The Glaucomas of Dogs and Cats

CL Davis 9/08

Richard R Dubielzig
Definition of Glaucoma

Intraocular pressure too high for the normal functioning of the retina and optic nerve head
The Canine Glaucoma Diseases

- Goniodysgenesis (Primary Glaucoma)
- Lens Luxation Glaucoma
- Thin Walled Iridociliary Cysts (Pigmentary Uveitis)
- Melanosis
Canine Primary Glaucoma

- Goniodysgenesis
- Pectinate ligament dysplasia
- Mesodermal dysgenesis
- Open angle closed cleft glaucoma (Peiffer)
- Acute angle closure glaucoma (Miller)
- Who knows what else
What is Goniodysgenesis?

- The normal Canine Iridocorneal Angle and the Drainage System
- Goniodysgenesis: A solid sheet of iris-like uveal tissue extending from the iris base to the distorted terminus of Descemet’s membrane
Primary Glaucoma in Dogs

- 333 Cases in Cocker Spaniels out of 1205 Cockers in COPLOW
- 122 Cases in Bassett Hounds out of 348 Bassetts in COPLOW
- 62% Female
The Normal Canine Angle
Goniodygenesis
Normal Pressure

Normotensive Basset Hound with Goniodygenesis
Goniodygenesis
Goniodygenesis with Glaucoma
Why Do Dogs With Goniodysgenesis Get Glaucoma?

- Only a small % of dogs with goniodysgenesis will end up with glaucoma.
- The more abnormal clock hours, the higher the chances of glaucoma during the life of the dog.
- Once the first eye has glaucoma, the second eye is very likely to develop disease.
- But, but, but: These facts do not contribute much to answer the question.

Faulty Thinking and Bad Models

• The obvious mechanism to explain the development of glaucoma in goniodysgenesis has been a gradual closure of the iridocorneal angle, because of progressive growth of the angle abnormality.
  – This has never been demonstrated!

• The Florida Beagle was put forward as the model of how “primary glaucoma” works in dogs, but it is not a good model.
The Florida Beagle Glaucoma
A Model for Primary Open Angle Glaucoma

- Heritable Glaucoma in Beagles is the only known animal model of primary open angle glaucoma.
- Inherited as an autosomal recessive trait
- Two groups of affected dogs:
  - Group 1. High IOP at young age
    (~ 40 mm Hg at 2 years)
    Blindness at ~ 4 years
  - Group 2. Gradual IOP increase
    Older animals (8-9 years) still visual

The intraocular pressure increases at about 12 months in both groups.
POAG Beagle

Iridocorneal angle and ciliary cleft normal throughout most of the disease

Glucomatous Beagle 1.5 years
Pictures from Kirk Gelatt
Because the POAG Beagle was assumed to be a Model of Dog Glaucoma, a whole series of incorrect assumptions were made:

• That the neurodegenerative aspect of the disease progressed gradually
• That the ganglion cell layer was the only retinal layer to be affected
• That the disease had an insidious onset
What is Canine Primary Glaucoma?

- Sudden onset of painful, red, often blind eye with very high pressures
- The response to treatment is variable, but severe cases are blind from the start
- Very poor success rate with any treatment protocols tried
- Females more than males
- Enucleation is a common outcome
  - When dealing with the second eye, enucleation is often chosen very early (24 hours from the first signs of disease)
Human Primary Angle Closure Glaucoma as a Potential Model for Canine Primary Glaucoma

- Eskimos and Asians
- Hyperopic eyes, smaller eyes
- Large lens
- Shallow anterior chamber
- Women 3x more than men
- Pathophysiology
  - Contact of the pupillary margins with the lens (pupillary block)
  - Pressure gradient between the anterior and posterior chambers
  - Forward bowing of the peripheral iris closes the angle
  - Treated successfully by laser iridotomy
The Relationship of Canine Primary Glaucoma with Pupillary Block

Normal
Glaucoma
Glaucoma

Thanks to Dr Paul Miller
Before Latanoprost

After Latanoprost
What can pathology say about the early changes leading to outflow obstruction in canine primary glaucoma?

- Evidence supports the idea that the pupillary iris rubs against the lens
- Evidence that pigment dispersion may play a role
- Evidence that acute inflammation plays an early role in the iridocorneal angle and the limbus
- Evidence of gradual atrophy of the corneoscleral trabecular meshwork
Evidence of Pupillary Iris Rubbing against the Lens Leading to Pigment Dispersion and Evidence of Acute Inflammation Playing a Role in the Iridocorneal Angle and the Limbus

Work done by Chris Reilly
30 hour Glaucoma
Pigment Dispersion and Rubbing of Iris Epithelial Cells

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<th>Up From Down</th>
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<th>Iris Pigment Absent</th>
<th>%</th>
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Table 1- Pigment dispersion patterns in eyes with PACG with respect to duration of clinical signs. Most parameters are more common in acute cases than chronic.
# The Role of Inflammation

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<th>Duration</th>
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<th>Neutrophils</th>
<th>%</th>
<th>Lymphoplasmacytic</th>
<th>%</th>
<th>Both</th>
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Table 2- Inflammation patterns in the trabecular meshwork of eyes with PACG with respect to duration of clinical signs. Note the strong correlation between 1-3d duration and neutrophilic inflammation.
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Evidence of gradual atrophy of the corneoscleral trabecular meshwork
What can pathology say about the progression of neuroretinal disease in glaucoma?

