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Ultrasonographic measurement of optic nerve sheath diameter in normal dogs

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This study was carried out to assess the feasibility of ultrasonographic measurements of the optic nerve sheath diameter (ONSD) in normal dogs and evaluate the effect of breed, sex, body weight and age on biometry of ONSD. The ONSDs were evaluated in 15 dogs (10-50 months old) with normal eye (7 Yorkshire terrier and 8 Maltese). Ultrasonographic measurements of the ONSD were carried out at a constant position located 5 mm behind the optic disc. Eyes were collected immediately after euthanasia, and were used for saline immersion technique and direct measurement by calipers for biometry of ONSD. In this study, there was no significant difference of ONSD between the left and the right eyes, and was no significant difference among ONSD values obtained from ultrasonographical method, saline immersion technique and direct measurement (k = 0.95). Also, there was no correlations between ONSD and sex, body weight and age, but was significant between the mean ONSD of Yorkshire terrier and Maltese (p < 0.01). The mean ONSD of Yorkshire terrier was 2.10 ± 0.22 mm and Maltese was 1.63 ± 0.23 mm. This study suggests that ultrasonographic measurements is useful method for biometry of the ONSD in normal dogs and provides baseline information for the study of evaluating ONSD in various breeds and diagnosing several diseases with the change of the ONSD.

Key words: Ultrasonographic measurement, optic nerve sheath diameter, yorkshire terrier, maltese

Introduction

Ocular biometry was one of methods to measure the axial dimensions of the eye and determine the position of intraocular components by ultrasound. It is one of the early uses of ultrasound in human opthalmology [1].

Biometry of the eye has been useful for the assessment certain pathologic abnormalities such as phthisis bulbi, microphthalmia, pseudoexophthalmia (unilateral axial myopia), scleral ectasia and congenital glaucoma [9]. It also has been useful for determining dioptric power for lens replacement following cataract extraction [10].

The optic nerve sheath (ONS) is continuous with dura mater, add has a subarachnoid space, so the cerebrospinal fluid (CSF) freely communicates between the intracranial space and the optic nerve. By ultrasound techniques, it is possible to determine the ONS diameter in B mode [5,7].

In human medicine, ultrasonographic measurement of optic nerve sheath diameter (ONSD) has been used as an indicator of neurological diseases with intracranial pressure (ICP) change and ocular disease with intraocular pressure (IOP). Hansen *et al.* [6] reported that the human ONS has sufficient elasticity to allow a detectable dilation in response to intracranial hypertension. Dichtl *et al.* [3] reported that ultrasonographic measurements of optic nerve thickness are significantly correlated with glaucomatous change of the optic disk and retinal nerve fiber layer.

In veterinary medicine, the ultrasonographic anatomy and biometry of the dog, horse, sheep and cattle eye have been investigated previously [8,2,4]. But these reports were limited in intraocular dimension and component.

To our knowledge there is no similar reports for dog eyes. Present study was performed to (1) assess the feasibility of ultrasonographic measurements of the optic nerve sheath diameter (ONSD) in normal dogs and (2) evaluate the effect of breed, sex, body weight and age on biometry of ONSD.

Materials and Methods

Experimental animals

Fifteen clinically healthy dogs (10 male, 5 female total 30 eyes) weighed from 2.0 to 6.1 kg (10-50 months old) were used for normal ONSD values. Two breeds of dogs (7 Yorkshire terrier and 8 Maltese) were used.

The dogs were housed in indoor cages and were fed a commercialized dry food. All dogs were screened and

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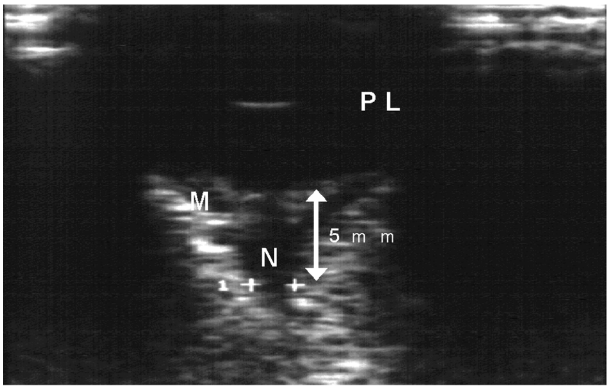

Fig. 1. B-mode ultrasonographic image of the ONSD measurement using eyelid technique. (PL: Posterior lens capsule, M: extraocular muscle, N: optic nerve)

considered normal based on complete ophthalmic and physical examinations prior to be used in the study.

