UNIVERSIDADE FEDERAL DO PARANÁ

THAYANE CRISTINE SANTOS VIEIRA

OPHTHALMIC FINDINGS IN AFRICAN-PYGMY HEDGEHOG

CURITIBA

2023

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Orientador: Prof. Dr. Juan Carlos Duque Moreno

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Obrigada, Thay!

Nem tudo são flores, mas tudo é semente.

RESUMO

Esta tese descreve a investigação e análise do bulbo ocular do ouriço-pigmeu africano (*Atelerix albiventris*) que é um *pet* não convencional e mesmo exótico no Brasil, vem apresentando maior popularidade. As investigações foram impulsionadas pela escassez de dados para determinar um parâmetros oftálmicos na espécie. Até o momento, somente alterações oculares como proptose do bulbo ocular e neoplasia foram descritos.

Nesta invesstigação foram realizadas: frequência de piscadas, mensuração da produção lacrimal (pelo teste EAPPTT- ponta de papel endodôntica absorvente estéril padronizada), coleta de material microbiológico com *swa*b da conjuntiva, mensuração do diâmetro de córnea, mensuração da fissura palpebral, medição da pressão intraocular com tonômetro de rebote; biometria ocular por meio de ultrassom; mensuração da espessura central da córnea e estesiometria corneana. Para determinar a condição de saúde de cada animal foram realizados ultrassom abdominal e coleta de amostra de sangue. Os achados oftálmicos descrevem um comportamento diferente das especias semelhantes já estudadas. O O estudo está em língua e normas de artigo científico da revista em que foi submetido: envio revista Journal of Zoo and Wildlife Medicine de qualificação B2.

Palavras-chave: *Atelerix albiventris*, teste lacrimal da ponta de papel endodôntica, estesiometria, pressão intraocular, microflora conjuntival, paquímetro ultrassônico.

ABSTRACT

This thesis describes the investigation and analysis of African-pygmy hedgehog (Atelerix albiventris) eye, which is an unconventional pet and even exotic in Brazil, it has been showing greater popularity. Investigations were inspired by the scarcity data in ophthalmic parameters in the species. So far, only ocular alterations such as ocular bulb proptosis and neoplasia have been described. In this investigation, it was performed the following tests: frequency of blinking, measurement of tear production (by the EAPPTT test - standardized sterile absorbent endodontic paper point tear test), collection of microbiological material with swab from conjunctiva, measurement of corneal diameter, measurement of palpebral fissure, measurement of pressure intraocular with rebound tonometer; ocular biometry by means of ultrasound; measurement of central corneal thickness and corneal esthesiometry. To determine the health condition of each animal, abdominal ultrasound and blood sample collection were performed. Ophthalmic findings describe a behavior different from similar species already studied. The study is in the language and standards of the scientific article of the journal to which it was submitted: submission to the Journal of Zoo and Wildlife Medicine with qualification B2.

Keywords: *Atelerix albiventris*. endodontic absorbent paper point tear test, estesiometria, pressão intraocular, microflora conjuntival, paquímetro ultrassônico.

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APH	African pigmy hedgehog
BF	Blink frequency
CCT	Corneal central thickness
CE	Corneal esthesiometry
BF	Blink frequency
EPPTT	Endodontic paper point tear test
IOP	Intraocular pressure
OD	Oculus dexter
OS	Oculus sinistre
OU	Oculus uterque
PFL	Palpebral fissure length

