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Ophthalmic ultrasound of dogs with different skull conformations

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ABSTRACT

The aim of this study was to establish mean values for intraocular structures and analyse if the differences are present for different skull conformations in dogs. In this study, 30 dogs were selected and distributed into three groups according to skull conformation; thus, group 1 (G1) was composed of brachycephalic dogs, group 2 (G2) was composed of mesocephalic dogs and group 3 (G3) was composed of dolichocephalic dogs. A and B-mode ultrasound was performed simultaneously for obtainment of measurements relating to anterior chamber depth (D1); lens thickness (D2); vitreous chamber depth (D3); and the axial length of the eye (D4). No differences were observed when comparing left and right eyes of dogs within the same skull conformation group ($p>0.05$). Differences were observed when comparing D3 and D4 between groups G2 and G3 ($p<0.05$). Skull conformation of brachycephalic dogs did not influence intraocular measurement values when compared to dolicephalic and mesocephalic dogs. Skull conformation of dolichocephalic dogs had an influence in values of vitreous chamber and the complete length of the eye when compared to mesocephalic dogs.

Key words: brachycephalic, dolichocephalic, eye, mesocephalic, ultrasound

Ultrassonografia oftálmica em cães com diferentes conformações cranianas

RESUMO

O objetivo deste estudo foi estabelecer valores médios para as estruturas intraoculares e analisar se existem diferenças entre eles nas diversas conformações cranianas de cães. Foram selecionados 30 cães alocados em três grupos, de acordo com a conformação craniana; assim, o grupo 1 (G1) foi composto por cães braquicefálicos, o grupo 2 (G2) por cães mesocefálicos e o grupo 3 (G3) por cães dolicocefálicos; ultrassonografia em modo A e B foi realizada simultâneamente para obtenção de medidas relacionadas à profundidade de câmara anterior (D1), espessura de lente (D2), profundidade de câmara vítrea (D3) e comprimento axial do bulbo do olho (D4); diferenças não foram observadas quando comparados olhos direitos e esquerdos de cães com mesma conformação craniana ($p > 0,05$). Diferenças foram constatadas na comparação entre D3 e D4 dos grupos G2 e G3 ($p < 0,05$); a conformação do crânio braquicefálico não influenciou nos valores das medidas intraoculares quando comparados aos valores encontrados para cães dolicocefálicos e mesocefálicos; a conformação do crânio dolicocefálico influenciou nos valores das medidas intraoculares de profundidade de câmara vítrea e profundidade do bulbo do olho quando comparados aos valores encontrados para cães mesocefálicos.

Palavras-chave: braquicefálicos, dolicocefálicos, olho, mesocefálicos, ultrassom

Introduction

Ophthalmic ultrasound is an indispensable tool in veterinary ophthalmology because it helps in diagnosing alterations that are not identified in the routine eye examination, especially when there is opacification of the transparent media of the eye (cornea, aqueous humor, lens and vitreous humor) (Gonçalves et al., 2000; Scotty et al., 2004). It plays an important role before cataract surgery, it contributes to satisfactory postoperative results making it useful for the evaluation of the posterior segment and also with respect to the selection of patients who will be submitted to cataract removal. It also allows the establishment of the proper intraocular lens to be used in surgery lens replacement (McMullen & Gilger, 2006; Gift et al., 2009; Ribeiro et al., 2009).

It is feasible to perform four measurements of the eye by ophthalmic ultrasound: anterior chamber depth, which includes the axial distance from the cornea to the anterior capsule of the lens (D1); lens thickness, measured from the anterior capsule of the lens to the posterior capsule of the lens (D2); vitreous chamber depth, measured from the posterior capsule of the lens to the posterior pole of the eye (D3); and the axial length of the eye, which corresponds to the measurement from the cornea to the posterior pole of the eye (D4) (Cottrill et al., 1989; Gonzalez et al., 2001).

The format and size of the canine skull vary according to the breed and individual conformation (Beserra et al., 2009). They can be divided into three types, according to their format: brachycephalic, mesocephalic and dolichocephalic skulls (Diesem, 1986).

Data regarding the comparison of intraocular structures and different skull conformations in dogs are scarce. Considering the wide variety of breeds and their significance as experimental models for the study of human myopia (Black et al., 2008; Williams et al., 2011) as well as the increasing number of cataract surgeries performed daily in veterinary facilities, it becomes important to know the intraocular measurements for different skull conformations. For this reason, the objective of this study was to establish mean values for intraocular structures and analyse if there were differences for each variable within the different skull conformations in dogs. A and B-mode ophthalmic ultrasound were performed using a 20 MHz transducer.

Material and Methods

This study was approved by the Ethics Committee on Animal Use of School of Agricultural and Veterinary Sciences of São Paulo State University, Jaboticabal, SP, Brazil (Protocol Number 002647/09) and followed the ethical guidelines of the Association for Research in Vision and Ophthalmology - ARVO (National Institutes of Health Publications No 85-23: Revised 1985).

Thirty adult dogs weighing up to 10 kg, male or female, clinically and ophthalmologically healthy were selected for this study.

