Original Article

ACTA FISIÁTRICA
www.revistas.usp.br/actafisiatrica

Patients with chronic migraine present persistent functional disorders in the interictal phase: observational case-control study

Pacientes com migrânea crônica apresentam distúrbios funcionais persistentes na fase interictal: estudo observacional de caso-controle

Maria Ivone Oliveira Dantas[1], Amanda Santos Feitosa[1], Fernanda Mylla Queiroz Ferreira[1], Ingrid Kyelli Lima Rodrigues[1], Itanara Barbosa dos Santos[1], Thais Alves Barreto Pereira[1], Josimari Melo DeSantana[1]

ABSTRACT

Objective: To investigate the presence of functional deficits in people with chronic migraine during the interictal phase, focusing on cervical range of movement, intensity of pain during movement, cervical disability and physical activity levels. **Method:** Observational case-control study carried out with patients with chronic migraine and healthy individuals between January 2019 and March 2020, aged between 18 and 55 years. Cervical range of movement (inclinometer), intensity of pain during movement (Numerical Pain Scale), cervical disability (Cervical Disability Index) and level of physical activity (International Physical Activity Questionnaire) were measured. **Results:** 32 patients with chronic migraine and 32 healthy controls were included. The group with chronic migraine had a lower range of motion in all cervical movements ($p<0.05$), except right cervical rotation ($p= 0.054$), as well as greater pain intensity during extension ($p=0.012$) and right rotation ($p= 0.015$). Cervical disability was significantly higher in the migraine group when compared to the control group ($p<0.001$). The level of physical activity was similar between the groups ($p= 0.839$). **Conclusion:** This study demonstrated that individuals with chronic migraine in the interictal phase present several functional deficits compared to healthy individuals. Specifically, we observed a significant reduction in cervical range of motion, a greater intensity of pain with cervical movement in some cases, and cervical disability ranging from mild to moderate. However, there was no significant difference in physical activity levels between the groups.

Keywords: Migraine Disorders, Range of Motion, Articular, Pain, Neck Pain

RESUMO

Objetivo: Investigar a presença de déficits funcionais em pessoas com migrânea crônica durante a fase interictal, com foco na amplitude de movimento cervical, intensidade da dor ao movimento, incapacidade cervical e níveis de atividade física. **Método:** Estudo observacional do tipo caso-controle realizado com pacientes com migrânea crônica e indivíduos saudáveis entre janeiro de 2019 e março de 2020, com idades entre 18 e 55 anos. Foram medidas a amplitude de movimento cervical (inclinômetro), intensidade da dor ao movimento (Escala Numérica de Dor), incapacidade cervical (Índice de Incapacidade Cervical) e nível de atividade física (Questionário Internacional de Atividade Física). **Resultados:** Foram incluídos 32 pacientes com migrânea crônica e 32 controles saudáveis. O grupo com migrânea crônica apresentou menor amplitude de movimento em todos os movimentos cervicais ($p<0,05$), exceto rotação cervical direita ($p= 0,054$), bem como maior intensidade de dor durante extensão ($p= 0,012$) e rotação direita ($p= 0,015$). A incapacidade cervical foi significativamente maior no grupo com migrânea quando comparada ao controle ($p<0,001$). O nível de atividade física foi semelhante entre os grupos ($p= 0,839$). **Conclusão:** Este estudo demonstrou que indivíduos com migrânea crônica na fase interictal apresentam vários déficits funcionais em comparação com indivíduos saudáveis. Especificamente, observamos uma redução significativa na amplitude de movimento cervical, uma maior intensidade de dor ao movimento cervical em alguns casos, e uma incapacidade cervical variando de leve a moderada. No entanto, não houve diferença significativa nos níveis de atividade física entre os grupos.

Palavras-chave: Transtornos de Enxaqueca, Amplitude de Movimento Articular, Dor, Cervicalgia

[1]Universidade Federal de Sergipe

Corresponding Author
Josimari Melo DeSantana
E-mail: josimelo@academico.ufs.br

Conflict of Interests
Nothing to declare

Submitted: April 23, 2024
Accepted: July 25, 2024

How to cite
Dantas MIO, Feitosa AS, Ferreira FMQ, Rodrigues IKL, Santos IB, Pereira TAB, DeSantana JM. Patients with chronic migraine present persistent functional disorders in the interictal phase: observational case-control study. Acta Fisiatr. 2024;31(3):146-152.

