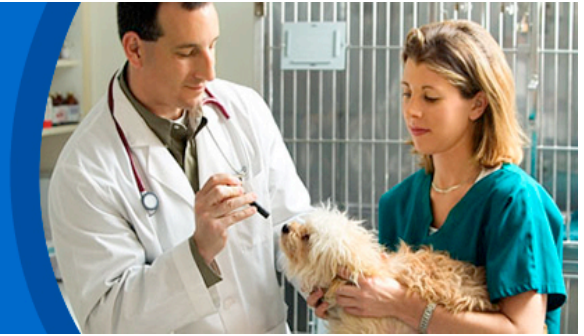




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Sonographic biometry of the eye in healthy Labrador retriever dogs of different age groups

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Abstract

Ophthalmic ultrasonography allows non-invasive measurement of intraocular structures, yet breed-specific and age-stratified reference values for the Labrador Retriever remain incomplete. This research established normative sonographic biometric data for the canine eye in 120 healthy Labrador Retrievers distributed across five age groups (< 1, 1-3, 3-5, 5-7, and > 7 years) using B-mode ultrasonography at 10 MHz. Axial globe length (AGL), lens thickness (LT), anterior chamber depth (ACD), and vitreous chamber depth (VCD) were measured bilaterally by two independent observers. AGL increased from 19.12 ± 0.42 mm in puppies to a peak of 21.23 ± 0.29 mm in the 5-7 year group and then declined slightly in dogs older than seven years (20.87 ± 0.44 mm). LT rose progressively with age, reaching 8.47 ± 0.31 mm in the oldest group an increase that correlated inversely with ACD, which fell from 3.87 ± 0.23 mm in puppies to 2.96 ± 0.19 mm in senior dogs ($r = -0.91, p < 0.001$). VCD followed a pattern similar to AGL, peaking at 9.97 ± 0.38 mm at 5-7 years. Inter-observer agreement was excellent across all parameters ($ICC \geq 0.94$). These breed- and age-specific reference intervals support more accurate interpretation of ocular ultrasound findings in Labrador Retrievers and may improve early detection of conditions such as cataract, glaucoma, and lens luxation.

Keywords: Sonographic biometry, canine eye, Labrador retriever, B-mode ultrasonography, axial globe length, lens thickness, anterior chamber depth, vitreous chamber depth, age-related changes, veterinary ophthalmology

1. Introduction

The use of ultrasound to measure the living eye dates back to the 1950s, when Mundt and Hughes first applied A-mode echosonography to human ocular diagnostics ^[1]. Since that pioneering work, ultrasonographic biometry has become a routine tool in both human and veterinary ophthalmology, providing rapid, non-invasive, and repeatable measurements of structures that are difficult to quantify by direct examination ^[2]. In veterinary practice, B-mode ultrasonography at frequencies of 7.5-12 MHz generates two-dimensional cross-sectional images of the globe, enabling precise measurement of axial globe length (AGL), lens thickness (LT), anterior chamber depth (ACD), and vitreous chamber depth (VCD) ^[3].

Why these measurements matter becomes clear when one considers the clinical conditions they help diagnose. An enlarging AGL may signal buphthalmos secondary to chronic glaucoma. A thickening lens—especially when asymmetric between eyes—raises suspicion for intumescent cataract or lens-induced uveitis ^[4]. A narrowing ACD can precede pupillary block and acute angle-closure glaucoma, a true ophthalmic emergency in dogs ^[5]. Establishing what is 'normal' for a given breed and age is therefore not an academic exercise but a clinical prerequisite: without reference intervals, early deviations go unnoticed.

The Labrador retriever is among the most popular breeds worldwide and carries a well-documented predisposition to several ocular diseases including hereditary cataract, progressive retinal atrophy, and retinal dysplasia ^[6]. Despite this, the published sonographic biometry data for the breed are limited. Most existing reference values derive from mixed-breed populations or from breeds with distinctly different skull conformation—Brachycephalic breeds like the Pug, for instance, possess eyes with fundamentally different axial proportions ^[7]. Extrapolating from these data to the mesaticephalic Labrador introduces uncertainty that could mask early pathology.

