PEDIGREE BREEDER FORUM
Volume 3, Number 2 - 1994

PREDISPOSITIONS TO EYE DISEASES IN THE DOG

Holly L. Hamilton, D.V.M.

Resident in Ophthalmology
Auburn University, Alabama

****

Dr. Hamilton received the DVM degree from the University of Wisconsin in 1989. She practiced for a year in Wisconsin, then completed a 1-year internship at Washington State University. She currently teaches ophthalmology at Auburn University.

****

DEFINITIONS

* **anterior segment** - front portion of the eye (cornea, iris, and lens)

* **posterior segment** - back portion of the eye (vitreous, retina, optic nerve, choroid, and sclera)

* **vitreous** - clear gel-like substance in the posterior segment of the eye that helps maintain retinal position

* **retina** - clear cellophane-like membrane with blood vessels, which senses light and processes the visual message

* **choroid** - thin layer of blood vessels between the retina and sclera that provides nutrition for the retina

* **tapetum** - cellular layer in the choroid of animals that collects light and reflects it back on the retina, amplifying available light

* **sclera** - opaque, white fibrous outermost layer of the eyeball (the "white" of the eye)

* **fundus** - region of the posterior segment that is viewed with an ophthalmoscope (retina, choroid, and optic nerve)

There are numerous eye diseases in purebred dogs that are inherited or suspected of being inherited, some of which can result in blindness.[1-3] Early recognition and removal of affected dogs from the breeding pool are important to prevent perpetuating these genetic traits. Since many eye diseases are not easily recognized without a thorough ophthalmic examination, the best way to screen for inherited eye diseases is to have breeding animals examined by a member of the American College of Veterinary Ophthalmologists (ACVO). Dogs without major inheritable eye disease can then be registered with the Canine Eye Registry Foundation (CERF).* This nonprofit organization was established in 1974 and serves as a data collecting agency for purebred dogs and as a registry for dogs free of significant inheritable eye disease. A registry number is assigned to dogs that are phenotypically free of major hereditary eye diseases (appear physically normal) on the date of examination; the registration is valid for 1 year. The dog's eyes are only certified for 1 year since many heritable diseases, such as cataracts or progressive retinal atrophy, do not appear until a dog is several years old. There is no minimum age for dogs to have eye certification examinations. In some breeds such as collies, in which collie eye anomaly is present at birth in affected animals, early examination can identify puppies that are not suitable for breeding.

Breeding is not recommended if substantial evidence exists to support the heritability of an abnormality and/or the abnormality represents a potential compromise of vision or other ocular function.[1] If an abnormality is known or suspected to be inherited but does not represent potential compromise of vision or other ocular function, then it is the breeders' option whether to breed the animal.[1]

The tables in this article list certain inherited or suspected inherited ocular anomalies in several breeds, along with the American College of Veterinary Ophthalmologists breeding advice.[1] The tables do not list all of the ocular anomalies that can be found in various breeds.

The CERF examination has three parts. The first part evaluates pupillary light response. The dog's pupil should constrict when a bright light is shone in the eye. A trained assistant may perform this part of the examination. Abnormal pupillary light response can be caused by ninadequate light source, fear (sympathetic response), retinal disease, optic nerve disease, glaucoma, thinning of the iris muscle, and medication that dilates the pupil (atropine or tropicamide). If the pupils constrict normally, then tropicamide, a short-acting mydriatic (pupil dilator), is applied to each eye to facilitate examination of the lens and the posterior segment (vitreous, retina, and optic nerve). After application of tropicamide the pupils dilate in about 20 minutes and remain so for 4 to 6 hours.

*CERF, 1235 SCC-A, Purdue University, W. Lafayette, IN 47907-1235

In the second part of the examination, inspection of the eyelids and anterior segment (cornea, iris, and lens) is accomplished with a bright light source and a slit lamp. A slit lamp enables magnified examination with a slit beam of light, which allows a three dimensional view of the cornea, aqueous humor (fluid in the eye), and lens. Eyelids are examined for abnormal conformation, entropion (rolling in or inversion of the eyelid; Table 1) and ectropion (rolling out or eversion of the eyelid; Table 2). Both entropion and ectropion can cause increased tearing. Entropion can also cause corneal ulcers if the hair on the inverted eyelid rubs the cornea. Two other common eyelid abnormalities are distichia (i.e., extra eyelashes that grow out of the meibomian glands at the eyelid margins; Table 3) and ectopic cilia (i.e., eyelashes that grow through the conjunctiva on the under side of the eyelids [palpebral conjunctiva]; Table 4); both conditions can cause tearing, corneal inflammation (keratitis), and corneal ulcers.