DOI: 10.11606/issn.23170190.v31i3a224224

ISSN 2317-0190 | Copyright © 2024 | Acta Fisiátrica
Instituto de Medicina Física e Reabilitação – HCFMUSP

INTRODUCTION

Migraine is a primary headache, usually unilateral and throbbing, with moderate to severe pain intensity that worsens during physical activity, accompanied by associated symptoms such as nausea, photophobia, phonophobia and osmophobia.[1,2] Didactically, it is divided into two subtypes: migraine without aura and with aura, which is characterized by the presence of transient focal neurological symptoms that usually precede headaches in addition to the other aspects already mentioned.[1]

Chronic migraine may present clinically with or without aura, if it occurs for 15 days or more per month for at least 3 months. It is worth mentioning that migraine is divided into phases, cited in some studies as ictal, which corresponds to the period of attack (premonitory, aura, headache and post-dromic), and interictal, the period between crises.[3] Some studies on migraine have shown changes in brain, cerebellar, and brainstem structures in both phases.[4]

Migraine is the second most disabling neurological disorder worldwide, with a global prevalence of 12%, females being the most affected, and a ratio of 1:3 between men and women.[2,5] In chronic pain, it is expected that patient presents not only a physical dysfunction, but also emotional conditions compromised by the disease.[6] Thus, some epidemiological studies have linked migraine with a predisposition to musculoskeletal disorders.[7-9] A study in women with chronic and episodic migraine showed less cervical rotation compared to a healthy control group.[8]

Only one study showed an association of cervical disability with pain intensity and range of motion in patients with episodic and chronic migraine. This study showed results of severe disability in patients with chronic migraine, but no change in range of motion.[7] In addition, the chronic migraine group had more pain in all movements of the cervical region compared to the episodic migraine group.[7]

In addition, other observational studies have noticed the prevalence of low levels of physical activity related to higher frequencies of episodes of crises, which may also be related to the chronicity of migraine.[6,10] A cross-sectional study analyzed that 67% of participants had both tension-type headache and neck pain associated with a low level of physical activity.[6] On the other hand, the articles present are still scarce and heterogeneous on the presence of functional deficits in the interictal phase of chronic migraine. However, it is extremely important in the clinical practice to know the functional status of the individual with this disease, even though the patient is not in attack (interictal phase) for planning appropriate procedures for the prevention and treatment of possible affections.

Thus, we hypothesized that migraine may cause a reduction in cervical range of motion and a decrease in physical activity levels, in addition to increasing pain on movement and cervical disability even during the interictal phase, presenting functional deficits compared to healthy individuals.

OBJECTIVE

The aim of this study was to investigate the presence of functional deficits in people with chronic migraine during the interictal phase, focusing on cervical range of motion, intensity of pain upon movement, cervical disability and physical activity levels, comparing them with healthy individuals.

METHOD

Study approved by the Ethics Committee in Research with Human Beings of Universidade Federal de Sergipe, participants were included in the study after signing the Free and Informed Consent Term, according to the Resolution 466/12 of the National Health Council.

Setting

Patients and healthy subjects were individually evaluated between January 2019 and March 2020 by a physical therapist with four years of training in the measurement protocols. Recruitment of participants was carried out through publicity on social networks (official pages of the laboratory and its members), advertisements on posters placed in strategic points on the university campus, referral by neurologists and emails sent by the Integrated Activity Management System Academic.

Study design

This is observational case-control study, arm of a randomized clinical trial. The target audience consisted of participants diagnosed with chronic migraine for the case group and healthy individuals for the control group. This study was carried out in accordance with the STROBE (*Strengthening the Reporting of Observational Studies in Epidemiology*).[11]

Participants

In the case group, individuals with a history of chronic migraine diagnosed according to the criteria of the *Headache Classification Committee of the International Headache Society* (IHS) were included, which was performed by a trained neurologist; age between 18 and 55 years and of any sex. Individuals with other types of headaches were excluded; history of head trauma; neurological and/or psychiatric diseases; inability to understand instructions or consent to the study. The recruitment of patients was carried out through a public call on social networks and official institutional websites.

For the control group, healthy individuals, without comorbidities, who did not have frequent headache episodes, of any sex, aged between 18 and 55 years, were accepted. Patients who presented any chronic condition, neurological and/or psychiatric diseases, inability to understand instructions or consent to the study were excluded from the control group. Recruitment of control participants was carried out through an active search and wide dissemination, prioritizing sample matching by sex and age data in relation to the case group.