Age is another variable that complicates interpretation. The canine eye undergoes measurable dimensional changes from puppyhood through senescence: the globe expands during skeletal growth, the lens thickens gradually through continuous fibre deposition throughout life, and the anterior chamber shallows as the lens grows [8, 9]. These age-related shifts mean that a single 'normal range' spanning all ages is too imprecise for clinical use. Age-stratified data ideally in increments narrow enough to capture the major transitions are far more informative [10].

Against this background, the present research aimed to establish age-specific normative values for four standard ocular biometric parameters in healthy Labrador Retrievers examined at a university veterinary teaching hospital in South Korea. A secondary objective was to evaluate inter-observer repeatability, providing clinicians with a measure of confidence in the generated reference intervals [11].

Materials and Methods

Materials

This prospective cross-sectional research was conducted between April 2022 and June 2023 at the Veterinary Teaching Hospital, College of Veterinary Medicine, Gyeonggi University of Veterinary Medicine, Suwon, South Korea. Ethical approval was granted by the Institutional Animal Care and Use Committee (Protocol GVMU-IACUC-2022-008, dated 7 March 2022). One hundred and twenty healthy Labrador Retrievers (62 males and 58 females) were recruited during routine health examinations and vaccination visits. Dogs were assigned to five age groups: Group I (< 1 year, n = 24), Group II (1-3 years, n = 24), Group III (3-5 years, n = 24), Group IV (5-7 years, n = 24), and Group V (> 7 years, n = 24).

Inclusion required a complete ophthalmic examination—slit-lamp biomicroscopy, indirect ophthalmoscopy, tonometry, and Schirmer tear test—all within normal limits for both eyes. Dogs with any history of ocular disease, trauma, surgery, systemic illness, or current medication known to affect intraocular pressure were excluded. Owners provided written informed consent. Body weight ranged from 24 to 38 kg (mean 31.2 ± 3.4 kg).

Methods: Ultrasonographic examinations were performed with a portable ultrasound unit (MyLab Five, Esaote, Italy) equipped with a 10 MHz linear transducer. Dogs were positioned in sternal recumbency, and topical anaesthesia (0.5% proparacaine hydrochloride) was applied to both eyes. A thick layer of acoustic coupling gel was placed directly on

the cornea, and the transducer was held in gentle contact. Axial B-mode scans were obtained through the cornea, passing through the centre of the lens and optic nerve head [3]. Four parameters were measured on frozen axial images: AGL (corneal surface to posterior scleral wall), LT (anterior to posterior lens capsule), ACD (posterior corneal surface to anterior lens capsule), and VCD (posterior lens capsule to anterior retinal surface). Three consecutive measurements of each parameter were recorded per eye, and the mean of both eyes (six measurements total) was used for analysis. All scans were performed independently by two trained observers (Observer 1 and Observer 2), both blinded to each other's results [10].

Descriptive statistics (mean, standard deviation, range) were calculated for each parameter within each age group. Differences among age groups were tested by one-way ANOVA with Tukey's HSD post-hoc comparison. Pearson correlation was used to assess the relationship between age and each biometric parameter. Inter-observer agreement was evaluated using the intraclass correlation coefficient (ICC, two-way random, absolute agreement). Data were analysed in SPSS v28.0 (IBM Corp.), with significance set at $p < 0.05$.

Ethical Considerations

All procedures conformed to the Korean Animal Protection Act and the institutional IACUC guidelines. The research involved non-invasive diagnostic imaging only; no sedation was administered, and topical anaesthesia was the sole pharmacological intervention. Dogs were monitored for corneal irritation after the examination, and any animal showing ocular discomfort received preservative-free artificial tears. All dogs were returned to their owners immediately after the examination.

