جامعة المستقبل

كلية التقنيات الصحية والطبية

قسم تقنيات البصريات

Second Stage 2024-2025

REFRACTIVE ERRORS 2

Lecture Title

strabismus

Lecture Number: 1 / course 2

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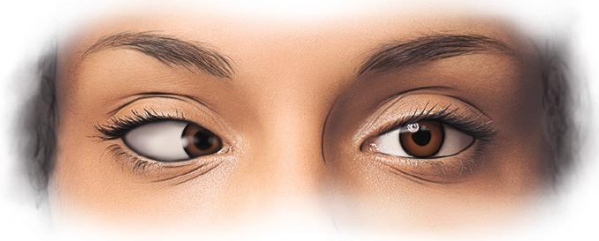
OPTOMETRIST

STRABISMUS

Strabismus is a condition characterized by a misalignment of the eyes, where one or both eyes fail to maintain proper alignment when focusing on an object. This can result in the disruption of binocular vision, leading to issues such as:

- ✓ Diplopia (Double Vision): When both eyes send conflicting visual signals to the brain.
- ✓ Suppression: The brain may ignore the image from the misaligned eye to avoid confusion.
- ✓ Amblyopia (Lazy Eye): Reduced vision in the misaligned eye due to prolonged suppression, commonly in children.

Monocular esotropia
One eye turned inward



Binocular esotropia
Both eyes turned inward

- The condition may manifest intermittently or persistently, depending on the underlying cause and severity.
- The term “strabismus” originates from the Greek word “strabismos” meaning “twisted” or “squinting”, to look obliquely and means ocular misalignment.
- Strabismus has been recognized since ancient times, with early descriptions by Hippocrates. Modern understanding began evolving in the 19th century with advancements in ophthalmology and binocular vision research

- This condition can affect individuals intermittently or constantly and may have various underlying causes, including abnormalities in the extraocular muscles, neural control, or congenital factors.
- It can affect children or adults. In children if not treated early, it can lead to amblyopia or "lazy eye" as the brain ignores input from the misaligned eye.
- Treatments can include eye patches, vision therapy, glasses, exercises, surgery to realign muscles, or botulinum toxin injections in muscles. Treatment aims to allow proper binocular vision development.

Types of Eye Positions:

- **Orthophoria**: is the ideal condition of perfect ocular alignment, even during monocular viewing.
- **Orthotropia**: is the term used more commonly, denoting correct ocular alignment under binocular conditions.
- **Heterophoria**: is a latent ocular misalignment that remains compensated by the brain's fusion mechanism under normal binocular conditions, maintaining binocular single vision. It becomes clinically evident only when fusion is disrupted, such as during monocular occlusion or dissociation tests (when one eye is covered).
  - ***Symptoms***: while often asymptomatic, it may cause eye strain, headaches, and intermittent double vision during visual fatigue, prolonged near tasks, or reading.
  - ***Diagnosis***: detected with the cover-uncover test or alternate cover test. Measured using prisms or the Maddox Rod test.
  - ***Management***:
    - Correct refractive errors with glasses.
    - Use prisms to reduce symptoms.
    - Perform vision therapy to strengthen fusion and improve binocular stability.

- **Heterotropia**: is a visible misalignment of the eyes that occurs because the brain's fusion mechanism fails to control ocular alignment. The deviation is constant or intermittent, even when both eyes are open

  - ***Symptoms***:
    - In children: Risk of amblyopia (lazy eye) due to suppression.
    - In adults: Double vision (diplopia), eye strain, or abnormal head posture to minimize symptoms.
    - Loss of binocular vision and depth perception.

  - ***Diagnosis:***
    - Measured using the Cover Test, Krimsky Test with prisms, and ocular motility testing.
    - Sensory adaptations can be identified with devices like the Synoptophore.

  - ***Management***:
    - Correct refractive errors (e.g., glasses for accommodative esotropia).
    - Use patching therapy for amblyopia in children.
    - Prisms for temporary symptom relief.
    - Surgery for significant deviations.
    - Vision therapy to improve eye coordination and binocular function.

Anatomy and Physiology of Normal Eye Alignment

Extraocular Muscles:

The six extraocular muscles are responsible for the precise movement of each eye:

- ✓ **Lateral Rectus (LR):** Moves the eye outward, away from the nose (abduction).
- ✓ **Medial Rectus (MR):** Moves the eye inward, toward the nose (adduction).
- ✓ **Superior Rectus (SR):** Moves the eye upward (elevation) and slightly inward (intorsion).

- ✓ **Inferior Rectus (IR):** Moves the eye downward (depression) and slightly outward (extorsion).
- ✓ **Superior Oblique (SO):** Rotates the top of the eye inward (intorsion) and assists in depression, especially when the eye is adducted.
- ✓ **Inferior Oblique (IO):** Rotates the top of the eye outward (extorsion) and assists in elevation, especially when the eye is adducted.

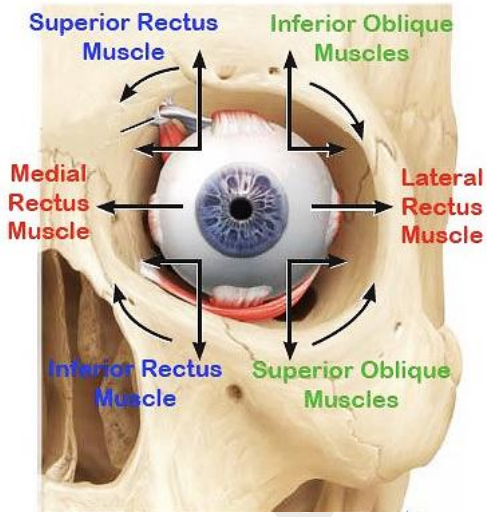
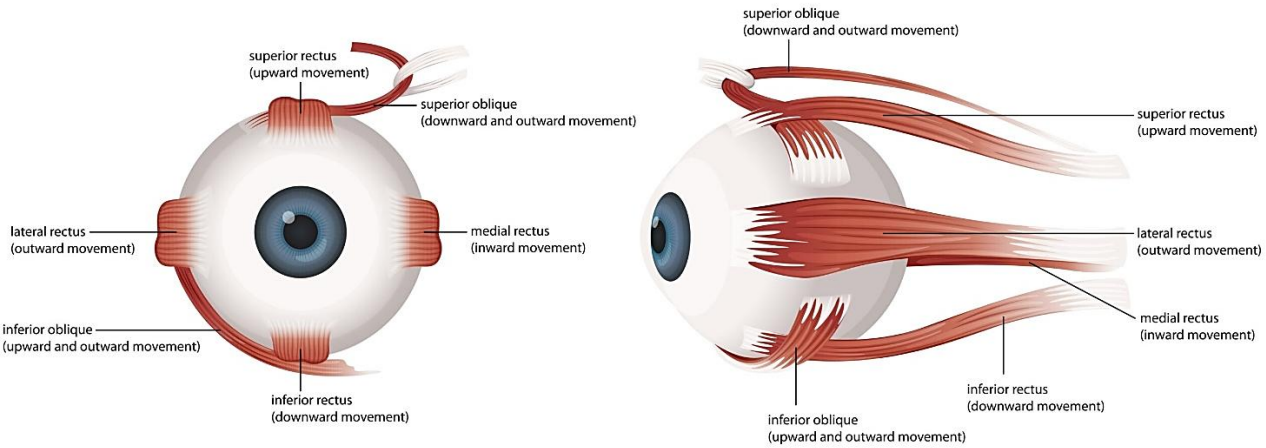


