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ARTIGO ORIGINAL

Intra and inter-rater reliability of ultrasonographic evaluation of longus colli muscle in women with migraine

Confiabilidade intra e interexaminadores da avaliação ultrassonográfica do músculo longo do pescoço em mulheres com migrânea

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Resumo

Objetivo: Determinar a confiabilidade intra e interexaminadores das medidas ultrassonográficas do músculo longo do pescoço em mulheres com e sem migrânea. *Métodos*: Trata-se de um estudo transversal, avaliando 20 mulheres com idade entre 20 e 24 anos (22 ± 2). Foram realizadas duas avaliações ultrassonográficas da área de secção transversa (cm^2) do músculo longo do pescoço, em repouso e em contração com intervalo de uma semana entre elas, por dois examinadores cegos. Para análise estatística, foram utilizados o coeficiente de correlação intraclasse (ICC) e os limites de concordância. *Resultados*: A confiabilidade intraexaminador do grupo com migrânea, em repouso e contração, foi excelente à direita e moderada à esquerda; no grupo sem migrânea variou de excelente (0,93) no repouso, à pobre (0,35) na contração. A confiabilidade interexaminadores foi excelente (ICC > 0,75) à direita e à esquerda, no repouso, em ambos os grupos. Na contração, variou de moderada (ICC = 0,71), no lado esquerdo no grupo sem migrânea, à excelente (ICC > 0,75) nas demais mensurações. Foram observados baixos limites de concordância dos intervalos de confiança em todas as medidas. *Conclusão*: Foram observados baixos limites de concordância, de acordo com o intervalo de confiança, na confiabilidade das medidas ultrassonográficas do músculo longo do pescoço em mulheres com migrânea.

Palavras-chave: transtornos da enxaqueca, músculos do pescoço, ultrassonografia, reprodutibilidade.

Abstract

Objective: To determine intra and inter-rater reliability of ultrasonographic measures of the longus colli muscle in women with and without migraine. *Methods*: This is a cross-sectional study involving 20 women aged between 20 and 24 years (22 ± 2). Two ultrasonographic assessments, conducted one week apart by two blind examiners, were made of the cross-sectional area (cm^2) of the longus colli muscle, at rest and in contraction. Statistical analysis used the intraclass correlation coefficient (ICC) and limits of agreement. *Results*: Intra-rater reliability in the group with migraine, at rest and in contraction, was excellent on the right and

moderate on the left; in the group without migraine it ranged from excellent (0.93) at rest to poor (0.35) in contraction. Inter-rater reliability was excellent (ICC > 0.75) at rest on the right and left, in both groups. In contraction, it ranged from moderate (ICC = 0.71) on the left in the group without migraine to excellent (ICC > 0.75) in the other measurements. Low limits of agreement were observed for the confidence intervals in all the measures. *Conclusion*: According to the confidence interval, low limits of agreement were observed, regarding the reliability of ultrasonographic measures of the longus colli muscle in women with migraine.
Key-words: migraine disorders, neck muscles, ultrasonography, reliability.

Introduction

Ultrasonography image processing is a noninvasive low-cost method commonly used in clinical practice that analyzes muscle dimensions at rest and in contraction [1,2], providing support for clinical decisions [3,4]. For this reason, this method was used in a number of studies to determine the association between the presence of chronic neck pain and alterations in dimensions and neck muscle activation [5,6]. However, no studies were found until this moment assessing the reliability of the data obtained from neck muscles of individuals with migraine using this tool.

In this respect, evidence shows the involvement of peripheral nociceptive stimuli in migraine pathogenesis. Nociceptive sensory stimuli from convergent afferences of a range of tissues, including tense and painful muscles in the neck region, innervated by cervical nerve roots, could contribute to activation of the trigeminovascular inflammatory cascade [7,8] and trigger migraine [9].

From a biomechanical viewpoint, the deep neck flexor muscles, primarily the long muscle of the head and the neck, play an important role in stabilizing this segment. Thus, imbalances between these muscles and superficial neck muscles make the spine less stable and more vulnerable to other balance forces that act in maintaining posture, thereby generating overload in other muscles [10] and consequently changes in muscle trophism.

