Measurement of intraocular pressure in the domestic pigeon (Columbia livia)

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MEASUREMENT OF INTRAOCULAR PRESSURE IN THE DOMESTIC PIGEON (COLUMBIA LIVIA)


Abstract: The purpose of this study was to establish intraocular pressure values in clinically normal pigeons. One hundred (52 male and 48 female) healthy pigeons (Columbia livia) of six different breeds, ranging in age from 20 to 51 mo were used in the study. Pigeons were gently physically restrained in a dorsoventral position without any pressure or extension to the head and neck. A rebound tonometer with a disposable probe was held horizontally and 4–5 mm from the central corneal surface. Calibration of the device was set to “P.” Overall, the mean ± SD intraocular pressure values of all eyes were 6.1 ± 0.9 mmHg (ranging from 3 to 9 mmHg). Mean ± SD values for left and right eyes were 6.1 ± 1.0 and 6.0 ± 1.2 mmHg, respectively. There was no statistically significant difference in IOP between the left eye and right eye or between males and females (P = 0.49; P = 0.74). Analysis of variance revealed that there were no significant differences in the IOP between the breeds (P = 0.22).

Key words: Bird ophthalmology, Columbia livia, glaucoma, pigeons, rebound tonometry, tonometry.

BRIEF COMMUNICATION

Pigeons (Columbidae) are small- to medium-sized birds; they generally have small heads, full-breasted bodies, and soft but very dense plumage. They are members of the order Columbiformes.6 Pigeons have been domesticated for more than 10,000 years and are found in nearly all parts of the world.9 Pigeons are widely bred in Iran and Turkey; in Iran, they have economic value as ornamental and game birds, as in the UK, where many are kept as racing birds with importance for the veterinary profession.7 With the sizeable worldwide population of pigeons and lack of ophthalmologic knowledge about this species, it is important to establish reference values for routinely used tests, including measurement of intraocular pressure (IOP). Recently, measurement of tear production by use of the phenol red thread test has been reported in pigeons,9 but as yet, the normal value of IOP has not been determined in this species. Ophthalmic examination is very important, especially in those birds suffering from head and ocular trauma, because trauma is considered one of the most important causes of ophthalmic diseases in free birds.1 The aim of rehabilitating wild birds is to ultimately release them into the wild, and vision is crucial for these birds.15 Therefore, a thorough ophthalmic examination should be performed for every free-ranging bird under human care.

Published reference ranges for IOP in avian species is limited and has not been reported for any species in the family Columbidae. IOP, as measured by applanation tonometry, has been reported in ostrich (Struthio camelus), Humboldt penguins (Spheniscus humboldti), bald eagles (Haliaeetus leucocephalus), owls, and raptors,1,4,10,11,16,17 IOP, as measured by rebound tonometry, has been reported in raptors, black-footed penguins (Spheniscus demersus), macaroni penguins (Eudyptes chrysolophus), rockhopper penguin (Eudyptes chrysocome), screech owls (Megascops asio), domestic chickens (Gallus domesticus), and American flamingos (Phoenicopterus ruber).3,8,12,13,14,15 The purpose of this study was to establish IOP values in clinically normal pigeons.

The study was approved by the Iran Society for Prevention of Cruelty to Animals in accordance with Iranian ethical codes for studies on laboratory animals. The study population consisted of 100 healthy pigeons (52 male and 48 female) of six different breeds (English fantails, roller pigeons, blue almond homer, Kazan Trjasun tumblers, Old Dutch Capuchine, and English magpie tumbler pigeons [Columbia livia]), ranging in age from 20 to
51 mo from a captive colony bred and organized by a pigeon fancier. The pigeons ranged in weight from 232 to 529 g. A brief physical examination was performed on all birds. All animals were selected on the basis of a normal physical and ophthalmic examination, including phenol red thread test to exclude cases of dry eye, fluorescein staining to exclude corneal ulceration, slit lamp biomicroscopy, and indirect ophthalmoscopy 7 days before the start of the study. Ophthalmic lesions were not observed in any pigeon in the study population. The mean air temperature and humidity, as measured with a standard thermometer and hygrometer, were 20°C and 45%, respectively, in the city of Shahriar (near Tehran), where the study was conducted in February 2015. Pigeons were gently physically restrained in a dorsoventral position without any pressure or extension to the head and neck.