Figure. Showing the six extraocular muscles that move the eye (left eye)

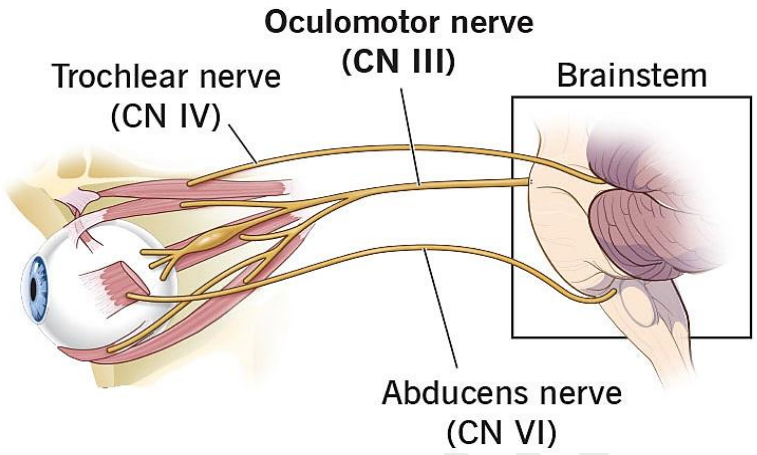
Origin and Insertion:

- All **rectus muscles** originate from the annulus of Zinn, a fibrous ring at the back of the orbit, and insert on the sclera.
- The **oblique muscles** have unique origins: the superior oblique originates from the trochlea, while the inferior oblique originates near the lower orbit.



Cranial Nerves

- ✓ **Cranial Nerve III (Oculomotor)**: Controls the medial rectus, superior rectus, inferior rectus, and inferior oblique.
- ✓ **Cranial Nerve IV (Trochlear)**: Controls the superior oblique.
- ✓ **Cranial Nerve VI (Abducens)**: Controls the lateral rectus.

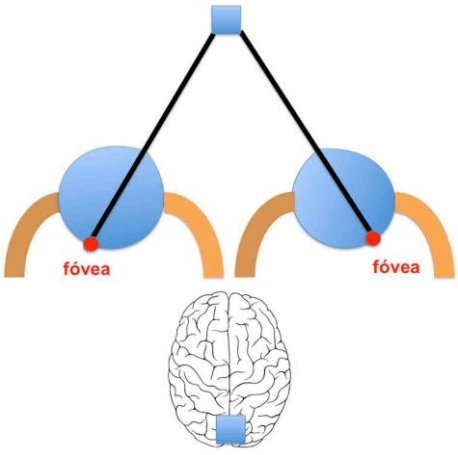


Physiology of Eye Alignment

Binocular Vision

- **Definition**: The ability to use both eyes together to create a single image.
- **Mechanisms**:

1. **Retinal Correspondence**: The foveas of both eyes are aligned to correspond to the same point in space.
2. **Fusion**: The brain merges images from both eyes to produce a unified perception.



In adults, this typically causes double vision (diplopia), where overlapping or disjointed images make visual tasks challenging.

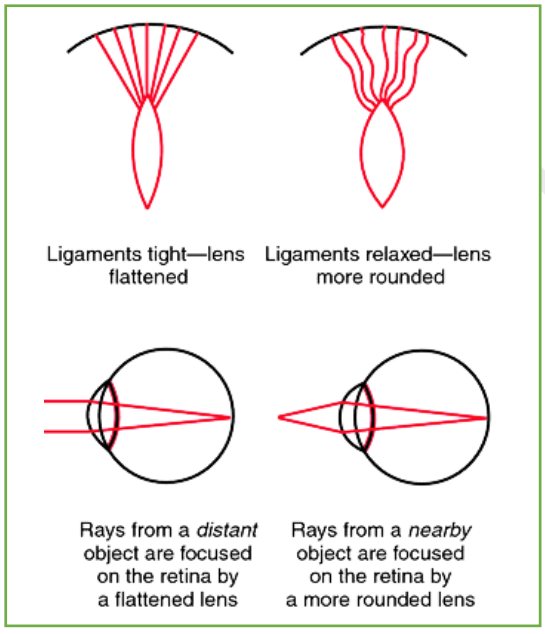
In children, the brain adapts by suppressing the image from the misaligned eye, which reduces confusion but can lead to amblyopia.

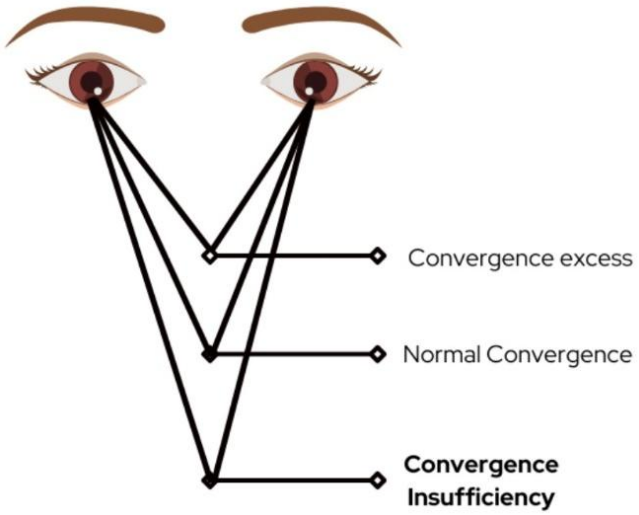
Motor Physiology

- **Primary Positions of Gaze**: straight-ahead alignment, with both eyes parallel to the midline.
- **Eye Movements**:

1. **Saccades**: Quick, simultaneous movements to reposition gaze.
2. **Pursuits**: Smooth tracking of moving objects.
3. **Vergence**: Convergent or divergent movements to adjust for near or far vision.
4. **Accommodation-Convergence Reflex**: When focusing on a near object, the eyes converge, the pupils constrict, and the lens adjusts to focus (accommodation).

Miosis refers to the constriction (narrowing) of the **pupil**, the black circular opening in the center of the eye. This physiological process is controlled by the **parasympathetic nervous system** and primarily involves the **sphincter pupillae muscle** in the iris.





Causes of Strabismus

1. Refractive Causes

- **Hyperopia (Farsightedness)**: Uncorrected hyperopia causes excessive focusing effort (accommodation) to see clearly. This can result in overactive convergence, leading to accommodative esotropia.
- **Anisometropia**: A significant difference in refractive power between the two eyes can cause one eye to deviate.

2. Neurological Causes

- **Cranial Nerve Palsies**:
- Damage to cranial nerves III (oculomotor), IV (trochlear), or VI (abducens) impairs the function of extraocular muscles, due to trauma, stroke, tumors, or systemic diseases, can result in paralytic strabismus, where eye movement is restricted.
- Example: Sixth nerve palsy causes inability to abduct the affected eye, resulting in esotropia.
- **Congenital Neurological Disorders**: Conditions such as cerebral palsy or hydrocephalus are commonly associated with strabismus.
- **Brain Injuries**: Trauma, stroke, or tumors affecting the brain regions responsible for eye movement (e.g., brainstem, cerebellum) can disrupt eye alignment.

