Evaluation of Postural Balance and Articular Mobility of the Lower Limbs in Chronic Neck Pain Patients by Means of Low-Cost Clinical Tests

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Abstract

Objective: The purpose of this study was to correlate measurements of chronic neck pain with the balance and mobility of the lower limbs and to compare these variables between individuals with chronic neck pain and asymptomatic participants.

Methods: This was a blinded cross-sectional study. Participants with chronic neck pain (n = 30) and asymptomatic participants (n = 30) were included in the study. To measure pain in the neck region, the Numeric Rating Scale, Neck Disability Index, and Pain-Related Catastrophizing Thoughts Scale were applied. The assessment of postural balance and mobility of the lower limbs was made using the Timed Up and Go Test, Functional Reach Test (FRT), Lateral Reach Test, and 30-second Chair Stand Test.

Results: No statistically ($P > .05$) and clinically ($d < 0.50$) significant differences were identified for the variables tested here. However, regarding the correlations, a significant association was identified only between the intensity of pain during cervical movements and FRT ($r = -0.312$).

Conclusion: Young adults with chronic neck pain present changes in static balance measured by means of the FRT; that is, the higher the intensity of pain, the lower the anteroposterior excursion of the body during the execution of the test. (J Manipulative Physiol Ther 2018;41:658-664)

Key indexing terms: *Neck Pain; Musculoskeletal Pain; Postural Balance*

Introduction

Neck pain is a musculoskeletal dysfunction characterized by a high prevalence, functional consequences and negative implications on quality of life.[1,2] The repercussions of neck pain are not exclusively limited to the region where the pain is located because previous studies have identified negative consequences on sensorimotor control.[3]

The cervical region is intimately related to postural control and stability. Previous studies point to the close relationship between sensorimotor control and head and eye position, as well as stimuli from the vestibular and visual systems.[3-5] Specifically, with respect to postural stability, some studies have been performed on patients with chronic and traumatic lesions,[6-9] using technological resources for such purposes.

Jørgensen et al[6] identified, by means of a force platform, that postural balance is altered in workers with neck pain, with the finding of slower postural responses. Using the same assessment instrument, Quek et al[7] reported that older adults with neck pain present with altered balance compared with healthy individuals, with a decreased ability to recruit the muscular proprioceptive system. Schieppati et al[8] used an electromyography and dynamometric platform to indicate that neck muscle fatigue alters postural control. Field et al[9] used a force platform and identified balance deficits in patients with idiopathic and whiplash-induced neck pain.

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However, to date and despite these scientific initiatives,[6-9] no studies have used low-cost instruments with good applicability in clinical practice to identify possible changes in the balance of patients with chronic neck pain. In view of this, the objective of the present study was to correlate measurements of chronic neck pain with the balance and mobility of the lower limbs. In addition, comparisons were made between individuals with chronic neck pain and asymptomatic participants.

The hypothesis of this study is that known alterations in the postural balance of individuals with chronic neck pain identified by means of evaluations performed with technological resources, such as in the use of a force platform, can also be identified by validated, reliable and low-cost clinical tests, thus supporting the use of these methods in the practice of professionals working in rehabilitation.

Methods

This was a blinded cross-sectional study. The researcher responsible for assessing postural balance did not know which group the participants belonged to. Participants were recruited from communities close to the institution where the study was performed (Clinical School of Physiotherapy of the Tiradentes University Center, Maceió, AL, Brazil) by means of verbal dissemination, posters, and the Internet. All participants in the study validated their participation by signing the informed consent form. All study procedures were approved by the research ethics committee of the Tiradentes University Center (protocol number 60587416.0.0000.5641).

The calculation of the sample was performed using the Ene Software, Version 3.0 (Autonomous University of Barcelona, Barcelona, Spain). The sample size was calculated based on a study conducted by Quek et al.[7] Dynamic balance was measured using the Timed Up and Go (TUG) test as the outcome variable. The calculation was based on the detection of differences of 1.04 seconds between the groups, assuming a standard deviation of 1.30 seconds. Thus, considering a statistical power of 80% and α of 5%, a number of 26 volunteers per group was estimated. Considering possible sample losses, a number of 30 volunteers were established for each group.

