http://dx.doi.org/10.1590/1678-4162-12323

Arq. Bras. Med. Vet. Zootec., v.74, n.5, p.807-813, 2022

Ocular echobiometry and relationship with cranial and body morphometric parameters in Shih Tzu dogs

[*Ecobiometria ocular e relação com a morfometria craniana e corporal em cães Shih Tzu*]

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ABSTRACT

The purpose of this paper is to determine the ocular echobiometry and investigate its correlation with cranial and body morphometric parameters in 50 adult Shih Tzu dogs. The echobiometric measurements of the anterior chamber (AC), vitreous chamber (VC), lens axial thickness (LTA), transverse lens thickness (LTT), and axial length of the eyeball (ALE) were obtained by two-dimensional ultrasonography. Morphometric measurements of bizygomatic distance (BDIST), frontal-occipital distance (FOD), withers height (WH), thoracic circumference (TC), and body length (BL) were also obtained. The mean of the AC depth was 2.83±0.50mm, the VC was 9.18±0.54mm, the LTA was 6.42±0.32mm and the LTT was 9.17±1.18mm, while the mean of the ALE was 18.82±0.66mm. There was no correlation between ocular echobiometric variables and cranial and body morphometric variables in adult dogs of the Shih Tzu breed, as well as no significant difference of these variables when considering gender and age of the dogs ($p \geq 0.05$).

Keywords: canines, biometrics, ultrasonography, ocular anatomy, ophthalmology

RESUMO

Objetivou-se, com este estudo, a determinação da ecobiometria ocular e a investigação de sua correlação com parâmetros morfométricos cranianos e corporais em 50 cães Shih Tzu adultos. As medidas ecobiométricas da câmara anterior (CA), da câmara vítrea (CV), da espessura axial (ELA), da transversal da lente (ETL) e do comprimento axial do globo ocular (CGO) foram obtidas por meio da ultrassonografia em modo bidimensional. As medidas morfométricas do distanciamento bizigomático (DBZ), do distanciamento fronto-occipital (DFO), da altura de cernelha (AC), da circunferência torácica (CT) e do comprimento corporal (CP) também foram obtidas. A média da profundidade de CA foi de 2,83±0,50mm, da CV foi de 9,18±0,54mm, da ELA foi de 6,42±0,32mm e da ETL foi de 9,17±1,18mm, enquanto a média do CGO foi de 18,82±0,66mm. Não foi verificada correlação entre as variáveis ecobiométricas oculares e as morfométricas cranianas e corporais em cães adultos da raça Shih Tzu, assim como não houve diferença significativa dessas variáveis quando considerado o gênero e a idade dos cães (P≥0,05).

Palavras-chave: caninos, biometria, ultrassonografia, anatomia ocula, oftalmologia,

INTRODUCTION

Among domestic animal species, dogs have the highest number of cranial variations, resulting from the more than 350 breeds bred during domestication (Curth *et al.*, 2017). In brachycephalic dogs, the orbit is shallower comparing with other cranial conformations, consequently making the exposure of the eyeball more evident, causing several ocular problems (Packer *et al*., 2015). Among the brachycephalic dogs, the Shih Tzu is a breed that presents several ocular problems (Christmas, 1992). The most common diseases in brachycephalics are lagophthalmia, keratoconjunctivitis sicca,

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Submitted: February 3, 2021. Accepted: June 24, 2022.

entropion associated with trichiasis, chronic keratitis, and eye trauma (Mcnabb, 2017). In dogs, echobiometric measurements of the eyeball differ mainly due to the size and shape of the skull of different breeds (Gonçalves *et al*., 2009). There are still few published studies that specifically elucidate the echobiometry of intraocular structures, as well as its correlation with cranial and body morphometric parameters, mainly of specific breeds that represent ophthalmologic importance. It is possible that Shih Tzu dogs with smaller cranial and body dimensions also have smaller ocular structures, establishing a parameter for the veterinarian in ocular ultrasonography exams in this breed.Thus, this study aimed to characterize the echobiometric measurements of ocular structures through two-dimensional ultrasonography and to evaluate their correlation with cranial, body, age, and gender morphometric parameters in Shih Tzu dogs.