3. Muscular and Anatomical Causes

- **Extraocular Muscle Abnormalities**: Weakness, overaction, or mechanical restriction of muscles leads to misalignment. Examples include Brown syndrome and Duane syndrome.
- **Orbital or Anatomical Defects**: Orbital fractures or structural abnormalities can physically restrict eye movement.
- **Fibrosis of Muscles**: Conditions such as thyroid eye disease can cause fibrosis or inflammation of extraocular muscles, leading to restrictive strabismus.

On physical examination, the girl was found to have diplopia on left gaze and limited extraocular movements with the right eye on upward and inward gaze (Figure).

The patient was diagnosed with right **Brown syndrome**, possibly congenital, based on her history of head tilt as a toddler. Given her age and prognosis, follow-up was recommended in 1 year, with no additional treatment recommended.

Figure. *showing the patient's different positions of gaze. (A) shows limited elevation of the right eye on upward gaze, resulting in diplopia. (B) shows marked limitation of elevation of the right eye on left superior-temporal gaze.*

4. Sensory Causes

- **Vision Loss or Amblyopia**: Poor vision in one eye disrupts binocular function, causing the brain to disregard input from the weaker eye, leading to sensory strabismus.
- **Congenital Cataracts**: Early-onset cataracts can impair visual development, causing misalignment.

5. Developmental Causes

- **Delayed Visual Maturation**: Infants with delayed development of binocular vision may exhibit intermittent strabismus, which typically resolves as visual coordination improves.
- **Genetic Predisposition**: A family history of strabismus increases the likelihood of its occurrence.

6. Systemic or Medical Conditions

- **Thyroid Eye Disease**: Inflammatory and fibrotic changes in orbital tissues and extraocular muscles cause restrictive strabismus.
- **Myasthenia Gravis**: Neuromuscular transmission defects result in fatigable weakness of extraocular muscles, causing variable strabismus.
- **Diabetes**: Ischemic damage to cranial nerves can result in acquired strabismus, especially in adults.

7. Trauma

- **Head or Orbital Trauma**: Damage to cranial nerves, muscles, or orbital structures can result in acute or permanent strabismus.

8. Idiopathic Causes

- **Unknown Origins**: In some cases, no specific cause can be identified, and strabismus is considered idiopathic.

Classification of Strabismus تصنيف الحول

Strabismus can be classified in various ways depending on the presentation, aetiology, pattern according the following criteria:

A. Based on Direction of Deviation حسب اتجاه الانحراف

1. Esotropia

- In esotropia, one or both eyes turn inward, towards the nose.
- It is also known as convergent strabismus.
- It is the most common type of strabismus.
- Common in children and often associated with hyperopia (farsightedness).

Right esotropia

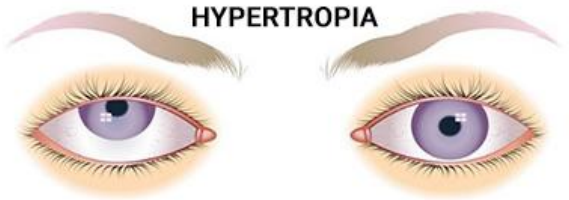
2. Exotropia

- Exotropia is the opposite of esotropia. In this type, one or both eyes turn outward, away from the nose.
- It is also called divergent strabismus.
- Can be intermittent initially but can become constant without treatment, more noticeable when the individual is tired or focusing on distant objects.

Right exotropia

3. Hypertropia

- Hypertropia refers to a condition in which one eye is higher than the other.
- It is characterized by the upward deviation of one eye relative to the other.



4. Hypotropia

- Hypotropia is the opposite of hypertropia. In this type, one eye is lower than the other, resulting in a downward deviation.

Table of Causes Hypertropia and Hypotropia

Condition	Hypertropia (Upward Deviation)	Hypotropia (Downward Deviation)
Trochlear Nerve Palsy (CN IV)	Yes	No
Oculomotor Nerve Palsy (CN III)	Yes	Yes
Brown Syndrome	No	Yes
Thyroid Eye Disease	No	Yes
Blowout Fracture	No	Yes
Dissociated Vertical Deviation (DVD)	Yes	No
Inferior Oblique Overaction	Yes	No
Stroke or Brain Injury	Yes	Yes
Myasthenia Gravis	Yes	Yes

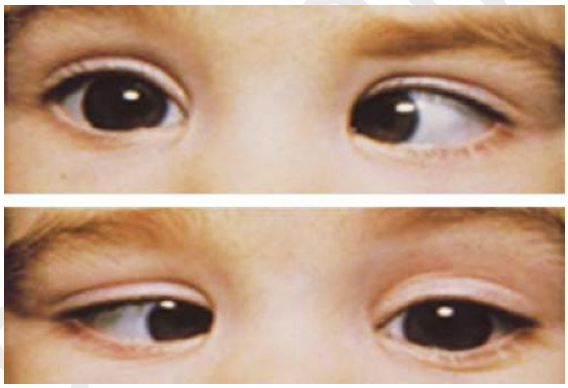
B. Based on the Timing of Onset

1. **Congenital (Infantile) Strabismus**:
   - Appears within the first six months of life.
   - Includes conditions such as infantile esotropia and is often associated with neurological or genetic conditions.
2. **Acquired Strabismus:**
   - Develops later in childhood or adulthood.
   - Causes include trauma, refractive errors, cranial nerve palsies, or systemic diseases like thyroid eye disease.

C. Based on Constancy and Comitancy على أساس الثبات والتوافق

1. **Intermittent strabismus (transient):** Misalignment occurs only under certain conditions, such as fatigue, stress, or when focusing on distant objects. More common in exotropia.
2. **Constant strabismus:** refers to a type of eye misalignment that is present continuously or nearly all the time, regardless of circumstances. Often seen in congenital or untreated cases.

3. **Comitant strabismus:** is refers to a type of strabismus where the angle of deviation or misalignment remains the **same in all directions of gaze**. Common in children, e.g., congenital esotropia and caused by refractive errors or sensory deficits.
4. **Incomitant strabismus:** is refers to a type of strabismus where the angle of deviation or misalignment **changes with the direction of gaze**. Often associated with neurological issues, paralysis or restriction of extraocular muscles.
5. **Unilateral strabismus:** the misalignment consistently affects the same eye, potentially leading to amblyopia (lazy eye).
6. **Alternating Strabismus:** Alternating strabismus occurs when the misalignment alternates between the two eyes. Sometimes one eye will turn inward, and at other times the other eye will turn inward, reducing the risk of amblyopia but impairing binocular vision and coordination.



D. Based on Underlying Cause

1. **Paralytic Strabismus:** results from cranial nerve palsies affecting the extraocular muscles.

For example:

- Overaction or tightness of the medial rectus muscle contributes to **esotropia**.
- Weakness in the lateral rectus muscle causes **esotropia**.
- Cranial nerve III palsy causes ptosis, outward deviation, and pupil dilation, while cranial nerve VI palsy affects lateral rectus function, causing esotropia.

2. **Restrictive Strabismus:** caused by mechanical restrictions in eye movement, such as in thyroid eye disease or orbital fractures.

3. **Sensory Strabismus:** secondary to poor vision or blindness in one eye, leading to misalignment.

E. According to Accommodative or Non-Accommodative

1. **Accommodative Strabismus:** is a specific type of strabismus (eyes cross) characterized by esotropia that results from excessive focusing efforts, typically associated with uncorrected hyperopia (farsightedness).