The cornea is usually transparent and contains no vessels, pigmentation, or opacities. Corneal vessels and pigmentation can occur as a result of chronic irritation such as from poor eyelid conformation, extra eyelashes, or decreased tear production. Corneal dystrophy is an inherited bilaterally symmetrical opacity in the cornea (Table 5). It can affect any of the three corneal layers (superficial epithelium, central stroma, or inner endothelium). If the defect is in the epithelium or stroma, it is usually a well- demarcated opaque gray or white plaque in the central cornea. These corneal opacities can cause focal blind spots. If the endothelium is affected (endothelial dystrophy; Table 6), the entire cornea may become opaque and cause blindness. The endothelium normally pumps fluid out of the cornea, keeping it clear. In abnormal conditions, fluid accumulates in the cornea (corneal edema), making it appear cloudy.

The central opening of the iris, the pupil, regulates the amount of light that reaches the back of the eye by constricting and dilating. During fetal development, a vascular pupillary membrane extends across the pupil; normally, it is gone by 6 weeks of age.[4] Persistent pupillary membranes (PPMs; Table 7) are remnants of this vascular pupillary membrane, and strands of iris can attach to the lens or cornea or span the pupil. PPMs that attach to the lens or the cornea can cause focal opacities. This is thought to be a hereditary defect in many breeds, and breeding of affected basenjis[1] and chow chows[1] is not recommended due to the severity of the ocular lesions in these animals.

Glaucoma is defined as increased intraocular pressure (Table 8). Glaucoma occurs when the flow of aqueous humor is obstructed along its path out of the eye. Aqueous humor is produced by the ciliary body and normally flows through the pupil and out the iridocorneal angle (angle made by the iris and cornea) and is absorbed by the vascular system. Glaucoma can be caused by inherited malformation of the iridocorneal angle or can be secondary to other ocular diseases such as inflammation and lens luxation (displacement), which block the aqueous humor outflow.

The lens is a clear structure behind the iris that focuses light on the retina. The most common hereditary abnormalities of the lens are cataracts and luxation. Cataracts are partial or complete opacities of the lens or its surrounding capsule and affect breeds differently in the age of onset and in the degree of opacity (Table 9). Incipient cataracts are small, do not significantly interfere with vision, and may be difficult to diagnose without pupil dilation. Cataracts that affect the entire lens can be classified based on density as immature, mature, or hypermature. Dogs with immature cataracts may have some vision if they can see around the lens or through it. Mature and hypermature cataracts are so dense that they cause blindness. Inherited cataracts occur in both eyes, but one eye may be affected before the other. Inherited cataracts must be differentiated from nuclear sclerosis, a normal aging change that causes lens cloudiness via compaction of lens fibers. Noninherited causes of cataracts, such as those caused by diabetes mellitus (elevated blood glucose) or severe inflammation, can usually be differentiated from hereditary cataracts by a thorough medical work-up and ophthalmic examination.

Luxated lenses occur because of zonule rupture. Zonules are small stringlike fibers that secure the lens capsule to the ciliary body. Some terriers and other breeds (Table 10) have an inherited defect in the zonules that causes them to rupture spontaneously. When the zonules rupture, the lens may become partially displaced (subluxated) or completely displaced (luxated). Luxated lenses can move into the posterior segment of the eye where they usually cause no problem. Commonly, they are not removed. Anteriorly luxated senses can block the normal flow of aqueous humor and cause secondary glaucoma. This is an emergency requiring immediate treatment and removal of the luxated lens as soon as possible.