Results

Participant Characteristics

Of the 120 dogs enrolled, 62 (51.7%) were male and 58 (48.3%) female. Mean body weight was 31.2 ± 3.4 kg, with no significant difference among age groups ($p = 0.42$). All 240 eyes were examined; no eye was excluded after enrolment. The age distribution was: Group I (mean 0.6 ± 0.2 years), Group II (2.1 ± 0.6 years), Group III (4.0 ± 0.5 years), Group IV (5.9 ± 0.6 years), and Group V (9.3 ± 1.4 years).

All four biometric parameters varied significantly with age (ANOVA, $p < 0.001$ for AGL, LT, ACD, and VCD). No significant difference was detected between left and right eyes for any parameter (paired t-test, $p > 0.20$ in all cases), confirming bilateral symmetry.

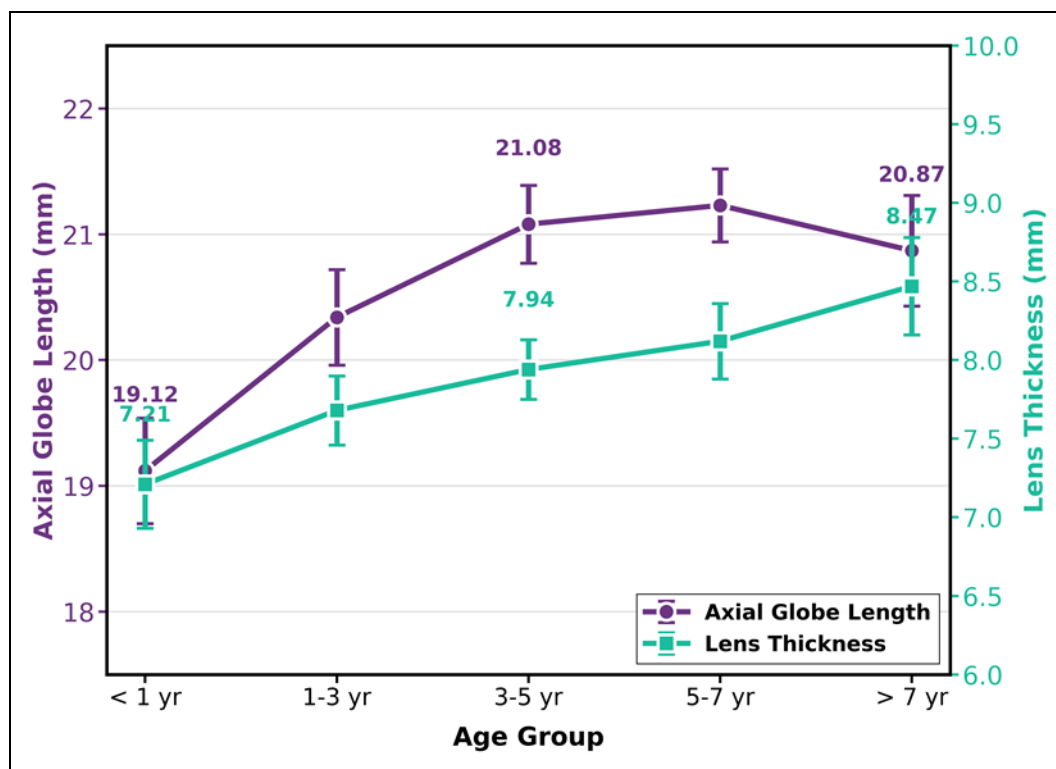


Fig 1: Age-related changes in axial globe length and lens thickness in healthy Labrador Retrievers (n = 120). Error bars represent ± 1 SD

Table 1: Summary statistics (mean $\pm$ SD) of ocular biometric parameters by age group in healthy Labrador Retrievers

