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Original article

Effects of teeth clenching on the soleus H reflex during lower limb muscle fatigue

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ABSTRACT

Purpose: We assessed whether the soleus H reflex was depressed or facilitated in association with voluntary teeth clenching during muscle fatigue.

Methods: A total of 13 and 9 healthy adult subjects were instructed to perform right-side tiptoe standing for 5 (TS1) and 10 min (TS2) to induce the soleus muscle fatigue. Electromyograms (EMGs) were recorded from the bilateral masseter as well as the right-side soleus muscles. H reflex was evoked using a surface electrode. The isometric muscle strength during plantar flexion was measured. We tested two dental occlusal conditions (1) with maximal voluntary teeth clenching (MVTC) and (2) at mandibular rest position (RP). H reflex was evoked before and after TS1 and TS2. The isometric muscle strength during plantar flexion was measured before and after TS1 and TS2.

Results: Mean amplitudes of H reflex with MVTC before and after TS1 were significantly larger than that with RP before and after TS1. The mean peak torque (PT) during isometric plantar flexion was observed significant differences in all subjects. The mean amplitude of H reflex with MVTC before TS2 was significantly larger than that with RP before TS2. No significant difference between RP after TS2 and MVTC after TS2. The mean PT with MVTC before TS2 was significantly larger than that with RP before TS2. There was no significant difference between RP and MVTC after TS2.

Conclusion: The present study demonstrated that teeth clenching could facilitate H reflex regardless of the degree of muscle fatigue.

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1. Introduction

It has been observed that we often clench our teeth when exerting considerable effort, such as lifting a heavy load. With

the development of sports medicine, an increasing number of studies have investigated the correlation between oral motor function and motor performance and muscle strength of the extremities. In previous studies, we reported that teeth

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clenching had an effect of increasing the isometric muscle strength of the lower extremities [1].

On the other hand, the generation of muscle fatigue due to exercise has been commonly observed. Muscle fatigue is defined as an exercise-induced reduction in the ability of a muscle or muscle group to generate maximal force or power [2]. Yamanaka et al. [3] revealed that the effect of teeth clenching on the isokinetic muscle strength of knee extension was dependent on muscular fatigue.

A number of studies have reported the H reflex during muscle fatigue. A previous study in our laboratory demonstrated that the soleus H reflex was facilitated in association with teeth clenching and showed a positive linear relationship with the biting force [4]. However, little is known of this association during muscle fatigue. Thus, we studied whether the soleus H reflex was depressed or facilitated in association with voluntary teeth clenching during muscle fatigue.

2. Materials and methods

2.1. Procedure to induce fatigue

The subjects performed right-side tiptoe standing for 5 (TS1) and 10 min (TS2) to induce the soleus muscle fatigue. During right-side tiptoe standing, they slightly put a right hand on the wall to maintain their posture and prevent from falling (Fig. 1). Soleus muscle fatigue was assessed by the changes in median power frequency (MdPF) from EMG data. MdPF during the last 30 s of the fatigue procedure was calculated as the relative change of MdPF over that period.

2.2. Subjects

Exclusion criteria included subjects showing symptoms of pain and active inflammatory processes within the areas of the head and neck, a present or past history of injury in the lower extremities, and temporomandibular disorder [5]. Inclusion criteria were a stable intercuspal position without any diseased teeth, such as caries or periodontal disease, and missing teeth, excluding wisdom teeth. TS1 and TS2 were studied in 13 [aged 28.5 ± 2.9 years; mean \pm standard deviation (SD), nine males] and 9 (aged 29.1 ± 3.0 years; mean \pm SD, six males) volunteers, respectively. The current study was approved by the Ethical Committee for Human Research, Faculty of Dentistry, Tokyo Medical and Dental University, and subjects gave their informed consent according to the institutional guidelines (No. 1045, 1163).

2.3. Stimulation and recording procedures

2.3.1. H reflex measurements

Electromyograms (EMGs) were recorded from the bilateral masseter as well as the right-side soleus muscles using bipolar surface cup electrodes (diameter 8.0 mm) placed 2 cm apart longitudinally over the middle part of the masseter and 3 cm apart longitudinally over the middle part of the soleus muscles, respectively. Activity of EMGs was amplified using conventional amplifiers (time constant 0.03 s and high-cut frequency 10 kHz). Data from EMGs, which were amplified

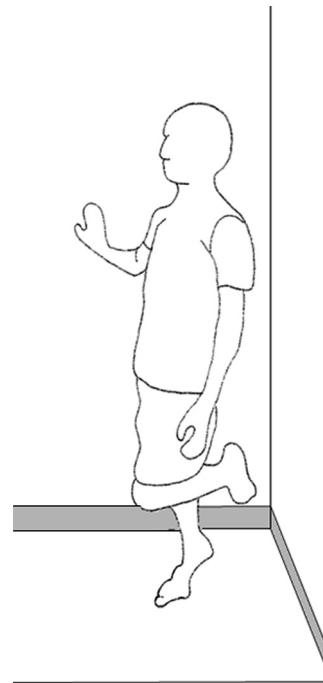


Fig. 1 – Scheme of right-side tiptoe standing to induce muscle fatigue.

with a gain of 1000 by conventional amplifiers, were recorded on a data recorder at 4000 Hz (AD Instruments PowerLab/s, Castle Hill, Australia). The soleus H reflex was evoked using a surface electrode positioned in the right popliteal fossa over the tibial nerve as the cathode, and a silver plate (35.0 mm \times 45.0 mm) was placed on the patellar region as the anode. The stimulating pulse of 1.0 ms in duration was used at intensities that evoked the H reflex with amplitude of approximately 30% of the maximum M wave, as described in our previous report [4]. Each session were randomly performed with the following two dental occlusal conditions: (1) with maximal voluntary teeth clenching (MVTC) in intercuspal position for 3 s and (2) at mandibular rest position (RP). When the display, which was placed in front of the subject, showed “clenching” or “rest,” subjects were instructed to maintain MVTC or RP, respectively (Fig. 2). A session comprised 25 trials, and a series of four sessions were performed before and after the fatigue procedure, respectively. During each session, the records of the initial three trials were discarded because of their instability, and MVTC and RP were recorded 11 times in a session at random (Fig. 3). The results of the remaining 22 trials in each session were statistically analyzed. The interstimulus interval was set from 8.0 to 11.0 s in 0.5 s steps in random sequence by the computer. The amplitude of the soleus H reflex was defined as the peak-to-peak amplitude, in other words, the difference between the maximum and minimum value within a time window of 20–50 ms after stimulation of the tibial nerve. The H reflex measurements in TS1 and TS2 were performed at an interval of at least 2 weeks between experimental days.

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