SUMÁRIO

OPHTHALMIC FINDINGS IN AFRICAN-PYGMY HEDGEHOG

Fifty-seven african-pigmy hedgehogs (*Atelerix albiventris)* were apprehended by the Environmental Military Police Green Force. Hedgehogs were taken to Federal University of Paraná (UFPR, Curitiba- Paraná, Brazil) to identify health conditions and perform veterinary assistance. Medicals records of physical examination and complementary exams were reviewed to collect ophthalmic data. This retrospective study included thirty-four hedgehogs. Patients manifesting any ocular or systemic disease were excluded. To support with this selection, medical records of complete blood tests, odontogram and abdominal ultrasound were interpreted. Selected ophthalmic tests evaluated: blink frequency, endodontic absorbent paper point tear test (EAPPTT), swab conjunctival (microbiologic sample), palpebral fissure length (PFL), corneal diameter (CD), intraocular pressure (IOP), B-mode ocular ultrasound, central corneal thickness (CCT), corneal esthesiometry (CE). Parameters found were: 7 blinks/minute (range 2 blinks/min); EAPPTT: 6 mm/min (range 3mm/min); PFL: 6.8 (1.2) mm; CD: 5.48 (0.43) mm; IOP: 2(3) mmHg; CCT:166.1 ±23.24; CE: 2.5 (1) cm; anterior chamber depth: 0.55 (0.1) mm); lens thickness:1.6 (0.3) mm; vitreous chamber depth: 1.8 (0.2) mm and axial globe length: 5.25 (0.4) mm. Only in IOP parameter was found significantly difference between male and female median (male > female, $P = 0.01$). Gram-positive bacteria were isolated in all samples and the most frequent bacteria found was *Staphylococcus* spp., present alone in half of samples followed by *Streptococcus* spp. These results can serve as useful parameters for ophthalmologic evaluation of african-pygmy hedgehog.

INTRODUCTION

Atelerix albiventris has become popular as unconventional pet in worldwide, generally referred as african-pygmy hedgehog.[36] It is a nocturnal insectivore member of Erinaceidae family (subfamily Erinaceinae) dorsally covered in short modified hair (spines). When threatened, the hedgehog roll itself into a compact ball shape mainly by contraction of orbicularis muscle (present along body sides). This behavior difficult clinical examination, even with a least manual restraint. Consequently, chemical restraint is usually needed to perform a complete exam. Wild *Atelerix albiventris* are widely encountered in steppes, grasslands, savannah, suburban gardens woodlands and agricultural fields of central and eastern Africa.[2,35] At least four hedgehogs genera and 14 species were registered in Erinaceinae subfamily widespread throughout Europe, Russia, China, and Africa.[33] However, there are limited citations about hedgehogs eye, and most of them, report specific ocular injuries (proptosis[31] and neoplasia[5, 9,16, 23]). Hedgehog ophthalmic diagnostic tests reported include studies other species in long-eared hedgehogs (*Hemiechinus auritus*)[6] and European hedgehog (*Erinaceus europaeus*)[34].

Establish reference values in ophthalmic tests is important to ocular health assessment of each specie. The purpose of this study was to report selected ophthalmic diagnostic tests in available *Atelerix albiventris.*

MATERIALS AND METHODS

Fifty-seven african-pigmy hedgehogs (*Atelerix albiventris)* were apprehended by the Environmental Military Police Green Force (police report nº 2021/58132)(in Brazil hedgehogs are forbidden for being part of exotic fauna)[11] and maintained by Fauna Sector of Water and Land Institute (*Setor de Fauna do Instituto Água e Terra - IAT*) responsibility. Hedgehogs were taken to Federal University of Paraná (UFPR, Curitiba- Paraná, Brazil) to identify health conditions and perform veterinary assistance. At university, the exotic medicine team work closely to ophthalmology group, consequently, selected ophthalmic diagnostic tests were part of health examination.

Medicals records were reviewed to collect ophthalmic data. Physical examination occurred in three consecutive days: the first and second with exact the same methods and chemical restraint, while third was with gently manual restraint. Hedgehogs were divided in two different groups to be examined in first and second day, half of them was examined in the first day and other half in the second day. All procedures of examination were the same in all hedgehogs and occurred in same day period at the same room with controlled temperature (25ºC) and ambient humidity (65%). Procedures were split between the investigators and to avoid discrepancies related to different observers, the same person always performed the same test. Before restraint blink frequency test, weight and gender were registered. Blink frequency was registered with a simple pathology hand count during five minutes with each hedgehog free in a transparent recipient without any restraint, after 10 minutes of adaptation.

First and second day of physical examination

On the first and second days, the complete physical examination was performed under chemical restraint (Barakas anesthesia system), with the patient kept under a 3% isoflurane mask inhalant. All patients were monitored by a multiparametric monitor during all examination that lasted around 25 minutes. Ophthalmic parameters included: (i) tear test; (ii) microbiological corneal sample; (iii) intraocular pressure (IOP); (iv) palpebral fissure length; (v) corneal diameter (equatorial axis) (vi) eye b-mode ultrasound biometry and (vii) fundoscopy. Following by accurate general observation, dentistry condition observation, abdominal ultrasound and blood test were performed.