The evaluation form contained sociodemographic data such as age, height, weight, body mass index, age of onset of migraine attacks, history of current illness, family history, medications used, associated diseases, social history, premonitory symptoms, and triggers recognized by the patient. Both groups tested all variables present in this study and were evaluated by the same evaluator. It is also worth mentioning that individuals with migraine were evaluated during the interictal phase.

Cervical Range of Motion

Range of motion (ROM) corresponds to the amount of movement in degrees,[12] ROM was assessed using an inclinometer

(Sanny®, São Paulo, SP, Brazil) during flexion, extension, right and left rotation and right and left lateral bending.

During the evaluation of flexion, extension and lateral bending movements, the subject was seated, with the feet on the ground and the thoracic and lumbar regions aligned.[13] In the rotation movements, the participant was instructed to position himself in dorsal decubitus, with flexed knees and feet supported for better spinal alignment.

Before each test, the evaluator demonstrated the movement to the participants, to promote familiarization through observation and execution of the movements once before the measurement. Participants were instructed to perform the widest range of active motion possible without compensating movements. Each measurement was performed three times and, later, the arithmetic mean between them was considered. After the first measurement, the intensity of neck pain during movement was evaluated.

Cervical Pain Intensity

Pain intensity is how much the patient reports pain in a given experience.[14] This study used an 11-point numerical scale to assess the intensity of pain in active cervical movement, measured through a score from 0 to 10, with 0 being "no pain" and 10 being "worst imaginable pain", verbally reported by the patient.[15] In chronic painful conditions, this scale has more responsiveness, detecting differences in pain intensity and making a clinically important change the difference of two points or 30% of the initial pain intensity.[16]

Cervical Disability

Cervical disability was assessed using the *Neck Disability Index* (NDI). The NDI is a one-dimensional questionnaire that allows assessing the presence of cervical disability and classifying its severity. This instrument was translated from English and validated in the Portuguese version for Brazil, showing a high degree of internal consistency.[17] The questionnaire consists of 10 items on neck pain, except for item five, which deals with headaches. At the end of the assessment, the severity of cervical disability was classified as mild (5 – 14 points), moderate (15 – 24 points), severe (25 – 34 points) or completely disabling (≥ 35 points).[18]

Physical Activity

Participants' physical activity levels were assessed using the short version of the International Physical Activity Questionnaire (IPAQ-SF). The questionnaire assesses, through seven items, the time spent performing activities of moderate or vigorous intensity, in addition to the time sitting and walking, with validity and reproducibility similar to other instruments internationally used to measure physical activity levels.[19] Recently, the IPAQ-SF has been used in studies on migraine.[6,20-21] The classification of total physical activity levels through the IPAQ short version are very active, active, irregularly active (A and B) and sedentary.

Bias

The study presented more participants than predicted by the sample size calculation, reducing selection bias. To reduce the risk of information bias by the researcher, since the evaluation was performed by a single researcher, all questionnaires were answered by hand by the participants, so the evaluator only answered questions eventually, avoiding any influence. Furthermore, in the ROM assessment, the movements were explained and demonstrated once by the researcher, avoiding information bias by the volunteer.

Study size

The sample size was determined based on the pilot of this study, comprising a sample of 10 participants in each group. The software PEPI-for-Windows (WinPEPI) was used in the Sample Size domain, comparing two groups (radius B:A= 1), using the standard deviation (SD), SD migraine group (A)= 2.96; SD control group (B)= 8.56, of the scores of the variable cervical disability through the Neck Disability Index, assuming a difference of 10 points in the average to generate the minimum difference[7]. Alpha domain was 5% and beta domain was 95%. The required sample consisted of 22 subjects (11 in group A and 11 in group B), with an expected precision of approximately 95% confidence interval (CI) for difference of means (D)= D − 5.474 to D + 5.474.

Statistical analysis

Collected data were transported to a Windows 2015® Excel data sheet, in which descriptive statistics were showed. Values were expressed as mean and standard error of mean or percentage.

All variables were tested for normality using the Shapiro-Wilk test. Data that followed a normal distribution were analyzed using the t test for independent measures, while non-parametric data were compared using the Mann-Whitney test. Categorical variables were evaluated using Fisher's exact test and the chi-square test, according to their specificities.

It is worth mentioning that, in all comparisons, a statistically significant difference was considered when the p value in the analyzes was less than 0.05, indicating a minimal chance of the event occurring due to chance.

