THE INFLENCES OF THE VIBRATION STIMULATION ON LINEAR AND NONLINEAR FEATURES OF ELECTROMYOGRAM ON THE FOREARM

Chang-Yong Ko, Yunhee Chang, Sol-Bi Kim, Shinki Kim, Gyoosuk Kim, Jeicheong Ryu, Musung Mun

Korea Orthopedics and Rehabilitation Engineering Center (KOREC), Republic of Korea

Introduction

In most of the present myoelectric hand-prostheses, there were no any sensory substitution devices which transmitted sensory feedback to the users. Thus, the users have been given sensory feedback by only visual feedback [Gonzalez, 2012]. However, it caused not only psychological but also physiological burden to the users. Recently, several researchers have suggested a supracutaneous vibration (SV) as sensory substitution devices mechanism due to easy fabrication, small size, and reliable function. Most of the previous studies have been focused on the discriminating ability between SV stimuli at varying frequencies. Although surface electromyogram (sEMG) is one of the main mechanism to manipulate the commercial myoelectric hand prostheses, only little study on the influence of the supracutaneous vibration on sEMG have been reported. Furthermore, sEMG has not only linear feature but alson non-linear features [Phinyomark, 2011]. The aim of this study, thus, was to investigate the influence of the supracutaneous vibration on linear and non-linear features of sEMG.

Methods

Eight female (36.1 ± 10.9 years old) and nine male (36.0 ± 8.7 years old) were involved in this study. All subjects were in good general health without any musculoskeletal and neurological disorders.

A vibration motor (YB1030, YB Micro Motor, Seoul, Korea) at a diameter of 10mm, a height of 3mm, and a weight of 1.1g was used as SV stimulation. Frequency of the vibration motor was controlled by the driving voltages ranging from 0.6 V to 4.0 V. The vibration at frequencies ranging from 37 Hz to 258 Hz was stimulated on the mid-point of the 40% site of proximal part on the forearm. Then sEMGs on the pronator teres were measured by using Telemyo 2400R (Noraxon Corp., USA). Root mean square (RMS) of sEMG as linear features was calculated and fractal dimension (D_F) of sEMG as non-linear features was calculated through a box-counting method [Phinyomark, 2011].

A two-way repeated measure analysis of variance was performed to evaluate the influence of vibration stimulation on sEMG features and to verify gender differences.

Results

From 37Hz to 223Hz, significant increases in the RMS of sEMG over frequency both genders were shown (Figure. 1, all $p < 0.05$). However, there were no significant gender-differences.

In the D_F of sEMG, there were no differences throughout all frequencies regardless of genders (Figure. 2, all $p > 0.05$). Furthermore, no significant differences between genders were shown (all $p > 0.0$).

Discussion

In this study, changes in the RMS and the D_F of sEMGs were shown after the supracutaneous vibration stimulation in both female and male. This result indicated that SV stimulation affected the linear and non-linear features of sEMG regardless of genders.

However, the influences of the supracutaneous vibration on sEMG were different between the linear and the non-linear features. Once the supracutaneous vibration was stimulated, the RMS of sEMG tended to be steadily increased up to 223Hz. Otherwise, the D_F of sEMG was maintained in all frequencies. However, there were no gender-differences in both the RMS and the D_F of sEMG. Together, the influence of the supracutaneous vibration was higher in sEMG`s linear feature than those non-linear feature, regardless gender. These results may contribute to design and develop sensory substitution devices for the users of myoelectric hand prostheses.

References

Gonzalez *et al*, J Neuroeng Rehabil, 9:33, 2012

Phinyomark *et al*, European Journal of Scientific Research," 62:24-34, 2011

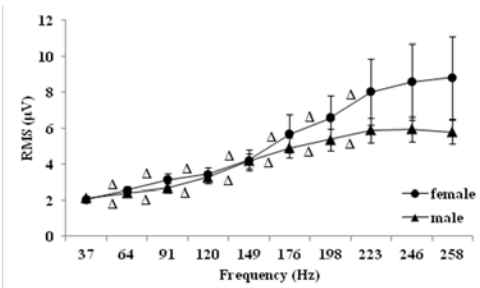

*Figure 1: Results of root mean square (RMS) of sEMG over frequencies, mean ± standard error of mean *: p < 0.05 over frequencies.*

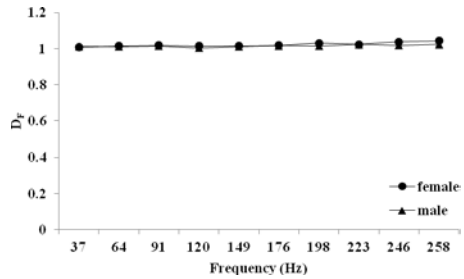

Figure 2: Results of fractal dimension (D_F) of sEMG over frequencies, mean ± standard error of mean.