What is Really Going on in Glaucoma?

25 years of experience

Richard R Dubielzig
Canine Primary Glaucoma

- Goniodysgenesis
- Pectinate ligament dysplasia
- Mesodermal dysgenesis
- Open-angle, closed-cleft glaucoma (Peiffer)
- Acute angle-closure glaucoma (Miller)
- Who knows what else
Goniodygenesis by breed, n=1710

- Dalmatian
- samoyed
- shiba inu
- bouvier des golden retriever
- akita
- Jack Russell
- Siberian husky
- chow chow
- shih tzu
- Labrador
- basset hound
- Mixed breed
- cocker spaniel
Primary Glaucoma in Dogs

- 28% of Cocker Spaniels in the COPLOW collection are affected
- 35% of Bassett Hounds
- 62% Female
The Normal Canine Angle

Dr Kerry Ketring
The Normal Canine Angle

Primary Pectinate Ligament
The Normal Canine Angle

- Ciliary Cleft
- Corneoscleral Trabecular Meshwork
Goniodygenesis
Normal Pressure

Normotensive Basset Hound with Goniodygenesis

Dr Kerry Ketring
What is Canine Primary Glaucoma?

• Sudden onset of painful, red, often blind eye with very high pressures
  – In this study the time of disease is measured from when the owner first notices a painful red eye (Hour 0)

• The response to treatment is variable, but severe cases are blind from the start

• 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)
Pigment Dispersion
and
Neutrophilic Inflammation

Chris Reilly
Pigment Dispersion in Primary Glaucoma

- Distinguish superior from inferior angle by pigment alone
  - 1 to 3 Days: 92%
  - 4 to 7 Days: 95%
  - Chronic: 79%
- Cells Stripped from Iris
  - 1 to 3 Days: 43%
  - 4 to 7 Days: 75%
  - Chronic: 55%
- Pigmented Cells in the Angle
  - 1 to 3 Days: 64%
  - 4 to 7 Days: 95%
  - Chronic: 50%

Neutrophilic Inflammation

- 1 to 3 Days: 86%
- 4 to 7 Days: 50%
- Chronic: 15%
Early Changes in the Iridocorneal Angle

30 hour Glaucoma

Neutrophils and Spindle Cell Proliferation
Evidence of Gradual Atrophy of the Corneoscleral Trabecular Meshwork

Normal Cocker Sp. 2 with Goniodysgenesis

One Day Trabecular Meshwork

Normal Atrophic
Pre-Glaucoma: The Second Eye

The Up Side

The Down Side
The Second Eye
Atrophy of the trabecular meshwork

Up

Down
Case Study

34 hour glaucoma

5 year-old spayed Labrador
Case Study

34 hour glaucoma

5 year-old spayed Labrador

Radiating bands of retinal necrosis
Case Study
34 hour glaucoma

Goniodygenesis
Case Study

34 hour glaucoma
Case Study
34 hour glaucoma

“Red-Dead” Ganglion Cells
Effects of Primary Glaucoma on the Optic Nerve and the Retina

Two Day Glaucoma, Canine

24 Hour Glaucoma, Canine
30 hour Glaucoma
Optic Nerve 2 to 4 Days

Necrosis of the neuropil
Three day Glaucoma
4 Day Optic Nerve Head Phagocytosis/Malacia
Five day Canine Glaucoma

Stained for phagocytes
5 day Canine Glaucoma

Gitter cell macrophages
By seven days the optic nerve head is end-stage with deep cupping and gliosis
Schnabel's cavernous optic atrophy

Entrapped vitreous
Early Progression of Retinal Disease

Kerry Ketring images
2 to 4 Day Glaucoma (Canine)

Four Day Glaucoma
2 to 4 Day Glaucoma (Canine)

Four Day Glaucoma

Sampled for Histopathology
One Day Glaucoma
Red-Dead Ganglion Cells
Glaucoma 2 Days after Laser Ablation of Melanocytoma

Proptosis, 3 days
Electronmicrograph of 4-Day Glaucoma Apoptosis
Buphthalmos
Scleral Thickness

4 Day Glaucoma

7 Day Glaucoma

Normal Canine
Buphthalmos
Scleral Thickness

4 Day Glaucoma

7 Day Glaucoma

Normal Canine
Average Ganglion Cell Counts

This count includes “Red Dead” cells

Graph showing data from different time points:
- Controls N=10
- Pre-Glaucoma N=3
- 1 Day N=5
- 2 Day N=7
- 3 Day N=5
- 4-5 Days N=7
- 7 Days N=7

Legend:
- GC Up
- GC Down
“Red Dead” Ganglion Cells

![Bar graph showing average number of Red/Dead GCs over different time periods.](image-url)
Average Retinal Thickness, $\mu$

- Controls, N=10
- Pre-Glaucoma, N=3
- 1 Day, N=5
- 2 Day, N=7
- 3 Day, N=5
- 4-5 Days, N=7
- 7 Days, N=7
Average Scleral Thickness, $\mu$
Phagocytes in the Retina and Optic Nerve

![Chart showing phagocyte counts in controls, pre-glaucoma, and different time points.](chart.png)
Retinal MHC-2 Phagocytes
Optic Nerve MHC-2 Phagocytes
MHC-2 on 4-5 Day Glaucoma Optic Nerve
Retinal GFAP
Suggested Timeline
Before the Owner Detects Pain

1. Young normotensive dog with goniodygenesis
   a) Ciliary cleft open at first
2. Gradual loss of ganglion cells
   a) Likely bouts of pressure spikes
   b) Pigment dispersion?
3. Gradual atrophy of the corneoscleral trabecular meshwork
4. Collapse of the ciliary cleft
   a) Detected with ultrasound biomicroscopy
Suggested Timeline
After the Owner Detects Pain

1. Sudden painful crisis
   a) Pathology suggests an event 2-3 days before owner detects
2. Stepwise rapid necrosis of the optic nerve and retina
   a) Neutrophils, dead ganglion cells, apoptosis, and finally phagocytosis
3. The second eye progresses through the same cycle