The occasional tonometry

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Although the importance of ocular pressure was recognized as early as 1875, the first truly practical instrument for its measurement was patented in 1905 by the Norwegian ophthalmologist Hjalmar Schiotz. The Schiotz tonometer has changed little since then and is still a viable choice for the rural physician.

Intraocular pressure is considered statistically normal at 16.1 (standard deviation 2.8) mm Hg. A value of 22 mm Hg, 2 standard deviations above this norm, represents the cut-off between "normal" and "high" intraocular pressure.[1]

TONOMETRY IN RURAL PRACTICE

Because the Schiotz tonometer is robust and cheap, and doesn't depend on a battery, we feel that it excels as an evaluation tool for the proverbial "red eye in the emergency department" for the rural physician. The "Schiotz" can sit on the shelf literally for years and still be ready for instant use. In acute angle-closure glaucoma, the pressure will be very high, often greater than 50 mm Hg, and this difference from the "normal" will be easily detectable by the Schiotz.[1]

Although it has received a "C" rating from the Canadian Task Force on the Periodic Health Examination, some physicians may have an interest in screening for glaucoma.[2] Treatment of glaucoma is really within the province of the ophthalmologist. However, rural physicians with an interest in glaucoma or practising in an area without access to an ophthalmologist may follow some patients. These physicians will likely be aware of the advantages and disadvantages of the various types of tonometer and may want to invest in a "noncontact" or "miniaturized" tonometer for a higher degree of accuracy and greater comfort for the patient (see Types of tonometers).

TYPES OF TONOMETERS

No tonometer pierces the eyeball and directly measures the intraocular pressure; all use some indirect method of estimating the true intraocular pressure. There are 4 broad classes of tonometers: indentation, applanation, noncontact and miniaturized.

- **Indentation tonometers**, such as the Schiotz tonometer (Fig. 1) (widely available from medical supply companies at a cost of about $350), use a rod-like "plunger" to "indent" the cornea and thus give an estimation of the pressure within the eyeball.

The other types of tonometers are available from the Canadian distributors listed in Appendix 1.

- **Applanation tonometers,** such as the Haag-Streit Goldmann ($1500–$2400*) and the Perkins ($1395–$1495*), determine intraocular pressure by measuring the force needed to flatten a small, central area of the cornea. This class of tonometer gives very accurate, "gold-standard" readings, but some require a slit lamp to use and all require some experience to obtain proper readings.
- **Noncontact tonometers**, such as



Fig. 1. The Schiotz tonometer.

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the Reichert PT100 ($8700*), the Keeler Pulsair 2000 ($9000*) and the portable Nidek NT-2000 ($12 500*), use a puff of air to flatten the cornea and thus indirectly measure the intraocular pressure. They do not require anesthesia of the eye — and so can be used by nonphysicians — and are preferred for screening for glaucoma. They are probably the least accurate of the 4 types and tend to give the highest readings.[3]

- **Miniaturized tonometers,** such as the Reichert Tono-Pen XL (18 cm long, 60 g; $3900*) and the Tono-Pen AVIA ($4400*), are hand-held, electronic tonometers that feature portability as their main advantage. They use a probe tip, protected by a disposable latex cover, to barely indent the cornea. This process is repeated several times and an average reading of intraocular pressure is displayed on an LCD (liquid crystal display) screen.

*Prices are courtesy of INNOVA Medical Ophthalmics (www.innova.ca), effective February 2012 and subject to change.

THE SCHIOTZ TONOMETER

The Schiotz tonometer[4–6] is inexpensive, simple to use and easily accurate enough for our purposes. We do recommend that an afternoon with an ophthalmologist, who can demonstrate it for you on a consenting patient, would be useful. The Schiotz is durable, requires little maintenance and can sit on the shelf for years between uses. There are no batteries to run down or leak! It would be a perfectly satisfactory device for the rural physician who has only an occasional interest in tonometry.

The Schiotz tonometer consists essentially of a hollow barrel with a relatively large footplate and a holder. A free-floating, rod-like plunger with a 5.5 g weight attached — the default weight — fits inside the barrel. When held vertically just above the eye, the plunger will move downwards by gravity and "indent" the cornea. This very small up-and-down movement is magnified by a lever arm to move a needle that gives a reading on a horizontal scale numbered arbitrarily 0–20. The "harder" the eye is due to higher intraocular pressure, the lower the indentation will be and so the lower the scale will read. By means of a table provided with the instrument, this scalar reading is converted to a reading of intraocular pressure in mm Hg.

To account for the range of pressure, different (supplied) weights (7.5 g and 10 g) may be added to the plunger.

Relative contraindications to Schiotz tonometry include corneal abrasions, infections and corneal edema or past damage, which may give a falsely high value. Potential side effects of the Schiotz are corneal abrasion, reaction to the local anesthesia and transmission of infection.[4–6]

HOW TO USE THE SCHIOTZ TONOMETER

1. Assemble the instrument. Because proper cleaning may not have been done, clean the plunger and footplate with alcohol and allow to dry (see Care of the Schiotz tonometer).
2. Calibrate the Schiotz by positioning it on the provided test block and taking the pressure. The reading should be zero. (If not, return to the supplier for servicing). We usually start with the 7.5 g weight on the tonometer (Fig. 2).
3. Recall that the best relaxant and analgesic is careful explanation of the procedure to the patient (Fig. 3).
4. Place the patient in the supine position. Loosen any tight collar.



Fig. 2. Calibrate the Schiotz.

