Course #
743
The Anatomy of Glaucoma
Technicians & The Anatomy of Glaucoma

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Glaucome Facts

• Approximately 10% of people who have glaucoma and receive proper treatment still experience visual loss. This vision loss can not be regained.
• Vision loss begins with loss of side vision
• Approximately (3+) million Americans have glaucoma - but only half of them know it!

Glaucoma Facts

• Of those (3+) million, approximately 120,000 are blind from glaucoma - accounting for 9-12% of all cases of blindness in the U.S. This makes glaucoma the second leading cause of blindness in the world (according to the World Health Organization).

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Glaucoma Facts

• Glaucoma is the leading cause of blindness among African-Americans and is 6-8x more common in African-Americans than Caucasians. Open Angle Glaucoma accounts for 19% of all blindness among African-Americans compared to 6% in Caucasians.
* Glaucoma is NOT curable - but in most cases it can be controlled to decrease the loss of vision.

Glaucoma Facts

• Most common form is Primary Open Angle Glaucoma
• There is an estimated 65 million suspected cases of glaucoma in the world.
• Blindness is ranked 3rd (after cancer and heart disease) as people’s major health fear. 50% of people have heard of glaucoma, but weren’t sure what it was. 30% of people have never heard of glaucoma! (Prevent Blindness Survey)
**Financial Glaucoma Facts**

- Glaucoma accounts for over 7 million physician visits each year.
- In terms of Social Security benefits, lost income tax revenue and health care expenditures, the cost to the U.S. government is approximately 1.5 billion dollars yearly! *(NEI report)*

**People At Risk**

- African Americans have a 6-8% higher risk
- People over 60 y.o.
- POAG is hereditary
- Asians run an increased risk for angle closure
- Past blunt trauma eye injuries may cause secondary glaucoma
- Patients that are very nearsighted
- Diabetics
- Patients with high blood pressure
- Thin corneal thickness ≤ 0.555 mm

**So... What is Glaucoma?**

Glaucoma is a disease that can be categorized as a triad disease process. This means that (3) “things” must occur before your eye doctor considers a diagnosis of glaucoma:

- Increased intraocular pressure
- Visual field changes
- Optic nerve changes

**Better yet – how does this happen??**

Glaucoma is:
- very slow
- progressive
- painless
- irreversible
- hard for your doctor to manage due to:
  a. medicines
  b. compliance

**If you think of the eyeball as a sink...**

In half of the patients with glaucoma, the “faucet” (ciliary bodies) are on full blast. The drain is normal, but the drain cannot handle the amount of fluid being created... or,... the faucet is at regular flow but the “drain” (trabecular meshwork) is partially clogged. The drain doesn’t drain the fluid adequately causing the water to rise in the sink.

**Aqueous Production: “the drain versus the sink”!**

Trabecular meshwork is how the aqueous flows out of the eye. “The drain”

Ciliary processes & bodies makes aqueous - “the faucet”
How Is Aqueous Made?

Aqueous is produced by the ciliary body & processes. It is a clear liquid that fills the anterior and posterior chambers.

What is Aqueous?

The composition of aqueous is similar to plasma. If you were to increase the protein content, it would begin to take on more plasmoid features.

Aqueous nourishes the eye.

Aqueous Flow & Outflow

There are (2) ways that aqueous leaves the eye.

* **conventional**: through the trabecular meshwork
* **unconventional**: passing through the ciliary body where part of it is absorbed by the uveal blood vessels.

Since the most efficient path is the trabecular meshwork, if the "flow" is too great or there is a problem with the "drain", then pressure will increase inside the eye resulting in:

* Damage to the optic nerve
* Damage to the corneal endothelium

Optic Nerve

An extension of the CNS with the fibers running from the ganglion cells in the retina to the chiasm.

The optic nerve is Cranial Nerve II and is approx. 50 mm in length. The right nerve eventually joins the left nerve to form the chiasm.

Optic Disc (Optic Nerve Head)

* Disc is approximately 1.5 mm in diameter.
* The "cup" is located in the center of the disc.

* Cups are usually symmetrical.
* Branches of the central retinal artery & vein merge from the center of the cup.

Lamina cribrosa = "sieve" where nerve fibers pass through
Optic Disc

C/D of 0.5 means that the Cup to Disc ratio is 0.5 i.e., cupping is about 50% of total disc area. The ‘orange/pink’ rim of disc contains nerve fibers. The white cup is a pit with no nerve fibers. As glaucoma advances, the cup (white pit) occupies most of the disc area.

Problems With Optic Nerve

Normal

Advanced cupping

C/D Progression

0.3

0.9

Nerve Fiber Layer

So... How Do We Check For Glaucoma?

- Applanation Tonometry
- Goldmann or Humphrey Visual Field
- Pachymetry
- Dilated Fundus Examination
- Other tests:
  - OCT
  - GDX

Why Do We Check Eye Pressure?

Tonometry: measuring *intraocular* pressure.