Thus, the development of studies with the inclusion of ultrasound evaluation is increasing. Despite the findings, and since it is an operator-dependent assessment instrument whose results can vary in repeated measures or with a change in examiner, it is necessary to assess the intra and inter-rater reliability of this resource. Therefore, the present study aims to determine the intra and inter-rater reliability of ultrasonographic measures of the longus colli muscle in women with and without migraine.

Methods

Design and study site

This cross-sectional study was conducted at the Department of Physiotherapy of Universidade Federal de Pernambuco, between March and December 2013, after approval was obtained from the Research and Ethics Committee (CAAE: 02219412.5.0000.5208). The sample size was not calculated because this is a pilot study. All participants gave their informed consent, in accordance with resolution 466/12 of the National Research Ethics Commission of the Ministry of Health.

Participants

The sample was composed of 20 female students from the Physiotherapy Program at Universidade Federal de Pernambuco, aged between 20 and 30 years, avoiding the biases related to the process of muscle changes resulting from natural biological aging. Furthermore, only nulliparous and nulligravida women were included in the sample, once the existence of a relationship between hormones and the presence of headache is well-established [11]. The women were diagnosed by a neurologist, in accordance with International Classification of Headache Disorders, 2nd edition criteria (2004) [12], and separated into a migraine and control group (women without migraine).

The migraine group was composed of women with episodic migraine (less than 15 days per month with headache), with the following characteristics: pure migraine (with aura, without aura or both), whose pain has pulsed character, unilateral location, intensity ranging from

moderate severe, lasting 4-72 hours, that worsens with physical activity and may be associated with the presence of nausea, photophobia or both and phonophobia. The control group included participants diagnosed with other types of headache or had intermittent headache attacks over their lifetime that were not associated with features of migraine [12].

The following women were excluded: 1) body mass index ≥ 30, because currently it is assumed obesity as a risk factor for triggering migraine attacks [13]; 2) chronic migraine, chronic tension headache; chronic neck pain; myopathies; fibromyalgia; abnormalities, fractures or history of spinal or thoracic surgery; symptomatic herniated disc; rheumatoid arthritis; history of spinal cord tumors; 3) score ≥ 15 on the Neck disability index whose purpose is to assess the functionality of the cervical region and how much pain this segment influence in carrying out daily activities. Their values range from 0 (no disability) to 50 (full disability). Values above 15 represent moderate disability [14]; 4) score ≥ 36 on the Beck depression inventory, instrument whose purpose is to assess depressive symptoms in the population, containing 21 items with scores ranging from 0 to 3 depending on the intensity and maximum score of 63. Values represent ≥ 36 severe depression; 5) score ≥ 30 on the Beck anxiety inventory, that is a questionnaire composed of 21 questions related to common symptoms of anxiety and a maximum score of 63. Values ≥ 30 indicate severe anxiety [15]. All questionnaires present version adapted and validated for the Brazilian population.

Procedures

Two examiners (1 and 2), blind to the diagnosis of headache, conducted ultrasonographic assessment of the longus colli muscle. During data collection participants could not be menstruating or using medication such as muscle relaxants, painkillers or anti-inflammatories, in the 48 hours before the exam.

Ultrasonographic assessment

An Aloka 1500 ultrasound system with a 7.5 MHz linear transducer was used. Images of the longus colli muscle were obtained bilaterally, applying a gel between the transducer and the skin. The transducer was positioned longitudinally in the anterior region of the neck, parallel to the trachea, approximately 5 centimeters from the midline and at the C5-C6 level [10], a position in which there is no overlap between the longus colli and long head muscles [16]. In the ultrasonography image the longus colli muscle is bordered inferiorly and medially by the vertebral body, laterally by the carotid artery, and superiorly by the retropharyngeal space [10].

Ultrasonography was performed with the participant in dorsal decubitus, knees flexed, arms alongside the body and head positioned on the midline [6]. The B-mode was used to capture and measure the cross-sectional area (in cm^2), considered the greatest distance between the inner edge of muscle extremities, without including facial contours in the measure [10].

Subjects were assessed by examiners 1 and 2, trained under the same protocol and ultrasonographic measuring techniques. For the inter- rater reliability study, three measures of the cross-sectional area were obtained bilaterally, during rest and muscle contraction, by examiner 1. Twenty minutes after conclusion of the test, examiner 2 repeated the same procedure. For the intra- rater reliability study, examiner 1 conducted a second assessment one week later, following the same protocol, in order to decrease the possibility of data memorization.

