Enzyme-Histochemistry of Normal External Ocular Muscles

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Enzyme-histochemical research in the last 13 years has contributed greatly to our knowledge of the diseases of skeletal muscles; it has practically become a routine examination in diseases of this organ. Hitherto, enzyme-histochemical techniques have practically not been used for the examination of the external muscles of the eye, and only few data are available concerning the histochemistry of normal human external ocular muscles.

In view of the considerable structural and functional differences between the external ocular muscles and the skeletal muscles, it appears likely that there are histochemical differences as well. In order to test this hypothesis, we have examined biopsy samples of 30 external ocular muscles. These biopsy samples originate from 6 persons; they were taken in the course of enucleation performed for a malignant intrabulbar process (see table). The patients exhibited no abnormalities of the oculomotor system, and in as far as could be ascertained, they had no history of neuromuscular diseases. Sections of 10 μ thickness were examined for the following enzymes: the activity of myosine adenosine triphosphatase (Guth and Samaha), the activity of an enzyme that may be regarded as a parameter of the aerobic metabolism (diphosphopyridine nucleotide diaphorase, Barka and Anderson), the activity of two parameters of the glycolytic metabolism (phosphorylase and «-glycerolphosphate dehydrogenase via menadione, by the methods of Meyer and Wattenberg and of Leong, respectively), and the activity of a lysosomal enzyme (acid phosphatase, Burstone).

The results of this investigation confirmed the above hypothesis; a number of distinct differences are indeed demonstrable: (1) The number of muscle fibers with a high activity of myosine ATP-ase (type II fibers) exceeds the number of fibers with a low degree of activity (type I). In most

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Table I. Enzyme histochemistry of external ocular muscles

skeletal muscles this is not the case, or not to the same extent. The myosine ATP-ase activity is supposed to be rate-limiting in regard to the velocity of contraction of the muscle fibers. This means that the extraocular muscles contain mostly rapidly contracting muscle fibers. (2) The transverse sections of the extraocular muscles just as those of skeletal muscles show a mosaic-like pattern consisting of muscle fibers with high, intermediary or low activity of the parameters of the aerobic and glycolytic metabolisms. However, the activity of the parameter of the aerobic metabolism on the average distinctly exceeded that of muscle fibers of skeletal muscles. It has been demonstrated in monkeys that the number of mitochondria in muscle fibers of extraocular muscles is two to six times as large as the number of mitochondria in skeletal muscle fibers.

Accordingly, it is a justifiable assumption that the number of mitochondria in human extraocular muscles also exceeds that in skeletal muscles. (3) The activity of the enzyme acid phosphatase, in muscle fibers of extraocular muscles may far exceed that in skeletal muscles. The significance of this finding on the ultrastructural level requires further investigation.

The results of this study are of importance in the diagnosis of diseases of the extraocular muscles, and may also contribute to our understanding of the pathophysiology of diseases of these muscles.

References