FULL PAPER *Anatomy*

Macromorphometric Study on Ciliary Body Location in Canine Eyes

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ABSTRACT. This macroscopic study firstly examined the precise locational information of the canine ciliary body, i.e., the ciliary crown and the ciliary ring in the beagle. The safe and effective transscleral laser photocoagulation technique requires the accurate location of the ciliary body. In both sides of the eyeball in 10 beagle dogs, the width of the ciliary ring and the distance from the limbus to the ciliary ring were measured with calipers using a stereomicroscope at the 8 points. The widest portion of ciliary body was found at the dorsal to ventro-temporal area of the lateral canthus (lateral portion of the eyelid; ear side). In contrast, the narrowest portion was seen at the ventro-nasal to nasal area of the medial canthus (medial portion of the eyelid; nasal quadrants). Use of transscleral photocoagulation at the present narrowest area of ciliary body may carry a high risk of destruction of the optic portion of retina.

KEY WORDS: canine, ciliary body, macromorphometry.

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The ciliary body is anatomically composed of the ciliary crown and the ciliary ring and the boundary of the pars optica retinae (optic part of retina). The ciliary crown produce and secrete aqueous humor. In glaucoma, the suppression of secretion and the obstruction of the discharge of the aqueous humor causes high intraocular pressure (IOP). For the glaucoma treatment, the reduction of intraocular pressure is commonly achieved through inhibition of the aqueous humor secretion. With this method, a laser is applied through the sclera to destroy the ciliary crown [1, 2, 4, 5, 9] and the ciliary ring [8]. As a consequence, a reduction of the intraocular pressure (IOP) occurs due to the inhibition of aqueous humor secretion. Additionally, laser irradiation to the flat part has also been used to reduce pressure and facilitate aqueous humor discharge in human glaucoma patients [4]. However, the laser irradiating point on the sclera in animals is reliant on previous experimental data, because there are no methods that allow for visual inspection of the inside configuration of the eyeball. In the dog, a laser probe is attached to the conjunctiva, approximately 5 mm posterior to the limbus, as this has been reported to be the anatomical location of ciliary body [1, 6, 7]. As we have to avoid laser damage to the optic portion of the retina (sensory epithelium), the exact anatomical information of the ciliary body in the dog is necessary. But there are few informations of the accurate location of the ciliary body [3]. For the safety and effectiveness of the veterinary ophthalmological technique, this study was undertaken to measure the precise width of the spread of the ciliary body and to determine the detailed anatomical locations inside the eyeball.

MATERIALS & METHODS

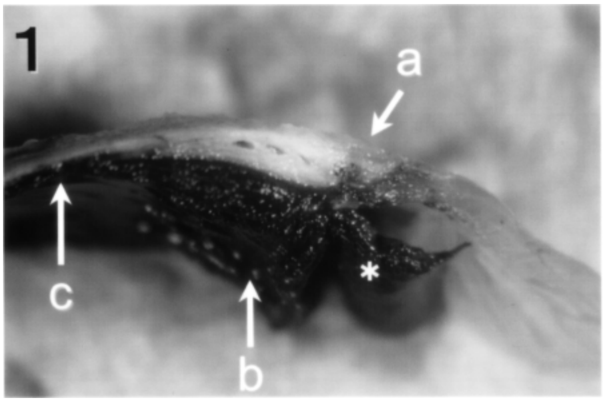
Animals: In our experiments, we studied 10 clinically normal mature male and female beagles (range of body weights: 6.5 to 14.5 kg) that had been donated to the veterinary school for educational purposes. The animals were cared for and used in accordance with humane standards and in compliance with relevant laws and standards for animal welfare as established by Azabu University.

Sample preparations: The beagles used in this study were euthanized by intravenously administering a lethal dose of pentobarbital, and then eyeballs were promptly enucleated. The eyeballs were immediately immersed in saline solution to prevent artificial deformation. Each eyeball was crosscut on the equator with a sharp blade after measurement of the diameters of the eyeball and the cornea. The width of the ciliary ring and the distance from the limbus to the ciliary ring were measured with calipers under a stereomicroscope at the 12:00 (dorsal), 1:30 (dorso-temporal/dorso-nasal), 3:00 (temporal/nasal), 4:30 (ventro-temporal/ventro-nasal), 6:00 (ventral), 7:30 (ventro-temporal/ventro-nasal), 9:00 (temporal/nasal) and 10:30 (dorso-temporal/dorso-nasal) positions on the dial plate of the frontal surface of the eyeball (Fig. 1, Fig. 2).