MATERIAL AND METHODS

The study was developed at the Universidade Estadual do Norte do Paraná, previously submitted to the Ethics Committee for the Use of Animals (CEUA) of Luiz Meneghel campus with approval according to protocol 02/2018.

The study was performed with dogs (*Canis lupus familiaris*) of the Shih Tzu breed, males and females, healthy and neutered, from 1 to 13 years old (mean 5 years ± 3.6 years), with body weight mean of 6.5±1.3kg. All with an adequate body score and without ophthalmologic alterations.All of them were submitted to a complete clinical examination and previous ophthalmologic evaluation. Dogs with apparent eye disorders in one or both eyes, less than twelve months old, under ophthalmologic or systemic treatment, with diseases or that did not allow manipulation were excluded from this study. After inclusion, the animals were divided into three groups according to age group: G1-5 (animals from 1 to 5 years of age), G6-9 (animals from 6 to 9 years of age), and G10-13 (animals from 10 to 13 years of age).

The cranial morphometric measurements of bizygomatic (BDIST) and frontal-occipital distance (FOD) were performed using a 200mm universal pachymeter (Lee Tools, Santo André, São Paulo, Brazil) as previously described (Beserra *et al*., 2009). For measuring the thoracic circumference (TC), withers height (WH), and body length (BL), a 1.5-meter tape measure was used (Vonder® OVD, Curitiba, Paraná, Brazil). The TC was performed by positioning the tape measure around the thorax at elbow height, while the WH was obtained with the tape measure positioned in a straight line from the distal support region of the animal to the palpable cranial scapular angle. The BL was obtained with the tape measure positioned from the nose tip to the region of tail insertion. All measurements were performed by a single evaluator and with the animals standing.

To perform the echobiometric measurements and obtain the intraocular pressure (IOP), the ocular surface was desensitized with the instillation of 1 drop of proximetacaine hydrochloride 0.5% (Anestalcon®, Novartis Biociências S.A, São Paulo, Brazil) 5 minutes before the measurements. The intraocular pressure was obtained by applanation tonometry with Tono-pen-VET® digital tonometer (Reichert.Inc., Buffalo, New York, United States of America) (Borges *et al*., 2007).

The dogs were manually restrained and kept in sternal decubitus to obtain the ocular measurements. The equipment Sonoscape® S6-V - SonoScape® (Medical Corporation, Shenzhen, China), was used in two-dimensional mode, with linear multi-frequency transducer of 7-12 MHz on the ocular surface, without recoil pad and with acoustic gel applied directly on the cornea (Ferreira *et al*., 2014). Aiming at standardizing the measurements in a single ultrasound section, the echobiometric measurement was performed with the visualization of the following ocular structures in the same ultrasound plane: corneal surface, the anterior capsule of the lens, iris-ciliary body complex, the posterior capsule of the lens and retina-choroid-sclera complex. The following measurements were obtained from both eyes, giving the following numerical pattern from 1 to 5: 1 anterior chamber (AC); 2 lens thickness on the axial section (LTA); 3 lens thickness on the transversal section (LTT); 4 vitreous chamber (VC); and 5 axial length of the eyeball (ALE). All measurements were obtained through the calipers of the ultrasound device itself (Fig. 1). After the procedure, the ocular surface was cleaned to remove the excess of acoustic gel with hydrophilic cotton soaked in physiological solution (NaCl 0.9%).

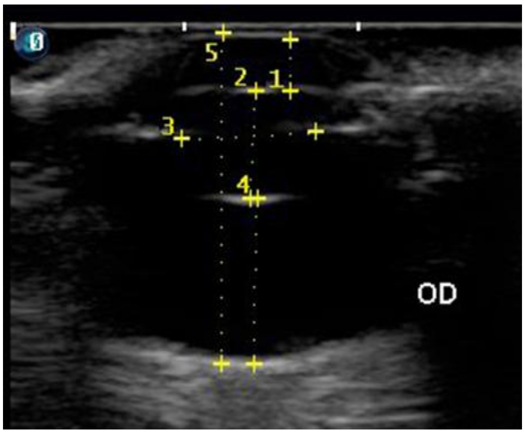

Figure 1. Two-dimensional axial-section ultrasound scan of the oculus dexter (OD) of a Shih Tzu dog, demonstrating the standardization of echobiometric measurements (1: anterior chamber (AC); 2: lens thickness on the axial section (LTA); 3: lens thickness on the transversal section (LTT); 4: vitreous chamber (VC); 5: axial length of the eyeball (ALE).

