Velocity dependence of the increase in the maximal voluntary concentric torque following a preceding isometric contraction

1 Atsuki Fukutani, 2 Naokazu Miyamoto, 3 Hiroaki Kanehisa, 2 Toshimasa Yanai, 2 Yasuo Kawakami
1 Graduate School of Sport Sciences, Waseda University, email: atsukifukutani@fuji.waseda.jp
2 Faculty of Sport Sciences, Waseda University
3 National Institute of Fitness and Sports in Kanoya

SUMMARY
The twitch torque increases after a high intensity contraction. This phenomenon is called postactivation potentiation (PAP). The preceding contraction for inducing PAP can also increase the maximal voluntary concentric torque. Previous studies reported that the extent of increase in the twitch torque was larger when the angular velocity during the twitch contraction was higher. Thus, we hypothesized that a larger increase in maximal voluntary concentric torque occurs when the velocity of the concentric contraction is higher. Twelve healthy male subjects performed the maximal voluntary isometric plantar flexions at 30°/s and 180°/s. At the same time, the twitch torque was also recorded for 6 seconds as the preceding contraction. Before and after the preceding contraction, the subjects performed maximal voluntary concentric plantar flexions at 30°/s and 180°/s. At the same time, the twitch torque was also recorded to confirm whether the potentiation effect induced by the preceding contraction was comparable between the two velocity conditions. The extent of increase in the twitch torque was similar between the two velocity conditions (p > 0.05), whereas the maximal voluntary concentric torque was increased significantly only in the fast velocity condition (p < 0.05). These results suggest that the increase in the maximal voluntary concentric torque is velocity dependent, with a larger increase at a higher velocity.

INTRODUCTION
The twitch torque generated by a muscle increases after a high intensity contraction of the same muscle. This phenomenon is called postactivation potentiation (PAP) [1]. Since PAP is caused by the enhancement of torque generating capability of the muscle after the preceding contraction [2], the preceding contraction increases not only twitch torque but also torque generated during a high intensity contraction [3]. Since a larger increase in the twitch torque after the preceding contraction occurred as the velocity of the twitch contraction was higher [4], it is hypothesized that a larger increase occurs when the velocity of the maximal voluntary concentric contraction is higher. If such velocity dependence exists for the increase in the maximal voluntary concentric torque after the preceding contraction, we could apply the preceding contraction effectively to sports activities or resistance training. Therefore, the purpose of this study was to examine the velocity dependence of the increase in the subsequent maximal voluntary concentric torque after the preceding contraction.

METHODS

RESULTS AND DISCUSSION
The twitch torque after the preceding contraction was increased significantly in each velocity condition at Post, 1min and 5min as compared to before the preceding contraction (p < 0.05). The time course of the relative change of the twitch torque was similar between the two velocity conditions (p > 0.05) (Figure 1). On the other hand, the maximal voluntary concentric torque after the preceding contraction was increased significantly only in the fast velocity condition immediately after the preceding contraction (p < 0.05) (Figure 2). Abbate et al. (2000) [5] demonstrated that the increase in the subsequent tetanic tension after the preceding contraction was larger as the shortening velocity of the muscle fiber was higher in the rat muscle. Thus, the results of our study indicate that the potentiative response of the muscle after the preceding contraction is more pronounced in faster shortening.

In addition, the present study showed that the subsequent maximal voluntary concentric torque increased only immediately after the preceding contraction in the fast velocity condition, unlike the fact that the increase in the twitch torque lasted for 5 minutes. These results would be caused by the difference of the sensitivity to the potentiation effect induced by the preceding contraction between twitch and maximal contraction.
voluntary concentric contractions. The potentiation effect saturates as the activation level during the subsequent contraction increases [6]. Such non-linearity of the potentiation response might be related to the observed differences in the change between twitch and maximal voluntary concentric contractions.

The M-wave amplitudes and RMS$_{EMG}$ were not different between the two velocity conditions, indicating that the changes of neural activities before and after the preceding contraction were identical. These results suggest that the increase in the maximal voluntary concentric torque only in the fast velocity condition was caused by the velocity dependence of the positive response residing in muscle fibers induced by the preceding contraction.

![Figure 1](image1.png)

**Figure 1:** %Change of the twitch torque after the preceding contraction. # and $: Significant difference from Pre values in each velocity condition.

![Figure 2](image2.png)

**Figure 2:** %Change of the maximal voluntary concentric torque after the preceding contraction. #: Significant difference from Pre value in fast velocity condition. †: Significant difference between velocity conditions.

**CONCLUSIONS**
The extent of increase in the maximal voluntary concentric torque after the preceding contraction is velocity dependent, with a larger increase at a higher velocity.

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**REFERENCES**