INTRAOCULAR PRESSURE

Natalie K Modersitzki, Dustin Randall MS4, Alex Vitale BS, Lydia Sauer MD, Alex Tolman MS2, Sophia Fang MD
• The cornea is the transparent tissue that covers the iris, pupil and anterior chamber of the eye
• The cornea accounts for about 60 Diopters of refractive power. Its innate ability to bend light comes from its convex nature
• The cornea is used as a point of reference when measuring intraocular pressure (IOP)
CORNEA

Moran axis
BIOMECHANICS

- Corneal rigidity is a direct result of the way that the collagen fibers line up in the corneal matrix.
- Corneal edema also affects pressure readings because of the fluid imbalance in the tissue.
- IOP is a measure of resistance when we depress the cornea. Thus, corneal thickness also affects IOP measurement.
CORNEAL EDEMA
INTRAOCULAR PRESSURE

- IOP is the fluid pressure inside the eye
- It is an integral part of a patient’s work-up as it is used as a screening tool for glaucoma
- Pressure is a measure of force per area
- IOP is determined by the amount of weight required to flatten 3.06 mm of the cornea
- Most tonometers measure pressure in millimeters of mercury (mmHg)

Imbert-Fick Principle

\[
\text{IOP} = \frac{F}{C} + P
\]

- \(F\) = aqueous flow
- \(C\) = aqueous outflow
- \(P\) = episcleral venous pressure
AQUEOUS HUMOR PATHWAY

- The clear fluid that fills the anterior chamber of the eye is known as aqueous humor.
- The majority of aqueous humor drains through the trabecular meshwork at the angle of the anterior chamber and into Schlemm’s canal where it eventually drains into episcleral veins.
- A small amount of the aqueous humor passes into the suprachoroidal space and enters venous circulation in the ciliary body, choroid, and sclera.
• The primary determinant of IOP is the production, drainage, and pathway of aqueous humor in the anterior chamber.
• The vitreous humor in the posterior segment has a fixed volume, and therefore it does not affect IOP measurements.
• IOP also can increase with elevated systemic blood pressure.
ANGLE

Moranaxis
IMPORTANCE OF IOP

• IOP is carefully regulated
• Pressure in the eye helps maintain the integrity of eye structure and shape
• Irregular IOP can suggest pathologies such as glaucoma, uveitis, or retinal detachment
NORMAL PRESSURE

• Although the pressure in the eyes can fluctuate throughout the day, **10-22 mmHg** is considered normal IOP.
MEASURING IOP

• There are many different ways to eye pressure including: pneumotonometry, rebound tonometry, air-puff tonometry, and the gold standard – applanation.
MEASURING IOP: TONOPEN

1. Instill a drop of topical anesthetic into the eye
2. Position the patient, seated supine, and have the patient fixate on a target
3. Position the pen in front of the cornea and make contact with the central cornea
MEASURING IOP: TONOMETER

1. Position the patient, seated supine, and have the patient fixate on a target
2. Position the tonometer in front of the cornea and click the button to measure the pressure with the probe
3. Its light-weight probe makes momentary contact with the cornea
4. This device uses rebound technology to measure intraocular pressure
MEASURING IOP: GOLDMAN APPLANATION

Wikicommmons/ Moran axis
GOLDMAN APPLANATION

1. Instil the local anesthetic drops and then the fluorescein. Only a small amount of fluorescein is needed.
2. For measuring the IOP in the right eye, make sure the slit beam is shining onto the tonometer head from the patient's right side; for the left eye, the beam should come from the patient's left side.
3. Adjust the slit lamp so that the blue filter is employed to produce a blue beam.
4. Fully widen the beam and maximize the brightness of the blue beam.
5. Ask the patient to look straight ahead, open both eyes wide, fixate their gaze on something straight ahead and hold still.
6. Using your thumb, gently hold up the patient's top eyelid, taking care not to put any pressure on the eye.
7. Direct the blue light from the slit lamp or the Perkins tonometer onto the prism head.
GOLDFMAN APPLANATION

• 8. Align the tonometer head level with the patient’s eye
• 9. Move the tonometer forward slowly until the prism rests on the center of the cornea
• 10. With the other hand, turn the calibrated dial on the tonometer clockwise until the two fluorescein semi-circles in the prism head are seen to meet and form a horizontal ‘S’ shape. The correct end point is when the inner edges of the two fluorescein semi-circle images touch
• 11. The reading on the dial is the IOP measurement
• 12. Withdraw the prism from the corneal surface and wipe its tip
MEASURING IOP: PALPATION

• It is possible to detect very high IOP using your fingertips
• Relative assessment of IOP
• Variable evidence in showing correlation between tactile assessment of IOP and tonometry
  – accuracy is limited and is generally more effective with very high and very low IOPs
  – may be useful in estimating IOP in patients who cannot undergo traditional applanation tonometry (i.e. severe ocular surface disease, post-operative penetrating keratoplasty)
CONTRAINDICATIONS

• Contraindications to measuring IOP include:
  – Trauma
  – Corneal ulcer
  – Open globe

• Additional pressure in these conditions can cause further damage to the globe and lead to extrusion of aqueous and/or vitreous humor
CORNEAL ULCER
OCULAR TRAUMA
Conditions associated with high Intraocular Pressure
GLAUCOMA: OPEN-ANGLE GLAUCOMA

• Glaucoma is a group of optic neuropathies usually (but not always) characterized by increased IOP