Biometry of optic nerve sheath diameter (ONSD)

All ultrasonographic measurements of ONSD were performed with Toshiba SSA-260A scanner (Toshiba, Tokyo, Japan), using a 7 MHz linear probe.

Ultrasonographic measurement by eyelid technique

The eye and orbit were imaged with a sitting position. Animals remained in a sitting position throughout the trial period. Coupling gel was applied to the closed upper lid and the scan was performed. Ultrasonographic measurements of the ONSD were carried out at a constant position located 5 mm behind the optic disc (Fig. 1) [5].

Saline immersion technique

To assess the feasibility of ultrasonographic measurements of ONSD in normal dogs using eyelid technique, normal eyes were collected immediately after euthanasia and prepared for two other biometric method of ONSD. Each eye was gently attached to a gauze pad at the optic nerve with 6-0 silk suture and immersed in 500 ml of normal saline. Measurements of the ONSD were carried out at a same position of eyelid technique.

Direct measurement

Direct measurement of ONSD were made using a mechanical calipers at a same position of eyelid technique.

Table 1. Comparison of ONSD in left and right eyes

Methods	No. of eyes	Mean ± SD (mm)
Ultrasonographic measurement		
Left	15	1.85 ± 0.22
Right	15	1.85 ± 0.23
Saline immersion technique		
Left	15	1.90 ± 0.22
Right	15	1.91 ± 0.24
Direct measurement		
Left	15	1.92 ± 0.23
Right	15	1.93 ± 0.21

Statistical analysis

Data were reported as mean SD values. Statistical analysis was performed using the SPSS statistical computer program. According to property of sample, paired sample t-test, independent t-test, reliability analysis, or linear regression analysis were applied to data analysis.

Results

Ultrasonographic measurement of optic nerve sheath diameter (ONSD)

Comparison between left and right eye

The mean ONSD value, standard deviation, and value range for left and right eyes were listed in Table 1. There was no significant difference of ONSDs between left and right eyes from each method.

Reliability

With regard to intra-methods variation, the intraclass correlation coefficient between measurements for the ONSD values were summarized in Table 2. There was no significant difference between ONSD values obtained from ultrasonographical method, saline immersion technique and direct measurement.

Effects of breed, sex, body weight and age on biometry of ONSD

Correlations with body weight of each breed

Correlations of ONSD with body weight of each breed were not significant. The correlations of the mean ONSD with body weight in Yorkshire terrier and Maltese are graphically displayed in Figs 2 and 3.

Table 2. Comparison of ONSD in three other methods

Method	No. of eyes	Mean ± SD (mm)	Reliability coefficient (κ)
Ultrasonographic measurement	30	1.85 ± 0.22	
Saline immersion technique	30	1.93 ± 0.25	0.95
Direct measurement	30	1.90 ± 0.24	

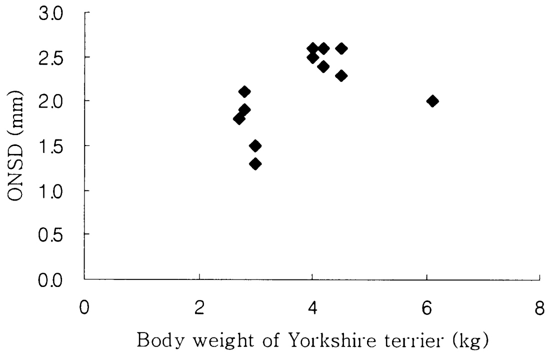

Fig. 2. Correlation of ONSD values obtained from ultrasonographic measurement with body weight of Yorkshire terrier (n = 14, r = 0.40).

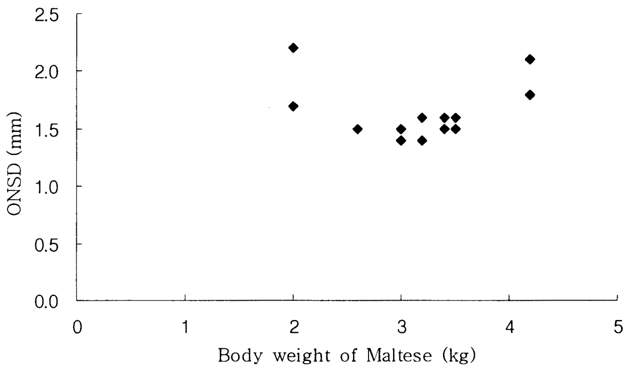

Fig. 3. Correlation of ONSD values obtained from ultrasonographic measurement with body weight of Maltese (n = 16, r = 0.01).