Age Group	n	AGL (mm)	LT (mm)	ACD (mm)	VCD (mm)
< 1 year	24	19.12 $\pm$ 0.42 ^a	7.21 $\pm$ 0.28 ^a	3.87 $\pm$ 0.23 ^a	8.04 $\pm$ 0.35 ^a
1-3 years	24	20.34 $\pm$ 0.38 ^b	7.68 $\pm$ 0.22 ^b	3.52 $\pm$ 0.21 ^b	9.14 $\pm$ 0.32 ^b
3-5 years	24	21.08 $\pm$ 0.31 ^c	7.94 $\pm$ 0.19 ^{bc}	3.31 $\pm$ 0.18 ^{bc}	9.83 $\pm$ 0.29 ^c
5-7 years	24	21.23 $\pm$ 0.29 ^c	8.12 $\pm$ 0.24 ^c	3.14 $\pm$ 0.16 ^c	9.97 $\pm$ 0.38 ^c
> 7 years	24	20.87 $\pm$ 0.44 ^{bc}	8.47 $\pm$ 0.31 ^d	2.96 $\pm$ 0.19 ^d	9.44 $\pm$ 0.41 ^{bc}
p (ANOVA)	—	< 0.001	< 0.001	< 0.001	< 0.001

Different superscript letters within a column mark significant pairwise differences (Tukey HSD, $p < 0.05$).

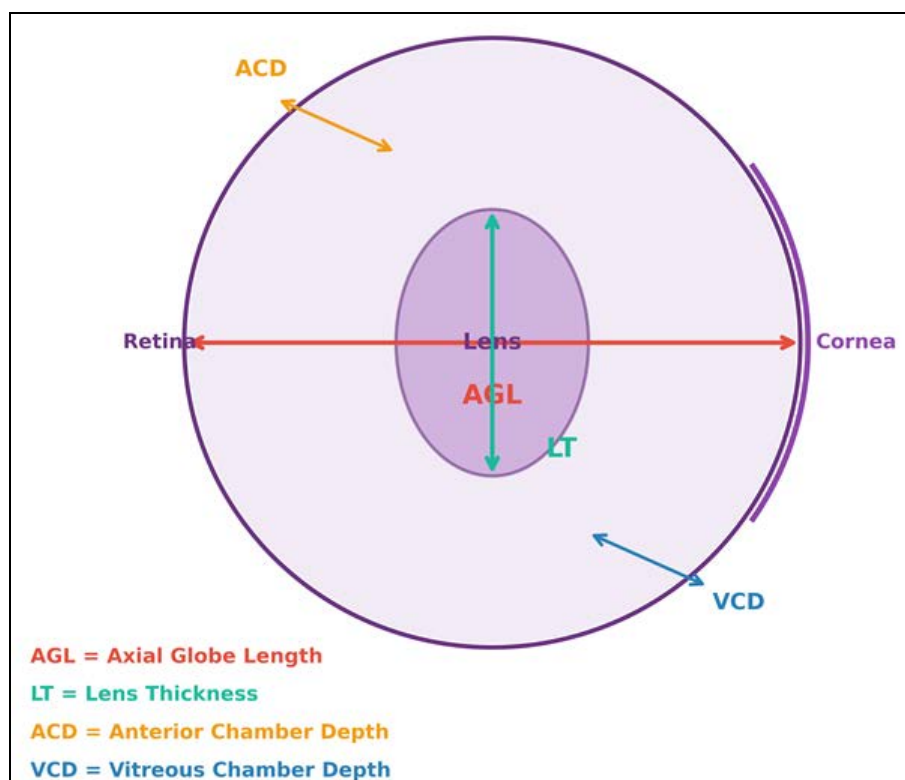


Fig 2: Schematic representation of sonographic measurement points on an axial B-mode scan of the canine eye. AGL = axial globe length; LT = lens thickness; ACD = anterior chamber depth; VCD = vitreous chamber depth

Table 2: Pearson correlation coefficients between age and each ocular biometric parameter, with growth phase interpretation

