The Merle Gene and Multiple Ocular Abnormalities

The Merle gene is responsible for a wide variety of beautiful coat and iris colors in the dog. This dilution gene acts to lighten the coat color. The dappling effect it creates is not evenly spread; rather, it is responsible for spotting of the coat and variations of the iris or colored part of the eye. A combination of colors may be found in one or both eyes. Colors expressed may range from a pale, light blue to greenish to amber. Unfortunately, the same gene that is responsible for the desirable coat and eye appearance is often responsible for many developmental eye defects. Breeds that have been identified as having the Merle gene include the Australian Shepherd, Rough and Smooth Collies, Shetland Sheepdog, Dachshund, Great Dane, Old English Sheepdog, American Foxhound and the Catahoula Leopard dog among others.

With respect to ocular effects, the Merle gene's most minor manifestation is a blue iris (or irides). The blue appearance may also be as an 'inclusion' or as a partial segment of another wise brown eye (heterochromia iridis). A blue iris does not absolutely indicate the presence of the Merle gene; it may also be expressed in dogs carrying the piebald gene, such as the Dalmatian. There is no adverse consequence of the presence of the blue iris alone. Conversely, the other effects of the Merle gene may result in devastating blindness. The abnormalities affect either the front or back part of the eye or a combination of both. When the whole eye is affected, the condition has been referred to as Merle Ocular Dysgenesis.

Since it is understood that multiple congenital ocular abnormalities in the dog may be inherited, a brief review of basic genetics is in order. In any dog, two copies of a gene are present, one from each parent. For the purpose of this discussion, the Merle gene will be termed "m" and the non-merle gene will be called "M". If both copies are the same for Merle, they are termed homozygous (mm) or a double merle. A double Merle will be a

predominantly white dog. If one copy is Merle and one is not, they are called heterozygous (Mm). One Merle gene copy is dominant over the non-Merle gene in that just one copy (Mm) will produce dilution of the coat and potentially different colored eyes, which is considered desirable in many breeds. A dog that is homozygous for non-merle (MM) is a normal, full-colored dog. In the Australian Shepherd dog, multiple ocular abnormalities due to the Merle gene occur secondarily to an autosomal recessive trait. Autosomal implies that this is not a sex-linked condition. Since a recessive trait is expressed only when homozygous, this means that affected dogs must be a double Merle (mm). Double merle animals may also have varying degrees of congenital deafness. The most severe abnormalities occur in homozygous merles with an excessive white hair coat involving the head region.

There are other, more serious ocular problems associated with the Merle gene. Microphthalmia is a congenital defect characterized by a small eye. Severely affected dogs may be blind at birth. Iris changes include thinning of the iris (iris hypoplasia) and possibly an eccentric or off-centered pupil, known as corectopia. An iris coloboma is an abnormality in the development of the iris that usually presents as a notch or cleft of the iris at the edge of the pupil. Another problem that occurs with the iris may be persistent pupillary membranes or PPMs. Pupillary membranes are present in the developing eye in utero but normally regress within the first few weeks of life. When persistent, they represent a congenital defect from blood vessel remnants that fail to regress.

They may appear as strands or sheets of tissue that originate from the iris and attach to another part of the iris, the lens, or the cornea. They range from being of minor significance to causing severe vision impairment. A cataract, or an opacity, of the crystalline lens or its capsule, is yet another possible heritable defect associated with the Merle gene. It may be found independently or in a microphthalmic eye. Cataracts, if focal, may only cause minor impairment of vision, but when cataracts are complete, blindness occurs.

The posterior segment (the back part of the eye) may also be affected. Colobomas, or notch defects, may affect the sclera or the white of the eye. A scleral coloboma indicates the presence of an abnormally thin region of sclera; this condition is known as scleral ectasia. When this occurs the vascular layer bulges out beneath the fibrous coat of the eye. This is known as a staphyloma. These may occur in the front half of the eye, apparent as a bulge underneath the eyelid or they may be in the back of the eye, only visualized using special instrumentation. Choroidal hypoplasia or choriodal colobomas may also be seen. In this condition, the vascular layer at the back of the eye develops incompletely. Posterior segment anomalies may also affect the optic nerve. The optic nerve's job is transmission of information from the retina to the brain for the interpretation of vision. When a defect at this level of the eye is minor, a patient remains visual; alternatively, a more serious defect of the optic nerve may be the cause of complete blindness.