Different colored surgical sutures were marked the direction at the 12:00 and 6:00 positions before the eyeball was enucleated. For the precise determination, the same part was measured 3 times and then the average value and standard errors were calculated ($p<0.25$).

RESULTS

In the left eyeball, the diameters of the eyeball (dorso-ventral direction) were 20.25 to 23.05 mm, with 21.37 ± 0.80 mm (mean ± SE), and the diameters of the eyeball (naso-temporal direction) were 21.7 to 24 mm, with 22.14 ± 0.79 mm (mean ± SE). The diameters of cornea (dorso-



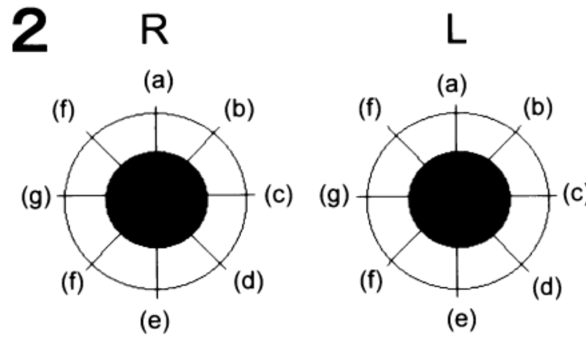


Fig. 1. Macrographical photograph of the cross section of eyeball through the cornea and the sclera junction. a) the limbus, b) the ciliary crown and c) the ciliary ring. * iris.

Fig. 2. Diagrams showing the measurement points. There are eight points on the dial plate of the frontal surface of the each eyeball. (a) at the12:00 (dorsal), (b) at the 1:30 (dorso-temporal/dorso-nasal), (c) at the 3:00 (temporal/nasal), (d) at the 4:30 (ventro-temporal/ventro-nasal), (e) at the 6:00 (ventral), (f) at the 7:30 (ventro-nasal/ventro-temporal), (g) at the 9:00 (temporal/nasal), and (h) at the 10:30 (dorso-temporal/dorso-nasal) positions. R: right eyeball, L: left eyeball.

Table 1. Morphometric data of measurement of the width of the ciliary ring and the distance from the limbus to the ciliary ring

			Dorsal	Dorso-nasal	Nasal	Ventro-nasal	Ventral	Ventro-temporal	Temporal	Dorso-temporal
Distance from the limbus to the ciliary ring (mm)	Left eye ball	Clock position	12:00	10:30	9:00	7:30	6:00	4:30	3:00	1:30
		Range	5.9–6.55	5–5.85	3.6–4.75	3.9–4.95	3.9–5.65	4.71–5.8	4.7–5.5	5.88–7.7
		Mean	6.17	5.33	4.16	4.46	5.09	5.25	5.06	6.35
		SE	0.07	0.16	0.12	0.10	0.16	0.08	0.08	0.10
	Right eye ball	Clock position	12:00	1:30	3:00	4:30	6:00	7:30	9:00	10:30
		Range	5.8–7	5–6.2	3.6–4.7	3.9–4.95	4.9–5.55	4.75–6.2	4.7–5.3	5.4–6.85
		Mean	6.33	5.57	4.08	4.31	5.25	5.29	5.05	6.23
		SE	0.10	0.14	0.11	0.11	0.07	0.15	0.07	0.14
Width of the ciliary ring (mm)	Left eye ball	Clock position	12:00	10:30	9:00	7:30	6:00	4:30	3:00	1:30
		Range	1.5–2.7	0.5–1.4	0.15–0.65	0.35–0.65	0.35–1.3	0.8–2.85	1.7–3.95	2–4.5
		Mean	2.03	0.96	0.39	0.79	1.68	2.77	3.06	3.00
		SE	0.13	0.23	0.05	0.20	0.19	0.09	0.05	0.08
	Right eye ball	Clock position	12:00	1:30	3:00	4:30	6:00	7:30	9:00	10:30
		Range	1.55–2.65	0.5–1.3	0.2–0.45	0.35–1	0.6–2.65	1.5–3.65	2.25–4.1	2–4.6
		Mean	1.84	0.91	0.32	0.72	1.37	2.74	3.01	3.07
		SE	0.01	0.08	0.03	0.07	0.21	0.19	0.16	0.22