Third day of physical examination

Third day occurred with soft tissue to involves the animal and manual restraint, only two ophthalmic parameters were possible: (vii) corneal esthesiometry (CE) and (viii) corneal central thickness (corneal axial axis).

Inclusion criteria

Hedgehogs were considered eligible for inclusion in this retrospective study data if they weight more than 130 g (below this weight they were too young), without manifesting any ocular (i.e. cataracts) or systemic disease (i.e. neoplasia, dermatitis). To help with this selection medical records with complete blood tests, odontogram and abdominal ultrasound were interpreted. Hedgehogs with mild bacterial plaque in teeth were included in the study, but if gingivitis or severe periodontitis were present, they became out of data source.

Tear test

Standardized sterile endodontic absorbent paper points - EAPPTT (Roeko Color®, size 30, Langenau, Germany) were used to measure aqueous tear production. The paper point was inserted into the medial conjunctival fornix (avoiding canthus), remaining there for 1 minute in each eye. After this time the paper point was removed of each eye and positioned in endodontic ruler for reading. The moisture part became flexible and allowed the reading measurement in millimeters. The absorbent paper was sterile and taken by point tweezers from case to the hedgehog's eye (avoiding contamination).

Corneal microbiological sample

For the microbiological analysis, samples were obtained by a gently carefully sweep of the cotton micro-swab stick (Absorve®, São Paulo, Brazil) along lower fornix (from inner to outer canthus) and corneal surface of each hedgehog left eyes. The swabs were kept in Stuart culture medium and sent for culture to Marcos Enrietti Diagnostic Center at Federal University of Paraná (protocol number: 2821/2021-DAB09). No topical anesthetic was used before (avoid sample contamination or interference) and the eyelids did not were touched (only conjunctival and corneal material was collected).

Intraocular pressure (IOP)

Intraocular pressure was measure using a "p" setting at rebound tonometer (TonoVet®, Kruuse). After three final IOP measures, the averages were taken by the Tonovet advice for each eye. The results were expressed in millimeters of mercury (mmHg).

Palpebral fissure length

Palpebral fissure length was measured in both eyes by the distance between the lateral canthus of each eyelid to the medial canthus using a stainless-steel digital caliper. The caliper used allow a good precision of 0 to 6" (0 to 150 mm) in 0.0005" (0.01 mm) increment and had a LCD display type (Mitutoyo, São Paulo, Brazil).

Corneal diameter

Corneal diameter in equatorial axis was measured in both eyes by the distance between using a stainless-steel digital caliper the same used for palpebral fissure length.

Ultrasound eye biometry

Ultrasound eye biometry was performed using B-mode system (GE Logiq F6, São Paulo - SP, Brazil) with linear 18 - MHz transducer in thyroid mode. The probe was positioned in horizontal axial orientation placed on the corneal surface with an ultrasound gel. Patients remain in ventral recumbency. Parameters were measured in millimeters: axial globe length (from cornea epithelium to retina), anterior chamber depth (from corneal endothelium to anterior lens capsule), lens thickness (anterior to posterior lens capsule) and vitreous chamber depth (posterior lens capsule lens to retina). Eyes and periocular were cleaned after exam with physiologic solution.

Fundoscopy

Fundoscopy visualization was possible after their pupils were dilated with eye drops (tropicamide ophthalmic solution at 1%: Mydriacyl®, São Paulo- Brazil) and with the endoscopy equipment Fujinon® model EPX-2200.

Central corneal thickness

Central corneal thickness was measured using an ultrasonic pachymeter (Model 200P+; Micropach Sonomed, Lake Success, NY, USA), with the speed of preset at 1640 m/s. Before, an anesthetic eye drop was applied (proparacaine eye drop- Alcon Laboratories, São Paulo). After three measurements the average was recorded.

