Glaucoma in dogs – (1) cause, clinical signs and diagnosis

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OPHTHALMOLOGY

Glaucomas refer to a large group of neuro-degenerative diseases caused by persistent and ongoing elevation of intraocular pressure. Eventually this will lead to permanent retinal degeneration and blindness owing to loss of the retinal ganglion cells and optic nerve damage (Pizzirani, 2015).

On the other hand, elevated intraocular pressure is termed ocular hypertension and should be distinguished from glaucoma. The final outcome is irreversible blindness and, in some primary glaucoma cases, bilateral enucleation is required.

Although elevated intraocular pressure is one of the most consistent risk factors for glaucomas, development in dogs (Pizzirani, 2015) genetics, ageing, vascular, immunologic and environmental factors all contribute to the optic nerve degeneration.

According to the *European College of Veterinary Ophthalmologists Manual,* 'It is characterised by an elevation of intraocular pressure (IOP) which, when sustained, results in destruction of intraocular structure and function, resulting in blindness. The elevated intraocular pressure occurs mainly with developmental abnormalities or disease processes affecting the intraocular circulation and especially the drainage of aqueous humour from the eye through the irido-corneal angle (ICA).

'Diagnosis and classification of glaucoma requires measurement of the IOP (tonometry) and examination of the iridocorneal angle (gonioscopy). DNA-tests for primary open angle glaucoma (POAG) in specific breeds are available.'

Measuring intraocular pressure

This can be performed using different devices: commonly either by an applanation tonometer (Tonopen) that measures the force to flatten a distinct area on the cornea; or a rebound tonometer (TonoVet) that expels a small, rounded probe on to the cornea – the higher the intraocular pressure, the quicker the probe returns to the instrument (**Figures 1** & **2**).

***Figures 1** & **2.** Intraocular pressure – can be measured using a tonometer.*

When measuring the IOP, one should ensure there is no pressure on or underneath the neck of the patient – for example, tight collars, harnesses, owners holding – or on the eye globe itself. When opening the eyelids, the fingers should rest on the bony orbital rims, not on the eye; and it is important to avoid overstretching the eyelids as well.

The dog should be in a sitting or standing position with the neck straight, and no overextension or flexion of the neck. When using the Tonopen, care should be taken to gently flatten the cornea without causing an obvious indentation – false high IOPs are easily obtained if the tip of the Tonopen is pushed with force against the cornea. Blepharospasm may also falsely elevate the IOP owing to eyelid spasm.

Repeated measurements should be taken. If in doubt, admit the dog for an IOP curve (measured every three hours) and monitor in hospital (Sanchez et al, 2017).

Diagnosis

It is important to take a full history and carry out a

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Figures 3-7. *Acute onset signs in primary glaucoma cases.*

thorough general physical examination, looking in particular for evidence of previous trauma and to rule out underlying systemic diseases, such as lymphoma. This should be followed by a full ophthalmic examination: including visual reflexes ('menace' response, dazzle and pupillary light reflexes), pupil size (miotic/mydriatic), fluorescein test, tonometry (TonoPen/TonoVet), funduscopy and gonioscopy.

Ocular ultrasonography is useful in order to rule out intraocular neoplasia, intraocular haemorrhage, vitriitis/vitreous membranes, and retinal detachment.

Depending on the stage of the disease, glaucomas can be classified as acute or chronic.

Acute onset glaucoma

This is more common in primary glaucoma cases (**Figures 3-7**) as evidenced by:

- severe ocular and head pain
- lethargy, reduced appetite
- diffuse corneal oedema
- blepharospasm
- epiphora
- marked conjunctival hyperaemia and, sometimes, mucoid discharge that can be misdiagnosed as conjunctivitis
- third eyelid protrusion
- marked episcleral vascular congestion
- mid- to large dilated and unresponsive pupil
- deep perilimbal corneal vascularisation
- mild aqueous flare or pigment dispersion in the anterior chamber
- changes to appearance of the optic nerve – pale or dark optic nerve head (atrophy), attenuation of the retinal vasculature, cupped optic nerve head (retinal vessels stop at the rim of the optic nerve, no vessels are seen crossing the optic nerve), hyperreflectivity of the tapetum fundus.

