

What is Glaucoma?

Most people understand glaucoma as a high pressure inside the eye...but, there is so much more!

First, we must understand what normal intraocular pressure is, that is, pressure inside the eye.

There is a normal amount of aqueous humor made that is equal to its outflow from the eye. This production and outflow is analogous to your kitchen sink faucet turned on and the drain being open and normal; there is no build up. Aqueous humor is the fluid in the front portion of the eye and is made by special cells called ciliary body epithelial cells. These ciliary body cells are located behind the iris and next to the lens. This fluid is secreted from the ciliary body cells into the space between the iris and the lens, then through the pupil into the anterior chamber (space between the iris and cornea). From the anterior chamber, the aqueous humor exits the eye primarily through the iridocorneal angle (spaces located between the iris and cornea 360 degrees around the eye). This angle then leads out of the eye and into the general circulation.

It is not possible for the ciliary body cells to make too much fluid, however in cases such as inflammation (uveitis) or normal aging in dogs, these cells can make less fluid.

Intraocular pressure=IOP

So, how does the IOP within the eye become too high?

Back to the faucet analogy, if the drain is clogged up, then the fluid will build up and rise within the sink! So, when the exit of aqueous humor is likewise backed up and cannot exit the normal way, then the fluid will build up, raising the intraocular pressure and, subsequently, causing damage to all cells of the eye, often leading to diminished vision and blindness.

Problems that cause impediment to outflow include:

1. the iridocorneal angle is too narrow or abnormally formed due to genetic factors in over 40 purebreed dogs; as the dog becomes an adult (typically between 3 and 9 years of age), these dogs can develop glaucoma because the narrow or abnormal iridocorneal angle eventually does not allow outflow of aqueous humor. This is **Primary Glaucoma**;

The rest of these causes are “secondary” causes of glaucoma:

2. inflammatory debris and/or cells (white and/or red blood cells) clog the outflow (like food clogging the drain in your sink);
3. tumors/neoplasia, these can grow into the outflow angle or make factors that result in the angle becoming blocked;

4. anterior lens luxation (the lens falls out of place and into the front (anterior) chamber of the eye, this can cause blockage in many ways. One way is that it blocks aqueous humor from going through the pupil from behind the iris, another way is that the weight of the lens pushes on the iris and causes the iridocorneal angle to narrow or close, or inflammation from the lens being out of place or developing cataractous changes will lead to clogging of the drainage angle;
5. retinal detachment causes VEGF (vascular endothelial growth factor) to be released, this results in formation of a membrane covering the iridocorneal angle, thus, inhibiting aqueous humor outflow from the eye.

Regardless of the cause, glaucoma is **PAINFUL** and will lead to blindness. Aggressive treatment and surgery can sometimes fail, still leading to blindness. It has been shown in humans and lab animal models that after the intraocular pressure has been elevated, affected cells can continue to die even if the intraocular pressure is kept in the “normal ranges.” This is a snowball effect because the cells damaged are the retinal ganglion cells as well as other retinal cells. When these cells die, they release toxins that damage nearby cells and they become unhealthy. These newly unhealthy cells can then die, doing the same to their neighbors.

Antioxidants such as coenzyme Q10 (ubiquinone), epigallocatechin gallate (green tea extract), and grapeseed extract have been shown to protect the retinal ganglion cells and other affected cells. These cells are very important to the health of the eye and sight.

Antioxidants are **NOT** a treatment for glaucoma, they are only supportive of the eyes' cells. This is why it is of utmost importance that a **veterinary ophthalmologist's** instructions be followed closely because this disease will cause permanent damage if the intraocular pressure in the eye remains high for more than a few hours. If the intraocular pressure is extremely elevated for more than 3 days, blindness is permanent.

How will my dog's disease be diagnosed as glaucoma?

First, your veterinarian or veterinary ophthalmologist will determine if the “red eye” that your dog has is actually glaucoma. The way he/she will do this is by measuring the IOP (intraocular pressure) with a special instrument. The special instrument will be either a Tono-Pen® (pen like instrument) or a TonoVet® (instrument with a pin-head like attachment).

If the IOP in your dog's eye is higher than it should be, then the cause is the next important step to determine. Then, the stage of glaucoma is important because it will give a prognostic indicator of your dog's potential for vision.

Primary glaucoma is a genetic disease, this diagnosis is made based on the breed of dog, the age of the dog, and the clinical signs that your veterinary ophthalmologist

sees inside the eye. This diagnosis has far-reaching implications because the dog should not be bred as he/she will pass on the defective gene(s) to its offspring. I also advise that if the siblings and parents are known, they should also be evaluated and possibly taken out of the breeding pool.

The **earliest stage** of primary glaucoma is early non-congestive glaucoma. Usually, there are very mild signs, if any. These signs include redness to the white part of the eye(s), tearing, pupil that does not constrict completely, changes inside the eye that your veterinarian or veterinary ophthalmologist will see with special instruments. This stage is treated with topical eyedrops and/or oral pills.

