

Under Pressure: Canine Glaucoma

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Outline:

- Definition
- Anatomy Review
 - Aqueous humor production and outflow path
- Clinical Signs
- Management- overview
- Forms
 - Primary
 - Secondary
- Treatment decision tree

Glaucoma

A group of diseases characterized by **increased intraocular pressure** leading to **optic nerve damage**, which result in the **loss of some or all vision**

NORMAL VISION



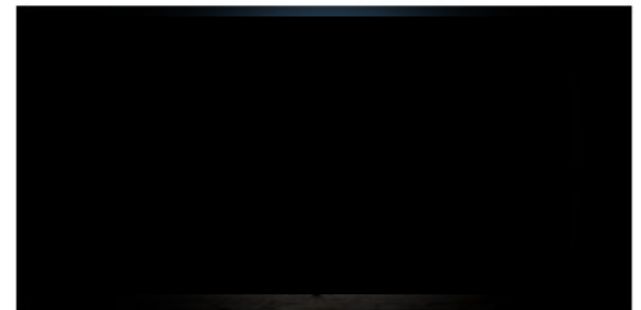
ADVANCED GLAUCOMA



EARLY GLAUCOMA

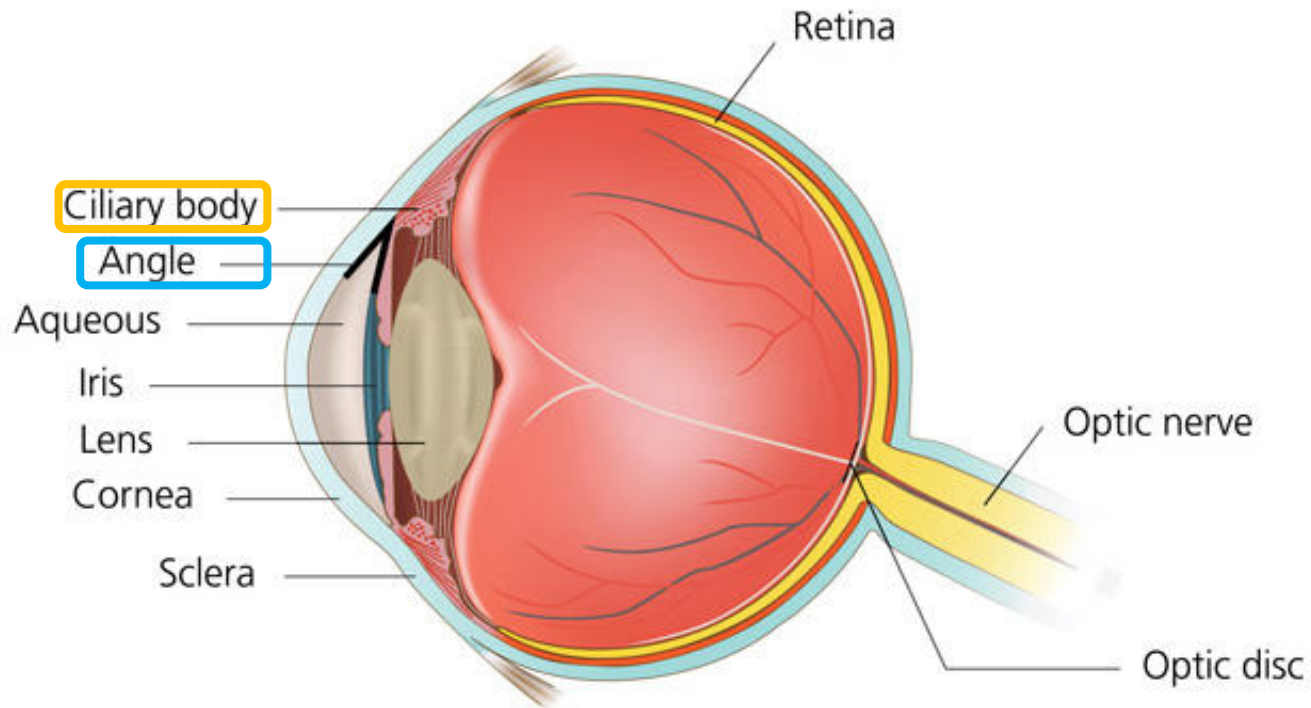


EXTREME GLAUCOMA

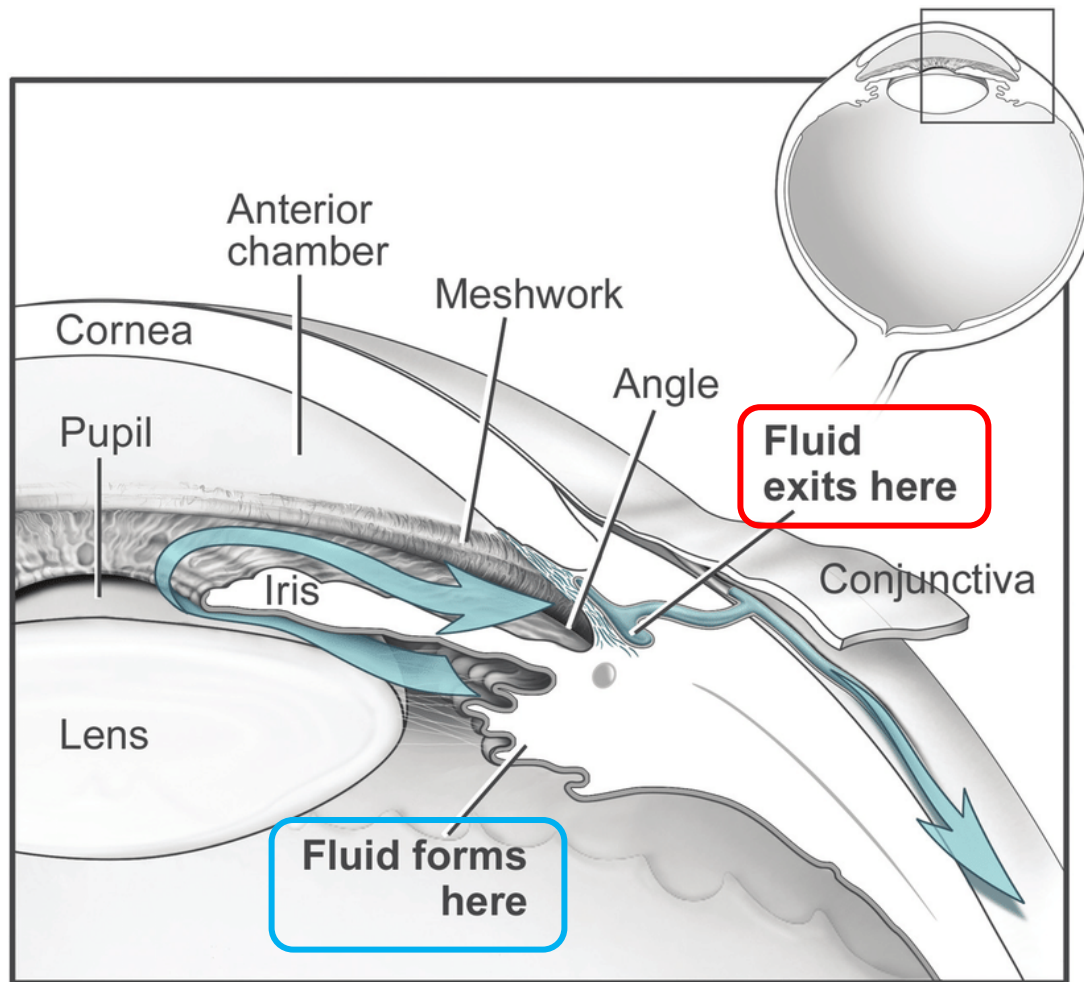


