Acute Glaucoma: A True Emergency

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THE BASICS OF GLAUCOMA

■ Glaucoma is an elevation of the intraocular pressure (IOP) with associated optic nerve and retinal damage.

■ Glaucoma in dogs is always due to a decreased drainage of aqueous humor (AH)—increased production does not occur.

■ AH is drained through 2 different pathways:
  ■ Most AH exits the eye via the iridocorneal angle (ICA), or conventional pathway, which is a complex sieve-like structure formed by the junction of the peripheral iris and cornea.
  ■ Approximately 15% of AH drains through the nonconventional, or uveoscleral outflow, pathway. This drainage pathway is the target of the most effective glaucoma drugs, the prostaglandin analogs.
  ■ The balance between AH formation and drainage determines the IOP.

CLASSIFICATION OF GLAUCOMA

Classification of glaucoma is important to enable proper diagnosis and therapy. Glaucoma should be classified according to the underlying cause of the decreased AH drainage and the duration of the glaucoma (TABLE 1).

Cause of Glaucoma

Primary Glaucoma

Primary glaucoma in dogs (FIGURE 1) is associated with an inherited malformation and malfunction in the ICA. Over time, the capacity for AH outflow is reduced and IOP increases. Primary glaucoma is strongly breed related, and some of the most commonly affected dog breeds are the beagle, basset hound, Boston terrier, cocker spaniel, and shar-pei. Other breeds that are commonly affected include the Siberian husky, Samoyed, Labrador retriever, and toy poodle. Mixed-breed dogs are also affected by primary glaucoma.
Secondary Glaucoma

Secondary glaucoma (FIGURE 2) results from a physical obstruction to AH drainage, usually occurring at the ICA or pupil. The ICA can become obstructed with cellular debris (red blood cells, white blood cells, tumor cells) or inflammatory proteinaceous debris. The pupillary flow of AH may be obstructed by iris adhesions to the lens (posterior synechia) or an anteriorly luxated lens. Certain breeds, such as terriers, Chinese crested dogs, and the shar-pei, are predisposed to anterior lens luxation because of an inherited abnormality in the lens zonule suspension system. Acute glaucoma in these breeds should prompt the clinician to look closely for an anterior lens luxation.

Duration of Glaucoma

Acute Glaucoma: This type of glaucoma (FIGURE 3) is defined as an elevation in IOP of less than 12 to 24 hours’ duration. If patients are treated during this phase, vision may be salvageable. Unfortunately, there are often subclinical spikes in IOP before the sustained elevation, which are quite detrimental. Thus, only about 50% of patients regain sight even when treated in the acute phase.

Chronic Glaucoma: This type (FIGURE 4) occurs when the IOP elevation is sustained for days or longer. Medical therapy may reduce the IOP, but vision cannot be regained. With time, many of the ocular structures undergo both physiologic and

TABLE 1 Key Aspects in Comparing Acute and Chronic Glaucoma

<table>
<thead>
<tr>
<th>ASPECT</th>
<th>ACUTE GLAUCOMA</th>
<th>CHRONIC GLAUCOMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of IOP elevation</td>
<td>&lt;12–24 h</td>
<td>Days to weeks</td>
</tr>
<tr>
<td>Globe size</td>
<td>Normal</td>
<td>Normal to buphthalmic</td>
</tr>
<tr>
<td>Menace response</td>
<td>Usually absent*</td>
<td>Absent</td>
</tr>
<tr>
<td>Direct PLR</td>
<td>Usually absent*</td>
<td>Absent</td>
</tr>
<tr>
<td>Indirect PLR</td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td>Dazzle reflex</td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td>Optic nerve/retina</td>
<td>Normal to mildly pale optic nerve</td>
<td>Cupped, dark optic nerve, regions of tapetal hyperreflectivity, generalized vascular attenuation</td>
</tr>
</tbody>
</table>

*Depends on degree of IOP elevation and previous IOP spikes.

FIGURE 1. Primary glaucoma. The right eye of an 8-year-old female spayed basset hound with primary, chronic glaucoma. Note the episcleral injection, corneal edema, buphthalmos, and lens subluxation (secondary to buphthalmos). The retina appears hyperreflective, with a significant lack of retinal blood vessels (retinal degeneration).

FIGURE 2. Secondary glaucoma. The left eye of an 11-year-old male castrated husky with secondary glaucoma. Note the diffuse iris discoloration and focal region of hyphema.
Secondary glaucoma results from a physical obstruction to AH drainage, usually occurring at the ICA or pupil.

morphologic changes in response to the persistently high IOP (see CLINICAL SIGNS). Many dogs present with chronic glaucoma because the acute phase is misdiagnosed or is overlooked completely by the owners.