Data processing and analysis

Using the SPSS Statistics Program, the Anova test was applied at a 95% confidence level ($p < 0.05$). Analysis of inter and intra-rater reliability was carried out using the intraclass correlation coefficient (ICC). Values below 0.4 suggest poor reproducibility, between 0.4 and 0.75 moderate reproducibility and above 0.75 excellent reproducibility [17]. Inter and intra-rater error was obtained by the Bland Altman method, using the SigmaPlot program and limits of agreement.

Results

In accordance with diagnosis of headache, 12 participants were assigned to the migraine group, 10 of whom suffered from migraine without aura, one from migraine with aura and another from migraine without aura and tension headache. The control group was composed of women with episodic tension headache (n = 4) and without primary headache (n = 4). The characteristics of the study population are presented in Table I.

Table II shows that the dimensions of the longus colli muscle did not differ between groups (p > 0.05).

Table III shows the intra-rater reliability of the longus colli muscle at rest and in contraction in the groups with and without migraine. Excellent reliability (ICC > 0.75) was observed for the right cross-sectional section, at rest and in contraction, in both groups. The left side exhibited moderate reliability in the migraine group. In the group without migraine, reliability was weak during contraction (ICC = 0.35) and excellent at rest (ICC = 0.93).

The results of inter-rater reliability are described in Table IV. At rest, reliability was excellent on the right and left, in both groups (ICC > 0.75). However, during contraction reliability was moderate (ICC = 0.71) on the left side in the group without migraine and excellent for the other measures.

The results of intra and inter-rater reliability are described in tables III and IV. Low levels of agreement were observed in both analyses.

Table I - *Characteristics of participants.*

Variables	Groups (M ± SD/ IC)		p*
	Migraine (n = 12)	Control group (n = 8)	
Age (years)	22 ± 1 (21.43-23.57)	22 ± 2 (20.83-24.17)	1.0
Height (m)	1.63 ± 0.06 (1.59-1.67)	1.63 ± 0.03 (1.60-1.65)	0.302
Weight (kg)	63 ± 8.31 (57.52-68.09)	58.7 ± 8.66 (51.47-65.95)	0.921
BMI	23.6 ± 3.5 (21.30-25.8)	22 ± 3.49 (19.12-24.97)	0.358

*Anova. M ± SD/ IC (mean ± standard deviation/confidence interval); m (meters); kg (kilograms); BMI (Body mass index).

Table II - *Intergroup analysis of the cross-sectional area of the longus colli muscle during rest and contraction.*

		Longus colli muscle					
		Left			Right		
		Groups			Groups		
	Measure	Migraine (n = 12)	Control (n = 8)	p*	Migraine (n = 12)	Control (n = 8)	p*
Examiner 1	CSA rest	0.52 ± 0.13 (0.43-0.61)	0.52 ± 0.11 (0.42-0.62)	0.956	0.54 ± 0.16 (0.44-0.63)	0.55 ± 0.14 (0.43-0.67)	0.851
	CSA contraction	0.43 ± 0.13 (0.34-0.52)	0.43 ± 0.09 (0.36-0.51)	0.976	0.44 ± 0.15 (0.34-0.54)	0.47 ± 0.11 (0.37-0.57)	0.642
Examiner 2	CSA rest	0.45 ± 0.16 (0.35-0.56)	0.49 ± 0.14 (0.36-0.61)	0.657	0.48 ± 0.21 (0.34-0.62)	0.55 ± 0.10 (0.46-0.63)	0.444
	CSA contraction	0.46 ± 0.14 (0.36-0.55)	0.48 ± 0.14 (0.35-0.61)	0.738	0.45 ± 0.16 (0.33-0.57)	0.51 ± 0.13 (0.40-0.62)	0.440

*Anova. Data are expressed as M±SD/ IC (mean± standard deviation/ confidence interval); CSA (cross sectional area - cm^2).

Table III - *Intra-rater reliability of the longus colli muscle cross-sectional area in women with and without migraine. (see PDF).*

Table IV - *Inter-rater reliability of the longus colli muscle cross-sectional area in women with and without migraine. (see PDF).*

Discussion

In this study, the intraclass correlation coefficient was adequate, ranging from moderate to high. On the other hand, the confidence intervals showed lower limits of agreement, based on

the Bland-Altman analysis. However, there is a lack of studies evaluating a priori what are the limits that could be interpreted as acceptable.