RESULTS

Initially, 69 eligible volunteers were triggered by telephone screening from the waiting list. However, 35 participants were excluded for the reasons shown in the Figure 1. Finally, 32 participants were included in the migraine group, being 28 women and 4 men. The control group consisted of 32 volunteers, 28 women and 4 men (p= 0.701).

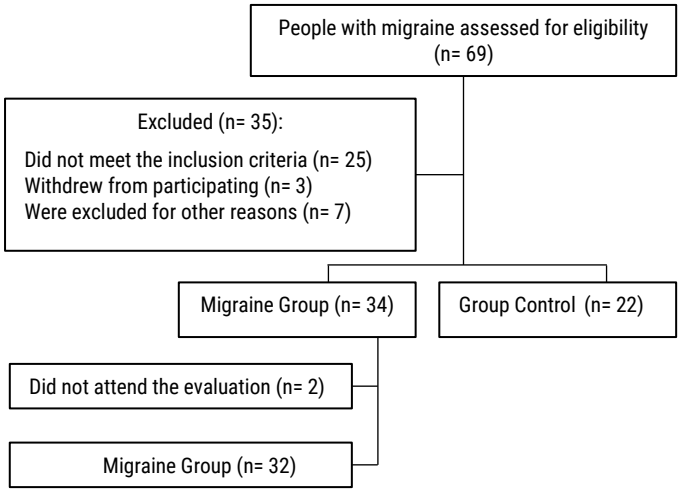


Figure 1. Flowchart of study participants; n: number of individuals per group

To illustrate, the values and general characteristics of the sample were described in Table 1.

Table 1. Characterization of the sample included in the study from June 2018 to March 2020

Variables	Migraine Group (n= 32)	Group Control (n= 22)	p
Sex			
Female	(28/32) 87.5%	(18/22) 81.8%	0.701[c]
Male	(4/32) 12.5%	(4/22) 18.2%	
Age (years)	33,84±1.47	29,27±0.93	0.047*[b]
Weight (kg)	64,64±2.94	66,19±2.13	0.514[b]
Height (m)	1,64±0.01	1,63±0.01	0.713[a]
BMI (kg/m2)	23,73±0.77	24,73±0.73	0.279[b]
Marital status			
Single	(15/32) 46.9%	(15/22) 68.2%	-
Married	(15/32) 46.9%	(7/22) 31.8%	
Divorced	(1/32) 3.1%	(0/22) 0%	
Widower	(1/32) 3.1%	(0/22) 0%	
Education			
Incomplete high school	(1/32) 3.1%	(0/22) 0%	-
Full medium	(10/32) 31.3%	(1/22) 4.5%	
Incomplete higher	(7/32) 21.9%	(3/22) 13.6%	
Graduated	(12/32) 37.5%	(2/22) 9.1%	
Postgraduate studies	(2/32) 6.3%	(16/22) 72.7%	

Data presented as mean, standard error of mean and percentage; n= number of participants per group; BMI= body mass index; a= t test for independent measures; b= Mann-Whitney test for independent measures; c= Chi-square test

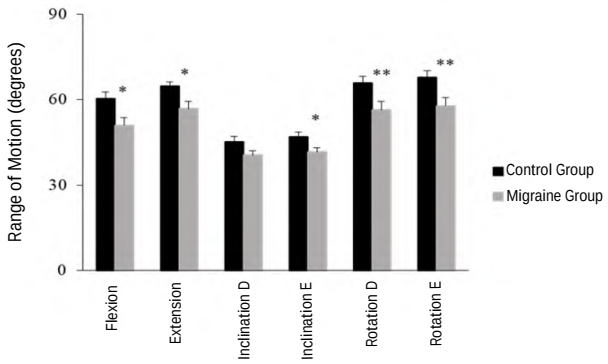
The characteristics related to the migraine attacks of the individuals included in the sample show that, on average, the participants had about 16 days of headache attacks per month, 43% had the presence of aura, and these attacks mostly occur for more than 15 years, with high pain intensity in the last attack and duration of more than 21 hours.

Range of Motion

The group with chronic migraine had lower ROM in all cervical movements compared to the control group, but without statistical significance for the right-bent movement [flexion (CG= 60.45±2.31º and MG= 50.99±2, 76º; p= 0.017); extension (CG= 64.70±1.49º and MG= 56.80±2.52º; p= 0.020); left tilt (CG= 47.04±1.54º and MG= 41.66±1.45º; p= 0.016); right rotation (CG= 65.81±2.48º and MG =56.38±3.08º; p= 0.049); left rotation (CG= 67.95±2.30º and MG= 57.84±2.85º; p= 0.039), and right inclination (CG= 45.31±1.86º; MG= 40.58±1, 52º; p= 0.054)] (Figure 2).

