Correlation between neck pain characteristics and gait parameters in patients with chronic mechanical neck pain

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Abstract

Background: Neck pain is now a widely recognized musculoskeletal problem in the global community. It has been linked to a variety of problems in the cervical spine as well as other structures. Walking is a basic human activity that is simple to perform, has a low risk of injury, and has many health benefits.

Aim: The present study was done to objectively investigate if there is a relationship between neck pain characteristics and gait parameters in people who had chronic mechanical neck pain (CMNP).

Material and methods: Twenty-six participants suffering chronic mechanical neck pain (G1) and twenty-six normal healthy matched subjects (G2) were assessed for neck pain characteristics and gait parameters. The visual analogue scale (VAS) was applied to assess pain intensity, the Neck disability Index (NDI) Arabic version was applied to assess neck function, and the Biodex Gait Trainer 2 TM device was used to assess spatiotemporal gait parameters.

Results: in comparison with the control group, the study group displayed a significant reduction of walking velocity, both feet step length, and left foot time of support. There were significant correlations between VAS, NDI, and gait parameters in patients with CMNP.

Conclusion: people with chronic mechanical neck pain showed a decrease in walking velocity, step length, and time on each foot. These results demonstrate that neck pain seems to have an effect on spinal health and gait.

Key words: cervical spine, Neck pain, gait, sensorimotor function.

Introduction

Neck pain becomes among the most debilitating musculoskeletal diseases, affecting about 30% of the adult population worldwide. **(1).** Mechanical neck pain occurs insidiously in 50-80% of cases involving back or neck pain, and is multifactorial in nature, involving one or more of the following: Anxiety, bad posture, depression, neck discomfort, and work-related behaviors are all factors to consider.. (**2**). People suffering from neck pain may notice subtle shifts in load distribution between synergistic muscles. **(3)** As well as changes in muscle activity distribution **(4)** there may also be biomechanical alterations, which including reduced neck range of motion in all planes, resulting in decreased overall cervical range of motion. **(5)** The combined motion in the frontal and sagittal planes was reduced during cervical rotation. (6), as well as a reduction in movement speed and smoothness (7). People suffering neck pain can also experience sensorimotor deficits, such as poorer proprioception (8) and increased postural sway during balance tasks. **(9)**. Gait speed is commonly regarded as a reliable measure of functional status and physical well-being, and it has been extensively studied by health care professionals in both clinical practice and health research**(10)**.

Several studies of gait characteristics and spine kinematics have found a higher consistency and impaired temporal relationship between pelvis and thorax transverse plane rotations during gait in low back pain patients **(11)**. These adjustments can represent stronger control of trunk motions in the transverse plane intended to prevent rapid and massive rotations, according to some theories **(12)**. Furthermore, individuals with low back pain contract their superficial muscles of the trunk more while walking, which is proportional to stiffening or guarding activity. **(13)**. These results back up the idea that people with low back pain use a defensive movement technique that requires increased trunk stiffness, which is consistent with the current theory of pain adaptations, that demonstrates pain has a general role in protecting the painful/stressful part of the body from real or expected additional pain/injury, and that motor adaptation may happen far away from the painful zone. **(14)**. In comparison, The effect of neck pain on walking is poorly understood, which is critical in daily practice as well as overall health and physical function, so our purpose from this study is to evaluate if there a significant correlation between neck pain and gait parameters in people suffering from neck pain.

Material and methods

A case-control study of 26 chronic mechanical neck pain patients (group 1) compared to 26 healthy normal controls (group 2) that were age, sex, weight, and height matched. Patients were recruited from Cairo University Faculty of Physical Therapy outpatient clinic for neuromuscular disorders and surgery. The patients in this study had chronic mechanical neck pain for more than three months. The patients possessed the requisite cognitive abilities to comprehend the study's requirements. We excluded patients who had undergone cervical spine surgery or had any other orthopedic problems affecting the cervical spine, as well as those who had vision or hearing problems, as well as those who had cervical radiculopathy or myelopathy.

Ethical consideration

The Cairo University Research Ethical Committee accepted this study, and the subjects provided their written informed consent to take part in it. (NO: P. T. REC/012/002871).

1) Pain intensity assessment:

Visual analogue scale (VAS) was applied in assessment of pain intensity Patients were told to mark on a line with "no pain" on the left and "worst possible pain" on the right for signifying the intensity of their pain.