5. Anesthetize the cornea, using whichever ophthalmologic anesthetic drops you are familiar with (Fig. 4).
6. Separate the eyelids with the fingers of one hand, being careful not to apply any pressure to the eyeball and thus raise the pressure (Fig. 5). Ask the patient to fixate forward (on the ceiling or other target above).
7. Hold the tonometer by the handle, above the eye, and lower it as vertically as possible, until the footplate is lightly resting on the centre of the cornea. We find it helpful to lower the tonometer in several short steps, stopping for a few seconds after each step, to allow the patient to get used to the object descending on his or her eye (Fig. 6).
8. Lower the handle to a position just between the top and bottom of the barrel, so that the tonometer is resting by its own weight on the cornea (Fig. 7).



Fig. 3. Carefully explain the procedure to the patient.



Fig. 4. Anesthetize the cornea.



Fig. 5. Separate the eyelids, being careful not to apply pressure to the eyeball.



Fig. 6. Lower the tonometer by a series of short steps to position the footplate over the centre of the cornea.



Fig. 7. Position the tonometer over the centre of the cornea.

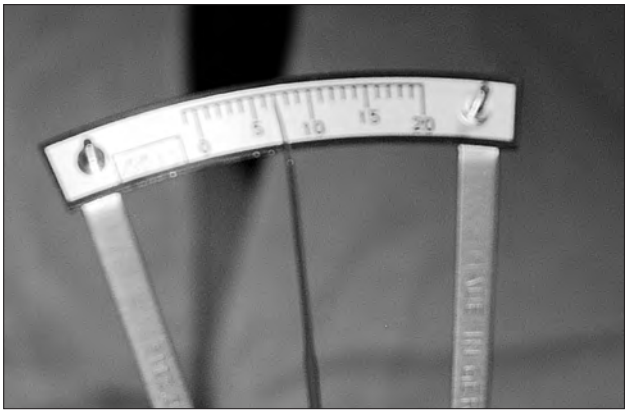


Fig. 8. Note the reading produced by the needle on the scale. Some oscillation of the needle is normal.

9. Note the reading produced by the needle on the scale. Some oscillation of the needle is normal and is due to the pulse transmitted to the intraocular fluid; it indeed confirms proper placement of the tonometer (Fig. 8). Try to take a reading at the centre point of the oscillation. If the reading is less than 4, add another weight onto the plunger and repeat the procedure. Using the conversion table in Appendix 2, convert the scalar reading to an ocular pressure reading, depending on which of the 2 weights has been attached (step 2). For example, with 7.5 g weight attached, a scalar reading of 7.0 indicates an intraocular pressure of 18.5 mm Hg, which is normal. With the 10.0 g weight attached, the corresponding value would be 27.2 mm Hg, which is elevated.



Fig. 9. Clean the plunger and tip with alcohol.

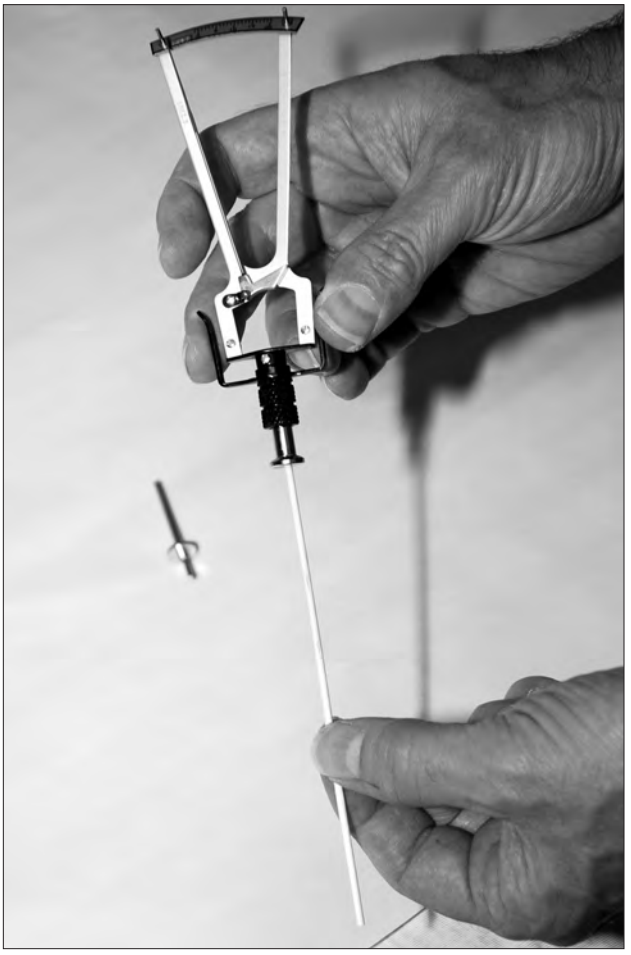


Fig. 10. Clean the barrel.

CARE OF THE SCHIOTZ TONOMETER

1. Remove the plunger, and use alcohol to clean the plunger and tip (Fig. 9).
2. Clean the inside of the barrel with an alcohol-soaked pipe cleaner or Q-tip and then with a dry pipe cleaner or Q-tip (Fig. 10).
3. Clean the footplate with alcohol.
4. Allow to dry and then place disassembled in the provided box.

Competing interests: None declared.

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Appendix 1. Distributors of tonometers

INNOVA Medical Ophthalmics
Toronto, Ont.; 416 615-0185
Pacific Medical Technologies, Inc.
Vancouver, BC; 604 540-1755
Toronto, Ont.; 888 855-6558
Precision Ophthalmic, Inc.
Anjou, Que.; 514 388-1515

Appendix 2. Schiotz scale conversion table

Scale reading	Ocular pressure, mm Hg	
	7.5 g weight	10 g weight
1.0	49.8	69.3
2.0	42.1	59.1
3.0	35.8	50.6
4.0	30.4	43.4
5.0	25.8	37.2
6.0	21.9	31.8
7.0	18.5	27.2