Relationship between reaction time and onset of the muscle activation during drop landing

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INTRODUCTION: Quickness is one of very important factors for athletes in sporting activities. Measuring reaction time reflects how quickly they can move by contracting associated muscles. Reaction time consists of the pre-motor time, as the time from stimulus input to the onset of the muscle activation, and the motor time, as the time from the onset of the muscle activation to the point of body motion begun. In 2004, Demont et al. were reported that a neuromuscular feed forward process as measured by preactivation of the muscle to stabilize joints dynamically during drop landing. This contributed to prevent injuries. Both time of pre-motor and preactivation were the muscle activities that occur before the body motion begins.
The purpose of this study was to clarify the relationship between reaction time and onset of the muscle activity during drop landing.

METHOD: Fifteen healthy female college students (age, 21.9 ± 2.1 years; height, 161.1 ± 5.0 cm; weight, 53.1 ± 5.5 kg) volunteered in this study. All subjects had no previous histories of orthopedic injuries or neurological disorders to their lower extremities. Prior to participation, informed written consent was obtained from each subject according to the university institutional review board policy. To measure reaction time, subjects jumped after the light flashes. It measured five times. Reaction time, time between the jump task occurs after the light flash, was measured using the exclusive measuring instrument REACTION (Takei Co.. Ltd. Japan). The apparatus automatically measured the elapsed time of the task occurrence after the light stimulus (Figure 1). They were instructed to jump immediately after the light flashed. In addition, subjects also completed five bilateral drop landings. Subjects landed from a 0.40m height box to a wooden floor. Before the measurement, a couple of practices were conducted to make subjects understand the task. For all landings, subjects performed in a standardized take-off position; hands were placed on iliac crests. Subjects were not given any special instructions with regards to their landing mechanics to prevent experimenter bias.
The electromyogram (EMG) data during drop landing were collected from 4 muscles; vastus medialis (VM), vastus lateralis (VL), semimembranosus (SM) and biceps femoris (BF). The onset of muscle activities was visually identified as the first point, which is the EMG amplitude of 100ms after the start of landing that exceeded the mean baseline activity by three standard deviations. The definition of the baseline was set as the EMG amplitude of the 100ms after the toe-off from the 0.40m height box. Pearson ‘r’ correlation was conducted between reaction time and the onset of each muscle activities. The statistical significance was set at 0.05.

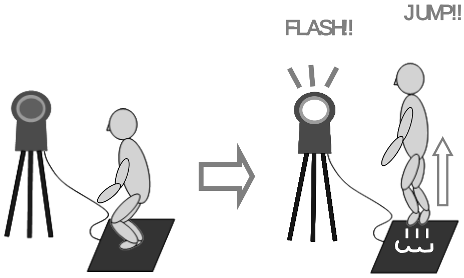

Figure 1. Measuring the reaction time
Subjects jumped after the light flashed.

RESULTS: The mean ± SD of reaction time was 331.8 ± 45.6 ms. The onsets of muscle activities during drop landing were shown in Figure 2. The initial contact occurred 311.3 ms after the toe-off on the box. There were correlations between reaction time and the onsets of SM (r=0.57) and BF (r=0.61) activities (p<0.05). However, VM (r=0.38) and VL (r=0.40) activity were no correlations with reaction time.

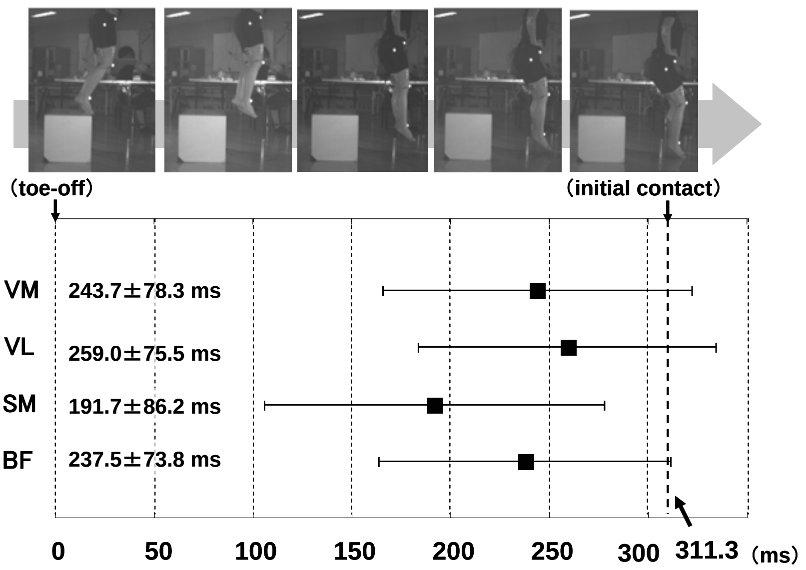

Figure 2. The timing of starting muscle activity during drop landing
Knee extensors: vastus medialis (VM), vastus lateralis (VL).
Knee flexors: semimembranosus (SM) and biceps femoris (BF).

DISCUSSION:
It is reported that the muscle prepares for an impact with activating associated muscles.
An anterior cruciate ligament (ACL) is commonly injured with landing motion. It is suggested that the load on the ACL is reduced by activating hamstring muscles. In 2009, Zebis et al. reported that noninjured female athletes with reduced EMG preactivity of the semitendinosus and increased EMG preactivity of the vatsus lateralis during side cutting were at increased risk of future noncontact ACL rupture. Thus, increasing the knee flexors activities contributed to prevent ACL injuries. In other words, the onset of SM and BF activities faster than those of VM and VL activities would be beneficial to prevent ACL injuries. There were significant correlations between reaction time and the onset of SM and BF activities during drop landing. This study suggests possibility to predict the onset of muscle activities during drop landing by measuring reaction time, though drop landing and jump were different movements.
In the future study, we will clarify the correlation between reaction time and the onset of thigh muscle activities on athletes.

CONCLUSION: This study identified the correlation between reaction time and onset of thigh muscle activities. Because SM and BF activities during drop landing significantly correlated to reaction time, it might be possible to make the onset of SM and BF activities occur faster by reacting to certain stimuli faster.

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