Retinal and optic nerve degeneration in canine primary glaucoma occurs rapidly and progresses according to a regular schedule.
Effects of Canine Primary Glaucoma on the Optic Nerve and the Retina

Two day glaucoma, Canine
Early and Later Optic Nerve and Retina

Kerry Ketring images
One Day Glaucoma
Glaucoma 2 Days after Laser Ablation of Melanocytoma
30 hour Glaucoma
Three day glaucoma
2 to 4 Day Glaucoma (Canine)

Four Day Glaucoma
TUNEL+ not seen before day 2/3

TUNEL for Apoptosis
Optic Nerve 2 to 4 Days
4 Day Optic Nerve Head
Phagocytosis/Malacia
Five day Canine Glaucoma
5 day Canine Glaucoma
Schnabel's cavernous optic atrophy
Pre-Glaucoma: The Second Eye

The Up Side

The Down Side
The Second Eye

Up

Down
A New Paradigm in the Pathogenesis of Canine Primary Glaucoma associated with Goniodysgenesis:

1. The angle abnormality, along with growth of the lens, causes contact between the lens capsule and the pupillary margin of the iris.
2. Pigment epithelial cells rub off from the pupillary margin of the iris.
3. Pigment in the angle causes atrophy/necrosis of trabecular-lining cells in the corneoscleral trabecular meshwork.
A New Paradigm, continued

4. This leads to increased pressure in the anterior chamber, pushing the iris against the lens.

5. Now there is a vicious cycle, which leads to explosive pressure rise that stops the perfusion of the optic nerve and retina.
The Canine Glaucoma Diseases

• Goniodysgenesis (Primary Glaucoma)
• Lens Luxation Glaucoma
• Thin Walled Iridociliary Cysts (Pigmentary Uveitis)
• Melanosis
Lens Luxation

• Best opportunity to make the diagnosis of lens luxation is from the history
• Second best is to record results at the time of grossing
  – Look at both the lens and the vitreous
• Histopathology very poor at detecting lens luxation
  – Atrophy of pars plicatus
  – Misdirection of the iris
  – Position of the lens in the globe
Zonular Ligament Phenotype and Breeds

- Dysplasia: 18/29 Terrier Breeds
  - 11/11 Fox, Jack Russell, or Rat Terrier family
  - 4/5 Shar Pei
- Collagenization: 7/19 Terrier Breeds
- Normal: 2/15 Terrier Breeds
Normal Zonular Ligament Staining Pattern

- H&E = pink
- PAS = Strongly +
- Trichrome = Mostly red with less blue
- Elastin = Black
Staining of Dysplastic Zonular Abnormality

- H&E = Thick pink membrane tightly adherent to ciliary epithelium with distinctive crossing pattern
- PAS = +
- Trichrome = Almost all of the material is +
- Elastin = Negative
The Canine Glaucoma Diseases

- Goniodysgenesis (Primary Glaucoma)
- Lens Luxation Glaucoma
- Thin Walled Iridociliary Cysts (Pigmentary Uveitis)
- Melanosis
Thin walled iridociliary cysts
(Pigmentary uveitis)

- 108 cases in Golden Retriever dogs
- Clinically considered inflammatory
- Histologic features
  - Thin walled cysts
  - Posterior synechia
  - Retrocorneal membrane
  - PIFM
  - Minimal inflammation
  - Pigmented cyst fragments
  - Pigment dispersion
The Canine Glaucoma Diseases

- Goniodysgenesis (Primary Glaucoma)
- Lens Luxation Glaucoma
- Thin Walled Iridociliary Cysts (Pigmentary Uveitis)
- Melanosis
Canine Ocular Melanosis
195 Cases

• Cairn Terrier... 48
• Labrador retriever... 26
• Boxer... 19
• Golden Retriever... 9
• Boston Terrier ... 8
• Dachshund... 6
The Glaucoma Diseases in Cats

- Lymphoplasmacytic Uveitis
- Angle Recession (Contusion)
- FDIM
- Aqueous Misdirect Syndrome
- Open Angle Glaucoma
The Glaucoma Diseases in Cats

- Lymphoplasmacytic Uveitis
- Angle Recession (Contusion)
- FDIM
- Aqueous Misdirect Syndrome
- Open Angle Glaucoma
Mechanism of Angle Recession

Impact

Cornea and lens displaced posteriorly

Cornea recovers

Lens still displaced

Angle tears
The Glaucoma Diseases in Cats

- Lymphoplasmacytic Uveitis
- Angle Recession (Contusion)
- FDIM: 514 cases
- Aqueous Misdirect Syndrome
- Open Angle Glaucoma
The Glaucoma Diseases in Cats

- Lymphoplasmacytic Uveitis
- Angle Recession (Contusion)
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The Glaucoma Diseases in Cats

- Lymphoplasmacytic Uveitis
- Angle Recession (Contusion)
- FDIM
- Aqueous Misdirect Syndrome
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Feline Open Angle Glaucoma
12 cases