Central esthesiometry

Corneal esthesiometry was performed by Cochet-Bonnet esthesiometer (Luneau Ophthalmology, Chartres Cedex, France). Corneal touch threshold was quantified in centimeters length of the filament necessary to cause a blink reflex.

Statistical analysis

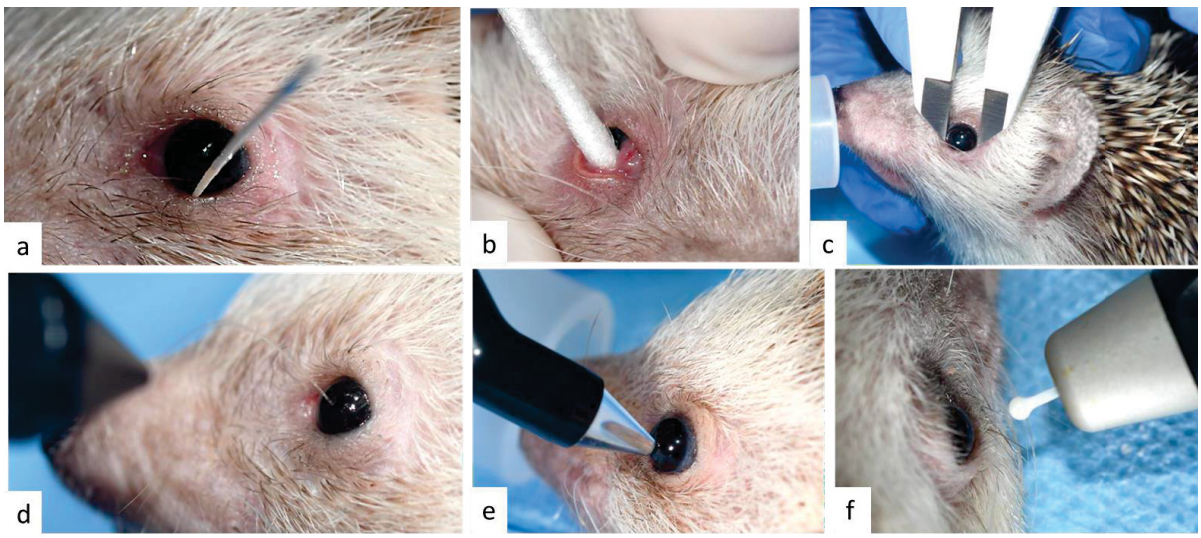
Statistical analysis was performed with computer software Sigma XL® (version 2021, Canada). To check normality Shapiro-Wilk test was used. Normality data is represented by mean and standard deviation and non-normally by median and interquartile range. Comparison between gender (female *vs.* male) and each eye side (right eye *vs.* left eye) were performed. Right and left

eye were considered independent measures. Linear regression was made between axial globe length and corneal diameter. Values of $P \leq 0.05$ were considered significant.

RESULTS

No complications occurred during all examination, at the end of first and second day, as long as isoflurane was discontinued, animals continue to receive oxygen flow until they recovered completely from sedation. One member of the veterinary team was responsible to check hedgehogs return and keep them warm. Some procedures are showed in Figure 1.

Figure 1. Photographs of selected ocular tests performed in *Atelerix albventris*. (a) Standardized sterile endodontic absorbent paper points tear test (EAPPTT); (b) swabbing the conjunctiva; (c) measure corneal axis equatorial (d) esthesiometry analysis of central cornea; (e) corneal pachymetry; and (f) tonometry.



The first and second day were performed in thirty-four *Atelerix albventris* (sixty-eight eyes): 20 females and 14 males, and the third day was possible in twenty animals (forty eyes): 12 females and 8 males for restraint technique. Exact age of each animal was not known, however, for its phenotypic characteristics it was assumed they were between 6 months to 3 years old (considering average lifetime in wild is 3-4 years, in captive can reach nine years old).[2] Hedgehogs weighted between 290 g and 320 g (322.05 ± 97.33 g). Blink frequency mean was 7 per minute with a variation of 2 blinks/min. Results are presented in Table 1.

Table 1. Results obtained for selected diagnostic tests in *Atelerix albiventris.* Normal values are represented in mean ± standard deviation, while non- normal are represented in median and interquartile range.