In addition to the optic nerve, the retina may also be affected negatively. Retinal dysplasia is abnormal development of the sensory retina with focal folds or widespread geographic maldevelopment. This may occur in conjunction with retinal detachment. If the retina becomes completely detached, blindness ensues. In some dogs with a Merle coat, the tapetum or reflective layer at the back of the eye is missing. These dogs may have somewhat poorer night vision compared to an eye with a tapetum, but there is no obvious functional abnormality with these dogs.

With an array of problems that may have a common end result of blindness, informed breeders will not breed affected animals because those with 'mild disease' may still produce severely affected offspring. It is also understood not to breed merle to merle as this will increase the chances for double merles in the litter. As such, it is advisable to include more 'solids' or darkly-colored animals in a breeding program. It is always ideal to have breeding animals evaluated by a veterinary ophthalmologist to rule out structural abnormalities of the eyes. This can be accomplished via an OFA Eye certification exam, formerly known as a CERF exam. The OFA is an organization that tracks heritable diseases in many parts of the body including eyes in dogs with the goal of identifying and eliminating genetic conditions. The certification exam can only be performed by a board-certified veterinary ophthalmologist. A certification exam is valid for one year. Ideally, dogs should be certified every year by a veterinary ophthalmologist to ensure that conditions that may be progressive or develop later in life have not appeared. These exams do not guarantee that the dog is not a carrier of genetic ocular disease; rather, a passing test proves that at that time of exam no genetic ocular disease was diagnosed. If a dog's status is unknown, it is strongly recommended not to breed. With respect to the Merle gene and ocular dysgenesis, these abnormalities are congenital, which means they are present at birth. They do not show up later in life; therefore, they may be diagnosed in a puppy as young as six weeks old.

If you have any further questions or concerns regarding the Merle gene's possible effects on ocular health or questions regarding OFA eye clinics, please do not hesitate to call us at Eye Care for Animals.

Back to Previous Page

Recent Articles

Congratulations Reuben Merideth, DVM, DACVO!

Trotsky the Husky

Congratulations Dr. Hoffman!

Explore Animal Eye Conditions:

Enter Keyword

Location Finder

Find us on

Download the app

Download on the App Store

GET IT ON Google Play

Problems Associated with the Merle Gene

The (M) allele is an excellent example of pleiotropy, the phenomenon where a single allele can cause distinct and seeming unrelated physical effects. Even in the heterozygous (Mm) dog the (M) allele is associated with deafness, eye defects, and problems with the dogs immune system. This can be explained by understanding a little bit about the early fetal development of the dog.

The process of coloration and color pattern in dogs begins with embryonic development. The specific cells that become the pigment producing cells come entirely from the same area of the embryo (neuronal crest) that the cells of the nervous system comes from. It stands to reason, that if you have defects in genes associated with color genetics you can have nervous system defects because both cells are derived from the same neuronal crest. This can explain why it is likely that certain dilute or patterned dogs, such as extreme piebalds, albinos, etc. as well as those that have the merle allele are prone to sensory, neurological and /or immunological problems. These defects have been observed and researched in other dog breeds (i.e. Australian Shepherds, Great Danes, Shetland Sheepdogs) that also carry these dilution alleles including the merle allele.

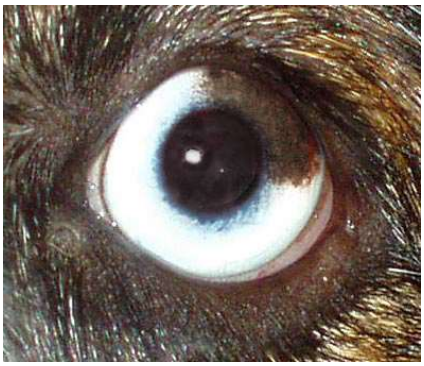
From this research it has been determined that the merle allele when expressed in the homozygous state (MM) is highly correlated to sensory, neurological and immune system defects in dogs. Some include distortion of the eye's appearance, lack of the reflective substance (tapetum lucidum) that lines the back of the dogs eye. Dogs that lack this substance have night blindness and other visual problems. Other eye problems have been identified with the merle allele includes, small eyeballs, with a prominent third eyelids, and a physical cleft in the iris of the eye. Abnormalities of the eyes are a key indicator of other neurological defects. Deafness or a reduction in hearing has also been identified, as the merle color locus exerts effects on ear development. Excessive white or dilution in a dog of any color can be a warning sign of hearing problems. From talking to breeders who's lines contain merle dogs, they relate that they are very aware of the potential health problems (sometimes being lethal to the affected pups). http://www.adbadog.com/p_pdetails.asp?fspid=47

*****Health issues The merle gene is often associated with congenital deafness, with merle dogs being more likely than other dogs to be born deaf. Dogs with two copies of the merle gene (homozygous merle or "double merle") have an even higher chance of being born deaf.[13] The UK Kennel Club has acknowledged the health risk associated with homozygous merle and will stop registering puppies produced from merle to merle matings starting from 2013.

