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MYOGLOBIN CONCENTRATION AND PARTIAL OXYGEN PRESSURE IN MUSCLE TISSUE DURING ALLERGIC REACTIONS

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The effect of sensitization to horse serum, brucellas, and BCG, and also the effect of allergic reactions induced by these antigens on the partial pressure of oxygen and myoglobin concentration in muscle tissue were studied. The myoglobin concentration was found to be reduced during the formation of increased sensitivity but only in the case of sensitization by living microbial strains. Allergic reactions of immediate and delayed types caused a decrease in the myoglobin concentration both in the myocardium and skeletal muscles. The partial pressure of oxygen in the skeletal muscles was lowered.

KEY WORDS: sensitization; allergic reactions; myoglobin; partial pressure of oxygen.

The basic biochemistry of altered reactivity and metabolic disturbances developing in allergic reactions has been inadequately studied, although the elucidation of these problems is of great interest for the understanding of the pathogenesis of allergic diseases and for the development of pathogenetically based methods of their treatment. An important role in the formation and manifestations of allergic reactions is played by muscle tissue which, according to some workers, is the target tissue for the antigens [3, 12].

The object of the present investigation was to study some indices of muscle tissue metabolism during the formation of increased sensitivity to various antigens.

EXPERIMENTAL METHOD

The myoglobin concentration was studied in cardiac and skeletal muscles and the partial pressure of oxygen was determined in the skeletal muscles during primary contact of animals with antigens (horse serum, tuberculin, therapeutic brucellosis vaccine — TBV), and at the height of the development of sensitization to horse serum, BCG, and *Brucella abortus* during realization of the allergic reaction to these antigens (Table 1). Altogether 10 series of experiments were carried out on 442 guinea pigs.

The combined determination of the myoglobin concentration and partial pressure of oxygen in skeletal muscles is of undoubted interest for myoglobin is a component of the oxygen transport system in muscle tissue [14], and it also takes part in the equalization of the partial pressure of oxygen, increasing its rate of diffusion within the muscle [9, 11, 13], and in electron transport and oxidative phosphorylation [8].

Determination of the partial pressure of oxygen reveals the character of the supply of oxygen to the body tissues and serves as an index of their oxygenation [2, 5].

The myoglobin concentration was determined spectrophotometrically [10] and the partial pressure of oxygen polarographically [1]. The experimental results were subjected to statistical analysis [7].

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TABLE 1. Experimental Conditions

Series of experiments	Experimental conditions
I. Control	Animals kept in animal house on ordinary diet of food and water
II. Injection of horse serum	10-15 min before experiment 0.1 ml serum/ 100 g body weight injected intravenously
III. Sensitization with horse serum	2 weeks before experiment two subcutaneous injections of 0.5 ml serum given at interval of 1 day
IV. Anaphylactic shock	Reacting dose of antigen injected into sensitized animals as in series II
V. Injection of TBV	500 million bacterial cells of TBV injected intravenously 8 h before experiment
VI. Sensitization with Brucella abortus	Animals sensitized by subcutaneous injection of 1 billion bacterial cells of *B. abortus* 45-50 days before experiment
VII. Allergic reaction of delayed type to TBV	500 million bacterial cells of TBV injected intravenously into sensitized animals 8 h before experiment
VIII. Injection of tuberculin	1 ml tuberculin injected intravenously 8 h before experiment
IX. Sensitization with BCG	Animals sensitized by subcutaneous injection of 1 mg BCG 45-50 min before experiment
X. Allergic reaction of delayed type to tuberculin	Reacting dose of tuberculin (1 ml) injected intravenously into sensitized animals 8 h before experiment

EXPERIMENTAL RESULTS

The myoglobin concentration in the heart muscle of the control animals was 39.9 ± 2.4 mg/g, almost twice its concentration in the thigh muscle (21.0 ± 2.6 mg/g). The partial pressure of oxygen in the thigh muscle was 12.2 ± 2.3 mm Hg.