	Total	Female	Male
	OD + OS	OD + OS	OD + OS
Anterior chamber depth (mm)	0.55 (0.1)	0.55 (0.1)	0.55 (0.1)
Axial globe length (mm)	5.25 (0.4)	5.2 (0.225)	5.3 (0.4)
Blink frequency (blinks/min)	7 ± 2	7 ± 2	6 ± 2
Central corneal thickness ($mm.10^{-3}$)	166.10 ± 23.24	164.666 ± 18.36	168.25 ± 29.661
Corneal diameter (mm)	5.4875 ± 0.4389	5.497 ± 0.4389	5.575 ± 0.499
Corneal esthesiometry (cm)	2.5 (1)	2 (0.5)	2.5 (0.75)
Endodontic paper point tear test (mm/min)	6 (3)	6 (3)	5,5 (2)
Intraocular pressure (mmHg)	2 (3)	2 (2)	3 (3)
Lens thickness (mm)	2.6 (0.3)	2.6 (0.325)	2.6 (0.2)
Palpebral fissure length (mm)	6.8 (1.2)	6.85 (0.8)	6.45 (1.675)
Vitreous chamber depth (mm)	1.8 (0.2)	1.8 (0.225)	1.8 (0.2)
Weight (g)	322.05 ± 97.33	328.95 ± 85.43	312.21 ± 114.9

Except in IOP values between male and female median (male > female, $P = 0.01$), no significant effects of animal gender, weight, eye side (right *vs.* left) were observed in selected

ophthalmic tests (P values are showed in Table 2). Axial globe length (mm) and corneal diameter (mm) showed weak and inverse correlation (R: - 0.6358) in sixty-eight eyes of *Atelerix albiventris* (Figure 2).

Table 2. P-values represented gender and eye side effect in each selected ophthalmic tests and weight from *Atelerix albiventris.* Only in intraocular pressure, gender significantly showed effect.

	female *vs.* male	OD *vs* OS
Anterior chamber depth (mm)	0.86502	0.30772
Axial globe length (mm)	0.96012	0.92034
Blink frequency (blinks/min)	0.47105	0.46279
Central corneal thickness ($mm.10^{-3}$)	0.413798	0.67035
Corneal diameter (mm)	0.61284	0.62074
Corneal esthesiometry (cm)	0.16452	0.8181
Endodontic paper point tear test (mm/min)	0.5686	0.7489
Intraocular pressure (mmHg)	0.01*	0.60306
Lens thickness (mm)	0.29372	0.21498
Palpebral fissure length (mm)	0.21498	0.60306
Vitreous chamber depth (mm)	0.4902	0.76418
Weight (g)	0.6291	

Bacterial organisms were isolated in all 34 samples collected and all of them were gram positive. The most frequent bacteria found was *Staphylococcus* spp., present alone in half of the samples followed by *Streptococcus* spp. check Table 3.

First, fundus imaging was planned to be captured with ophthalmic camera iNview ® (Volk, USA), however, *Atelerix albiventris* have a tiny eye size. Fundoscopy register was possible with the digestive endoscope, but the size of probe (9.8mm) permitted visualization of fundus in parts (see Figure 3), to complement the images it was adapted by a 3.9mm wi fi LED endoscope camera for Smartphone – Xiaomi.

Figure 2. Representation of the weak and inverse correlation (R: - 0.6358) between axial globe length (mm) and corneal diameter (mm) in sixty-eight eyes of *Atelerix albiventris.*

