International Journal of Veterinary Sciences and Animal Husbandry

ISSN: 2456-2912
VET 2024; 9(2): 154-157

www.veterinarypaper.com
Received: 13-12-2023
Accepted: 16-01-2024

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Differentiation of normal lens and cataractous lens of dog (*Canis domesticus*) on its gross anatomical structure

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Abstract
The current study was conducted on six geriatric dogs with normal and cataractous eye lenses. The cataractous lens was opaque compared to the normal lens, whereas the lens of a normal dog appeared clear, soft, avascular, biconvex, and spherical. The dogs with normal as well as cataractous eye lenses had less convexity at the anterior surfaces than posterior surfaces. The weight and axial thickness of the lens of the cataractous dogs were more than the normal dogs. The Equatorial Diameter of the lenses in both groups of dogs did not differ considerably.

Keywords: Normal lens, cataractous lens, *Canis domesticus*, gross anatomical structure

Introduction
The eyeball is a highly sensitive structure in the body (Banks, 1986) [2]. The lens is a clear biconvex, avascular and soft material that rests at the front of the vitreous humour and behind the iris of the eye. This portion of the eye is responsible for concentrating light and transmitting visuals from the outside environment onto the retina. The anterior surface of the lens is less curved than the posterior one. The centers of the anterior and posterior surfaces are called the anterior and posterior poles respectively. The lens consists of the capsule, anterior epithelium, and lens fibers. It is differentiated into two regions, the cortex (outer areas near the capsule) and the nucleus (central area). In the equatorial region the collagenous fibres known as lens zonules or suspensory ligaments adhere to the ciliary body processes and rest the lens in the center of the pupil. The anterior lens epithelial cells secrete a basement membrane which acts a a capsule for the anterior lens. It is composed of type-IV collagen and a mucopolysaccharide matrix (Bernays and Peiffer, 2000) [3]. A cataract is characterised as a focused or widespread opacity of the crystalline lens or its capsule, which causes light to be scattered and appear white or grey. It can cause blurred vision and eventually entire lens become cloudy with loss of all functional vision (Raghuvanshi *et al*., 2013) [15]. Amongst the various eye conditions that affects the dog, cataract are the prevalent concern. Older dogs are more likely to develop cataracts, which are frequently classified as "senile" or "age-related" when no other underlying reason is visible. Cataract increases with age and all dogs above 13.5 years of age are affected with some degree of lens opacity (Williams *et al.*, 2004) [18]. Common causes of canine cataract include heredity, diabetes, systemic drug toxicity, secondary to other eye diseases, traumatic eye and the age (Kanemaki *et al*., 2012) [7]. Cataracts are classified clinically by age of onset, position within the lens, stage of maturity, etiology and appearance.

Materials and Methods
The current investigation involved the collection of six lenses from normal eyes and cataractous eyes of nondescript dogs, irrespective of their side and gender. The lenses were extracted from the eyeball of deceased dogs. Detail observation was made regarding the gross anatomical characteristics such as colour, position, and shape of the lenses from the dogs' normal and cataractous eyes.

The gross anatomical observations of lens of normal and cataractous eye of the dogs were recorded in respect of color, location and shape of lens. The biometric observations including weight of lens (gm), equatorial diameter (mm) and axial thickness (mm) of lens of normal and cataractous eye of dog were recorded.

Results and Discussion

The present research work was done on the Differentiation of normal lens and cataractous lens of dog (*Canis domesticus*) on its gross anatomical structure. The lens of normal eye of the dog was clear, soft, avascular, biconvex, spherical in shape and having crystalline appearance (fig-01). The lens of the cataractous eye was opaque as compared to the normal lens (fig- 02). These findings are in correlation with Santosh *et al.* (2019) [16] in dog, Kwang and Doo (2018) [9] in dog, Hollmann *et al.* (2017) [5] in cattle, Murgiano *et al.* (2014) [12] in cattle, Raghuvanshi *et al.* (2013) [15] in dog, Nasisse (2001) [13] in dog. Lens was placed between the iris and the vitreous body of eye. The lens's posterior surface was in contact with the vitreous body of the eye, while the anterior surface was in contact with the posterior surface of the iris. The equatorial zone was attached by the zonular fibers to the ciliary epithelium which helps the lens to rest at the center of the pupil. The anterior surface of lens of normal as well as cataractous eye was less convex as compared to the posterior surface. These findings are in agreement with the observations made by Malsawmkima *et al.* (2015) [11] in buffalo.