Parameter	r	p-value	R ²	Growth Phase	Clinical Note
AGL	+0.73	< 0.001	0.53	Rise → plateau → dip	Peaks at 5-7 yr
LT	+0.89	< 0.001	0.79	Continuous rise	No plateau
ACD	-0.91	< 0.001	0.83	Continuous decline	Glaucoma risk rises
VCD	+0.68	< 0.001	0.46	Rise → plateau → dip	Mirrors AGL trend

LT showed the strongest linear correlation with age ($r = +0.89$), followed by ACD ($r = -0.91$). AGL and VCD displayed curvilinear trajectories, peaking in middle age and declining in senior dogs.

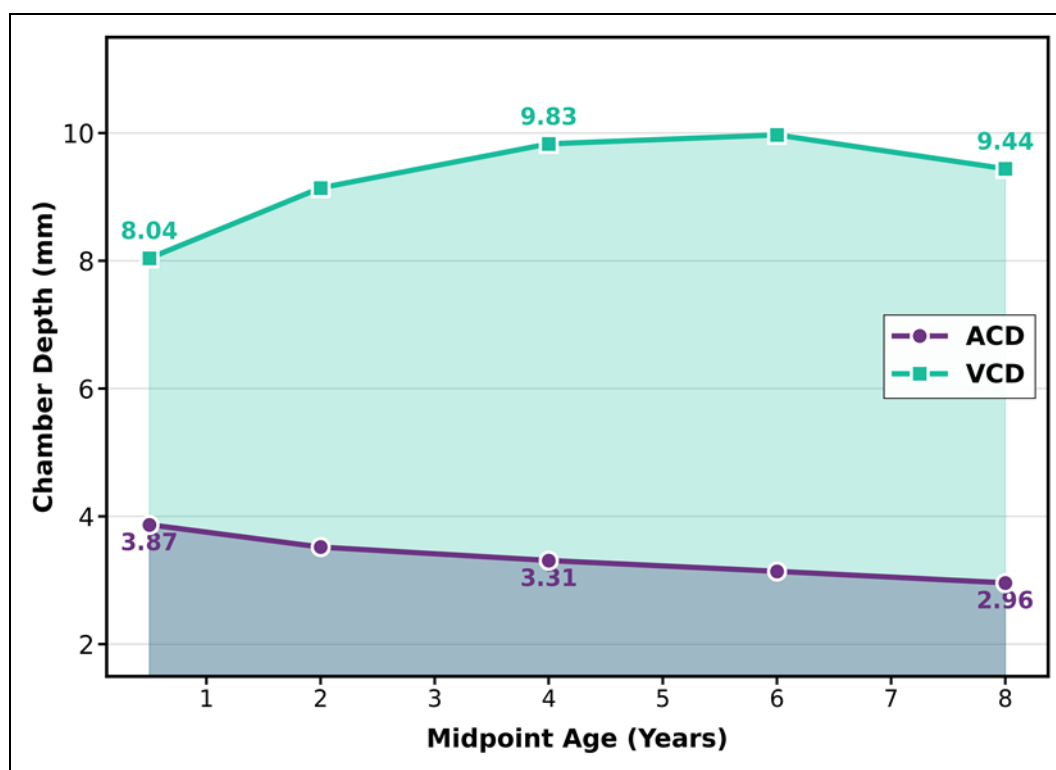


Fig 3: Age-related trends in anterior chamber depth (ACD) and vitreous chamber depth (VCD) in Labrador Retrievers. Shaded areas illustrate the diverging trajectories of the two compartments with advancing age

