Canine Glaucoma: Pathophysiology and Diagnosis*

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Abstract: Canine glaucoma encompasses a diverse group of diseases associated with an increase in intraocular pressure that results in retinal ganglion cell death and eventual blindness. Dogs may have congenital, primary, or secondary glaucoma. The diagnosis is made by recognizing clinical signs, interpreting ophthalmic examination findings, and determining intraocular pressure. Identifying the underlying cause of the glaucoma is essential to providing appropriate treatment recommendations.

Aqueous humor is produced by the ciliary body and flows through the pupil into the anterior chamber of the eye. In dogs, most aqueous humor exits the eye through the iridocorneal angle; approximately 10% to 15% exits the eye through uveoscleral outflow. Normal intraocular pressure (IOP; range: 10 to 25 mm Hg) is maintained by an equilibrium between aqueous humor production and drainage. Canine glaucoma is usually due to a disturbance in the conventional outflow pathway that results in an increased IOP.

Primary glaucoma is considered a heritable condition in some breeds (BOX 1). The disease is progressive and may result from changes in the iridocorneal angle or from abnormal metabolism of the trabecular cells within the outflow pathway. Primary glaucoma is further classified as open-, narrow-, or closed-angle, based on the appearance of the drainage angle. It is always a bilateral condition.

Secondary glaucoma results when another condition disrupts aqueous humor outflow. Several disease conditions can lead to secondary glaucoma, including cataract, lens luxation, hyphema, intraocular neoplasia, retinal detachment, and uveitis. In some of these conditions, the release of vasoactive factors may lead to the formation of a preiridal fibrovascular membrane and subsequent secondary glaucoma. Although secondary glaucoma is not considered heritable, some of the inciting causes do have a genetic basis (e.g., cataract, lens luxation). Dogs of breeds that are predisposed...
to these conditions that have developed a high IOP in one eye should have the contralateral eye routinely monitored for the development of disease.6,7 Additionally, if cataract surgery is performed, postoperative glaucoma is a potential complication that can be vision-threatening.8,9 If secondary glaucoma can be diagnosed early and managed appropriately, vision may be preserved.

**Diagnosis**

The history, clinical presentation, and ophthalmic examination findings assist in diagnosing glaucoma. It is crucial for the veterinarian to determine the stage of the glaucoma (acute or chronic) to provide appropriate treatment.

**Clinical Signs**

Glaucoma can be a painful condition. Signs of ocular pain include blepharospasm, epiphora, and an elevated third eyelid. Episcleral congestion or corneal edema may also be present, and owners may describe the eye as reddish or blue.2,10 Dogs may also present without vision, lacking menace responses, pupillary light reflexes (PLRs), and dazzle reflexes.11 Unfortunately, most subtle or transient increases in IOP lack overt clinical signs in the acute phases, and most dogs present with chronic glaucoma. IOP, corneal edema, and visual status may be similar in acute and chronic glaucoma. Globe size and fundic examination help determine the duration of the disease. Signs of acute glaucoma may include a normal-sized globe with corneal edema, mydriasis, and a relatively normal retina. Dogs with chronic glaucoma generally present with buphthalmia, blindness, corneal edema, and fixed, dilated pupils in one or both eyes. Fundic examination may reveal retinal degeneration and optic disc cupping.2,12

**Ophthalmic Examination**

The first objective of the ophthalmic examination is to determine the visual status and potential of each eye. Menace responses and direct and consensual PLRs should be assessed. If these responses are absent, dazzle reflexes should be assessed by shining a bright light into each eye in turn and monitoring for a blink response. A recent study11 demonstrated that dogs with acute glaucoma and absent menace responses, PLRs, and dazzle reflexes may regain some visual function in days to weeks if aggressive medical or surgical management is pursued early in the course of the IOP elevation.

Determination of IOP in both eyes involves proper restraint (avoiding neck pressure) and correct use of equipment to obtain accurate measurements.4 A recent study13 demonstrated that body position can affect IOP readings in dogs without glaucoma; therefore, it is important to keep the dog’s body position consistent during IOP measurement. There are three methods of measuring IOP: indentation, applanation, and rebound tonometry. Indentation tonometers, such as the Schiotz, indent the corneal surface and provide a measurement that can be converted for use in dogs by using the accompanying human conversion table.14 Applanation tonometers, such as the TonoPen VET (Reichert), measure IOP by flattening the corneal surface and are commonly used in general practice. Rebound tonometers (e.g., TonoVet, Icare) measure IOP by projecting a small probe at the corneal surface and analyzing the characteristics of its rebound. Rebound tonometers have been shown to be as accurate and easy to use as applanation tonometers.3,15 Because IOP measurements obtained using different instruments vary,15 it is recommended that the same instrument be consistently used when monitoring a patient. TABLE 1 compares the three most commonly used tonometers.

