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Refractive state using streak retinoscopy of phakic eyes in dogs

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Refractometry was performed on 40 eyes of 20 clinically healthy dogs of different breeds and both sexes using a handheld streak retinoscope. Pupillary dilation was achieved with 1% cyclopentolate ophthalmic solution. Based on the net spherical refractive error, the eyes were classified as emmetropic (57.50%, n=23), hyperopic (12.50%, n=5), or myopic (30.00%, n=12). No significant difference was observed between the refractive errors of the right and left eyes (P=0.219). The mean net spherical refractive errors of both eyes indicated the overall refractive status of the dogs, revealing that 55% (n=11) were emmetropic, 30% (n=6) were myopic, and 15% (n=3) were hyperopic. Furthermore, a significant positive correlation was observed between refractive error and the age of the dogs (P=0.003).

Keywords: Dog, Emmetropia, Hyperopia, Myopia, Refractive error, Streak retinoscopy

Maintenance of good visual acuity depends on a transparent optical pathway, accurate optical refraction, and proper neuronal processing within the retina, visual pathways, and visual cortex (Miller and Murphy, 1995). Refractive value represents the degree of light defocusing on the retina and is categorized as emmetropia, myopia, or hyperopia. Refractive examination is used to determine refractive error and is broadly classified into two methods: skiascopy and autorefractometry (Rotsos *et al.*, 2009).

In veterinary ophthalmology, determination of refractive error by skiascopy has been documented in several animal species, including dogs, cats, horses, and birds (Ofri, 2007; Kubai *et al.*, 2008; Black *et al.*, 2008). Among the available techniques, streak retinoscopy remains the gold standard for assessing refractive status. In dogs, refractive error assessment is generally limited to the measurement of spherical aberration only (Groth *et al.*, 2013).

The availability of a simple, reliable, and easily performed method for determining refractive status in veterinary patients would encourage more practitioners to assess refractive errors routinely. This could broaden the existing knowledge on refractive abnormalities in animals, enhance clinical services for companion and working animals such as guide and performance dogs, and contribute to the diagnostic evaluation of animals with impaired vision. Therefore, the present study was undertaken to evaluate refractive status in clinically healthy dogs of different breeds and both sexes using a handheld streak retinoscope.

Materials and Methods

The present study was conducted on 40 eyes of 20 healthy dogs (8 female and 12 male) of different breeds, age and either sex with normal visual acuity. These dogs were reported for routine ophthalmic examination. Detailed ophthalmic examination included reflexes like menace, palpebral, pupillary light, tapetal, corneal, direct, indirect ophthalmoscopy, Schirmer's tear test, fluorescein dye test, intraocular pressure, ocular ultrasound and routine haemato-biochemical testsin order to ascertain visual acuity and health condition of the dogs.

Estimation of refractive state of phakic eyes

Retinoscopy (skioscopy) was performed using a hand-held streak retinoscope (Skioscope- Heine BETA 200 Streak Hand Held Retinoscope, HEINE Optotechnik GmbH & Co. KG | Dornierstr. 6 | 82205 Gilching | Deutschland, Germany) (Fig. 1A) and with trial lenses (Unitech Vision Golden Silver Metal Ring Trial lens set - with Trial Frame 22 mm in Wooden Box, Unitech Vision, New Delhi, India) (Fig. 1B) 30 min after administration of 1% cyclopentolate hydrochloride. All dogs were examined under physical and manual restraining without sedation. The distance between the examiner and the dog's eye (working distance) was kept 50 cm. The light from retinoscope was moved perpendicular to the orientation of intercept. When streak was oriented vertically retinoscope was moved horizontally and vice versa. Vertical streak was used to check refractive power at 90 degree meridian (vertical meridian) and horizontal streak at 180 degree meridian (horizontal meridian). When the retinal reflex streak moved in the direction of movement of retinoscope light it was termed "with motion" and when it moved in opposite direction it was termed "against motion"(Fig. 2). Streak with motion was neutralised with a plus trial lens and streak against motion with a minus trial lens. During examination refractive error was recorded in both vertical and horizontal meridians (Fig. 1D).

Calculation of net spherical refractive error

Working distance power was subtracted from the observed values of refractive error in vertical and horizontal meridians.

