COMPARATIVE MORPHOMETRIC EVALUATION OF THE MUSCLE COAT OF ARTERIES AND THEIR FUNCTIONAL STATE

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KEY WORDS: artery; Kernahan's index; morphometry; dynamic tone.

To compare the quantitative characteristics of blood vessels, Kernahan's index is used, namely the ratio of the thickness of the muscular coat of the vessel and the diameter of its lumen [1]. This index gives some idea of the power of the vessel [2], for it is a measure of the amount of muscle tissue per unit surface area of the lumen of the vessel. It also characterizes the "rigidity" of the vessel wall, which determines the character of the response of the artery to vasoconstrictor impulses [3]. By the method suggested previously [4-6] the ratio of the thickness of the muscle coat to the diameter of the lumen of the vessel can be determined independently of any dynamic change of tone. Under these circumstances, however, dynamic tone itself, i.e., the degree of vasoconstriction, is determined visually by the investigator, and it can be judged either by the greater or lesser degree of tortuosity of the inner elastic membrane of the media of the arteries.

The method which the present writer now suggests can express the degree of vasoconstriction of the vessel as a concrete and determinate number, the index.

To calculate this index we must know the real area of cross section of the vessel S_1 and the largest possible area of cross section of the vessel S_2 when the inner elastic membrane

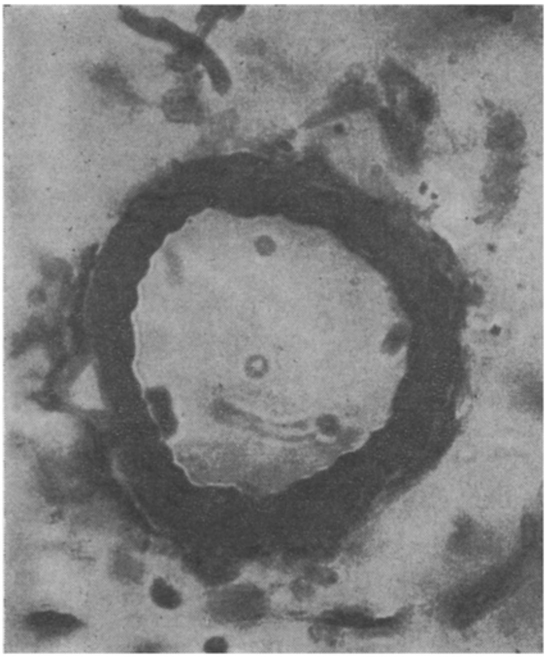

Fig. 1. Transverse section through artery of the rabbit brain. Stained with picrofuchsine and fuchselin. 300 ×.

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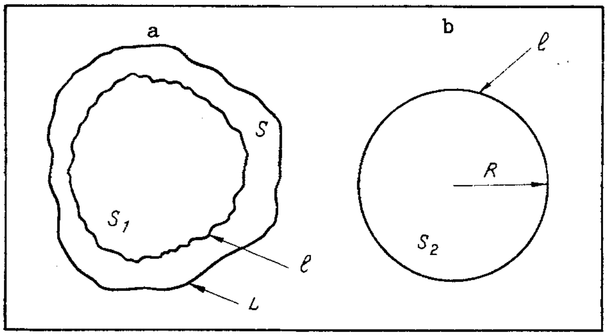

Fig. 2. Determination of areas of muscle coat of arterial wall on diagrams. a) Real state of artery in histological preparation: l) inner contour, L) outer contour of media of arteries, S) area of muscle coat in transverse section through artery, S_1) area of cross section of lumen of vessel; b) circle with area S_2 — the greatest possible area of cross section for the given vessel when the inner elastic membrane is completely straightened out (l), R) radius of circle.

