FIBER-OPTIC TONOMETER FOR MEASURING INTRAOCULAR PRESSURE

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The applanation tonometers presently being used for measuring intraocular pressure (IOP) have certain shortcomings. Thus, the Maklakov tonometer, which is the most common one in our country, requires the use of a dye when determining the pressure, which is not tolerated well by all patients. In addition, blurring of the edges of the impressions of the flattened segment of the cornea affects the accuracy of the measurements.

In other widely used applanation tonometers complex optical systems are used for an accurate determination of intraocular pressure, which increases the cost of the instruments. Thus, the Goldman tonometer is used in combination with a slit lamp and the Meller manual tonometer is equipped with a microscope.

The simplest and most convenient instrument is the IOP indicator developed by S. A. Vinokurskii, A. Ya. Bunin, and A. A. Stetsin. However, it is intended only for an approximate determination of the IOP during job medical examinations.

The need arose for developing an accurate and comparatively uncomplicated applanation tonometer. We attempted to create such an instrument on the basis of a new principle – the use of a focon as the measuring unit. As is known, a focon is a light guide which permits obtaining a magnified image of the object touching one of the planes of the focon.

On touching the cornea with one of the planes of the light guide-focon the several fold magnified image of the flattened circle of the cornea is projected onto its other plane. Thanks to this, there is no need to use complex optical attachments for measuring the diameter of the flattened circle of the cornea. We use a scale which is applied on the end of the light guide facing the observer (Fig. 1). The scale is graduated in linear units (in millimeters) and pressure units (in mm Hg), which permits taking measurements of the tonometric and true IOP.

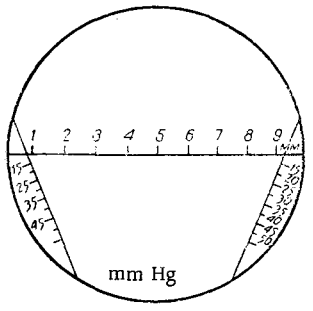

Fig. 1. Tonometer scale.

For convenient use of the light guide-focon when measuring the IOP we manufactured an instrument with the use of the elements of the aforementioned intraocular pressure indicator. A stop and additional counterweights are provided for in the design, which permits securing the instrument during measurement and determining the IOP in a vertical and horizontal position of the patient. The focon is used as the measuring unit. The proposed tonometer is shown in Fig. 2. Lever 4 is fastened on axle 1 of bracket 3. Near the place of attachment of the lever to the bracket is an adjustable counterweight 2. The distance from the place of attachment of the counterweight to the axle 1 can be changed so that the pressure of the focon on the eye is equal to that necessary for the investigation (10, 15 g, etc.). The light guide-focon measuring unit 7 is fastened on the end of the lever. A loupe 6 with a fivefold magnification is installed on the bracket opposite the light guide. It permits accurate reading of the measurement

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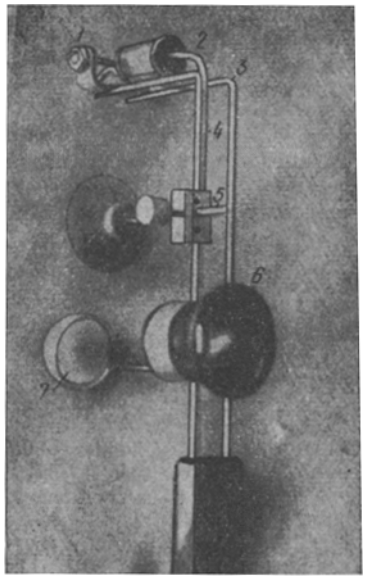

Fig. 2. Light guide tonometer. 1) Axle; 2) counterweight; 3) bracket; 4) lever; 5) stop; 6) loupe; 7) light guide-focon.

results. The total magnification of the light guide-loupe system is 12X. To secure the instrument on the forehead of the patient, a stop 5 with a rubber cup is fastened on the bracket.

An additional counterweight is used when measuring the intraocular pressure in a horizontal position.

The instrument is adjusted so that the focus of the loupe matches the plane of the focon with the magnitude image of the flattened circle of the cornea when the pressure on the eye is equal to that selected (for example, 10 g).

To calibrate the tonometer, a weight whose mass corresponds to the required pressure on the eye is suspended on the end of the arm opposite to that on which the focon is fastened. The necessary pressure on the eye ball is established accurately by moving the counterweight. In so doing, as indicated above, the focus of the loupe matches the plane of the image on the focon.

The process of measuring by means of our tonometer is comparatively simple. After epibulbar anesthesia the instrument is secured on the patient's forehead and the sensor (light guide) is brought into contact with the cornea.

The IOP is determined (in mm Hg) from the measurement scale by observing the flattened circle of the cornea through the loupe. The true IOP is determined by measuring the diameter of the flattened circle from the scale.

As investigations showed, the random measurement error is about 4% of the level of the IOP, i.e., does not exceed the error obtained in measuring the IOP by the Maklakov tonometer.

Laboratory testing of the instrument and preliminary experimental and clinical investigations give grounds to assume that the instrument will broaden considerably the possibilities of diagnosing one of the severe diseases of the eyes, glaucoma.