ROLE OF MUSCLE SPINDLE DURING DYNAMIC HUMAN MOVEMENTS: EXPERIMENTAL AND SIMULATION STUDIES

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INTRODUCTION: Muscle spindle does important roles balancing muscle tone during human movement such as exercise and stretching. The primary objective of this study is to explore the contribution of muscle spindles on the modulation of voluntary movement.

METHODS: An experiment was conducted using 6 healthy male subjects without musculoskeletal disease. It is known that short period of mechanical vibration loaded on muscle or tendon can reinforce Ia afferent activity, yet if it is applied for a prolonged period, Ia afferent feedback to alpha motoneuron is depressed. Moreover, it was reported that its activity level gradually recover after the cessation of vibration. Conditioning of the human movement responses by tendon vibration can be a tool to investigate Ia afferent functions during human movements.

To attenuate the Ia afferent functions of the soleus, 100Hz of vibration was loaded on Achilles tendon for 30 min(DPS-285, DiaMedical System, Tokyo, Japan). To observe a change of the Ia afferent activity to the vibration, every 15 min points of H-reflex, M-wave amplitude after the vibration were recorded. To explore dynamic human movement, force plate and motion capture system collects the data of hopping movement (Hopping jump using ankle joint only at the same point above force plate). Based on collected data, force impulse, joint torque and jump height were calculated.

As a next step, this study developed a muscle tendon unit (MTU) computational model to determine the relation of muscle spindle' Ia afferent feedback information and movement modulation effect. This model is consisted with the muscle-tendon dynamics, musculoskeletal geometry and muscle spindle feedback function of the body during movement using MATLAB (The Math Works Inc., USA). Kinematic result, H-reflex and M-wave data collected by above-mentioned experiments were used as inputs to the MTU computer simulation model .

RESULTS & DISCUSSION: Result shows a decrease and recovery of 'H-reflex/M-wave max' rate (H/Mmax) after the vibration. Also force impulse of hopping movement were decreased significantly related to its depression of H /Mmax. These experiment data shows that decreased H/M-max makes depressed force during dynamic movement. And the analysed simulation data supports that Ia afferent sensitivity of muscle spindles has significant interrelation with decreasing of muscle force.

CONCLUSION: This study identified the contribution of muscle spindles during dynamic movement. It would be possible to suggest specific relation of both factors, if decreased force impulse by decreased H /Mmax shows almost same tendency with simulated results by further study.

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