"Glaucomas, however, can easily mask underlying systemic diseases, such as infectious uveitis and neoplasia"

Chronic glaucoma

Signs of chronic glaucoma include:

- Haab striae – breaks in Descemet membranes secondary to stretching of the globe
- buphthalmos – a permanently enlarged eye caused by chronically elevated intraocular pressure
- scleral thinning and visualisation of the underlying choroid owing to globe enlargement
- phthisis bulbi – in advanced cases, when the ciliary body stops producing aqueous humour.

Glaucomas can be classified into congenital, primary and secondary, depending on their cause.

Congenital glaucoma

This is rare in the dog. It develops within the first few months of life (three to six months) and is a consequence of extensive goniodysgenesis or trabecular meshwork maldevelopment. Different structural genes have been associated with the trabecular meshwork malformation.

Primary and secondary glaucomas can be difficult to distinguish clinically.

Primary glaucoma

Primary glaucoma is a bilateral disease that occurs spontaneously with no evidence of trauma or other intraocular disease. There is an increased incidence of the condition with age and this could be the result of changes in the iridocorneal angle seen with age (Palko et al, 2016).

Primary glaucomas are classified on the gonioscopic

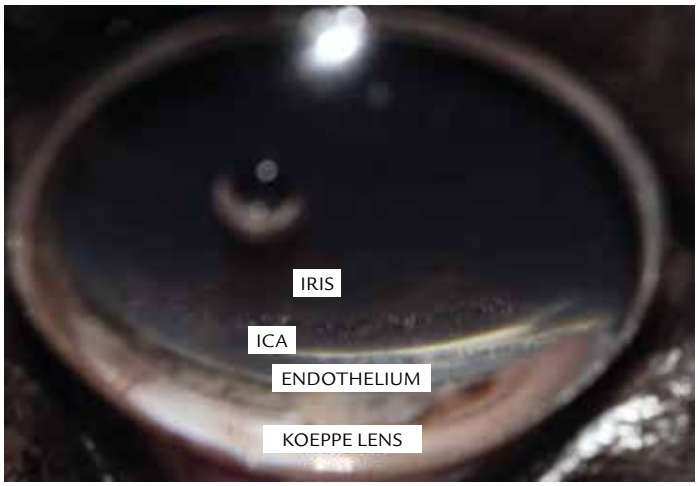

***Figure 8**. In order to perform gonioscopy, a special contact lens (goniolense, such as the Koeppe lens) is placed on the surface of the cornea to change the refraction angle of the incoming light.*

***Figures 9-12.** Secondary glaucoma occurs when the aqueous humour outflow is impeded by the presence of other intraocular diseases.*

appearance as open-angle glaucoma – seen particularly in the beagle, petit basset griffon vendeen, basset hound, shar pei, Norwegian elkhound – and closed-angle glaucoma which is seen in the majority of breeds, for example, the cocker spaniel and Welsh springer spaniel.

The ICA can be assessed by gonioscopy and an abnormal appearance is termed goniodysgenesis. This occurs owing to a defect in the development of the angle, which can have a decreased width or malformation of the pectinate ligament (Miller and Bentley, 2015).

In order to perform gonioscopy, a special contact lens (goniolense, such as the Koeppe lens) is placed on the surface of the cornea to change the refraction angle of the incoming light (**Figure 8**). The ICA can then be visualised using a slit lamp biomicroscope. The pectinate ligament (thin fibres from the iris base to its insertion at the cornea) and the iridocorneal angle width are evaluated by gonioscopy – the latter to determine its proportion of 360 degrees. A grading scheme of the changes visualised at gonioscopy is in place to classify the degree of goniodysgenesis – open, narrow, closed, closed angle.