<https://www.eyecareels.com/glaucoma/>

Ocular anatomy



https://www.glaucoma.org/uploads/anatomy-healthy-eye_650.jpg



https://www.researchgate.net/figure/Figure-The-mechanism-of-aqueous-humor-production-and-drainage-Diagram-available-in-the_fig1_50265205

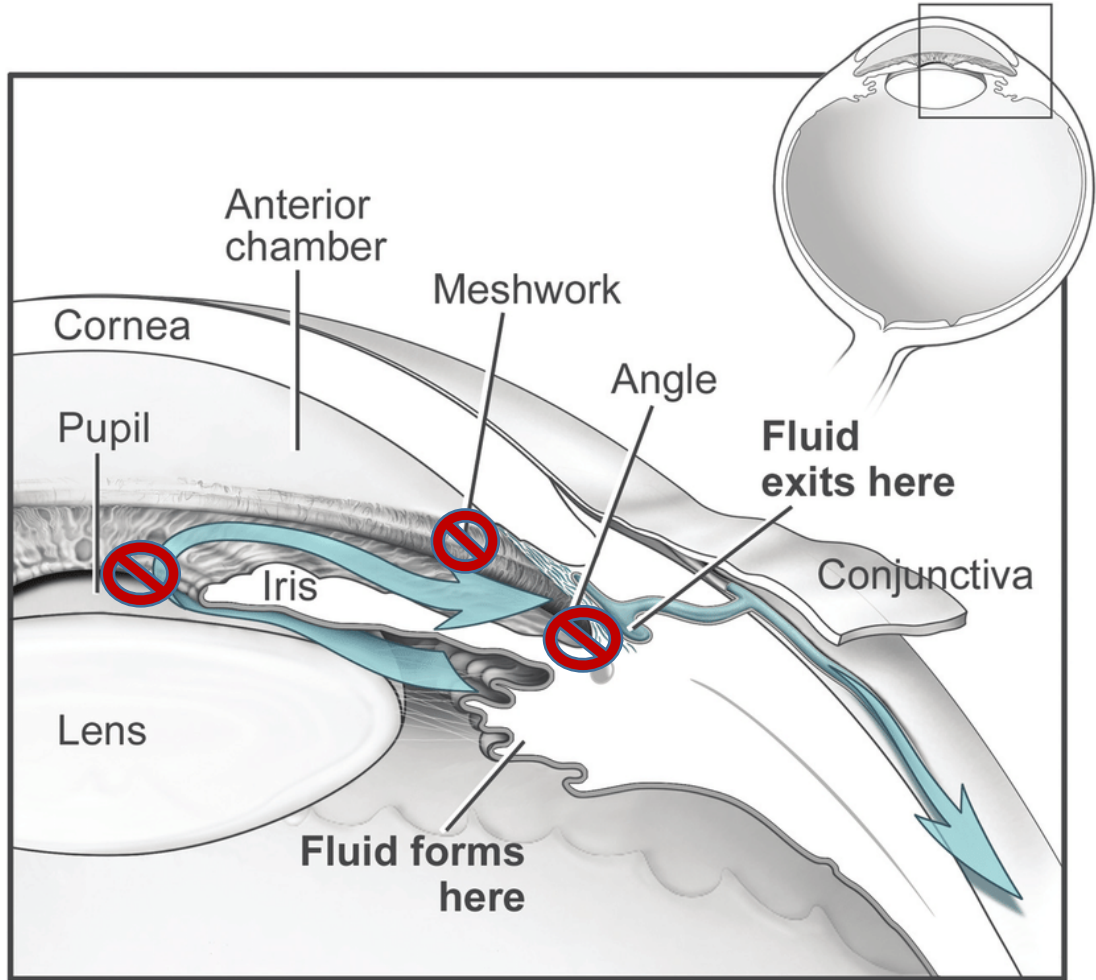
Sink analogy



<https://www.sunrisespecialty.com/wp-content/uploads/2019/11/Kitchen-Faucet-Flow-Rate-Standard-Maximum.jpg>



https://cdn.shortpixel.ai/client/q_glossy,ret_img,w_980/https://www.detourplumbing.com/wp-content/uploads/2020/04/Woman-Cleans-Plunger-With-Clogged-kitchen-sink-980x654.jpg