The present study was composed of 2 groups: individuals with chronic neck pain and asymptomatic participants. The inclusion criteria for the first group were individuals of both sexes, sedentary, aged between 18 and 45 years, and with a history of chronic neck pain (for more than 90 days) not radiating to the upper limb.[10] Neck pain was identified according to the following criteria: Neck Disability Index (NDI) $\geq$ 5 points and Numeric Rating Scale (NRS) $\geq$ 3 at rest or during active cervical movement.[11]

The exclusion criteria adopted in the present study were volunteers who presented a history of cervical trauma; surgery on the head, face, cervical, upper and lower limbs; cervical hernia; diagnosis of degenerative diseases of the spine; had undergone physiotherapeutic treatment in the last 3 months; use of analgesics, anti-inflammatories or muscle relaxants in the last week; presence of systemic diseases; medical diagnosis of fibromyalgia; signs and symptoms of musculoskeletal or joint disease in lower limbs with or without neurologic involvement; and changes in postural balance as a result of vestibulopathies or cerebellar diseases.

For the group of asymptomatic individuals, men and women without neck pain, sedentary, and aged between 18 and 45 were recruited. The exclusion criteria adopted for this group were the same as for participants with chronic neck pain.

In both groups, individuals who reported not performing any type of regular physical activity in the last 12 months were considered sedentary. In addition, the Baecke questionnaire was applied to accurately quantify the degree of sedentarism of the participants.[12] To measure pain in the neck region, the following instruments were applied: NRS, NDI, and Pain-Related Catastrophizing Thoughts Scale.

The NRS is a simple and easy-to-measure scale consisting of a sequence of numbers (0-10), in which 0 represents ”no pain” and 10 represents ”worst pain you can imagine.” Thus the participant framed his or her pain according to these 2 extremes.[13] The degree of pain was evaluated with the participant in the resting condition and after active movements of the cervical spine for flexion, extension, rotations, and lateral inclinations.

The NDI was used to measure pain-related neck disability. It consists of an instrument adapted and validated for the Brazilian population,[14] composed of 10 questions that investigate neck disability and pain. For each question, it is possible to indicate 1 of 6 answers, corresponding to scores 0 to 5, with total score varying between 0 and 50 points.[15]

The Pain-Related Catastrophizing Thoughts Scale was used for pain-related catastrophic evaluation, adapted and validated for the Brazilian population by Sardá Junior et al.[16] The scale is composed of 9 items staggered on a Likert scale ranging from 0 to 5 points associated with the words ”almost never” and ”almost always” on the extremities. The total score is the sum of the items, divided by the number of items answered, and the minimum score can be 0 and maximum 5. There are no cutoff points, with higher scores indicating greater presence of catastrophic thoughts.

The assessment of postural balance and mobility of the lower limbs was made using the TUG, Functional Reach Test (FRT), Lateral Reach Test, and 30-second Chair Stand Test. The order of application of the tests was defined by means of a draw on the day of the evaluation.

The TUG was used to evaluate dynamic balance and mobility, as validated by Podsiadlo and Richardson,[17] and the time spent in the course of 3 meters was quantified. It was clarified to the participant that this was a timed test and that the goal was to walk as quickly as possible without running. Initially the participant was sitting in a chair with upright posture, hands on thighs and feet resting on the ground; then, through signaling the researcher, the participant got up from the chair, walked as quickly as possible, walked around a cone that marked the 3 meter point, returned to the chair, and sat down again. Three measurements were performed, with an interval of 1 minute between them, and the mean was considered for the statistical analysis. Smith et al[18] established acceptable test–retest reliability values for this evaluation.

