The most common posture misalignment of the cranio-cervical spine is forward head posture (FHP). FHP consists of head protrusion accompanied by extension of the upper cervical spine and flexion of the lower cervical spine[28,37].

The adoption of a FHP during daily activities may lead to muscle imbalances such as increased anterior tension forces, stretching of the anterior neck structures and shortening of posterior neck musculature (suboccipital, semispinalis, spleniis, upper trapezius). These imbalances may potentially result in decrease blood flow, fatigue, tissue damage, and muscle weaknesses, leading to disc degeneration and to myofascial pain[11,30,36,37]. Therefore, these muscle imbalances can lead to muscle remodeling changes and perpetuate the adoption of this posture[11] and the onset of neck pain[11,31,41].

Although migraine headache is mainly related to dysfunction of central pathways, many clinical manifestations are considered peripheral, since peripheral nociceptive stimuli can precipitate a migraine attack. Neck symptoms such as tenderness, weakness, stiffness are often reported by individuals with migraine[7], and it is

estimated that 74% of these patients also suffer from neck pain[4,8,18,23]. In fact, neck pain can be present in the premonitory phase and/or during the migraine attack[23]. In addition, external pressure to sensitive points in the neck can precipitate migraine attacks in some patients[7].

The presence of cervical symptoms in patients with migraine is usually justified by the convergence of the nociceptive afferences from the upper cervical spine nerves (C1-C3) and the trigeminal nerve within the trigemino-cervical complex[5]. This relationship justifies the need to examine head and neck posture in individuals with headaches to determine its potential contribution to pain.

Profile photography is the most frequent method employed in clinical practice and in research[20,21] to determine head/neck posture, due to its low cost, non-invasive nature and objectivity compared to visual assessment[19,22]. Forward head posture is routinely measured using the cranio vertebral angle (CVA), but the reliability of these measurements had been questioned due of the lack of information regarding their psychometric properties[19]. In parallel, radiographic recording is generally considered the gold standard for assessment of the vertebral column[24] due to precision, although it exposes individuals to radiation and it involves higher costs[39].

There has been an increasing interest in the relationship between the presence of FHP in primary headaches, e.g., tension type headache (TTH)[14,16] and migraine[15,17,38], however, no previous study has investigated the postural changes simultaneously as assessed by photographic and radiographic recordings in individuals with migraine. Therefore, the main objective of the current study was to determine the differences in FHP between women with migraine and healthy women assessed by radiographic and photographic measures. Our secondary aim was to

determine whether FHP was associated with the clinical features of migraine including frequency, intensity and duration of the attacks. Thus, our hypothesis was that women suffering from migraine headaches would exhibit greater FHP than healthy women observed in the records obtained with the two different measures.

Methods

Design

A blinded cross-sectional case-control study was conducted. All participants read and signed a consent form prior to their participation. The study was approved by local ethics board of the School of Medicine Ethics Committee of Ribeirão Preto (Process15821-2011).

Participants

The study was conducted on 33 women, aged 18 to 55 years of age, diagnosed with migraine according to the International Classification of Headache Disorders (ICHD-II)[25] by neurologists, and 33 age-matched healthy women without any headache attack in the previous 6 months. Patients with migraine were recruited from a tertiary outpatient clinic specializing in headache, and healthy controls were recruited from the general population. Subjects with the following conditions were excluded: 1, other concomitant headache, e.g. tensional type headache and cervicogenic headache; 2, history of cervical trauma/injury; 3, cervical disc herniation; 4, systemic diseases, e.g., fibromyalgia syndrome; 5, neurological diseases and compressive syndromes; 6, cancer; 7, previous nerve blockades within the previous 6 months before the study; 8, previous physiotherapy intervention during the last year; or, 9, male gender.

The following clinical characteristics of migraine headache were recorded: 1,

time of pain onset (years); 2, frequency of pain (days per month); 3, duration of episodes (hours); 4, intensity of pain attacks during the last 3 months; and 5, intensity of pain at the time of evaluation [numerical pain rate scale, (NPRS) 0-10; 0: no pain; 10: the worst possible pain experienced][6].