The names of the medications you may recognize include:

1. Trusopt or Azopt eyedrops
 - a. Decrease the amount of aqueous humor made by the eye
2. Xalatan or Travatan eyedrops
 - a. Allow the aqueous humor to exit the eye using the unconventional pathways (15% in dogs)
3. Methazolamide (pills)
 - a. Similar mechanism as Trusopt or Azopt and decrease the amount of aqueous humor made by the eye

Once the IOP is managed (kept within a specific range or below a specific number in mmHg), it will be checked every 1 to 3 months. Even with perfect treatment regimens, glaucoma can become uncontrolled quickly. This is why it is imperative to take your dog to your veterinarian or veterinary ophthalmologist if you suspect that the eye does not look “right” to you.

This can be subtle and includes:

1. Affected eye is more red than the other eye
2. A bluish haze to the eye
3. Blindness, this can be difficult to assess because dogs mask this by compensating with the other eye
4. Lethargy, your dog does not appear to feel well
5. Hiding in a dark room
6. Tearing or wetness below the eye
7. The third eyelid is elevated (this can look like your dog’s eye is rolling back or like the eye is missing from its normal location)

The **intermediate stage** of glaucoma is next and the eye has changes that show that the IOP has been elevated in the past. The back of the eye is the most important place where these changes can be seen by your veterinary ophthalmologist. The optic nerve head is often smaller (mild to moderate changes) than the other one or than normal. The retina may have degenerative changes. The pupil may be unable to constrict completely (but medications can make the pupil smaller than normal so this is not a definitive change to look for). This stage may have unstable IOP measurements.

Treatment for the intermediate stages of glaucoma, in addition to medical management, often includes the option of different surgical procedures. These will either decrease the production of aqueous humor by the ciliary body cells or create an alternative outflow pathway for aqueous humor. These include:

1. Gonioimplants

- a. These are small tubes that are placed into the anterior chamber to give aqueous humor another way to exit the eye
- b. These have variable success because dog eyes make more inflammation than human eyes; this inflammation can plug the tube.
- c. If the inflammation can be controlled, these small tubes can work for months to years.

2. Laser surgery

- a. The most common type of laser used in veterinary ophthalmology is diode laser technology. Diode lasers target the cells in the ciliary body and destroy them. This diminishes the amount of aqueous humor being made.
- b. Diode lasers can be used in one of 2 ways:
 - i. Applied to the outside of the eye over where the ciliary body resides. This method is less precise and not used as much anymore.
 - ii. Endolaser technology
 1. Like an arthroscope is used to look into a joint to perform surgery, the laser is likewise put through a fiber optic tube with a camera that will allow precise laser destruction to the ciliary body cells.
 2. Sometimes, this is used in conjunction with cataract surgery. Cataract surgery is concurrently performed when the lens has some cataractous changes that will preclude vision.

3. Combination approach

- a. Some veterinary ophthalmologists will perform endolaser surgery with gonioimplant placement
- b. This provides the both ways of treating glaucoma i.e. diminishing production of aqueous humor and allowing an alternative outflow for aqueous humor.

4. **Medical treatment** is always continued during the recovery phase. Some dogs end up on very few eyedrops once they have recovered.

5. The **success rate** of endolaser surgery is presently estimated to be 85 to 90%. This means that the eye is able to see and the glaucoma is controlled.

6. Like all diseases, this wonderful success rate still means that 10 to 15% of eyes will have **complications**. These can include:

- a. Bleeding inside the eye (usually resolves);

- b. Inflammation (all surgery has inflammation as a side effect): sometimes inflammation is very difficult to control and is case-dependent;
- c. Retinal detachment;
- d. Cataract development (can occur if the lens is not removed, but likelihood is low);
- e. Blindness: even in the most ideal of situations, glaucoma can still steal sight due to uncontrollable reasons.

What if my dog's glaucoma cannot be controlled, the eye is painful, and the eye is blind?

Unfortunately, this occurs in some cases. There are three options that can be considered for eyes blind due to chronic glaucoma.

1. Enucleation

- a. Removal of the eye
- b. Even though this seems extreme, this is often chosen because the eye will not need eyedrops or any type of treatment anymore other than normal post-operative antibiotics and pain relief

2. Evisceration with intrascleral prosthesis

- a. This entails removing the inside structures of the eye, leaving the cornea and sclera (outside wall of the eye) and replacing them with a silicone sphere.
- b. This is a very cosmetic option
- c. This will likely still require some care and it must be watched for trauma since the eye is blind

3. Ciliary ablation

- a. This option is not for every dog.
- b. A drug named gentamicin is injected into the vitreous humor (back half) of the eye. This will destroy the cells that make aqueous humor, but also destroys the retina.

Carmen M H Colitz, DVM, PhD

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