Comparison of the activity of kallikrein inhibitors in sick and healthy children and in adults (Tables 2 and 3) shows that the existence of an inflammatory and inflammatory-allergic condition, or its exacerbation, in the lungs and liver are accompanied by changes in their concentration in fresh plasma. As a rule the activity of kallikrein inhibitors falls under such conditions. The degree of fall corresponds to the severity of the disease and the ability of the patient to compensate. If the plasma is kept in the refrigerator the increase in activity of kallikrein inhibitors in plasma from patients also remains low by contrast with that from healthy donors (compare Tables 1 and 3). If the prognosis of the disease is poor, activity of the inhibitors does not increase during keeping of the plasma at 4°C. Determination of kallikrein inhibitors is thus of both diagnostic and prognostic value. In addition, in conjunction with the levels of plasma kallikrein activity, it can be used as an objective criterion for deciding whether to administer antiproteases such as Contrykal, Trasylol, or Gordox, and as a laboratory control to monitor the times of administration of these substances.

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CONTACT TRANSDUCER FOR CONTINUOUS MEASUREMENT OF THE DIAMETER OF BLOOD VESSELS

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When responses of blood vessels to nervous and humoral influence are studied, transducers enabling the diameter of the tested vessel to be recorded continuously are extremely effective [1]. The same technical problem arises also when the mechanical properties of blood vessels are studied. Since blood vessels characteristically exhibit viscoelastic behavior (especially under conditions of activation of the smooth muscles of the vessel wall), recording deformation of the wall in response to a change in tension must also be undertaken continuously. A number of special transducers have been introduced to solve this problem. Foremost among them are external contact transducers of various types, catheter transducers, enabling the internal diameter of the vessel to be measured, and no-contact transducers (ultrasonic and optical). Examples of the use of such instruments can be found in [1-4]. Most methods can be successfully used on comparatively large arteries (over 1.0 mm in diameter). More recently external contact transducers of cantilever type, described in [2] have become popular. An improved variant of a transducer of this type is suggested.

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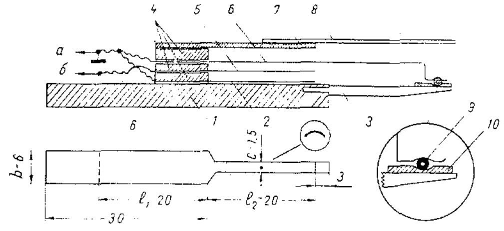

Fig. 1. Diagram of transducer (explanation in text).

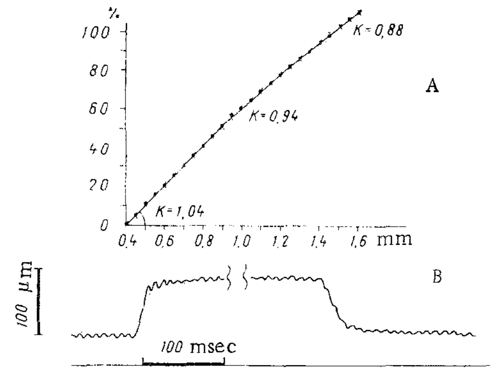

Fig. 2

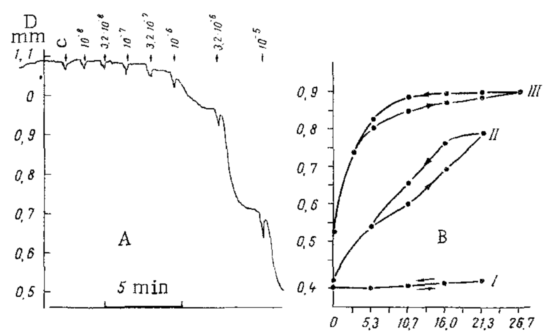

Fig. 3

Fig. 2. Static and dynamic characteristics of the transducer. A) Changes in output voltage ΔU_{out} (in % of nominal output voltage of instrument) as a function of diameter of vessel D (in mm). Points – D increasing; crosses – D decreasing; B) changes in external diameter of silicone rubber tube recorded during stepwise change in air pressure inside it.

Fig. 3. Examples of results. A) Constrictor responses of caudal artery of a rat in response to increasing concentrations (g/ml) of noradrenalin in external solution. c) Control (in Tyrode solution). Spikes on curve are artefacts due to change of solutions; B) diameter of caudal artery as a function of intravascular pressure. External solution contained: I) noradrenalin hydrotartrate 10^{-5} g/cm^3; II) the same, 10^{-6} g/cm^3; III) the same, 10^{-4} g/cm^3. Abscissa, transmural pressure (in kP); ordinate, diameter of artery (in mm).

