EFFECTS OF MUSCLE VIBRATION ON STRETCH REFLEX OF HAND INTRINSIC MUSCLES

[1]Guan-Jhih Wang, [1]Po-Chieh Lin, and [1,2]Bing-Shiang Yang

[1]Department of Mechanical Engineering and [2]Brain Research Center, National Chiao Tung University, Hsinchu, Taiwan

e-mail: bsyang@mail.nctu.edu.tw

INTRODUCTION

Previous studies have shown that muscle vibration (MV), below the threshold of inducing illusory movements or tonic vibration reflex, could modulate motor evoked potentials (MEP), evaluated by transcranial magnetic stimulation, of pathways controlling hand intrinsic muscles in intact and chronic stroke individuals [1,2]. It is evident that this type of sub-threshold MV provides corticomotor modulations on the pathways controlling the vibrated and adjacent non-vibrated muscles [2,3]. However, spinal-level contribution to the MV-induced changes in MEPs is not clear. The purpose of this study, therefore, is to use stretch reflex, an essential test of pure spinal neural pathway, to examine the spinal-level contribution to the effect of sub-threshold MV on motor pathway excitability.

METHODS

Ten healthy male subjects (age: 24.1±1.5 years; body height: 178.1±5.4 cm; body weight: 76.3±14.3 kg) participated in this study. All subjects gave informed consent to the study, and the test procedures were approved by the Institutional Review Board of Chang Gung Memorial Hospital. The subject was seated with upper extremities supported by custom-made armrests at 45° shoulder flexion, 30° shoulder abduction, and 135° elbow extension. Vibration was applied to the muscle belly of the three target muscles – first dorsal interosseus (FDI), abductor pollicis brevis (APB) and abductor digiti minimi (ADM) – individually by an electromechanical vibrator (ET132-2; Labworks Inc, USA) with a custom-made 7 mm-diameter probe. The probe was placed on the muscle with an average contact force of 0.4N. Muscle activation were recorded from surface electromyography (EMG), using an AMT-4 amplifier (Bortec Biomedical Ltd, Canada) with band-pass filter between 10 and 1 KHz. Dual Ag/AgCl electrodes with spacing of 18 mm (Noraxon Inc, USA) were placed over the muscle bellies. A custom-made finger stretching device driven by a servo motor (MHMD082P1S, Panasonic Corp, Japan) was employed to induce a rapid finger adduction at 850°/s through a range less than middle 70% of subject's range of motion, hence to stretch the target muscle. A custom-designed software written in LabVIEW 8.2 (National Instruments Corp, USA) was used to control the device and conduct EMG data acquisition. The vibration frequency was set at 80Hz, and the amplitude just below the threshold of inducing illusory movement or tonic vibration reflex of each subject. The onset of finger stretching was randomized from 1 to 3s after onset of MV. The duration of MV lasted 1s after the stretching offset. Subjects were instructed to perform an isometric contraction in the target muscle at 20% of maximum voluntary contraction before finger stretching and maintain the activation level until the end of each trial. The primary variable investigated here was the peak amplitude of rectified EMG signals induced by muscle stretch, i.e. the so-called M1 response described in previous studies [5,6], and the latency of M1 (Figure 1). The stretch onset time was as the maximum acceleration of fingers measured by an accelerometer. The onset threshold of M1 was three times standard deviation of EMG baseline. The mean peak amplitudes and latencies of M1 of 20 trials were determined for each target muscle. Paired t tests were used to compare the means with to without MV.

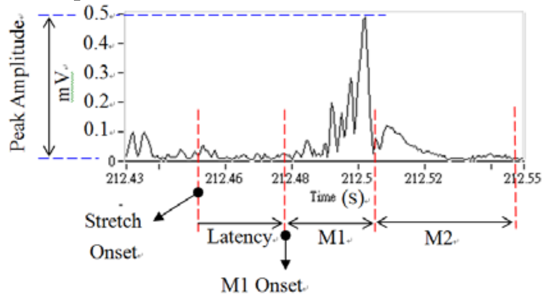

Figure 1: Rectified EMG signals and measuring variables of stretch reflex response [5, 6].

RESULTS AND DISCUSSION

The sub-threshold muscle vibration significantly suppresses the reflex magnitude, but not the latency, after the target muscles were stretched as compared to that without muscle vibration (Figure 2). Previous studies reported that in intact individuals, muscle vibration could facilitate MEPs in the pathway controlling the vibrated muscle [2,3].
Our finding suggests that this MV-induced MEP facilitation may not occur in the spinal-level pathway.

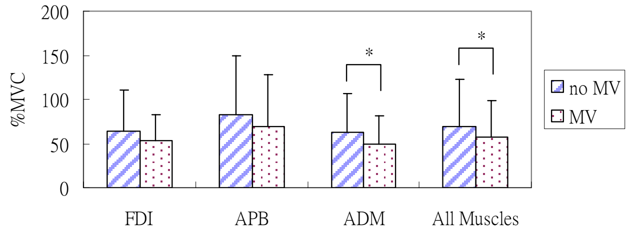

Figure 2: Mean peak amplitude of M1 of 20 trials in three hand muscles with muscle vibration (MV) and without MV (no MV) of ten subjects. Paired t-test：*: $p<0.05$.

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