Tonometry is the measurement of the intraocular pressure (IOP) within an eye. The IOP is affected by the rate of formation and outflow of the aqueous humor, extraocular muscle tone, blood pressure, head position, restraint, including pressure applied to the eyelids/globe and/or collar and hence the jugular veins, the administration of xylazine in horses (reported to lower the IOP up to 23%), and auriculopalpebral nerve blocks in horses (may or may not affect the IOP). There are many different instruments (tonometers) available and commonly used to measure the IOP in man; however, in veterinary medicine, IOP is typically estimated/measured by either digital palpation, Schiotz (indentation) tonometry, Tonopen (applanation) tonometry, or Tonovet (rebound) tonometry. Methods of measurement of IOP (i.e., the ideal tonometer) need to be easy to use, atraumatic, require minimal restraint, and provide accurate and repeatable estimates of the IOP in both normal and diseased eyes across a wide range of species.

There are several ocular diseases with clinical signs resembling those of glaucoma and uveitis but for which measurement of the IOP is necessary in order to rule in or rule out these diseases. For example, corneal edema with conjunctival hyperemia are common in uveitis cases for which the IOP will typically be lower than the contralateral normal eye or near normal in an eye that has developed corneal endothelial decompensation (CED). Pupillary dilation is a common clinical sign in not only glaucoma but also iris atrophy (clinically insignificant, age-related thinning of the iridial sphincter muscles), following pharmacologic dilation (e.g., atropine or tropicamide), or in some neurologic syndromes (e.g., pupillotonia which is manifested by pupil dilation caused by the loss of the parasympathetic innervation of the iris sphincter muscles). A red, inflamed, painful eye with corneal edema may not only represent clinical glaucoma but can also be present in a nonglaucomatous eye with a corneal ulceration. Thus, a reliable and accurate means of determining the intraocular pressure in dogs, cats, horses and exotics is especially important when examining patients with possible glaucoma and/or uveitis.

Digital tonometry is that in which the IOP is estimated by the examiner balloting the globes with his/her finger following the instillation of a topical anesthetic. The abnormal and normal eyes should be compared. Digital tonometry can differentiate between soft and hard eyes but it is not a substitute for a more objective measurement. Rather than using a finger, I suggest using a rounded, linear object such as the plunger of the Schiotz tonometer, observe the plunger indent the cornea at a ninety degree angle and compare the normal to abnormal eyes. A hypotensive globe will easily indent versus a glaucomatous globe will only subtly indent when compared to the fellow, normal eye.

The Schiotz indentation tonometer is inexpensive, reasonably accurate if used correctly and in a cooperative patient, can be used in dogs and cats but not horses nor most exotics, requires proper care of the instrument for accurate results, has a large footplate (10 mm
diameter) and a central plunger that is 2.75 mm in diameter, and is probably the most frequently used instrument in veterinary private practice for estimating IOP. Careful application of the Schiotz tonometer to the eye is necessary to avoid errors in estimates of the IOP and iatrogenic damage to the cornea. The instrument must be kept meticulously clean to allow free movement of the plunger, applied vertically to the eye, and tension must not be applied to the globe via excessive eyelid retraction. The Schiotz tonometer consists of a 10 mm diameter corneal footplate which approximates the curvature of the human cornea, a 2.75 mm diameter plunger, a holding bracket, and a scale. Following the instillation of a topical anesthetic (0.5% proparacaine), the instrument is assembled, it is calibrated using the included, circular plate (should read zero), the patient’s head and eyes are directed upward, the footplate is rested in the center of the cornea with the instrument held vertically, and the scale reading is read. The Schiotz tonometer measures the amount of corneal/globe indentation produced by a given weight (5.5 gram, 7.5 gram, or 10 gram system). The human calibration table developed by Friedenwald in 1955 and provided with the tonometer appears to be the most clinically useful conversion table for converting Schiotz tonometer measurements to mm of Hg in dogs and cats with normal eyes. The normal mean canine and feline readings with the Schiotz tonometer and the 5.5 gram system were 4.9 and 3.9 tonometer scale units and 18.0 and 21.6 mm of Hg conversion using the human calibration table, respectively.

Applanation tonometry (i.e., Tonopen) is based on the Imbert-Fick law that states that an external (applanating) force against a sphere equals the pressure within the sphere multiplied by the area flattened (3.2 mm tip) by the external force; i.e., applanation tonometers measure the force required to flatten, or applanate, a precise area of the corneal surface. For the law to be valid, however, the sphere must be perfectly spherical, flexible, dry, and infinitely thin. Because the cornea fails to satisfy any of these requirements, modifications of the law are necessary for an aspherical cornea, corneal rigidity, tear surface tension, and corneal thickness. The Tonopen is portable (lightweight and small) but fragile, handheld, battery operated, uses a disposable latex membrane cover, provides the mean IOP with a coefficient of variance (5%, 10%, 20%, or 20%) on a liquid crystal display, and requires the observer apply a light tapping of the instrument to the patient’s cornea and thus yields a tremendous potential for user variability. Although developed for use in humans, the Tonopen applanation tonometer can provide reproducible and accurate measurement of IOP in dogs, cats, horses, cows, sheep and many exotics in the normal range of IOP’s but tends to overestimate low IOP’s and underestimate high IOP’s.

The rebound tonometer (Tonovet) was specifically designed to measure IOP in animals and was introduced in 2004. The rebound tonometer probe tip is very small {approximately 1 mm diameter versus 3.2 mm (Tonopen) and 2.75 mm (Schiotz)} and as such allows the measurement of IOP’s in very small eyes. The Tonovet, disposable probe is electromagnetically propelled to come in contact with the patient’s cornea and then rebound from the corneal surface. The characteristics of the magnetic probe’s rebound are used to estimate the IOP. Six measurements are obtained, averaged, and a mean value is displayed. The rebound tonometer is portable, battery operated, lightweight, does not require topical anesthesia, and eliminates user variability as the
observer only pulls a trigger. The Tonovet rebound tonometer has been shown to provide more consistent IOP measurements with lower standard deviation than the Tonopen in repeat measurements of normal rabbits. Values obtained with the rebound tonometer were on average 2 mm Hg lower in dogs and 1 mm Hg higher in horses when compared with the values obtained with the Tonopen applanation tonometer. It has been reported that rebound tonometers provide more accurate measurement of the IOP than do applanation tonometers.

S. J. Dugan has used all of the techniques and instruments described in this brief summary and can state, without hesitation, that the Tonovet rebound tonometer is the best instrument that I have used thus far. If your office properly cares for the Schiotz, Tonopen, and/or the Tonovet tonometer, and uses of them correctly, they will all assist you in obtaining accurate IOP’s in several species for many, many years.

References