VALIDATION OF INTRAMUSCULAR PRESSURE SENSOR IN RAT GASTROCNEMIUS MUSCLE DURING ISOMETRIC CONTRACTION

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INTRODUCTION

The inability to directly measure the internal loads acting within articular joints has been a limitation in biomechanics. Currently, skeletal muscle loads must be estimated from EMG measurements or calculated computationally. Intramuscular pressure (IMP) has been shown to be well correlated with muscle tension and has recently become a feasible *in vivo* measure [1,2]. The sensor used in this study is based on fiber-optic technology and has been used extensively in rabbit [3]. The purpose of this study was to evaluate the performance of the fiber-optic IMP sensor during galvanic isometric contractions in intact rat skeletal muscle.

METHODS

Sprague-Dawley rats (weight 200-300g) were anaesthetized and secured to a custom-made jig with the knee fixed at 90°. Hind limb muscles were exposed, but left intact. The foot was attached to a lever articulating about the ankle from which force was measured. The biceps femoris was reflected and the sciatic nerve exposed. Platinum wire electrodes were placed around the nerve and isometric contractions of the hind limb muscle group were elicited (Grass Instruments, S-88 stimulator). A 360 µm diameter fiber-optic pressure sensor (Luna Innovations Inc., Blacksburg, VA) was inserted into the belly of the gastrocnemius muscle via a 22-gauge needle, parallel to the direction of the muscle fibres. IMP, force and muscle length were measured simultaneously at stimulation levels of 2.4, 3.0, 3.5, 4.0, 4.5, 5.0 and 5.5 volts with at least 1 minute rest between levels to minimize fatigue.

RESULTS

The results of this experiment indicate that the length-tension curve for isometric contractions was mimicked by the length-pressure curve for active conditions (Figure 1). To confirm this finding, muscle force and IMP were plotted against each other and linear regression was performed (Figure 2). There was a strong linear correlation (R^2=0.76) between IMP and muscle force.

DISCUSSION

This study quantified the relationship between IMP and muscle force during galvanic isometric contractions in intact rat skeletal muscle. These findings confirm previous work done in rabbit skeletal muscle [3]. Further work must now be concentrated on the validity of the sensor under dynamic contraction conditions.

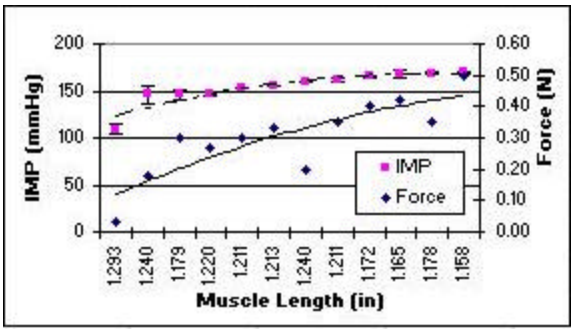
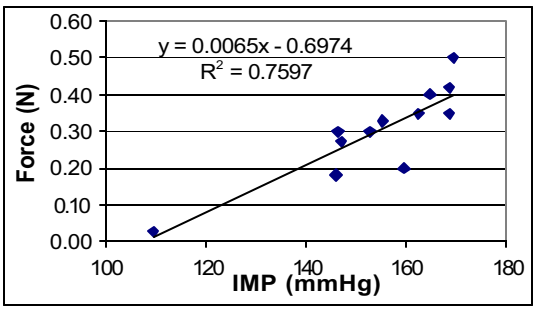


Figure 1. Relationship between IMP and isometric muscle force for rat gastrocnemius muscle at varying lengths.



Figrure 2. Relationship between isometric force and intramuscular pressure at various stimulation levels. Force and IMP were well correlated (R^2=0.76).

REFERENCES

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