Relationship Between Proprioception and Endurance Functionality of the Cervical Flexor Muscles in Chronic Neck Pain and Asymptomatic Participants

Leila Ghamkhar, PhD,[a] Amir H. Kahlaee, PhD,[a] Mohammad R. Nourbakhsh, PhD,[b] Amena Ahmadi, PT,[a] and Amir M. Arab, PhD[a]

Abstract

Objective: The purpose of this study was to compare the relationship between flexion endurance capacity and joint position error in participants with or without chronic neck pain (CNP).

Methods: Sixty-one CNP and 60 asymptomatic volunteers participated in this cross-sectional, case-control, and correlational analysis study. The measured variables included absolute and constant joint repositioning errors in the sagittal and horizontal directions, clinical flexor endurance test score, pain intensity, and neck disability index.

Results: The groups did not statistically differ in flexion endurance ($P > .05$). The CNP group had a smaller absolute error on the right ($P < .01$) and left ($P = .01$) rotation and an overshooting error pattern in the flexion direction ($P < .05$). But the asymptomatic group did not exhibit any over-/undershooting pattern tendency ($P > .05$). Although flexion endurance was not correlated with any of the joint repositioning error components in either group, pain and disability scores were significantly correlated with left rotation absolute error ($r = –0.34$ and $\rho = –0.37$, respectively).

Conclusion: The clinical cervical flexor endurance test, ignoring the relative contribution of the deep and superficial groups of muscles, may not efficiently characterize CNP patients. (J Manipulative Physiol Ther 2018;xx:1-8)

Key Indexing Terms: *Chronic Pain; Spine; Proprioception*

Introduction

Chronic neck pain (CNP) is a common musculoskeletal problem with considerable personal and financial costs.[1] Physical,[2-4] psychological,[5] and sensorimotor[2] impairments have been found to be correlated with CNP in several studies. The multifactorial nature of the disease has made it difficult to identify the main contributing mechanisms and their relative relevance to the consequences of CNP.

Proprioceptive function accuracy has recently gained considerable attention in the description and assessment of CNP.[6-8] Proprioception functioning in a closed loop between peripheral mechanoreceptors (lying within muscles and other connective soft tissues) and the brain plays a crucial role in the maintenance of joint stability in a dynamic situation.[9] This sense (in conjunction with visual and vestibular afferents) provides the central nervous system (CNS) with the necessary information to parameterize the efferent motor commands necessary for postural and motor control.[10,11] Some investigators assume that proprioception deficit might be a factor predisposing to pain and injury via poor motor control.[12] Understanding the proprioceptive function alterations in the presence of CNP thus seems necessary for evaluation and rehabilitation of these patients.[13,14]

Muscles are proprioceptive information sources. The deep cervical muscles, being rich in muscle spindles,[15,16] have been thought to play a relatively more prominent role in sensory motor function of this region.[17] The deep neck flexors are responsible for maintenance of cervical lordosis and intersegmental stability during activities of daily living.[15] Patients with CNP tend to have lower flexor muscle endurance compared with asymptomatic persons.[18-20] There is evidence indicating that fatigue of the cervical and scapular muscles may adversely affect the cervical joint position sense.[21,22] Hence, deep neck flexor muscle dysfunction in terms of increased fatigability may be associated with proprioceptive

[a] Physical Therapy Department, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran.

[b] Department of Physical Therapy, North Georgia College and State University, Dahlonega, Georgia.

Corresponding author: Amir M. Arab, PhD, Department of Physical Therapy, University of Social Welfare and Rehabilitation Sciences, Evin Koodakyar Ave, Tehran, Iran. Tel.: +98 21 22180037. (e-mail: *arabloo_masoud@hotmail.com*).

Paper submitted April 9, 2017; in revised form July 30, 2017; accepted August 23, 2017.

0161-4754

https://doi.org/10.1016/j.jmpt.2017.08.006

dysfunction and poor postural control in patients with CNP. Endurance training of the deep cervical flexor muscles has been reported to improve joint position sense accuracy in CNP patients.[14,23] This might suggest the 2 functions have a common source, that is, the deep flexor muscles. Although there is evidence for the relevance of both factors to CNP, to our best knowledge no study has yet investigated the association between the force maintenance (endurance) capacity and proprioceptive functioning of the deep cervical flexor muscles in CNP patients. In this study, we addressed the following questions: Is there a relationship between proprioceptive and endurance functioning of the cervical flexor muscles? Is this relationship affected by the presence of CNP?