CLINICAL SIGNS OF GLAUCOMA

- Signs of ocular pain
  - Blepharospasm
  - Epiphora
  - Head shyness
  - Elevated third eyelid
  - Lethargy, decreased appetite, and sleeping more are subtle signs of pain that may be overlooked

- Ophthalmic examination findings consistent with acute glaucoma:
  - Episcleral congestion and conjunctival hyperemia
  - Corneal edema, present in dogs with IOPs >40 mm Hg

- A dilated, nonresponsive pupil and negative menace response
  - The pupil size may be normal in cases of mild IOP elevation, or even constricted in cases of glaucoma secondary to anterior uveitis
  - The presence of a consensual pupillary light reflex (PLR; constriction of the contralateral pupil when light is shone into the affected eye) and dazzle reflex
  - These are important keys to diagnosing acute glaucoma because they indicate existing retinal function and the possibility of regaining vision with IOP control
  - Significant and abrupt IOP elevations may lack a consensual PLR, even if vision is salvageable

- Ophthalmic examination findings consistent with chronic glaucoma:
  - Buphthalmos
  - Chronic corneal disease (Haab’s stria, neovascularization, exposure keratitis)
  - Lens subluxation or luxation
  - Retinal degeneration
  - Optic nerve degeneration and cupping

DIAGNOSIS OF GLAUCOMA

Measurement of IOP is indicated in any patient with a red, painful eye. Normal IOP in dogs is 15 to 25 mm Hg and decreases normally with age. A dilated
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Please see Brief Summary on page 42.
pupil and decreased vision are further suggestions that glaucoma may be present. Importantly, a dog with significant anterior uveitis and an IOP in the normal range should raise great concern for impending glaucoma. This is an indication of AH outflow obstruction because the IOP should be low in cases of uveitis.

Tonometry determines IOP and is truly just an estimation using various measuring devices. It is crucial that tonometry be performed with proper restraint and correct use of equipment to obtain accurate measurements. Studies have demonstrated large variations in IOP with jugular pressure, excessive eyelid manipulation, and even changes in body position.6

The 2 commonly used and accurate methods to measure IOP are applanation and rebound tonometry. Applanation tonometers, such as the Tono-Pen VET (reichert.com), measure IOP by flattening the corneal surface and are commonly used in general practice. This method is highly accurate when performed correctly, is portable, and can be used with light restraint and variable head positions. A series of readings is obtained, and a digital display shows the average IOP of the readings and a percentage error indicating the consistency of the measurements. This method requires the use of a topical anesthetic.

Rebound tonometers, such as the TonoVet (tonovet.com), measure IOP by projecting a small probe at the corneal surface and analyzing the characteristics of its rebound. Rebound tonometers are as accurate and easy to use as applanation tonometers. The probe must be held horizontally; thus, proper head positioning is necessary. These tonometers are slightly more expensive and do not require topical anesthetic before use.

TREATMENT OF ACUTE GLAUCOMA

Acute glaucoma is considered an emergency, and the IOP should be reduced as quickly as possible to attempt to salvage vision. It is also important to address the specific underlying cause that led to the decreased AH outflow. In cases of acute glaucoma secondary to anterior lens luxation, referral to an ophthalmologist for emergency surgical removal of the lens is advised.

Osmotic Diuretics

Hyperosmotic agents reduce the formation of AH by reducing plasma flow through the ciliary body and cause dehydration of the vitreous. For maximum

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efficacy, water should be withheld for 4 hours after hyperosmotic treatment.\(^3\)

- Mannitol significantly reduces IOP within 15 minutes of administration and can remain effective for 6 to 10 hours.
- Mannitol can be used safely in most dogs but should be used with caution in dogs with cardiac or renal disease, or in dehydrated patients.
- I usually begin with 1 g/kg IV over 30 to 45 minutes. IOP should be measured at the end of the infusion to assess for efficacy.
- If the IOP remains elevated at >25 mm Hg, an additional 1 g/kg IV dose may be given.
- Monitoring of electrolytes should be considered.

### Prostaglandin Analogs

Prostaglandin analogs lower IOP primarily by increasing AH outflow via their action on iris and ciliary body musculature. They induce a profound miosis and may physically open the ICA and improve flow. Prostaglandin analogs should be avoided in cases of glaucoma secondary to anterior lens luxation or severe uveitis.\(^6\)–\(^8\)

- Latanoprost (Xalatan [xalatan.com]) results in a dramatic decrease (about 45%) in IOP within 20 minutes.
  - The duration of effect is 8 to 12 hours, although this can vary between dogs.
  - Additional doses may be given every 15 to 20 minutes if the initial response is insufficient.
  - If the IOP remains >25 mm Hg after 3 doses/1 hour of treatment, alternate methods of IOP reduction should be attempted.

### Anterior Chamber Paracentesis

Removing AH from the anterior chamber is a reliable method to quickly reduce IOP (FIGURE 5). Depending on the clinician's skill level and the temperament of the patient, this procedure can be performed awake or with mild to moderate levels of sedation. The duration of effect of paracentesis varies widely, and additional hypotensive methods should be instituted.