The degree of goniodysgenesis also changes with age. Evaluation of the ICA in the affected glaucomatous eye may be difficult because of the presence of corneal oedema; therefore, a gonioscopy of the contralateral unaffected eye is recommended. This technique requires practice and training under specialist supervision.

A list of breeds recognised to be predisposed to goniodysgenesis may be found under the BVA Eye Health Scheme available online. Pre-eminent among these are the dandie dinmont terrier, Japanese shiba inu, Leonberger, flat-coated retriever, Siberian husky, cocker spaniel, English springer spaniel and Welsh springer spaniel.

Primary closed-angle glaucoma (PCAG)

This is the most common form of primary glaucoma in dogs. There is a strong breed predisposition – American cocker spaniel, basset hound, chow chow, Welsh springer spaniel, miniature and toy poodles, great Dane – as well as a genetic influence. In most breeds, there is a significant female predisposition and most dogs are middle- to older-aged.

A dog can be considered to have PCAG, if it is presented with clinical signs of glaucoma (mydriasis, blepharospasm, elevated IOP), with absence of other intraocular diseases (neoplasia, chronic uveitis with iris bombe, lens luxation), and abnormal ICA at gonioscopy of the contralateral unaffected eye (Miller and Bentley, 2015).

An acute presentation of glaucoma – with no other intraocular findings in a dog included on the list of predisposed breeds for PCAG – should raise the suspicions of primary glaucoma and prophylactic treatment of the contralateral eye should be considered.

Early diagnosis and treatment is essential, because normalising the intraocular pressure reduces the progression of the disease and prolongs the retention of vision. Therefore, referrals of glaucoma cases should be made early, if not straight after, diagnosis. However, despite treating the initial pressure spike event promptly, the disease continues to progress.

When presented in the acute congestive phase, the visual reflexes are reduced or absent; but they can return if the intraocular pressure normalises

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quickly. The normal canine retina begins to show evidence of effects from an elevated IOP at 33mmHg (Gelatt KN et al, 2013). Lowering IOP is critical for maintaining vision. The optic nerve axons are sensitive to pressure oscillations and their flow becomes 100 per cent obstructed at an IOP of 50mmHg (Gelatt KN et al, 2013).

Primary open-angle glaucoma

Primary open-angle glaucoma is the least common form of glaucoma in dogs and has been linked to a mutation in the ADAMTS10 and ADAMTS 17 genes in several breeds – beagle, Norwegian elkhound, basset hound and petit basset griffon vandeen (Komáromy and Petersen-Jones, 2015). The iridocorneal angle is normal initially, however it progressively closes during successive months to years owing to the effects of elevated intraocular pressure.

Secondary glaucoma

This occurs when the aqueous humour outflow is impeded by the presence of other intraocular diseases, such as uveitis, cataract, post-phacoemulsification, iridociliary cysts, lens luxation, neoplasia, retinal detachment and haemorrhage (**Figures 9-12**).

Diagnosing glaucoma secondary to chronic uveitis can be difficult as inflammation is present in all cases of glaucomas (Weinstein et al, 2007).

Signs of active or chronic uveitis may already be present in the glaucomatous or contralateral eye – with fibrin, hyphaema or hypopion in the anterior chamber, keratic precipitates, iris bombe, anterior or posterior synechiae – which could help in guiding the diagnosis. Pre-iridal fibrovascular membranes (PIFMs) form with chronic uveitis and lead to iris bombe and obstruction of the aqueous humour circulation in the eye and impaired outflow. Always examine the contralateral 'unaffected' eye, which can reveal subtle signs of uveitis, such as flare and cells in the anterior chamber.

Cataracts

Cataracts can cause phacolytic uveitis via the 'leakage' of proteins in the anterior chamber or phacoclastic uveitis owing to rupture or tear of the lens capsule (in diabetic cataracts). Glaucoma occurs either as the result of the tumescence of the lens – which occludes the ICA (phacomorphic glaucoma); or secondary to uveitis resulting from extensive posterior synechiae, or PIFMs, or secondary to retinal detachment or inflammation of the vitreous (vitriitis) and/or secondary traction bands.

