5.4 Eye Tonometer, Applanation Tonometer

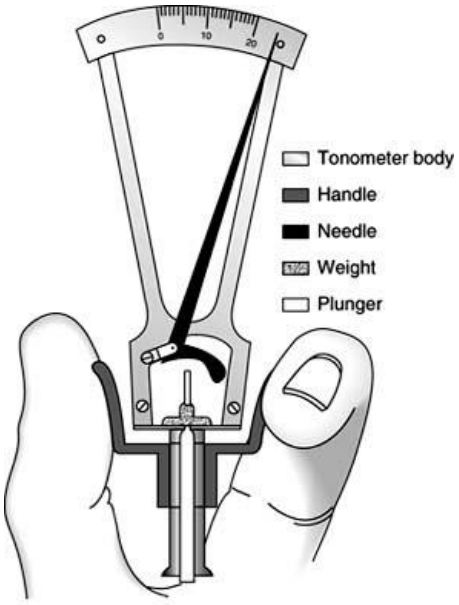
- An **eye tonometer** is a medical device used to measure the pressure inside the eye, known as **intraocular pressure (IOP)**.
- It is primarily used to screen for, diagnose, and monitor conditions such as **glaucoma**, where elevated IOP can damage the optic nerve and lead to vision loss.

Intraocular pressure (IOP):

Intraocular Pressure (IOP) refers to the pressure exerted by the fluids (primarily the aqueous humor) inside the eye against its walls. It is a critical factor in maintaining the eye's shape, ensuring proper function, and supporting the overall health of ocular structures.

Eye Tonometer:

- A tonometer is a device used to measure the intraocular pressure (IOP) of the eye.
- IOP is the fluid pressure inside the eye, and it's important for maintaining the health of the eye. Elevated IOP can be a sign of glaucoma, a condition that can damage the optic nerve and lead to vision loss.



❒ This diagram illustrates a **Schiötz tonometer**, an instrument used in ophthalmology to measure intraocular pressure (IOP), which is crucial for diagnosing and managing conditions like glaucoma.

Components and Their Functions:

1. **Tonometer Body**:
   - ❖ The main structural component that houses the mechanism and provides support for other parts.
2. **Handle**:
   - ❖ Allows the examiner to hold and stabilize the instrument during the procedure.
3. **Needle**:
   - ❖ Indicates the scale reading that corresponds to the intraocular pressure.
   - ❖ Moves as the plunger is displaced by the resistance of the eye.
4. **Weight**:
   - ❖ Attached to the plunger to apply a specific, known force onto the eye.

- Different weights can be used depending on the required measurement range.

5. **Plunger**:

- Comes into direct contact with the cornea via the footplate.
- Its displacement, influenced by the resistance of the cornea, determines the IOP measurement.

Working Principle:

1. **Positioning**:

- The patient lies in a supine position, and anesthetic drops are applied to numb the cornea.
- The tonometer is gently placed on the corneal surface.

2. **Force Application**:

- The weight on the plunger applies a known force to the cornea.
- The resistance of the cornea to indentation determines how much the plunger moves.

3. **Measurement**:

- The needle on the scale indicates the extent of indentation.
- The reading is converted to IOP using a calibration chart provided with the instrument.

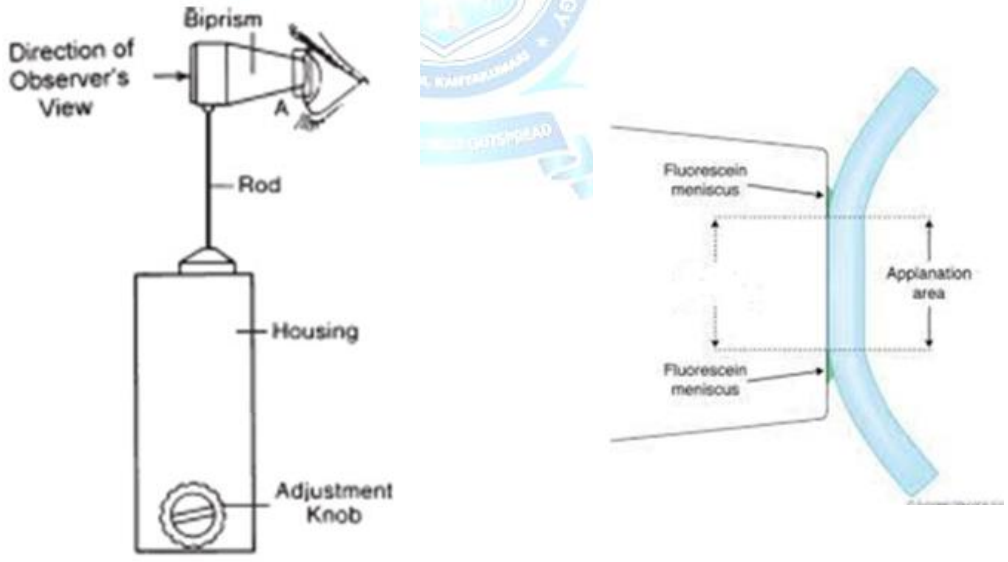
Applications:

- **Glaucoma Diagnosis**: Measures elevated intraocular pressure, a key indicator of glaucoma.
- **Post-Surgery Monitoring**: Evaluates IOP after eye surgeries.
- **Routine Eye Exams**: Assesses eye health, particularly in patients at risk of ocular hypertension.