- Rinse the ocular surface with a dilute solution of povidone–iodine (1:20 diluted in saline).
- Instill topical anesthetic.
- If the patient is sedated, place a lid speculum and stabilize the globe with small, toothed forceps. In my opinion, when used without sedation these instruments cause undesired patient distress.
- Use a small-gauge needle (30-, 27-, or 25-gauge) without a syringe attached.
- Insert the needle at the dorsolateral limbus and direct it in a plane parallel to the iris; take caution not to touch the corneal endothelium, iris, or lens.
- Allow the hub of the needle to passively fill; 1 to 3 drops of AH can spill over. Do not use suction.
- Slowly remove the needle and measure the IOP immediately.
- Note that the desired IOP is <15 mm Hg; repeat the process if necessary.
Maintenance Therapy to Control IOP

All of the emergency methods to reduce IOP have limited durations of efficacy. Thus, once IOP has been reduced, additional therapy to maintain control of the IOP should be instituted.

**Carbonic Anhydrase Inhibitors**

Both systemic and topical carbonic anhydrase inhibitors (CAIs) are available. Inhibition of carbonic anhydrase decreases AH production by reducing synthesis of bicarbonate in the ciliary body.\(^9\)\(^{–}\)\(^11\)

- Methazolamide is an oral CAI that can be used in dogs for control of IOP.
- Commonly used dosages include 2.5 to 5 mg/kg PO q8–12h.
- Methazolamide has potential adverse systemic effects, including gastrointestinal upset, metabolic acidosis, and hypokalemia.
- I use this medication to treat glaucoma in dogs only if it cannot be treated topically.
- Topical CAIs have the advantage of providing adequate ocular concentrations of the drug and reducing the risk for systemic adverse effects.
- Brinzolamide (Azopt; novartis.com) and dorzolamide (Trusopt; merck.com) are commercially available and reduce IOP effectively in dogs and cats.
  - Dorzolamide 2% is available in a generic form, which makes it more cost-effective.
  - The degree of IOP reduction observed with topical CAIs is similar to that of oral CAIs, and combination of the drugs does not further decrease IOP!
  - The most common adverse effect of topical dorzolamide is transient blepharospasm after instillation; this is less common with brinzolamide.
  - Topical CAIs are most often used q8–12h.

**β-Blockers**

β-Blockers reduce the formation of AH via their effects on β receptors present in the ciliary body. Undesirable cardiac and respiratory effects can be seen with topical β-blockers, including bradycardia and bronchoconstriction. Thus, these medications should be avoided in patients with cardiovascular disease and asthma.\(^11\)\(^{–}\)\(^12\)

- The degree of IOP reduction with β-blockers is mild; thus, these medications are often combined with other antiglaucoma therapy.
- A solution of 2% dorzolamide and 0.5% timolol (Cosopt; merck.com) is available in generic form.
  - This combination therapy is as efficacious in reducing IOP as concurrent use of each drug, but the combination improves client compliance because it requires only 1 drop to be instilled 2 to 3 times daily.
- Betaxolol and timolol are also commonly used as prophylactic treatment for prolonging the onset of glaucoma in the fellow eye of dogs with primary glaucoma.\(^13\)\(^{–}\)\(^14\)
- β-Blockers are most often used q12h.

**Miscellaneous Therapy for Acute Glaucoma**

**Pain Control**

Pain control is advocated for most patients during an acute glaucoma spike. Systemic pain control will improve patient comfort and also likely improve compliance for repeated IOP measurements. Numerous analgesic medications are available; however, I generally use one of the following options:

- Methadone, 0.2 to 0.3 mg/kg IV q4–6h
- Tramadol, 4 to 6 mg/kg PO q8–12h

**Anti-inflammatories**

Anti-inflammatory therapy is indicated in most cases of acute glaucoma. Topical anti-inflammatories are beneficial for ocular surface inflammation and also treat any anterior segment inflammation. The frequency of use and drug chosen depends on the degree of inflammation, the presence of concurrent uveitis, and the health of the cornea. Most patients are treated q8–12h. Topical nonsteroidal anti-inflammatories should be avoided because they can reduce the efficacy of latanoprost therapy and
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exacerbate IOP elevation.\textsuperscript{13} Oral anti-inflammatories are considered important to treat the posterior segment (retina and optic nerve) inflammation that develops during an acute IOP spike.\textsuperscript{1-3}

- Topical anti-inflammatories:
  - Prednisolone acetate 1%
  - Dexamethasone 0.1%
- Oral anti-inflammatories:
  - Carprofen, 2.2 mg/kg PO q12h
  - Meloxicam, 0.1 mg/kg PO q24h
  - Prednisone, 0.5 mg/kg PO q12h

**Prophylactic Therapy**

Primary glaucoma is a bilateral disease, and prophylactic therapy of the contralateral eye should be recommended. Therapy with 0.5% betaxalol q24h delays the onset of glaucoma from an average of 8 months to 31 months in dogs.\textsuperscript{13}

**MONITORING OF IOP**

Once the IOP has been reduced, the patient should be monitored for 8 to 12 hours on maintenance therapy to ensure continued control of the pressure. A recheck examination is recommended within 2 to 5 days of discharge, and all medications must be given as directed on the day of the recheck exam. It is always important to note the time that medications were given in relation to the IOP measurement and to keep tonometer types consistent.

**References**

15. Pirie CG, Maranda LS, Pizzizzani S. Effect of topical 0.03% flurbiprofen and 0.005% latanoprost, alone and in combination, on normal canine eyes. Vet Ophthalmol 2011;14(2):71-79.

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