EFFECT OF PROLONGED ARTERIAL HYPOTENSION ON THE RELATIVE FUNCTIONING CAPILLARY VOLUME IN WORKING SKELETAL MUSCLES

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The blood flow in the soleus (red) muscle is known to be much greater than in the gastrocnemius (white) muscle [4, 6-9]. These observations are supported by our own results [1] indicating that the relative capillary volume in the soleus is significantly greater than in the gastrocnemius muscle. It has also been shown that physical work, inducing a considerable increase in the blood flow in the gastrocnemius muscle, has hardly any effect on the blood flow in the soleus muscle [4, 6-8].

It was accordingly interesting to study the effect of physical work on the number of functioning capillaries in skeletal muscles of these two types, and also changes in this parameter in skeletal muscles working under conditions of arterial hypotension of varied duration. The investigation described below was devoted to a study of these problems. The relative erythrocyte volume (REV) in the capillaries of these muscles was taken as a measure of the number of functioning capillaries.

EXPERIMENTAL METHOD

Noninbred albino rats of both sexes weighing initially 180-200 g were used. Under pentobarbital anesthesia (30 mg/kg) and under sterile conditions, a nichrome coil was applied to the abdominal aorta distally to the origin of the renal arteries, constricting the vessel and causing pressure in the vessels of the posterior part of the animal's body to fall by 30-50%. Under pentobarbital anesthesia the soleus and gastrocnemius muscles were isolated in both hind limbs of five control rats, seven rats with arterial hypotension for 14 days, and seven rats with hypotension for 3-4 months, after which the right sciatic nerve was placed on electrodes and stimulated (2 V, 0.7 msec, 8 Hz) for 1 min. Stimulation of the sciatic nerve was accompanied by distinct contractions of muscles of the right hind limb. At the end of the period of stimulation all four muscles were simultaneously covered with liquid propane, cooled with liquid nitrogen, and excised. Full details of the technique of obtaining the material, preparing the specimens, and staining were given previously [2]. The test with benzidine and nitroprusside gave intense black staining of erythrocytes filling the capillaries, and thus revealed those capillaries which were open (functioning).

The REV was determined by the method in [5]. For counting a 16x objective, 12.5x ocular, and grid with 400 crossings were used. Only capillaries coinciding with crossings of the grid were counted. The principle of counting was described previously [3].

EXPERIMENTAL RESULTS

REV in the control rats, reflecting the number of functioning vessels, was significantly higher in the soleus than in the gastrocnemius muscle, and the increase in this parameter during work (relative to the resting state) in these two muscles was 37 and 54% respectively. Lowering the arterial pressure (BP) for 14 days and for 3-4 months had virtually no effect on REV in the red and white muscles in the resting state (Table 1).

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TABLE 1. Changes in REV in Skeletal Muscles with Local Arterial Hypotension

Experimental conditions	Soleus muscle		Gastrocnemius muscle	
	resting	working	resting	working
Control	1,2±0,08	1,6±0,1*	0,5±0,04	0,8±0,01*
Hypotension				
14 days	1,2±0,08	1,9±0,2*	0,7±0,07	0,6±0,1
3—4 months	1,1±0,08	1,6±0,13*	0,6±0,11	0,6±0,06

Legend. *P < 0.05 compared with corresponding value before work.

However, responses of the vessels of these muscles to muscular contractions under hypotensive conditions differed completely. For instance, only 14 days after lowering of BP the increase in REV in the working gastrocnemius muscle has virtually disappeared, whereas after 3-4 months there was actually a tendency for this parameter to decrease during work by the muscle.

By contrast, arterial hypotension for 14 days and 3-4 months had absolutely no effect on the degree of increase in REV in the working soleus muscle. Moreover, 14 days after lowering of BP some increase in the responses of the vessels could be observed.

It is difficult as yet to suggest a logical explanation for these data. Only a number of observations on this question can be put forward.

It seems very probable that the mechanisms of working hyperemia in the soleus and gastrocnemius muscles are different. Working hyperemia in the soleus muscle is evidently due mainly to the opening of a small number of reserve vessels and depends to a lesser degree on changes in tone of the resistive vessels. By contrast, working hyperemia in the gastrocnemius muscle is probably due not so much to activation of reserve vessels as to a decrease in tone of the resistive vessels. It can be postulated that considerable dilatation of resistive vessels, maintaining the normal blood flow during arterial hypotension, "inactivates" the mechanism of opening of the reserve vessels in this muscle, and this is manifested as disappearance of the phenomenon of an increase in REV, reflecting the number of functioning vessels in the gastrocnemius muscle.

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