APPARATUS FOR MEASURING ARTERIAL AND VENOUS PRESSURE AND TONE

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At the present time many methods are used in studying the cardiovascular system in man and animals.

Any one of these methods measures only a single quantity, which may be the arterial or venous pressure, the temperature, arterial or venous tone, rate of blood flow, etc.

However, frequently the study of only one or two of these quantities is insufficient, while simultaneous use of several different methods, which may be very complex, is difficult or even impossible, particularly when cannulation methods are not applicable.

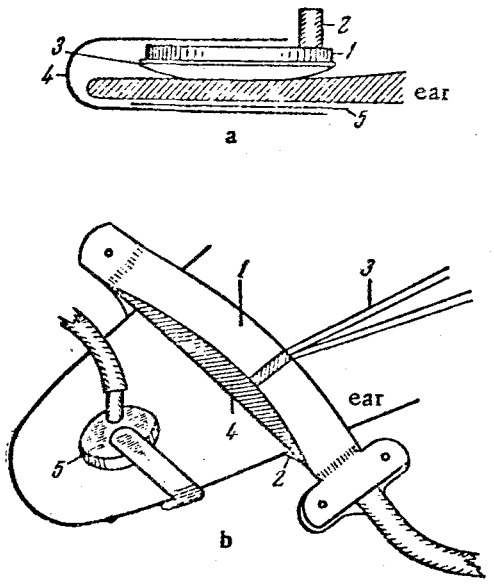

Fig. 1. (a) Spring element; (b) clamping sleeve. Explanation in text.

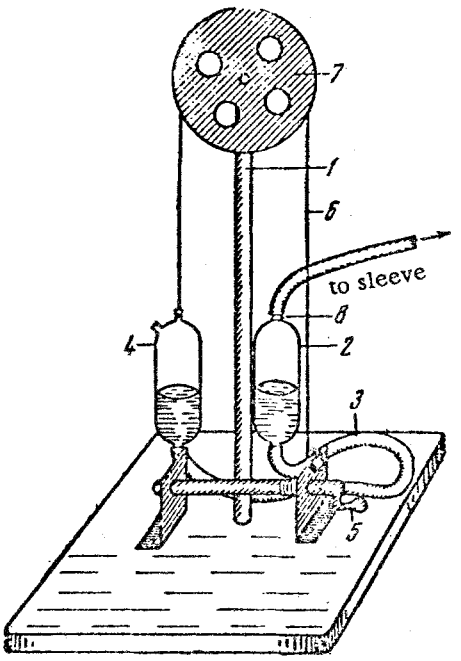

Fig. 2. Apparatus for evenly inflating the clamping sleeve with air. Explanation in text.

Changes in the arterial and venous pressure, arterial and venous tone, and also reflex reactions to compression of an organ can be studied using a volume manometer.

In 1912, Frank and Ray, and Howell devised an apparatus for measuring venous pressure by observing volume changes in the organ under investigation.

In 1930, Ia. S. Leitman produced a modification of this method. The apparatus, which he called a volume-manometer, allows measurement of arterial and venous pressure, rate of blood flow, and elasticity of arteries and

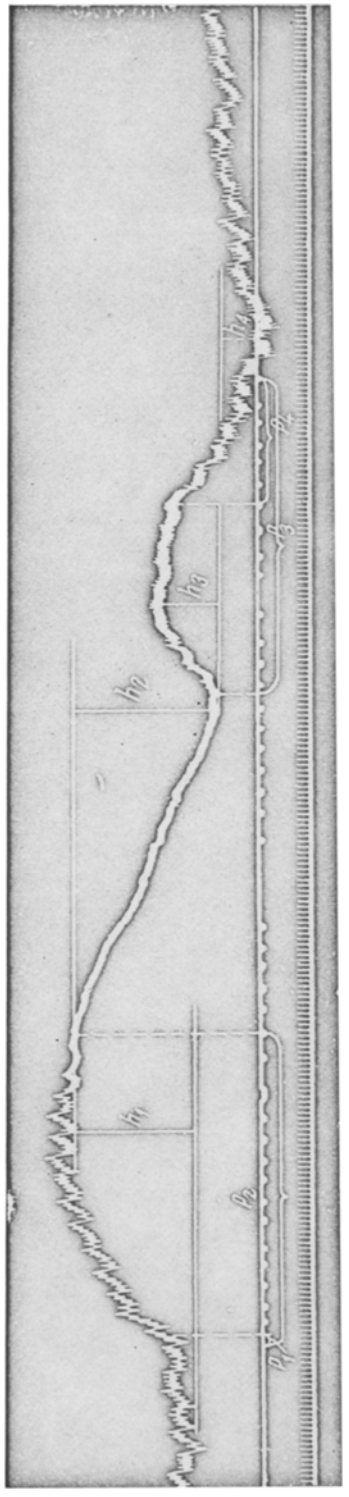

Fig. 3. Trace recorded using the universal manometer. Explanation in text. Reduced three times. Traces from above downwards: plethysmograph, pressure markings, and time markings.

capillaries. In 1940, V. A. Val'dman introduced the plethysmograph method of measuring venous pressure. In 1952 N. I. Arinchin constructed a volume manometer which allowed measurement of arterial and venous pressure and venous tone.