Glaucoma=
 Problem with drainage
 OUTFLOW

Pupillary block
 Angle closure or block

Clinical signs



CHRONIC

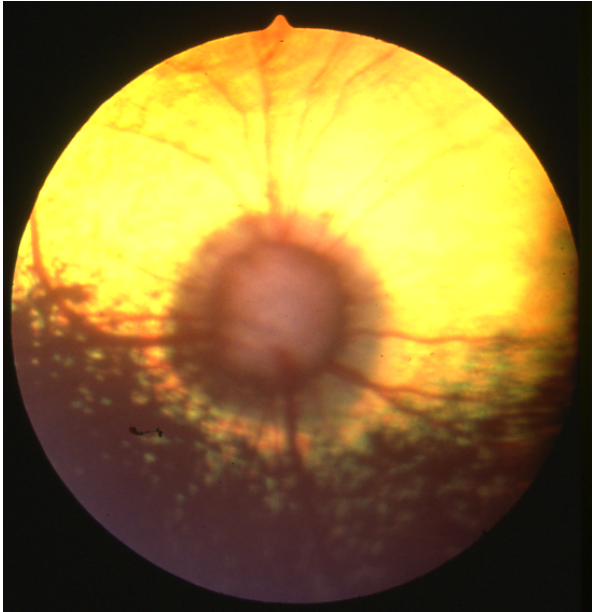
- Buphthalmos
- Lens subluxation
- Optic nerve cupping
- Retinal scarring
- Visual deficits
- Haab's striae



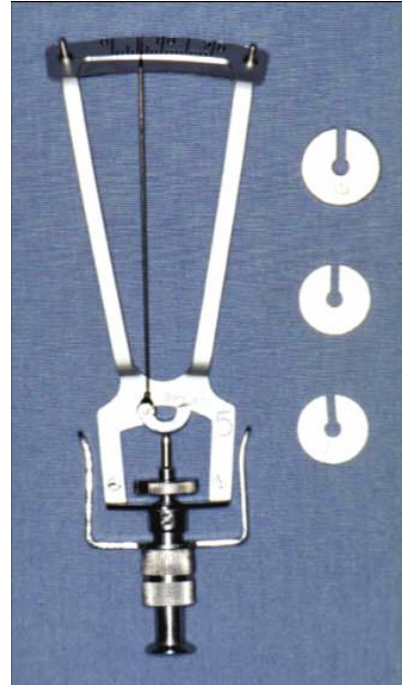
ACUTE

- Scleral injection
- Corneal edema
- Mydriasis (dilated pupil)
- Ciliary flush
- Blepharospasm
- Epiphora
- Visual deficits





Diagnostics- pressure reading



- Lowest reading= most accurate
- False pressure elevation with
 - Jugular occlusion
 - Pressure on the globe
 - Patient struggling
- Consistency- use same tonometer for successive measurements

Gonioscopy



https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQxpZ0l_jqBHAHrG6hyBU26t420I9jKxLLkQ&usqp=CAU



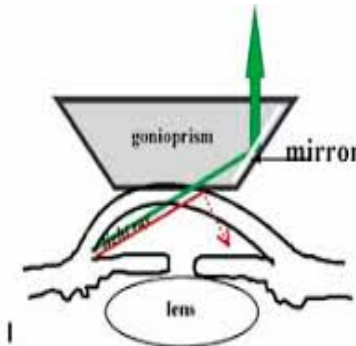
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Examining iridocorneal angle

- Critical angle for viewing= too steep in dogs to view without special lens
- Goniolens

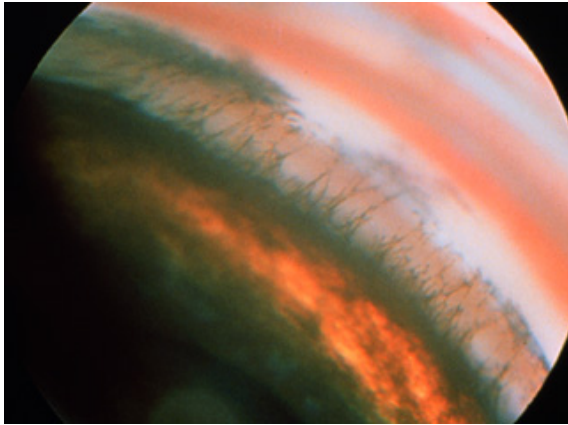


<https://sep.yimg.com/ay/western-ophthalmics/ocular-thorpe-four-mirror-gonio-lens-18.gif>



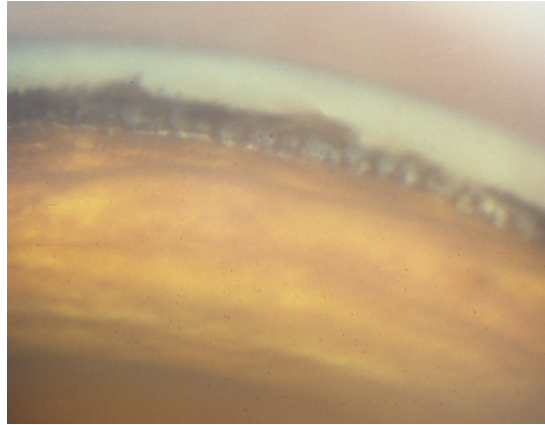
The index of refraction of gonioprism allows the ray to continue to the mirror where it is reflected to the examiner.