Types of Eye Tonometer:

- **Applanation tonometer:** This is the most common type of tonometer. It uses a small cone-shaped tip that is gently pressed against the cornea. The amount of force required to flatten a small area of the cornea is measured and converted into a reading of IOP
- **Non-contact tonometer:** This type of tonometer uses a puff of air to flatten the cornea.
- The pressure of the air is measured and converted into a reading of IOP
- **Rebound tonometer**: This type of tonometer uses a small probe that is gently tapped against the cornea. The rebound of the probe is measured and converted into a reading of IOP

Applanation Tonometer:



Construction of an Applanation Tonometer:

1. **Measuring Probe:**
   - A transparent, flat-tipped probe with a contact area designed to flatten exactly **3.06 mm** of the cornea.
   - Made of high-quality, durable materials like acrylic or glass.

2. **Prism:**
    - ❖ A bi-prism at the tip of the probe splits the image of the fluorescein-stained corneal surface into two semicircles, aiding alignment.
3. **Mechanical Arm:**
    - ❖ Holds the probe and allows precise movement toward the patient's cornea.
4. **Calibration Mechanism:**
    - ❖ Ensures accurate measurement by adjusting the applied force.
5. **Illumination:**
    - ❖ Often used with a slit lamp for proper visualization of the corneal area and alignment of the tonometer.
6. **Scale/Readout System:**
    - ❖ Displays the force required to flatten the cornea, which is converted into IOP values (measured in millimeters of mercury, **mmHg**).

Working of an Applanation Tonometer:

Principle of Operation

- ❖ The **Goldmann applanation tonometer** is the gold standard in IOP measurement because the flattening of a 3.06 mm area simplifies the Imbert-Fick law.

❒ **Key Assumptions:**

- ❖ The cornea is a thin, elastic, and spherical surface.
- ❖ Surface tension of the tear film cancels out corneal rigidity when the flattened area is 3.06 mm in diameter.

❒ **Practical Implementation:**

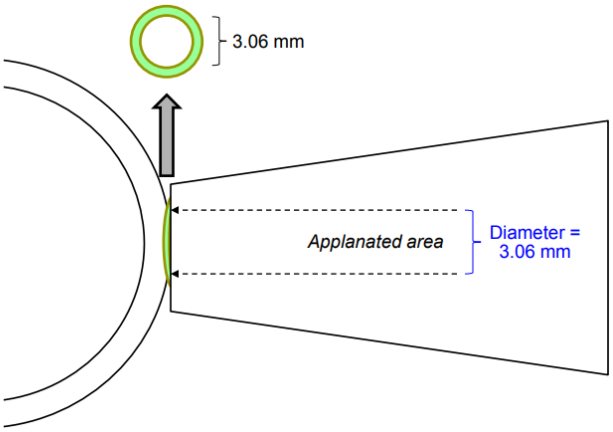
- ❖ At this diameter, **1 gram of force** applied corresponds to **10 mmHg** of intraocular pressure, simplifying calculations.

❒ It works on the **Imbert –Fick** principle,

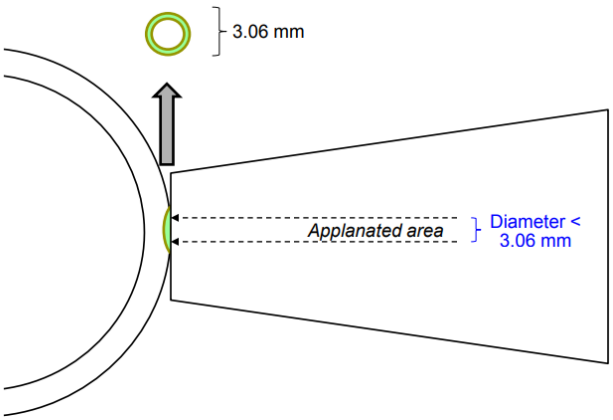
❒ The Imbert-Fick principle states that the pressure inside a closed, thin-walled, dry sphere is equal to the force required to flatten its surface divided by the area of flattening:

P = F / A

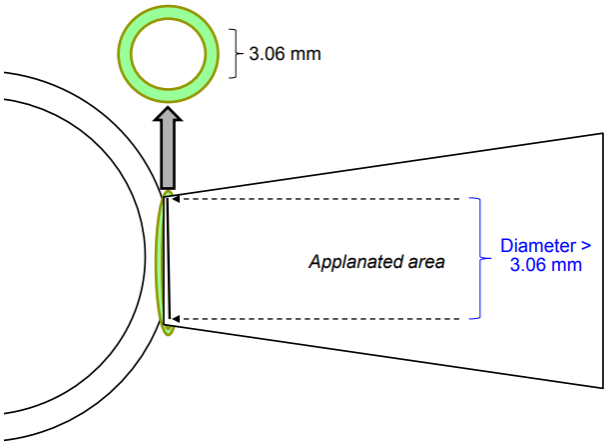
- The law is this: Intraocular pressure = Contact force/Area of contact.
- The law assumes that the cornea is infinitely thin, perfectly elastic, and perfectly flexible.



- When the diameter of the flattened area is 3.06 mm, the force being applied by the tip equals the pressure inside the eye



- When the diameter of the flattened area is less than 3.06 mm, the force being applied by the tip is less than the pressure inside the eye



- When the diameter of the flattened area is greater than 3.06 mm, the force being applied by the tip is greater than the pressure inside the eye

Limitations of Applanation Tonometer:

- **Need for Topical Anesthesia:** Since the device directly contacts the cornea, it requires the use of a topical anesthetic (eye drops) to numb the area, which can be uncomfortable for the patient.
- **Risk of Infection:** Because it involves direct contact with the cornea, there is a risk of introducing infections or causing minor abrasions if the probe is not properly sterilized.
- **Corneal Thickness Impact:** The accuracy of applanation tonometry can be affected by the **thickness** and **shape** of the cornea. Thicker corneas can give artificially high IOP reading.

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