A diagram of the transducer is given in Fig. 1. The principle of its operation is as follows. When the diameter of the artery (9) increases, the measuring plate (6) is shifted upward, and this leads to an increase in the gap between it and the plate (5) and, consequently, a decrease in the capacitance of the condenser formed by the plates (5 and 6). When the diameter of the artery decreases, the opposite picture is observed. Plate (2) serves to screen the measuring part from below from the capacitance effect of external objects. During operation, moreover, the whole sensitive part of the transducer is surrounded by a grounded removable screening jacket (not shown in Fig. 1). The spacers (4) are made of transparent plastic, just like the base (1) and protecting plate (7). The guard (8) consists of a stainless steel tube 0.8 mm in diameter. The support (3) is made from a steel rod 2.5 mm in diameter and is glued to the base (1). The supporting piece (10), which fits beneath the blood vessel, is made of Noracryl plastic. The end of the measuring plate, which makes contact with the vessel, is covered with varnish or fluorine plastic padding. The plate (5) is made of "soft" Duralumin. By bending this plate the gap between it and plate (6) can be regulated and the sensitivity of the transducer can thereby be changed in the required direction. In the variant suggested the gap was about 1 mm. Examples of the measuring plate of the transducer as used to record the dimensions of vessels with a diameter of 0.4-1.0 mm are given in Fig. 1. The broken line indicates the level of embedding of the plate when secured in the transducer. The narrow part of the plate is shaped, so that its rigidity to bending is significantly greater than the rigidity of the wide part. The plate is made of thin (0.05 mm) titanium. To measure changes in capacitance (output connections a and b) a Reactance Converter 51 B 02 (from DISA Electronic) instrument was used. The output signal was recorded on a KSP-4 potentiometer and N-327 instrument.

To determine the sensitivity of the transducer and the linearity of its readings, two types of calibration experiments were carried out. In the first type, instead of an artery, a metal cylinder from 0.3 to 1.5 mm in diameter was placed in the measuring part. In the other experiments the end of the measuring plate was raised by a measured amount of means of a micrometer screw device. Since the results obtained by the two methods of calibration were in good agreement, it was decided for preference to use the second method, by means of which displacements of the plate could be applied with a step of 50 μm. The voltage at the output of the instrument was measured by means of a type Shch 1312 digital voltmeter. The results of one such experiment are given in Fig. 2A. The total absence of hysteresis will be noted. The slight degree of nonlinearity is a common failing of capacitance transducers. However, within the range of diameters of blood vessels from 0.4 to 1.0 mm it did not exceed 10%. The force of contact was measured by means of torsion scales. When the diameter of the vessel was 0.4 mm the force was 5×10^{-5} N (5 mg) and it increased to 25×10^{-5} N (25 mg) if the diameter was 1.4 mm, i.e., the rigidity of the transducer is 20×10^{-5} N/mm. An increase in diameter of 1 mm was accompanied by a decrease in capacitance by 0.5 pF, i.e., the conversion factor of the transducer was 0.5 pF/mm. The temperature drift, applied to the input, was 7 μm/°K. The natural frequency of oscillation of the transducer in air was 25 Hz and the logarithmic decay decrement 0.08. To verify the dynamic characteristics, a silicon rubber tube, with an external diameter of 1.5 mm and internal diameter 0.8 mm, the air pressure inside which could be changed stepwise, was fitted into the transducer. The results are given in Fig. 2B. The duration of the transition process during an increase in diameter was about 20 msec and during a decrease in diameter 35 msec.

Traces of constrictor responses of the caudal artery of a rat to increasing doses of noradrenalin and the curve of stretching of this artery during an increase in transmural pressure, obtained by means of the transducer, are illustrated in Fig. 3A, B.

Equations for calculation, which may prove useful when similar instruments are designed, are given below. The rigidity of the transducer

$$\frac{\Delta F}{\Delta d}=\frac{Ebh^3}{4l_1^3}\left\{1+3\left(1+\frac{l_2}{l_1}\right)\frac{l_2}{l_1}\right\}^{-1},$$

where ΔF is the increase in the force of contact with an increase in diameter by Δd, E is the modulus of elasticity of the material of the plate, h its thickness, l_1, l_2, and b are defined in Fig. 1. The natural frequency of oscillations

$$W=\left\{\frac{Ebh^2}{4\rho l_1^3\left(Cl+0.24bl_1\right)}\right\}^{1/2},$$

where β is the density of the material of the plate and C is defined in Fig. 1.

The suggested variant of capacitance transducer has an important advantage over the strain gauge type of transducer now in use [2]: although its dynamic characteristics are similar, it enables the contact force to be reduced by about 30 times. This, first, reduces errors of measurement due to compression of the vessel, and it accordingly allows smaller arteries and veins to be studied (especially at low pressures), second it simplifies the method of measurement, by doing away with the need for a set of transducers, each of which must be used with a vessel of strictly corresponding diameter.

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