Gonioscopy



Photos courtesy of Dr. KE Myrna

Open Angle
Normal pectinate
ligament



Narrow angle
Normal pectinate
ligament



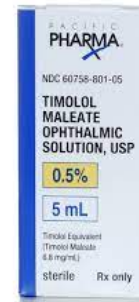
Closed to narrow angle
Goniodysgenesis

Glaucoma management- Goals

- Medications
 - Decrease aqueous humor production
 - Open ciliary cleft
 - Increase uveoscleral (alternative) outflow
- Surgery
 - Re-establish outflow
 - Decrease aqueous humor production

Decreasing AH production does not correct the primary problem of decreased outflow

Medications



Prostaglandin analogues	Carbonic anhydrase	Beta adrenergic blockers	Combo
<p>PGF2 derivative</p> <p>Species and dose specific</p> <p>Increase uveoscleral outflow</p> <p>Intense miosis</p> <p>Can decrease IOP by 50mmHg</p>	<p>Decreases AH production</p> <p>Decreases IOP by 20-30%</p> <p>First choice in most secondary glaucoma</p> <p>*Acidosis, hypokalemia, keratitis</p>	<p>Not potent</p> <p>Decrease AH production</p> <p>Doesn't work if sleeping</p> <p>Prophylactic</p> <p>Synergistic with other medications</p>	<p>"Co-Sopt"</p> <p>Dorzolamide and timolol together</p> <p>Saves time</p>

Additional medical therapy

Beta adrenergic agonist	Cholinergic	Hyperosmotics
<p>Not potent Can be helpful with secondary glaucomas Epinephrine 1-2% q6-12h Dipivefrin 0.1% q12h (more potent than epinephrine) May increase outflow</p>	<p>OLD Pilocarpine Increases outflow Miosis reopens angle</p>	<p>Osmotic gradient dehydrates vitreous Huge drop (50-60mmHg) in 1-2 hrs Short lived effect Doesn't work if blood eye barrier not intact Don't use with heart failure patients</p>

Surgical therapy

- Decrease output
 - Cyclo-destructive procedures
 - Cryosurgery
 - Laser
- Increase outflow
 - Gonioshunt
 - Ahmed valve

Cyclophotocoagulation- Transcleral



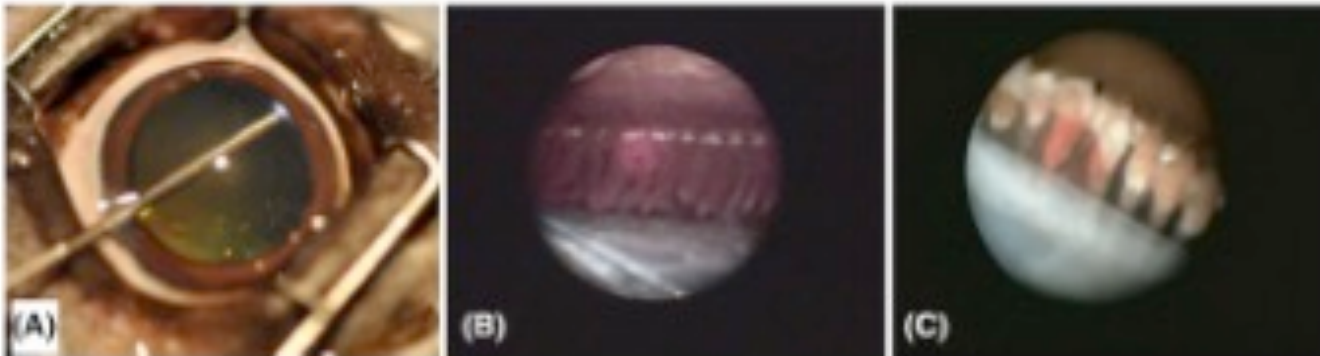
<https://d3i71xaburhd42.cloudfront.net/024e181b2546941d5731203b18bb686bd54036c0/6-Figure3-1.png>



- Non invasive, easy to perform
- Nonselective destruction of adjacent tissues
- Long term success rate= lower (50% vision and IOP control 1 yr post),
- Risks: corneal ulceration, immediate pressure spikes, retinal detachment, hemorrhage, hypotony and phthisis bulbi

Cyclophotocoagulation- Endolaser

- Advantages: ciliary processes and laser treatment effect visualized directly through endoscope= controlled application of less laser energy
- Disadvantages: must be combined with phacoemulsification, longer anesthesia, expensive equipment and additional training required
- Less effective with blue irises/no pigment in ciliary musculature



Komaromy et al. The future of canine glaucoma therapy. Vet Ophth (2019) 22: 726-740

Micropulse laser

- Short wave energy followed by an off cycle
- Allows adjacent nonpigmented tissue to cool off-
 - minimizes collateral thermal damage to adjacent tissues
- Preliminary results mixed



