The effect of muscle length changes on the X-ray diffraction pattern from
tetanized frog skeletal muscle II

Hidehiro TANAKA¹, Takakazu, KOBAYASHI², Yasunori TAKEZAWA³,
Yasunobu SUGIMOTO³, Kanji OSHIMA³, Katsuzo WAKABAYASHI²

¹School of Nursing, Teikyo Heisei Junior College, Ichihara, Chiba 290-0192
²Dept of Electronic Engineering, Shibaura Institute of Technology, Minato-ku, Tokyo 108-8548
³Dept of Biophysical Engineering, Graduate School of Engineering Science, Osaka University,
Toyonaka, Osaka 560-8531

Introduction
When the skeletal muscle is stretched slowly at the
plateau of the isometric tetanus, the tension increases
during the stretch. The tension behaves in a similar but opposite way. The intensity of the 3rd meridional reflection (M3), which arises from the 14.3 nm repeat of the myosin heads, decreases during both stretch and release [1-3]. The change of M3 by the length change is explained as follows: if myosin heads attach to the thin filament in a configuration perpendicular to the filament axis, both stretch and release tilt the myosin heads. This tilting of the myosin heads results in the broadening of axial projection of the mass of the myosin heads [2,3]. In the previous report it was showed that M3 increases during stretch and decreases during release if the applied length change is smaller than 1% of the muscle length. [4,5]

Methods
The sartorius muscle from a bullfrog was tetanized for 2.2
sec by applying supra-maximal current pulses (20Hz at
12°C). The contraction was repeated 10 times at an
interval of 3 min. The length change of the muscle was
applied at the plateau of the isometric tetanus. The X-ray
patterns were recorded by an X-ray CCD detector with a
time resolution of 15 msec.

Results
Fig.1 shows the intensity distribution across the meridian in the region of the M3 reflection. Peak
broadening of M3 was observed when the muscle
contracted. But the width of M3 after the contraction
remained unchanged during and after stretch. The absence of peak broadening rules out some types of disorder as possible origins of the intensity change, and suggests it is
due to either (i) a change in conformation of the myosin
heads so that their mass projection is more sharpened
(increased) or spread out (decreased) along the filament
axis, or (ii) a change in the dispersion of the axial
positions of the heads from the ideal 14.3 nm periodicity.
Fig.2 shows an increase in M3 when the muscle is
stretched by 1 % Lo with a steady velocity of 0.15Lo/sec, which is 10
times faster velocity than the previous case [4],
suggesting an intensity increase by stretch is caused by
the amount of stretch rather than the speed of the stretch.

References
kobataka@sic.shibaura-it.ac.jp