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2) Neck Functional Assessment:

The Functional disability of each patient was assessed by Arabic Neck Disability Index (NDI). Each question in the questionnaire was explained in details and the Patients were asked to choose one of six sentences that better described their neck function. It consists of ten multiple-choice questions for neck pain in which the patient chooses one sentence from six that best explains their function; a higher score of 5 indicates a significant loss of function, whereas a lower score of 0 indicates no impairment (full disability). For scores ranging from 0 to 50, the numeric answer for each item was added up, and the percentage of disability scores was determined.

3) Measurement of gait spatiotemporal parameters by using Biodex Gait Trainer 2 TM system:

Name, gender, age, and height of the subjects were documented. Spatiotemporal parameters of gait were measured at the biodex gait trainer 2 lab. All the procedures were explained to the patients before starting the assessment. Patients stood on the biodex gait trainer bare feet and holding the handrails for safety and monitoring the heart rate. During the assessment the velocity was adjusted for each patient. The duration of walking on the system was three minutes for each patient. Three trials were done for each patient then collected the average.

Statistical analysis:

Descriptive statistics were utilized in presenting the subject's demographic and clinical data. The sex distribution between the two groups was compared using the Chi-squared test. The study and control groups' gait parameters were compared using an unpaired t-test. The correlation between VAS and NDI with gait parameters in the study group was investigated using the Pearson correlation coefficient. Regarding to whole statistical tests, the significance level was measured at p 0.05. The statistical package for social sciences (SPSS) version 25 for Windows was used to carry out all statistical measures.

Results

- Participants *characteristics*:

Table 1 shows the characteristics of the participants. There was no significant difference between the study and control according to age, weight, height, BMI, and sex distribution ($p > 0.05$).

Table 1. Basic characteristics of participants.

	Study group	Control group	p-value
	Mean ± SD	Mean ± SD	
Age (years)	22.61 ± 1.57	22.73 ± 1.4	0. 78
Weight (kg)	70.38 ± 8.54	68.69 ± 6.55	0. 42
Height (cm)	172.61 ± 8.04	170.88 ± 6.91	0.4
BMI (kg/m²)	23.47 ± 1.12	23.42 ± 0.93	0.86
Sex, n (%)			
Females	16 (61.5%)	14 (54%)	0.57
Males	10 (38.5%)	12 (46%)	

SD, standard deviation; p-value, level of significance

Comparison of gait parameters between the study and control groups:

There was a significant decrease in walking velocity, right and left sides step length, and time on the left foot of the study group compared with that of the control group ($p < 0.001$). There was a significant increase in time on the right foot of the study group compared with that of the control group ($p < 0.001$).

Table 2. Mean walking velocity, step length and time on each foot of the study and control groups:

	Study group	Control group	MD	t- value	p value
	Mean ± SD	Mean ± SD			
Walking velocity (m/s)	0.74 ± 0.02	0.79 ± 0.01	-0.05	-8.12	0.001
Right side step length (m)	0.53 ± 0.03	0.67 ± 0.02	-0.14	-14.17	0.001
Left side step length (m)	0.51 ± 0.04	0.66 ± 0.03	-0.15	-14.18	0.001
Time on right foot (%)	51.35 ± 0.79	50.04 ± 0.66	1.31	6.43	0.001
Time on left foot (%)	48.65 ± 0.79	49.96 ± 0.66	-1.31	-6.43	0.001

SD, standard deviation; MD, mean difference; p-value, probability value

Correlation between VAS and gait parameters

The correlations between VAS and gait parameters were strong negative significant correlation with walking velocity ($r = -0.94$, $p = 0.001$), the right step length ($r = -0.7$, $p = 0.001$), the left step length ($r = -0.71$, $p = 0.001$) and moderate positive significant correlation with time on right foot (r = 0.56, p = 0.002) and moderate negative significant correlation with time on the left foot (r = -0.56, p = 0.002). (Table 3).

Correlation between NDI and gait parameters

The correlations between NDI and gait parameters were strong negative significant correlation with walking velocity (r = -0.95, p = 0.001), moderate negative significant correlation with right step length (r = -0.64, p = 0.001), left step length with (r = -0.65, p = 0.001) and with time on left foot (r = -0.54, p = 0.004), and moderate positive significant correlation with time on right foot (r = 0.54, p = 0.004). (table 3).

Table 3: Correlation between VAS and NDI with gait parameters in the study group.