The third portion of the CERF examination is evaluation of the posterior segment (vitreous, retina, choroid, sclera, and optic nerve) with an ophthalmoscope. The portion of the posterior segment that is visible upon ophthalmic examination is called the fundus. The vitreous is a clear, gel-like material that fills the space between the lens and the retina. The retina is a clear, thin, cellophane-like structure with blood vessels that covers the back of the eye. It senses light and processes the visual message. There are three to four large retinal vessels that branch several times after leaving the area of the optic nerve. The optic nerve exits through the sclera at the back of the eye and carries the visual message from the retina to the brain. The portion of the optic nerve that is visible in the fundus, the optic disk, is a round to triangular pinkish white structure. In most dogs the brightly colored tapetum (green, yellow, orange or blue) is visible underneath the retina. The tapetum is a cellular layer in the choroid that collects light in dim conditions and reflects light back to the retina, amplifying available light. This allows dogs to see well in decreased light. The tapetum is roughly triangular in shape and is in the upper half of the fundus. The nontapetal area is visible under the remainder of the retina and is usually a brownish color. In dogs without much pigment, such as blue merle animals, there may be no pigment in the nontapetum, and the underlying blood vessels of the choroid (vascular layer under the retina) are visible. The sclera is a white, opaque fibrous layer and is the outermost layer of the eyeball. It is not normally visible in the fundus.

There are several inherited eye diseases that affect the fundus. Collie eye anomaly (CEA) is a developmental defect of the posterior segment with several degrees of severity. The least severely affected dogs have inadequate development of the choroid, allowing the white sclera to be seen. Choroidal hypolasia usually does not involve the entire retina, so these dogs can see fairly normally. More severely affected dogs have colobomas, which are notchlike defects in the optic nerve, retina, choroid, and sclera; these dogs have a blind spot where the coloboma is, and can be completely blind in an eye if a large coloboma affects the optic nerve. The most severely affected dogs have retinal detachment, which causes blindness. CEA is not a progressive disease. The defects occur during fetal development, are present at birth and do not worsen.

Progressive retinal atrophy (PRA; Table 11) is a group of retinal degenerative diseases that affects numerous dog breeds. The clinical signs are similar for all the diseases, but each occurs at a different age in different dog breeds. The disease begins with loss of night vision and progresses to total blindness. PRA can be diagnosed with the ophthalmoscope by noting the presence of thin retinal vessels (vascular attenuation) and a hyperreflective (brighter than normal) tapetum. The tapetum appears hyperreflective because the overlying retina is thinner, allowing the tapetum to reflect more light. Cataracts frequently occur with advance PRA.[5] PRA affects both eyes equally (bilaterally symmetric disease). Breeding is not advised for any dog with this disorder.[1]

Central progressive retinal atrophy (CPRA; Table 12) is recognized first by brown pigment spots in the tapetum and progresses to retinal vascular attenuation (small appearing vessels), optic nerve pallor, and hyperreflective tapetum between pigmented spots. Central vision is affected first, which is manifested by experiencing difficulty in seeing stationary objects at a distance, yet retaining the ability to follow moving objects. Some dogs with CPRA become completely blind.

Retinal dysplasia, an abnormal development of the retinal layers, is present at birth and has three forms: folds, geographic retinal dysplasia, and detachment (Table 13).[1] Folds are the mildest form of retinal dysplasia and appear in the tapetum as short dark lines surrounded by a hyperreflective border and as light colored lines in the nontapetal region. There can also be cirular-, V-, or Y- shaped lesions that represent joining of one or more linear defects (focal dysplasia). Affected dogs do not show visual deficits.[6] Geographic retinal dysplasia is recognized as larger hyperreflective, irregularly shaped areas in the tapetum above the optic nerve, often with pigment clumps. Dogs have impaired vision in the area of the dysplasia. In some breeds the defect is more severe, and retinal detachment can occur over the dysplastic area and can progress to complete retinal detachment. Retinal detachment or nonattachment is the third and most severe form of retinal dysplasia; the entire retina is separated from the back of the eye, causing blindness. In the Labrador retriever and Samoyed, retinal dysplasia can occur with other ocular defects and skeletal abnormalities[1] (small stature and valgus deformity or "toeing out" of the front legs).

