X-ray diffraction studies on the effect of reduction of stretch velocity in tetanized frog skeletal muscle by a CCD-X ray detector

Takakazu KOBAYASHI*,1, Hidehiro TANAKA1, Katsuzo WAKABAYASHI1, Yasunori TAKEZAWA1, Yasunobu SUGIMOTO1 and Haruo SUGI1

1Department of Electronic Engineering, Shibaura Institute of Technology, Minato-ku, Tokyo 108-8548
2Department of Physiology, School of Medicine, Teikyo University, Itabashi-ku, Tokyo 173-8645
3Department of Physiology, School of Nursing, Teikyo Heisei Junior College, Ichihara, Chiba 290-0158
4Department of Biophysical Engineering, Graduate School of Engineering Science, Osaka University, Toyonaka, Osaka 560-8531

Introduction

When moderate stretch velocity is suddenly reduced during stretch in tetanized skeletal muscle, tension rises during the first part of stretch, and then starts to decay. To investigate molecular mechanism under-lying the stretch velocity sensitive force response to stretch, we measured the intensity changes of the meridional reflections of the X-ray diffraction with 15ms time resolution, which give information about behavior of actin-myosin linkages.

Materials and methods

The sartorius muscle fiber was mounted isometrically at in length and set to monochromatized X-ray beam path of wavelength 0.155nm from beam line 15A of synchrotron radiation. The muscle fiber was tetanized at 20Hz and then the muscle was stretched with moderate fast velocity (1.5%Lo, 0.15Lo/s) followed by slow (1.5%Lo, 0.015Lo/s) or opposite sequence during steady state of tension by the vibrator. The intensity of the meridional reflections was recorded by the CCD-Xray detector with tension. All experiments were made at 12°C.

Results

The intensity changes of 143 and 215 meridional refraction (I143, I215) with fast stretch followed by slow and opposite sequence are shown Fig.1A and 1B. The I143 suddenly decrease during early phase of isometric tetanus and then recovered to lower level during steady state of isometric tetanus. The I143 further decreased during fast stretch and then slightly decreased during followed slow stretch (Fig. 1A). In contrast, the I215 slightly increased during slow stretch and then suddenly largely decreased during followed fast stretch (Fig. 1B). After completion of stretch the I143 recovered slowly to isometric tetanus level. The I215 decreased monotonically during rising phase of isometric tetanus and then no remarkable changed.

References


Figure 1. Length, force and intensity changes of 143 and 215 meridional reflection (I143, I215) during fast stretch followed by slow stretch (A) and opposite sequence (B).

*kobata@shibaura-it.ac.jp