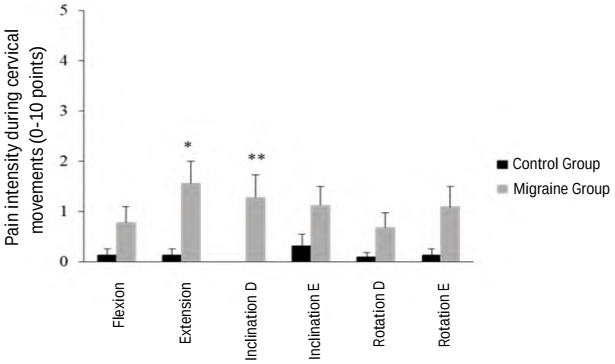
Pain on Movement in the Cervical Region

Pain intensity on motion was significantly higher in migraine than in healthy subjects during cervical extension (MG= 1.56±0.44 and CG= 0.13±0.13; p= 0.012) and right cervical tilt (MG= 1.28±0.45 and CG= 0±0; p= 0.015). In the other cervical movements, there was no statistically significant difference between the groups (p>0.05) (Figure 3).



** Difference during flexion, extension and left bending between migraine group x control group, t-test for independent samples (p<0.05)*
*** Difference during right and left rotation movements between migraine group x control group, Mann-Whitney test for independent samples (p<0.05)*

Figure 2. Range of motion of the cervical region (in degrees) in migraine and control groups. Data expressed as mean and standard error of the mean



** Mann-Whitney test for independent measures. Different from the control group, p= 0.012*
*** Mann-Whitney test for independent measures. Different from the control group, p= 0.015*

Figure 3. Pain intensity during cervical movements measured using an 11-point numerical scale (0-10) between the control group and the migraine group. Data presented as mean and standard error of mean

Cervical Disability

Most patients with migraine had cervical disability ranging from mild (17/32= 53%) to moderate (10/32= 31.3%), followed by severe (3/32=9.4%) and completely disabling (only 1/32= 3.1%). Furthermore, only one participant (3.1%) did not present cervical disability. The migraine group had a significantly higher cervical disability than the control group (p<0.001) (Table 2).

Table 2. Classification of the degrees of neck disability by NDI between the migraine group and the control group included in the study from June 2018 to March 2020

Classification NDI	Migraine Group (n= 32)	Group Control (n= 22)	p
No disability	(1/32) 3.1%	(17/22) 77.3%	<0.001*
Mild disability	(17/32) 53.1%	(5/22) 22.7%	
Moderate disability	(10/32) 31.3%	(0/22) 0%	
Severe disability	(3/32) 9.4%	(0/22) 0%	
Complete disability	(1/32) 3.1%	(0/22) 0%	

Data presented in percentage. n: number of individuals per group. NDI: Neck Disability Index

Physical Activity Level

The level of physical activity was not significantly different between the groups (p= 0.839). The migraine group had a lower percentage of very active participants than the control [CG: 18/32 (81.8%); MG: 23/32 (71.9%)], although no statistical significance was detected. On the other hand, the migraine group had a higher percentage in the active level compared to the control group [CG: 2/32 (9.1%); MG: 5/32 (15.6%)]. Only 3.1% and 6.3% of the migraine group were classified, respectively, as irregularly active A and irregularly active B, while 3.1% were classified as sedentary.

DISCUSSION

The results mostly confirmed the hypothesis that patients with migraine present greater losses in functional aspects when compared to healthy individuals, even in the interictal phase. On the other hand, it was observed that the levels of physical activity were similar between groups, being migraineurs and control individuals, for the most part, classified as active and very active respectively.

First, the range of cervical motion of migraineurs was reduced. In contrast, a case-control study investigating women with chronic and episodic migraine showed lower amplitude only for cervical rotation compared to the healthy control group.[8] Another observational cross-sectional study found no differences in cervical ROM between patients with chronic and episodic migraine.[7]

Thus, studies are heterogeneous for the relationship between migraine and reduction in cervical ROM. This may have occurred due to methodological differences between them, such as the division of groups, type of study and the inclusion of more than one type of migraine in the sample.

