

GLAUCOMA AND CATARACTS CAN WE ELIMINATE THEM?

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INTRODUCTION

Of the inherited eye diseases in dogs, the glaucomas, cataracts, and progressive retinal degenerations are the most frequent, and all can produce visual impairment and blindness. The treatments of these inherited eye conditions are equally expensive and frustrating, and often not very successful. With the advent of DNA methodologies, we have at our disposal a powerful tool to identify affected (often years before the diseases appears) and carrier animals, and can eliminate these animals from our breeding populations in many breeds. Let us briefly reveal what we know about the epidemiology and genetics of the glaucomas and cataracts in purebred dogs, and then we can determine our chances of eliminating these diseases.

THE BREED-RELATED PRIMARY GLAUCOMAS

Glaucoma is defined as an elevation of intraocular pressure (IOP) that is incompatible with the health and normal function of the optic nerve. Clinically, the glaucomas are divided into the three categories of primary, secondary, and congenital glaucoma. The primary glaucomas are breed-related and consist of a group of diseases characterized by an abnormal elevation in IOP due to decreased aqueous outflow without overt ocular disease. These primary glaucoma's are categorized further into open-angle, narrow-angle, and closed-angle glaucoma by gonioscopic examination of the iridocorneal angle, and are breed specific (see below).

The primary glaucomas are dynamic and usually progressive diseases and appear clinically different as the disease advances. Hence, any classification scheme for the dog often lists the same breed with different types of glaucoma; this is probably because the disease is being diagnosed clinically at different stages.

TABLE 1: BREEDS OF DOGS WITH THE PRIMARY GLAUCOMAS:

A. BREEDS PREDISPOSED:

Akita	Italian Greyhound
Alaskan Malamute	Lakeland Terrier
Basset Hound	Maltese
Beagle	Miniature Pinscher
Border Collie	Miniature Schnauzer
Boston Terrier	Norfolk Terrier
Bouvier des Flandres	Norwegian Elkhound
Brittany Spaniel	Norwich Terrier
Cairn Terrier	Poodle (Toy/Miniature)
Cardigan Welsh Corgi	Samoyed
Chihuahua	Scottish Terrier
American Cocker Spaniel	Sealyham Terrier
Dachshund	Shih Tzu

Dalmatian	Siberian Husky
Dandie Dinmont Terrier	Skye Terrier
English Cocker Spaniel	Smooth Fox Terrier
English Springer Spaniel	Tibetan Terrier
German Shepherd	Welsh Springer Spaniel
Giant Schnauzer	Welsh Terrier
Greyhound	West Highland White Terrier
Irish Setter	Wire Fox Terrier

B. TYPES OF THE GLAUCOMAS REPORTED:

Open Angle	Closed Angle
Beagle	Akita*
Great Dane*	American Cocker Spaniel
Keeshond	Basset Hound*
Norwegian Elkhound	English Cocker Spaniel*
Poodle (Miniature/Toy)	English Springer Spaniel*
Samoyed	Flat Coated Retriever*
Siberian Husky*	Golden Retriever
	Poodles (Miniature/Toy)
	Samoyed
	Shar Pei*
	Welsh Springer Spaniel

*Pectinate ligament dysplasia

The modes of inheritance of the primary glaucomas for most breeds of dogs are still not determined. In the Beagle primary open angle glaucoma is inherited as an autosomal recessive trait. The primary angle closure glaucomas in the Great Dane and Welsh Springer Spaniel are thought to be inherited as autosomal dominants with variable penetrance. Most important in understanding the primary and breed-specific glaucoma is that the disease is expressed in both eyes, although the stage of the disease may differ between fellow eyes.

SECONDARY GLAUCOMAS AND LENS LUXATION

In any discussion of the breed-related glaucomas, the inherited lens luxations and their associated secondary glaucomas must be considered because of the high frequencies of these diseases. The secondary increase in intraocular pressure seems associated with the lens becoming 'loose' within the eye and causing inflammation and physical barriers to the outflow of aqueous humor from the eye. In the breed studies these lens luxations/displacements seem associated with a zonular / vitreous abnormality. This defect also affects both eyes, and is predominately a terrier breed problem (see table below).

Inherited and Breed Predisposition to Lens Luxation in the Dog.

Inherited	Breed Predisposed
Border Collie ^a	Australian Collie
Cairn Terrier	Basset Hound
Jack Russell Terrier	Beagle
Lakeland Terrier	Chihuahua
Manchester Terrier	German Shepherd
Miniature Bull Terrier	Greyhound
Norfolk Terrier	Miniature Poodle
Norwich Terrier	Miniature Schnauzer
Scottish Terrier	Norwegian Elkhound
Skye Terrier	Spaniel Breeds
Sealyham Terrier ^b	Pembroke Welsh Corgi
Smoothhaired Fox Terrier	Welsh Terrier
West Highland White Terrier	Toy Poodle
Tibetan Terrier	Toy Terrier
Wirehaired Fox Terrier ^b	

^aPresumed autosomal recessive.