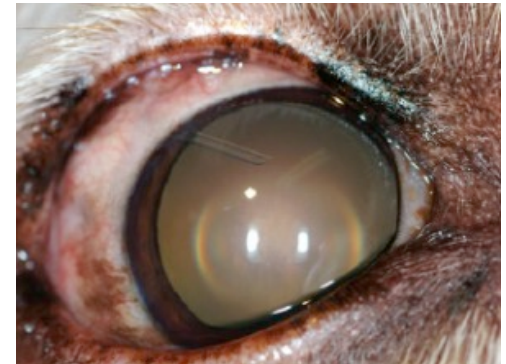
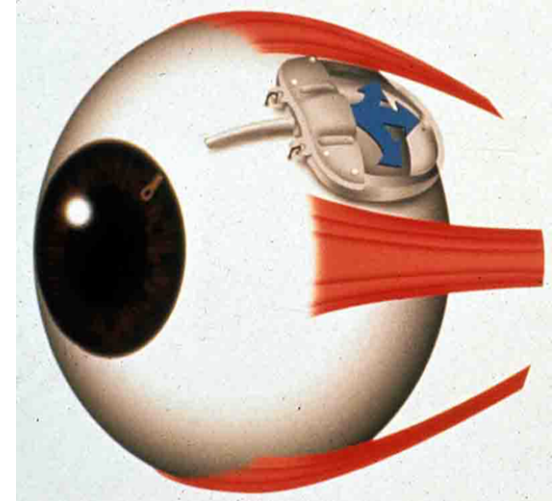
Komaromy et al. The future of canine glaucoma therapy. Vet Ophth (2019) 22: 726-740

Cyclophotocoagulation- Follow up/Risks

- Frequent follow up (vs. hospitalization) required
 - Pressure lowering effect not immediate
 - Must manage IOP and inflammation following procedure
- Treatment:
 - Dorzolamide + Timolol- q6h
 - +/- Latanoprost
 - Systemic carbonic anhydrase inhibitor
 - Topical steroid q4h
 - Oral anti-inflammatory (Steroid or NSAID)
 - Aqueocentesis as needed to address IOP spikes unresponsive to medications

Goniovalve placement

- Shunts aqueous humor out of the anterior chamber to the subconjunctival space when pressure rises
- Scar formation over subconjunctival bleb main reason for implant failure
- Several implant designs available
 - Ahmed, Molteno, Baerveldt
- Very effective until scarring prevents outflow
 - ~6 months



Komaromy et al. The future of canine glaucoma therapy. *Vet Ophth* (2019) 22: 726-740

Treatment/follow up

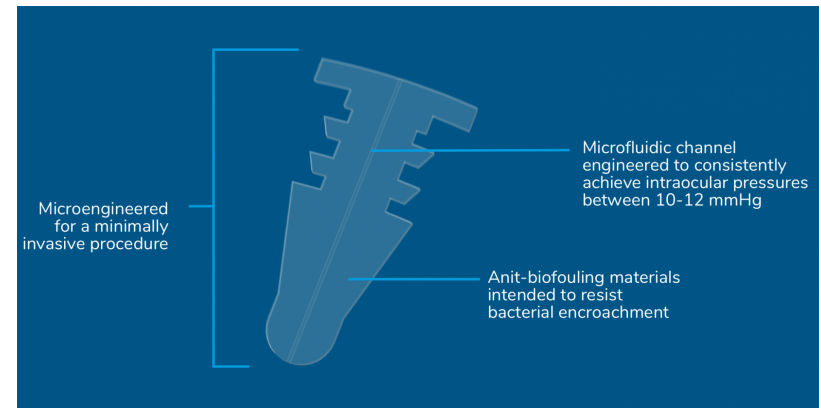
- Frequent IOP checks
 - Pressure should remain below 12mmHg
- Topical anti-inflammatory q4-6h
- Oral anti-inflammatory (steroid vs. non-steroidal)
- Dorzolamide +/- timolol q6-12h
- +/- latanoprost
- TPA injection as needed to disrupt fibrin surrounding shunt

Combination procedures

- To maximize chance of success, goniovalve placement often combined with cyclophotocoagulation.
- Increases chance for vision and comfort
 - From ~50% to around 70% visual and comfortable up to 1 year after surgery
- More expensive, longer surgery but worth it(?) for better outcome

Microinvasive glaucoma surgery (MIGS)

- ***New therapy***
- SalVO/Brown Glaucoma Implant
 - Drains aqueous humor to the ocular surface via a 39 μm diameter hydrogel channel
 - Safe and effective in normal Yucatan pigs
 - Not yet tested in humans and dogs- currently under investigation



https://microoptx.com/cached/general/5639/About-Beacon-3_dbf8d6a38dd21a4600d81f78eddc413.webp

Case Example: Buddy

- 8yo MC Cocker Spaniel
- Acutely bulging, red eye OD
- Vision impairment
- Historical 1 wk history of treatment for “allergic conjunctivitis” OS with NPDex
 - Mild to no improvement
 - No problems with vision at that time



https://www.indiantrailanimalhospital.com/sites/default/files/styles/large/public/cocker-spaniel-dog-breed-info.jpg?itok=2A6hWH_-

Clinical findings

OS:

Buphthalmic

Lens subluxation

Keratitis

Corneal edema

Blind

Severe optic nerve cupping
and retinal degeneration

IOP: 65mmHg

OD:

