METHOD OF RECORDING CONTRACTIONS OF ISOLATED BLOOD VESSELS WITH THE AID OF A PHOTORESISTOR

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An apparatus for recording the tone and contractions of isolated vessels of various animals is described. The principle of the method consists of recording changes in the volume of an isolated vessel filled with Ringer–Locke solution by means of a photoresistor.

Key words: contractions of isolated vessels – recording.

A method of recording the tone and contractions of isolated blood vessels (arteries or veins) of large and medium caliber is described.

The principle of the method consists of recording changes in the volume of an isolated vessel (Fig. 1, 1) filled with Ringer–Locke's or Krebs' solution, tied hermetically at one end and connected at the other end with a thin glass tube (internal diameter 1.5-2 mm; T) in which the meniscus of a colored fluid changes its position depending on contraction or relaxation of the muscles of the vessel wall. The liquid is colored with methylene blue. The tied end of the vessel is fixed to the bottom of the chamber (2) in which it is placed. The liquid surrounding it is kept at a constant temperature (38°C) and is saturated with oxygen. Movements of the meniscus of the colored fluid are recorded by the photoresistor (R_1), the illumination of which changes with movement of the column of liquid in the tube placed between the lamp (L_1) and the photoresistor.

The recording instrument (3) contains a balanced bridge, into one arm of which the photoresistor R_1 is included. A change in the light flux falling on the photoresistor unbalances the bridge. After preliminary amplification (UBP-2-03 or other amplifier) (4) the signal is led to a recorder (5). An automatic electronic potentiometer (ÉPP-09 MZ) is used, but any other ink-writing recorder will serve.

To secure the highest sensitivity the elements of the bridge satisfy the condition $R_1=R_3=R_4=R_5$ (Fig. 1). The resistor R_2 is used to balance the bridge accurately. Its value should best be about 0.1 R_1. It is better to choose a photoresistor R_1 with lower inertia (the type FSA-1) although other devices responding to intensity of illumination (photoresistors, photoelectric cells) can be used instead with appropriate modification to the scheme of the recording system.

To increase the dynamic range, limited in the present case by the working surface of the photoresistor, two or more resistors can be connected in series, after appropriate modification to their design.

The FSA-1-330 kΩ photoresistor and a 12-V dc power unit (B_1) were used, and a sensitivity of the order of 1 mV to 1 mm of change in level of the column of contrast fluid was obtained. If the method is to be used for pharmacological and physiological investigations the substance for testing (chemical agent, mediator, etc.) is added in the required concentration to the Ringer–Locke solution surrounding the vessel. If required a small volume of the substance can be injected directly into the lumen of the vessel through a side branch of the measuring tube. For this purpose, as much fluid as will later be injected with the test substance must first be withdrawn from the measuring tube. Fluctuations of the meniscus (artefact of injection of the substance) recorded during these manipulations do not conceal or simulate the response of

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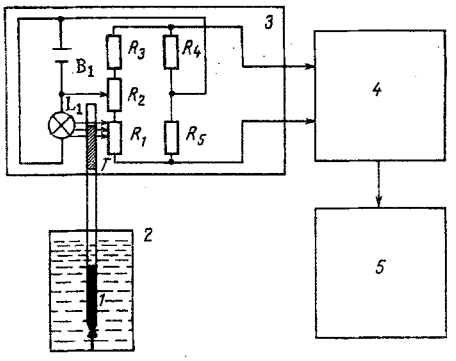

Fig. 1

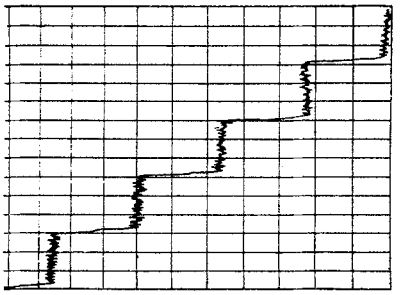

Fig. 2

Fig. 1. Diagram of apparatus for recording contractions of isolated blood vessels: 1) isolated segment of blood vessel; 2) chamber containing Ringer–Locke solution; 3) measuring device; B_1) dc battery; L_1) incandescent lamp; T) glass tube with contrast fluid; R_1) type FSA-1 photoresistor; R_3, R_4, R_5) resistors of bridge arms; R_2) potentiometer for setting initial level (reference point). Remainder of explanation is in text.

Fig. 2. Calibration of readings of instrument. Each step on the curve corresponds to a shift of 1 mm of the sensitive element relative to the meniscus of the colored fluid.

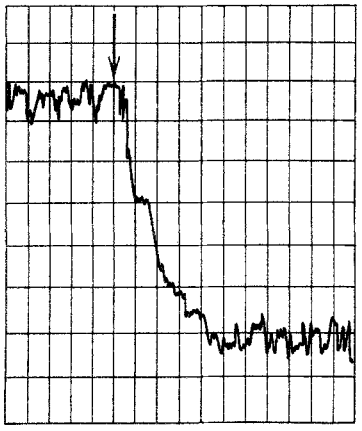

Fig. 3. Response of isolated blood vessel (cat femoral artery) to papaverine (1:10,000). Arrow indicates time of injection of the preparation.

the vessel to injection of the substance, for the response is always observed after a latent period of several seconds and it differs in shape from the injection artefact.

It is possible to act directly on the intima of the vessel by injecting the substance for testing into the Ringer–Locke solution surrounding the vessel, having first turned the vessel carefully inside out.

However, experience shows that it is simpler and more convenient to add the test substances to the solution surrounding the vessel the normal way round. By administering the test substance in this way a well-marked vascular response can be obtained after a short latent period.

The design of the apparatus enables its readings to be calibrated (Fig. 2) by changing the position of the sensitive element fixed to a rack with divisions relative to the stationary meniscus of the colored fluid. Knowing the internal diameter of the measuring tube, the changes in volume of the tested blood vessel can be calibrated directly in units of volume.

By way of illustration (Fig. 3), a record of a control experiment in which papaverine was added in a dilution of 1:10,000 is given. The action of the drug on an isolated segment of the cat femoral artery of known length was studied. Administration of the spasmolytic in this concentration clearly led to a sharp decrease in vascular tone.

The apparatus gives linear amplification over the whole dynamic range. With maximal amplification the drift of the zero line, when shifted into any region of the dynamic range in response to displacement of the meniscus in the measuring tube, does not exceed 5% of the dynamic range in 1 h. This is perfectly sufficient for exact quantitative assessment of the strength and duration of action of the substances on the tone of the isolated vessel if applied at the same time.

The suggested method has been used successfully to record the contractions of other hollow smooth-muscle organs: the intestine, ureter, uterus, and gall bladder of various laboratory animals.