Statistical analysis was performed by using SPSS statistical software program (SPSS 20.0, SPSS Inc., Chicago, Illinois 60606, USA). Normality was tested by a one-sample Kolmogorov–Smirnov test. Data were analyzed by using a two-way analysis of variance (ANOVA) procedure to study the effects of sex and breed and the interaction between them. Significant differences were tested further by using Tukey’s multiple range test to determine the differences among treatments. A paired sample t-test was used to compare the IOP obtained from the right and left eyes. Correlation analyses were performed by using Pearson’s correlation test. A P-value of < 0.05 was considered statistically significant.

All continuous numeric data obtained for IOP in the population used in this investigation were normally distributed according to the one-sample Kolmogorov–Smirnov test (P = 0.44). Values are

### Table 1. Measured IOP in different avian species by means of rebound tonometer.

<table>
<thead>
<tr>
<th>Species</th>
<th>Intraocular pressure (mmHg)</th>
<th>Setting of device</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td></td>
</tr>
<tr>
<td>Raptor species</td>
<td>8.5–29.9</td>
<td>3.0–6.1</td>
<td>D</td>
</tr>
<tr>
<td>Black-footed penguins</td>
<td>28.1–30.4</td>
<td>4.27–6.8</td>
<td>D</td>
</tr>
<tr>
<td>Macaroni penguins</td>
<td>25.0</td>
<td>4.95</td>
<td>H</td>
</tr>
<tr>
<td>Rockhopper penguin</td>
<td>29.1</td>
<td>7.1</td>
<td>D</td>
</tr>
<tr>
<td>Screech owls</td>
<td>24.1</td>
<td>5.0</td>
<td>D</td>
</tr>
<tr>
<td>Domestic chickens</td>
<td>9.0</td>
<td>1.8</td>
<td>P</td>
</tr>
<tr>
<td>American flamingos</td>
<td>14.0</td>
<td>2.4</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>17.5</td>
<td>0.1</td>
<td>N/A</td>
</tr>
</tbody>
</table>

* N/A, Not Available.

The rebound tonometer (TonoVet®, Jorgensen Laboratories, Loveland, Colorado 80538, USA) with a disposable probe was held horizontally and 4–5 mm from the central corneal surface. Calibration of the device was set to “P.” The tonometer obtained six consecutive measurements and displayed a reading of the mean IOP in millimeters of mercury. The series of measurements were repeated until the tonometer indicated that an acceptable SD between the six measurements had been obtained (Fig. 1). The procedure was repeated for each eye.

The same examiner (SMR) conducted all ocular tests, examinations, and measurements to minimize variations in restraint or experimental technique. All IOP measurements were performed between 10 AM and 1 PM to minimize the possible variations associated with diurnal changes. No ocular discomfort was observed within 6 hr after the measurements.

![Figure 1. Measurement of intraocular pressure using a veterinary rebound tonometer on the P setting in an English magpie tumbler pigeon.](image-url)
given as mean ± SD. Overall mean ± SD IOP values of all eyes were 6.10 ± 0.94 mmHg (ranging from 3 to 9 mmHg). There was no statistically significant difference in IOP between left eye (6.16 ± 1.07 mmHg) and right eye (6.04 ± 1.22 mmHg) or between males (6.14 ± 0.80 mmHg) and females (6.06 ± 1.07 mmHg; P = 0.49, P = 0.74). Mean ± SD values for different breeds are summarized in Table 2.

ANOVA revealed that there were no significant differences in the IOP between the breeds (P = 0.22). Pearson’s correlation revealed that there was not a linear relationship between mean IOP with body weights of study populations (P = 0.7).