- Occurs in patients with moderate to high uncorrected hyperopia (typically +2.00 D to +6.00 D).
- Usually manifests between 2-3 years of age, gradual onset, and intermittent at first.
- Occurs in infants with congenital esotropia often present with a large-angle deviation, whereas acquired esotropia may indicate an underlying neurological disorder.
- High AC/A ratio: A high Accommodative-Convergence/Accommodation (AC/A) ratio leads to excessive convergence even with minimal accommodation effort.
- Symptoms: Eyestrain, blurred vision, and intermittent diplopia, particularly during near tasks.
- Management: Bifocal lenses or progressive addition lenses to reduce near-point accommodative demand

2. Non-Accommodative Strabismus: form of strabismus where the eye deviation is unrelated to accommodative effort. The misalignment persists regardless of refractive correction. It is caused by factors that disrupt the normal alignment of the eyes, such as:

✓ Neurological issues

✓ Weakness or overactivity of extraocular muscles

✓ Anatomical abnormalities

Differences Between Accommodative and Non-Accommodative Strabismus

Feature	Accommodative	Non-Accommodative
Cause	Related to hyperopia and accommodative effort.	Related to neurological, muscular, or anatomical issues.
Onset	Typically, between 2–3 years of age.	Can occur at any age.
Response to Glasses	Deviation resolves or reduces with glasses.	Deviation persists despite refractive correction.
Management	Primarily optical correction (glasses, bifocals).	Often requires surgery or other non-optical interventions.

The Accommodative Convergence to Accommodation (AC/A) ratio:

is a measure of the relationship between the amount of convergence that occurs per unit of accommodation. This ratio is crucial in understanding binocular vision anomalies, particularly in conditions like accommodative esotropia.

Methods of AC/A Ratio Calculation

- **Gradient Method**

- This method measures the change in ocular deviation when accommodation is altered using lenses.

- The patient fixates on an accommodative target at a constant distance (typically 33 cm or 6 m).
- Plus or minus lenses (e.g., +1.00 D, +2.00 D, +3.00 D, or -1.00 D, -2.00 D, -3.00 D) are used to modify accommodation.
- The change in ocular deviation (in prism diopters) is divided by the lens power used, providing the AC/A ratio.
- The Gradient AC/A Ratio is calculated using the formula:

$$\mathbf{AC/A} = \frac{\boldsymbol{Near\ Phoria\ with\ Lens\ -\ Near\ Phoria\ without\ Lens}}{\boldsymbol{Lens\ Power\ (D)}}$$

Explanation of Terms:

- Near Phoria without Lens: The patient's baseline phoria at near (measured in prism diopters).
- Near Phoria with Lens: The patient's phoria at near while wearing a specific lens (e.g., +1.00 D or -1.00 D).
- Lens Power (D): The power of the lens used to change accommodation (usually ±1.00 D or ±2.00 D).

Clinical Interpretation

✓ Normal AC/A ratio: 3:1 to 5:1 (prism diopters per diopter of accommodation).

✓ High AC/A ratio: Found in conditions like convergence excess and accommodative esotropia, where excessive convergence occurs for a given amount of accommodation.

✓ Low AC/A ratio: Found in convergence insufficiency, where less convergence occurs for a given accommodation effort.

Understanding the Relationship with Strabismus

The AC/A ratio helps in diagnosing **types of strabismus** and guides **treatment plans**.

(A) Low AC/A Ratio < (3:1) - Convergence Insufficiency

- **Characteristics:**
  - More **exophoria** at near than at distance.
  - Difficulty in **sustaining convergence** while reading.
  - Symptoms: **Eye strain, headaches, double vision**, losing place while reading.
- **Treatment:**
  - **Vision therapy** (pencil push-ups, Brock string exercises).
  - **Reading glasses with plus lenses** (+1.00 D) to relax accommodation.

👉 **In our case, the child has a low AC/A ratio, which suggests convergence insufficiency.** ✅

(B) High AC/A Ratio > (5:1) - Convergence Excess

- **Example:** A child with **esophoria** (inward deviation) at near but normal alignment at distance.
- **Characteristics:**
  - More **esophoria** at near than at distance.
  - Symptoms: **Blurred vision, eye fatigue, headaches while reading**.
- **Treatment:**
  - **Bifocal lenses (Add +2.00 D for near)** to reduce accommodative demand.
  - **Prism glasses** to reduce stress on convergence.

(C) Normal AC/A Ratio (3:1 to 5:1)

- **Example:** A child with the **same amount of exophoria or esophoria at both near and distance**.
- **Characteristics:**
  - Strabismus is likely **due to muscle imbalances** rather than accommodation.
- **Treatment:**
  - **Eye exercises, glasses, or surgery** depending on severity.

Practical Example to Understand AC/A Ratio & Types of Strabismus

Example 1: A 10-year-old child visits an eye clinic with complaints of double vision while reading and occasional eye strain. The optometrist conducts a cover test and finds that the child has 6 PD exophoria at near and 2 PD exophoria at distance.

Answer:

Near Phoria without Lens = 6 PD outward

Near Phoria with +1.00 D Lens = 3 prism diopters outward

Lens Power Used = +1.00 D

$$\frac{\mathbf{AC}}{\mathbf{A}} = \frac{(3-6)}{1} = = \frac{(-3)}{1} = \mathbf{3:1}$$

- **The child's AC/A ratio is 3:1, which is low (Normal range: 3:1 to 5:1).**

Example 2: A 5-year-old girl is brought to an eye clinic by her parents, who noticed that her right eye turns inward when she looks at objects up closely. She also complains of headaches while reading.

Examination:

Distance Cover Test: Orthophoria (eyes aligned)
Near Cover Test without lens: 28 PD Esotropia
Refractive Error: +3.00 D hyperopia in both eyes
Near Cover Test with lens: 10 PD Esotropia

$$\frac{\mathbf{AC}}{\mathbf{A}} = \frac{(10-28)}{3} = = \frac{(-18)}{3} = \mathbf{6:1}$$

***Diagnosis*:** Accommodative Esotropia (AC/A Ratio: 6:1)
The child's high AC/A ratio means that when she accommodates to focus on near objects, her eyes converge excessively, leading to esotropia.

Management:

Prescription glasses with +3.00 D to reduce the need for excessive accommodation.
Monitoring for possible bifocals if esotropia persists at near.

Example 3: A 12-year-old boy complains of eye strain, blurred vision, and double vision when reading for long periods. His teacher reports that he often loses his place while reading.

Examination:

Distance Cover Test: Orthophoria
Near Cover Test: 8 PD Exophoria
AC/A Ratio: 2:1 (Low AC/A)
Near Point of Convergence (NPC): 15 cm (abnormally far)

Diagnosis: Convergence Insufficiency (CI)
The child has difficulty bringing his eyes inward to focus on near objects due to a low AC/A ratio.

Management:

Vision therapy exercises (pencil push-ups, convergence training).
Prism lenses if symptoms persist.

Example 4: A 10-year-old child visits an eye clinic with complaints of occasional double vision, especially when tired or daydreaming. Parents notice that his left eye drifts outward when watching TV.