In parallel, the migraine group also presented greater intensity of neck pain in movement, but of low intensity, for extension and right inclination. It is worth mentioning the unilateral predominance of headache in migraine, which, hypothetically, could have influenced the pain response.[3] The cross-sectional study by Carvalho et al.[7] found that more patients with chronic migraine had pain on motion compared to patients with episodic migraine, except for flexion.

Furthermore, the study by Florencio et al.[22] showed increased electrical activity of the superficial neck extensor muscles, especially the upper trapezius when acting as an antagonist, during the Craniocervical Flexion Test in women with chronic, but not episodic, migraine. This fact, together with the data of the present study, suggest that the tension caused by sustained hyperactivation of this musculature in chronic migraine can generate pain and limitation of cervical movements.

Another factor is the sensitization in the cervical muscles present in patients with frequent headaches, shown in the systematic review by Castien et al.[23] In line, a study by Florencio et al.[24] observed lower pressure pain threshold in the upper trapezius, suboccipital, sternocleidomastoid, scalenus anterior and elevator scapula muscles in patients with migraine. As this musculature is involved in the movements evaluated in the present study, this relationship favors our results and confirms our hypothesis that migraineurs may present functional deficits in the cervical region in the interictal period.

The present study found that the majority of migraineurs (84.4%) were classified as having mild to moderate cervical disability. In parallel, studies by Carvalho et al.[7] and Florencio et al.[25] showed a higher prevalence of neck pain in chronic migraineurs when compared to episodic patients. Thus, the data corroborate our findings, where it was possible to perceive that neck pain persists in the interictal phase of chronic migraine.

Contrarily to the data found in the previous literature, the present study shows high levels of physical activity in individuals with chronic migraine, since approximately 87.5% reported active or very active levels of physical activity. One review reported that several studies showed an association of low levels of physical activity with higher prevalence and frequency of migraine and other headaches.[10] A cross-sectional study showed that patients who had tension-type headache (TTH), neck pain and coexisting migraine reported a low level of physical activity.[6] This suggests that the low level of physical activity is associated with the coexistence of these conditions.

Another point of view is that the high level of physical activity in the sample may be related to low pain intensity in the migraine group. Current literature shows that regular physical activity can modulate pain through neurophysiological effects, such as the release of endogenous opioids and serotonin in brainstem pain inhibitory pathways.[26,27] As a perspective for future studies, the level of physical activity could be related to pain in migraineurs so that this relationship can be better defined.

Among the limitations of the study, our data need to be used cautiously in translation for the male population, since most of our sample consisted of female patients. In addition, it would have been interesting to have evaluated more aspects, such as the headache predominant side and high cervical mobility with more specific tests, such as the CCFT.[28] These aspects could be compared and included in the assessment of cervical mobility in the study in question. However, the variables were defined based on the prevailing methodology in the literature in the period in which it was started.

Future studies need to take into account a more detailed analysis of musculoskeletal aspects and their relationship with range of motion, since the cervical disability index is based on patient self-report and active range of motion can be influenced by kinesiophobia.[29,30] The predominant side of the headache can also be analyzed in a simple way and associated with kinetic-functional data. Another option is to better study functional aspects in the male population separately.

On the other hand, as strengths we have the characterization of the functional status of chronic migraine during the interictal phase, which can provide more guidance in clinical practice. Furthermore, it was possible to emphasize that the assessment of cervical mobility should include other forms of assessment in addition to range of motion, such as SPN and NDI, for a more accurate kinetic-functional diagnosis. In addition, the study presents methodological rigor and design, in addition to following the recommendations of the STROBE statement, which allows the replication and analysis of our methodological criteria in a concise manner.

The clinical and rehabilitation implications of this study indicate that patients with migraine, even in the interictal phase, may present with reduced cervical range of motion and greater intensity of neck pain on movement. This suggests the need to include assessment and treatment of cervical mobility in rehabilitation plans, using specific instructions to improve range of motion and reduce pain.

Furthermore, neck pain should be addressed as an integral part of migraine treatment, employing pain management techniques

such as manual therapy, exercise, and central sensitization approaches.

The finding of increased levels of physical activity among individuals with chronic migraine suggests that promoting an active lifestyle may have beneficial effects in modulating pain and improving migraine symptoms by taking advantage of neurophysiological effects such as the release of endogenous opioids. and serotonin. Therefore, a multidisciplinary approach that includes mobility and neck pain specifications, along with the promotion of regular physical activity, is essential for the effective management of migraine patients.