ventral direction) were 13.5 to 16.85 mm, with 14.58 ± 1.09 mm (mean ± SE), and the diameters of the cornea (naso-temporal direction) were 14.6 to 17.6 mm, with 15.48 ± 0.95mm (mean ± SE). The widest portion from the limbus to the ciliary ring was at the 1:30 position (dorso-temporal area), and the widths were 5.88 to 7.7 mm, with 6.35 ± 0.10 mm (mean ± SE). The widest portion of the ciliary ring was at the 3:00 position (temporal area). The widths were 1.7 to 3.95 mm, with 3.06 ± 0.05 (mean ± SE). The narrowest portion from the limbus to the ciliary ring was at the 9:00 position (nasal area), and the widths were 3.6 to 4.75 mm, with 4.16 ± 0.12 mm (mean ± SE). The narrowest portion of the ciliary ring was in the same area, and the widths were 0.15 to 0.65 mm, with 0.39 ± 0.05 mm (mean ± SE; Table 1, Fig. 3, Fig. 4).

In the right eyeball, the diameters of the eyeball (dorso-ventral direction) were 20.3 to 22.5 mm, with 21.27 ± 0.58 mm (mean ± SE), and the diameters of the eyeball (naso-temporal direction) were 21.5 to 23.5 mm, with 22.03 ± 0.62 mm (mean ± SE). The diameters of cornea (dorsal-ventral direction) were 13.1 to 16.9 mm, with 14.41 ± 1.07 mm (mean ± SE), and the diameters of the cornea (naso-temporal direction) were 14.15 to 17.7 mm, with 15.25 ± 1.04 mm (mean ± SE). The widest portion from the limbus to the ciliary ring was at the 12:00 position (dorsal area). The widths were 5.8 to 7 mm, with 6.33 ± 0.10 mm (mean ± SE). The widest portion of the ciliary ring was at the 10:30 position (dorso-temporal area). The widths were 2 to 4.6

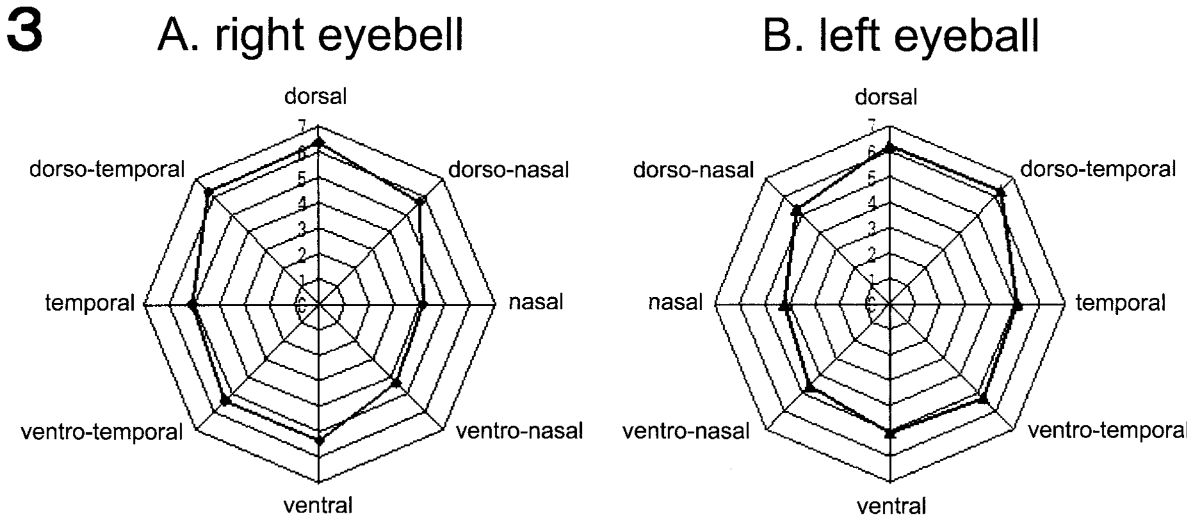


Fig. 3. The raider charts showing the measurement results with a mean value from the limbus to the ciliary ring at each point (A; right eyeball, B; left eyeball). The area of the whole ciliary body that exhibited the greatest width was primarily observed from the dorsal to ventro-temporal side area of the lateral canthus (lateral portion of the eyelid). The narrowest area was from the ventro-nasal to nasal side area of the medial canthus (medial portion of the eyelid).

