Determining mean normal intraocular pressure in the Asian elephant (Elephas Maximus), a case series of twenty-four eyes

Bepaling van de gemiddelde normale oogdruk bij de Aziatische olifant (Elephas Maximus), een casusreeks van vierentwintig ogen

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ABSTRACT

The objective of this case series was to determine the mean normal intraocular pressure in the Asian elephant (Elephas Maximus). Twelve elephants (24 eyes) at five different locations underwent an ocular assessment including determination of intraocular pressure. The intraocular pressure was measured with a rebound tonometer. The eyes were divided into two groups: normal eyes and eyes with significant eye abnormalities. Sixteen eyes were found to be normal. In the normal group, the mean intraocular pressure was 29.4 mmHg +/- 4.02 mmHg (SD). The median intraocular pressure was 29 mmHg.

SAMENVATTING

De doelstelling van deze casusreeks was het bepalen van de gemiddelde normale oogdruk bij de Aziatische olifant (Elephas Maximus). Twaalf olifanten (24 ogen) op vijf verschillende locaties ondergingen een oogheelkundig onderzoek, inclusief meting van de oogdruk, die werd gemeten met een terugslag-tonometer. De ogen werden ingedeeld in twee groepen: normale ogen en ogen met significante oogafwijkingen. Zestien ogen werden als normaal beoordeeld. In die groep bedroeg de gemiddelde oogdruk 29,4 mmHg +/- 4,02 mmHg (SD). De mediane oogdruk was 29 mmHg.

INTRODUCTION

In January and February 2025, site visits were carried out to several elephant sanctuaries and hospitals in Southern Thailand (Khao Sok Elephant Conservation Centre, Krabi Elephant Hospital, Phang Nga Elephant Park, Phuket Elephant Sanctuary and Southern Thailand Elephant Foundation Hospital) with the aim to perform ocular assessments in the Asian elephant (Elephas Maximus). Due to changing rules and regulations, the gradual abolition of working elephants and improving welfare standards, many more Asian elephants in Thailand are now being kept in elephant sanctuaries (Rees, 2021). With their prolonged time in captivity, most are approachable with the assistance of their keeper (mahout) and many are tame enough to tolerate ocular examination. Nevertheless, these are massive mammals which sometimes can be unpredictable; therefore, safety guidelines must always be observed during clinical assessment (Dama et al., 2014).

Intraocular pressure measurement was accurately performed in twelve elephants during their ocular assessment. At the time of writing, there were no published reports on the intraocular pressure in the Asian elephant. A mean normal intraocular pressure is useful to identify patients with abnormal readings. This helps with the diagnosis of uveitis and glaucoma.

MATERIALS AND METHODS

Twelve female elephants were examined for this study. All elephants underwent an ocular assessment which included observation, assessment of vision, examination with magnification, intraocular pressure (IOP) measurement and ophthalmoscopy (direct and indirect) by two experienced ophthalmologists. The IOP was measured with an Icare® Tonovet Plus (Icare Finland Oy, Finland) (Figure 1) on the equine setting by the same operator for all eyes. The Icare® Tonovet Plus is a rebound tonometer in which a very light-weight probe is used to make a momentary contact with the cornea. In rebound technology, motion parameters of the probe are recorded during the measurement. The Tonovet Plus has the advantage no local anesthetic is required, hence from a practical point of view, it was chosen to measure the IOP in the elephants. The elephant being a large mammal with a strong palpebral reflex is very difficult to medicate topically, hence applying a local anesthetic prior to tonometry would have been an additional barrier to ocular examination and assessment. Applying topical medication in these intelligent animals prior to assessment can also make these patient less cooperative for further close examination. The elephant has a series of long and thick accessory hairs originating from the skin on the upper palpebrae (Figure 2); these are not eyelashes as they are not associated with the eyelid margin (Manchip et al., 2019; Suedmeyer 2006; Wong et al., 2012). To be able to measure the IOP in the elephants, it was necessary to gently lift these accessory

Figure 2. Typical long and thick accessory hairs on the upper eyelids in the Asian elephant.

Figure 1. Icare® TONOVET Plus (Icare Finland Oy, Finland).

hairs with one's non-dominant hand and holding them in place to provide access for the tonometer probe prior to taking a reading. To be able to reach the eye and have stability, the black head-support button on the tonometer was removed and the remaining head-support button-base (grey) was used for stabilization onto the non-dominant hand (which was holding the accessory hairs in place). Patience was required as some elephants would initially try to close their eyes with interference from the third eyelid and some would also flap their earflaps forcefully. Patience and a relaxed demeanor settled the elephants into opening their eyes, after which several accurate readings could be obtained. Once used to this approach, consistent and repeatable IOP measurements could be captured, without causing any distress to the elephants. Several readings were taken per eye with the instrument displaying the average of the readings. When measuring IOP in horses, similarly the upper eyelid is gently lifted to avoid interference of the instrument with the ciliae (Mustikka et al., 2020); in a larger cohort study of horse eyes by Mustikka et al. (2020), a very good repeatability of readings was reported.