These dogs were subjected to evaluation of skull conformation according to what was proposed (Diesem, 1986) and distributed into three groups.

Group 1 (G1) was composed of 10 brachycephalic dogs, six females and four males, with a mean weight of 5.85 kg and mean age of 4.4 years. Group 2 (G2) was composed of 10 mesocephalic dogs, six females and four males, with a mean weight of 4.58 kg and mean age of 6.2 years. Group 3 (G3) was composed of 10 dolichocephalic dogs, six females and four males, with a mean weight of 7.67 kg and mean age of 5.8 years.

For ophthalmic ultrasound, the patients were positioned in sternal recumbency, restrained manually and the eyelids were held open by an assistant. An anesthetic eyedrop (proxymetacaine hydrochloride - Anestalcon 0,5% - Alcon, São Paulo, Brazil) was used approximately 5 minutes before the exam.

An ophthalmic ultrasound unit (Ultra Scan Imaging System, Alcon Laboratories, Inc., Texas, USA) equipped with a 20 MHz transducer was used for obtainment of A- and B-mode ultrasound simultaneously by the same operator.

Direct contact with the cornea was used since it allows sharper images of intraocular structures. An immersion technique was used by applying a large amount of ultrasound gel (Carbogel-ULT – Carbogel Ind. E Com Ltda., São Paulo, Brazil) acting as a standoff pad between the eye and the transducer. The transducer was positioned in a longitudinal position (axial plane), i.e., perpendicular to the central surface of the cornea until optimal B scans images, according to echoes of A mode image, were obtained. In this way, reliable images of intraocular structures and their corresponding peaks could be obtained.

The intraocular measurements performed were: D1 - anterior chamber depth, from the cornea to the anterior capsule of the lens; D2 - lens thickness, from the anterior capsule of the lens to the posterior capsule of the lens; D3 - vitreous chamber depth, from the posterior capsule of the lens to the posterior pole of the eye; and D4 - the axial length of the eye, from the cornea to the posterior pole of the eye (Figure 1).

The data obtained for all variables (anterior chamber depth, lens thickness, vitreous chamber depth and length of the eye) were subjected to analysis of variance (ANOVA).

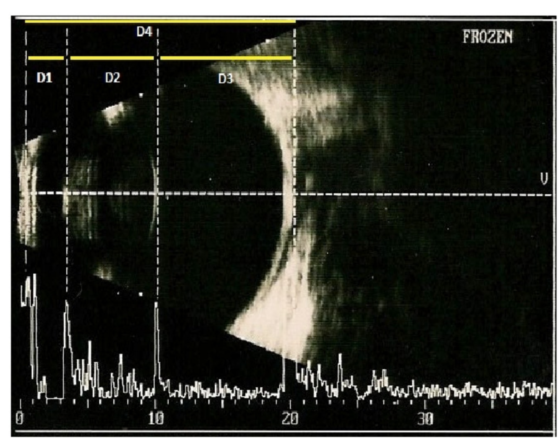

Figure 1. Ultrasound image obtained with a 20 MHz transducer and the simultaneous use of A and B-modes showing an axial section of the right eye globe of a brachycephalic dog illustrating measurements obtained in the evaluation. D1 corresponds to the distance between the cornea and the anterior lens capsule; D2 the distance from the anterior capsule to the posterior lens capsule; D3 the distance from the posterior capsule to the posterior pole of the eye; and D4 the axial length of the eye, from the cornea to the posterior pole of the eye

For comparison of mean values obtained for each variable between right and left eye in dogs of the same group, Student t-test was used with a significance level of 5% ($p<0.05$). For detection of differences between mean values obtained for each variable in the same groups, the Tukey's test was used with a significance level of 5% ($p<0.05$). Pearson's test was applied to verify correlation between the weight of dogs and the variables ($p<0.05$).

Results

Conductive gel used as a standoff pad was effective and allowed adequate evaluation of the anterior segment of the eye, as well as identification of its structures in all eyes evaluated.

The anterior chamber, filled with aqueous humor, was identified as an anechoic area in B-mode and as an area with the absence of high peaks in A-mode.

The cornea was characterized by two parallel hyperechoic lines in B-mode and two high peaks in A-mode. Therefore, the measurement of the complete length of the eye was performed from the first peak of the cornea to the posterior pole of the eye.

In B-mode, it was possible to identify the lens by identifying both anterior and posterior capsules as parallel hyperechoic lines and high peaks in A-mode. The nucleus of the lens was identified as an anechoic area in B-mode and absence of high peaks in A-mode.

The vitreous chamber, filled with vitreous humor, was identified as anechoic in B-mode and as an area with the absence of high peaks in A-mode.

The posterior pole of the eye, which includes the retina, the choroid and the sclera, was identified as a hyperechogenic and convex structure in B-mode and as a high peak in A-mode.

Dogs within the same conformation groups had the eyes evaluated individually and no differences were observed between right and left eyes ($p > 0.05$).

Differences between G2 and G3 were found ($p <0.05$) when comparing D3 and D4. The comparison between the values obtained for intraocular structures and skull conformations is demonstrated in Table 1.