^bPresumed autosomal dominant.

KEY TO DETECTION OF THE GLAUCOMAS

Paramount to the diagnosis of the glaucomas in purebred dogs is the accurate measurements of intraocular pressure (IOP). IOP can be estimated manually by digital compression; however, a more accurate measurement is obtained from the use of a tonometer (Tonometry = measurement of IOP). Electronic applanation tonometers are more accurate, but unfortunately more expensive. Our choice is the TonoPen-XL, by Mentor.

THERAPY FOR THE GLAUCOMAS

Specific therapy of patients with the glaucomas depends on the type and cause of the elevated IOP; but unfortunately most glaucomas in dogs are presented late in the disease when medical therapy is not very effective. Therapy is directed toward reducing intraocular pressure. This may be accomplished by either reducing the formation and secretion of aqueous humor and/or by increasing the aqueous humor outflow from the eye. When forming a therapeutic plan, the goals of therapy should be kept in mind. The two important goals to have in mind are 1) restore or preserve vision or 2) prevent pain in a blind eye +/- preservation of the globe itself.

A. **Medical Management of Glaucoma.** Medical therapy is usually successful for only short periods of time as the iridocorneal angle progressively narrow or closes. Therapeutic agents used in the management of glaucoma are usually used in different combinations. They include: osmotic diuretics, miotics, carbonic anhydrase inhibitors (topical and systemic), adrenergic agonists and beta adrenergic blocking agents. When primary glaucoma is diagnosed and therapy initiated in one eye, prophylactic therapy should be started in the other eye to maintain the IOP within a normal range. Frequently, this consists of topical miotic therapy or beta blocker given once daily prior to darkness to prevent dilation of the pupil. One recent clinical study suggests that prophylactic therapy delays the onset of breed-specific glaucomas about 30 months, where as the medical control of glaucoma and preservation of vision (once the disease has been diagnosed) is only 6 months.

B. **Surgical Management of the Glaucomas:** There are several surgical procedures used to manage the breed-related primary glaucomas, but the most popular procedures at this time are anterior chamber tube implants to create a new bypass for the exit of aqueous humor and the destruction of the ciliary body by YAG and diode laser. For the secondary glaucomas secondary to luxation of the lens, lens removal alone or in combination with other procedures may restore normal IOP.

CATARACTS:

The definition of cataracts is an opacity of the lens or lens capsule. Another histologic definition would be the actual death and disruption of the lens epithelia and lens fibers. In the consideration of the breed-associated cataracts in dogs, use of a number of classification schemes is necessary. The classification of cataracts may help evaluate etiology and prognosis.

1. **Classified by age of onset:**
 - a. Congenital cataracts: present at birth or shortly thereafter. Included are those inherited (see table below); maternal infection; toxic induced (DNP); nutritionally induced (arginine deficiency in milk replacers); most are bilateral and may partially resolve.
 - b. Juvenile: developmental or early onset between 2-5 years of age. Several causes include: Inherited (see table below); trauma; diabetes; intraocular inflammation; other.
 - c. Senile (senescent) Cataracts: lens opacities in dogs over 6 years of age.
 - d. Nuclear sclerosis: a normal lenticular alteration in most dogs over 6 years.
2. **Classified by cataract location:** Capsular: anterior and posterior; subcapsular; cortical; nuclear and perinuclear; and polar/equatorial.
3. **Classification of cataracts by degree of maturation**
 - a. Incipient: Earliest lens changes; focal opacity of the lens; and radiations or "spoke" shaped opacities
 - b. Immature: Increased size of lens due to imbibition of fluid; intumescent = swollen in some cases. May cause glaucoma; fundic reflex still present (usually present peripherally); and vision is impaired to a variable extent.
 - c. Mature: Lens totally opaque; fundic reflex absent; vision lost; and the lens usually

normal size.

d. Hypermature: Wrinkling of the anterior lens capsule, due to resorption with decrease in total lens volume. Also capsule may have areas of fibrosis and dystrophic calcification.

4. Classification based of etiology of cataracts:

1. Inherited (Tables I & 2)
 - a. Primary
 - b. Associated with other ocular anomalies.
2. Trauma
3. Metabolic disorders - Systemic disease
 - a. Diabetes
 - b. Hypocalcemia
4. Toxins
 - a. DNP
 - b. DMSO
5. Nutritional
 - a. Arginine deficiency. Milk replacer - commercial and homemade.
6. Secondary to inflammation i.e. anterior/posterior uveitis of any cause.
7. Idiopathic
8. Associated with progressive retinal atrophy. Posterior subcapsular cataracts that usually progress, occur due to release of free radicals and other toxic substances from the degenerating photoreceptors.