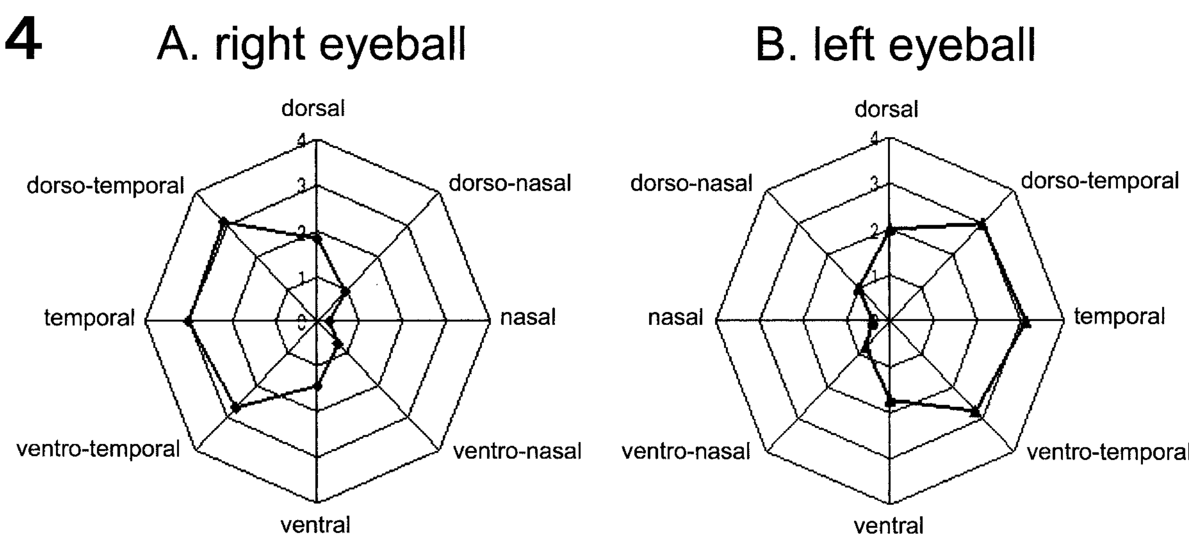


Fig. 4. Charts showing the measurement results with the mean value of the width of the ciliary ring at each point (A; right eyeball, B; left eyeball). The area of the ciliary ring that exhibited the greatest width was primarily observed from the dorso-temporal to ventro-temporal side area of the lateral canthus (lateral portion of the eyelid). The narrowest area was from the nasal to ventro-nasal side area of the medial canthus (medial portion of the eyelid).

mm, with 3.07 ± 0.22 mm (mean ± SE). The narrowest portion from the limbus to the ciliary ring was at the 3:00 position (nasal area), and the widths were 3.6 to 4.7 mm, with 4.08 ± 0.11 mm (mean ± SE). The narrowest portion of the ciliary ring was in the same area, the widths were 0.2 to 0.45 mm, with 0.32 ± 0.03 mm (mean ± SE; Table 1, Fig. 3, Fig. 4).

DISCUSSION

The present study documented the precise morphometrical pattern of the ciliary body in the beagle, and these patterns were found to be slightly different between the each eyeball. The area of the ciliary body that exhibited the greatest width was primarily observed from the dorsal to ventro-temporal side area (12:00 to 4:30 positional direction on the left eyeball and 7:30 to 12:00 position on the right eyeball) of the lateral canthus (lateral portion of the eyelid;see Table 1). The narrowest area was from the nasal to ventro-nasal side area (7:30 to 9:00 directional position on the left eyeball and 3:00 to 4:30 position on the right eyeball) of the medial canthus (medial portion of the eyelid;see Table 1).

The present data indicates that the circumferential irradiation of 5 mm from the posterior part of the limbus, as the conventional standard transscleral photocoagulation conducted on the ciliary process of the dog ciliary body, may not be correct. This is especially adapted to the irradiation from the dorsal to ventro-temporal side area (12:00 to 4:30 position for the left eyeball and 7:30 to 12:00 position for the right eyeball) of the lateral canthus (lateral portion of the eyelid). Therefore, it may be risky to irradiate the ciliary ring at the nasal to ventro-nasal side area (7:30 to 9:00 position on the left eyeball and 3:00 to 4:30 position on the right eyeball) against the medial canthus (medial portion of the eyelid). We should not be perform this procedure to avoid the potential destruction of the optic portion of the retina. The present results would be firstly contribute to greater safety and effective laser irradiation for canine eye surgery.

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