INTRODUCTION

Muscle force development during voluntary contractions is very history dependent. A classic example of this is the depression in force that occurs during prolonged activity, i.e. fatigue. A lesser known example is the increase in force observed consequent to brief (unfatiguing) activity, an outcome referred to as postactivation potentiation (PAP). In both fatigue and PAP, intracellular mechanisms modulate the intrinsic force-generating ability of individual muscle fibers within the motor unit population. During activity, these respective processes may coexist and the muscle force may indeed reflect the balance between these competing phenomena [1].

The influence of PAP on motor unit activation is not understood. In principal, PAP could down-regulate the motor unit discharge rate required to attain a given force or power output. Indeed, Adams and De Luca [2] reported an early and transient reduction in the discharge rate of select motor units within fatigued vastus lateralis muscle. The origin of this response, i.e., fatigue or PAP, was not, however, identified. On the other hand, Klein et al. [3] noted that motor unit discharge rates were reduced when PAP was observed in triceps brachii muscle during submaximal isometric contractions.

Given the uncertainty regarding the etiology of reduced motor unit discharge rates, we sought to clarify the role of PAP on this parameter. To this end, we compared motor unit discharge rates of unfatigued tibialis anterior muscle during submaximal contractions in the potentiated and unpotentiated state.

METHODS

Ten healthy college aged subjects were recruited with no history or neurological or neuromuscular disorders. The subjects visited the Electromyographic Kinesiology lab at Brock University on three separate occasions. The first visit was a familiarization, the second involved data collection without indwelling electrodes and the final visit involved all aspects of the study, including indwelling electrode data collection.

Day 1:
Day 1 consisted of subject initiation to the laboratory environment where they were introduced to the equipment and informed of all aspects of the study. Subjects then signed an informed consent document, and were asked to assume a supine position to locate the most proximal motor point on the tibialis anterior. The skin surface was cleaned and mildly abraded in preparation for placement of the surface electrodes. Once the surface electrodes were placed on the skin, the subject was moved to a testing chair for the remainder of the testing session (Figure 1). Baseline measurements were taken that included maximum voluntary contraction (MVC) of the dorsiflexors and a maximal motor response...
(M\textsubscript{max}) was elicited by electrical stimulation of the peroneal nerve.

**Day 2 and 3:**

Day 2 and 3 consisted of the identical subject preparation for data collection as was seen in Day 1. Once the surface electrodes were placed and the subject was moved to the testing chair, both MVC and M\textsubscript{max} were again determined (this was done post needle placement on Day 3). Subjects were given a rest period (ten minutes) and three twitches were evoked to elicit M\textsubscript{max} followed by a five second contraction equal to 50% of MVC and another three M\textsubscript{max} twitches (Unpotentiated condition). The subjects were again given a ten minute rest period. Another three twitches to elicit M\textsubscript{max} were given, followed by a ten second contraction equal to 50% of MVC, which was also followed by three M\textsubscript{max} twitches (Unpotentiated condition).

Days 2 and 3 were identical, except on Day 3, the indwelling electrode was additionally used to record motor unit activity.

**Statistical Analysis:**

All data were analyzed using the *a priori* planned comparisons (single-degree of freedom F-tests).

**RESULTS AND DISCUSSION**

**M-wave**
The peak-to-peak amplitude of M\textsubscript{max} exhibited no statistically significant differences among all conditions ($p's > 0.05$).

**MPF**
The frequency content of surface electromyographic (sEMG) activity showed no statistically significant differences ($p's > 0.05$) in Mean Power Frequency (MPF) between pre- and post-unpotentiated conditions. However, when comparing both (pre/post) unpotentiated conditions to the potentiated condition there was a statistically significant decrease (Pre 58.1 ± 8.5, Post 62.2 ± 8.3, Potentiated 53.6 ± 8.6; 13.8% change; $p=0.005$).

**Firing Rates:**
The results of the firing rates derived from indwelling recordings followed the same pattern as was seen with the sEMG MPF data. The pre/post unpotentiated data showed no significant differences between the two conditions ($p>0.05$). However, similar to the MPF data, the potentiated compared to unpotentiated conditions resulted in a statistically significant decrease in firing rate (Pre 20.3 ± 2.4, Post 20.0 ± 3.7, Potentiated 18.3 ± 3.0; 9.9% decrease; $p=0.004$).

The RMS data supported the findings for the M\textsubscript{max}, as it remained constant throughout all trial conditions. The stability of M\textsubscript{max} suggests that the differences seen in firing rate could not be attributed to muscle fatigue. These findings accompanied with the frequency and firing rate data (surface and indwelling, respectively) indicate that the potentiation of the muscle caused a decrease in motor unit firing rates compared to the same unpotentiated muscle.

**CONCLUSIONS**

Based on the data presented, we can support the findings of De Luca et al. [4] who also observed a decrease in firing rates, which they speculated were due to potentiation. This research protocol set out to specifically target the potentiation of the muscle and the subsequent response. This study demonstrated that potentiation does decrease firing rates when the motor response is unchanged in subjects with no neuropathies.

**REFERENCES**


**ACKNOWLEDGEMENTS**

This research was supported by NSERC grants (DG)(RV)