Corneal edema

Scleral injection and ciliary
flush

Blind

Mydriatic

Normal fundic exam

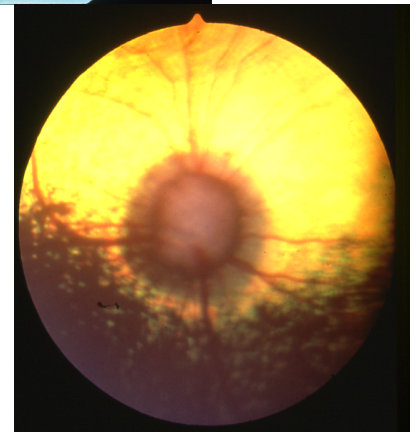
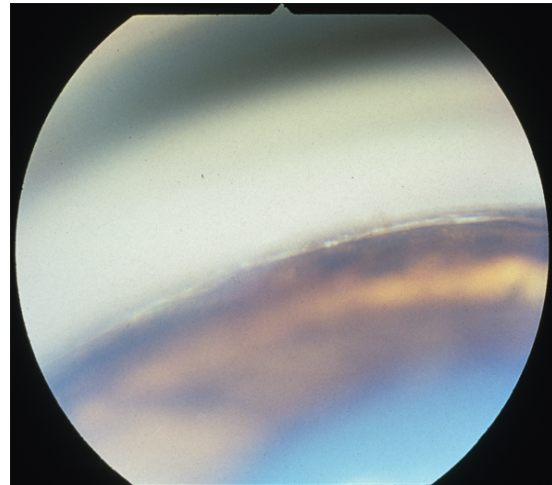
IOP: 47mmHg



<https://fidoseofreality.com/wp-content/uploads/2020/08/MAIN-CAT-min.webp>

Primary Angle Closure Glaucoma (PACG)

- Narrow to closed angle
- Goniodysgenesis
 - Abnormal pectinate ligament
- Heritable
- Acute onset pressure spike
- Bilateral but asymmetric onset
 - First eye develops pressure spike
 - Second eye develops problems months later



https://veteriankey.com/wp-content/uploads/2016/08/B9780721605616500150_gr23.jpg

Treatment

- Latanoprost
 - BID- TID
 - First drug of choice- Made for this!
- Dorzolamide
 - BID-QID
- Timolol
 - BID to QID
 - Use as proph treatment for contralateral eye BID
 - Delays IOP spike for 6-8 mo
- Topical steroid
 - To help address inflammation secondary to the glaucoma
- Mannitol IV
 - 2g/kg over 30min, withhold water, make sure to administer through filter
 - If no response to topical medications and there is hope to save vision
- Surgery
 - Best chance of preserving vision if IOP starting to increase despite medical therapy or in acute setting if still visual and not responding to pressure lowering medication

Case Example: “Bonnie”

- 4 yo FS beagle
- Progressive “eye bulging” and cloudiness OD
- No obvious visual impairment at home



<https://dogtime.com/dog-breeds/beagle#/slide/1>

Clinical presentation

OD:

- Buphthalmos
- Scleral injection
- Lens subluxation
- Avisual
- IOP= 47mmHg

OS:

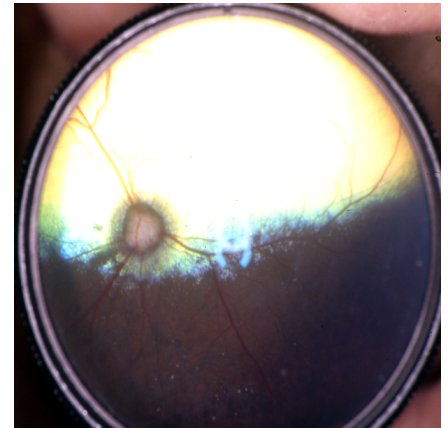
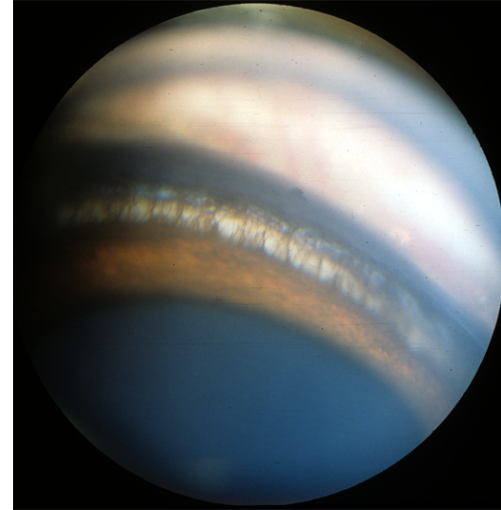
- WNL



<https://i2.wp.com/veteriankey.com/wp-content/uploads/2020/07/c09f006a.jpg?zoom=1.5&w=960>

Primary Open Angle Glaucoma (POAG)

- “Beagle” glaucoma
- Open angle on gonioscopy
- Normal pectinate ligament
 - Obstruction within trabecular meshwork
- VERY slow, gradual elevation of pressure over time
- Type of glaucoma most commonly seen in humans
- Both eyes affected; unilateral onset



<https://els-jbs-prod-cdn.jbs.elsevierhealth.com/cms/attachment/0543bb05-095e-49bd-8217-0f8c03ccb55c/gr1.jpg>

Treatment- same as for PACG

- Latanoprost*
 - Especially in the acute setting when pressure severely elevated
 - BID-TID
- Dorzolamide
 - BID-QID
- Timolol
 - BID to QID
 - Can also be used as prophylactic for contralateral eye BID
- Mannitol IV
 - 2g/kg over 30min, withhold water, make sure to administer through filter
 - If no response to topical medications and there is hope to save vision
- Surgery
 - Best chance of preserving vision if IOP starting to increase despite medical therapy or in acute setting if still visual and not responding to pressure lowering medication

***NEW* Treatment**

- Latanoprostene bunod
 - Nitric oxide-donating prostaglandin F2alpha agonist
 - Improved IOP lowering effect vs. latanoprost
 - Increases uveoscleral and trabecular aqueous humor outflow
- Netarsudil
 - Rho kinase inhibitor
 - Targets trabecular meshwork cells and increases outflow facility
 - Reduces cell contractility and cell stiffness
 - Decreases expression of fibrosis related proteins
 - More effective in open angle vs. closed angle glaucoma
 - Initial study not encouraging...