Canine glaucoma does not usually present symmetrically, and because primary glaucoma is always a bilateral disease, it is critical to thoroughly evaluate and routinely monitor the contralateral eye. Depending on the breed of dog,
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Primary glaucoma usually manifests in middle or old age\(^2\); therefore, routine monitoring of at-risk puppies is not useful. When a dog presents with unilateral glaucoma, gonioscopy (iritocorneal angle examination) can be performed by a veterinary ophthalmologist to determine if the drainage angle is abnormal. This information helps differentiate primary and secondary glaucoma. Prophylactic medical therapy in the contralateral eye of an affected dog can significantly prolong visual status.\(^1\) In a multicenter clinical trial,\(^1\) topical 0.5% betaxolol twice daily or topical 0.25% demecarium bromide once daily and a topical corticosteroid once daily significantly delayed or prevented the onset of glaucoma in the second eye. Untreated control dogs developed glaucoma in the second eye earlier (median: 8 months) than eyes treated with prophylactic medication (median: approximately 31 months). Sharing this timeline with owners of dogs with primary closed-angle glaucoma helps keep the progressive nature of the disease in perspective and provides motivation to maintain compliance with the recommended prophylactic medications.

**Conclusion**

Canine glaucoma may be congenital, primary, or secondary in origin. It is crucial to determine the underlying cause of the glaucoma, the chronicity of the condition, and the visual potential of the affected eye because these factors decide the appropriate treatment recommendations and affect prognosis.

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**QuickNotes**

It is important to keep the dog’s body position consistent during IOP measurement.

**TABLE 1** Comparison of Available Tonometry Methods\(^3,10,15,a\)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Indentation Tonometry</th>
<th>Applanation Tonometry</th>
<th>Rebound Tonometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instrument</td>
<td>Schiotz tonometer</td>
<td>Tono-Pen VET</td>
<td>TonoVet</td>
</tr>
<tr>
<td>Average cost(^b)</td>
<td>$\sim$300</td>
<td>$2500+$</td>
<td>$2500+$</td>
</tr>
<tr>
<td>Corneal contact area(^c)</td>
<td>3 mm</td>
<td>3 mm</td>
<td>1 mm</td>
</tr>
<tr>
<td>Clinical considerations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>▶ Requires appropriate patient</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>positioning and restraint</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>▶ Readings must be converted to</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>mm Hg using a chart</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>▶ Requires topical anesthetic</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)Leiva M, Naranjo C, Pena MT. Comparison of the rebound tonometer (iCare) to the applanation tonometer (Tonopen XL) in normotensive dogs. Vet Ophthalmol 2006;9(1):17-21.

\(^b\)Prices vary by supplier.

\(^c\)The amount of corneal exposure required may exceed this area.

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1. Canine glaucoma usually results from
   a. an increase in the amount of aqueous humor produced by the ciliary body.
   b. a disturbance in the aqueous humor outflow pathway.
   c. external pressure on the globe (tumor, cyst, abscess).
   d. a and b

2. Normal canine IOP is _______ mm Hg.
   a. 5 to 10
   b. 10 to 25
   c. 15 to 30
   d. 20 to 30

3. Which statement is true with regard to congenital canine glaucoma?
   a. It is a common condition in certain breeds of dogs.

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b. It is usually a result of an early traumatic injury to the globe.
c. It becomes clinically evident in the first 2 to 3 years of life.
d. It may be unilateral or bilateral and may be associated with other ocular anomalies.

4. Which statement is true with regard to primary canine glaucoma?
   a. It is a heritable condition in many breeds.
   b. It is the result of a malformation of the drainage angle.
   c. It is always a bilateral disease process.
   d. all of the above

5. Secondary canine glaucoma can be caused by
   a. lens luxation, uveitis, or intraocular neoplasia.
   b. conjunctivitis and blepharitis.
   c. cataracts and cataract surgery.
   d. a and c

6. A 6-year-old spayed bassett hound presents with buphthalmia, corneal edema, and a dilated pupil with no PLR. A cupped optic disc and retinal degeneration are visible on fundic examination. This dog has _______ glaucoma.
   a. acute   c. congenital
   b. chronic d. none of the above

7. If a dog with elevated IOP lacks a menace response and direct and consensual PLRs,
   a. the prognosis for vision is grave.
   b. the dog must have chronic glaucoma.
   c. dazzle reflexes should be assessed.
   d. magnetic resonance imaging should be performed to attempt to identify intracranial disease.

8. Accurate determination of IOP requires
   a. proper restraint and avoidance of excessive neck pressure.
   b. sedation or light anesthesia.
   c. a dark environment.
   d. that no topical medications be applied to the eye.

9. Which statement regarding tonometers is true?
   a. The reading obtained with the Schiotz tonometer must be converted to mm Hg using the supplied conversion chart.
   b. Applanation tonometry and rebound tonometry require a topical anesthetic.
   c. The newest tonometer, the TonoVet, is the only style of tonometer that provides a digital display of the IOP.
   d. Rebound tonometry has been shown to be more accurate than applanation tonometry.

10. In a case of apparently unilateral glaucoma, evaluation of the contralateral eye is crucial because
    a. primary glaucoma is always a bilateral disease, even though it may present asymmetrically.
    b. gonioscopy may help to identify an eye that is at risk for developing glaucoma.
    c. prophylactic medical therapy can significantly prolong visual status in an eye at risk for developing glaucoma.
    d. all of the above
References

4. Pauli AM, Bentley E, Diehl KA, Miller PE. Effects of the application of neck pressure by a collar or harness on intraocular pressure in dogs. JAAHA 2006;42(3):207-211.