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Neck muscle vibration can improve sensorimotor function in patients with neck pain

Konstantin Beinert, MSc[a,b,*], Martin Keller, MSc[a], Wolfgang Taube, PhD[a]

[a]University of Fribourg, Department of Medicine, Unit of Sports Science, Chemin du Musée 3, 1700 Fribourg, Switzerland

[b]Academy for Health Professions, Institute of Applied Science of the Human Movement System, Maximilianstraße 20, 67433 Neustadt an der Weinstraße, Germany

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Abstract

BACKGROUND CONTEXT: People with neck pain display a diminished joint position sense and disturbed postural control, which is thought to be a result of impaired somatosensory afferent activity and/or integration. Afferent processing can be artificially manipulated by vibration and was shown to reduce motor performance in healthy subjects. However, the effect of vibration on sensorimotor function in neck pain patients is scarcely investigated.

PURPOSE: To assess the effect of neck muscle vibration on joint position sense and postural control in neck pain subjects and healthy controls.

STUDY DESIGN: Case control study.

PATIENT SAMPLE: Thirteen neck pain patients and 10 healthy controls participated in the present study.

OUTCOME MEASUREMENTS: Cervical joint position sense and dynamic and static postural stability.

METHODS: Short-term, targeted neck muscle vibration with 100 Hz was applied after baseline measurement.

RESULTS: Vibration had opposite effects in patients and healthy subjects. Patients showed improved joint position sense ($p<.01$) and reduced dynamic postural sway ($p<.05$) after vibration, whereas vibration resulted in reduced joint position sense acuity ($p<.05$) and a nonsignificant increase in postural sway in healthy controls.

CONCLUSIONS: This is the first study showing an improved motor performance after neck muscle vibration in patients with neck pain. Thus, vibration may be used to counteract sensorimotor impairment of the cervical spine. Potential underlying mechanisms are discussed.

Keywords: Neck pain; Vibration; Proprioception; Postural control; Cervical joint position sense; Sensory reweighting

Introduction

Neck pain patients demonstrate multiple sensorimotor impairments, such as reduced joint position sense [1], reduced force steadiness [2], and increased postural sway [3]. The underlying mechanisms of these impairments are not well understood, but one common feature of these sensorimotor impairments is their dependency on afferent somatosensory input of proprioceptors [4]. Recently, the interrelation between proprioceptive stimulation leading to an altered afferent input and sensorimotor performance was investigated in patients with neck pain. Muceli et al. [2] determined the effect of neck muscle vibration on cervical force steadiness and electromyographic activity. After short-term vibration, an increased cervical force steadiness and an altered electromyographic frequency band were observed. In contrast, several studies described immediate impairments of sensorimotor function because of neck muscle vibration in healthy subjects. For instance, an increased postural sway was observed during and immediately

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* Corresponding author. Department of Medicine, Movement and Sport Science, University of Fribourg, Switzerland. Tel.: (41) 263-007-285; fax: (41) 263-009-771.

E-mail address: konstantin.beinert@unifr.ch (K. Beinert)

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after neck muscle vibration [5,6]. More specifically, subjects showed increased body sway displacements toward the side opposite to the vibrated spot [6]. Furthermore, altered postural alignment in the upper cervical spine [7], a shifted perception of the body midline [8,9], and illusory movements have been reported [10]. These vibration-induced impairments are of short duration and depend on the length of application. The influence of vibration on healthy subjects is, therefore, similar to the impairments frequently observed in people with neck pain and are thought to rely on the alterations of the sensorimotor system. The phenomenon is argued to be caused by a mismatch of afferent activity provoked by vibration and the actual maintained joint position, thus, a proprioceptive disturbance [5]. In summary, studies in healthy subjects revealed negative effects of neck muscle vibration on sensorimotor function, whereas the only study which investigated neck pain patients observed a positive influence of vibration on cervical force steadiness [2]. Thus, it may be speculated that vibration affects sensorimotor function differently in healthy subjects and in neck pain patients. To clarify this point, the purpose of the present study was to examine the effects of neck muscle vibration on sensorimotor function in patients with neck pain and healthy controls. Cervical joint position sense [11] and postural control [12] are considered to rely on afferent input from the cervical spine. Therefore, these sensorimotor tasks represent good models to investigate the effects of cervical muscle vibration on sensorimotor function. Thus, the present study compared the outcomes of neck muscle vibration by assessing the accuracy of a cervical repositioning task and the stability in static and dynamic postural tasks. We hypothesized that neck muscle vibration causes impairments in cervical joint position sense and postural stability in healthy subjects but causes beneficial effects in neck pain patients.

Methods

Participants

For this case-control study, 13 subjects with chronic, recurrent neck pain and 10 healthy controls were recruited by advertisement in the local network of six physical therapy schools with over 600 students. Eligibility of participants was assessed with a structured interview and a questionnaire, which is described in more detail in the following section. The interviewer (KB) asked for the last pain episode, the frequency of episodes in a month, and the total amount of episodes in 1 year with professional medical help. Furthermore, people were asked to mark the area of their neck pain on a body chart.

Subjects in the neck pain group (seven men, six women), aged 18 to 35 years (22.4±4.7 years), reported at least one episode of neck pain per month (mean 9.1±7.1) during the previous year with average pain intensities from 4 to 8 (5.8±1.2). Patients reported idiopathic neck pain unilaterally or bilaterally, with no referral into the upper extremity. In all patients, physical examination of the cervical spine revealed positive findings such as altered joint motion and painful reactivity to palpation. Healthy control subjects were included in the control group (21.8±3.5 years; between 18 and 27 years) when no major neck pain episode and no medical consultation were apparent over a period of 1 year, no abnormal joint signs were observed during the physical examination, and neurologic disorders were excluded. Subjects in the control group were similar in body height and weight, age, and local distribution. Subjects were also excluded if they had undergone cervical spine surgery, reported any neurologic signs or symptoms in the upper extremity, or had participated in a neck exercise program in the past 12 months. To clearly differentiate and describe neck pain patients and healthy controls, participants completed the German version of the Neck Pain Disability Scale (NPAD-d). The German version of this questionnaire (NPAD-d) has been validated and showed excellent test-retest reliability with an intraclass coefficient (ICC) of 0.97, where Cronbach alpha varied between 0.87 and 0.97 for the different subscales [13] and revealed a mean value of 0.94 [13,14]. Highly significant correlations ($p<.001$) with criterion variables such as depression, anxiety, and health care use were found in both studies [13,14].

All participants were fully informed about the study and included after providing written informed consent. The study was approved by the local ethics committee and was conducted in accordance with the latest declaration of Helsinki.

Assessments

All subjects were tested in three different experiments (see the following section) in a random order. A rest period of 15 minutes was given between experiments to exclude the effects of fatigue and vibration on the subsequent experiment. Assessment of sensorimotor function included cervical joint position sense testing and evaluation of dynamic and static postural control. No other investigation or assessments were performed at the day of the study. The order of the tests (joint position and postural tests) was randomized between subjects, but was performed in the same order for each subject before (premeasurement) and after vibration (postmeasurement). The researcher who performed the neck muscle vibration was not blinded to the subject's condition (patient vs. healthy control) as he had to know where the vibration had to be applied (over the painful side in patients). However, the outcome assessor (MK, movement and sports scientist) was blinded to the subject's condition. All outcome measurements were performed directly after the vibration.

Joint position sense

To assess joint position sense, we used the method that was first described by Revel et al. [15], where a cervical