Table 1. Mean and standard deviation (mm) values for intraocular structure measurements comparing groups of dogs according to their skull conformation

	G1 (n=20 eyes)	G2 (n=20 eyes)	G3 (n=20 eyes)
D1	2.92(± 0.37)[a]	3.08 (± 0.67)[a]	3.07 (± 0.65)[a]
D2	7.03 (± 0.61)[a]	7.02 (± 0.87)[a]	7.00 (± 0.81)[a]
D3	9.48 (± 0.74)[ab]	8.76 (± 1.23)[a]	9.75 (± 0.98)[b]
D4	19.43 (± 0.60)[ab]	18.86 (± 1.45)[a]	19.82 (± 0.95)[b]

The same letters in a row indicate there were no difference between the groups ($p>0.05$). Different letters in a row indicates the difference between groups ($p<0.05$). Tukey's test. D1: anterior chamber depth. D2: lens thickness. D3: vitreous chamber depth. D4: axial length of the eye

No correlation using Pearson's test was observed between variables D3 and D4 and the weight of animals in group 2 or group 3 ($p < 0.05$).

Discussion

The characterization of skull conformation in the dogs of this study was conducted as proposed before (Diesem, 1986). Body weight of animals was restricted to 10 kg, since the size of the animal can interfere with the size of intraocular structures (Sampaio et al., 2002).

Ophthalmic ultrasound was feasible in all dogs by manual restraint, sternal recumbency and manual opening of the eyelids (Martins et al., 2010). Thus, sedation and general anesthesia, proposed previously (Schiffer et al., 1982; Hager et al., 1987), did not appear necessary. Therefore, anesthesia risks and additional costs were eliminated.

All dogs were tolerant to ultrasound examination of the eye after instillation of anesthetic eyedrop and no iatrogenic injury on the corneal surface was observed. Such statements corroborate those reported previously (Martins et al., 2010; Toni et al., 2010).

In the present study, the use of equipment specific for ophthalmic ultrasound allowed the examination of A and B-mode simultaneously and therefore adequate measurement and evaluation of the morphology of intraocular structures.

Higher frequency transducers are ideal for ophthalmology since they exhibit higher resolution images, especially those between 8 and 20 MHz (Martins et al., 2010). The use of a 20 MHz transducer in this study allowed a depth penetration of 2-4 cm which is necessary for evaluation of the eye and identification of its internal structures (Ribeiro et al., 2009).

The use of the conductive gel acting as a standoff pad (Cottrill et al., 1989), allowed adequate visualization of the cornea and anterior chamber, which is important for the obtainment of reliable images and measurements. It also provided adequate contact of the transducer with the surface of the cornea, with minimal pressure on the eye, which resulted in less discomfort for the patients (McMullen & Gilger, 2006; Wilkie et al., 2006; Toni et al., 2010).

No differences were observed between mean values found for intraocular structures when comparing between right and left eyes of animals from the same conformational group, which is in agreement with data reported by other authors (Williams, 2004; Tuntivanich et al., 2007). With this, it is possible to say that measurements of the normal eye can provide reliable parameters for determination of the size of eye prosthesis in cases of malformation or enucleation of the opposite eye.

Although there are satisfactory data about ophthalmic ultrasound in dogs, data regarding the correlation of the size of intraocular structures and skull conformation are scarce.

In the present study, no statistically significant differences were observed when comparing the mean values obtained for variables D1, D2, D3 and D4 between groups G1 and G2 as well as G1 and G3.

It has been attributed that the shallow anatomical conformation of the orbit of brachycephalic dogs causes prominence of the eye (Smith, 1999). However, its intraocular structures do not differ from mesocephalic or dolichocephalic, which have larger orbits and less prominent eyes.

Differences were found when comparing mean values of D3 and D4 between groups G2 and G3. These findings sustain the conclusion which reported that dolichocephalic dogs have a larger axial length of the eye when compared to mesocephalic dogs (Cottrill et al., 1989). This feature is important considering the use of dogs as experimental models for the study of myopia in humans (Black et al., 2008; Williams et al., 2011), which remains a significant and highly prevalent worldwide problem. Finding an animal model that most closely mimics the human form and know the details of their anatomy conformation would allow for the most informative evaluation of interventions designed to prevent myopia onset or to slow its progression (Williams et al., 2011).

Compared with other ocular components such as the cornea and the lens, axial length is typically regarded as the primary determinant of refractive error. The correlation with refractive error is larger for axial length than for any other component (Mutti et al., 2007; Fontes et al., 2011). Considering the increasing number of cataract surgeries with intraocular lens placement performed daily in veterinary facilities, it becomes important to know the axial length measurements for different skull conformations.

Conclusions

Based on the results obtained in the present study it is possible to conclude that ophthalmic ultrasound in A and B-modes, simultaneously, is effective to determine echoic peaks and the anatomical relation necessary to perform biometry of intraocular structures. The skull conformation of brachycephalic dogs did not exhibit influence in intraocular measurement values. The skull conformation of dolichocephalic dogs had an influence in values of vitreous chamber and complete length of the eye when compared to mesocephalic dogs

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