A SIMPLE MANOMETER FOR THE CONTINUOUS MEASUREMENT OF INTRA-OCULAR PRESSURE *

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THE adequate measurement of the intra-ocular pressure, both clinically and experimentally, has remained a baffling problem. The tonometer has obvious disadvantages which have been summarized by Duke-Elder (1932). Chief amongst these, in the opinion of the present authors, is the possibility of self-deception, since the variations in the results of repeated determinations are often quite large and there is always a danger that the investigator will choose unconsciously the value expected. Manometric methods involve the insertion of a needle into the anterior chamber; this of itself may upset the normal physiology of the eye, although unequivocal evidence that it does so is lacking. Moreover the investigator is ignorant of the pressure within the eye before inserting the needle, so that to prevent loss or gain of fluid by the eye, he must arbitrarily choose a certain pressure of saline within the needle to minimize these changes. An incorrect choice may disturb the normal mechanism of production and drainage of aqueous humour, and there is thus some uncertainty regarding the physiological condition of the eye on this count and greater uncertainty regarding the true value of the intra-ocular pressure in the eye before the needle was inserted, since the pressure imposed on the eye by the saline in the needle may persist for some time. Again, the mechanical registration of changes in the intra-ocular pressure requires that fluids either leave the eye or enter it; this may be largely cut down by a compensatory device in which the excursions of a minute bubble of air in the recording system are kept to a minimum; the operation of such a compensator is, however, tiresome, and a membrane-type manometer, in which very small changes in the volume of fluid in the system are magnified into large excursions of a reflected beam of light, is preferable. The instrument to be described here is of this type and gives a deflection of some 3 to 4 in. of a light spot on a scale, 5 feet away, in response to a rise in pressure of 10 cm. H_2O ; the fluid loss involved in this reflection is only 8 mm. corresponding to some 2 to 3 minutes' production of aqueous humour if present estimates of this rate are acceptable; it is sufficiently sensitive to show the normal pulsation corresponding to the arterial systole.

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Apparatus

Fig. 1 illustrates the manometer itself, which consists of a piece of pyrex glass tubing approximately 45 mm. long by 7 mm. in diameter, worked to a lip (A) at one end and ground to fit an ordinary

FIG. 1.—Construction of manometer.

record-type hypodermic needle at the other end (B). A No. 15 needle is removed from its brass base by the application of heat to the soldered joint and is re-soldered into a brass adaptor made to fit a length of polythene tubing. The end of the brass holder from which the needle was removed is turned down for a few mm. of its length so that it may also fit the polythene tubing. A tap (T) is fitted into a length of 3 mm. pyrex glass tubing, one end of which pierces the 7 mm. tube, while the other end is drawn out slightly for union with a length of small diameter rubber tubing.

Fig. 2 illustrates the frame, which has an over-all length of 30 mm. and carries at one end a clamp (C) capable of gripping the manometer rigidly in any position along its length; the other end is bent through 90° and filed out to form two diverging rods 2 mm. square (X, X). The inset to Fig. 2 shows a light brass carrier soldered to the centre of a short length of watch hair-spring (S) which is soldered

in turn, under slight tension, between the 2 mm. rods (X, X) at the end of the frame, in such a way as to bring the mirror (M_1) a little below and at an angle to the top of the frame when the spring (S) is at rest. (R) is a perspex roller, 3 mm. in diameter and 4 mm. in length; it is mounted between two small projections on the carrier, and should turn very freely on its axle. M_2 is a small reference mirror of the same dimensions as M_1 , mounted on a

FIG. 2.—Frame with clamp and arrangement of mirrors.

small piece of brass foil soldered to the frame. L_1 is a locking device which, when released, allows the frame to be tilted a few degrees in relation to its mounting block (H), which may, in turn, be rotated around or raised upon a vertical rod, and locked in position by L_2 .

Fig. 3 shows the manometer in its frame, P being a thin latex rubber membrane tied with a silk thread over the lip end of the manometer. The carrier (Fig. 2, inset) is of such dimensions that the perspex roller (R) makes contact with the

FIG. 3.—Manometer set up in frame.

centre of the membrane. A parallel beam of light is reflected off the two mirrors (M_1 and M_2) to give two spots on a suitably placed scale. The foil mounting of M_2 may have to be bent slightly to bring the reflections into close proximity. Any adjustment for height or direction may be carried out by releasing the locks (L_1 and L_2). The whole apparatus is filled with normal saline through the reservoir.

Fig. 4 shows the general arrangement for a set-up with two manometers.

Calibration.—With the needle inserted into a rubber bung and the tap open, the reservoir is raised to varying heights and the scale deflections recorded.

Measurement of Intra-Ocular Pressure. — With the level in the reservoir some 30 cm. above the level of the eye, the tap is turned

FIG. 4—Two manometers set up for use.

on so as to give a continuous drip; the superior rectus is gripped firmly and the needle inserted near the limbus; the tap is closed and, from then on, readings of the spot on the scale are made at intervals of a few minutes or less.

REFERENCE

- DUKE-ELDER, W. S. (1932). "Text-book of Ophthalmology". Vol. I, p. 487. Kimpton, London.