Correlations with body weight and age

Correlations of ONSD with body weight and age were not significant. The correlations of ONSD with body weight and age are graphically displayed in Figs 4 and 5.

Comparison in breed and sex

The mean ONSD value of all 30 eyes was 1.85 ± 0.22 mm. The mean ONSD of Yorkshire terrier was 2.10 ± 0.22 mm and Maltese was 1.63 ± 0.23 mm, respectively. There was significant difference between the mean ONSD of Yorkshire terrier and Maltese (Independent *t* test: $p<0.01$). The result is listed in the Table 3. When the mean values

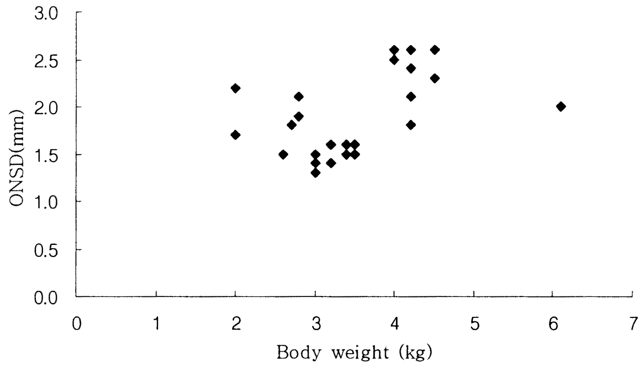

Fig. 4. Correlation of ONSD values obtained from ultrasonographic measurement with body weight (n = 30, r = 0.44).

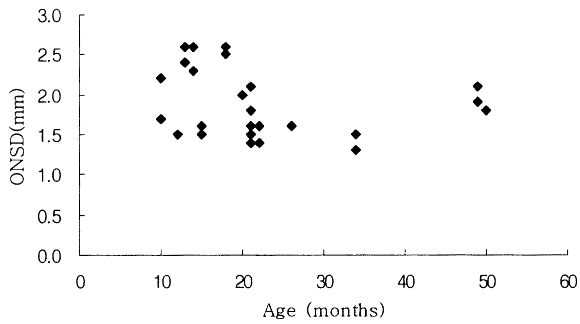

Fig. 5. Correlation of ONSD values obtained from ultrasonographic measurement with age (n = 30, r = –0.18).

between the male and female were compared, significant difference was not shown (Table 4).

Discussion

The present study compared three other methods for assessing the feasibility of ultrasonographic measurements of the ONSD in normal dogs. Ultrasonographic measurements of the ONSD by eyelid technique were carried out at a constant position located 5 mm behind the optic disc to improve ultrasound sensitivity, resolution, and reproducibility [5]. Measurements of the ONSD by the other methods were carried out at a same position of eyelid

Table 3. Comparison of ONSD (mm) in Yorkshire terrier and Maltese using ultrasonographic measurement

Breed	No. of eyes	Min.	Max.	Mean ± SD
Yorkshire terrier	14	1.30	2.60	2.10 ± 0.22
Maltese	16	1.40	2.20	1.63 ± 0.23

Table 4. Comparison of ONSD (mm) in male and female using ultrasonographic measurement

Sex	No. of eyes	Min.	Max.	Mean ± SD
Male	20	1.30	2.60	1.84 ± 0.40
Female	10	1.40	2.60	1.87 ± 0.43

technique.

Ocular biometry with ultrasound can be done using an immersion or contact technique; however inadvertent scanning of the cornea by contact technique may cause inaccurate measurements [11]. For that reason, saline immersion technique was conducted before direct measurement with calipers in this study.

There was no significant difference between ONSD values obtained from ultrasonographical method, saline immersion technique and direct measurement through reliability analysis. Therefore, it is recommended that ultrasonographic measurement is used to evaluate the ONSD in normal dogs.

In this study, it was noticed that there was no statistically significant differences between ONSD and sex, body weight and age. But there was significant difference within breeds. But conclusion of this study must be subject to the following limitations. First, an ONSD biometry in various breeds cannot be provided because it was difficult to recruit. Second, body weight and age of animals are not relatively various.

This study suggests that ultrasonographic measurements is useful method for biometry of the ONSD in normal dogs and provides baseline information for the study of evaluating ONSD in various breeds.

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