TABLE - INHERITED CANINE CATARACTS

BREED	MODE OF INHERITANCE	AGE OF ONSET	
Afghan Hound (suspected)	Autosomal recessive	Congenital to 2 yrs	
American Cocker	Autosomal recessive	Congenital & juvenile (0.6-6+ yrs)	
Beagle	Incomplete dominant	Congenital to 4 mos	
Bichon Frise	Autosomal recessive	1.5-6 yrs	
Boston Terrier	Autosomal recessive	Congenital to 4 mos	
Chesapeake Bay Retriever	Incomplete dominant	6 mos to 7 yrs	
Cavalier King Charles Spaniel	Unknown	Congenital	
German Shepherd	Dominant	Congenital to 2 yrs	
Golden Retriever	Unknown	Congenital	
	Autosomal dominant	1.5 yrs +	
Irish Setter	Unknown	4.5 mo to 2 yrs	
Labrador Retriever	Autosomal dominant	1.5 yrs +	
	Unknown	Congenital	
Miniature Poodle	Autosomal recessive	Juvenile	
Miniature Schnauzer		Autosomal recessive	Congenital
	Autosomal recessive	Congenital +	
Old English Sheepdog	Autosomal recessive	Congenital	
Red Cocker Spaniel	Unknown	Congenital	
Siberian Husky	Autosomal recessive	4-18 mo	

Staffordshire Bull Terrier	Autosomal recessive	4 mos +
Standard Poodle	Autosomal recessive	Congenital to 2 yrs
Toy Poodle	Autosomal recessive	Juvenile
Welsh Corgi	Autosomal recessive	Congenital to 2 yrs
Welsh Springer	Autosomal recessive	Congenital to 8 weeks
West Highland White Terrier	Autosomal recessive	Congenital to 6 yrs

TABLE: CHARACTERISTICS OF INHERITED CANINE CATARACTS:

BREED	AREA AFFECTED	RATE OF DEVELOPMENT
Afghan Hound	Equatorial cortical vacuoles	Rapid
American Cocker Spaniel	Congenital – Nuclear and Cortical	Slow to rapid
	Juvenile – Posterior axial	Moderate
Beagle	Posterior axial to diffuse	Moderate
Boston Terrier	Nuclear	Slow
Chesapeake Bay Retriever	Nuclear and cortical	Variable but usually progressive
Cavalier King Charles Spaniel	Nuclear and Posterior Cortex	Unknown
German Shepherd	Cortical	Slow
Golden Retriever	Homozygote – cortical and nuclear diffuse	Rapid
	Heterozygote – Posterior axial	Usually nonprogressive
	subcapsular triangular	
Irish Setter	Cortical	Rapid
Labrador Retriever	Cortical	Moderate to rapid
Miniature Poodle	Cortical	Moderate to rapid
Miniature Schnauzer	Posterior subcapsular	Variable
	and nuclear	
Old English Sheepdog	Cortical and nuclear	Moderate to rapid
Siberian Husky	Posterior subcapsular and equatorial	Slow (usually)
Staffordshire Bull Terrier	Nuclear	Slow
Standard Poodle	Equatorial cortex	Moderate
Toy Poodle	Cortical	Moderate
Welsh Corgi	Posterior subcapsular or equatorial	Slow

Complications of Cataracts:

1. Blindness or severe visual impairment
2. Lens induced uveitis
3. Secondary glaucoma

Treatment of Cataracts:

1. Spontaneous cataract absorption:
Young dogs less than 3 years with rapidly progressing cataracts may undergo spontaneous absorption negating the need for surgical removal, but lens induced uveitis must be managed. This may require topical and systemic therapy.
2. Medical treatment
 - a. Topical mydriatics may improve vision in cases of axial cataracts that obstruct vision and cause blindness in bright light. Mydriasis allows for peripheral vision around a central cataract. Mydriatics do not alter the opacity per se.
 - b. Several drugs have been proposed to prevent cataracts and to dissolve formed cataracts; currently none of these drugs are considered to be of value.
3. Surgical treatment = cataract (lens) removal.

NOW, THE ANSWER TO THE QUESTION:

With the existing technologies available, including annual eye examinations of all breeding animals, careful and multiple generations of pedigrees, and unimpeded exchange of information among breeders; and future breeding studies to prove or disprove inheritance in certain cataractous breeds, and DNA studies (to demonstrate carrier dogs, and affected animals months to years before the cataracts develop), we can markedly reduce the frequency of cataracts in many breeds in the next several years. HOWEVER, hard work, patience, and dedication by the involved breeders will be essential for success.