CONCLUSION

This study demonstrated that individuals with chronic migraine in the interictal phase present several functional deficits compared to healthy individuals. Specifically, we observed a significant reduction in cervical range of motion, a greater intensity of pain with cervical movement in some cases, and cervical disability ranging from mild to moderate. However, there was no significant difference in physical activity levels between the groups. These findings highlight the need for targeted therapeutic approaches to improve cervical functionality and quality of life in people with chronic migraine.

REFERENCES

1. Headache Classification Committee of the International Headache Society (IHS) The International Classification of Headache Disorders, 3rd edition. Cephalalgia. 2018;38(1):1-211. Doi: 10.1177/0333102417738202
2. Mier RW, Dhadwal S. Primary Headaches. Dent Clin North Am. 2018;62(4):611-628. Doi: 10.1016/j.cden.2018.06.006
3. Maleki N, Szabo E, Becerra L, Moulton E, Scrivani SJ, Burstein R, et al. Ictal and interictal brain activation in episodic migraine: Neural basis for extent of allodynia. PLoS One. 2021;16(1):e0244320. Doi: 10.1371/journal.pone.0244320
4. Ashina S, Bentivegna E, Martelletti P, Eikermann-Haerter K. Structural and Functional Brain Changes in Migraine. Pain Ther. 2021;10(1):211-223. Doi: 10.1007/s40122-021-00240-5
5. GBD 2016 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet. 2017;390(10100):1211-1259. Doi: 10.1016/S0140-6736(17)32154-2
6. Krøll LS, Hammarlund CS, Westergaard ML, Nielsen T, Sloth LB, Jensen RH, et al. Level of physical activity, well-being, stress and self-rated health in persons with migraine and co-existing tension-type headache and neck pain. J Headache Pain. 2017;18(1):46. Doi: 10.1186/s10194-017-0753-y
7. Carvalho GF, Chaves TC, Gonçalves MC, Florencio LL, Braz CA, Dach F, et al. Comparison between neck pain disability and cervical range of motion in patients with episodic and chronic migraine: a cross-sectional study. J Manipulative Physiol Ther. 2014;37(9):641-6. Doi: 10.1016/j.jmpt.2014.09.002
8. Ferracini GN, Florencio LL, Dach F, Bevilaqua Grossi D, Palacios-Ceña M, Ordás-Bandera C, et al. Musculoskeletal disorders of the upper cervical spine in women with episodic or chronic migraine. Eur J Phys Rehabil Med. 2017;53(3):342-350. Doi: 10.23736/S1973-9087.17.04393-3
9. Luedtke K, Starke W, May A. Musculoskeletal dysfunction in migraine patients. Cephalalgia. 2018;38(5):865-875. Doi: 10.1177/0333102417716934
10. Amin FM, Aristeidou S, Baraldi C, Czapinska-Ciepiela EK, Ariadni DD, Di Lenola D, et al. The association between migraine and physical exercise. J Headache Pain. 2018;19(1):83. Doi: 10.1186/s10194-018-0902-y
11. Malta M, Cardoso LO, Bastos FI, Magnanini MMF, Silva CMFP. Iniciativa STROBE: subsídios para a comunicação de estudos observacionais. Rev Saúde Pública. 2010;44(3):559–65. Doi: 10.1590/S0034-89102010000300021
12. Pourahmadi MR, Bagheri R, Taghipour M, Takamjani IE, Sarrafzadeh J, Mohseni-Bandpei MA. A new iPhone application for measuring active craniocervical range of motion in patients with non-specific neck pain: a reliability and validity study. Spine J. 2018;18(3):447-457. Doi: 10.1016/j.spinee.2017.08.229
13. Florêncio LL, Pereira PA, Silva ER, Pegoretti KS, Gonçalves MC, Bevilaqua-Grossi D. Agreement and reliability of two non-invasive methods for assessing cervical range of motion among young adults. Rev Bras Fisioter. 2010;14(2):175-81.
14. Chiarotto A, Maxwell LJ, Ostelo RW, Boers M, Tugwell P, Terwee CB. Measurement Properties of Visual Analogue Scale, Numeric Rating Scale, and Pain Severity Subscale of the Brief Pain Inventory in Patients With Low Back Pain: A Systematic Review. J Pain. 2019;20(3):245-263. Doi: 10.1016/j.jpain.2018.07.009
15. Ferreira-Valente MA, Pais-Ribeiro JL, Jensen MP. Validity of four pain intensity rating scales. Pain. 2011;152(10):2399-2404. Doi: 10.1016/j.pain.2011.07.005
16. Farrar JT, Young JP Jr, LaMoreaux L, Werth JL, Poole MR. Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. Pain. 2001;94(2):149-158. Doi: 10.1016/S0304-3959(01)00349-9
17. Cook C, Richardson JK, Braga L, Menezes A, Soler X, Kume P, et al. Cross-cultural adaptation and validation of the Brazilian Portuguese version of the Neck Disability Index and Neck Pain and Disability Scale. Spine (Phila Pa 1976). 2006;31(14):1621-7. Doi: 10.1097/01.brs.0000221989.53069.16
18. Pietrobon R, Coeytaux RR, Carey TS, Richardson WJ, DeVellis RF. Standard scales for measurement of functional outcome for cervical pain or dysfunction: a systematic review. Spine (Phila Pa 1976). 2002;27(5):515-22. Doi: 10.1097/00007632-200203010-00012
19. Matsudo S, Araújo T, Matsudo V, Andrade D, Andrade E, Oliveira LC, et al. Questionário Internacional de Atividade Física (IPAQ): Estudo de Validade e Reprodutibilidade no Brasil. Rev Bras Ativ Fís Saúde. 2001;6(2):05-18.

