ATPase Activity of Two Rabbit Laryngeal Muscles

Skeletal muscles, regardless of species, contain fibres which tend to show differences of the slow versus the fast type. Slow muscles or muscle fibres are rich in enzymes of mitochondrial oxidative metabolism, but low in myofibrillar ATPase, this type is preponderant in red muscles. Fast muscles or muscle fibres show opposite characteristics, they are poor in mitochondrial enzymes, but rich in myofibrillar ATPase, and this type is preponderant in white muscles. The distinction of two types of muscles or muscle fibres only is certainly an oversimplification and some authors distinguish muscle fibres of 3 to 8 types according to histochemical analysis. The idea that many types of different muscle fibres exist is justified, considering that muscles differ not only in speed of contraction, but also in total amount of contractile activity and consequently energetic demands. According to this, it is not surprising that exceptions exist to the general concordance oxidative type of metabolism in slow muscle and glycolytic type of metabolism in fast muscle. At least 2 examples show that the metabolic type of muscle is determined not only by speed of contraction but also by total contractile activity. Some insect and the humming birds skeletal muscles, which contract at extremely high speeds, have been found by electron microscopy to be packed with mitochondria[1]. The thyroarytenoid of the rabbit, an extremely fast muscle, is histochemically a red muscle[2]. On the other hand the temporalis muscle of the guinea-pig[3] shows marked sexual differentiation according to mitochondrial oxidative enzymes, but no differences in contractile properties and ATPase activity.

Contraction time of thyroarytenoid muscle of the rabbit is approximately 3 times shorter, compared with the fast tibialis anterior muscle, but thyroarytenoid has a high succinate dehydrogenase activity[2]. It seemed, therefore, important to compare the ATPase activity of thyroarytenoid muscle with that of the extensor digitorum longus and soleus muscles, i.e. typical fast and slow muscle, to ascertain whether this 'red' muscle is really a fast muscle, concerning ATPase activity, for which a close relation to speed is assumed[4].

Adult male rabbits were used for experiments. Myofibrils were isolated from a homogenate of muscles in 0.15 *M* KCl, 0.01 *M* borate pH 7.1 by differential centrifugation, similar to that described by PERRY[5]. Myosin was prepared by the dilution and precipitation procedure[6], but with 10 m*M* sodium pyrophosphate and 1 m*M* magnesium chloride included in the extraction medium. Protein was determined by the biuret method and inorganic phosphate according to FISKE and SUBBAROW[7].

Table I and II show the ATPase activity of myofibrils and myosin of 2 laryngeal and of the fast (white) and slow (red) rabbit muscles. Myofibrils or myosin from thyroarytenoid muscle have an ATPase activity 25–55% higher when compared with fast cricothyroid muscle or with the extensor digitorum longus muscle, i.e. a typical fast white muscle. This difference is smaller than that found in contraction times between thyroarytenoid and tibialis anterior (also a fast muscle)[2]. Nevertheless, the considerably higher ATPase activity of the thyroarytenoid muscle distinguishes this muscle clearly from the soleus muscle, a typical example of a slow red muscle.

The results thus confirm that the thyroarytenoid muscle is indeed a fast muscle also according to the ATPase activity. This fast muscle is presumably also well adapted for sustained activity as can be judged from the high activity of oxidative enzymes.

Table I. Comparison of ATPase activity of myofibrils/ΔP_i µmoles/mg of protein/min

Muscle	10 m*M* $CaCl_2$	5 m*M* $MgCl_2$ + 0.1 m*M* $CaCl_2$
Thyroarytenoid	0.50	0.70
Cricothyroid	0.36	0.38
Extensor digitorum longus	0.40	0.39
Soleus	0.19	0.16

Conditions of assay: 5 m*M* ATP, 0.025 *M* KCl, 0.025 *M* *tris*-HCl, pH 7.5, 25 °C.

Table II. Comparison of ATPase activity of myosin/ΔP_i µmoles/mg of protein/min

Muscle	
Thyroarytenoid	0.80
Cricothyroid	0.59
Extensor digitorum longus	0.60
Soleus	0.19

Conditions of assay: 5 m*M* ATP, 0.025 *M* KCl, 0.05 *M* *tris*-HCl, pH 7.5, 10 m*M* $CaCl_2$, 25 °C.

Zusammenfassung. Die Myofibrillen- und Myosin-ATPase-Aktivität des schnellen «roten» M. thyroarytenoideus von Kaninchen ist höher als die ATPase-Aktivität des «weissen» M. extensor digitorum longus und wesentlich höher als die ATPase-Aktivität des «roten» M. soleus. Daraus folgt, dass in Abhängigkeit besonderer funktioneller Ansprüche auch rote Muskeln schnell sein können.

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