The analysis of variance test (ANOVA) was used to the comparison between the ocular variables. Tukey´s test was performed when a difference between the groups was found (G1-5; G6-9; G10-13). The correlations between cranial and body morphometric measurements with the ocular variables were investigated using Pearson's correlation. For comparison between males and females, as well as OD and oculus sinister (OS), Student's t test was used. All of them were tested at 5% significance level. The statistical analysis was performed using the R software (Copyright (C) 1989, 1991 Free Software Foundation, Inc).

RESULTS

Fifty-three animals were evaluated in this study. Three dogs were excluded due to non-cooperative behavior during eyeball ultrasonography. Fifty dogs (30 females and 20 males) were finally included and divided among the groups: 26 dogs in G1-5; 16 dogs in G6-9 and 11 dogs in G10-13. There was no significant difference in the echobiometric measurements of the ocular structures among the aged groups, as well as no difference between genders and between oculus dexter and oculus sinister. The measurements of the AC, VC, LTA, LTT, and ALE, as well as the minimum and maximum values for each measurement obtained, are described in Table 1.

Table 1. Echobiometric values of the eyeballs of 50 adult Shih Tzu dogs

Ocular Variables	Mean (mm)	Standard Deviation	Minimum (mm)	Minimum (mm)
Anterior Chamber (AC)	2.83	0.50	1.51	4.10
Vitreous Chamber (VC)	9.18	0.54	8.02	10.21
Lens Thickness on the Axial Section (LTA)	6.42	0.32	5.27	6.95
Lens thickness on the transversal section (LTT)	9.17	1.18	5.27	12.41
Axial length of the eyeball (ALE)	18.82	0.66	17.50	20.24

Statistical Method: ANOVA

No significant difference in cranial and body morphometric measurements was found among the aged groups. In all cranial and body morphometric measurements the male dogs had a slightly higher mean than the females (Table 2), however, the results showed no statistically significant differences.

For the correlation between the ocular echobiometry with the morphometric parameters of the skull and body, Pearson's linear correlation was performed, which did not show any correlation among the variables studied in adult dogs of the Shih Tzu breed. The values of the correlation coefficients are shown below (Table 3).

Table 2. Means, standard deviation, and p-value of cranial and body morphometric variables in 50 Shih Tzu dogs

Morphometric Variables		Gender		
		Male	Female	p-value
Bizygomatic distance (mm)	MeanStandard deviation	77.80 7.07	74.50 5.51	0.07
Frontal-occipital distance (mm)	MeanStandard deviation	75.10 5.90	73.73 6.60	0.45
Withers height (mm)	MeanStandard deviation	273.75 21.00	263.73 20.30	0.09
Thoracic circumference (mm)	MeanStandard deviation	425.65 37.61	413.06 51.16	0.35
Body length (mm)	MeanStandard deviation	546.2 59.82	521.83 53.24	0.13

Statistical Method: ANOVA for morphometric variables and Student's t test for gender.

Table 3. The correlation coefficient (Cor) and p-value of the ocular echobiometric measurements compared with the cranial and body morphometric variables in 50 Shih Tzu dogs