• **Open-angle glaucoma** is an optic neuropathy resulting in a progressive loss of retinal ganglion cell axons
  - Usually is asymptomatic, but rarely can manifest initially as visual field loss and can lead to irreversible blindness if left untreated
    • A leading cause of irreversible blindness world-wide
  - A decrease in aqueous outflow or an increase in aqueous production are possible mechanisms for increased IOP
GLAUCOMA - OPEN ANGLE
NEOVASCULAR GLAUCOMA

• A secondary glaucoma characterized by a development of new vessels over the iris and iridocorneal angle
• Primarily occurs in diabetic patients or those with a previous retinal vein occlusion
  – Posterior segment ischemia induces VEGF production, which stimulates iris and angle neovascularization
  – Formation of new vessels and fibrous membrane blocks the iridocorneal angle, leading to an obstruction of aqueous humor outflow
  – Outflow obstruction leads to an increased IOP
• Associated with poor visual prognosis
NEOVASCULAR GLAUCOMA

Moran axis
NEOVASCULARIZATION IN THE ANGLE

Moran axis
PSEUDOEXFOLIATION SYNDROME (PXF)

- Systemic condition in which a basement membrane particulate material is deposited at the edge of the pupil, on the lens, in the drainage structures, and throughout other structures in the front of the eye
- The material adheres to the anterior lens capsule and can rub pigment off the iris and subsequently clog the trabecular meshwork, causing an increase in IOP
- Can cause zonular instability
  - Leads to surgical complications
PXF DEPOSITS ON THE LENS

Moran Axis
PIGMENT DISPERSION SYNDROME (PDS)

• Occurs when the posterior surface of the iris rubs against the zonules
• Pigment clumps float in the aqueous humor and eventually clog the trabecular meshwork, leading to an increase in IOP
• Causes a transillumination defect in the iris
• Most prevalent in young, white, myopic males
ACUTE ANGLE CLOSURE

• A medical emergency in which the lens is located too far forward anatomically and plasters against the iris
  – The resistance creates a pressure gradient across the iris that forces the lens and iris to an even more anterior position
  – As a result, the irido-corneal angle can become sealed off, completely blocking the trabecular meshwork, leading to a rapid, painful rise in IOP

• Without immediate treatment, the increase in pressure can damage the optic nerve and many other integral structures in the eye
Acute Angle Closure

- red/painful eye
- sluggish/mid-dilated pupil
- very high pressure—greater than 60mmHg
- nausea/vomiting
- corneal swelling
- patient sees halos around light
- rock hard upon palpation
- Can quickly lead to blindness
NARROW ANGLE
UVEITIS

- Inflammation of the uvea, which is the middle portion of the eye
- Elevated IOP affects 5-19% of uveitis patients
- Many different uveitic syndromes can lead to increased IOP including: varicella zoster virus, herpes simplex virus, cytomegalovirus, sarcoidosis, toxoplasmosis, syphilis, acute uveitic angle closure and anterior uveitis (synechiae)
- Chronic and acute corticosteroid usage can also contribute to an increase in IOP in these patients
  - Corticosteroids decrease outflow of aqueous humor
TREATMENT FOR HIGH IOP

• Decrease aqueous humor production:
  – Beta blocker - timolol
    • Systemic side effects can occur from nasal absorption of topical Beta blockers, making it especially important to ask your patients if they have asthma, COPD, or any cardiac problems
  – Alpha agonists - brimonidine
  – Carbonic anhydrase inhibitor (CAI) - acetazolamide

• Increase uveoscleral outflow:
  – Prostaglandin analogues latanoprost, bimatoprost
    • They can make eyelashes grow longer, and in a few patients it may darken their iris color, turning green and blue eyes brown
TREATMENT FOR HIGH IOP

• **Increase uveoscleral outflow:**
  – Prostaglandin analogues latanoprost, bimatoprost
    • They can make eyelashes grow longer, and in a few patients it may darken their iris color, turning green and blue eyes brown

• **Increase trabecular outflow:**
  – M3 agonist- pilocarpine, carbachol

• **Surgical options**
  – Trabeculectomy – creates an alternate drainage pathway
  – Bleb- reservoir for aqueous to flow into under the conjunctiva
  – Argon laser trabeculoplasty(ALT) – used to burn parts of the trabecular meshwork causing increase in outflow
Conditions with Low Intraocular Pressure
HYPOTONY

- Defined as low IOP (below 10mmHg)
- Often associated with decreased vision
- Causes include:
  - Post surgical wound leak
  - Chronic inflammation
  - Retinal detachment
LEAKING WOUND

• Loss of intraocular fluid leads to low eye pressure
• Complaints of epiphora, defined as unintentional (not caused by crying) overflow of tears onto the face
• Physical manifestations include:
  – shallow anterior chamber
  – large corneal folds
  – choroidal effusion
  – optic nerve edema
• Seidel positive upon examination
SEIDEL POSITIVE

Moranaxis
SUMMARY

• IOP is a measure of resistance when we depress the cornea.
• Different diseases can cause fluctuations in pressure readings.
• IOP is an important part of a comprehensive eye exam.
SPECIAL THANKS

• James Gilman, CRA, FOPS
• Sophia Fang, MD
REFERENCES

• www.RootAtlas.com
• www.Wikimediacommons.com
• www.AAO.org/intraocularpressure
Thank you