RESULTS

The twelve elephants of the present study were split into two groups: group A: normal eyes (Table 1) and group B: eyes with significant eye abnormalities (Table 2).

Table 1. Group A: Intraocular pressure in the normal eyes (elephant numbers in chronical order of assessment).

Elephant Nr.	Age (years)	Sex	Eye	IOP (in mmHg)
3	14	F	OS	23
3	14	F	OD	32
4	33	F	OS	27
4	33	F	OD	26
6	18	F	OS	27
6	18	F	OD	27
7	20	F	OS	37
7	20	F	OD	27
8	16	F	OS	25
8	16	F	OD	25
9	15	F	OS	33
9	15	F	OD	34
10	58	F	OS	32
10	58	F	OD	31
11	28	F	OS	32
11	28	F	OD	33

IOP: intraocular pressure; F: female; OD: oculus dexter; OS: oculus sinister

Table 2. Group B: Intraocular pressure in eyes with significant ocular abnormalities (elephant numbers in chronical order of assessment)

Elephant Nr.	Age (years)	Sex	Eye	IOP (in mmHg)	Main ocular abnormalities
1	39	F	OS	14	Anterior lens luxation, cataract, blind
1	39	F	OD	32	Anterior lens luxation, cataract, blind
2	55	F	OS	33	Mature cataract
2	55	F	OD	37	Mature cataract, blind
5	55	F	OS	16	Mature cataract, iris darkening
5	55	F	OD	47	Mature cataract, iris rests and iris darkening
12	70	F	OS	40	Mature cataract, ocular discharge, keratitis
12	70	F	OD	44	Mature cataract, ocular discharge, keratitis

IOP: intraocular pressure; F: female; OD: oculus dexter; OS: oculus sinister

In the normal group (Figures 3, 4, 5, 6 and 7), the readings ranged from 23 to 37 mmHg. The mean intraocular pressure in the normal eyes (16 eyes) was 29.4 mmHg +/- 4.02 mmHg (SD). The median IOP in this group was 29 mmHg.

In the abnormal group (eight eyes), the IOP ranged from 14 mmHg to 47 mmHg. The main ocular abnormalities in this group are listed in Table 2. All these eyes were either blind or had poor vision. Elephant 1 had chronic bilateral anterior lens luxation. Both eyes had generalized corneal opacification with secondary corneal edema as well as areas of corneal melanosis (Figure 8). The left eye in this elephant was hypotonic with a pressure of 14 mmHg. The lenses in both these eyes were dense hyper-mature cataracts. This elephant was blind in both eyes. Elephant 2 had bilateral mature cataracts with no vision in the right eye and poor vision in the left eye. Elephant 5 had bilateral cataracts with signs of previous episodes of anterior uveitis represented by iris darkening in both eyes and with iris rests visible on the anterior lens capsule in the right eye. Vision was poor in both eyes. Elephant 12 was a seventy-year-old elephant with bilateral mature nuclear cataracts, abnormal frothy ocular discharge and keratitis (Figure 9). Both eyes had poor vision. She also had a bilateral pronounced arcus senilis (Figure 9). Arcus senilis is commonly seen in elephants and is more common with increasing age (Suedmeyer, 2006). An arcus senilis is a perilimbal circumferential (in the form of a ring) corneal deposit and is thought to be an accumulation of fatty (cholesterol) deposits. In humans, the arcus senilis is a perilimbal lipid deposition in the peripheral corneal stroma which encircles the entire circumference in the late stages. It is related to aging and is found in 60% of humans over the ages of fifty and sixty (Schwab et al., 1997). In dogs, an arcus lipoides corneae can be seen in some patients with systemic disease (hypothyroidism for instance); however, these tend to be more extensive and are seen at younger age (Schenk et al., 2023).

DISCUSSION

Knowledge of the mean normal intraocular pressure helps to differentiate between normal and in-

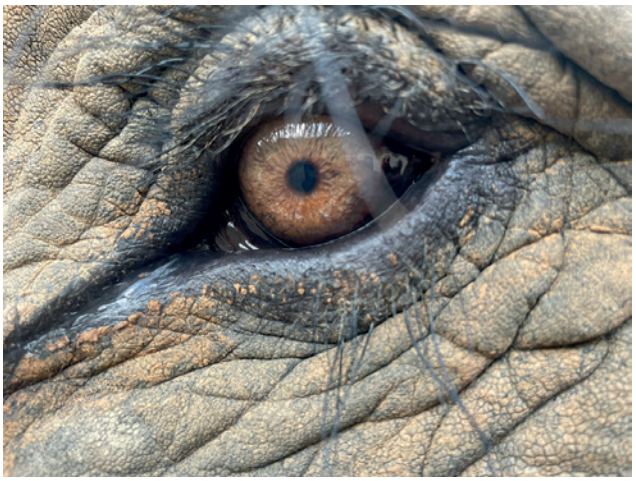

Figure 3. Group A: Elephant 4, left eye with IOP of 27 mmHg.