After intravenous injection of horse serum into unsensitized guinea pigs the myoglobin concentration in the myocardium and skeletal muscles was unchanged, although the partial pressure of oxygen in the latter was only 65% of the control level (8.5 ± 0.9 mm Hg). After intravenous injection of microbial antigens (tuberculin and TBV) into unsensitized animals a significant decrease was observed in the myoglobin concentration in the myocardium to 68% (27.1 ± 2.7 mg/g) and 66% (26.3 ± 2.2 mg/g) of its level in the control animals. The myoglobin concentration in the thigh muscles was significantly reduced only after injection of TBV into the animals (by 31%; 11.1 ± 0.6 mg/g) and the partial pressure of oxygen in them remained at the control level. Injection of tuberculin, on the other hand, caused a reduction by 60% in the partial pressure of oxygen in the muscles (4.9 ± 1.7 mm Hg), although their myoglobin concentration was unchanged.

The absence of any parallel in the changes affecting these indices is proof that the myoglobin concentration was not the primary factor determining the partial pressure of oxygen in the muscle tissue; this index depends on many factors — the velocity of the blood flow, the state of the microcirculation, the blood vessels, permeability of membranes, the degree of oxygenation of hemoglobin, and so on.

The decrease (not statistically significant) in the partial pressure of oxygen observed in the skeletal muscles after vaccination with microbial antigens was probably due partly to a reduction in the myoglobin concentration in the skeletal muscles by 53% (9.9 ± 0.5 mg/g) in the case of sensitization to brucellas and by 29% (14.8 ± 1.7 mg/g) in the case of sensitization with BCG.

The sharp decrease in the myoglobin concentration in the myocardium (by 38%; 25.0 ± 1.9 mg/g) and in the skeletal muscles (by 53%) in the case of vaccination with living brucellas is in good agreement with the ability of this vaccine to induce myositis and myocarditis, with

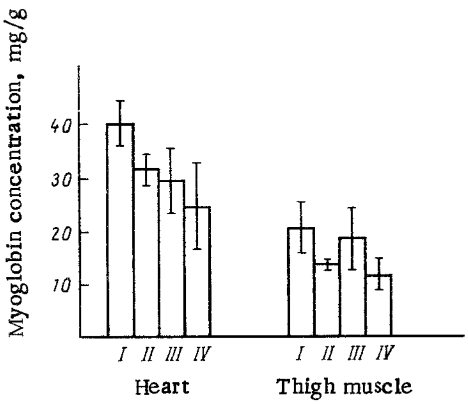

Fig. 1. Myoglobin concentration in myocardium and skeletal muscles of control guinea pigs (I), in anaphylactic shock (II), during an allergic reaction of delayed type to brucella antigen (III), and to tuberculin (IV).

the formation of granulomas in the muscle tissue [4, 6]. In the writer's view, the reduction in the myoglobin concentration in muscle tissue during sensitization to living vaccines can be explained, not by the formation of increased sensitivity, but by a toxico-infectious process developing in the recipient after injection of living vaccine strains. This conclusion is confirmed by the absence of any decrease in the myoglobin concentration during sensitization with horse serum and in animals vaccinated with heat-killed culture of a vaccine strain of brucellas.

Anaphylactic shock and the allergic reaction of delayed type to tuberculin caused a decrease in the partial pressure of oxygen in the skeletal muscles by 30% (8.5 ± 0.9 mm Hg) and by 64% (4.4 ± 0.6 mm Hg) respectively. The myoglobin concentration fell both in the myocardium and in the skeletal muscles during all types of reaction (Fig. 1).

The experiments thus showed that the process of sensitization to living vaccine strains of microorganisms and realization of the allergic response to all antigens studied were accompanied by a fall in the myoglobin concentration in the myocardium and skeletal muscles and by a decrease in the partial pressure of oxygen in the latter. The changes thus observed unquestionably impaired the oxygen supply to the muscle tissue and facilitated the development of tissue hypoxia in them.

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