Examination:

Distance Cover Test: 8 PD Exophoria
Near Cover Test: 6 PD Exophoria
AC/A Ratio: 4:1 (Normal)
Suppression detected on Worth 4 Dot test

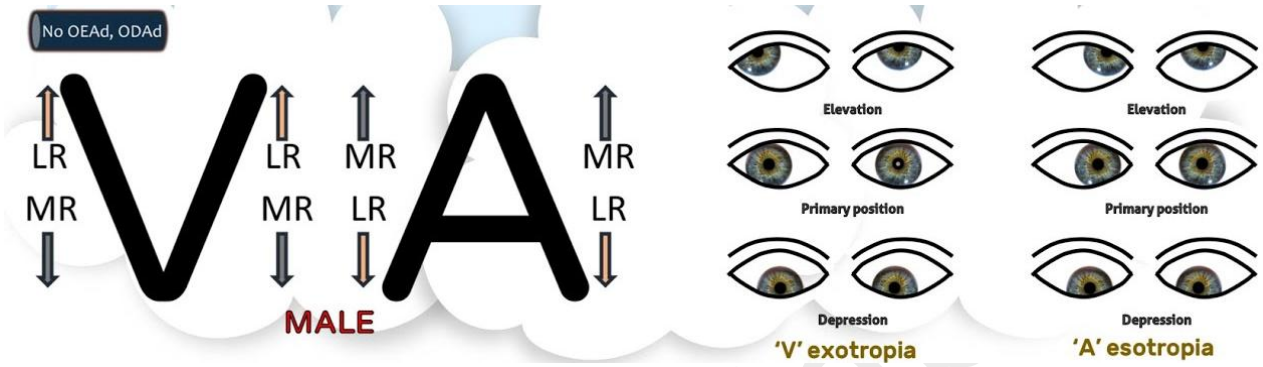
Diagnosis: Intermittent Exotropia
The child has a normal AC/A ratio but struggles to maintain eye alignment, especially when fatigued.

Management:

Observation if symptoms are mild.
Part-time patching to strengthen binocular vision.
Surgical correction if exotropia worsens.

A and V Patterns in Strabismus

The A and V patterns in strabismus describe how ocular misalignment (esotropia or exotropia) varies in different gaze positions—upgaze and downgaze. These patterns occur due to an overaction or underaction of extraocular muscles, leading to characteristic A-pattern or V-pattern deviations.



1. A-Pattern Strabismus

- In A-pattern esotropia, the eyes turn more inward (eso) in upgaze than in downgaze.
- In A-pattern exotropia, the eyes turn more outward (exo) in upgaze than in downgaze.

Clinical Signs

- A-pattern esotropia: The esotropia (inward deviation) decreases in downgaze and increases in upgaze.
- A-pattern exotropia: The exotropia (outward deviation) decreases in downgaze and increases in upgaze.

Causes

- Overaction of the superior oblique muscles.
- Underaction of the inferior oblique muscles.
- Sometimes linked with craniofacial syndromes.

Treatment

- Surgery: Superior oblique weakening or inferior oblique strengthening procedures.
- Glasses or prisms may be used in mild cases.

2. V-Pattern Strabismus

- In V-pattern esotropia, the eyes turn more inward (eso) in downgaze than in upgaze.
- In V-pattern exotropia, the eyes turn more outward (exo) in downgaze than in upgaze.

Clinical Signs

- V-pattern esotropia: Esotropia increases in downgaze and decreases in upgaze.
- V-pattern exotropia: Exotropia increases in downgaze and decreases in upgaze.

Causes

- Overaction of the inferior oblique muscles.
- Underaction of the superior oblique muscles.
- Commonly seen in conditions like Down syndrome.

Treatment

- Surgery: Inferior oblique weakening or superior oblique strengthening procedures.
- Prism lenses to reduce deviation in specific gaze positions.

Table: Differences Between A-Pattern and V-Pattern Strabismus

Feature	A-Pattern	V-Pattern
Common in	Superior oblique overaction	Inferior oblique overaction
Esotropia (inward deviation)	Worse in upgaze	Worse in downgaze
Exotropia (outward deviation)	Worse in upgaze	Worse in downgaze
Treatment	Superior oblique weakening, Inferior oblique strengthening	Inferior oblique weakening, Superior oblique strengthening

Pseudostrabismus

It refers to the appearance of misaligned eyes, where one or both eyes seem to deviate when, in reality, the eyes are properly aligned. Unlike true strabismus, pseudostrabismus does not involve actual misalignment of the visual axes and does not affect binocular vision or depth perception.

Causes of Pseudostrabismus

- **Wide Nasal Bridge:**

A broad or flat nasal bridge can make the eyes appear crossed (esotropia), especially in children.

- **Epicanthal Folds:**

Extra skin folds covering the inner corners of the eyes (commonly seen in infants and certain ethnic groups) can obscure the sclera and create the illusion of esotropia.

- **Asymmetric Eyelid Shape:**

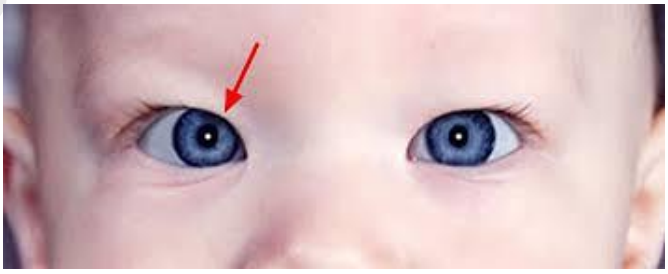
Differences in eyelid size or position can lead to the perception of strabismus.

- **Wide Interpupillary Distance:**

A large distance between the pupils can mimic exotropia (outward deviation of the eyes).

- **Corneal Light Reflex:**

Minor variations in the reflection of light on the cornea during a physical exam may give the false impression of eye misalignment.



Symptoms of strabismus (general)

1. Misaligned eyes
2. Double vision (diplopia)
3. Eye strain and discomfort
4. Poor depth perception
5. Squinting or closing one Eye
6. Head tilt or turn
7. Reduced visual acuity

Strabismus in children can be associated with several disorders:

1. Down syndrome
2. Cerebral palsy
3. Hydrocephalus
4. Brain tumors
5. Retinopathy of prematurity
6. Retinoblastoma
7. Traumatic brain injury
8. Thyroid Eye Disease
9. Congenital Cataracts
10. Infectious or Inflammatory Conditions

Strabismus in adults can be associated with several disorders:

1. Stroke
2. orbital trauma
3. brain tumors
4. multiple sclerosis
5. cranial nerve palsy
6. Head trauma or injury to the eye
7. Vision Changes: Significant changes in vision, such as uncorrected refractive errors, cataracts, or retinal disorders
8. Thyroid Eye Disease: Thyroid eye disease, also known as Graves' ophthalmopathy
9. Age-related Muscle Weakness
10. Systemic Health Conditions: Certain systemic health conditions, such as diabetes
11. Medications or Drug Side Effect

Diagnosis of strabismus

- **History Taking:**
  - Family history of strabismus or related conditions.
  - Duration and frequency of misalignment.
  - Presence of diplopia (double vision), headaches, or eye strain.
- **Visual Acuity Testing:**
  - Assesses the clarity of vision in each eye using an eye chart.
  - Identifies differences in visual acuity between the eyes.
  - Helps detect amblyopia (reduced vision in one eye).
- **Refraction Testing**
  - Determines if refractive errors (myopia, hyperopia, astigmatism) contribute to strabismus.
  - Performed using lenses, an automated refractor, or a retinoscope.