The different methodologies used in the ultrasound evaluation of the cervical muscles make comparisons between the studies limited. Many of them do not present the agreement analysis values, only evaluating the intraclass correlation coefficient [18]. One study [5], evaluating patients with chronic neck pain, corroborates our findings related to the ICC analysis of the cross-sectional area of the longus colli muscle at rest (ICC in our study: 0.68 to 0, 93). The results of this study [5] showed the ICC values ranging from 0.76 to 0.93, indicating excellent reproducibility.

On the other hand, in our study the results of the limits of agreement analysis were smaller. Similar findings were observed when assessing the reliability and validity of ultrasonographic measurements of the cross-sectional area of the long neck muscle in healthy volunteers [16].

Given that it is an operator-dependent assessment, ultrasonography is subject to bias, which may be one of the reasons for the low limits of agreement observed in this study, especially inter-rater agreement. These biases include equipment resolution, examiner training, accurate identification of anatomic sites [1,19], levels of participant adiposity [20] and a number of individual factors that can influence the accuracy of the measures, such as adequate muscle relaxation [19].

Due to the complexity in obtaining ultrasonographic images, even though the examiners received identical training to apply the test, the fact that they were not specialists in image diagnosis may have contributed to the low limits of agreement. It is probable that the reliability of the measures potentially improves with the continuous practice of the evaluators [4]. Furthermore, since it has been found that intra-rater reliability is greater than inter-rater reliability, it is likely that examiners will agree more with their own data in a same procedure than with those of other examiners [21].

Another factor that could explain the low levels of intra-rater reliability agreement in this study is participant stability. To control this bias, during data collection subjects could not be menstruating or using medication that might interfere in their mobility or the state of tension in the cervical region. Nevertheless, after a one-week interval between the two tests, factors such as the presence of pre-menstrual tension and acute neck pain may have influenced the stability of participants and consequently the different muscle measures.

On the other hand, a comparison between our findings and those of another study [10] shows the use of reliability analysis without including limits of agreement or calculating the reliability limits for the limits of agreement. Moreover, a number of current studies report results based on statistical significance, providing limited information on clinical relevance [22]. This may represent a bias, since it forces a correlation which might in fact not be true [23].

In addition, the differences in limits of agreement should be assessed clinically [24,25]. A number of authors suggest that an acceptable difference be established before the study [26]. In this respect, despite the wide variation in limits of agreement, to date there are no studies establishing a minimum important difference in neck muscle dimensions in subjects with migraines and their healthy counterparts.

In the present study, the sample was composed of young adult women with primary headache, while other studies analyzed older women (30 ± 6 years) diagnosed with chronic neck pain. It is known that after the age of 30 years there may be a progressive reduction in the cross-sectional area of the muscle [27-29] as a result of the aging process. Furthermore, chronic neck pain may be accompanied by muscular atrophy [30,31], possibly explaining the differences between the findings of our study and suggesting greater correlation between alterations in neck muscles and the process of pain chronification, as occurs in the aging process or in conditions such as chronic migraine and chronic neck pain, than in headache pathogenesis.

One of the aims of a rapid assessment, harmless and inexpensive, such as ultrasound, is the clinical applicability. Thus, our contribution is the use of ultrasonography in the clinical examination of neck muscles, guiding physiotherapeutic interventions in patients with headache. The study shows the importance of determining a priori the magnitude of changes outside the limits of the variability of measurement from the neck muscle in women with migraine. It also reveals the need to establish the minimum significant difference in neck muscles dimensions in individuals with and without migraine. Furthermore, this is a pioneering study that analyzed the reliability of ultrasonographic measures of neck muscles in individuals suffering from migraine, including the limits of agreement.

This study has some limitations. Due to the necessity to control some factors that could influence participant stability and, consequently, muscle changes during the retest, it was not possible to get a sample with larger and more homogeneous distribution between groups. The irregular distribution of the sample between groups was due to difficulty in forming the control group based on the criteria established in our methodology. Added to this, because it is a pilot study analyzes interpretations are more restricted.

Conclusion

Low levels of agreement were observed in relation to inter and intra-rater reliability of ultrasonographic measures of the longus colli muscle in women with and without migraine.

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