Measuring IOP is an intricate part of diagnosing many ophthalmic diseases, including uveitis and glaucoma.17 The applanation tonometer is the only device that has been validated for reliable measurement of IOP in birds.15 The veterinary applanation tonometer (Tono-Pen® VET™ Tonometer, Reichert, Inc. New York 14043, USA) is restricted to use in eyes with a corneal diameter exceeding 9.0 mm and requires the application of a local anesthetic.15 Rebound tonometry is a reliable method to measure IOP in smaller eyes and offers a stress-minimizing, well-tolerated tool for ophthalmic diagnostic testing in birds.6 The diameter of the contact surface of rebound probe of the veterinary rebound tonometer is only 1.4 mm. Measurements can be taken without topical anesthesia, and results are provided within a few seconds.13,15

Comparison of results from the veterinary applanation tonometer to a manometric method revealed good correlation of manometry and tonometry between 10 and 25 mm Hg; below 10 mm Hg, this tonometer provided falsely high results, whereas in the pressure range above 25 mm Hg, results were falsely lowered.14 In avian species, rebound tonometry was found to over- or underestimate IOP in comparison to manometry.10,12,14,15

In rock pigeons, accuracy of the veterinary rebound tonometer and human applanation tonometer (Tono-Pen XL, Reichert, Inc.) has been determined against true manometric IOP, but a reference range or mean IOP was not reported in this species.7 That report revealed that the accuracy of veterinary rebound tonometer and human applanation tonometer decreased with increasing IOP. In rock pigeons, the veterinary rebound tonometer was tolerated well and can be used even in species with very small globes, but its accuracy seems to be correlated to the corneal radius and declines with the decreasing size of the eye.5

The veterinary rebound tonometer has three internal calibration settings: D, for dogs and cats; H, for horses; and P, for other species. Mean ± SD IOP values of all reported avian species using the veterinary rebound tonometer were higher than the pigeon population in our study. The eyes of this avian species were all significantly larger than those of the pigeons. Mean IOP in adult free-ranging birds of prey have been reported as between 8.5 and 29.9 mmHg by using a veterinary rebound tonometer with the D setting.15 Mean IOP values using veterinary rebound tonometer were reported for black-footed penguins (between 25.05 to 30.41 mmHg, D and H settings), macaroni penguins (29.1 mmHg, D setting), rockhopper penguins (24.1 mmHg, D setting), screech owls (9 mmHg, P setting; 14 mmHg, D setting), domestic chickens (17.51 mmHg, P setting), and American flamingos (11 mmHg, P setting).3,8,12,13,14 Given that the pigeon’s globe is substantially smaller than a dog or horse globe and the corneal thickness is correspondingly less, the P setting, as used in small rodents, was chosen in this study rather than the D or H setting.

No differences were found between genders and breeds or left or right eye in pigeons. The same
results were obtained in Humboldt penguins, black-footed penguins, ostriches, American flamingos, screech owls, and birds of prey.4,6,8,12,13,15,17

Primary glaucoma is not described in birds due to the width of the iridocorneal angle.2 The disease has been described in secondary form in poultry, raptor species, and the canary.18 It can be secondary to uveitis, hyphema, lens luxation or chronic inflammation, with posterior or peripheral anterior synechiae and preiridal fibrovascular membrane formation.2,18 It has been induced experimentally in birds maintained in constant light or darkness.2 Buphthalmia is not very severe in glaucoma, due to the inflexibility of the sclera because of the ossicles.2

In our study, contact between the cornea and probe rarely caused a corneal reflex in pigeons. In other avian species, the veterinary rebound tonometer has similarly been well tolerated. The difference in species and breeds, handling and restraint of animals, time of day, and position of body or head could be responsible for this difference between IOP of pigeons and other avian species, but in these authors’ estimation, these factors are unlikely to result in such a marked difference, because of the size of the eye and the tensile strength of the cornea rather than the pressure inside, but this requires further evaluation.

Results of this study may be beneficial for the diagnosis and therapy of glaucoma. This study provides IOP values by means of rebound tonometry in different breeds of pigeons.

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LITERATURE CITED


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