By use of the universal manometer described by us here, it is possible to measure arterial and venous pressure and tone, as well as reflex contraction of the blood vessels in dogs. For our investigation we used the ear flap of a dog. This has two advantages. Since the distal portion of the ear has no muscles, firstly there is no danger of artifacts caused by muscular contraction [1], and secondly one can be sure that it is the skin vessels which are being investigated.

The apparatus consists of three parts for measuring pulse volume, for measuring pressure in the sleeve, and for clamping the ear. The first consists of a plethysmograph which allows the extent to which the ear is filled with blood to be determined. It consists of a spring element (the receiving portion) and a sensitive Votchal-Filippovich capsule (recording portion). The spring element (Fig. 1,a) consists of a flat metal box (1) diameter 3 cm and height 0.5 cm, to the bottom of which a metal tube (2) is soldered. Within the element is placed a phosphorbronze spring (diameter 0.5 mm), consisting of 3-4 turns, one end of which lies at the base of the element and the other against a ring of x-ray film of a somewhat smaller diameter than that of the box. A sheet of thin rubber is stretched over the free edge of the element so that it is pressed out by the spring at the edge (3). The device is fixed to the animal's ear by means of a bent strip (4). To record the pressure in the system we used the contact mercury manometer of P. M. Vinogradov, made at the AMN SSSR Moscow Instrumen. Works. The clamping device consisted of a pressurizing system and a sleeve.

To produce an even increase in pressure in the sleeve, the apparatus shown in Fig. 2 was assembled; this consists of a Bunsen stand (1) to which is attached one of the two communicating vessels (2). The second glass vessel (4) is attached to a cord which passes over a pulley (7) and is attached to the rod which ends in the handle (5). Mercury is poured into both vessels. The output tube (8) on the upper part of the fixed vessel is connected to the rubber balloon (4) (Fig. 1,b). When the handle (5) is turned slowly the cord is wound around the rod and vessel (4) rises. Mercury now passes out of (4) into (2) displacing air from it into the rubber balloon (4) (Fig. 1,b). The clamping sleeve (Fig. 1,b) consists of two metal strips (1 and 2), which enclose the rubber balloon (4) which is connected to the pressurizing mechanism.

The three traces were recorded on photographic paper by means of an oscillograph. The animals were placed on their sides.

The operations were performed in the following sequence.

The clamp and sleeve were attached to the ear and held in position by the strings (3) (Fig. 1,b). The plethysmograph (5) was placed distally to this. On rotating the handle the air displaced from the fixed vessel passes into the clamped sleeve so that the pressure rises.

A contact manometer gives an electrical pulse to the oscillograph every 5 mm mercury pressure interval, and these are recorded on the moving photographic paper.

The plethysmograph element is sensitive to changes in the degree of filling of the blood vessels produced by pressure applied to the vessels by the clamping device. Figure 3 shows the traces obtained using the "universal manometer."

We agree with the usual view that the pressure corresponding to the first hump of the plethysmogram (P_1) corresponds to the pressure in the veins. The pressure at which the pulse oscillations disappear (P_2) corresponds to the maximal pressure in the arteries. The height to which the plethysmogram trace rises (h_1) indicates venous tone and initial flow rate, and the pulse amplitude is an indication of the tone of the arterial walls. The pressure at which the second elevation of the plethysmogram (P_3) occurs corresponds to the maximum arterial pressure, and P_4 that of the veins on decompression. The heights h_2 and h_3 evidently indicate the tone of the vessels, and the drop (h_4) of the plethysmogram after complete decomposition corresponds to reflex blood vessel contraction.

SUMMARY

A universal manometer which consists of an instrument with the aid of which the pressure that is created in the sleeve is recorded on an apparatus, and of a mechanism for gradual compression of a dog's ear lobe, and which registers the pulse volume is proposed. One may determine the value of arterial and venous pressure by the curve obtained with the aid of this manometer. The tone of the veins and arteries, as well as the reflex contraction of the vessels after decompression may, likewise be evaluated by analyzing this curve.

LITERATURE CITED

[1] V. V. Iakovlev, Biull. Eksptl. Biol. i Med. 40, 8, 69-72, (1955).