Radiographies and photography of cranio-cervical posture were taken from each subject's right side in the same day in different rooms. A profile radiography and photograph of the cervical spine was obtained with participants in a habitual/comfortable position with the head in neutral[22]. A cephalostat was not used in this study. In order to determine the postural system of the subject, the participants were instructed to stand in a relaxed position without their shoes, with feet apart in a comfortable distance, with their eyes looking forward and their teeth in occlusion. Subjects were asked to breath deeply and then exhale normally[20,21,22]. A metal plumb line was positioned beside subjects for a vertical reference. Each procedure is described below

Radiographic Outcomes

All radiographs were obtained by the same technician and was blinded to clinical condition of the subjects. The distance between the X-ray equipment and the photographic film was standardized at 180cm according to the procedure of the radiology hospital service. The imaging technique was static, with subjects remaining still until the radiographic examination was completed. The area of the images included the nasion-sella line to the seventh cervical vertebra (C7) including the body of the vertebrae and spinous processes.

Beforehand radiographic tracings the following points were determined: posterior portion spine, inferior nape line of the occipital bone, posterior surface of

the odontoid process, posterior surface (superior and inferior) of the vertebral bodies of C2, C3, C4, and C7, inferior arch of C1, and mid-point of the posterior superior aspect of C1. The radiographic tracings were done using the software (K-Pacs®) of the X-ray equipment. The posture of the head related to the mid- or lower cervical spine was measured from the tracing of the following angle and distance:

1) High cervical angle (HCA): the angle formed by the intersection of 2 tracings including the McGregor plane (i.e., the most inferior line from the occipital surface to the posterior portion of C1) and odontoid process plane (posterior surface of the odontoid process of C2). The smaller the angle, the greater the extension of the head on the cervical spine26 (FIG. 1A)

2) C0-C1 distance (C0-C1): the vertical distance between C0 and C133. Although there is no normative data of C0-C1, Rocabado and Tapia33 suggested that values raging from 4 to 9 mm do not represent a postural change, since the shorter the C0-C1 distance, the greater the extension of the head on the cervical spine (**FIGURE 1B).**

Photographic Outcomes

Photographs were obtained by the same technician previously trained who was blinded to clinical condition of the subjects. A digital camera (Canon Rebel EOS-300®) was positioned on a tripod at a distance of 4m from the subject and the height of the lens remained in the midpoint of the subject's body[27,32].

All images were analyzed by a second examiner blinded to the clinical condition of the subject using the Corporis Pro 3.1®software (Data Hominis Tecnologia®, Uberlândia, MG, Brazil). The following anatomical reference points were marked: 1, spinous process of C7; 2, occipital bone; and, 3, tragus. Thus, we assessed the

cranio-vertebral (CV) angle, formed by a horizontal line connecting the tragus of the ear to the spinous process of C7: the smaller the angle, the greater the forward head posture (FHP)[33] (**FIGURE 2)**.

Intra-image reliability

Three trials were obtained for the HCA and C0-C1 on each radiographic image. Similarly, 3 trials were also obtained for the CV angle in each photographic image. For statistical purposes, the final value of each angle/distance was calculated as the mean of the 3 trials. After one week, new tracings were performed in 10 radiographic images and 10 photographic images randomly selected for the reliability study. Therefore, three trials were performed on the same image (radiographic and photographic) for calculating intra-rater reliability, and the mean between 2 raters to calculate inter-examiner reliability. The examiners were physical therapists trained to perform the measurements and who were blinded to the clinical condition of the participants.

Statistical analysis

Data were calculated using the SPSS software, version 17 (Chicago IL, USA). A 2-tailed Student t-test for independent samples was used to determine differences in clinical features and cervical posture between both groups.

The intra-class correlation coefficient (ICC)[8] was used for determining intra-rater and inter-rater reliability. For intra-rater reliability, 2 repeated measurements from the same image (radiograph and photograph) were realized, 1-week apart from each other. For inter-rater reliability, the mean between 2 raters was compared. ICC values were classified as follows: <0.4 indicated poor agreement; 0.4 to 0.75 suggest

moderate agreement; and >0.75, excellent agreement[9].