The FRT was applied to measure the limits of stability when the individual was standing, reflecting on the static balance, as validated by Duncan et al.[19] Based on the description of Silveira et al,[20] the participant was instructed to adopt the following position: standing barefoot, with the dorsal region perpendicular to the wall, with the feet parallel in a comfortable position, without touching the wall, with the shoulder flexed at 90° and the elbow extended. The hand was closed. A tape measure was attached to the wall, parallel to the floor, positioned at the height of the participant's acromion. The initial measurement corresponded to the position where the third metacarpal was on the measuring tape. The participant was then instructed to lean forward as much as possible without losing balance or taking a step. The displacement on the tape of the dominant upper limb was checked. Three replicates were made and the mean of these was recorded for the statistical analysis. Lin et al[21] established acceptable levels of reliability for this instrument considering different examiners and different times.

The Lateral Reach Test was applied to identify the mediolateral limit of postural stability, according to Brauer et al.[22] As described by Silveira et al,[20] the participant was instructed to adopt the following position: standing barefoot, with the dorsal region parallel to the wall, parallel feet at a distance of 10 cm between the medial heel region, each foot at an angle of 30° outward without touching the wall, abduction of the dominant arm at 90°, and the elbow and fingers extended. A tape measure was positioned as described previously for the FRT. The initial measurement corresponded to the position of the third finger end of the dominant upper limb on the measuring tape. The participant was instructed to leave the nondominant arm along the body and, from there, to move as far as possible to the lateral without flexing the knees or rotating or flexing the trunk, maintaining this position for 3 seconds; then the maximum displacement of the dominant member was measured on the measuring tape. Brauer et al[22] establish acceptable levels of test–retest reliability for this instrument.

The 30-second Chair Stand Test was applied to identify mobility, strength, and resistance in the lower limbs, according to validation studies by Macfarlane et al[23] and Unver et al.[24] In this way, the participant began the examination sitting on a chair, with feet resting on the floor and upper limbs crossed over the thorax. On the command given by the researcher, the participant lifted from the chair, assuming a completely erect posture, and then sat down again. For 30 seconds the participant performed the maximum lifting and sitting movements in the chair, and the researcher recorded the amount of complete erect position assumed during this time interval. Three executions of the test were performed, with a 1-minute interval between them, and the mean was used for statistical analysis. For this test, Unver et al[24] provided scientifically acceptable test–retest reliability values.

For the statistical analysis, SPSS Software, Version 17.0 (IBM Corp, Armonk, New York), was used for statistical processing. The distribution of the data was analyzed first by histogram analysis. Then the Pearson correlation coefficient was used to assess the associations between variables. Comparisons between groups were performed using Student *t* test, and the data are presented as mean, standard deviation, mean difference, and confidence interval of the difference at 95%. The level of significance was set at 5% for all statistical tests. Cohen's d statistic was used to calculate the effect size and the interpretation was based on the values established by Cohen: <0.2 (small effect), approximately 0.5 (moderate effect), and >0.8 (large effect).[25]

Results

A total of 61 participants were recruited; 1 participant was excluded because of a history of meniscal injury in the left knee. Participants with chronic neck pain (n = 30) and asymptomatic individuals (n = 30) were included in the study. Overall, the sample consisted of young, eutrophic individuals, of whom 71.66% (n = 43) were women and 93.33% (n = 56) were right-handed. Of the 30 participants in the chronic neck pain group, 23 were women and 28 were right-handed, whereas among the 30 participants in the asymptomatic group, 20 participants were women and 28 were right-handed. By means of the χ^2 test, no differences were identified between the groups in the comparisons between sex and upper limbs dominance ($P > .05$). Data referring to the other anthropometric and clinical characteristics of the participants are provided in Table 1.

Regarding the comparisons between the groups, no statistically ($P > .05$) and clinically ($d < 0.50$) significant differences were identified for the variables tested here (Table 2). However, regarding the correlations (Table 3), a significant association was identified only between the intensity of pain during cervical movements and FRT ($r = -0.312$); that is, the higher the intensity of pain, the lower the anteroposterior excursion of the body during the execution of the test.

