FOCAL POINT

★ Clinically useful age estimations in adult dogs and cats can be achieved by evaluating changes in ocular crystalline lens reflections and appearance.

KEY FACTS

■ A patient's age affects many decisions made regarding its care, but owners of strays and shelter animals often have no idea of their pets' true ages.

■ It is critical to notice the barely perceptible light identifying the earliest origins of the reflection from the posterior nucleus of the lens.

■ The diameter, or the largest dimension of a reflection, is measured by holding a model with six circles (ranging from pinpoint to 4 mm) directly next to the eye being evaluated.

■ Holding a penlight too close to the eye or too far from the optic axis can cause inaccurate conclusions about the size of ocular reflections.

Estimating Age in Dogs and Cats Using Ocular Lens Examination

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ABSTRACT: Nuclear sclerosis increases the refractivity of the ocular crystalline lens as animals get older. This increased refractivity causes the two pinpoint lens reflections seen in the eyes of young adult dogs and cats to appear to increase in size. Increasing refractivity also causes the clear lens nucleus to develop a faint blue–gray appearance that becomes increasingly intense. When categorized, these changes can be used to divide life span into age groups, thereby allowing the age of mature dogs and cats with unknown histories to be determined more accurately than is possible using the dental method of estimating ages.

An animal's age is a critical part of its history. Age-based expectations about conformation, strength, mobility, and stress tolerance can vary widely between younger and older animals. Failure to consider age can result in disastrous consequences. The age of a patient affects the thought processes concerning every aspect of veterinary medicine, including how animals are restrained, diagnostic differentials are evaluated, treatment modalities are considered, and anesthetics and drug doses are selected; age also affects an animal's adoptability and life expectancy as well as euthanasia decisions. Veterinarians in private practice or humane shelters are called on daily to determine the age of animals with unknown histories or to examine animals in which stated ages are incorrect.

The ocular age estimation system described in this article is perhaps the first realistic method for use in mature cats. In dogs older than 4 years of age, it is more than twice as accurate as is the dental method of estimating age.[1,2] This technique can be learned quickly and does not require special equipment.

OCULAR REFLECTIONS IN YOUNG ANIMALS

Three ocular reflections (Purkinje-Sanson images) can be seen in young adult
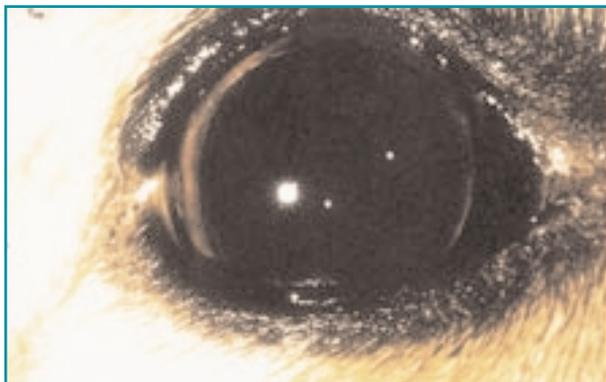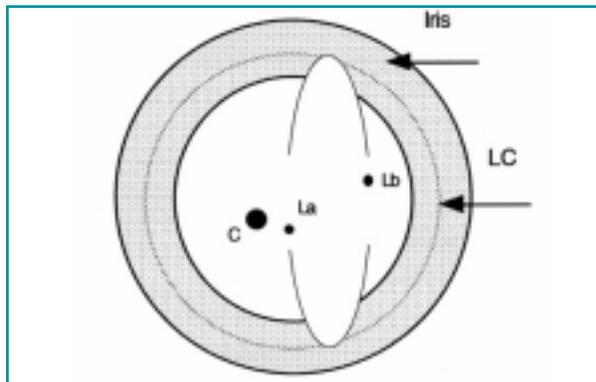
Figure 1A

Figure 1B

Figure 1—Photograph (**A**) and diagram (**B**) of reflections of a point light source in the right eye of a young adult dog. Reflections from the anterior *(La)* and posterior *(Lb)* lens capsule are pinpoint. The bright reflection from the cornea *(C)* is ignored. The lens appearance was graded as clear (L1), and the dog was classified as belonging in age group 1 (see Table I). (*LC* = lens circumference)
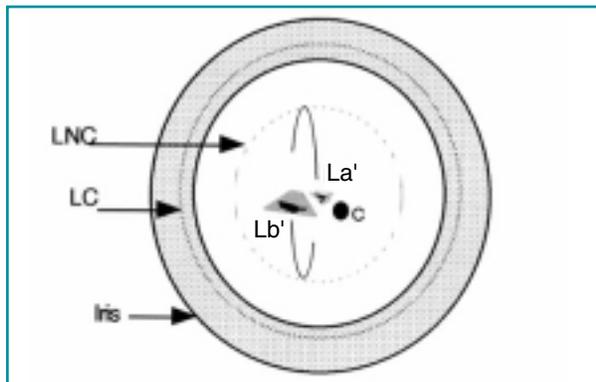