The Spearman rho correlation test was used to analyze the relationships between postural tracings (HCA, CV, C0-C1) and the clinical characteristics of migraine (i.e., frequency, intensity, and duration)[10].

Multiple regression analysis was used to determine the association between head posture and migraine pain. The independent variables for this analysis were the postural tracings, i.e., HCA, CV, C0-C1, and the dependent variables were frequency, intensity and duration of migraine. When performing each regression analysis, one dependent variable was included with the remaining 3 independent variables[34].

The level of significance was set at 5% (P≤0.05) with a 95% confidence interval. In spearman correlation test and for multiple regression analysis, an alpha value adjusted of 0.017 (P≤0.0017) and alpha unadjusted of 0.05 (P≤0.05), were considered, respectively.

Results

A total of 500 subjects were screened over a period of 12 months. Of these, 450 were excluded for the following reasons: other headaches (n=281), other co-morbidities such as fibromyalgia, rheumatoid arthritis or depression (n=139), and no interested in participating in the study (n=14). Thus, a total of 33 women with migraine, mean age 32±11.3 years and 33 women without headache, mean age 33±12.6 years, were included in the current study. The clinical characteristics of the subjects are listed in **TABLE 1**.

There were no statistical or clinical differences between both groups regarding forward head posture (extension of the head) according to all measurements of the

cervical posture as determined either by radiography or photography (**TABLE 2**). Intra- and inter-examiner image-reliability was excellent for all postural tracings (**TABLE 3**).

Migraine frequency was negatively correlated with the HCA (r_s=-0.42; P=0.013): i.e., the higher the frequency of migraine episodes, the lower the HCA (i.e., the greater the extension of the head). Migraine intensity (last 3 month and at the time of evaluation) were not associated with any angle or distance (all, P>0.05)**.**

A multiple regression analysis revealed a significant association between HCA and the frequency (R^2=0.19, R^2adj=0.10, F=2.23, P=0.02) and intensity (R^2=0.12, R^2adj=0.09, F=4.34, P=0.04) of migraine. The coefficient of variation determined that 10% of the variation in the migraine frequency and 9% of the variation in the intensity of migraine was explained by the HCA (**TABLE 4**). Nevertheless, when considered an adjusted alpha level (P≤0.017), no significant association was observed between the HCA and the frequency and intensity of migraine (**TABLE 4**).

Discussion

This is the first study investigating forward head posture (extension of the head on the cervical spine) in women with migraine using simultaneous radiographic and photographic measures. The results demonstrated that women with migraine did not exhibit an increase in head extension as compared to women with no history of headache. These findings agree with those previously found by Zito et al[42] who also did not observe differences in head posture in individuals with migraine. In contrast, Fernandez-de-las-Peñas et al[15] and Ferreira et al[17], using photographic analysis,

demonstrated that individuals with migraine appeared to exhibit forward head posture (FHP) as compared to controls.

FHP is a head/neck postural pattern commonly identified in patients with different types of headache. Fernandez-de-las-Peñas et al[14,16] observed that subjects with episodic and chronic tension-type headache show FHP when compared to healthy controls. Watson and Trott[40] observed FHP in subjects with cervicogenic headache. However, these studies only included photography measurements for determining head posture abnormalities. A recent study was the first one investigating head posture in individuals with cervicogenic headache by using radiography[13]. This study found limited association between general cervical lordosis and pain in this headache population[13]. Discrepancies between previous studies maybe related to the fact that FHP can play a potential different role. For instance, in tension-type headache, muscle imbalances related to FHP[11,28,30,36] may be implicated in the genesis or maintenance of headache[14,16],whereas in cervicogenic headache[13,40] FHP may contribute to joint dysfunctions related to this posture, but its relationship is more indirect.

Our study can be interpreted by two different ways. First, when considered the unadjusted alpha level ($P \leq 0.05$), we found some relation between the frequency of migraine and the HCA: the greater the frequency of migraine attacks the greater the HCA, i.e., the lesser extension of the head on the cervical spine. Moreover, 10% of the variation in migraine frequency and 9% of the variation in migraine pain intensity was explained by changes in the HCA. Secondly, when considered an adjusted alpha

level (P≤0.017), these relationships cannot be considered significant. Hypothetically many other factors, e.g. psychological, physical, or social factors, not explored in this study, can interfere in the variability in the frequency and intensity of migraine. Future studies are needed to explore other variables which can influence these results.