1. Cover/Uncover Test:

A clinical test to detect and classify ocular misalignment, distinguishing between phoria (latent strabismus) and tropia (manifest strabismus).

Purpose

- Detect tropia (manifest strabismus): constant deviation of one eye while the other fixates.
- Detect phoria (latent strabismus): misalignment controlled by fusion but apparent when fusion is disrupted.
- Estimate the magnitude and direction of the misalignment.

Procedure

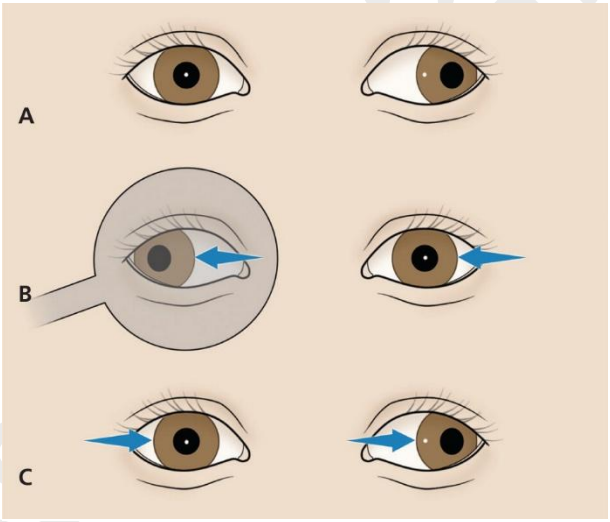
Step 1: Cover Test (to detect tropia)

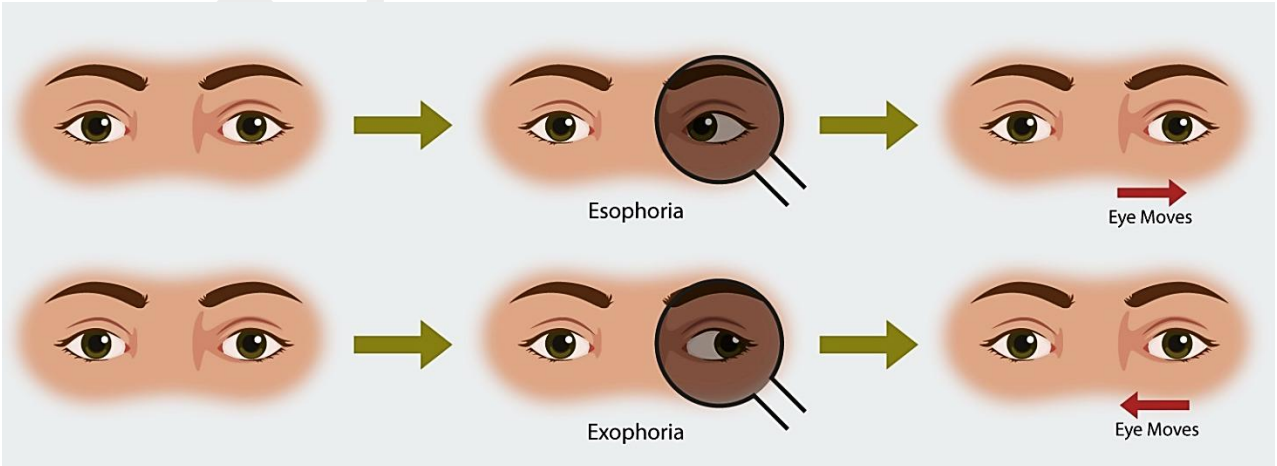
- The patient fixates on a target (near or distance fixation).
- The examiner covers one eye and observes the uncovered eye for movement.
  - ✓ No movement: either orthotropia (no misalignment) or deviation in the covered eye.

- ✓ Movement of the uncovered eye:
  - ▪ Inward movement: Exotropia (eye was outwardly deviated).
  - ▪ Outward movement: Esotropia (eye was inwardly deviated).
  - ▪ Upward/Downward movement: Vertical deviations (hypertropia or hypotropia).

Step 2: Uncover Test (to detect phoria)

- The examiner covers one eye for 2–3 seconds before removing the cover.
- Upon uncovering, the previously covered eye is observed for movement:
  - ✓ No movement: Orthophoria (aligned binocular vision).
  - ✓ Movement: Latent deviation (heterophoria) becomes apparent.





2. Prism Cover Test (PCT)

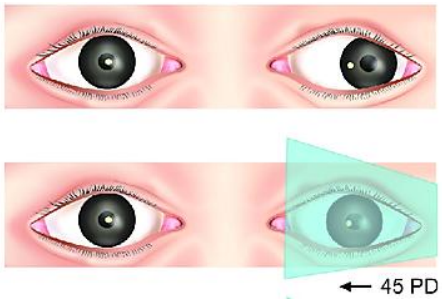
- Gold standard for detecting manifest and latent deviations.
- Uses prisms to measure ocular deviation accurately.
- Determines the magnitude of deviation in prism diopters (Δ).
- Differentiates between esotropia, exotropia, hypertropia, and hypotropia.

Procedure

- The patient fixates on a target at a standard distance (e.g., 6 meters for distance or 33 cm for near testing).
- The examiner holds a prism in front of one eye.
- Prisms are introduced in different orientations to neutralize deviation.
  - ✓ Base-out for esodeviation.
  - ✓ Base-in for exodeviation.
  - ✓ Base-up for hypotropia.
  - ✓ Base-down for hypertropia.

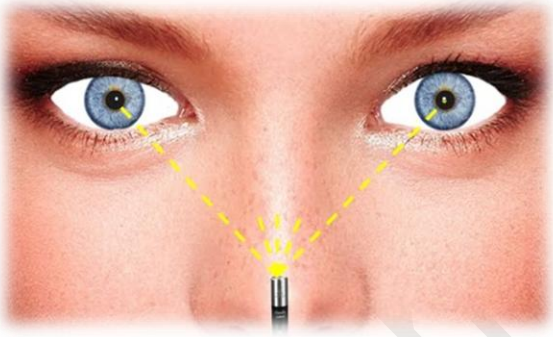
i. The prism power is increased (or decreased) incrementally until no movement of the uncovered eye is observed when the cover is removed. This is known as the neutralization point**.**

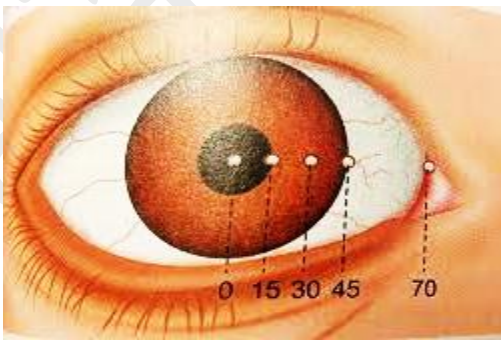
ii. The magnitude of the deviation is recorded in prism diopters, with the direction of the deviation noted (e.g., 10Δ Base-out for esotropia or 8Δ Base-in for exophoria).