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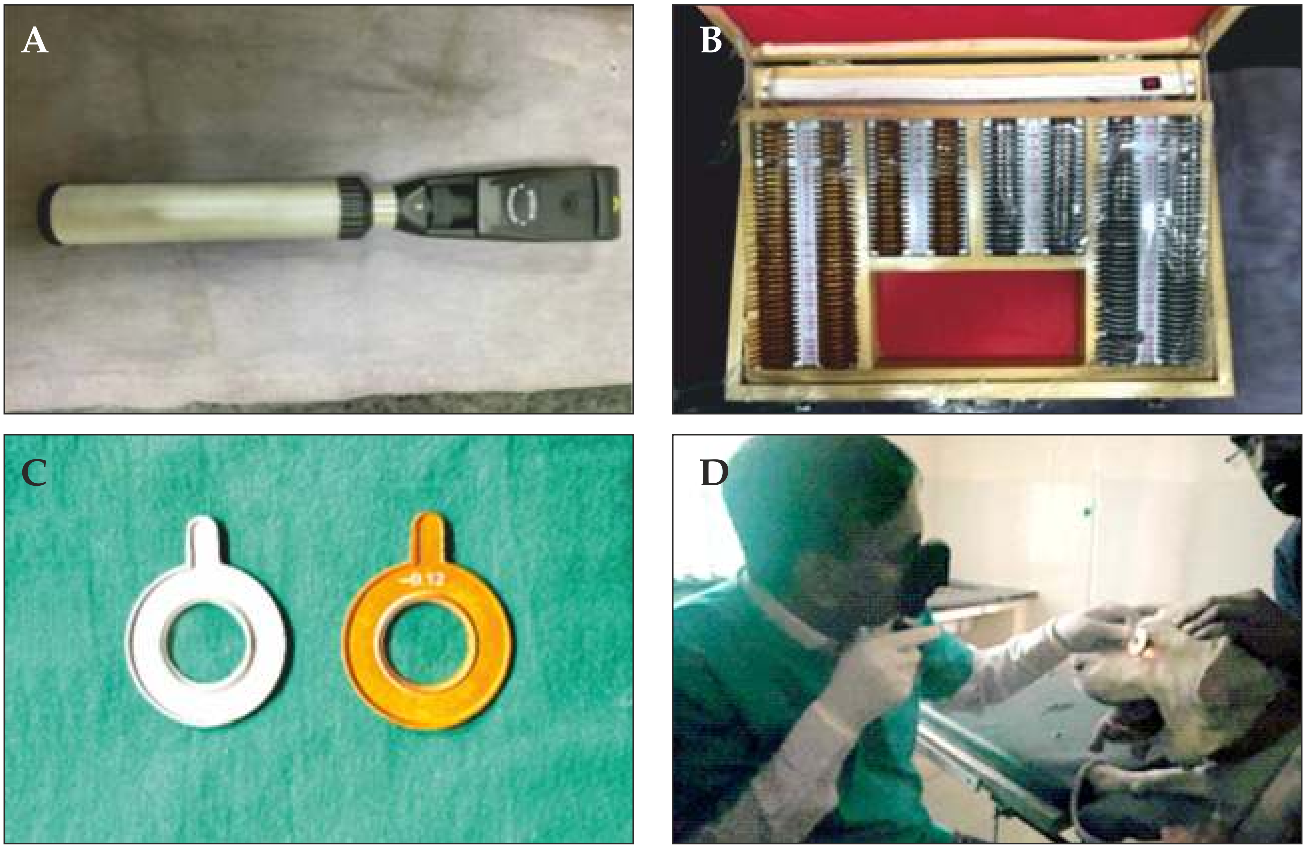

Fig. 1: Retinoscopy of healthy phakic eye: (A) Streak retinoscope, (B) Trial lens set, (C) Trial lense, and (D) Retinoscopy of healthy eye (semi dark condition).

Working distance power (D)
= 100/working distance in cm
= 100/50 = 2 D

The refractive value of vertical and horizontal meridians was averaged after subtraction of working distance power to calculate net spherical refractive error of the eye (Groth et al., 2013).

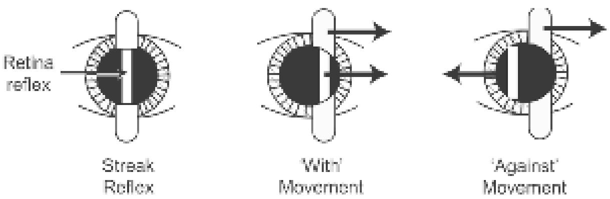

Fig. 2: Neutralization guide (Adapted from Godby, 2013).

Classification of refractive state of eyes

The refractive error of the subjects' eyes was classified as per the previous report by Kubai *et al.* (2008) and Vieira and Delgado (2018). Eyes were defined as emmetropic when the refractive value was between -0.5 and 0.5 D; myopic if < -0.5 D and hyperopic when > 0.5 D. When a difference of 1.0 D was detected between two eyes in the same dog, it was classified as anisometropia where both eyes were either hyperopic or myopic, and antimetropia when one of the eyes was hyperopic and contralateral eye was myopic.