Figure 2A

Figure 2B

Figure 2—Photograph (**A**) and diagram (**B**) of reflections of a point light source in the left eye of a 14-year-old domestic cat. Reflections from the anterior *(La')* and posterior *(Lb')* lens nucleus were 2 and 3 mm, respectively. The halos, seen more obviously in live animals than in a photograph, are included in the measurement of both reflections. The reflections are triangular. The bright corneal reflection *(C)* is ignored. The lens appearance was graded as severe loss of nuclear clearness (L2d), and the cat was classified as belonging in age group 5 (see Table II). (*LC* = lens circumference; *LNC* = lens nuclear circumference)

dogs and cats (Figure 1). In their usual anterior-to-posterior order of appearance, these reflections are labeled C (this is the brightest and largest of the reflections; it comes from the anterior corneal surface), La (a pinpoint reflection from the anterior lens capsule), and Lb (a pinpoint reflection from the posterior lens capsule). Although not used in this method of age estimation, the C reflection is seen approximately at the level of the iris and moves in the same direction as the penlight. The La reflection is seen in the anterior half of the lens and moves in the same direction as the penlight, whereas the Lb reflection is seen in the posterior half of the lens and moves in the opposite direction of the penlight.

NUCLEAR SCLEROSIS

Ocular lenses continue to enlarge during animals'
lifetimes because new curved layers of material are generated and then compact toward the central area or nucleus of the lens. This process causes the nuclear area to gradually increase its refractivity and change its appearance from clear to a faint blue–gray and eventually to an obvious blue–gray in older animals.

OCULAR REFLECTIONS IN MATURE ANIMALS

When dogs and cats are approximately 4 years of age, the lens nucleus begins to reflect faint but clinically apparent light. The nucleus can be considered to have anterior and posterior hemispheres, producing anterior and posterior nuclear reflections (La' and Lb', respectively). The diameters of these nuclear reflections are measured to estimate an animal's age. The reflections from the anterior and posterior lens capsule (i.e., La
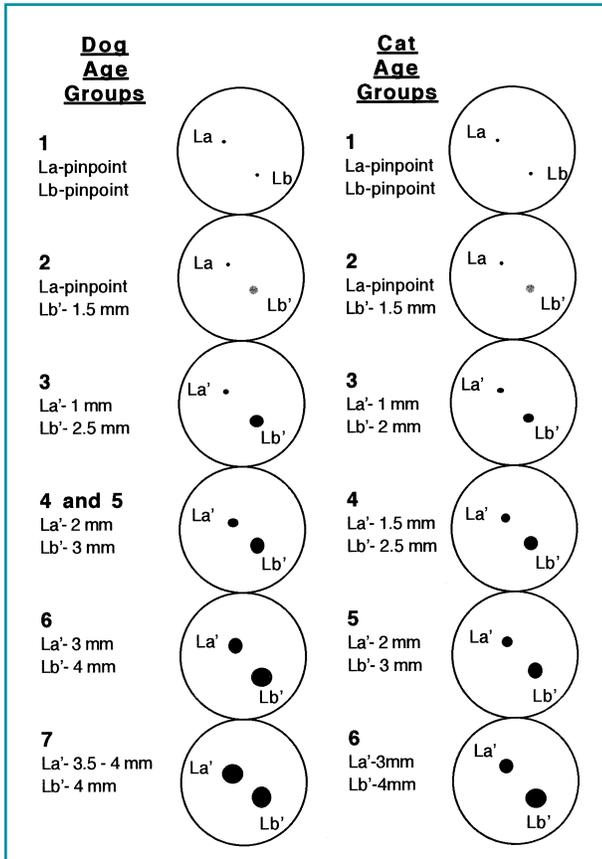
Figure 3—Lens reflections as seen in ascending age groups (circles represent dilated pupils). After reflections from the posterior lens nucleus *(Lb')* in age group 2 and the anterior lens nucleus *(La')* in age group 3 (see Tables I and II) evolve, reflections from the posterior lens capsule *(Lb)* and anterior lens capsule *(La)*, respectively, are assumed to be obscured and thus are not shown. Note: Changes in age group 2 are the most difficult and critical to recognize. Reflection Lb' is barely visible, and the pinpoint Lb reflection just deep to it may be the only one noticed. Only by moving the penlight slightly side to side is the blurred Lb' reflection seen.

and Lb, respectively) remain as pinpoints during an animal's lifetime but become less obvious because of the proximity of the developing nuclear reflections.