20. Aguila MR, Rebbeck T, Pope A, Ng K, Leaver AM. Six-month clinical course and factors associated with non-improvement in migraine and non-migraine headaches. Cephalalgia. 2018;38(10):1672-1686. Doi: 10.1177/0333102417744360
21. Krøll LS, Hammarlund CS, Linde M, Gard G, Jensen RH. The effects of aerobic exercise for persons with migraine and co-existing tension-type headache and neck pain. A randomized, controlled, clinical trial. Cephalalgia. 2018;38(12):1805-1816. Doi: 10.1177/0333102417752119
22. Florencio LL, Ferracni GN, Chaves TC, Palacios-Ceña M, Ordás-Bandera C, Speciali JG, et al. Analysis of Head Posture and Activation of the Cervical Neck Extensors During a Low-Load Task in Women With Chronic Migraine and Healthy Participants. J Manipulative Physiol Ther. 2018;41(9):762-770. Doi: 10.1016/j.jmpt.2018.07.002
23. Castien RF, van der Wouden JC, De Hertogh W. Pressure pain thresholds over the cranio-cervical region in headache: a systematic review and meta-analysis. J Headache Pain. 2018;19(1):9. Doi: 10.1186/s10194-018-0833-7
24. Florencio LL, Giantomassi MC, Carvalho GF, Gonçalves MC, Dach F, Fernández-de-Las-Peñas C, et al. Generalized Pressure Pain Hypersensitivity in the Cervical Muscles in Women with Migraine. Pain Med. 2015;16(8):1629-34. Doi: 10.1111/pme.12767
25. Florencio LL, Chaves TC, Carvalho GF, Gonçalves MC, Casimiro EC, Dach F, et al. Neck pain disability is related to the frequency of migraine attacks: a cross-sectional study. Headache. 2014;54(7):1203-10. Doi: 10.1111/head.12393
26. Sluka KA, O'Donnell JM, Danielson J, Rasmussen LA. Regular physical activity prevents development of chronic pain and activation of central neurons. J Appl Physiol (1985). 2013;114(6):725-33. Doi: 10.1152/japplphysiol.01317.2012
27. Sluka KA. How does physical activity modulate pain? Pain. 2017;158(3):369-370. Doi: 10.1097/j.pain.0000000000000792
28. Bragatto MM, Bevilaqua-Grossi D, Benatto MT, Lodovichi SS, Pinheiro CF, Carvalho GF, et al. Is the presence of neck pain associated with more severe clinical presentation in patients with migraine? A cross-sectional study. Cephalalgia. 2019;39(12):1500-1508. Doi: 10.1177/0333102419854061
29. Benatto MT, Bevilaqua-Grossi D, Carvalho GF, Bragatto MM, Pinheiro CF, Straceri Lodovichi S, et al. Kinesiophobia Is Associated with Migraine. Pain Med. 2019;20(4):846-851. Doi: 10.1093/pm/pny206
30. Gil-Martínez A, Navarro-Fernández G, Mangas-Guijarro MÁ, Lara-Lara M, López-López A, Fernández-Carnero J, et al. Comparison Between Chronic Migraine and Temporomandibular Disorders in Pain-Related Disability and Fear-Avoidance Behaviors. Pain Med. 2017;18(11):2214-2223. Doi: 10.1093/pm/pnx127