A METHOD OF MEASUREMENT OF MUSCULAR TONE IN ANIMALS

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In experimental investigations on the study of changes in muscle tone it is desirable to use a method which would give accurate, quantitative readings, with as simple as possible a method of measurement. During investigations of the changes in muscle tone in experiments on frogs and cats, we used an indicator apparatus which combined simplicity of construction with accuracy. In experiments requiring measurement of the tension and the hardness of muscle it is advisable to discontinue the use of the spring which returns the pointer of commercial scales to its original position.

By means of this apparatus it is possible to carry out measurements of the changes in both length and hardness. In addition by means of two indicators it is possible to measure both these factors at the same time.

The scheme of the apparatus is shown in Fig. 1.

The object to be tested (a dissected muscle) is placed on a platform, the surface of which can move by means of screws in two mutually perpendicular directions in a horizontal plane.

The indicator in the apparatus which is in a vertical position (see Fig. 1, b) is used for measurement of the hardness of the muscle.

For this purpose a plunger 2 is screwed into the rod 1, its surface of contact with the muscle being covered with stearine. To the other end of the rod is fixed, by means of a screw, a small plate 3 for small weights. The rod is maintained in equilibrium by means of a counterpoise 4. In this position the plunger is just in contact with the surface of the muscle and exerts barely any pressure on it.

Before starting the experiment it must be checked that the rod with the attached plunger and small plate for weights are in equilibrium, and the rod moves freely inside the body of the apparatus.

In order to determine the hardness of the muscle, a weight of definite magnitude is placed on the plate 3, which depresses the rod and causes the plunger to compress the muscle. The pointer indicates the depth to which the plunger sinks into the muscle tissue. The deeper the plunger sinks as a result of the pressure exerted, or the lower the resistance of the muscle to the action of the weight compressing it, the less obvious is its hardness, which is one of the criteria of muscle tone.

In order to make the results of the experiments clearer it is essential to select a particular weight for each muscle. If the weight applied is too small it will fail to demonstrate differences in the hardness of the muscle under test in different conditions, since the small pressure will cause insignificant change in the shape of a harder or a softer muscle. The difference may be so small that it cannot be detected. If the weight applied is too large it may lead to considerable changes in the functional state of the muscle under examination. In practice, from experience, we usually used weights of 20-30 g.

Measurements of the tension of the muscle are made by means of an indicator fixed in the horizontal position (Fig. 1, a).

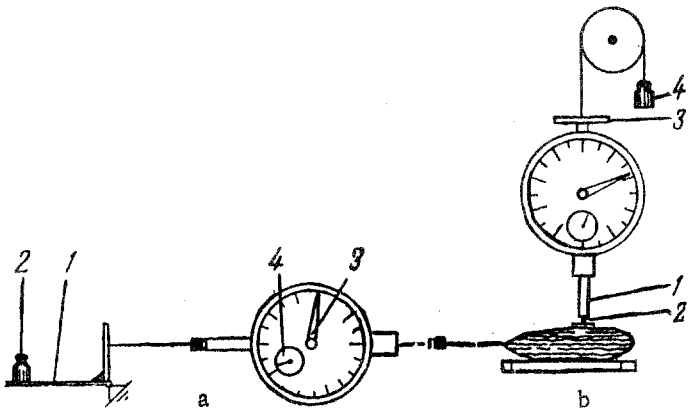

Fig. 1. Apparatus for measurement of the tension and hardness of muscles of animals.
a) Indicator in the horizontal position; 1) angular lever; 2) weight, acting as a counterpoise; 3 and 4) pointers indicating the degree of displacement of the rod; b) indicator in the vertical position.

Lengthening of the Thread (length 10 cm) by the Action of the Stretching Load

Load acting (in g)	Magnitude of stretching (in cm)	Load acting (in g)	Magnitude of stretching (in cm)	Load acting (in g)	Magnitude of stretching (in cm)
25	0	300	0	600	0
		400	0	700	0
50	0	450	0	800	0,05
100	0	470	0	900	0,06
200	0	500	0	1000	0,07

One end of the rod is connected to an angular lever 1, on which is placed a weight 2 acting as a counterpoise; it turns the lever 1, and with it the rod, back to its original position after shortening of the muscle (for example, at the moment of its contraction). The other end of the rod is attached to the muscle under examination by means of a thread.

The muscle is placed under tension by placing additional weights to the existing weight 2. The lever 1 then moves downwards and pulls the rod with it; this in turn stretches the muscle under test. The displacement of the rod, depending on the tension of the muscle, is indicated by the pointers 3 and 4.

After removal of the weight the muscle, returning to its original condition, shortens and pulls the rod with it, and its displacement is indicated by the pointers. Thus the length of the muscle is registered also at the moment of removal of the stretching load.

The lower the muscle tone, the more it will be stretched by the weight, and the greater the length of the muscle for a given load, and conversely the higher the muscle tone, the less it will be stretched and the shorter it will be for a given load.

The apparatus described is fixed to a firm universal stand.

By means of the stand and a platform it is possible to assemble the measuring apparatus sufficiently accurately in relation to the muscle to be tested without moving the animal from its place.

As already pointed out the muscle is connected to the apparatus by means of a thread. Control experiments showed that within the limits of the loads used in the determination of muscle tone (20-30 g), the thread is in practice inextensible (see Table).

When working with this suggested apparatus it is essential to bear in mind that for overcoming the force of friction arising during movement of the parts of the apparatus it is necessary to determine the force required to displace the mechanism from its state of rest. We determined the minimum value of the load which, when applied, would set the apparatus into action. For the measurer of the muscle hardness this amounted to 1-1.5 g, and for the measurer of the length of the muscle – 300-500 mg.

The construction of the apparatus enables simultaneous kymographic recording of the changes in hardness and extension of the muscle to be made by means of the ordinary Engelman levers at the same time as the measurements are indicated by the pointers.

As shown by experiments on animals (frogs and cats), it is possible by the use of this method to detect even insignificant changes in the tension and hardness of a muscle under the influence of various factors. In this way it was discovered that as a result of certain gross measures (for example, denervation, interference with the blood supply) the tension and hardness of muscles may be altered unequally, whereas under normal conditions the tension and hardness of muscles alter in a parallel manner.

SUMMARY

The author recommends a new method of measuring the muscle tone with the aid of a simple instrument – a modified indicator.

The method developed on frogs and cats gives precise quantitative readings, while the technique of the measurement is very simple. This method enables measurement of tensile strength and the hardness of the muscles simultaneously; kymography may be performed at the same time.