

Changes in total protein and myofibrillar protein of compensatory hypertrophied muscle in Rat

Shigeru Yamada, Yoshio Kuroda

Department of Sports Science, College of Arts and Sciences,

University of Tokyo

Abstract

This study was designed to observe the effect of exercise training on total protein and structural protein of muscle by means of the electrophoresis technique. Compensatory hypertrophy was induced in the soleus and plantaris muscle on one limb by cutting the tendon of the synergistic muscle, the gastrocnemius. The contractile limb received only a sham operation and served as a control. During one week after a tenotomy the wet weight of the plantaris of the operated limb was 32% greater and that of the soleus was 49% greater than those of the control muscles. Total protein and myofibrillar protein of muscle were separated by Na-dodecyl sulfate (SDS) polyacrylamide electrophoresis. It was demonstrated densography of total protein in muscle that some peaks of the densography in hypertrophied muscle indicated high density than those of the control muscles. Some peaks of the densography of myofibrillar protein in hypertrophied muscle indicated higher density than in control muscles.

Key Words : Muscle hypertrophy, 64 kd protein, Muscle protein, Fast muscle, Slow muscle, Tenotomy

Introduction

It was well known that a muscle tissue increase its strength by exercise training accompanied with its hypertrophy. Morpurugo (1875) found that exercise could cause the cross-sectional areas of the sartorius muscle to increase without altering the total number of muscle fibers⁽¹⁾. Helander (1960) indicated that muscle hypertrophy was usually associated with an increase in the myofibrillar proteins of the muscles⁽²⁾. Goldspink (1964) found an increase in the myofibrillar protein in the gastrocnemius with a weightlifting exercise program⁽³⁾. In 1967, Hamosh, reported that the increase in hypertrophied muscle weight apparently related to increased concentration of RNA in microsomes⁽⁴⁾ and in 1968 it was found that the hypertrophied muscle to contain an increased incorporation of labelled amino acid into the protein⁽⁵⁾⁽⁶⁾. The purpose of this study was to determine whether exercise training induced an increase in muscle protein and to observe the qualitative change of total protein and myofibrillar protein in muscle by exercise training.

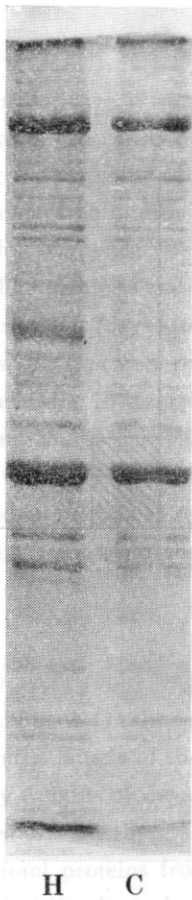


Fig. 3A Electrophoretic patterns.

A. SDS polyacrylamide gel electrophoresis of soleus muscle total proteins, from hypertrophied (H) and control (C) muscles were electrophoresed as described in "Methods" and stained with Coomassie blue.

B. Densitometric tracing of electrophoregrams of muscle. Arrows indicate the position of 64 Kd protein.

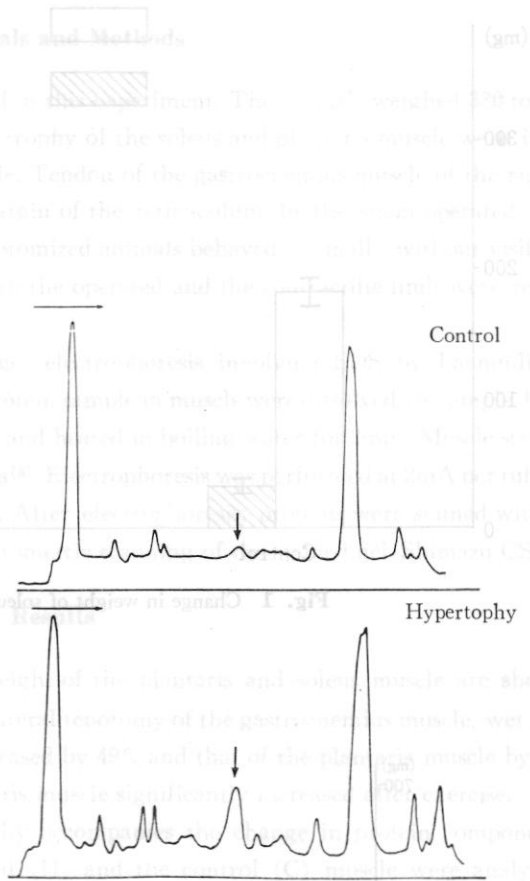
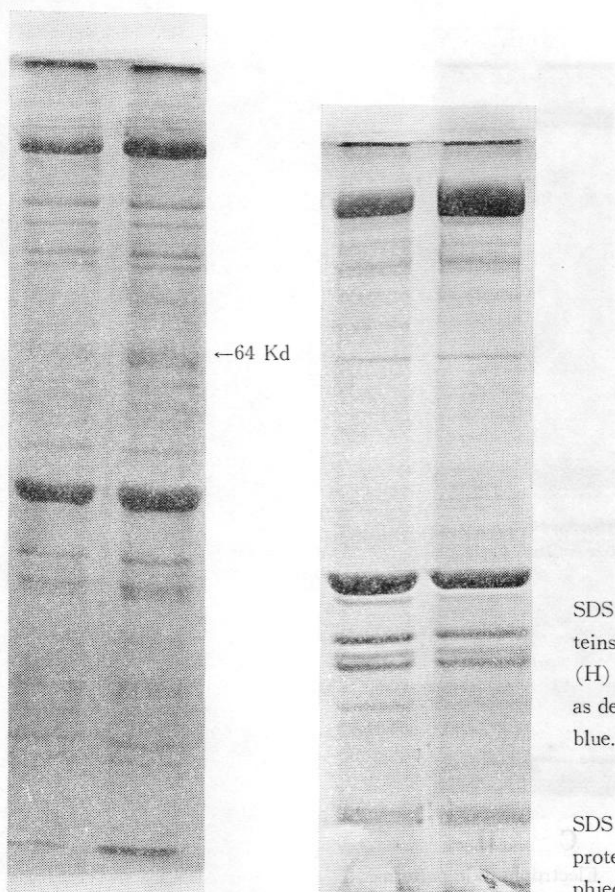