	AC[1] OS[a]	AC OD[b]	VC[2] OS	VC OD	ATHK[3] OS	ATHK OD	TL[4] OS	TL OD	ALE[5] OS	ALE OD
BDIST[7]	Cor 0.17 p-value 0.22	Cor -0.02 p-value 0.85	Cor 0.15 p-value 0.29	Cor -0.09 p-value 0.50	Cor 0.23 p-value 0.10	Cor 0.11 p-value 0.42	Cor 0.06 p-value 0.63	Cor -0.22 p-value 0.12	Cor 0.13 p-value 0.35	Cor 0.24 p-value 0.09
FOD[8]	Cor 0.18 p-value 0.20	Cor -0.00 p-value 0.94	Cor 0.02 p-value 0.84	Cor -0.26 p-value 0.06	Cor 0.17 p-value 0.21	Cor 0.18 p-value 0.19	Cor 0.10 p-value 0.46	Cor -0.24 p-value 0.08	Cor 0.14 p-value 0.31	Cor -0.02 p-value 0.88
WH[9]	Cor -0.05 p-value 0.69	Cor 0.15 p-value 0.29	Cor 0.02 p-value 0.85	Cor 0.08 p-value 0.57	Cor 0.07 p-value 0.62	Cor 0.05 p-value 0.68	Cor 0.16 p-value 0.25	Cor 0.00 p-value 0.97	Cor -0.05 p-value 0.68	Cor 0.15 p-value 0.27
TC[10]	Cor 0.01 p-value 0.93	Cor -0.11 p-value 0.41	Cor 0.07 p-value 0.59	Cor -0.06 p-value 0.66	Cor 0.23 p-value 0.09	Cor 0.10 p-value 0.47	Cor -0.19 p-value 0.17	Cor -0.13 p-value 0.36	Cor 0.21 p-value 0.13	Cor 0.17 p-value 0.23
BL[11]	Cor 0.11 p-value 0.41	Cor -0.05 p-value 0.69	Cor -0.17 p-value 0.21	Cor 0.12 p-value 0.38	Cor 0.08 p-value 0.55	Cor 0.04 p-value 0.73	Cor 0.10 p-value 0.47	Cor 0.01 p-value 0.93	Cor 0.03 p-value 0.82	Cor 0.29 p-value 0.03

OS[a]: Oculus Sinister; OD[b]: Oculus Dexter; AC[1]: Anterior Chamber; VC[2]: Vitreous Chamber; ATHK[3]: Axial Thickness; TL[4]: Transverse Lens Thickness; ALE[5]: Axial Length of the Eyeball; CC[6]: Cranial Circumference; BDIST[7]: Bizygomatic Distance; FOD[8]: Fronto-occipital distance; WH[9]: Withers height; TC[10]: Thoracic Circumference; BL[11]: Body Length. Statistical Method: Pearson's correlation.

DISCUSSION

The bidimensional ultrasonography is notoriously an effective tool for obtaining the echobiometric measurements proposed in this study. Besides being non-invasive, it does not require chemical restraint and does not cause eye lesions or pain to the animals, when properly conducted. Although computerized tomography has been used for measuring eye biometrics (Chiwitt *et al*., 2017), ultrasonography is still superior because it is more accessible, has low cost, is easier to perform, and eliminates the necessity for general anesthesia (Beserra *et al*., 2009; Akduman *et al*., 2008).

The mean depth of the AC of the animals evaluated in this study (2.83±0.50mm) was lower than that found in another study with dogs of the Shih Tzu breed (4.06±0.10mm) (Kobashigawa *et al*., 2015). The measurement of the AC is the most affected by variations during the procedure, due to the pressure exerted on the cornea, which decreases the size of the chamber analyzed (Miller and Murphy, 1995). The use of a linear transducer in this work, unlike another study (Kobashigawa *et al*., 2015) that used convex transducer, may have influenced the measurements of AC, due to the greater demand for maneuvers to obtain the appropriate sonographic cut.

The mean of the LTA in this study (6.42±0.42mm) corroborates with the values observed in another study with dogs of the same breed (Kobashigawa *et al*., 2015). Dogs without a defined breed also seem to show similar values to those found in this study, with LTA ranging from 6.70±0.08mm to 7.10±0.30mm (Beserra *et al*., 2009).
Few studies have evaluated the lens diameter in cross-section, making it difficult to compare them with the data of this study. While the mean of the lens thickness in cross-section in the studied dogs was 9.17±1.18mm, other studies obtained higher values. Evaluating dogs of different breeds and weights (1.5 to 28.5 Kg) one study determined values of 12.2±1.10mm (Silva *et al*., 2018) and another assay got values between 10.4±0.10 and 11.0 ± 0.20mm (Beserra *et al*., 2009). Moreover, the variability of the lens thickness may be due to the accommodating power of the lens, which changes its shape according to the focal point, during the sonographic technique (Beserra *et al*., 2009).