	VAS		NDI	
	r – value	**P- value**	**r – value**	**P- value**
Walking velocity (m/s)	-0.94	0.0001	-0.95	0.0001
Right step length (m)	-0.7	0.0001	-0.64	0.0001
Left step length (m)	-0.71	0.0001	-0.65	0.0001
Time on right foot (%)	0.56	0.002	0.54	0.004
Time on left foot (%)	-0.56	0.002	-0.54	0.004

r value: Pearson correlation coefficient; p value: Probability value

Discussion:

To better understand the effect of cervical pain on walking performance, our study assessed neck pain characteristics and gait parameters in people who had chronic mechanical neck pain. Biodex Gait Trainer 2 TM system was used in this study which is an objective tool for evaluating gait parameters in CMNP. As compared to healthy controls, participants with neck pain had significantly lower walking velocity, time on the left foot, and Step lengths on both the right and left sides while walking.

Our results support the concept that patients with neck pain have impaired gait features which may be resulted from abnormal cervical afferent inputs **(15)**. Afferent information from vestibular, visual, and proprioceptive systems is important for control of postural stability and motion **(16)**. When one source of information is disrupted, it can cause declines in the maintenance of postural stability and locomotion **(15)**. Cervical spine has a high percentage of muscle spindles providing proprioceptive information **(17)**. Previous studies suggested that pain originating in the neck could alter muscle spindle sensitivity and cervical afferent input **(15)**.

So, decreased maximum gait speed may be due to the lack of congruence between abnormal cervical proprioception and other normal sensory afferent inputs, or changes in sensorimotor integration. Maintaining dynamic balance is an important item of walking function **(16)**. According to a previous review patients with cervical pain showed an impaired dynamic balance when compared with healthy controls **(18)** while maximum gait speed is progressively more challenged and requires greater dynamic stability, a slower gait speed may be a compensation related to postural instability while walking in neck pain participants **(19)**.

Cervical pain is frequently unilateral, with one part being worse than the other. **(20)** that could result in uneven afferent input across soft tissue receptors, affecting postural control, orientation, as well as body schema interpretation **(21).** Also, individuals with chronic cervical pain showed a skewed body schema as a result of their pain. **(22).** Neck pain, according to Uthaikhup et al., alters sensory modulation from the neck to the central nervous system, which is possibly the cause of low sensorimotor performance **(23).** While walking, sensory input from the lower extremities is linked to neural circuits from central pattern generators upon the spinal cord **(24).**

Decreased gait parameters were found to be closely linked to pain severity and disability in this study. This finding is consistent to recent reviews that stated individuals with chronic cervical pain have psychological symptoms that are linked to their pain and disability. Anxiety, catastrophizing, and depression seem to be the psychological states most closely linked to self-reported impairment, while anxiety is often linked to pain severity in persons with nonspecific chronic cervical pain **(25).**

Conclusion:

Based on the current findings participants with chronic mechanical neck pain provide a significant reduction in walking velocity, right and left sides step length and time on the left foot compared the control group. So, Clinicians should consider assessing and managing gait performance and balance in patients with mechanical neck pain.

Scientific Responsibility Statement

The authors announce that they are solely responsible for the scientific content of the paper, including research design, information gathering, methodology, and interpretation, writing, some or all of the main line, and final approval of the article's final edition.

Animal and human rights statement

All procedures in this study were carried out in compliance with the institutional and/or national research committee's ethical standards, as well as the 1964 Helsinki declaration and its subsequent revisions or equivalent ethical standards. The authors did not conduct any animal or human research for this study.

Funding: None

Conflict of interest

There was no financial assistance provided to any of the writers that could be construed as a possible conflict of interest in relation to the manuscript or its submission.

References:

