Effects of amino acids bearing net charges on Ca^{2+}-activation properties of skeletal muscle fibres

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Amino acids are one class of solutes found in significant concentrations in skeletal muscle that may affect contraction. In a previous study we found that amino acids with polar (glycine) and non-polar (proline) uncharged side chains have little or no effect on the contractile apparatus of skeletal muscle[1]. In this study we investigated whether amino acids with side chains bearing a net charge alter Ca^{2+}-activation properties of the contractile apparatus in four structurally and functionally different types of skeletal muscle; long- and short-sarcomere fibres from the claw muscle of the yabby and fast- and slow-twitch fibres from limb muscles of the rat.

The amino acids used were arginine bearing a net positive charge and glutamate bearing a net negative charge on their respective side chains. The effect of phosphoarginine was also studied, as it bears a net negative charge on its side chain.

The rats were killed by Halothane overdose and the yabbies were killed after being kept at 5°C for 30 minutes. EDL and soleus muscles from the rat and claw muscle fibres from the yabby were dissected out and single fibres were then chemically or mechanically skinned as previously described[1].

Results show that arginine (33-36mM) and glutamate (36-40mM) respectively increased and decreased sensitivity to Ca^{2+}-activated contraction by 0.08-0.19pCa units in all fibres. Phosphoarginine (9-10mM) increased sensitivity to Ca^{2+} by 0.18-0.24pCa units in mammalian fibres, but had no significant effects on the force-pCa relation in yabby fibres. Arginine, phosphoarginine and glutamate had little or no effect on the maximum Ca^{2+}-activated force.

The results suggest that the opposing effects of glutamate and arginine may not be related to simply their charge structure, but may involve complex interactions between these molecules, Ca^{2+} and the regulatory and myofibrillar proteins.

(1) Powney et al. (2003) J. Muscle Res. Cell Motil. 24(7): 459-467