with all its folds is straightened out completely, with circumference l. This area S_1 can be measured by means of the TAS morphometric system (Leitz, West Germany) by a gravimetric or planimetric method, when the area is determined from a drawing of the outline of the artery on paper, taken from a histological section by means of a drawing apparatus. The length l can also be measured by means of the TAS morphometric system or a curvimeter from a drawing of the vessel on paper. Knowing the length l when the inner elastic membrane is completely straightened out, the greatest possible area of cross section of the lumen of the artery S_2 can be determined. Assuming that $R=\frac{l}{2\pi}$, where R is the radius of a circle of circumference l, for the area required we obtain $S_2 = \pi R^2$. Since S_1 is the area of cross section of the lumen of the artery in histological section and since S_2 is the greatest possible area of cross section of that same vessel, the functional state of the artery can be defined as the ratio between the two areas:

$$A=\frac{S_1}{S_2}.$$

A can have any value from unity to zero. When $S_1 = S_2$, A will be unity, and when S_1 tends toward zero, during spasm of the artery, for example, A also will tend toward zero.

If the value of the index A is multiplied by 100%, the significance of the formula obtained can be expressed as follows: a given lumen is a certain percentage of the greatest possible lumen of the vessel during maximal vasodilatation. The index determined in this way allows the degree of vasoconstriction of a vessel to be estimated quantitatively regardless of its diameter.

Example. The transverse section through an artery in the rabbit brain is shown in Fig. 1. By the methods described above, Kernahan's index can be determined from Fig. 2, a and b, by the equation:

$$K=\frac{\sqrt{S+\pi R^2}-R\sqrt{\pi}}{2R\sqrt{\pi}},$$

where S is the area of a circle formed by the tunica media and calculated by one of the methods described above for the determination of areas.

$$S=1055\ \text{mm}^2,\ l=132\ \text{mm},\ R=21\ \text{mm},\ K=0{,}164.$$

Let us determine the index A of the functional state of this vessel, for which we find S_1 and S_2: $S_1 = 1264\ \text{mm}^2$, $S_2 = \pi R^2 = 1387\ \text{mm}^2$.

$$A=\frac{1264}{1387}=0{,}91.$$

This means that this particular lumen of the vessel amounts to 91% of the greatest possible lumen during total vasodilatation.

These two quantitative parameters, which are mutually complementary, thus enable a wider estimation to be given both of possible hypertrophy or dystrophy of the vessel wall, and also of the vasoconstrictor, functional state which, as this example clearly shows, was low, i.e., virtually absent.

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ECOLOGICAL DIFFERENCES IN STRUCTURAL ORGANIZATION OF THE RESPIRATORY REGIONS OF THE LUNGS

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KEY WORDS: lobe of the lung; acinus; segment.

The respiratory system of Arctic animals is adapted to breathing air at low temperatures, and the adaptive mechanisms are genetically consolidated. The study of these mechanisms in endemic Arctic species may help to assess the possible directions of individual physiological adaptation in animals and man. However, only a few details of the structure of the air passages and of the air–blood barrier have so far been described in endemic Arctic animals [1-5]. The morphological and functional basis of ecological differences in the respiratory portions of the lungs has not hitherto been studied.

The aim of this investigation was to study the structural features of the respiratory regions of the lungs in an endemic Arctic animal, namely the Arctic fox *Alopex lagopus* L. and to compare them with those of the dog.

EXPERIMENTAL METHOD

The lungs of 35 mature Arctic foxes (weight 6 kg), kept in open sheds in the Magadan Game Farm, and the lungs of 15 dogs (weight 8-9 kg), living in an animal house in Novosibirsk, were investigated. The Arctic foxes were well adapted to breathing air at low temperatures and could tolerate a frost down to −50°C. Material for investigation was taken during the winter. The animals were killed by electrocution. The lungs were divided into segments and the segments into lobules by dissection of freshly eviscerated complexes and by the use of corrosion preparations of the bronchial tree. The acrylic glue Protakril was used as plastic material. The plastic mass was prepared immediately before injection by mixing the monomer and polymer in the ratio of 1:1. In this way the Protakril was of the correct viscosity for filling the peripheral segments of the air passages as far as the terminal bronchioles. Polymerization was carried out for 3-4 h at 70-80°C. Fifteen lung lobules were reconstructed by a graphic method from serial preparations obtained from three Arctic foxes and three dogs.

EXPERIMENTAL RESULTS

The lobes of the lungs of the animals investigated were divided into segments, isolated from each other to some degree by intersegmental septa. In the cranial, middle, and accessory

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