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# Twenty-four–Hour Measurement of Intraocular Pressure in Guinea Pigs (*Cavia porcellus*)

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**The objective of this study was to measure intraocular pressure (IOP) in intact, healthy guinea pigs (15 male, 15 female) every 2 h for a 24-h period. First, IOP was measured by using rebound tonometry (RBT). After a 1-min rest period, 0.5% proparacaine ophthalmic solution, a topical anesthetic, was applied to both eyes; 4 min after anesthetic instillation, IOP was measured by using applanation tonometry (APT). The IOP was lower during the light period (0700 to 1900) than during the dark phase (2000 to 0600). The lowest IOP by both RBT and APT (3.68 and 13.37 mm Hg, respectively) occurred at 0700, whereas maximal IOP occurred at 2300 for RBT (8.12 mm Hg) but at 2100 for APT (20.62 mm Hg). No significant differences in IOP between the left and right eyes or between RBT and APT were noted. In addition, daily variations in the IOP of guinea pigs seem to be independent of sex and body weight. The results of this study may be beneficial in the diagnosis and observation of glaucoma in guinea pigs.**

**Abbreviations:** APT, applanation tonometry; IOP, intraocular pressure; RBT, rebound tonometry

Tonometry measures the intraocular pressure, which results from the balance between the inflow and outflow of aqueous humor in the eye. This technique helps in the diagnosis of ocular pressure abnormalities, such as ocular hypertension and glaucoma, which may severely or permanently impair vision, and ocular hypotension, which is a cause of uveitis.[7]

Intraocular pressure is dynamic and fluctuates from minute to minute as the physiologic state of the subject changes. Fluctuations in IOP associated with the time of day, if this information were readily available, might influence therapeutic decisions. Ideally, IOP should be measured in the subject's normal environment at regular intervals and without the subject's knowledge for as long as necessary to study the principle being investigated. Realizing the ideal situation is difficult, but fluctuations in the IOP over 24 h can be revealed by measuring IOP at a 1- to 2-h interval to provide a dynamic characterization of IOP and improve methods for treating hypertensive eyes.[13] To our knowledge, the current study is the first to characterize the 24-h pattern of IOP in guinea pigs by using rebound tonometry (RBT) and applanation tonometry (APT).

Animal research on glaucoma plays an important role in the evaluation and development of new treatments. Although precise measurement of the IOP is desirable, researchers and veterinarians typically are more interested in the changes and trends in IOP over time.[13] The results of the current study may be beneficial in the use of guinea pigs as an experimental animal model for glaucoma research, for example.

## Materials and Methods

The study population comprised 30 intact, healthy guinea pigs (444 to 544 g; 15 male, 15 female). All guinea pigs underwent ophthalmologic examination, including slit-lamp biomicroscopy, direct and indirect ophthalmoscopy examinations of the anterior and posterior segment, tonometry, phenol red thread testing, and fluorescein staining.

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Beginning 7 d before the first day of the study, all guinea pigs were housed individually under normal controlled conditions of temperature and humidity in an air-conditioned room and were exposed to a 12:12-h light:dark photocycle. They were fed a commercial guinea pig diet, vitamin C supplement, and green leafy vegetables. Water was freely available.

Over 24 h, IOP was measured every 2 h. First, IOP was measured by using a rebound tonometer (TonoVet tonometer, iCare, Tiolat, Helsinki, Finland) set on the 'p' calibration. At 1 min after the completion of RBT, a topical anesthetic agent, 0.5% proparacaine ophthalmic solution (Proparacaine hydrochloride 0.5%; Paracain, Sunways, Mumbai, India), was applied to both eyes and allowed to act for 4 min. Then IOP was measured by using an applanation tonometer (Tono-Pen VET tonometer, Reichert NY). A single examiner (SMR) performed all of the ocular tests, examinations, and measurements. The measurements were always obtained in the right eye first. For IOP assessment during the nocturnal phase, the measurements were performed under dim red light illumination (16-W bulb) to minimize the alteration of IOP by light perception.[10] None of the guinea pigs demonstrated signs of ocular discomfort during and for 24 after measurements were made. In addition, all of the guinea pigs were reexamined at 5 d after the study, and none showed any signs of conjunctivitis, keratitis, blepharitis, corneal ulceration, or intraocular disease were not detected in any of the guinea pigs.