Fig 1: Photograph of lens of normal eye of dog showing crystalline appearance

Fig 2: Photograph of lens of cataractous eye of dog showing opaque appearance

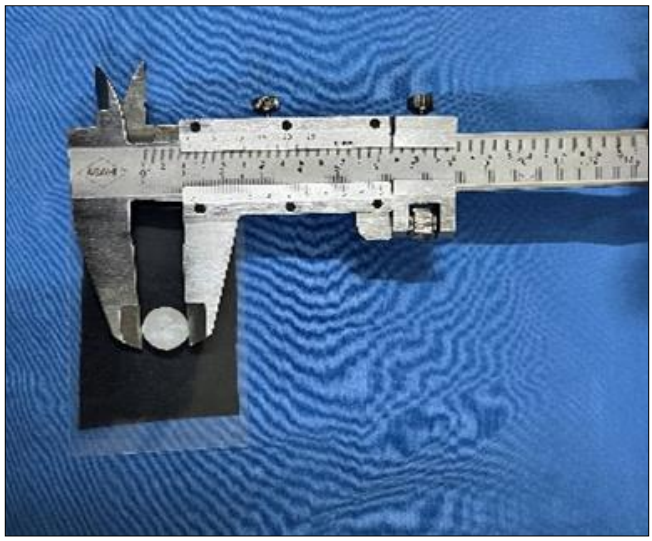

Fig 3: Photograph showing measurement of equatorial diameter of lens with Vernier calliper

The weight of the lens of the normal eye of dog ranged from 0.476 to 0.592 gm with a mean of 0.525±0.039 gm. The weight of the lens of the cataractous eye of dog ranged from 0.624 to 0.724 gm with a mean of 0.675±0.039 gm. The weight of the lens of normal and cataractous eye of dog varied significantly at both 5% and 1% level ($p<0.01$). Malsawmkima *et al.* (2015) [11] noted the weight of lens to be 2.52±0.07 gm in adult Surti buffalo. This difference in the weight of the lens of the dog observed in the present study may be due to differences in species.

The equatorial diameter of the lens of the normal eye of the dog ranged from 10.3 to 11.9 mm with a mean of 11.183±0.621 mm. The equatorial diameter of lens of cataractous eye of dog ranged from 11.3 to 12.6 mm with a mean of 11.533±0.894 mm. The equatorial diameter of the lens of the normal and cataractous eye of dog did not vary significantly ($p>0.05$). The findings of the present study comply with the observations reported by Ivan *et al.* (2022) [6] noted equatorial diameter of the lens normal eye in Beagle dog as 12.11±0.46 mm. Silva *et al.* (2018) [17] noted the equatorial diameter of the lens normal eye in dog as 12.2±1.0 mm. Kumar *et al.* (2017) [8] measured the equatorial diameter of the lens of normal eye in dog as 12.11±0.22 mm in left eye whereas 12.20±0.25 mm in right eye. Ganesan and Ramani (2018) [4] reported equatorial diameter of lens of cataractous eye in dog as 12.35±0.27 mm in diabetic cataractous eye, 11.38±0.17 mm in the mature cataractous eye while it was 10.99±0.19 mm in the immature cataractous eye. Lavanya *et al.* (2021) [16] observed equatorial diameter of the lens of the normal eye in dog and reported it to be 9.52±0.17 mm in right eye whereas in left eye it was 9.41±0.17 mm. Andrade *et al.* (2020) [1] reported equatorial diameter of lens of normal eye in French bulldog as 20±0.6 mm.