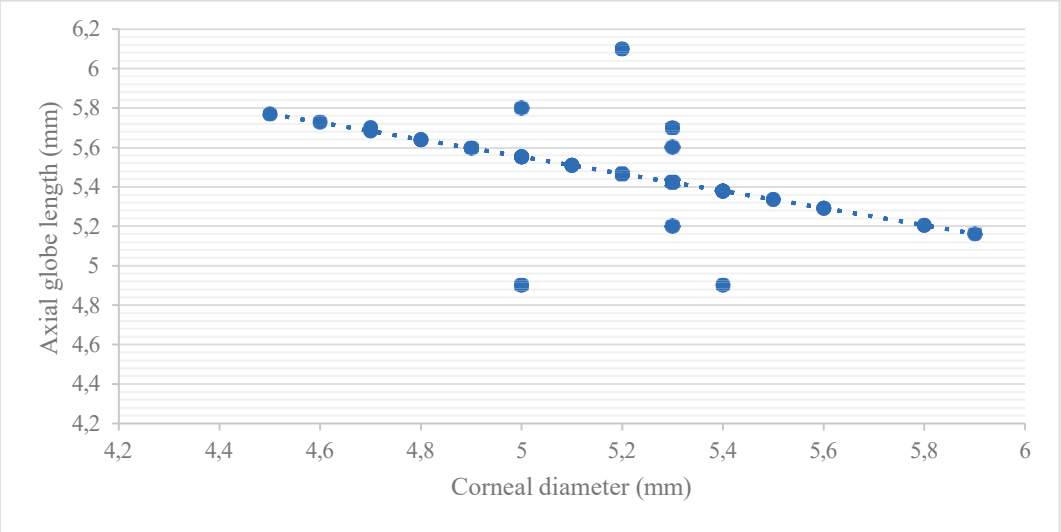
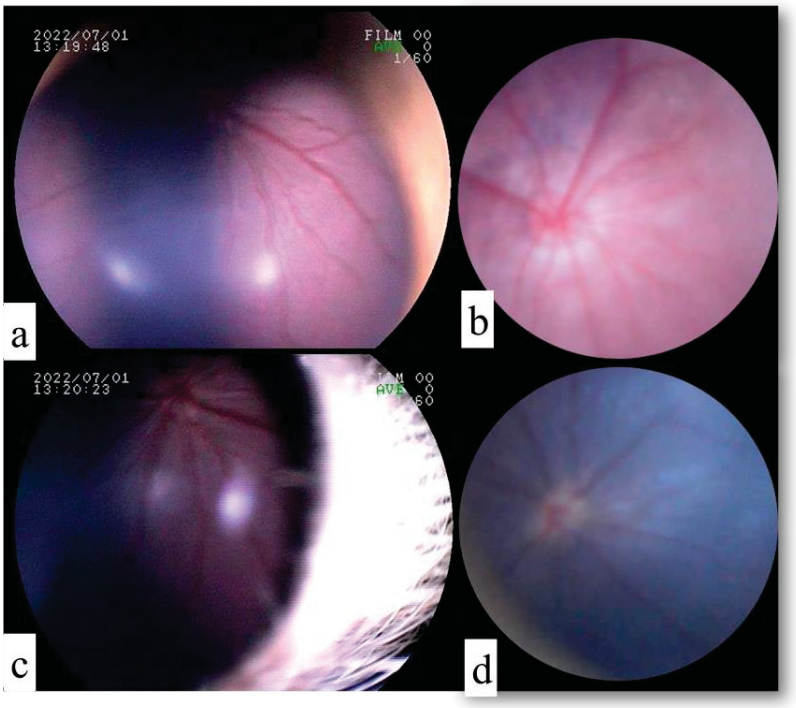


Table 3. Ocular bacterial genera isolated from cornea and conjunctiva from thirty-four eyes of available *Atelerix albiventris* without any ocular or systemic disease.

Bacterial Type	*n*
Bacillus spp.	2
Micrococcus spp.	2
Staphylococcus spp.	17
Streptococcus spp.	2
Micrococcus spp. and *Streptococcus* spp.	1
Staphylococcus spp. and *Streptococcus* spp.	10

Figure 3. Fundus photograph of the left eye of two different (female: a, b; and male: c, d) *Atelerix albiventris* individuals, both have colored iris. Note the hollangiotic pattern with vessels radiating from the optic disc, which is irregular in shape. Myelinization of the optic nerve fibers result in a pinky-colored disc.



DISCUSSION

It is important to mention that over citing literature, ophthalmic diagnose tests of *Atelerix albventris* (to author knowledge) are unknown. Even in de same family the information is sparse. Therefore, this study was compared with other existing ones even if the mammal cited specie is distant in the evolution scale.