Figure 4. Group A: Elephant 4, right eye with IOP of 26 mmHg.

Figure 5. Group A: Elephant 7, right eye with IOP of 27 mmHg.

Figure 6. Group A: Elephant 10, left eye with IOP of 32 mmHg.

Figure 7. Group A: Elephant 11, right eye with IOP of 33 mmHg.

flamed and/or glaucomatous eyes. Knowledge of IOP helps with the diagnosis and decision-making in cases of uveitis and glaucoma. Monitoring of the intraocular pressure pre and post-intraocular surgery is necessary. This case series is useful for clinicians involved in cases where cataract surgery in the Asian elephant is being considered. Cataracts are common in the Asian elephant with increasing numbers of elephants affected with age (Godagama et al., 1999; Kraiwong et al., 2016). Although intraocular pressure ranges have been published in many different species (Gum et al., 2013), to date, no report has been published on the mean normal intraocular pressure in the Asian elephant (Elephas Maximus). In the present study, the readings in the Asian elephant were close to intraocular pressure readings reported in dairy cattle, with mean readings of 27.5 +/- 4.8 mmHg (range 16-39 mmHg) in a first study of 15 Holstein and 17 Jersey cows using the MacKay-Marg applanation tonometry (Gum et al., 1998) and with mean readings of 28.2 +/- 4.6 mmHg (range 19-39 mmHg) using MacKay-Marg applanation tonometry and 26.9 mmHg +/- 6.7 mmHg (range 16-42 mmHg) using TonoPen-XL applanation tonometry in a second study of 15 Holstein and 12 Jersey cows (Gum et al., 1998). In a comparison of three different methods of tonometry (Tonovet, Tonovet Plus and Tono-pen Avia) in horses, it was found that the Tonovet and Tonovet Plus carried the closest and strongest agreement between readings, with the Tonovet Plus showing slightly higher measurements (Latham et al., 2023). All three devices used in that study were appropriate for the use in horses, but it was recommended to use the same operator of the device for all patients to avoid operator variability. In a study by Passareli et al., (2021) comparing four tonometers in dogs (TonoVet, TonoVet Plus, Tono-Pen Avia Vet, and Kowa HA-2) for measuring IOP, it was found that all tonometers performed accurately, with the TonoVet Plus returning the highest values. Two intraocular pressure readings in an African elephant (Elephas Africana) of 18 mmHg in the right eye (which had a mature cataract) and 21 mmHg in the left eye (which had a nuclear incipient cataract) were found in the literature (Cerreta et al., 2019). These readings were slightly lower than the reported normal mean in the present study, but were both measured with a Tono-pen Vet™ which is an applanation tonometer that generally shows lower readings than with the Tonovet Plus (Passareli et al., 2021; Latham et al., 2023); moreover, both eyes had ocular abnormalities. This elephant was under treatment with topical flurbiprofen in both eyes to decrease the inflammation associated with cataract formation.

In conclusion, the mean normal intraocular pressure as measured with the Tonovet Plus, in the Asian elephant in this study was 29.4 mmHg +/- 4.02 mmHg (SD). To the authors' knowledge, this is the first study of its kind in the Asian elephant.

Figure 8. Group B: Elephant 1, left eye with IOP of 14 mmHg.

Figure 9. Group B: Elephant 12, left eye with IOP of 40 mmHg.

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Paardentram

Een merkwaardige foto van een paardentram met driespan, toebehorend aan de familie De Bruyne en weleer rijdend tussen Vurste, Melsen, Schelderode en Gent. De foto is rond 1910-1915 genomen. Het betreft een dubbeldekker met open rijtuig, die interlokaal van gemeente naar gemeente reed. In tegenstelling tot sommige stadstrammen reed deze tram niet op sporen. Het voertuig was wellicht eerder bestemd voor toeristische uitstapjes *(char à bancs)* dan voor de lijndienst. Aan de kledij van de passagiers te zien gaat het hier vermoedelijk om een zondagse uitstap.

De voerman is rond 1870 geboren. Zijn familienaam De Bruyne is op het voertuig vermeld. Volgens zijn achterkleinzoon maakte zijn overgrootvader dagelijks het traject Vurste – Melsen – Schelderode – Gent heen en terug. Eén van de vijf mannen boven op de tram is Alfons De Bruyne (°1898), zoon van de voerder. De foto bevindt zich in het rusthuis in Drongen, waar de moeder van de achterkleinzoon verblijft.

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