The incidence of postoperative hypertension after phacoemulsification was reported to be 18 per cent in non-Labrador retriever dogs and 33 per cent in Labrador retrievers. The latter are also at increased risk of postoperative glaucoma and blindness – the risk further increasing with age and whether they had postoperative hypertension (Moeller et al, 2011). Furthermore, other breeds – such as cocker spaniel, Boston terrier, bichon frise, shih tzu and Jack Russell terrier – were found to be at increased risk of glaucoma following cataract surgery in a histopathological study (Scott et al, 2013).

Pupil block glaucoma

This occurs with anterior lens luxation, anterior vitreous prolapse, mature diabetic cataracts (intumescent lenses) and extensive posterior synechiae. Aqueous humour circulation from the posterior to anterior chamber is impeded owing to pupil block and cannot exit via the conventional outflow (iridocorneal angle). This leads to increased pressure in the posterior chamber, which then displaces the iris anteriorly towards the cornea. The ICA becomes narrow and collapses.

This can be visualised on slit lamp examination as the anterior chamber becomes very shallow and the iris is swollen and anteriorly displaced ('iris bombe').

Glaucoma secondary to iridociliary cysts has been reported in several breeds – golden retriever, great Dane – and although the mechanisms are not completely understood, it is thought that glaucoma occurs secondary to anterior displacement of the iris and occlusion of the ICA (Pumphrey et al, 2013; Holly et al, 2015).

Retinal detachment can lead to glaucoma as a result of the obstruction of the ICA with photoreceptor outer segments – released during degeneration of the retina – and formation of PIFMs secondary to retinal hypoxia (Matsuo et al, 1986).

Intraocular neoplasia causes obstruction of the ICA – anterior uveal melanocytoma or iris melanoma, for example – owing to the space-occupying lesion. When the iris is expanded by the tumour, secondary uveitis also occurs.

Summary

Glaucoma is an irreversible blinding disease defined by degenerative changes of the retinal ganglion cells and optic nerve. Elevated intraocular pressure is a consistent risk factor in dogs. Early diagnosis and treatment are essential to the prolongation of vision. Ultimately, all glaucoma cases might have the same outcome and require enucleation to restore comfort.

Glaucomas, however, can easily mask underlying systemic diseases, such as infectious uveitis and neoplasia. Therefore, submission of the enucleated eyes for histopathological examination is always recommended in order to gain a better understanding of the underlying disease process and to rule out intraocular neoplasia or evidence of metastatic disease. ■

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PPD Questions

1. With respect to primary glaucoma, which of the following sentences is FALSE?
   A. dogs with primary open-angle glaucoma have a normal iridocorneal angle initially, which becomes abnormal with the progression of the disease
   B. iridocorneal angle can be evaluated by gonioscopy and this helps identifying dogs that have goniodysgenesis
   C. dogs with goniodysgenesis have an increased risk of developing primary closed-angle glaucoma
   D. you can differentiate primary glaucomas from secondary glaucomas based on the lack of inflammation in the former.

2. Regarding gonioscopy, which of the following sentences is TRUE?
   A. you can evaluate the iridocorneal angle using a direct ophthalmoscope
   B. gonioscopy of the glaucomatous eye is easy to perform
   C. special lenses (e.g. Koeppe) are used to aid visualising the iridocorneal angle with a slit lamp biomicroscope
   D. the iridocorneal angle does not change with age.

3. Regarding secondary glaucoma, which of the following sentences is TRUE?
   A. lens luxation and tumescent cataracts cause secondary glaucoma owing to pupil block and impeded aqueous humour flow in the anterior chamber
   B. uveitis causes secondary glaucoma owing to an increased production of aqueous humour
   C. secondary glaucoma in chronic uveitis occurs through overhydration of the vitreous humour and posterior displacement of the iris
   D. retinal detachment causes secondary glaucoma by anterior displacement of the iris and obstruction of the iridocorneal angle.

Answers
1.D 2.C 3.A

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