African-pigmy hedgehog (*Atelerix albventris*) and members of Erinaceidae family are the oldest living placental mammals[8] and now the newest classification is that they belong the order

Eulipotyphla. Most species in this order have small eyes and poor vision (i.e moles from Talpidae family) and phylogenetic relationships between families remain controversial. They are important to provide a living model to study evolutionary adaptation, since it almost did not change over millions of years.[8,10]

In this study *A. albventris* revealed a more sensitive and thinner cornea with less intraocular pressure, high blink frequency, lower aqueous layer of the tear compared with small mammals of others families members. Furthermore, a wide palpebral fissure and shallow orbits that predispose to proptosis.[28] Some exotic medicine clinicians consider prophylactic tarsorrhaphy to minimize accidents.[31] Physical ophthalmic conformation of *A. albventris* is probably for its behavior to roll up when threatened, considering when they roll into a ball, they need a good mobility of the eye in orbit (retraction muscle to pull the eye deep in orbit). During the examination, it was accidentally proved when a gently face manipulation resulted in a reversible exophthalmia.

A. albventris palpebral fissure length found was very close to european hedgehog (*Erinaceus europaeus*) (respectively; 6.7 mm range 1.12 mm and 6.88 range 2 mm[34]). Anatomically they are very similar, but the african hedgehog is smaller in size and weight (african: 300g- 600g *vs.* european: 600 g- 1100 g). Palpebral fissure length and blink frequency affects directly in tear production and its spreads in corneal surface. African-pigmy hedgehog showed higher blink frequency (7 times per minute) than other small mammals registered species (guinea pig 2- 5 every 20 min,[30] hamster 1- 2 / min,[20] cat 1 blink every 5 minutes,[7] dog 3-5 / min,[7] chinchilla 2- 3 / 10 min,[14] and black-tufted marmosets 4- 5 / min[15]). This blink frequency might be related to capacity hibernate when climate gets cold,[8] or even the composition of tear (less aqueous portion or more evaporation, and more need to spread).[22] Tear composing, physiologic

exophthalmia and wide palpebral fissure length make high blink frequency requirement. Lacrimal components variation was associated with type of environment in which the animal lives.[22] If hedgehogs are considered living models of evolution studies, blink frequency revealed the evolution of the preys to keep eyes open and do not lose the predator of sight. Lower blink frequency was observed in chinchillas, and small prey rodents[14] testify this evolution.

Aqueous portion of tear was measured through endodontic absorbent paper point tear test (EAPPTT), which was developed for animals with smaller eyes.[15] Lower production of tear aqueous portion was similar in european hegehogs and long-eared hedgehog (*Hemiechinus auritus*)[6,34]. The Schirmer tear test strip was, found to be too large for such a small globe[6] while in long- eared, values stayed at 1.2 mm/min.[34] It would be a better opportunity to use EAPPTT and compare these three species.

African-hedgehog intraocular pressure (IOP) is the lowest found in small mammals (2 mm/Hg, range 3mm/Hg) even though syrian hamster (4.55 ± 133 mmHg)[20] and bats

(10.0 mmHg, range of 10 mmHg for *Artibeus lituratus* and 6 mmHg, range 9 mmHg for *Anoura caudifer*)[29] which weight less (syrian hamster 83.4 ± 18.2 g; 52 ± 10.9 g for *Artibeus lituratus;* 15 ± 1.1 g *Anoura caudifer*). In the same family using the rebound tonometer was registered in wild rescued european hedgehog a pressure mean of 12.6 ± 1.8 mmHg[34]. Moreover, another previous study in healthy long-eared hedgehog (*Hemiechinus auritus*) bred as pets, used an applanation tonometer (20.1 ± 4.0 mmHg). Long-eared hedgehog were immobilized with an intramuscular injection of combined ketamine and diazepam.[6] It is known that age, position (of animal and the probe),[21] cornea-probe of rebound tonometer distance,[24]cornea properties hysteresis,[3,4] type of equipment (tonometer of rebound or applanation in some species,[13,2]restraining technique[21] and anesthetic drug used can influence in IOP results. Hence, this discrepancy between IOP

hedgehogs can be justify by restraint drugs used (isoflurane can reduced IOP[27]) and tonometer device used. A controlled population of both species and device could offer information more homogenic. Gender, hormones and age effect in IOP was observed in humans[12] and cats,[18] with this on mind it is assumed these females of *A. albiventris* were older than male or influenced by hormones (male > female, $P = 0.01$*).

