PS C53

Myosin lever arm tilt during sinusoidal oscillations when the power stroke is suppressed

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Rapid load change of isometrically contracting muscle causes a synchronised actomyosin power stroke. This power stroke causes a change in intensity (I_{M3}) of the meridional X-ray reflection at 14.5 nm, which is thought to indicate both elastic and active changes in the myosin lever arm tilt. During sinusoidal length oscillations (0.1–1 kHz), I_{M3} signals are approximately sinusoidal, but distorted at the point of maximum shortening, where I_{M3} crosses an intensity maximum ($I_{M3,max}$), causing an I_{M3} well. As oscillation frequency approaches 1 kHz, this well is attenuated until, above 1 kHz, it is absent and I_{M3} signals become undistorted sinusoids (Bagni *et al.* 2001). The frequency domain in which I_{M3} distortion decreases corresponds to that over which the power stroke contribution to I_{M3} becomes increasingly attenuated. If both power stroke and elastic components of I_{M3} signals arise from lever arm tilting, then I_{M3} distortion at high frequencies would be restorable by raising its elastic tilting component through increased length oscillation amplitude.

Intact fibre bundles from a toe muscle (dorsal interossei) of *Rana temporaria* (killed by decapitation) were mounted horizontally between a moving coil motor and a capacitance force transducer. Synchrotron radiation (from the source Elettra, Trieste, Italy; wavelength 0.15 nm, dimensions 0.3 × 3.0 mm) was admitted to the experimental chamber by a fast shutter mechanism at the plateau of an isometric tetanic contraction, while sinusoidal length oscillations were imposed simultaneously at 2.8 kHz. I_{M3} was monitored by a 1D delay line detector at 2.6 m from the preparation, with a sampling time resolution of 17 μs.
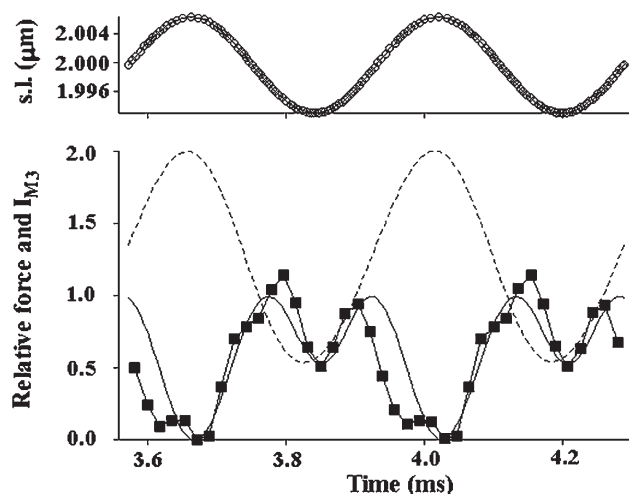

Figure 1. ■, I_{M3} signal during sinusoidal length oscillations. Continuous line: calculated I_{M3} signal to simulated sarcomere length changes (s.l., upper trace, ○) and force (dashed line). Temperature 2°C.

Oscillation amplitudes causing a peak to peak force oscillation equal to tetanic tension (P_o) produced an undistorted I_{M3} signal. However, when the force oscillation was increased to 1.4–1.6 P_o, distortion became evident (Fig. 1), similar to that seen at lower oscillation frequencies. Simulation of these effects using the molecular structure of myosin support a tilting mechanism model of the power stroke event, and show a mean tilt during oscillations of 0.76 ± 0.20 nm ($n = 7$) from that at $I_{M3,max}$.

Bagni MA *et al.* (2001). *Biophys J* **80**, 2809–2822.

All procedures accord with current national guidelines