The objectives of the current study were to (1) investigate the association between cervical proprioceptive functioning, cervical flexor endurance, pain intensity, and disability scores and (2) compare the proprioceptive accuracy and cervical flexor endurance capacity of CNP patients with those of asymptomatic participants.

Methods

Design

This was a cross-sectional, case-control, and correlational analysis study. The participants were recruited into the study after being familiarized with the purpose and content of the study and signing the informed consent form approved by the human ethics committee of the University of Social Welfare and Rehabilitation Sciences (Approval Code: IR.USWR.REC.1394.224). The study was registered with ClinicalTrials.gov (No. NCT02789631).

Participants

Sixty-one participants (41 female) with idiopathic CNP and 60 asymptomatic participants (37 female) from the community voluntarily participated in this study between October 2015 and August 2016. The inclusion criteria for the CNP group were as follows: age 20-55 years, pain experience in the suboccipital to the first thoracic vertebra region for at least 6 months with a frequency no less than once a week. The control group participants had no history of neck pain within the last year. Participants would be excluded from either group if they had any history of trauma or surgery on the spine; congenital deformity or inflammatory diseases; positive Spurling[24] and Dix Hallpike[25] tests for radiculopathy signs and vestibular impairment, respectively; diagnosis of fibromyalgia; or history of neck physical therapy within 6 months prior to our testing. The physical examination and medical history review were performed by an experienced orthopedic physical therapist. The demographic characteristics of both groups are summarized in Table 1.

Table 1. *Demographic Characteristics of Chronic Neck Pain Patients and Asymptomatic Participants*

	Chronic Neck Pain (n = 60)	Asymptomatic (n = 61)	*P* Value
Age, y	33.61 ± 9.5	31.00 ± 9.70	.10
Weight, kg	67.03 ± 16.96	66.75 ± 15.97	.95
Height, cm	167.58 ± 7.84	167.40 ± 9.57	.91
Body mass index (kg/cm^2)	23.85 ± 5.10	23.74 ± 4.41	.84
Past-week VAS (cm)	4.81 ± 2.32		
NDI score	10.57 ± 6.53		

Values are presented as means ± standard deviation.
NDI, neck disability index; *VAS,* visual analogue scale.

Outcome Measures

Clinical Characteristics of the CNP Group. Pain intensity over the last week was measured using a blank 100-mm visual analogue scale (VAS), where 0 corresponded to "no pain at all" and 100 to "the worst imaginable pain." Neck pain-related disability was assessed with the Persian version of the Neck Disability Index (NDI-P).[26] The NDI covers 10 items of daily living activities and is scored from 0 to 50, with higher scores corresponding to greater disability.

Neck Flexor Endurance Test. The participants would assume the "crook lying" position with the arms alongside the body and were asked to raise their head approximately 2 cm of the plinth while keeping their chins tucked in (craniocervical flexion posture). Losing the chin-tucked posture, having the back head in contact with the plinth for more than 1 second, or reluctance to continue for any reason would lead to test termination. The test duration was measured in seconds with a stopwatch. The examiner visually monitored the cervical posture during the test.[27] The test was performed only once to prevent pain exacerbation in patients.

Joint Position Reproduction Test. The test was performed as described by Revel et al.[28] After being familiarized with the test procedure, the participants were asked to sit upright in a comfortable position on a chair and look straight ahead. A Velcro strap was fixed around the skull, level with the top of the ears. A laser pointer (Class 3A Laser product, Wen Zhou Xinke, China) was fixed on the Velcro strap between the eyebrows aimed at a target 90 cm away. The participants were instructed to remember baseline neutral head position before moving their heads slowly through the maximum comfortable range of motion and to return to the initial position with their eyes kept closed. The point where the laser beam stopped on the target was marked and labeled according to the movement direction and trial number. The test was performed through 4 directions of cervical motion (flexion, extension, right and left rotation, with 3 trials for each) with a 1-minute rest interval between the directions; the order of movements was randomized. After each trial, the examiner moved the participant's head back to the