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Assessment of the biodynamic response of human body exposed to whole-body vibration using apparent mass and muscle activation level

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Abstract

Introduction

During exposure of seated human body to vertical whole-body vibration, muscles are activated to maintain the stability of the musculoskeletal system in response to the perturbation of the vibration. Vibration transmitted to body may cause functional and structural degenerations on spinal region, especially at the lumbar region.[1] Electromyography (EMG) signals and apparent mass (APMS) can be used to reflect the fundamental biodynamic responses of the human body under vibration. The objective of this experimental study was to investigate the relationship between the APMS and EMG signals, if any, which can provide further insight regarding the evaluation of the degenerative effects of whole-body vibration on the spine of seated participants.

Methods

Twelve subjects participated in the experiments (ethical approval was obtained from University of Southampton). Postures of the seated subjects were normal upright on a rigid seat with hands in lap without the backrest contact, wearing a loose lap belt. Subjects' feet were supported from an adjustable footrest. Sinusoidal random vibrations in vertical direction with duration of 30-second, magnitudes of 0.5, 1.0 and 2.0ms^{-2} root mean square (rms) and frequency range between 0.5 and 20Hz were applied to the subjects through the rigid seat. A 60-second resting period was given before each trial.

Acceleration data at the seat base were recorded using accelerometers (SiliconDesigns2260-005), while the forces in the vertical direction were simultaneously recorded at the rigid seat pan using a force plate (Kistler9281B). Muscle activity was measured from longissimus thoracis between T6 and T10, iliocostalis lumborum between T11 and L2, and lumbar multifidus between L2 and L5 using 16-channel array EMG electrode (EMG-USB128, LISiN–OT,Bioelettronica). EMG signals during the

maximum voluntary contractions (MVC) of the corresponding muscles were also recorded without vibration affect based on the Biering-Sorensen test motion.

Results

The calculated APMSs were normalized with APMS value at 0.5 Hz. The rms value of muscle activation data for all applied frequency were calculated and normalized with MVC. Fig.1. shows the APMS and muscle activation for all magnitudes (A,B and C) and all muscles (D,E and F).

Discussion

It was found from Fig.1 (A, B and C) that the activity of spinal muscles increased when the APMS increased and the muscle activation increased with increasing the magnitudes of excitation. Fig.1 (D, E and F) indicated that during the excitation, the multifidus and iliocostalis were more affected than the longissimus.

Acknowledgments

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References

[1] Dupuis H, Zerlett G. Whole-body vibration and disorders of the spine. Int Arch Occup Environ Health 1987;59:323-336.

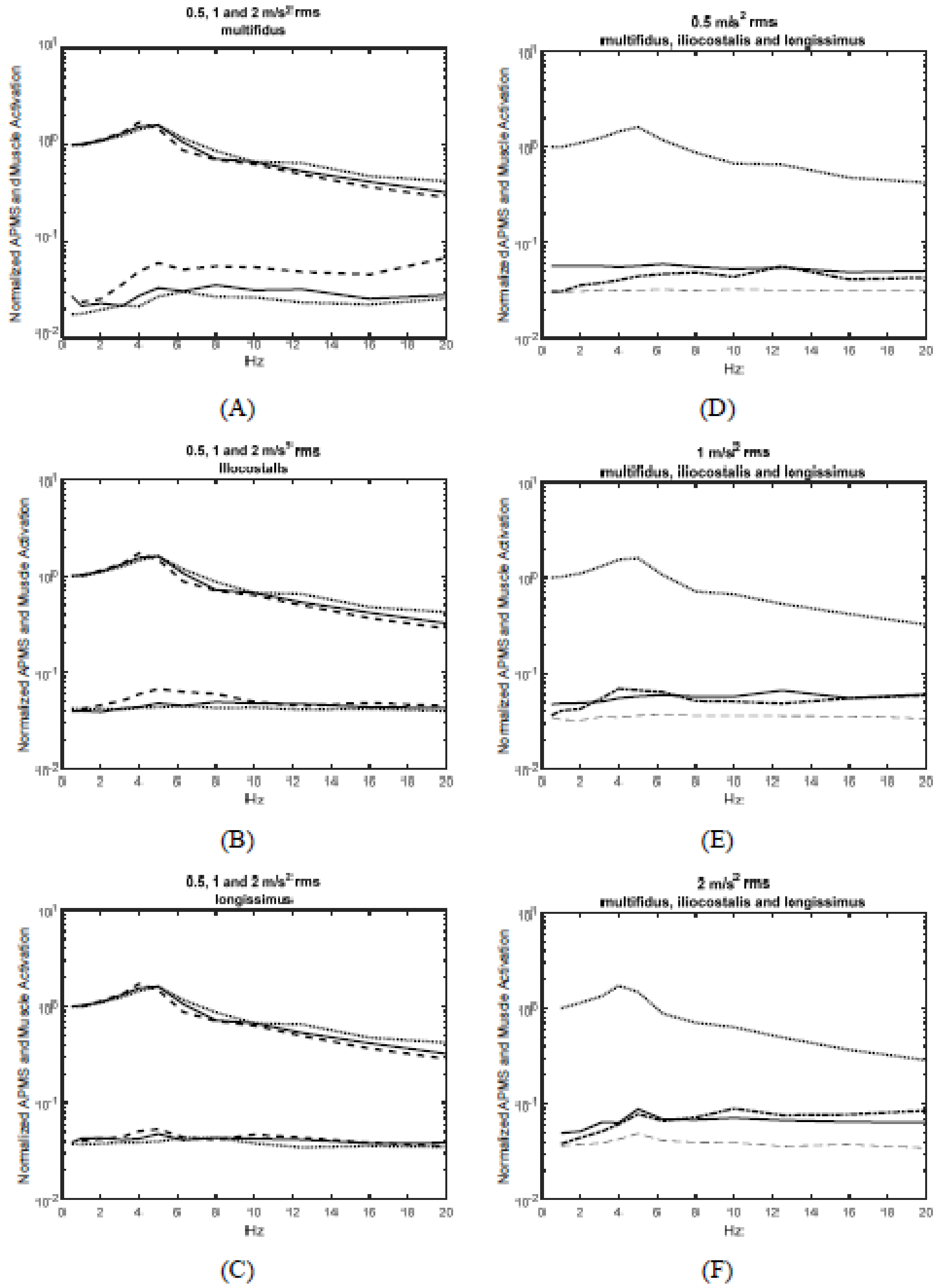

Fig. 1. The apparent masses (upside) and muscle activation (underside), (A) right multifidus, (B) iliocostalis and (C) longissimus muscles for excitation with magnitude 0.5 (dotted line), 1 (solid line) and 2 (dashed line) m/s^2 rms and (D) 0.5 m/s^2 rms, (E) 1.0 m/s^2 rms and (F) 2.0 m/s^2 rms for right multifidus (dotdash line), iliocostalis (solid line) and longissimus (dashed line) muscles.