1) **A. Middleton, S.L. Fritz, M. Lusardi, *et al*.Walking speed: the functional vital sign**J. Aging Phys. Act., 23 (2) (2015), pp. 314-322.
2) **Boyd-Clark LC, Briggs CA, Galea MP**. Muscle spindle distribution, morphology, and density in longus colli and multifidus muscles of the cervical spine. Spine J 2002; 27: 694-701.
3) **C. Moreira, A.R. Bassi, M.P. Brandão, *et al*.Do patients with chronic neck pain have distorted body image and tactile dysfunction?** Eur. J. Physiother., 19 (4) (2017), pp. 215-22.
4) **De RMJ. Zoete, P.G. Osmotherly, D.A.** Rivett **Snodgrass, sensorimotor control in individuals with idiopathic neck pain and healthy individuals: a systematic review and meta-analysis** Arch. Phys. Med. Rehabil., 98 (6) (2017), pp. 1257-1271.
5) **Dimitriadis Z, Kapreli E, Strimpakos N, Oldham J.** Do psychological states associate with pain and disability in chronic neck pain patients?. *J Back Musculoskeletal Rehabil*. 2015, 28(4):797-802.
6) **Falla D, Arendt-Nielsen L, Farina D**. Gender-specific adaptations of upper trapezius muscle activity to acute nociceptive stimulation. *Pain*. 2008;138:217-255.
7) **Falla DL, Jull GA, Hodges PW.** Patients with neck pain demonstrate reduced electromyographic activity of the deep cervical flexor muscles during performance of the craniocervical flexion test. *Spine (Phila Pa 1976)*. 2004;29:2108-2114.
8) **Falla, D., Jull, G., Russell, T., Vicenzino, B., & Hodges, P.** Effect of neck exercise on sitting posture in patients with chronic neck pain. Physical therapy,2007, 87(4), 408-417.
9) **Grip H, Sundelin G, Gerdle B, Karlsson JS.** Cervical helical axis characteristics and its center of rotation during active head and upper arm movements— comparisons of whiplash-associated disorders, non-specific neck pain and asymptomatic individuals. *J Biomech*. 2008;41:2799-2805.
10) **Hodges P, Falla D.** Interaction between pain and sensorimotor control. In: Jull G, Moore AP, Falla D, Lewis J, McCarthy C, Sterling M, eds. *Grieve's Modern Musculoskeletal Physiotherapy*. 4th ed. Edinburgh, UK: Elsevier; 2015:ch 6.
11) **I. Tsang Rheumatology: 12. Pain in the neck** JAMC, 164 (8) (2001), pp. 1182-1187.
12) **M. Plotnik, R.P. Bartsch, A. Zeev, *et al*.Effects of walking speed on asymmetry and bilateral coordination of gait** Gait Posture, 38 (4) (2013), pp. 864-869.
13) **O'Riordan, C., Clifford, A., Van De Ven, P., & Nelson, J**. Chronic neck pain and exercise interventions: frequency, intensity, time, and type principle. Archives of physical medicine and rehabilitation ,2014, 95(4), 770-783.
14) **S. Uthaikhup, G. Jull, S. Sungkarat, *et al.*The influence of neck pain on sensorimotor function in the elderly** Arch. Gerontol. Geriatr., 55 (3) (2012), pp. 667-672.
15) **Shumway-Cook A, Woollacott M.** Motor control: translating research into clinical practice. Philadelphia: Lippincott Williams & Wilkins; 2012.

16) **Sjölander P, Michaelson P, Jaric S, Djupsjöbacka M**. Sensorimotor disturbances in chronic neck pain—range of motion, peak velocity, smoothness of movement, and repositioning acuity. *Man Ther*. 2008;13:122-131.

17) **Sjöström H, Allum JH, Carpenter MG, Adkin AL, Honegger F, Ettlin T**. Trunk sway measures of postural stability during clinical balance tests in patients with chronic whiplash injury symptoms. *Spine (Phila Pa 1976)*. 2003;28:1725-1734.

18) **Stokell R, Yu A, Williams K, Treleaven J**. Dynamic and functional balance tasks in subjects with persistent whiplash: A pilot trial. Man Ther 2011; 16: 394-8.

19) **Treleaven J, Jull G, LowChoy N.** The relationship relationship of cervical joint position error to balance and eye movement disturbances in persistent whiplash. *Man Ther*. 2006;11:99-106.

20) **Treleaven J**. Sensorimotor disturbances in neck disorders affecting postural stability, head and eye movement control. Man Ther 2008; 13: 2-11.

21) **Uthaikhup S, Sunkarat S, Khamsaen K, Meeyan K, Treleaven J**. The effects of head movement and walking speed on gait parameters in patients with chronic neck pain. Man Ther 2014; 19: 137-41.

22) **van den Hoorn W, Bruijn SM, Meijer OG, Hodges PW, van Dieën JH**. Mechanical coupling between transverse plane pelvis and thorax rotations during gait is higher in people with low back pain. *J Biomech*. 2012;45:342-347.

23) **van der Hulst M, Vollenbroek-Hutten MM, Rietman JS, Hermens HJ**. Lumbar and abdominal muscle activity during walking in subjects with chronic low back pain: support of the “guarding” hypothesis? *J Electromyogr Kinesiol*. 2010;20:31-38.

24) **Woodhouse A, Vasseljen O**. Altered motor control patterns in whiplash and chronic neck pain. *BMC Musculoskelet Disord*. 2008;9:90.

25) **Wu WH, Meijer OG, Bruijn SM, et al.** Gait in pregnancy-related pelvic girdle pain: amplitudes, timing, and coordination of horizontal trunk rotations. *Eur Spine J*. 2008;17:1160-1169.