Definition, Classification, and Pathophysiology of Canine Glaucoma

Stefano Pizzirani, DVM, PhD

KEYWORDS

• Canine • Glaucoma • Primary glaucoma • Secondary glaucoma • Open angle
• Closed angle • Goniodysgenesis

KEY POINTS

- Glaucoma is a group of diseases with optic nerve degeneration and blindness as a final outcome.
- In primary glaucoma the main risk factors are age, breed, gender, and goniodysgenesis.
- Classification is based on clinical evaluation and assessment of the iridocorneal angle and ciliary cleft with gonioscopy and ultrasound biomicroscopy.
- Cellular and extracellular progressive changes occur at the level of the lamina cribrosa and in the trabecular meshwork and are responsible for retinal ganglion cell degeneration and decreased outflow.
- Mechanical and vascular theories are predominant to explain the pathogenesis of the disease, leading to oxidative stress and molecular inflammation, which in turn contribute to disease progression.

DEFINITION

Glaucoma is a heterogeneous group of progressive disorders characterized by retinal ganglion cell (RGC) apoptosis and a specific optic neuropathy (glaucomatous optic neuropathy [GON]) associated with cupping of the optic disc. In human patients, peripheral visual field loss and tunnel vision are common initial clinical signs, which may eventually progress to irreversible blindness.[1,2] Primary glaucoma is considered a bilateral disease, although both eyes may not be affected simultaneously.

This definition is widely accepted in medical ophthalmology. Compared with the common definition used in veterinary medicine, several interesting points emerge.

Disclosure: The author has nothing to disclose.
Ophthalmology, Department of Clinical Science, Cummings School of Veterinary Medicine, Tufts University, 200 Westboro Road, North Grafton, MA 01536, USA
E-mail address: stefano.pizzirani@tufts.edu

Vet Clin Small Anim 45 (2015) 1127–1157
http://dx.doi.org/10.1016/j.cvsm.2015.06.002 **vetsmall.theclinics.com**
0195-5616/15/$ – see front matter

First, glaucoma is a group of diseases with many different phenotypes. This variation expands the possible causes and means that its classification is not straightforward.

Second, increased intraocular pressure (IOP), which has historically been a common definition for the disease in small animals, is not mentioned in the accepted definition used by physician ophthalmologists. Increased IOP is considered an important, but not necessary, major risk factor.[3–5] IOP values in humans are not considered sensitive or specific to make a diagnosis or suggest prognosis,[6] because IOP can be normal in patients affected with normotensive glaucoma (NTG).[7]

Unlike in people, increased IOP has historically been a requirement for the diagnosis of clinical glaucoma in dogs,[8] despite pattern-electroretinography (pERG) changes and posterior-segment blood flow abnormalities having been reported before the onset of clinical signs of primary open-angle glaucoma (POAG) in dogs,[9–11] suggesting that pathologic changes in the retina can occur before any increase in IOP. Furthermore, glaucoma is a progressive disease in humans and in dogs even with a controlled normalized IOP, suggesting that additional pathophysiologic mechanisms must be involved.[12]

Recently, an updated version of the definition of glaucoma in animals included increased IOP as a constant risk factor.[8] The differences between the definitions commonly used in physician-based and veterinary ophthalmology may in part relate to the anatomic and functional differences between the 2 species (ie, differences in angle morphology; presence or absence of a central retinal artery), but likely follow largely from small animals with glaucoma typically being initially assessed at an advanced stage of disease. A few factors are responsible for this:

- The inability of nonhuman patients to communicate verbally
- The reliance of the veterinarian on information provided by the pet owner
- The different levels of attentiveness displayed by pet owners regarding changes to their pet's eyes or vision
- The better tolerance dogs are likely to have for initial, prodromic signs not associated with acute pain
- The possibility for dogs to display apparently normal visual behavior until the point at which significant, usually bilateral, vision loss has occurred

Although people undergo regular and periodic assessments when they age, and can report and be tested for peripheral visual field deficits, dogs continue to behave normally even with substantial loss of retinal function.

Besides increased IOP, several other risk factors are considered of major importance and correlate with an increased likelihood of disease occurrence. These factors include:

- Age
- Familial history
- Breed and presence of goniodysgenesis
- Gender
- Systemic blood hypotension

Age

The incidence of primary glaucoma is strongly correlated with aging in several species. Data in **Fig. 1** compare the exponential relationship between age and the incidence of primary glaucoma in humans and the more commonly affected canine