Discussion

The results of the present study indicate that chronic neck pain reduces postural balance assessed by the FRT. In other words, higher pain intensity in the cervical region is

Table 1. *Anthropometric and Clinical Characteristics of Study Participants According to the Groups*

Outcomes	Mean	SD	95% CI	*P* Value
Age (y)				
Neck pain	20.06	2.63	19.16-21.14	.228
Asymptomatic	20.86	2.44	20.06-21.75	
Mass (kg)				
Neck pain	64.18	13.20	62.62-72.94	.599
Asymptomatic	62.99	15.48	64.97-76.35	
Height (m)				
Neck pain	1.67	0.09	1.64-1.71	.705
Asymptomatic	1.68	0.08	1.65-1.71	
Body mass index (kg/m^2)				
Neck pain	24.08	4.50	22.45-25.63	.692
Asymptomatic	24.58	5.19	22.98-26.51	
Chronicity of pain (m)				
Neck pain	29.70	21.51	22.27-37.34	<.001 [a]
Asymptomatic	0	0	0	
NRS at rest (score)				
Neck pain	2.46	2.22	1.70-3.23	<.001 [a]
Asymptomatic	0.16	0.46	0.03-0.34	
NRS after movements (score)				
Neck pain	4.90	1.97	4.20-5.65	<.001 [a]
Asymptomatic	0.56	1.16	1.33-2.48	
NDI (score)				
Neck pain	9.90	3.53	8.70-11.25	<.001 [a]
Asymptomatic	4.60	3.90	3.34-5.92	
PCTS (score)				
Neck pain	1.33	1.03	1.00-1.72	<.001 [a]
Asymptomatic	0.34	0.34	0.24-0.49	
BQ (score)				
Neck pain	4.19	1.12	3.78-4.56	.106
Asymptomatic	4.60	0.80	4.31-4.88	

BQ, Baecke Questionnaire; *CI,* confidence interval; *NDI,* Neck Disability Index; *NRS,* Numerical Rating Scale; *PCTS,* Pain-Related Catastrophizing Thoughts Scale; *SD,* standard deviation.

[a] Statistically significant difference ($P < .05$).

Table 2. *Comparison Between the Groups of Postural Balance and Mobility of the Lower Limbs Tests*

Outcomes	Group	Mean	SD	MD (95% CI)	Cohen d (95% CI)
TUG (s)	Neck pain	5.50	0.73	0.01 (-0.32 to 0.34)	0.02 (-0.49 to 0.52)
	Asymptomatic	5.49	0.54		
FRT (cm)	Neck pain	33.15	8.10	-2.85 (-6.55 to 0.85)	-0.48 (-0.91 to 0.11)
	Asymptomatic	36.06	6.07		
LRT (cm)	Neck pain	25.45	6.49	-0.63 (-4.10 to 2.84)	-0.09 (-0.60 to 0.41)
	Asymptomatic	26.09	6.93		
30-CST (score)	Neck pain	20.60	4.28	-1.09 (-3.33 to 1.15)	-0.25 (-0.76 to 0.26)
	Asymptomatic	21.69	4.39		

30-CST, 30-second Chair Stand Test; *CI,* confidence interval; *FRT,* Functional Reach Test; *LRT,* Lateral Reach Test; *MD,* mean difference; *SD,* standard deviation; *TUG,* Timed Up and Go test.
No statistically ($P > .05$) and clinically ($d < 0.50$) significant difference.

Table 3. *Correlation Among Chronicity, Pain Intensity, Disability, and Catastrophizing With the Variables of Balance and Mobility of the Lower Limbs*

Outcomes	Chronicity	NRS at Rest	NRS at Movement	NDI	PCTS
TUG	$r = 0.152$	$r = 0.116$	$r = 0.069$	$r = 0.064$	$r = 0.170$
FRT	$r = -0.159$	$r = 0.013$	$r = -0.312$ [a]	$r = -0.024$	$r = 0.063$
LRT	$r = 0.164$	$r = 0.023$	$r = -0.114$	$r = 0.090$	$r = 0.052$
30-CTS	$r = -0.170$	$r = 0.002$	$r = -0.137$	$r = -0.058$	$r = -0.003$

30-CST, 30-second Chair Stand Test; *FRT,* Functional Reach Test; *LRT,* Lateral Reach Test; *NDI,* Neck Disability Index; *NRS,* Numeric Rating Scale; *PCTS,* Pain-Related Catastrophizing Thoughts Scale; *TUG,* Timed Up and Go test.
[a] Significant correlation ($P < .05$).

associated with less excursion of the anteroposterior of the center of mass of the body during the execution of this test.