The axial thickness of the lens of normal eye of the dog ranged from 5.3 to 6.5 mm with a mean of 6.033±0.427 mm. The axial thickness of lens of the cataractous eye of dog ranged from 6.2 to 8.2 mm with a mean of 7.2±0.740 mm. The axial thickness of lens of normal and cataractous eye of dog varied significantly at both 5% and 1% level ($p<0.01$). These findings of the present study with observations reported by Williams *et al.* (2004) [18] in dog. He reported axial thickness of lens of normal eye in dog as 6.7±1.0 mm while in cataractous eye of dog, it was reported as 7.4±0.9 mm. They also reported that the axial thickness of the lens of diabetic

cataractous eye as 8.4±0.9mm and opined that the increase in axial thickness of diabetic cataractous eye may be due intumescence. Paunksnis *et al.* (2001) [14] reported axial thickness of lens of normal eye of dog and reported as 5.84±0.6 mm in left eye while it was 5.54±0.9 mm in right eye of dog. Lavanya *et al.* (2021) [16] observed axial thickness of lens of normal eye in dog as 5.68±0.14 mm in right eye while in left eye it was 5.69±0.15. Andrade *et al.* (2020) [1] reported axial thickness of lens of normal eye in French bulldog as 7.4±0.3 mm. These differences in the findings in the present study may be due to breed variation. Ganesan and Ramani (2018) [4] reported axial thickness of lens as 8.34±0.66 mm in diabetic cataractous eye, 6.59±0.19 mm in mature cataractous eye while it was 6.63±0.20 mm in immature cataractous eye in dog.

Table 1: Biometrical observations on various parameters of lens of normal eye of dog

Dog No.	1	2	3	4	5	6	Range	Mean	SE
Weight of lens (gm)	0.582	0.491	0.551	0.524	0.476	0.517	0.476 to 0.592	0.525	0.039
Equatorial diameter (mm)	11.9	10.6	11.7	11.3	10.3	11.3	10.3 to 11.9	11.183	0.621
Axial thickness (mm)	6.5	5.8	6.3	6.1	5.3	6.2	5.3 to 6.5	6.033	0.427

Table 2: Biometrical observations on various parameters of lens of cataractous eye of dog

Dog No.	1	2	3	4	5	6	Range	Mean	SE
Weight of lens (gm)	0.712	0.644	0.724	0.686	0.658	0.624	0.624 to 0.724	0.675	0.039
Equatorial diameter (mm)	10.9	12.6	11.8	12.4	10.3	11.2	10.3 to 12.6	11.533	0.894
Axial thickness (mm)	7.8	6.9	8.2	7.4	6.7	6.2	6.2 to 8.2	7.200	0.740

Table 3: Statistical analysis of various biometrical parameters of lens of normal and cataractous eye of dog

Lens	Functions	Normal	Cataractous
Weight (gm)	Range	0.476 to 0.592	0.624 to 0.724
	Mean	0.525±0.039**	0.675±0.039**
Equatorial diameter (mm)	Range	10.3 to 11.9	10.3 to 12.6
	Mean	11.183±0.621	11.533±0.894
Axial thickness (mm)	Range	5.3 to 6.5	6.2 to 8.2
	Mean	6.033±0.427**	7.200±0.740**
*: $p \leq 0.005$ **: $p \leq 0.001$			

Conclusion

In conclusion, this study elucidated significant differentiations between the gross anatomical structures of normal lenses and cataractous lenses in dogs. The normal lens exhibited characteristics such as clarity, softness, and a biconvex, spherical shape with a crystalline appearance, while the cataractous lens appeared opaque in comparison. These findings are consistent with previous research in dogs and other species. The weight and axial thickness of the lenses varied notably between normal and cataractous eyes, with the latter showing significant increases. However, the equatorial diameter remained relatively consistent between the two conditions. These results provide valuable insights into the anatomical variations associated with cataracts in dogs, contributing to our understanding of ocular health in canines. Further studies may explore the underlying mechanisms driving these differences, considering factors such as species and breed variations. Such investigations could potentially inform clinical approaches for diagnosing and managing cataracts in dogs, ultimately improving veterinary care and outcomes for affected animals.

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