Nuclear reflections are seen closer to the center of the lens than are the capsular reflections because the former originate from more highly curved reflective surfaces. When a light is shined into the eye, the expected order of the reflections from most anterior to most posterior in dogs and cats is La, La', Lb', Lb. However, because the nuclear reflections obscure the capsular reflections over time, only La' and Lb' are typically seen, particularly in animals older than 7 years of age. Animals 4 to 7 years of age are in a transitional period in terms of which reflections may be observed; Lb' becomes visible
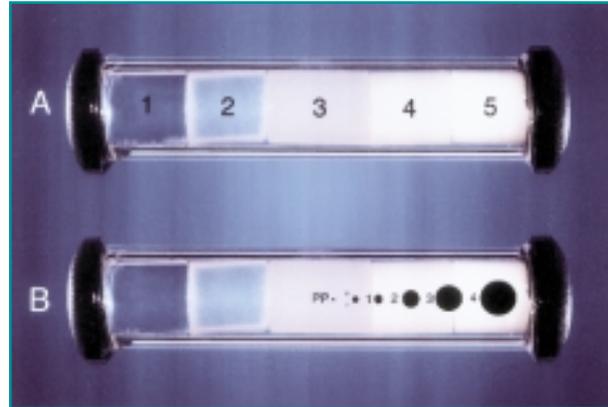

Figure 4—Model (6 cm in length) used to grade lens appearance *(A)* and measure reflections *(B)*. *(A)* View showing four progressively deteriorating grades *(L1* through *L4)* of lens nuclear appearance and how they compare to a cataract *(L5)*. Cataracts are a pathologic change unrelated to sclerosis; cataracts cause opacity of the lens, whereas sclerosis does not. *(L1* = clear; *L2* = early loss of clearness [like antique glass]; *L3* = mild sclerosis [very pale blue–gray]; *L4* = moderate sclerosis [pale blue–gray]; *L5* = cataract). *(B)* Side view of model showing a range of lens reflection diameters, from 0.3 (pinpoint; *PP*) to 4.0 mm. (From Tobias G, Tobias T, Abood S, et al: Determination of age in dogs and cats by use of changes in lens reflections and transparency. *Am J Vet Res* 59:947, 1998; with permission.)

before La' does and therefore three reflections (La, Lb', and Lb) are seen in animals in this age range. La' becomes more visible in animals older than 7 years of age; shortly thereafter, only La' and Lb' are obvious. The reflections vary in shape and may be round, oval, triangular, or linear (Figure 2).

OCULAR AGE ESTIMATION TECHNIQUE

The reflections are produced by placing an animal in a darkened room and shining a penlight into its eye from a distance of approximately 20 cm. Extreme darkening is not needed. The distance of the penlight from the eye is important; holding the penlight too close (within 8 cm of the eye) artificially enlarges the reflections.

Moving the light source a few centimeters to either side of the optic axis (i.e., an imaginary line running through the anterior and posterior poles of the eye) causes similar or opposite movement of the reflections and aids in identifying them. Anterior reflections move in the same direction as the penlight, whereas posterior reflections move in the opposite direction.

To determine an animal's age, the patient's lens reflections are compared to those in Figure 3. For accuracy in measuring the diameter of a reflection, representations of the different sizes of reflections should be

TABLE I
Age-Related Changes in Canine Ocular Lens Reflections and Appearance

Approximate Anterior Lens Reflection Diameter (mm)[a]	Approximate Posterior Lens Reflection Diameter (mm)[b]	Appearance of Lens Nucleus[c]	Canine Age Group	Age Range (yr)	Average Age (yr)
PP	PP	L1	1	0–4	2
PP	1–2	L1	2	>4–7	5.5
1	2.5	L2	3	>7–8.2	7.6
2	3	L3 early	4	8.3–10	9.1
2	3	L3 late	5	>10–12	11
3	4	L4 early	6	>12–15	13.5
3.5	4	L4 late	7	>15	>15