**Purpose:** to aid in the detection of *undiagnosed* glaucoma. ↑ IOP puts you at *risk* for glaucoma, it *does not* mean you have the disease. Whether you get glaucoma depends on whether or not your optic nerve can tolerate the increase.
Applanation Tonometry

Fluorescein-stained semicircles seen with Goldmann tonometry

- Too Small
- Too Large
- Endpoint

Errors That Can Cause An Increase In IOP

- Weightlifting
- YOGA: Head Stands
- Tight Tie or Collar
- Holding Breath

Ocular Rigidity

"Displacement of ocular coats"

Applanation tonometry is the most efficient way of performing tonometry because it does not indent the eye, therefore there is no artificial increase in pressure. Nor does it increase the eye pressure due to any weight induced by the tonometer prism. Applanation also minimizes artificially low pressures in eyes that have low ocular rigidity (myopes).

Tonometry is designed to be a gentle touch on the cornea.

Because the tonometer flattens the cornea and does not indent it, the pressure can be measured within 0.5 mm Hg. Scleral rigidity is disregarded because less than 0.5mm of volume is displaced. There also is minimal to no massage effect that can occur due to repeated measurements.

The prism tip has a 3.06 mm diameter. This also prevents an artificial increase in intraocular pressure.
How to Perform

Look through **one** eyepiece. Adjust the position of the mires by moving the joystick up or down until they **slightly overlap**.

Signs Of “Aggressive” Tonometry!

Abrasions due to alcohol on probe

Abrasions due to repeated measurements

Tech “Angles” = AC depth

Gonioscopy

Grade 0 = closed Grade 4 = wide open

Anatomy of the Angle
Pachymetry: Corneal Thickness

The Ocular Hypertension Treatment Study (OHTS) (2002) showed central corneal thickness (CCT) to be a strong indicator of glaucoma.

Average corneal thickness = 540 microns

Eye with cornea thickness less than 555 (thin corneas) were found to have a 3x higher risk of developing glaucoma and therefore, CCT under 555 should be seen as a potential risk factor for the development of glaucoma. So.. the 540 normal CCT also falls into the potential risk category!

Errors can occur because:

* thicker corneas cause false high
* thinner corneas cause false low

IOP readings.

Corneal Thickness Affects IOP Accuracy

Goldmann TA is accurate with average corneal thickness—540 to 570 microns

- Reads low if cornea is thinner than average: approximately 500 microns or less
- Reads high if cornea is thicker than average: approximately 600 microns or more

How Can We Use This Data?

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<th>Thick cornea + NL IOP</th>
<th>Thick cornea + High IOP</th>
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GLAUCOMA GVF

Paraclinal scotomas within acute depression
Nasal step
Nasal depression
Accute scotoma (in lamellar region)

Ocular Computerized Tomography

Types of Glaucoma

- *OHTN* Ocular Hypertension
- NTG Normal Tension Glaucoma
- POAG Primary Open Angle Glaucoma
- NAG Narrow Angle Glaucoma
  - Traumatic
  - Congenital
  - Steroid Induced

Normal Tension Glaucoma:
(also known as Low Tension Glaucoma)

* Damage occurs to the nerve without the eye pressure exceeding normal limits (10-20)
* Cause unknown
* **Watch the nerve closely!!**
* Risk Factors:
  - Japanese ancestry, cardiovascular disease, women > men

Primary Open Angle Glaucoma

* Most common type of glaucoma
* Strong family tendency
* Degeneration of the trabecular meshwork
* Decrease in aqueous drainage leading to ↑ IOP

Abnormal internal pressure

Optic Nerve endings slowly deteriorate under abnormal pressure

Clogged Trabecular meshwork leading to drainage canal

Pressure builds when aqueous fluid is blocked
Open Angle Versus Narrow or Closed Angle Glaucoma

Angle Closure Glaucoma

Caused by:
Primary: Pupillary block
Secondary: something pushing or pulling iris into the angle.
Causes: neovascular glaucoma, due to:
   a. diabetes  b. Uveitis  c. central retinal vein occlusion

Angle Closure Glaucoma
The "drainage canal" (trabecular meshwork) becomes blocked. Aqueous cannot leave the eye efficiently causing the IOP to increase drastically.

Secondary Glaucoma
Outflow of aqueous is blocked because of another eye disorder ...

injury, hemorrhage, inflammation or drug induced.

Congenital Glaucoma
Caused by developmental abnormalities in children or abnormalities in the aqueous formation mechanism. The eye appears foggy or cloudy. The child is often photophobic and has increased tearing present. "Bupthalmous" = "cow eyes"

Pigmentary Glaucoma
- Bilateral
- Males > Females
- Ages 20-40
Caused by lens zonules rubbing the back of the iris and the cells shedding into the aqueous. The pigment "travels" and gets "stuck" in the trabecular meshwork (as well as other places) causing ↑ IOP.
**Pigmentary Dispersion Syndrome**

Same as the previous syndrome, but in this case there is **no increase in IOP**, **no visual field changes** and the **optic nerve appears normal**.

A large number of people with PDS may go on to develop Pigmentary Glaucoma.