THE EFFECTS OF LACTATE ON WHOLE MUSCLE AND ISOLATED SACROPLASMIC RETICULUM FUNCTIONS

by

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EFFECTS OF LACTATE ON SKELETAL MUSCLE FORCE PRODUCTION AND SACROPLASMIC RETICULUM FUNCTION

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(ABSTRACT)

Numerous studies have attributed the decrease in force production of skeletal muscle during exercise to a increase in lactate concentration ([lactate]). This notion is based on the high negative correlation between plasma lactate and force during fatigue and recovery. These experiments attempted to determine if lactate directly effects force production in skeletal muscle. Mouse extensor digitorum longus muscles (EDL) were isolated and incubated in a buffered Ringers solution at a pH 7.2 and exposed at three minute intervals to a final concentration of 10, 20, 30, 50mM lactate. At 21° C, tetanic force production (P_o, 250ms, 110Hz) decreased to 99.3 ± 1.0, 97.1 ± 1.2, 94.9 ± 1.1* and 93.1 ± 1.3*% of initial and the rate of force development (+dP/dt) was reduced to 99.4 ± 0.7, 96.8 ± 0.5, 93.5 ± 0.6*, and 89.3 ± 1.2*% of initial (*$p<0.05$ vs untreated muscles). At 37° C the effects of lactate were augmented. P_o was reduced to 89.7 ± 1.1, 81.0 ± 2.4, 73 ± 3.9*, and 61.6 ± 5.4*% and +dP/dt was reduced to 79.4 ± 1.8*, 65.9 ± 2.8*, 55.4 ± 4.0*, and 44.3 ± 5.0*% of initial (*$p<0.05$ vs control muscles). The next phase was to determine if the changes in P_o and +dP/dt were due to alterations in the sacroplasmic reticulum (SR) Ca^{2+} exchange. The SR of EDL homogenates were actively loaded with Ca^{2+} and release was initiated by 25 μM $AgNO_3$. The rate of Ca^{2+} release was significantly reduced by 31% (2.48 ± 1.21 vs 1.72 ± 0.24 $\mu mol \cdot mg^{-1} \cdot min^{-1}$) in the presence of 25 mM lactate. These results indicate that exposure to increased [lactate], independent of the H^+, decreases force production of whole muscle, effects that are greater at 37° C than 21° C. Also increased lactate reduces the rate of SR Ca^{2+} release. These results suggest that lactate depresses whole muscle force production by altering Ca^{2+} release of the SR. They also support the idea that increased lactate concentrations disrupt normal muscle function leading to the development of fatigue.