It was observed intense miosis in *A. albiventris* with isoflurane, however, when tropicamide eyedrop was instilled mydriasis came fast in 5 minutes (lasting around 15 minutes) Isoflurane trigger parasympathetic branch in iris, in consequence, the activation of pupil constrictor muscle in *A. albiventris*.

Central cornea thickness measured using ultrasonic pachymetry (166.59 ± 22.39 mm.10^{-3}) is thinner than mammalian species reported and close to the rat (156 ± 30 mm.10^{-3})[14]. In addition, to cornea thickness, *A. albiventris* revealed a cornea sensitivity similar to described in dogs[32] (*A. albiventris*.: 2.5 ± 0.52 cm; dogs: 2.6 ± 0.7 cm). Guinea pigs[14,30] and rabbits[32] have less cornea touch threshold them bigger mammals described and *A. albiventris*. (1.3 ± 0.6 cm and 1.4 ± 0.6 cm respectively). *A. albiventris* must have great cornea sensitivity to protect itself quickly from predators turning into a ball spiny shape.

Beyond general ocular B-scan ultrasonography use (i.e. support to diagnose lesions, tumors, uveitis) eye morphology help in understanding of mammal evolution. Changes in the eye morphology over time of visually dependent vertebrates are explained with reference to basic dioptric principals. Nocturnal mammals have adaptations for increased retinal image brightness, which is related to the size of pupil and angle of acceptance of a photoreceptor. The angle is inversely proportional of the posterior nodal distance (or focal length) of the eye. Cornea diameter limits maximum pupil diameter. Hence, nocturnal animal exhibit allometric

enlargement of pupil and cornea diameter relative to focal length. Axial diameter of globe is an estimative of posterior nodal distance, that determines retina image size. Enlargement cornea diameter reduces focal length (consequently axial diameter), increase image brightness in retina and increase visual sensitivity.[25] Given this description, it is relevant to locate *A. albventris* in agreement with an inversely proportional correlation between cornea diameter and axial globe length (5.4875 mm and 5.25 mm respectively). Cornea diameter is bigger than the axial globe length to inside the eye more light. They have an anterior chamber relatively small, likewise nocturnal mammals. *A. albventris* have large lens (median 2.6 mm range of 0.3 mm) that allows a better vision during the night, when they spend most of their time predating on invertebrates.[8] Likewise, some small rodents as chinchilla, guinea pigs and rats have lens thickness- to- axial globe length ratio 1:2[14,17].

Atelerix albiventris revealed a hollangiotic pattern very similar to rats.[26] Vessels coming out of optic disc, which is irregular in shape and pinky-colored disc. In contrast of very scientist believe, that hedgehogs had a primitive visual system, they have well-developed visual area. This accompanied of auditory and somatosensory systems in major subdivisions of neocortex. Hedgehog cortex is organized in a similar to that found in many other small mammals; three somatosensory areas occupying much part of the central-cortical area, surrounded caudally and laterally by visual and auditory cortex, respectively. And it suggested with microelectrodes tests, that they have even a second visual area in neocortex.[1] In contrast of a primitive vision and rod-dominant retina lacking, the hedgehog *Echinops telfairi* showed a cone proportion in dorsal retina of 70%.[19]

Staphylococcus spp. was the bacteria most isolated (more than 50 % in sample), followed by *Streptococcus* spp. Others include *Micrococcus* spp. and *Bacillus* spp. All samples were collected from healthy conjunctiva, suggesting they are normal in *A. albventris* conjunctival

normal microflora. These bacteria are gram-positive and were isolated from clinically normal eyes in a variety of mammalian species (dogs, cats, cows, rabbits, pigs, sheeps, cow, horses) and in birds.[7]

Limitations of this study included no ideal controlled captive condition (hedgehogs from apprehension scenario). Future research also could explore the difference between these species in the same controlled and conditions captive. Nevertheless, it is hoped that this study contributes with veterinary community in understanding evolution process and in support ocular examination diagnostic in this crescent unconventional pet.

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ANEXOS

Normas para submissão da revista Journal of Zoo and Wildlife Medicine

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