Fig. 3B

Weight of soleus and plantaris muscle of the rat increased significantly in 7 days after operation in the present study as well. Goldberg (1968) reported that the increase in muscle weight was directly proportional to the increase amino acid incorporation and presumably in protein synthesis. Although greater incorporation of amino acid occurred both in sarcoplasm and in myofibrillar proteins, the ratio of myofibrillar to soluble counts by radioactivity did not change with hypertrophy. Goldspink (1974) indicated that the proportion of radioactivity in substrate extracted from actomyosin system might be related to increased amount of myofibril during hypertrophy. In the present study, therefore, we analyzed the hypertrophy-associated changes in muscle structural proteins by means of electrophoresis method. However, the change in total protein and muscle structural protein in our experiments did not directly contribute to the study on these relations.

The muscle hypertrophy by tenotomy is known to be accompanied with decrease of tetanic tension output and prolongation of contraction time. (10)



C H
Fig. 4

C H
Fig. 5A

Fig. 4 Electrophoretic patterns.

SDS polyacrylamide gel electrophoresis of total proteins in plantaris muscle. Proteins from hypertrophied (H) and control (C) muscles were electrophoresed as described in "Methods" and stained with Comassie blue.

Fig. 5A Electrophoretic patterns.

SDS polyacrylamide gel electrophoresis of structural proteins in soleus muscle. Proteins from hypertrophied (H) and control (C) muscles were electrophoresed as described in "Methods" and stained with Comassie blue.

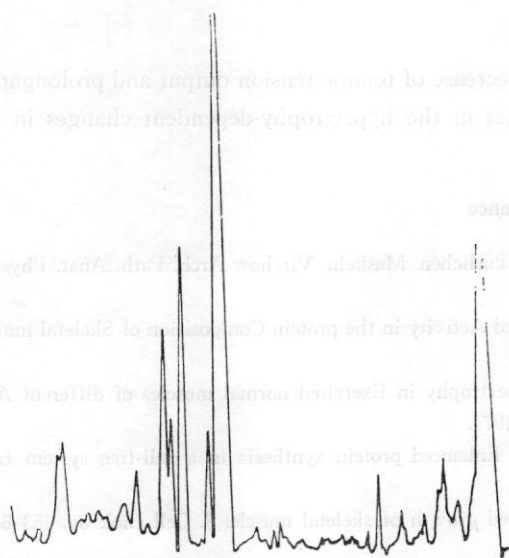


Fig. 5B Structural protein in control muscle.

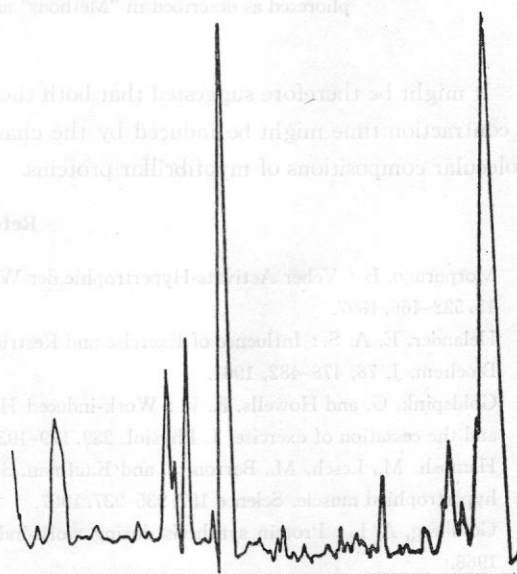


Fig. 5B Structural protein in hypertrophied muscle.

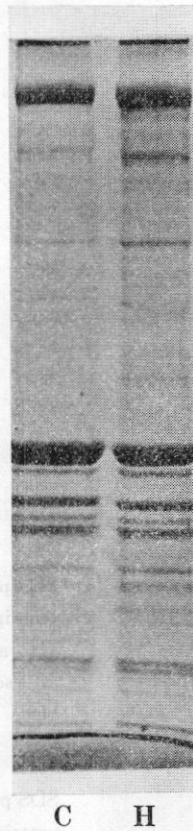


Fig. 6 Electrophoretic patterns.

SDS polyacrylamide gel electrophoresis of structural proteins in plantaris muscle. Proteins from hypertrophied (H) and control (C) muscles were electrophoresed as described in "Methods" and stained with Comassie blue.

It might be therefore suggested that both the decrease of tetanic tension output and prolongation of contraction time might be induced by the changes in the hypertrophy-dependent changes in the molecular compositions of myofibrillar proteins.

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