Statistical analysis for was done and correlated by using standard statistical procedure (Snedecor and Cochran, 1996).

Results and Discussion

To evaluate the refractive status of the eyes, the selected dogs were examined without the use of sedatives or topical anaesthetics after confirmation of normal visual acuity and haemato-biochemical parameters. The dogs included in the study belonged to the age group of 2-8 yr, with a mean age (±SE) of 3.68±0.42 yr. Kubai *et al.* (2008) included dogs of different breeds ranging from 0.1 to 15 yr of age, with a mean age of 2.4 yr. Similarly, Sivagurunathan (2011) performed retinoscopy on 50 guide dogs aged between 13 and 34 months, with a mean of 17 months, which was comparatively lower than that of the present study. In contrast, Hernandez *et al.* (2016) included nine Beagles aged 1-14 yr in a refractometric study, representing a comparatively higher age range than that observed in the present study.

The hand-held retinoscope was found to be satisfactory for evaluating refractive error in dogs during the present study. Neutralization of the reflected fundic reflex was achieved successfully in all 40 eyes without any difficulty. Retinoscopy was performed following the method described by Kubai *et al.* (2008) with a working distance of 50 cm.

Table 1: History of healthy dogs and refractometric values.

Sl. No.	Breed	Age (yr)	Sex	Body weight (kg)	Refractometric values (D) Right eye	Refractometric values (D) Left eye	Individual mean refractive error (D)	Difference (D)
A1	German shepherd	2	M	35	0.0 (E)	+0.37 (E)	+0.19 (E)	0.37
A2	Labrador retriever	6	F	37.6	-1.12 (M)	-1.50 (M)	-1.31 (M)	0.38
A3	Cocker spaniel	5	M	18	+0.50 (E)	+0.37 (E)	+0.44 (E)	0.13
A4	Shih Tzu	3	F	6.5	+0.32 (E)	+0.50 (E)	+0.41 (E)	0.18
A5	Beagle	2.5	M	15	+0.24 (E)	+0.37 (E)	+0.31 (E)	0.13
A6	Golden retriever	1	F	33.5	+0.12 (E)	0.0 (E)	+0.06 (E)	0.12
A7	Beagle	2.5	M	17	+0.37 (E)	+0.25 (E)	+0.31 (E)	0.12
A8	Spitz	2	F	8.2	+0.37 (E)	+0.75 (H)	+0.56 (H)	0.38
A9	Non-descript	8	M	20.5	-2.25 (M)	-1.87 (M)	-2.06 (M)	0.38
A10	Labrador retriever	3	M	35.9	+1.00 (H)	+1.12 (H)	+1.06 (H)	0.12
A11	Doberman	5.5	M	29.2	+1.25 (H)	+1.00 (H)	+1.13 (H)	0.25
A12	Lhasa apso	4	F	8.5	+0.50 (E)	+0.12 (E)	+0.31 (E)	0.38
A13	German shepherd	5	M	37.8	-2.12 (M)	-1.75 (M)	-1.94 (M)	0.37
A14	Beagle	1.5	M	12.5	0.0 (E)	+0.12 (E)	+0.06 (E)	0.12
A15	Shih Tzu	2	F	6	+0.37 (E)	+0.25 (E)	+0.31 (E)	0.12
A16	Labrador retriever	3	M	34.1	-1.12 (M)	-0.75 (M)	-0.94 (M)	0.37
A17	Golden retriever	4	M	37	-0.37 (E)	-0.25 (E)	-0.31 (E)	0.12
A18	Daschund	2.5	F	13.5	+0.37 (E)	0.0 (E)	+0.19 (E)	0.37
A19	Non-descript	4	F	21.2	-1.25 (M)	-1.00 (M)	-1.13 (M)	0.25
A20	German shepherd	7	M	38	-2.75 (M)	-1.62 (M)	-2.19 (M)	1.13 (A)
Mean±SE		**3.68± 0.42**		**23.25± 2.69**	**-0.28±0.25**	**-0.18±0.21**	**-0.23±0.23**	**0.29 ± 0.05**
Average of 40 eyes					**-0.23±0.16**			

E = Emmetropic when refractive value is between -0.5 and 0.5 D; M =Myopic when refractive value is < -0.5 D; H = Hyperopic when refractive value is > 0.5 D; A = Anisometropia when a difference is 1.0 D between two eyes in the same dog.

However, Kim *et al.* (2008) and Groth *et al.* (2013) reported a working distance of 67 cm for retinoscopic evaluation. The net spherical refractive error of the eyes was calculated according to the method suggested by Groth *et al.* (2013).