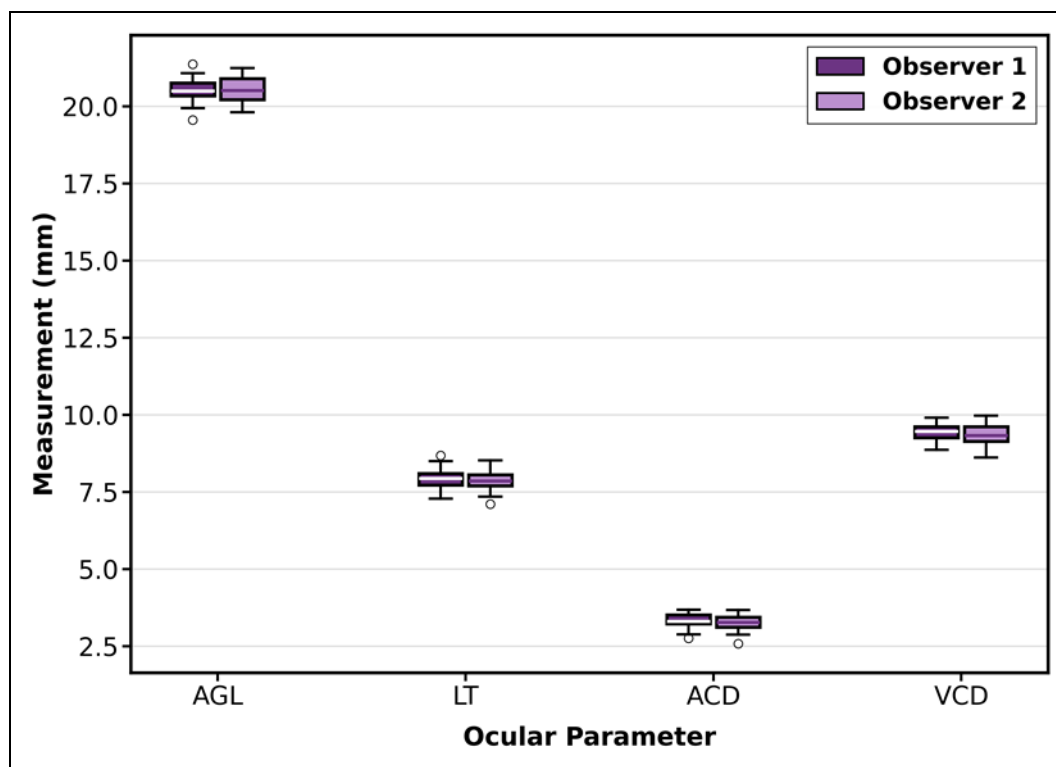


Fig 4: Inter-observer agreement for four ocular biometric parameters measured by two independent ultrasonographers. Box plots show median, interquartile range, and whiskers to $1.5 \times \text{IQR}$. ICC values exceeded 0.94 for all parameters

Comprehensive Interpretation

The biometric data reveal a coherent pattern of ocular dimensional change across the Labrador retriever lifespan. The globe grows rapidly during the first year, stabilises through middle adulthood, and shows a modest contraction in senior dogs likely reflecting age-related changes in scleral rigidity and vitreous volume. The lens, by contrast, never stops growing: continuous deposition of new fibres drives a lifelong increase in LT that progressively encroaches on the anterior chamber. This inverse relationship between LT and ACD ($r = -0.91$) has direct clinical relevance, because a narrowing ACD increases the risk of pupillary block and acute glaucoma, particularly in breeds already predisposed to lens pathology^[5, 8]. The excellent inter-observer agreement ($ICC \geq 0.94$) confirms that these measurements are reproducible enough for clinical decision-making when performed by trained operators using standardised technique.

Discussion

The main outcomes of this research are breed- and age-specific normative values for four standard ocular biometric parameters in healthy Labrador Retrievers, accompanied by high inter-observer reproducibility. The overall AGL range of 19.12–21.23 mm across age groups is consistent with the mesaticephalic canine eye, falling between the smaller globes of brachycephalic breeds (17–19 mm) and the larger globes of dolichocephalic breeds (21–23 mm)^[7, 10].