Secondary Glaucoma

- Glaucoma caused by another, underlying condition:
 - Severe or chronic uveitis
 - Peripheral anterior synechia
 - Pre-iridal fibrovascular membrane and pupillary block
 - Inflammatory debris clogging drainage angle
 - Lens luxation
 - Pupillary block glaucoma- acute
 - Secondary to uveitis- chronic

Case Example: Goldie

- 11 yo FS Golden Retriever
- Vision impairment
- Increased haziness to the eyes



<https://s3.amazonaws.com/cdn-origin-etr.akc.org/wp-content/uploads/2020/05/23125156/Golden-Retriever-laying-down-on-a-trail-in-the-forest-500x486.jpg>

Clinical Findings

- Absent menace and PLR OS, normal OD
- 2+ flare with pigmented cell OS, no active inflammation OD
- Posterior synechia and pupil dyscoria with significant pigment deposition on lens and early incomplete cataract OS
- Pigment dispersion over lens, focal posterior synechia OD, some adjacent poorly pigmented iridal cysts attached to the pupil margin
- Mild diffuse corneal edema OD, moderate edema OS
- Difficult to examine fundus OS due to anterior segment changes, but normal OD
- Intraocular pressures: 12mmHg OD, 42mmOS

Golden Retriever Pigmentary Uveitis

- Late age onset
 - Mean age= 8 yr
- No sex predilection
- Most frequently bilateral
- Characterized by:
 - Poorly pigmented uveal cysts
 - Pigment dispersion across anterior lens capsule
 - Adhesions between iris and lens + peripheral iris and cornea
 - Secondary cataract
 - Progresses to obstructive glaucoma



<https://onlinelibrary.wiley.com/cms/asset/88716686-42f6-4417-8257-83d6be7b21ae/vop12796-fig-0021-m.jpg>



<https://i.shgcdn.com/3f71b2e5-2f31-46df-926b-eb8f6c54c2db/-/format/auto/-/preview/3000x3000/-/quality/lighter/>

Treatment

- Anti-inflammatory
 - No proof that anti-inflammatory therapy helps to delay onset of glaucoma in early stages
 - Start with topical NSAID BID, change to topical steroid if pressure starting to trend upward
- Dorzolamide
 - BID-QID
- Timolol
 - BID-QID
- Latanoprost?
 - Not very effective
 - Exacerbates inflammation
 - Last resort
- Surgery
 - Poor prognosis
 - Not very successful

Case example: Basil

- 6yo MC JRT
- Acute onset redness, squinting, discharge
- Enjoys shaking toys



<https://www.k9web.com/wp-content/uploads/2021/02/portrait-of-jack-russell-terrier-dog.jpg>

Clinical findings

OD

- Blepharospasm
- Focal corneal edema
- Scleral injection
- Shallow anterior chamber
- Normal consensual PLR but absent direct
- Decreased menace
- Normal fundic examination
- IOP=82mmHg

OS

- Normal

Primary Lens Luxation

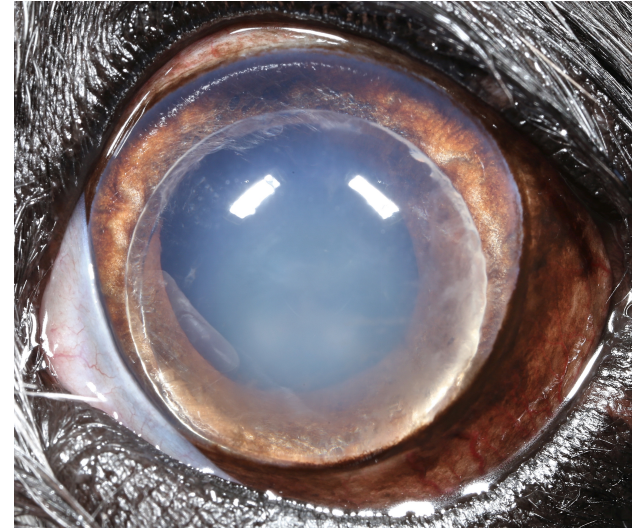
- Heritable in Terrier Breeds
- Inherent weakness in zonular ligaments suspending the lens
- Early age of onset
 - 3-6yr
- Very acute pressure spikes
 - Pupillary block
- Uveitis



Treatment- Surgery

Lensectomy

- Physical removal of entire lens through large corneal incision
- Best chance for long term vision and comfort
- TIME SENSITIVE
- Risk of retinal detachment, secondary glaucoma
 - Need frequent recheck examinations
- Multiple topical and oral medications to address inflammation and pressure spikes



https://www.merckvetmanual.com/-/media/manual/veterinary/images/anterior-lens-luxation-dog-high.jpg?thn=0&sc_lang=en

TREATMENT- TRALL

Trans corneal reduction of anterior lens luxation

- Only effective if performed shortly after luxation
- Sedate
- +/- mannitol if IOP severely elevated
- Tropicamide
- Gentle manual pressure over closed eyelid
- Latanoprost BID for LIFE
- Topical steroid SID-BID to control inflammation
- Still blind later from development of secondary glaucoma (50% after 6 mo)

Treatment- Conservative

Medical management

- Tropicamide q4-6 hr to see if lens will fall posterior
 - Latanoprost BID after
- Dorzolamide
 - BID- QID
- Timolol
 - BID-QID
- Topical steroid
 - BID
 - Address secondary inflammation due to lens luxation
- Pain medications