3. Hirschberg Test (Corneal Light Reflex Test)

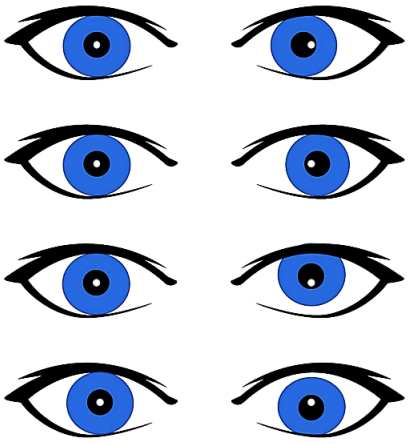
- A quick and qualitative method to assess the presence and approximate severity of strabismus.
- A light source is directed at the patient's eyes from about 33 cm away.
- The examiner observes the position of the corneal light reflex.
- In normal alignment, the reflex is symmetrically centered in both pupils.
- In strabismus, the reflex is displaced in the deviating eye, with the direction of displacement indicating the type of misalignment.
- Useful in children or non-cooperative patients, as it does not require active participation.





4. Krimsky Test

- Builds on the Hirschberg Test by providing a more quantitative measurement of ocular misalignment using prisms.
- A prism bar is placed in front of the fixating eye, and the strength of the prism is increased until the corneal light reflex is symmetrically centered in both eyes.
- The strength of the prism needed to neutralize the deviation determines the angle of misalignment in prism diopters.
- Effective for measuring deviations in young children and patients unable to cooperate with more formal testing methods.



Esotropia (eye turned inward)

Exotropia (eye turned outward)

Hypertropia (eye turned upward)

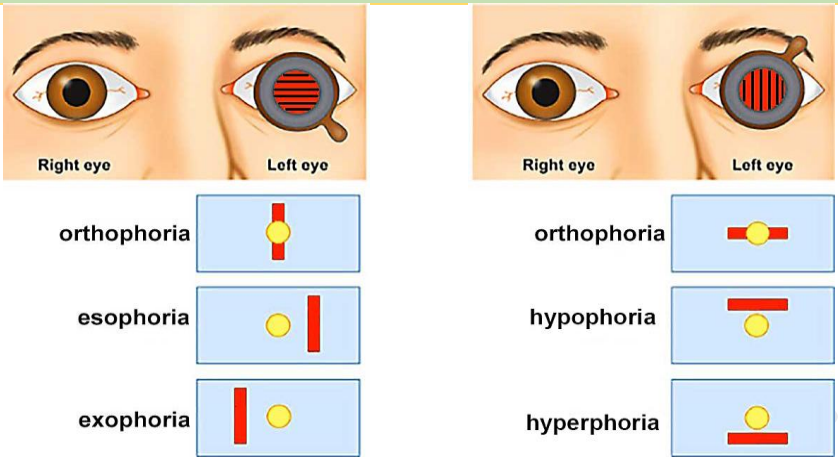
Hypotropia (eye turned downward)

Table: Main Differences Between Krimsky Test and Prism Cover Test

Criteria	Krimsky Test	Prism Cover Test
Principle	Uses corneal light reflex and prisms to estimate eye deviation.	Uses cover/uncover technique with prisms to measure eye movement and misalignment.
Accuracy	Less accurate, provides an approximate estimation of strabismus.	More precise in measuring the degree of strabismus.
Patient Cooperation	Suitable for infants, young children, or uncooperative patients.	Requires patient cooperation, used for older children and adults.
Type of Strabismus Measured	Measures manifest strabismus (Tropia) only.	Measures both manifest (Tropia) and latent (Phoria) strabismus.
Use of Prisms	Prisms are used to shift the corneal reflex into alignment.	Prisms are used to neutralize eye movement during the cover test.
Best for	Estimating strabismus in young or non-cooperative patients.	Accurately measuring strabismus, especially for surgical planning.

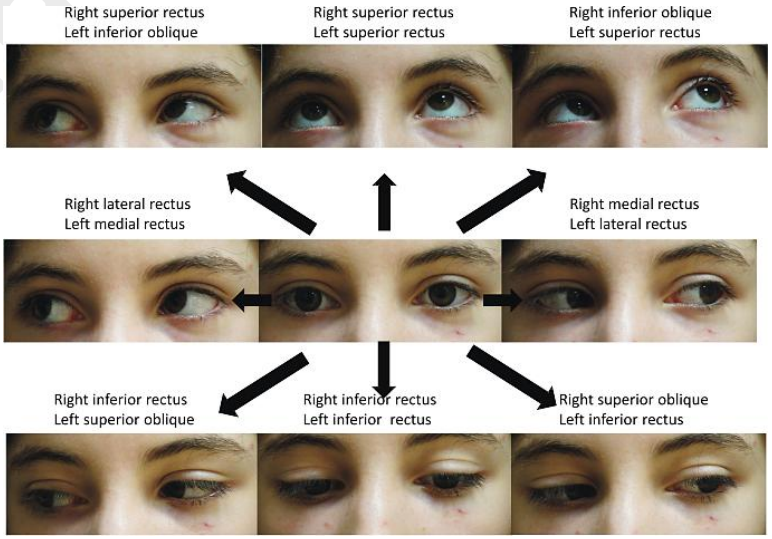
5. Maddox Rod Test

- The Maddox Rod Test is a simple method to detect and differentiate phorias (latent deviations) and tropias (manifest deviations).
- A Maddox rod (a cylindrical lens) is placed over one eye, and the patient fixates on a light source.
- The rod converts the light into a streak, and the examiner notes the position of the streak relative to the light.
- Horizontal, vertical, or torsional deviations can be identified, helping to determine esophoria/exophoria, hyperphoria/hypophoria, or cyclophoria.
- This test is particularly useful for diagnosing subtle or latent deviations.



6. Ocular Motility (OM) Test:

- Ocular Motility Testing evaluates the function of the extraocular muscles by assessing eye movements in all nine cardinal positions of gaze (up, down, right, left, and diagonals).
- The patient is asked to follow a target, such as a pen or light, while the examiner observes for limitations in movement, overactions, or restrictions.
- This test is crucial for detecting muscle paralysis, overactions (e.g., inferior oblique overaction in V-pattern exotropia), and mechanical restrictions, such as those seen in thyroid eye disease.
- It is particularly helpful for diagnosing incomitant strabismus, where the deviation varies with gaze direction.