Kobashigawa *et al*. (2015) reported a value of 9.56±0.05mm for VC Shih Tzu dogs. This study corroborates with the above data, where a mean of 9.18±0.29mm was obtained. Other authors obtained means of 9.60±1.60mm (Cottrill *et al*., 1989), 9.10±0.50mm (Gonçalves *et al*., 2000), and 8.30±0.10 to 10.0±0.10mm (Beserra *et al*., 2009) in dogs without a defined breed, all similar to those found in this study.

The larger the animal's skull, the longer the ALE must be (Cottrill *et al*., 1989). In one study, the mean ALE in small and medium-sized dogs without a defined breed was 18.80±0.90mm (Gonçalves *et al*., 2000), while other research identified means ranging from 17.30±1.10 and 17.50±1.00mm in dogs of various sizes (Silva *et al*., 2018). In dogs with weights between 15 and 28 kg, and proportionally larger skulls, the means were 17.00±0.20 to 20.60±0.40 (Beserra *et al*., 2009). The average ALE obtained in Shih Tzu dogs in this study was 18.82±0.66mm, as well as 20.25±0.13mm in dogs of the same breed in another research (Kobashigawa *et al*., 2015). Shih Tzu dogs are small in size and have small cranial conformation, however, they showed proximity in VC and ALE values when compared to dogs without a defined breed, various sizes and with higher cranial conformation. This implies proportionally larger measures for the Shih Tzu breed, considering that the vitreous establishes the almost spherical shape to the eyeball (Leite *et al*., 2013).

The echobiometric measurements did not show significant difference between the oculus sinister and oculus dexter, as reported in other studies (Silva *et al*., 2018; Beserra *et al*., 2009). It is remarkable the absence of variability of echobiometric measurements between the eyes, a fact that ultrasonography describes as symmetry and can be considered for the diagnosis of ocular disorders, giving the veterinary ophthalmologist the possibility of echographic comparison between the oculus sinister and oculus dexter in conditions of unilateral lesion.

Among the genders, a significant difference was observed in the measurement of the ALE in male dogs (Schiffer *et al*., 1982). In our research, no difference in echobiometric measurements between the genders was observed. The Shih Tzu dogs evaluated in this study showed low variability associated with eye measurements between genders. This factor may be linked to the selection of individuals with characteristics of brachycephaly over the years, driving the breeding of individuals with similar characteristics. The male Shih Tzu dogs in this study showed larger body measurements than females, but the breed has a well-defined racial pattern, thus the slight difference in size between genders did not influence eye measurements.

In dogs without a defined breed, influence of bizygomatic and fronto-occipital distance was found on the VC (Beserra *et al*., 2009), which did not occur in this study. It was also possible to verify that there was no correlation of ocular echobiometric measurements with cranial and body morphometric variables in adult dogs of the Shih Tzu breed. This correlation may only be established during the growth phase of the animals (Paunksnis *et al*., 2001; Tuntivanich *et al*., 2007).

Some limitations can be listed in this paper, as the use of applanation tonometry for general ocular evaluation of dogs, instead of rebound tonometry, which is more specific. Furthermore, the use of higher frequency transducers (18-20 Mhz) could show more details of intraocular structures.

In dogs, the echobiometry of the eyeball is still the object of a few studies, mainly in specific breeds. The Shih Tzu dogs showed ocular and cranial characteristics pertinent to the ophthalmologic routine, being important the measurement of characteristics that contribute in a positive way to the standardization, therapeutics and welfare of the breed. Similarly, studies with the growth curve of the Shih Tzu dogs are necessary to establish a possible correlation among the ocular, cranial, and body morphometric variables.

CONCLUSIONS

We concluded that there was no significant difference between the echobiometric and the cranial and body morphometric variables when considering the gender and age of the dogs. Moreover, there is no influence of cranial and body morphometric variables in the echobiometric measurement of ocular structures in adult dogs of this breed. Finally, it was possible to establish the echobiometric measurements of the ocular structures and the reference values to the Shih Tzu breed.

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