Use of 1% cyclopentolate ophthalmic solution produced adequate pupillary dilation and facilitated the refractometric procedure, which is in agreement with the findings of Costa *et al*. (2016). All dogs were examined under physical restraint without the use of sedation, similar to the procedures followed by Nowak and Neumann (1987), and de Oliveira *et al.* (2020).

Kubai *et al.* (2008) also used cyclopentolate as a cycloplegic agent prior to performing streak retinoscopy in dogs and reported it to be an effective cycloplegic. In contrast, Black et al. (2008), Kubai *et al.* (2008), de Oliveira *et al.* (2020) used tropicamide as a cycloplegic agent before retinoscopic examination in dogs. Furthermore, Groth *et al.* (2013) evaluated 100 eyes of 50 dogs of different breeds and concluded that there was no significant difference between refractive errors measured in cycloplegic and non-cycloplegic eyes.

The refractive values of the right eyes ranged from -2.75 D to +1.25 D, with a mean value of -0.28±0.25 D (Table 1). Similarly, de Oliveira *et al.* (2020) reported a mean refractive error of -0.75±0.94 D for the right eyes in a streak retinoscopy study conducted on 62 dogs. Among the 20 right eyes evaluated in the present study, 2 eyes (10%) were hyperopic, 6 eyes (30%) were myopic, and 12 eyes (60%) were emmetropic. In the left eyes, 3 eyes (15%) were hyperopic, 6 eyes (30%) were myopic, and 11 eyes (55%) were emmetropic.

Murphy *et al.* (1992) reported a mean refractive error of -0.27±1.41 D in 240 phakic dogs of various breeds, which closely agrees with the findings of the present study. In contrast, Itoh *et al.* (2011) reported a comparatively higher mean refractive value of +1.32±0.99 D, with a refractive range of -0.75 to +3.5 D in 46 cycloplegic eyes of 23 Beagle dogs. Likewise, Maehara et al. (2011) observed a higher mean refractive error of +0.08±0.87 D in 54 eyes of healthy Beagles. These variations may be attributed to differences in breed composition and the comparatively higher mean age of dogs included in those studies. The higher incidence of myopia and hypermetropia observed in those reports may also be associated with the use of a single breed (Beagle) and differences in age distribution.

Pollet (1982), Murphy *et al.* (1992) and Kim *et al.* (2008) similarly reported that the majority of examined canine eyes were emmetropic. In the present study, only three eyes exhibited refractive errors greater than -2.0 D (right eyes of dogs A9, A13, and A20). Murphy *et al.* (1997) and Ofri et al. (2012) reported that myopia of at least -2.0 D can reduce visual acuity and adversely affect performance by limiting object recognition to distances below 140 m.

The overall mean refractive error observed in the present study was lower than that reported by de Oliveira *et al.* (2020), who recorded a refractive error of -0.75 ± 0.75 D in 123 canine eyes. Based on the mean refractive status of both eyes, 11 dogs (55%) in the present study were emmetropic, while the remaining 45% were ametropic, including 3 hyperopic dogs (15%) and 6 myopic dogs (30%). In comparison, de Oliveira *et al.* (2020) reported emmetropia in only 19% of dogs (12/62), whereas 81% were ametropic, including 64.52% myopic and 16.13% hyperopic dogs. However, Kubai *et al.* (2008) and Williams *et al.* (2011) also reported emmetropia in the majority of dogs examined.

Three dogs (15%) were hyperopic, six dogs (30%) were myopic, and eleven dogs (55%) were emmetropic. In contrast to the present findings, Vieira and Delgado (2018) reported 30% hyperopia, 26% myopia, and 44% emmetropia. Variations in refractive status among studies may be influenced by differences in breeding environment and skull conformation, as suggested by Gaiddon *et al.* (1996).

The interocular difference in refractive values ranged from 0.12 to 1.13 D, with a mean difference of 0.29±0.05 D. In contrast, Maehara *et al.* (2011) reported a higher mean interocular difference of 0.36±0.51 D, with values ranging from 0 to 1.75 D. One dog (5%) in the present study was anisometropic, exhibiting a refractive difference greater than 1 D (1.13 D) between the two eyes. Similar incidences of anisometropia were reported by Kubai *et al.* (2008) and de Oliveira *et al.* (2020) who observed anisometropia in 6% and 5% of dogs, respectively.

A significant positive correlation between refractive status and age was observed in the present study (P=0.003). Murphy *et al.* (1992) reported that canine eye size was not significantly associated with refractive value, which is in agreement with the present findings. Variations in refractive values among different studies may therefore be attributed to factors such as age, breed, skull conformation, and associated ophthalmic conditions.

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