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Modeling Analysis of Myosin-based Meridional Reflections from Skeletal Muscles Stretched to the Non-overlap Length

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Introduction

The modeling analysis of the myosin-based meridional reflections in the X-ray diffraction patterns of live frog skeletal muscles at the full-overlap length was reported in the previous report [1,2]. When muscles were stretched to the non-overlap length of thin and thick filaments in a sarcomere, the effect of the lateral filament arrays on the intensities of meridional reflections was more reduced than that in the case of the full-overlap length due to the disordering of the lattice structure. But it still remained in some meridional reflections. These intensities of the reflections were corrected as described previously [1,2]. Using the corrected data, we investigated to propose a relaxed model for the crossbridge structures of myosin filaments in muscle with the non-overlap length and the model was compared with that of myosin filaments in muscle with the full-overlap length [2].

Experimental

Live frog sartorius muscles were used for X-ray studies. X-ray diffraction experiments were performed at BL15A1. The 2D-X-ray diffraction patterns from muscles stretched to the non-overlap length were recorded with an image plate at the specimen-to-detector distance of ca. 2.4 m. Whether muscles were stretched to the non-overlap length was made sure by measuring the diffraction periods from the sarcomere of stretched muscles with a laser. The X-ray intensities were obtained by integration of the data in the radial narrow range of 0 - 8.5x10^{-4} nm^{-1}. The intensity profile of a reflection was deconvoluted by Gaussian functions, yielding its integrated intensity and peak position.

Results and Discussion

Compared the corrected intensity distribution of the myosin reflections from the non-overlapped muscle with that of those reflections from the full-overlapped muscle, they were seemed to be very similar. Using the corrected intensities of the second to eleventh order myosin meridional reflections from the non-overlapped muscle, we carried out the modeling analysis as reported previously [2]. In the model, the crown regions with a regular repeat of 14.3 nm (the regular regions) were assumed to be located on both sides of the perturbed region with a 43.2 nm period. The most probable model was determined by searching the best fit of the calculated intensities to those observed.

Figure 1 shows the distributions of the perturbed and regular regions of the myosin filaments in the non-overlapped and full-overlapped muscles. Figure 2 illustrates the configuration of two-headed myosin crossbridges along the thick filaments in the regular and perturbed regions. Our simulation shows that the structural models of crossbridges along the myosin filaments in the non-overlapped and full-overlapped muscles are fairly similar to each other. This suggests that the distribution and orientation of crossbridges along the thick filaments doesn't depend on the extent of the overlap between myosin and actin filaments.

References

[1] Oshima et al., PF Activity Rep #21 (2004)
[2] Oshima et al., Fibre. Dif. Rev. 13 (2005)

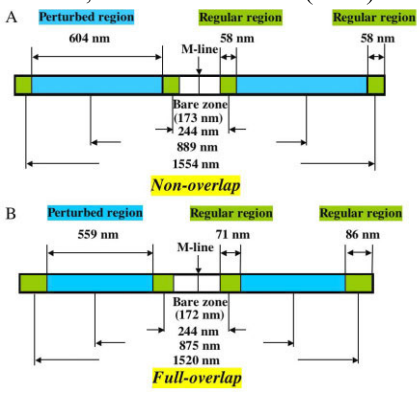

Figure 1 The distribution of the arrays of myosin crossbridge along the thick filaments. A; the non-overlap length, B; the full-overlap length.

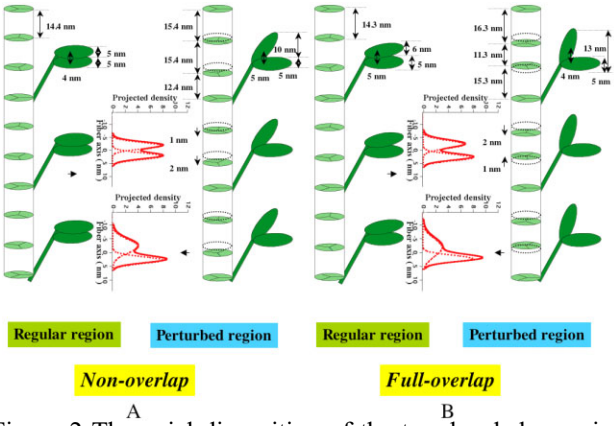

Figure 2 The axial disposition of the two-headed myosin crossbridges along the thick filaments. A; the non-overlap length, B; the full-overlap length.

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