We also did not observe a relationship between the intensity of migraine and the CV angle and C0-C1 distance, suggesting that our study does not support the hypothesis that the forward head posture (head extension on the cervical spine) is an antalgic posture in an attempt to reduce pain. Falla et al[12] found that improvements in FHP were not associated with decrease in pain and disability in individuals with neck pain. Maybe others variables are more important for postural changes rather than pain intensity.

Although we carefully evaluated head posture in relation to the mid cervical spine by two types of recordings, the present study has some potential limitations. First, we only assessed one possible postural misalignment, FHP. Further studies should consider others possible postural misalignment of the neck and thoracic spine. We do not know the clinical role of other cervical postural abnormalities in migraine. Further, we only assessed posture in a standing position, so we do not know if posture in the seated position can be related to migraine. Second, patients were recruited from a tertiary outpatient clinic; hence, it is possible that they represent a specific group of the population with migraine. Third, the regression analysis was done with only 33 participants, therefore it is possible that the analysis did not exhibit proper statistical power. Fourth, other factors possibly contributing for the variability in HCA were not included. Finally, we encourage other studies to determine the validity and sensitivity of the angles measured on photography and radiography.

Conclusion

The present study did not find significant differences in the presence of forward head posture (head extension on the cervical spine) between women with migraine and healthy women as assessed by radiography and photography; however, though weak the frequency of migraine was associated with variations in the high cervical angle as assessed by radiography.

KEY-POINTS

Findings: Women affected by migraine headaches did not exhibit forward head posture compared with women not affected by headaches. There was a weak indication that greater frequency of migraine may be associated with smaller high cervical angle.

Implication: This study suggests that although women with migraine did not, on average, demonstrate forward head posture, head posture may be weakly associated headache frequency.

Caution: We assessed one possible postural misalignment in a limited number of subjects.

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Table 1: Clinical features of the participants*

	Migraine (Mean±SD)	Healthy controls (Mean±SD)	P
Age (years)	32±11.3	33±12.6	0.47
BMI (kg/m^2)	25.5±5.6	26.1±6.4	0.69
Time of disease onset (years)	16.5±12.8	-	-
Headache intensity - NPRS (last 3 months)	7.2±1.8	-	-
Headache intensity - NPRS (time of evaluation, n=19)	5.3±2.4	-	-
Frequency of headache (days/month)	12.9±8.2	-	-
Duration of headache (hours per crisis)	17.3±14.5	-	-
Pain location			
Right Side	14 (42%)		
Left Side	6 (18%)	-	-
Bilateral	13 (40%)		

n: number; BMI: body mass index; NPRS: numeric pain rate scale

* Data are expressed as means ± standard deviations

Table 2: Radiographic and photographic tracings values of patients with migraine and healthy women*

	Migraine Patients	Healthy controls	P
HCA (°)	66.1±5.6	67.9±3.4	0.16
CV (°)	46.1±5.3	44.5±5.1	0.06
C0-C1 (mm)	8.5±3.2	8.7±2.3	0.70

HCA: high cervical angle; CV: cranio-vertebral angle; C0-C1: C0-C1 distance.

* Data are expressed as means ± standard deviations

Table 3: Intra-rater and inter-rater reliability of postural tracings*

	Intra-rater reliability		Inter-rater reliability	
	ICC (SEM)	**95% CI**	**ICC (SEM)**	**95% CI**
HCA (°)	0.96 (1.17)	0.87-0.99	0.88 (2.46)	0.52-0.97
CV (°)	0.93 (1.15)	0.76-0.98	0.99 (0.34)	0.98-1.00
C0-C1 (mm)	0.92 (0.58)	0.67-0.98	0.97 (0.38)	0.90-0.99

HCA: high cervical angle; CV: cranio-vertebral angle; C0-C1: C0-C1 distance; SEM: standard error of the mean; ICC: intra-class correlation coefficient