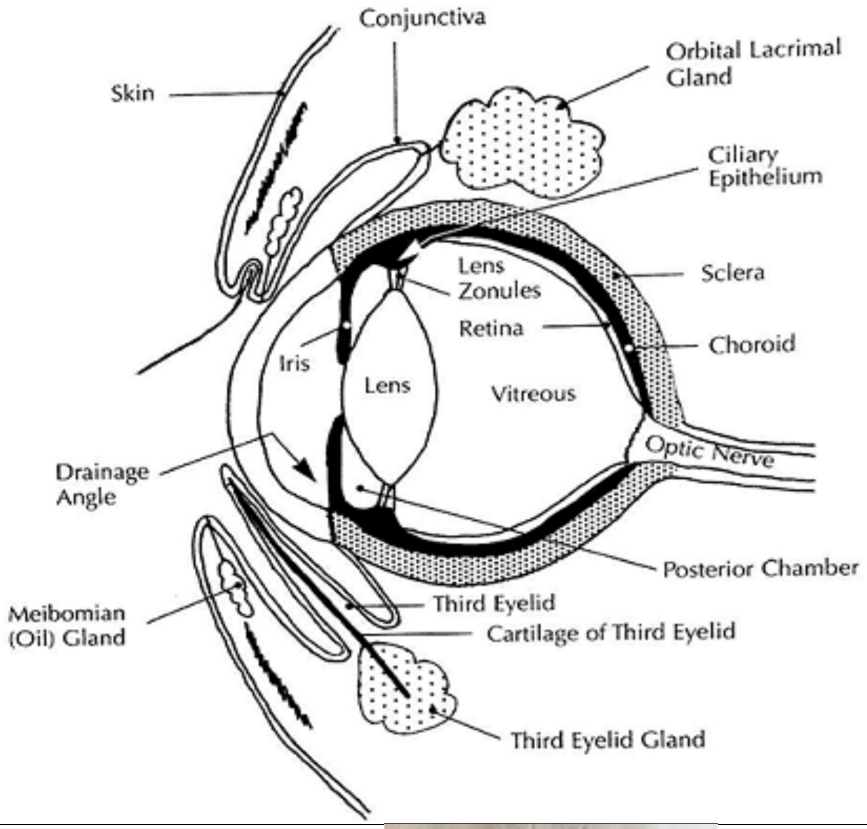
The suppression of pigment cells (melanocytes) in the iris and in the stria vascularis of the cochlea (inner ear) leads to blue eyes and deafness. An auditory-pigmentation disorder in humans, Waardenberg syndrome, reflects some of the problems associated with heterozygous and homozygous merle dogs and genetic research in dogs has been undertaken with the goal of better understanding the genetic basis of this human condition.[1
NEED MORE PROOF: Study done out of LSU.
http://www.lsu.edu/deafness/StrainMerleJVIM2009.pdf

The homozygous merle (MM) may also suffer from a variety of eye defects, resulting in some loss of vision to complete blindness

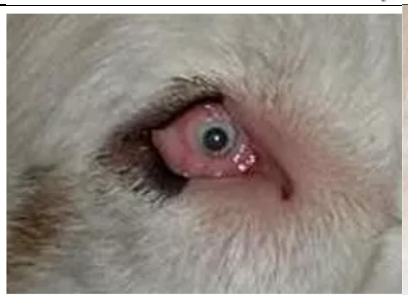
Eyes

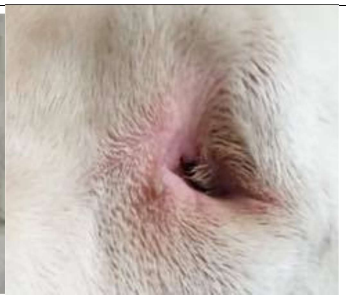


Normal blue eye with brown area & no visible defects. The eye is of normal size with no visible defects of the iris. The pupil (the hole in the iris that lets light through to the lens) is round.



The most common defect that can be easily seen is Microsphthalmia (abnormally small eye), which can vary from just a noticeable to no visible eye with the result that the dog may suffer from reduced vision or blindness





These defects often make the eye very light sensitive. The pupil cannot react to light as it should. Usually these vision problems are there at birth and do not change much throughout the dogs life. Remember blindness or vision loss can be caused by other conditions that have nothing to do with the mere gene. They are also found in some normal Mm merle dogs. Other defects may occur that cannot be detected by the naked eye.