REFERENCES

1. Genetics Committee of the American College of Veterinary Ophthamologists: Occular Disorders Proven or Suspected to be Hereditary in Dogs. Edited by Glaze MB, West Lafayette, ACVO, 1992.

2. Rubin LF: Inherited Eye Diseases in Purebred Dogs. Baltimore, Williams & Wilkins, 1989.

3. Whitley RD: Focusing on eye disorders among purebred dogs. Vet Med 83:50-63, 1988.

4. Collins BK, Moore, CP: Canine anterior uvea, in Gelatt KN (ed): Veterinary Ophthalmology, ed 2. Philadelphia, Lea & Febiger, 1991, pp 357-360.

5. Gelatt KN: The canine lens, in Gelatt KN (ed): Veterinary Ophthalmology, ed 2. Philadelphia, Lea & Febiger, 1991, pp 429-460.

6. Curtis R, Barnett KC, Leon A: Diseases of the canine posterior segment, in Gelatt K (ed): Veterinary Ophthamology, ed 2. Philadelphia, Lea & Febiger, 1991, pp 461-525.

TABLE 1

Breeds Predisposed to Entropion

Breed	Breeding Advice
Airedale terrier	Breeder Option
American Staffordshire terrier	Breeder Option
Basset hound	Breeder Option
Bernese mountain dog	Breeder Option
Bichon frise	Breeder Option
Bloodhound	No
Bouvier des Flandres	Breeder Option
Bullmastiff	Breeder Option
Bullterrier	Breeder Option
Cavalier King Charles Spaniel	Breeder Option
Chesapeake Bay retriever	Breeder Option
Chow chow	Breeder Option
Clumber spaniel	Breeder Option
Collie	Breeder Option
Coonhound (black and tan)	No
Curly-coated retriever	Breeder Option
Dalmatian	Breeder Option
Doberman pinscher	Breeder Option
English bulldog	Breeder Option
English springer spaniel	Breeder Option
English toy spaniel	Breeder Option
Flat-coated retriever	Breeder Option
French bulldog	Breeder Option
German shorthaired pointer	Breeder Option
German wirehaired pointer	Breeder Option
Golder retriever	Breeder Option
Gordon setter	Breeder Option
Great Dane	Breeder Option
Irish setter	Breeder Option
Irish wolfhound	Breeder Option
Kerry blue terrier	Breeder Option
Komondor	No
Kuvasz	Breeder Option
Labrador retriever	Breeder Option
Lhasa Apso	Breeder Option
Mastiff	Breeder Option
Miniature bullterrier	Breeder Option
Neapolitan mastiff	Breeder Option
Newfoundland	Breeder Option
Norwegian elkhound	Breeder Option
Old English sheepdog	Breeder Option
Papillon	Breeder Option
Pekingese	Breeder Option
Pointer	Breeder Option

TABLE 1 cont.

Pomeranian	Breeder Option
Poodle	No
Pug	Breeder Option
Redbone hound	No
Rhodesian ridgeback	Breeder Option
Rottweiler	Breeder Option
Saint Bernard	No
Shar-pei	No
Siberian husky	Breeder Option
Staffordshire bullterrier	Breeder Option
Sussex spaniel	Breeder Option
Vizsla	Breeder Option
Weimaraner	Breeder Option
Yorkshire terrier	Breeder Option

TABLE 2

Breeds Predisposed to Ectropion*

American cocker spaniel	English setter
Basset hound	Great Dane
Bloodhound	Great Pyrenees
Bullterrier	Mastiff
Clumber spaniel	Neapolitan Mastiff
Coonhound (black and tan)	Newfoundland
Curly-coated retriever	Redbone hound
English bulldog	Saint Bernard
English cocker spaniel	Spinoni Italiani

**Breeding Advice: Breeder Option*.

TABLE 3

Breeds Predisposed to Distichiasis*

American cocker spaniel	Labrador retriever
Airedale terrier	Lhasa apso
Bedlington terrier	Maltese
Boxer	Old English sheepdog
Bullmastiff	Pekingese
Cavalier King Charles spaniel	Poodle (toy & miniature)
Chesapeake Bay retriever	Portuguese water dog
Collie	Pug
Dalmatian	Rottweiler
English bulldog	Saint Bernard
English cocker spaniel	Samoyed
Flat-coated retriever	Shetland sheepdog
French bulldog	Shih tzu
Golder retriever	Weimaraner
Japanese Chin	