[a]In age groups 1 and 2, the anterior lens reflection comes only from the anterior lens capsule (La) and is usually pinpoint; in groups 3 to 7, it comes primarily from the anterior lens nucleus (La').
[b]In age group 1, the posterior lens reflection comes only from the posterior lens capsule (Lb) and is usually pinpoint; in groups 2 to 7, it comes primarily from the posterior lens nucleus (Lb').
[c]Loss of clearness progresses from just perceptible to severe and usually starts in the center and expands to the entire nucleus (see Figure 4).
L1 = clear; *L2* = there is an early loss of clearness (like antique glass), and the circumference of the nucleus becomes visible (pupillary dilation is likely needed to detect); *L3 early* = mild sclerosis (very pale blue–gray) primarily in the center of the nucleus; *L3 late* = mild sclerosis involves most of the nucleus; *L4 early* = moderate sclerosis (pale blue–gray) primarily in the center of the nucleus; *L4 late* = moderate sclerosis involves most of the nucleus; *PP* = pinpoint.

TABLE II
Age-Related Changes in Feline Ocular Lens Reflections and Appearance

Approximate Anterior Lens Reflection Diameter (mm)[a]	Approximate Posterior Lens Reflection Diameter (mm)[b]	Appearance of Lens Nucleus[c]	Feline Age Group	Age Range (yr)	Average Age (yr)
PP	PP	L1	1	0–4.5	2.2
PP	0.7–2.0	L2a	2	4.6–7.5	6
1	2	L2b	3	7.6–9	8.2
1.5	2.5	L2c	4	>9–13	11
2	3	L2d	5	>13–15	14
3	4	L3	6	>15	>15

[a]In age groups 1 and 2, the anterior lens reflection comes only from the anterior lens capsule (La) and is usually pinpoint; in groups 3 to 6, it comes primarily from the anterior lens nucleus (La').
[b]In age group 1, the posterior lens reflection comes only from the posterior lens capsule (Lb) and is usually pinpoint; in groups 2 to 6, it comes primarily from the posterior lens nucleus (Lb').
[c]Loss of clearness progresses from just perceptible to severe and usually starts in the center and expands to the entire nucleus (see Figure 4).
L1 = clear; *L2a* = circumference of the lens nucleus becomes visible (pupillary dilation is likely needed to detect); *L2b* = center of the lens nucleus loses clearness (like antique glass); *L2c* = loss of clearness is obvious and encompasses the entire nucleus; *L2d* = loss of clearness is severe and often represents the beginning of L3; *L3* = mild sclerosis (very pale blue–gray).

drawn on a short strip of hard plastic and held close to the eye being examined (Figure 4). The halo surrounding the brighter center of the reflection should be included in the measurements.

Changes in the appearance of the lens nucleus are also helpful in estimating the ages of animals; most changes start in the center of the nucleus and expand to the nuclear circumference. Descriptions of these changes in dogs have been divided into four grades (L1 to L4; Table I). The fifth grade (L5) represents a cataract, which is a pathologic con-

dition and not part of normal aging. Changes in the appearance of the feline lens nucleus (i.e., from clear to blue–gray) are substantially less intense (Table II).

The approximate age of an animal can therefore be ascertained by assessing both the size of nuclear reflections and the appearance of the lens nucleus. The differences in the appearance of the lens nucleus can be subtle. Holding a model[a] of the changes next to the eye may aid in the evaluation (Figure 4). Dilation of the pupil with 1% tropicamide ophthalmic solution can make the reflections easier to see for those new at the technique and can expose age-related changes in the lens periphery (e.g., the circumference of the lens nucleus becomes visible). Some examiners may wish to use binocular magnifiers to enhance their vision.

POTENTIAL CAUSES OF ERROR

Errors can result if the penlight is moved too far from the optic axis in any direction. A 45° or greater movement from the axis falsely enlarges or distorts the reflections. Moving the penlight too close to the eye, a common tendency of novice examiners or when the penlight battery is weakening, may also falsely enlarge the lens reflections. The intensity of the penlight, the width of the light beam, and the darkness of the room are other variables that can affect results and thus should be kept as uniform as possible.

Other causes of error are loss of corneal clarity, cataracts, or other lens abnormalities. Reflections are distinguished from these ocular defects by the fact that only reflections move when the penlight is moved. Defects in the eye, depending on their location, can affect the size of reflections and make estimating an animal's age more difficult or impossible. Pupil dilation, which causes more light to enter the pupil, can cause a fractionally less intense change in nuclear appearance.

OCULAR AGE ESTIMATIONS IN CATS

Two veterinarians independently examined 73 cats and correctly placed approximately 62% into specific age groups (Table II) using the ocular age estimation method.[3] No cats in group 6 (older than 15 years of age) were available for testing.