Statistical analysis was performed by using SPSS for Microsoft Windows (SPSS 20.0, IBM, Chicago, IL). Paired-samples *t* tests were used to compare the IOP obtained from the right and left eyes. Independent-samples *t* tests were used to compare the mean IOP values according to sex and body weight. Two-way repeated-measures ANOVA was used to analyze the data from the 24-h measurement period. Pearson correlation was used to evaluate the relationship between mean IOP and body weight. A *P* value of less than 0.05 was considered statistically significant.

## Results

Mean IOP of guinea pigs by RBT and APT are summarized in Table 1. IOP was lower during the light period (0700 to 1900) than during the dark period (2000 to 0600). The lowest

**Table 1. Mean (± 1 SD) IOP of guinea pigs over 24 h**

| | Intraocular pressure (mm Hg) by | |
|---|---|---|
| | Rebound tonometry | Applanation tonometry |
| 0700 | 3.68 ± 0.53 | 13.37 ± 1.45 |
| 0900 | 6.31 ± 0.38 | 15.81 ± 1.25 |
| 1100 | 7.50 ± 0.48 | 17.68 ± 1.95 |
| 1300 | 6.75 ± 0.50 | 17.31 ± 2.10 |
| 1500 | 7.43 ± 0.60 | 13.43 ± 1.07 |
| 1700 | 6.93 ± 0.46 | 13.62 ± 1.15 |
| 1900 | 6.12 ± 0.50 | 14.18 ± 0.78 |
| 2100 | 6.56 ± 0.68 | 20.62 ± 1.23 |
| 2300 | 8.12 ± 0.45 | 17.62 ± 1.43 |
| 0100 | 5.56 ± 0.54 | 18.81 ± 1.77 |
| 0300 | 5.25 ± 0.40 | 18.56 ± 1.98 |
| 0500 | 4.12 ± 0.85 | 15.06 ± 1.81 |

IOP measured by both RBT and APT (3.68 and 13.37 mm Hg, respectively) occurred at 0700. Maximal IOP occurred at 2300 for RBT (8.125 mm Hg) and at 2100 by APT (20.62 mm Hg). IOP in guinea pigs did not differ significantly between the left and right eyes or between RBT and APT. Figure 1 demonstrates the fluctuation in the average IOP measured by RBT and APT in guinea pigs over a 24-h period.

## Discussion

Increased IOP is a major risk factor for the development of glaucoma. A single IOP measurement in the clinician's office is probably inadequate for the optimal management of glaucoma, given possible variation in this value throughout the day. Instead, the diurnal IOP curve provides a better estimate of an individual's IOP than does a single reading.[9]

Daily rhythms of IOP have been documented in many species; the phase and amplitude of these rhythms differ among them. Rhesus macaques show an increase in IOP during early morning,[5] whereas studies in both rabbits and rats have consistently demonstrated that IOP in these species increases during night.[4,13] In cats, high values of IOP occurred during night.[10] In contrast, the highest IOP values in beagles were detected in the morning, and the lowest IOP happened in the early evening.[6] It can be hypothesized that, for each species, higher values of IOP correlate with the awakening or activity phase.[10] The present results, obtained by using both APT and RBT, showed that the highest values of IOP in guinea pigs occur during night.

In guinea pigs, the difference between the highest and lowest mean IOP values throughout the 24-h light:dark cycle was 4.43 mm Hg by means of RBT and 7.25 mm Hg by means of APT. In comparison, this difference is approximately 5 mm Hg in humans, cats, and mice.[1,8,10] In contrast, a difference of 8 to 10 mm Hg has been reported for rats and chickens.[11,12]

