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Deep tissue hyperalgesia after computer work

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ABSTRACT

Background and purpose: A growing number of people are using computers. Shoulder and neck pain occur commonly during computer work. Peripheral and central sensitization may play a major role in establishing and maintaining several chronic pain conditions. We have previously reported that a 90 min simulated computer office-work induced substantial pain in the shoulders and neck. We hypothesized that the development of pain during the computer work may be related to sensitization. The aim of the present study was to examine if the 90 min computer work induced deep tissue muscle hyperalgesia manifested as altered pressure pain thresholds (PPTs).
Methods: Twenty-two subjects with chronic shoulder and neck pain (pain group) and 26 healthy and pain free subjects (reference group) performed a standardized computer office-work task with use of a computer-mouse and with time pressure and high precision demands continuously for 90 min. The pressure pain threshold was measured with a pressure algometer in shoulder and forearm muscles (bilaterally in upper trapezius and extensor carpi radialis), and at sternum, before and 15 min and 30 min after the computer work task.
Results: The PPTs before starting the computer work were not different between the groups at any of the five locations. In both groups, the PPTs in the active and inactive side of the upper trapezius as well as in the extensor carpi radialis of the forearm operating the computer mouse were significantly reduced after the 90 min computer work compared with the pre-work levels. In the pain group, also the PPT in the inactive resting forearm was significantly reduced. The changes seen in PPTs from pre- to post-work were not significantly different between the groups, except for the inactive resting forearm where the groups exhibited different time course.
Conclusion: A decrease in pressure pain thresholds of involved muscles suggests that computer office-work can induce deep tissue hyperalgesia within 90 min. The development of pain during the computer work indicates peripheral sensitization as the predominant mechanism. Decreased pressure pain thresholds also in sites distant from pain areas may indicate a contribution from central sensitization in the subjects with chronic shoulder and neck pain.
Implications: The lasting pain after work and the reduced PPTs both in involved and distant musculature may indicate need for frequent pauses during computer work, especially when performed with time pressure and high precision demands, in order to avoid pain to increase and sustain after work, and thus to prevent the possibility of pain to become chronic.

1. Introduction

A growing number of people are using computers. In 2007 about 30% of all employees in the European Union reported using computers all or most of the time for their work compared to 14% in 1991 [1]. Computer use may increase the risk of developing musculoskeletal symptoms in the upper extremities [2,3]. Shoulder and neck pain occur commonly, with prevalence rates around 10% [4–6].

Perception of acute musculoskeletal pain occurs in response to activation of group III (aδ-fiber) and group IV (C-fiber) muscle nociceptors. The nociceptors are activated by noxious or potentially noxious stimuli, and have a high mechanical stimulation threshold [7]. The muscle nociceptors are thus not excited by physiological movements. Musculoskeletal pain disorders are often associated with muscular hyperalgesia [8]. Deep tissue hyperalgesia may be

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explained by sensitization of muscle nociceptors and manifested as a decrease in the mechanical excitation threshold, often measured as a decreased pressure pain threshold (PPT) [9]. Among occupational office and industrial workers with shoulder and neck complaints, lower pressure pain thresholds in the shoulder and neck region compared to asymptomatic subjects is a common finding [10–15]. Studies targeting pressure pain sensitivity during and after muscle work show however inconsistent results. During light assembly work, both increased PPTs [16] and unchanged PPTs [17] of the working muscles in healthy subjects have been reported. During submaximal isometric upper or lower body exercise, increased, decreased or unchanged PPTs in corresponding musculature of healthy subjects, as well as in pain afflicted subjects, have been reported [18–26].

Continuing input from nociceptors may drive dorsal horn neurons into a state of sensitization [27]. Central sensitization is proposed to be one step in the transition from acute to chronic muscle pain [28]. Lowered pressure pain thresholds in sites distant from pain areas suggest a generalized sensitivity to pressure stimuli [29], and have been reported in subjects with shoulder and neck pain exposed to low-load repetitive work for months or years [11,15,30].

Peripheral and central sensitization may play a major role in establishing and maintaining several chronic pain conditions [27]. Recently, we have reported that computer office-work performed continuously for 90 min, with time pressure and high precision demands, induced substantial pain in the shoulders and neck as well as in the forearm operating the computer mouse both in subjects with chronic pain and in healthy references [31,32]. The aim of the present study was to examine if the 90 min computer work induced deep tissue muscle hyperalgesia manifested as altered pressure pain thresholds. We hypothesized that the development of pain during the 90 min computer work could be related to sensitization.