Data are expressed as means and 95% confidence interval (95% CI)

***** mean of 3 measurements. Images selected at random.

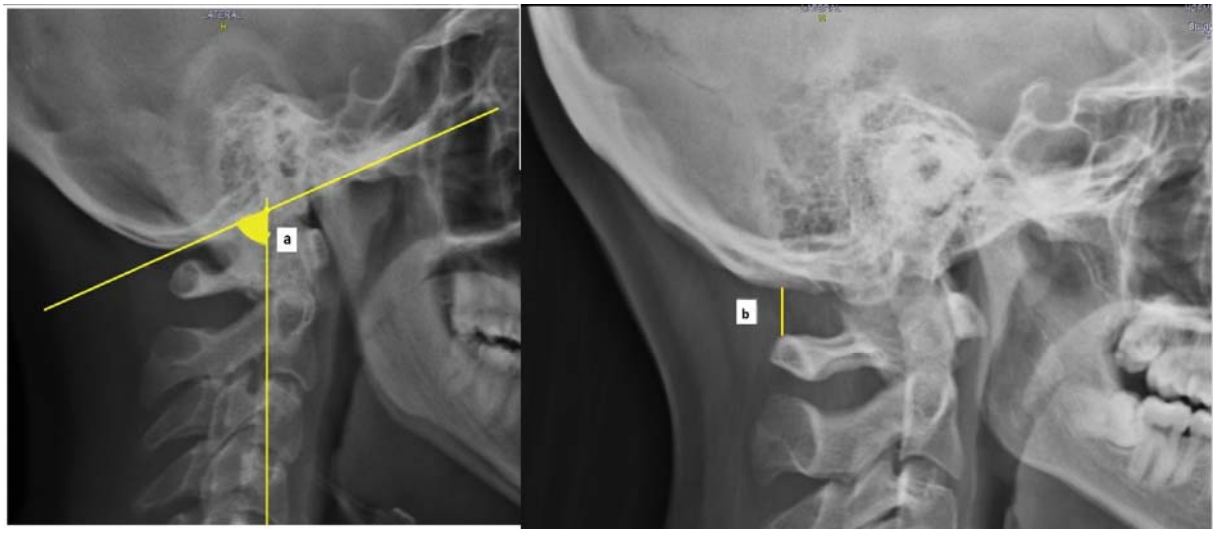
Table 4: Multiple linear regression analysis

Dependent Variable	Independent Variable	R^2	Adjusted R^2	F	P	B	SE B	β	T
	HCA	0.19	0.10	2.23	0.02*	-0.61	0.24	-0.42	-2.52
Frequency	**CV**	0.01	-0.06	0.14	0.87	0.06	0.33	0.03	0.17
	C0-C1	0.01	-0.02	0.25	0.62	0.27	0.54	0.09	0.50
	HCA	0.12	0.09	4.34	0.04*	0.09	0.05	0.35	2.08
Intensity	**CV**	0.13	0.04	1.39	0.76	-0.02	0.06	-0.05	-0.30
	C0-C1	0.12	0.06	2.10	0.94	-0.01	0.10	-0.01	-0.07
	HCA	0.03	-0.01	0.78	0.17	-0.35	0.39	-0.16	-0.89
Duration	**CV**	0.06	-0.04	0.57	0.44	-0.40	0.51	-0.14	-0.79
	C0-C1	0.04	-0.03	0.55	0.38	0.48	0.83	0.10	0.57

HCA: high cervical angle; C0-C1: C0-C1 distance; CV: cranio-vertebral angle; R^2: coefficient of determination, Adjusted R^2: adjusted coefficient of determination, F: frequency, P: P-value, B: slope coefficient, SEB: standard error of the slope, β: β slope coefficient, t: t value.

* Statistically significant only when considered P ≤0.05

Figure 1: Illustrative diagram of the radiographic measurements



a) HCA: High cervical angle: McGregor plane and the odontoid process plane
b) C0 and C1 distance: Inferior point of the occipital base to the posterior arch of C1.

Figure 2: Measurement of forward head posture as represented by the cranio-vertebral angle

Cranio-vertebral angle: line from the spinous process of C7 to tragus of the ear.