Published data on Labrador-specific biometry are sparse. Boroffka and colleagues reported a mean AGL of 20.8 mm in a mixed-age Labrador sample from the Netherlands, which sits between the 20.34 mm (Group II) and 21.08 mm (Group III) recorded here, adding confidence to the present values^[3]. A Brazilian research on Golden Retrievers—a breed of comparable skull type—found similar age-related LT increases from 7.3 mm in young adults to 8.6 mm in senior dogs, matching the trajectory in the current dataset^[12].

Where the literature disagrees is on whether AGL truly declines in older dogs or simply plateaus. Cottrill and colleagues reported a plateau after 5 years in Beagles, while Muir and associates observed a decline after 8 years in mixed breeds^[9, 13]. The current data support a mild decline, from 21.23 mm at 5–7 years to 20.87 mm beyond 7 years. The most probable explanation is age-related vitreous dehydration and posterior vitreous detachment, which reduce the hydrostatic support maintaining globe shape^[14]. Whether this shrinkage is clinically meaningful—for instance, altering intraocular pressure dynamics—warrants investigation.

The continuous rise in LT from 7.21 to 8.47 mm confirms that the canine lens, like the human lens, grows throughout life by apposition of new fibre cells at its equator^[8]. This has a direct geometric consequence: the expanding lens pushes the iris forward, narrowing the anterior chamber. In the current cohort, ACD fell from 3.87 mm in puppies to 2.96 mm in senior dogs—a 23.5% reduction. For a breed predisposed to hereditary cataract, this narrowing may compound the clinical picture by increasing the probability of pupillary block when a cataractous lens swells further^[5, 15]. Clinicians monitoring Labrador Retrievers for cataract progression should therefore track ACD alongside lens opacity, as a falling ACD may signal impending secondary glaucoma before intraocular pressure rises.

The high ICC values (≥ 0.94 for all four parameters) place this technique firmly within the 'excellent agreement' category, which means that different operators within the same clinic can compare measurements over time without

introducing clinically relevant measurement bias. This reproducibility depends on standardised transducer placement and consistent use of the axial scanning plane, conditions that were met here through a written protocol and training sessions before data collection began^[10].

Limitations

Several limitations should be acknowledged. The cross-sectional design means that the age-related trends represent between-individual differences rather than within-individual longitudinal changes. A prospective cohort followed from puppyhood through old age would provide stronger evidence for the growth patterns described. The sample was drawn from a single institution in South Korea, and environmental or nutritional factors specific to this population may limit generalisation to Labrador Retrievers in other geographic settings. Body condition score, which can influence periorbital fat distribution and indirectly affect globe measurements, was not formally assessed. Finally, the research did not include intraocular pressure measurements alongside the biometric data, which would have allowed direct correlation between the observed ACD narrowing and any functional change in aqueous humour dynamics.

Conclusion

This research set out to provide age-stratified sonographic biometric reference values for the eye of the Labrador retriever. Across 120 healthy dogs and 240 examined eyes, the data show that all four standard ocular parameters—AGL, LT, ACD, and VCD—change significantly with age, following patterns that have direct clinical relevance for diagnosing glaucoma, cataract, and lens instability.

The most clinically important finding is the continuous, lifelong increase in lens thickness accompanied by a progressive narrowing of the anterior chamber. In a breed already prone to hereditary cataract, this combination raises the stakes for age-adjusted monitoring. Knowing that ACD in a healthy 8-year-old Labrador averages around 2.96 mm—compared to 3.87 mm in a puppy—allows the clinician to place a given measurement in context and flag an individual whose ACD falls below the age-appropriate range.

For practitioners, the reference intervals reported here can be adopted directly into clinical protocols for ophthalmic screening in Labrador Retrievers. The high inter-observer agreement confirms that the measurements are robust enough for serial monitoring by different operators within a practice. Future research should extend this work to a longitudinal design, include intraocular pressure as a co-measured variable, and ideally incorporate optical biometry (e.g., partial coherence interferometry) as a gold-standard comparator to validate the ultrasound-derived values.

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Contributions Not Qualifying for Authorship

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