If no improvement in IOP- recommend treatment for end stage glaucoma

End stage

- BLIND
- UNCOMFORTABLE
 - Not always easy to tell clinically
 - Decreased energy level at home
 - Decreased appetite
- Pressure >30mmHg?
 - Migraine like symptoms



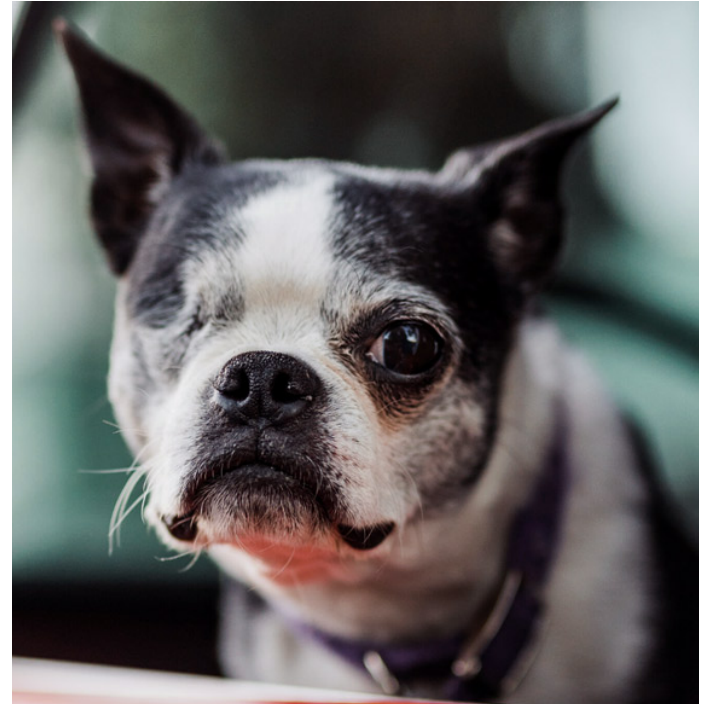
https://www.merckvetmanual.com/-/media/manual/veterinary/images/chronic_glaucoma_dog_high.jpg?thn=0&sc_lang=en

End-stage Therapy

- Enucleation
 - Most definitive
 - Brief post-op discomfort (24-48hr)
 - Fastest return to function
 - Sinking of the skin into orbit



<https://www.animaleyecollectors.com/images/content/eye-services/enucleation-prosthesis-ciliary-body-ablation.jpg>



<https://media.publit.io/file/cuddla/boston-terrier-eye-injury.jpg>

End Stage Therapy- Surgery

Enucleation with orbital prosthesis

- Same procedure as enucleation
- Placement of appropriately sized silicone ball into orbit before closure
- Prevents sinking of skin into orbit
- Small risk (<5%) of implant rejection/complication

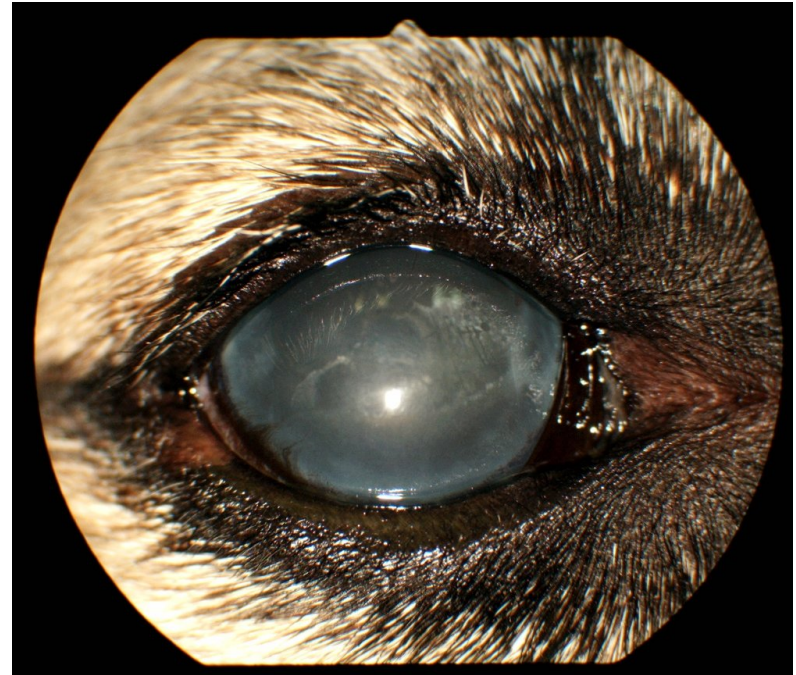


<https://neuticles.com/wp-content/uploads/2019/10/Eyeplants-300x300.jpg>

End Stage Therapy- Surgery

Evisceration + prosthesis

- Maintains appearance of an “eye”
- More costly
- Longer recovery time (1-2mo)
- Need for continued medications
 - Anti-inflammatory
 - Tear stimulant
 - Artificial tears
- Risk of fibrosis
 - Poor cosmetic result



<https://www.acvo.org/common-conditions-1/2018/2/23/ocular-prosthesis-evisceration>

End Stage Therapy- contin

Chemical ciliary body ablation

- Intravitreal injection under propofol
 - Gentamicin
 - Cidofovir
- 60% effective after one injection
 - Sometimes needs to be repeated
- Must manage inflammation post op, continue pressure lowering medications short-term
- Risk of dry eye/ corneal ulceration in future
- Eye may become phthisical

Good for patients that are high risk for anesthesia or that have owners unwilling to consider eye removal