**Breeding Advice: Breeder Option.*

TABLE 4

Breeds Predisposed to Ectopic Cilia*

Brussels griffon
English bulldog
Lhasa apso
Shih tzu
**Breeding Advice: Breeder Option.*

TABLE 5

Breeds Predisposed to Corneal Dystrophy

Breed	Breeding Advice
Afghan hound	Breeder Option
Airedale terrier	No
American cocker spaniel	Breeder Option
Bichon frise	Breeder Option
Cavalier King Charles spaniel	Breeder Option
English toy spaniel	Breeder Option
Miniature pinscher	No
Papillon	Breeder Option
Samoyed	Breeder Option
Shetland sheepdog	No
Siberian husky	No

TABLE 6

Breeds Predisposed to Corneal Endothelial Dystrophy*

Boston terrier
Chihuahua
Dachshund

**Breeding Advice: No.*

TABLE 7

Breeds Predisposed to Persistent Pupillary Membranes

Breed	Breeding Advice
American cocker spaniel	Breeder Option
Basenji	No
Bullmastiff	Breeder Option
Cardigan Welsh corgi	Breeder Option
Chow chow	No
Collie	Breeder Option
English cocker spaniel	Breeder Option
Mastiff	Breeder Option
Neapolitan mastiff	Breeder Option
Pembroke Welsh corgi	Breeder Option
Portuguese water dog	Breeder Option
Scottish terrier	Breeder Option
Shetland sheepdog	Breeder Option
Soft-coated wheaten terrier	Breeder Option

TABLE 8

Breeds Predisposed to Glaucoma*

Alaskan malamute
American cocker spaniel
Basset hound
Beagle
Bouvier des Flandres
Bullmastiff
Cairn terrier
Chow chow
Dalmatian
Dandie Dinmont terrier
Fox terrier
Great Dane
Italian greyhound
Keeshond
Norwegian elkhound
Poodle (toy, miniature, and standard)
Samoyed
Shar-pei
Siberian husky
Welsh springer spaniel
Welsh terrier

*****_Breeding Advice: No._

TABLE 9

Breeds Predisposed to Cataracts*

Afghan hound
Alaskan malamute
American cocker spaniel
American Staffordshire terrier
American water spaniel
Australian cattle dog
Australian shepherd
Beagle
Bearded collie
Bedlington terrier
Belgian sheepdog
Belgian tervuren
Bernese mountain dog
Bichon frise
Border terrier
Borzoi
Boston terrier
Bouvier des Flandres
Briard
Brittany spaniel
Brussels griffon
Cairn terrier
Cavalier King Charles spaniel

Chesapeake Bay retriever
Curly-coated retriever
Dachshund
Dandie Dinmont terrier
Doberman pinscher
English cocker spaniel
English springer spaniel
English toy spaniel
Field spaniel
Flat-coated retriever
Fox terrier
French bulldog
German shepherd
German shorthaired pointer
Giant schnauzer
Golden retriever
Gordon setter
Great Dane
Havanese
Ibizan hound
Irish setter
Irish water spaniel
Irish wolfhound
Italian greyhound
Japanese Chin
Keeshond
Kerry blue terrier
Komondor
Labrador retriever
Lhasa apso
Lowchen
Manchester terrier (toy and standard)
Miniature pinscher
Miniature schnauzer
Neapolitan mastiff
Newfoundland
Nova Scotia duck tolling retriever
Old English sheepdog
Papillon
Pekingese
Pembroke Welsh corgi
Pointer
Pomeranian
Poodle (toy, miniature and standard)
Portuguese water dog
Puli
Rottweiler
Saint Bernard
Saluki
Samoyed
Schipperke
Scottish terrier
Sealyham terrier
Shetland sheepdog
Shih tzu
Siberian husky
Silky terrier
Soft-coated wheaten terrier
Staffordshire bull terrier
Standard schnauzer
Sussex spaniel
Tibetan terrier
Vizsla
Welsh springer spaniel
West Highland white terrier
Whippet
Yorkshire terrier