2. Material and methods

2.1. Subjects

A pain group consisting of 14 women and 10 men with chronic shoulder and neck pain and a reference group of 16 women and 12 men, all healthy and pain-free, were recruited through advertisements in local papers and the Internet.

Inclusion criteria for the pain group were: self reported pain in the shoulders or neck for at least 2–3 days per week during the previous 4 weeks and tender points in the upper trapezius muscles, age between 18 and 45 years, and working more than 80% full time and working with a computer more than 20% of the working time. The subjects had to be familiar with the Norwegian language to perform the text-editing task. Exclusion criteria were: fibromyalgia; cervicobrachialgia; rotator tendinosis or other shoulder disorders; inflammatory, metabolic or cardiac diseases; regular medication of importance for circulation; pregnancy; alcohol or medicament abuse; or dyslexia. The reference group was recruited with the same inclusion- and exclusion criteria as for the pain group, except that subjects with current musculoskeletal pain were excluded.

Two women in each group were excluded due to reporting pain as a consequence of the laser Doppler probes insertion in the trapezius muscle (see Refs. [31,32]). The mean age for those in the pain group was $39 \pm (1SD)$ 6 years vs. 33 ± 6 years for those in the reference group, $p < 0.001$, and the body mass index respectively $23.2 \pm 2.8\ kg/m^2$ vs. $23.6 \pm 3.2\ kg/m^2$, $p = 0.62$. All except two were right handed. For further characteristics of the subjects, see Ref. [32].

All participants received written information and signed an informed consent. The Norwegian Regional Committee for Medical Research Ethics and the Norwegian Social Science Data Services approved the study.

2.2. Experimental protocol

All subjects reported to the laboratory twice; a pretest session and an experimental session. On average 5.5 (range 1–12) days separated the two sessions for subjects in the pain group vs. 4.2 (1–15) days for those in the reference group ($p = 0.12$).

At the pretest all subjects were examined by a specialist of physical medicine and rehabilitation. The examiner was aware of the subject's pain status, thus not blinded. The examination included range of motion of the cervical spine and shoulders, tests for nerve compression in the neck and upper extremities, and tests for subacromial problems. A neurological examination of muscle force, reflexes (biceps, triceps and brachioradialis tendon reflexes), and sensory function was performed on the upper extremities to identify any exclusion criteria. In addition, tender points in the neck and shoulder muscles, defined as localized pain occurring on a thumb pressure below 4 kg, and the typical areas of tenderness in fibromyalgia, were examined. None of the subjects fulfilled the ACR criteria for fibromyalgia [33], but all subjects in the pain group had tender points in the upper trapezius muscles (i.e. perceived pain on testing). The pretest further included familiarization with the measurements and procedures, and test trials of pressure pain thresholds before and after a 15 min computer work task training. During the computer training session the subject was encouraged to work as fast and accurately as possible without any pauses. The performance of this training session served to set the subject's standard for time pressure (see below), although the subjects were not aware of this.

At the experimental day the subjects reported to the laboratory in the morning. Pre-work PPTs were determined approximately 90 min before starting the computer work task, and before mounting the measurement equipments (the present study is part of a larger study, for more details see Refs. [31,32]. Post-work PPTs were performed 15 min and 30 min into the recovery period following the 90 min computer work task.

2.2.1. Computer work task

The computer office-work task consisted of using a computer mouse to correct typographical errors in a standardized text presented in a word processor (Microsoft Word 2000, Microsoft Corp., Seattle, WA, USA) as fast and as accurately as possible continuously for 90 min. Each error required at least two clicks with the left mouse button; first, the letter to be removed was marked and then a delete button in the word processor was activated. The task was designed to pose a high demand for precision in that all errors to be corrected required marking the letters f, i, j, l, and t in the letter type Arial in 11-point font. Each page comprised about 200 words with 20 spelling errors. The words with spelling errors were underlined in red, making them easy to locate to reduce the cognitive workload of the task. When a correct adjustment was made, the underlining disappeared. Pauses were not allowed, and the reporting of pain on the VAS was incorporated into the task using the same hand operations. The text was presented on a 17-inch LCD monitor (CTX model S721A, 1280×1024 pixels, Chuntex Electronics Co., Ltd, Taipei, Taiwan). A standard mouse (Logitech Inc., Fremont, CA, USA) with medium pointing speed was used, and this was operated by the subject's dominant hand.

During the 15-min work task training (at the pretest) the time spent to complete each page was recorded. The best (i.e. the shortest) time used to complete one page correctly was used to calculate the number of pages to complete for a period of 15 min, and ser-