DENTAL AGE ESTIMATIONS IN DOGS

Four independent veterinarians[4] used notes and drawings describing the dental age estimation technique[2] to assess the age of 50 adult dogs based only on open-mouth close-up photographs of the frontal views of their incisor and canine teeth. The dogs' ages ranged from 1 to 14 years; breeds included German shepherds,

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TABLE III		
Accuracy of Estimating Age by Dental versus Ocular Methods in Dogs		
	Percent of Correct Age Estimations	
Age Groups (Age Range [yr])	*Dental Method*	*Ocular Method*
2–6 (4–15)	22.9	51
1 (0–4)	78.3	43.2
1–6 (0–15)	39.5	49.6

schnauzers, poodles, Siberian huskies, Labrador retrievers, setters, and pointers. For ease of comparison, the age estimations were subdivided into the same groups used in ocular age estimations (Table I); no dogs were old enough for group 7 (older than 15 years of age).

The veterinarians' accuracy in identifying group 1 animals (0 to 4 years of age) from the 50 photographs was analyzed using the Chi-square test ($\chi^2 = 6.47$; degrees of freedom = 3; $P < .1$). The degree of probability indicates that the ages of animals in group 1 can be reliably estimated using the dental technique.[4]

The accuracy in identifying animals in groups 1 through 6 (0 to 15 years of age) from the 50 photographs was also analyzed ($\chi^2 = 93.25$; degrees of freedom = 15; $P < .005$). This low probability suggests that when all six groups are considered together, dental age estimation is highly variable and has limited clinical value.[4]

Using photographs of teeth to estimate age in dogs is not as desirable as looking at the teeth of a live animal, but this was offset by ensuring that examiners were not influenced by other clues about an animal's age. Unintentional observations of such factors as staining or tartar accumulations on the premolars and molars, gray hairs on the face, nuclear sclerosis of the lens, or obesity could have influenced the examiners' opinions.

DENTAL VERSUS OCULAR AGE ESTIMATIONS IN DOGS

A comparison of the dental and ocular age estimation methods in dogs is presented in Table III. The numbers represent the percent of animals that were correctly placed into specific age groups by the examining veterinarians using the two different age estimation methods. The ocular age estimation percentages were derived from the raw data from the 1998 article by Tobias and associates[3] and the dental age estimation percentages from an unpublished study.[4] Using the dental method, only 22.9% of dogs older than 4 years of age were assigned to the correct group compared with 78.3% of dogs younger than 4 years of age.

DISCUSSION AND CONCLUSIONS

The limited value of dental age estimations in mature dogs is likely related to the many variables that can affect dental wear. Examples of these variables include diet (e.g., soft versus dry foods or bones), oral health, oral hygiene, excessive chewing, dental trauma (e.g., fractures, avulsed teeth), malocclusion, or differences in enamel quality. Veterinarians using the dental age estimation technique may actually be paying more attention to the amount of staining and tartar accumulation or the number of missing teeth rather than the erosion of the surface of incisor teeth.

Because the lens is an internal structure, it is susceptible to very few variables other than pathology of the eyeball. Variables involved in actually using the ocular technique are under examiner control.

We conclude that the dental and ocular methods for estimating the age of animals complement each other. The dental method was more accurate in dogs approximately 1 to 4 years of age, whereas the ocular method was superior in dogs older than 4 years of age. Ocular age estimation provides veterinarians and humane societies with the first safe, easily performed, and noninvasive method to estimate the age of mature cats and a more accurate method for estimating ages in mature dogs.

The original research validating the method of ocular age estimation was described in 1998.[3] That study[3] involved 85 dogs ranging in age from 1 to 14 years; the breeds included were the same as described in the dental study described in this article.[4] The 1998 study[3] showed that the age of a dog or cat could be determined within ±1.7 years with a 75% degree of confidence.

SUMMARY

Clients who have adopted animals from shelters or found them as strays are often misinformed about the true age of their pets. In mature dogs, the dental method of estimating age lacks accuracy because of the many variables that can affect the rate of dental erosion.

A more reliable method to estimate the age of adult dogs and cats uses changes in ocular crystalline lens reflections and nuclear appearance caused by nuclear sclerosis. This method is more than twice as accurate as the dental method is in dogs older than 4 years of age and is the first realistic, noninvasive method of estimating ages in mature cats. The ocular method is easily completed during a routine physical examination and requires only a darkened room and a penlight.

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