Some previous studies have provided a pathophysiological explanation for the results of the present study (ie, the relationship between chronic neck pain and altered balance). Treleaven[5] emphasized that the sensorimotor control of erect and stable postural balance is conditioned to the afferent information of the vestibular, visual, and proprioceptive systems. In addition to these structures, the cervical spine participates in this integrated neural mechanism because it has a high number of mechanoceptors and is therefore an important proprioceptive source for postural stability. In addition, Pettorossi and Schieppati[4] pointed out that the proprioceptive influence of the cervical region contributes to body orientation and motion and to the mental representation of the space in which the individual is located.

Technological resources to assess postural balance have identified the behavior of body sway in recent decades by means of a force platform in participants with neck pain. Otadi et al[26] reported changes in mean velocity and the center of foot pressure, Cheng et al[27] identified disturbed balance control in these patients during quiet standing, and Jørgensen et al[6] and Quek et al[7] identified changes in the postural control of cleaners and older adults with neck pain, respectively. Regarding the use of a pressure platform, only 1 study[28] was found; researchers reported that no baropodometric alterations were identified in young adults with chronic neck pain. Therefore the present study is in agreement with previous investigations carried out with a force platform.

Some clinical implications can be made based on the results of this study. The FRT is capable of identifying changes in postural balance and should be used by rehabilitation professionals to evaluate this variable in patients with neck pain. In addition, because chronic neck pain, even if slightly disabling, interferes with postural balance, interventions should be planned to resolve or reduce pain with the goal of gaining postural balance and to provide benefits during professional and sports activities by the patients. However, we emphasize that this is only a supposition because only a well-conducted clinical trial could make inferences about the effects of clinical interventions on postural balance in this population.

Limitations

The present study was performed on young adults who were sedentary and had chronic neck pain. It is known that aging is a factor that contributes to changes in postural balance. Therefore it would be advisable that future studies consider investigating the relationship between neck pain and balance in older patients. In addition, the relationship among neck pain, physical activity, and balance was not the focus of the present investigation and should be considered by future studies. The participants in the present study had mild pain intensity and disability, and the observation of aspects related to postural balance with low-cost tests in individuals with more severe painful still lacks publications.

Conclusion

Young adults with chronic neck pain present with changes in static balance measured by means of the FRT; that is, the higher the intensity of pain, the lower the anteroposterior excursion of the body during the execution of the test.

Funding Sources and Conflicts of Interest

The study received scholarship of the Alagoas Research Foundation (FAPEAL). No conflicts of interest were reported for this study.

Contributorship

Concept development (provided idea for the research): A.V.D.-F.
Design (planned the methods to generate the results): C.A.F.d.P.G., C.d.S.S., N.T.A.d.S., A.V.D.-F.
Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): C.A.F.d.P.G., C.d.S.S., N.T.A.d.S., A.V.D.-F.
Data collection/processing (responsible for experiments, patient management, organization, or reporting data): P.K.A.G., R.B.C.S., I.M.D.d.F., A.V.D.-F.
Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): P.K.A.G., R.B.C.S., I.M.D.d.F., A.V.D.-F.
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Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): C.A.F.d.P.G., C.d.S.S., N.T.A.d.S., A.V.D.-F.

Practical Applications

- Postural balance as measured by the Functional Reach Test was changed in individuals with chronic neck pain.
- Higher pain intensity in the cervical region was associated with less excursion of the anteroposterior of the center of mass of the body during the execution of this test.

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