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Does eccentric-exercise-induced jaw muscle soreness influence brainstem reflexes?

Tetsurou Torisu [a,b], Kelun Wang [a], Peter Svensson [c], Antoon De Laat [d], Yoshihisa Yamabe [b], Hiroshi Murata [b], Lars Arendt-Nielsen [a,*]

[a] Center for Sensory-Motor Interaction (SMI), Laboratory for Human Experimental Pain Research, Aalborg University, Fredrik Bajers Vej 7 D-3, DK-9220 Aalborg, Denmark
[b] Department of Prosthetic Dentistry, Graduate School of Biomedical Sciences, Nagasaki University, Nagasaki, Japan
[c] Department of Clinical Oral Physiology, School of Dentistry, University of Aarhus, Aarhus, Denmark
[d] Cluster of Oral Physiology, Department of Oral and Maxillofacial Surgery, Catholic University Leuven, Leuven, Belgium

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ABSTRACT

Objective: To investigate the effects of soreness evoked by eccentric jaw exercises on two types of brainstem reflexes: the short-latency stretch reflex and the longer-latency exteroceptive suppression (ES), and to test for possible relationships between magnitude of soreness and reflex responses.
Methods: The brainstem reflexes of jaw-closing muscles were recorded before (Baseline), immediately after (Post-task), and 1 day after (1-day-after) a 30-min eccentric exercise in 15 healthy men. All subjects participated in a control session without exercise.
Results: Soreness sensations at rest and during maximum biting were significantly elevated until 1-day-after the eccentric exercise ($P < 0.014$). The ES responses tended to be increased (more inhibition) at Post-task and 1-day-after. There was a significant correlation between the ES response and the soreness sensation during maximum biting ($P < 0.04$). The jaw-stretch reflex did not show significant change after the eccentric exercise.
Conclusions: Muscle soreness associated with eccentric jaw exercises has a differential impact on the jaw-stretch reflex and the ES response.
Significance: Experimentally induced acute muscle pain has previously been shown to influence both the ES and the jaw-stretch reflex, thus, different types of muscle pain and symptoms can be speculated to have different effects on a variety of brainstem reflexes.

1. Introduction

Eccentric or unaccustomed exercise induces delayed-onset muscle soreness (DOMS) (Gleeson et al., 1995). DOMS is associated with muscle injury, inflammation and/or tissue necrosis (Allen, 2004; Lieber and Fridén, 2002; Gleeson et al., 1995). DOMS has also been reported in jaw muscles (Christensen, 1971; Arima et al., 1999; Svensson and Arendt-Nielsen, 1995; Svensson et al., 1997). It is also suggested that some types of musculoskeletal pains in the orofacial region are associated with DOMS (Lund et al., 1991); however, the differential diagnosis of such muscle pain conditions is mainly based on the history and clinical judgment rather than on the knowledge of pathophysiological mechanisms and impact on the measures of motor function.

The exteroceptive suppression (ES) response in the jaw muscles, as well as the jaw-stretch reflex, has been extensively studied as a possible quantitative or qualitative tool for the diagnosis of pain syndromes of the masticatory system (De Laat et al., 1985, 1998; Cruccu and Deuschl, 2000; Cruccu et al., 2005). On the other hand, the ES response can be modulated by various conditions, e.g., jaw-muscle pain (Wang et al., 1999; Romaniello et al., 2000), headache (Bendtsen et al., 1996; Schoenen et al., 1987) and fatigue (Bendtsen et al., 1993; Torisu et al., 2007). The stretch reflex also can be facilitated during jaw-muscle pain (Wang et al., 2004a) or temporomandibular joint pain (Wang et al., 2004b), whereas the reflex response can be inhibited during muscle fatigue (Gandevia, 2001). However, the effects of eccentric exercise and associated soreness on the ES and/or the stretch reflex have not been examined so far.

Thus, the purposes of this study were to investigate the effects of eccentric exercise and the development of jaw-muscle soreness on the jaw-stretch reflex and the ES response and to test for associations between the magnitude of soreness and the brainstem reflex responses.

2. Materials and methods

2.1. Subjects

Fifteen healthy male volunteers (mean 25.6 ± 0.5 SEM years) participated in this study. The subjects did not have signs or symp-

* Corresponding author. Tel.: +45 96358830; fax: +45 98154008.
E-mail address: LAN@smi.auc.dk (L. Arendt-Nielsen).

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toms of TMD (Dworkin and LeResche, 1992), daily headache (less than 12 days per year), nor were they aware of excessive parafunctional activities such as jaw clenching. The study was approved by the local ethics committee (County of Aarhus: 20040074). All individuals gave their informed consent in accordance with the Helsinki Declaration, and understood that they were free to withdraw from the experiment at any time.

2.2. Experimental protocol and recordings

The experimental protocol is illustrated in Fig. 1. All subjects participated in 2 randomized sessions with a task of "eccentric open–close jaw exercise" or "no-exercise (control)". Each session had two successive experimental days and the sessions were at least a one week apart. The subjects were seated upright in a comfortable dental chair. At the beginning of each experimental day, two maximum jaw-clenching efforts were performed for 3 s each in the intercuspal position to calculate the root-mean square (RMS) value of the maximum voluntary contraction (MVC) (Fig. 1). The value of the left masseter muscle (MAL) was used as the feedback level of the pre-stimulus EMG activity for the jaw-stretch reflex and the exteroceptive suppression (ES) recordings. The mean values of the MVC of each muscle calculated from the two efforts were used for statistical analysis to check the constancy of the baseline EMG activity level throughout the four different experimental days.