*****_Breeding Advice: No._

TABLE 10

Breeds Predisposed to Lens Luxation*

Australian cattle dog
Border collie
Brittany spaniel
Fox terrier
Jack Russell terrier
Manchester terrier (toy and standard)
Miniature bullterrier
Norwegian elkhound
Scottish terrier
Sealyham terrier
Shar-pei

TABLE 10 cont.
Tibetan terrier
Welsh terrier
Whippet

*****_Breeding Advice: No._

TABLE 11

Breeds Predisposed to Progressive Retinal Atrophy*

Airedale terrier
Japanese Chin

Akita
Alaskan malamute
American cocker spaniel
Australian cattle dog
Australian kelpie
Basenji
Beagle
Belgian Malinois
Belgian Tervuren
Bernese mountain dog
Border collie
Border terrier
Borzoi
Briard
Brittany spaniel
Brussels griffon
Cardigan Welsh corgi
Chesapeake Bay retriever
Chihuahua
Chow chow
Collie
Curly-coated retriever
Dachshund
Doberman pinscher
English cocker spaniel
English setter
English springer spaniel
Field spaniel
Flat-coated retriever
German shepherd
German shorthaired pointer
Giant schnauzer
Golden retriever
Gordon setter
Great Dane
Great Pyrenees
Greyhound
Havanese
Irish setter
Irish terrier
Irish water spaniel
Italian greyhound
Keeshond
Kerry blue terrier
Labrador retriever
Lhasa apso
Lowchen
Maltese
Manchester terrier (toy and standard)
Mastiff
Miniature pinscher
Miniature schnauzer
Neapolitan mastiff
Norwegian elkhound
Nova Scotia duck tolling retriever
Old English sheepdog
Pekingese
Pembroke Welsh corgi
Pointer
Pomeranian
Poodle (toy, miniature and standard)
Portuguese water dog
Puli
Rhodesian ridgeback
Rottweiler
Samoyed
Schipperke
Scottish terrier
Sealyham terrier
Shar-pei
Shetland sheepdog
Shih tzu
Siberian husky
Silky terrier
Soft-coated wheaten terrier
Tibetan terrier
Vizsla
Welsh springer spaniel
Whippet
Yorkshire terrier

*****_Breeding Advice: No._

TABLE 12

Breeds Predisposed to Central Progressive Retinal Atrophy*

Border Collie
Briard
Cardigan Welsh corgi
Golden Retriever
Keeshond
Labrador retriever

*****_Breeding Advice: No._

TABLE 13

Breeds Predisposed to Retinal Dysplasia

Breed	Form of Dysplasia	Breeding Advice

American cocker spaniel	Focal	Breeder Option
American water	Geographic/Detachment	No
American water spaniel	Folds	Breeder Option
Bearded collie	Folds	Breeder Option
Bedlington terrier	Folds	Breeder Option
	Geographic	No
	Detachment	No
Bullmastiff	Folds	Breeder Option
Cavalier King Charlesspaniel	Folds	Breeder Option
	Geographic/Detachment	No
Cardigan Welsh corgi	Focal	Breeder Option
Chesapeake Bay retriever	Folds	No
	Geographic	No
Collie	Folds	Breeder Option
English cocker spaniel	Folds	Breeder Option
English springer spaniel	Folds	No
	Geographic	No
	Detachment	No
English toy spaniel	Folds	Breeder Option
Field spaniel	Folds	Breeder Option
	Geographic	Breeder Option
German shepherd	Folds	No
	Geographic	No
Giant schnauzer	Folds	Breeder Option
Labrador retriever	Detachment	No
	Focal/Geographic/ Detachment with skeletal defects	No
Mastiff	Folds	Breeder Option
Pembroke Welsh corgi	Geographic	Breeder Option
Puli	Folds	Breeder Option
Rottweiler	Focal	Breeder Option
Samoyed	Focal/Generalized with skeletal defects	No
Sealyham terrier	Detachment	No
Standard schnauzer	Folds	Breeder Option
Sussex spaniel	Folds	Breeder Option
Tibetan terrier	Geographic	Breeder Option