Given that higher values of IOP were detected at night than during the light phase, it seems possible that the pupil size may influence this parameter.[10] However, pupil size was not assessed throughout the current study, because the use of light to determine pupil size would have influenced the IOP. Infrared evaluation of pupil size would have been valuable, but this technology was unavailable to us. The importance of 24-h IOP monitoring has increasingly been highlighted by numerous studies, particularly of ocular diseases.[10] In the present study, diurnal–nocturnal variations of IOP were assessed only in the normal eyes of guinea pigs, which is a limitation of the study. The second limitation was the small sample size. Changes in diurnal activity, which might affect IOP, have been studied previously in guinea pigs,[2,3] but these findings show considerable variation, in that some animals had a clear diurnal pattern to their activity and physiologic variables whereas others did not. Futures studies should evaluate activity on a case-by-case

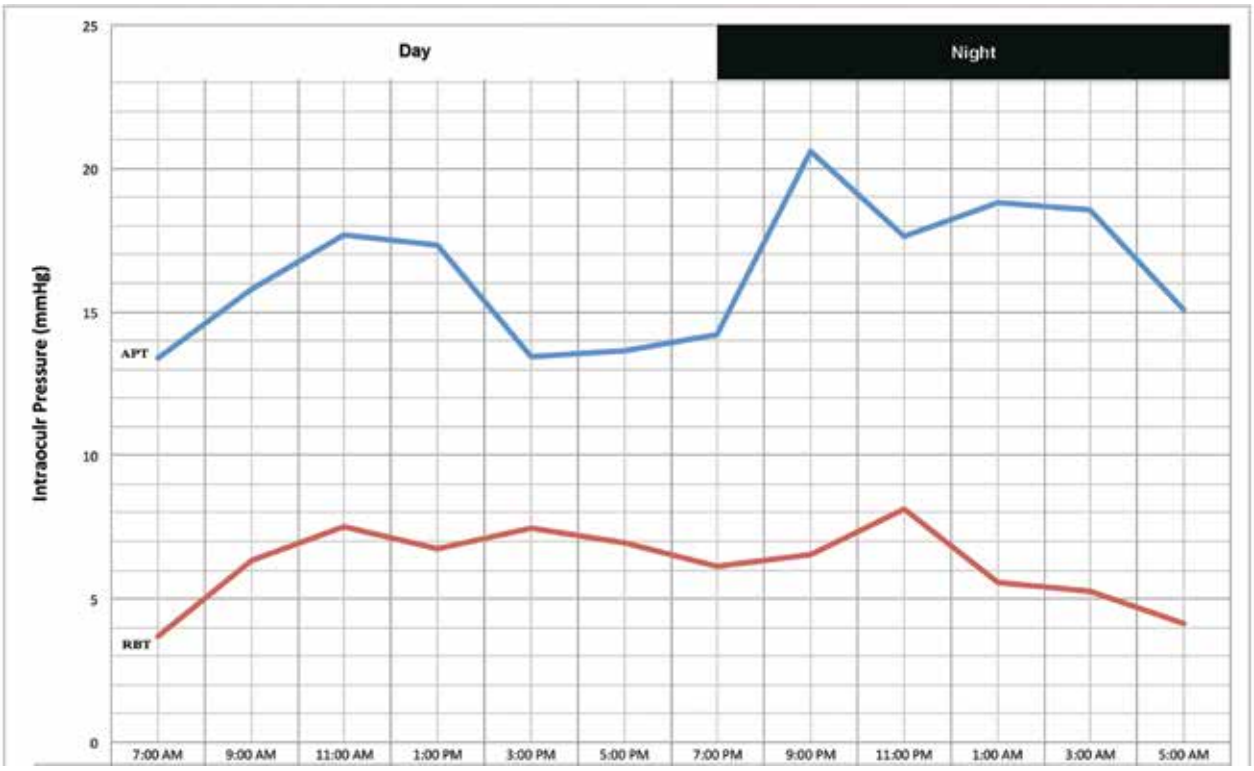


**Figure 1.** Average IOP measured by RBT and APT in guinea pigs over a 24-h period.

basis concurrent with the measurement of ocular variables, such as IOP.

The results of the current study may be useful in the diagnosis and monitoring of glaucoma in guinea pigs. Although glaucoma is not a common condition this species, it has been reported to occur.[14] Further studies should evaluate the diurnal activity of the individual animals studied and should determine pupil diameter concurrent with the IOP measurement.

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