Intensity of soreness sensation, soreness drawing area, the jaw-stretch reflex and the ES was recorded before the task (Baseline), immediately after the task (Post-task) and the 1 day after the task (1-day-after) (Fig. 1). Soreness sensations were recorded by using a 0-10 cm visual analogue scale (VAS) in two conditions, i.e. at rest and during maximum voluntary biting (MVB) (Fig. 1) on a biting-force transducer. During the MVB, the subjects held a 6-mm thick strain-gauge bite-force transducer (SN002, JNI Biomedical, Denmark) between the upper and lower incisors, and were instructed to bite twice with maximum force for 3 s, with a 60 s interval.

For the EMG recordings, bipolar disposable surface electrodes (720-01-k, Neuroline, Medicotest, Denmark) were placed 10 mm apart along the central part of the left and right masseter and anterior temporalis muscles (MAL, MAR, TAL, TAR). The common electrode (879100, PALS, Axelgaard, USA) was attached to the left wrist. The EMG signals were amplified, filtered with bandpass 20 Hz–1 kHz (Counterpoint MK2, Dantec, Denmark), sampled at 4 kHz, and stored together with the bite force for off-line analysis.

2.3. Eccentric jaw open–close movement

Eccentric jaw open–close movements were carried out against the resistance of spring coils as described in the previous reports (Svensson and Arendt-Nielsen, 1995; Svensson et al., 1997). Briefly, eight constant torque spring coils (250 g each, Tensator ltd, UK) were attached caudally to the lower canine via a string to pull the lower jaw. The other side of the coils was attached to the frame of the cephalostat. The subjects were instructed to open maximally and close the lower jaw steadily in a rhythm dictated by a metronome (0.3 Hz) for 5 min on the first day in the eccentric session. Since the subjects were asked to open slowly they had to contract their jaw-closing muscles during opening which is negative work for the jaw-closing muscles. In this study, we did not record EMG of the masseter or temporalis during the eccentric exercise, but such EMG activities have been documented in the previous studies (Svensson and Arendt-Nielsen, 1995; Svensson et al., 1997), in which the same device was used. These jaw movements were repeated in 6 blocks with 1 min interval, i.e., a total of 30 min eccentric exercise.

2.4. Jaw-stretch reflex recording

Sixteen jaw-stretch reflexes were evoked in both the masseter and the temporalis muscles with a muscle stretcher based on that described by Miles et al. (1993) and in our previous studies (Wang and Svensson, 2001; Wang et al., 2004a,b). Briefly, the subject clenched onto metal bars with their incisor teeth. The vertical position of the lower bar was controlled precisely with a powerful electromagnetic vibrator (Ling Dynamic System, model 406, UK) whose moving core was under servo control. The initial gape of the jaw bar was 4.0 mm. The short-latency component of the jaw-stretch reflex was evoked by a displacement of 1 mm with

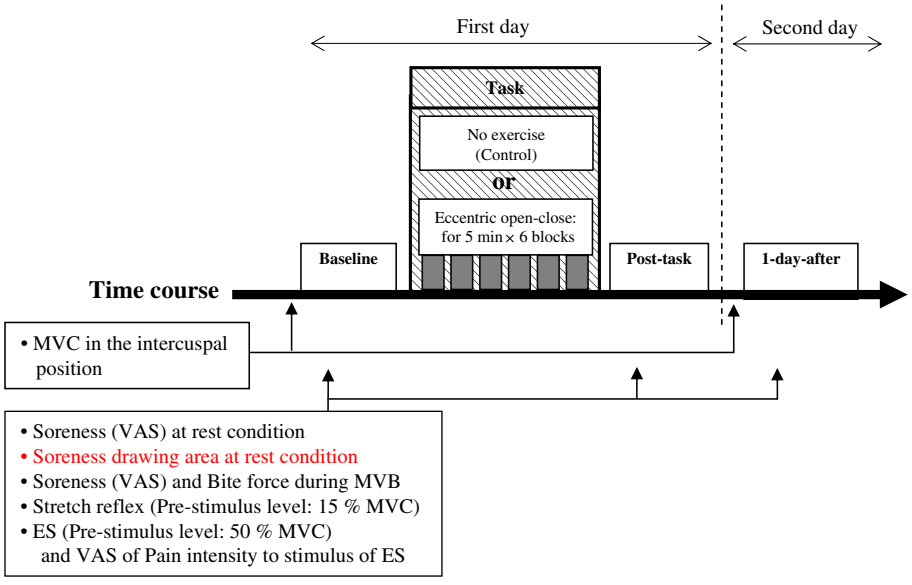

Fig. 1. Experimental protocol. "Eccentric exercise session" and "No-exercise (control) session" were carried out at least in one-week interval. Task ("eccentric exercise" or "no-exercise") were performed at the shaded period. A gray-colored block means one bout of eccentric jaw open–close movement for 5 min. Baseline: baseline recordings. MVC, maximum voluntary contraction; MVB, maximum voluntary biting; VAS, visual analogue scale; EMG-RMS, root-mean square value of electromyographic activity; ES, exteroceptive suppression.