

CONTROL OF THE FORCE-VELOCITY RELATION BY MYOSIN HEAVY CHAINS
IN MOUSE SOLEUS AND EDL MUSCLE

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The force velocity relation is described by three parameters: S_0 , the maximum isometric stress (in mN/mm^2), a/S_0 , the force constant, and b , the velocity constant (in mm/s per mm of muscle length). The ratio $b / (a/S_0)$ is the maximum velocity of contraction, V_{max} . It is widely accepted that V_{max} is controlled by the type of myosin heavy chains (MHC). We tested the hypothesis that MHC also controls the force constant.

Mouse soleus muscles ($n=108$) and EDL muscles ($n=83$) were tetanized isometrically at 20°C and released at controlled velocities during the tetanus. The parameters of the force-velocity relation were computed using the Gauss-Newton method. The proportions of myosin heavy chains were measured by quantitative SDS-PAGE.

We observed a strong linear correlation between a/S_0 and b ($P < 0.0001$): $b = a + B \cdot a/S_0$. Using a simple additive model, we computed a and B for the various MHC isoforms: MHC1, MHC2As from soleus data, and MHC2Af, MHC2B from EDL data. a is 0.29 for soleus and 0 for EDL. B is 1, 3, 17 and 6 for: MHC1, MHC2As, MHC2B, MHC2Af, respectively. V_{max} increases in the same order.

The mean value of a/S_0 was 0.14 for soleus and 0.21 for EDL. However the ranges were approximately the same: 0.05 to 0.38 (soleus) and 0.08 to 0.49 (EDL). Thus the difference in a/S_0 observed between slow-twitch and fast-twitch muscles results from a difference in the distribution of the parameter a/S_0 rather than from a difference in its range. Muscles of similar content in MHC have similar V_{max} but the force constant varies widely, within the above mentioned range.

We conclude that the type of MHC controls V_{max} but not a/S_0 . Since a/S_0 completely determines the normalized maximum power M^2 , it follows that M^2 is not dependent on the type of myosin heavy chain: it must be controlled by an as yet unidentified factor. A second conclusion is that myosin heavy chain from soleus identified as MHC2A may be different of that from EDL, since its V_{max} is more than five times slower.