POST-TETANIC POTENTIATION or POST ACTIVATION POTENTIATION

“Perhaps the best-known of the potentiation responses is the effect of prior activity on twitch force. The magnitude of the twitch force is extremely variable and depends on the activation history of the muscle. A twitch elicited in a resting muscle does not produce the maximal twitch force. Rather, twitch force is maximal following a brief tetanus; This effect is known as post-tetanic potentiation of twitch force.

The post-tetanic potentiation of twitch force can be substantial and can be elicited by either voluntary contractions or electrical stimulation. For example the potentiation of twitch force in the ankle dorsiflexion muscles of human volunteers ranged from 29% to 150% after 20 to 40 seconds of intermittent electrical stimulation applied to the nerve, and by 150% 280% after a 6s MVC. Post-tetanic potentiation is greatest after contractions that last five seconds to 10 seconds and decreases with long-duration contractions. The amount of twitch potentiation is similar for isometric, shortening, and lengthening MVC’s and does not substantially change either the contraction time or half–relaxation time of the twitch or the M wave. However, twitch potentiation in the knee extensor muscles after a fatiguing contraction was greater at a short muscle length and was associated with a longer time to task failure, and was reduced in the ankle plantar flexor muscles after a series of anisometric contractions that fatigue the muscles.

At least two processes are involved in post-tetanic twitch potentiation. An early potentiation occurs after brief contractions and decays relatively quickly. After a delay of about 60 seconds a late potentiation process emerges, which reaches a peak about 200 seconds and then decays to control levels after 8 to 12 minutes of recovery. The mechanisms underlying these potentiation processes may involve an alteration in calcium kinetics, the phosphorylation of myosin light chains, and the force-velocity characteristics of the cross bridges. The most commonly accepted explanation for post-tetanic potentiation is an increase in the sensitivity of the contractile proteins to activation by Ca2+ due to phosphorylation of the myosin light chains.

Potentiation of the sub maximal force occurs in all three types of motor units (types SS, FR, and FF). When motor units were activated with a stimulus that elicited a sub maximal titanic force, the potentiation (increase in peak force) was greater for the fast-twitch motor units than for the slow-twitch motor units. However, the incidence of potentiation among the motor units was greater for the fatigue-resistant motor units compared with the fatigable units. Because the occurrence of potentiation was distributed across all three types of motor units, the mechanisms underlying the potentiation differ from those that define motor unit type.

The study of post-tetanic twitch potentiation has emphasized that the processes of potentiation and fatigue occur concurrently, beginning from the onset of activation. For example, when the extensor digitorum longus muscle of rats was stimulated with a protocol that reduced the sub maximal tetanic force to an average peak force of 36% of the control value, 50% of the muscles exhibited post-tetanic twitch potentiation. This effect was not observed in soleus, which largely consists of slow-twitch fibers. The coexistence of potentiation and fatigue has also been observed in the quadriceps femoris muscles of humans after a 60s MVC.”

- Enoka, Roger. Neuromechanics of Human Movement