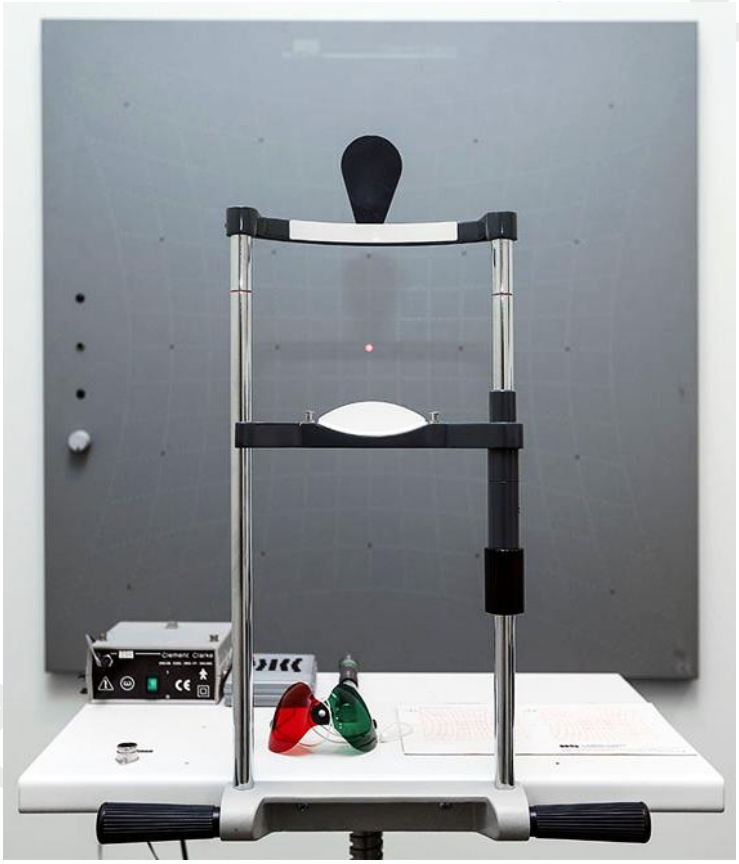


7. Synoptophore Test

- Specialized instrument used to evaluate binocular vision, fusion, suppression, and stereopsis (depth perception).
- The patient views two separate images presented to each eye.
- The examiner assesses the patient's ability to align and fuse these images into a single perception.
- Measures the angle of deviation and identifies abnormal retinal correspondence (ARC) or suppression.
- Valuable tool for understanding sensory adaptations in strabismus.
- The Synoptophore is a specialized instrument used to evaluate binocular vision, fusion, suppression, and stereopsis (depth perception). The patient views two separate images presented to each eye, and the examiner assesses the patient's ability to align and fuse these images into a single perception. The Synoptophore also measures the angle of deviation and identifies abnormal retinal correspondence (ARC) or suppression. It is a valuable tool for understanding sensory adaptations in strabismus.

8. Hess Screen Test

- Evaluates ocular muscle function by plotting eye positions in all directions of gaze.
- The patient wears red-green glasses and fixates on lights on a screen while deviations are recorded.
- The plotted results help identify weak or overacting muscles.
- Particularly useful for diagnosing paralytic strabismus or incomitant deviations.
- Evaluates ocular muscle function by plotting eye positions in all directions of gaze.
- Useful for diagnosing paralytic strabismus and incomitant deviations.

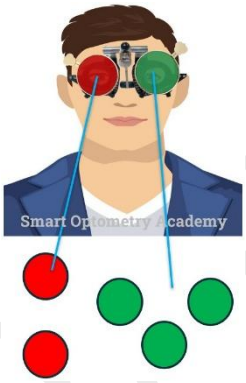


9. Cycloplegic Refraction

- Uses cycloplegic drops (cyclopentolate, atropine) to temporarily paralyze accommodation.
- Identifies refractive errors, especially in accommodative esotropia.
- Essential for prescribing corrective lenses.

10. Worth Four-Dot Test

- Assesses binocular vision and detects suppression or diplopia.
- Uses red-green glasses to determine if fusion, suppression, or double vision is present.



11. Forced Duction Test

- Differentiates between restrictive (mechanical) and paralytic strabismus.
- The examiner manually moves the eye under topical anesthesia.
- Resistance suggests mechanical restriction (e.g., thyroid eye disease); free movement suggests neurological causes.

12. Neuroimaging (MRI/CT)

- MRI: Evaluates cranial nerve palsies, brainstem lesions, or tumors affecting ocular alignment.
- CT: Detects structural abnormalities such as orbital trauma, fractures, or restrictive strabismus.

13. Bagolini Striated Glasses Test

- Evaluates binocular vision, fusion, suppression, and stereopsis.
- Measures the angle of deviation.
- Assesses abnormal retinal correspondence (ARC).
- Evaluates binocular single vision (BSV).
- Detects suppression or diplopia based on the perception of striated light streaks.

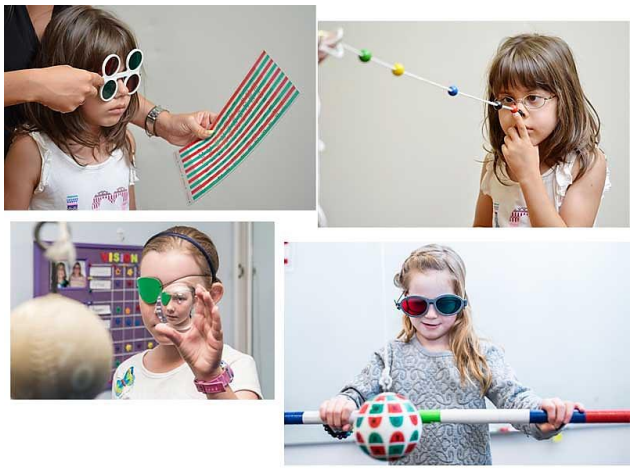
Treatment Strabismus for Children

1. Refractive Error Correction: If refractive errors, such as nearsightedness, farsightedness, or astigmatism, are contributing to the strabismus, the child may be prescribed **glasses** to correct their vision. Properly correcting refractive errors can sometimes improve eye alignment and reduce the strain on the eyes.

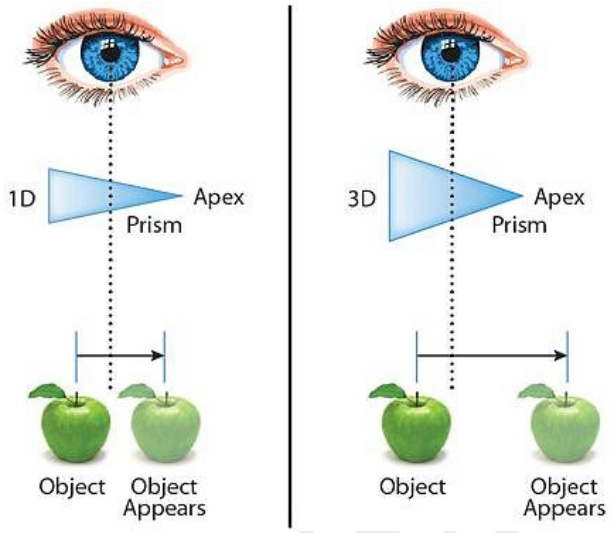
2. Occlusion Therapy (Patching): Used to treat amblyopia associated with strabismus by covering the dominant eye to stimulate use of the amblyopic eye. This helps improve vision and alignment.

3. Pharmacologic Treatments: Cycloplegic agents like atropine may blur the vision in the better-seeing eye, encouraging use of the amblyopic eye

4. Orthoptic Exercises: Exercises to strengthen eye muscles and improve coordination are helpful in certain cases of intermittent exotropia or convergence insufficiency



5. Prism Lenses: In some cases, glasses with prism lenses may be prescribed. Prism lenses can help align the images seen by each eye, reducing the strain and visual confusion caused by strabismus and reduce double vision in some cases of mild strabismus. They can be particularly beneficial for individuals with small-angle or intermittent strabismus.



6. Botulinum Toxin Injections: In certain types of strabismus, such as infantile esotropia, Botox injections may be used as a temporary measure to weaken specific eye muscles.

7. Timing of Surgery: Early surgical intervention is often recommended for congenital or severe strabismus, ideally by age 12 months or at the latest by age 2 years. This helps improve binocular cooperation. The surgery is typically performed under general anesthesia, and the specific procedure will depend on the type and severity of strabismus.

Treatment Strabismus for Adults

1. **Correction of Refractive Errors:** Adults with strabismus caused by refractive errors may benefit from prescription glasses or contact lenses.
2. **Prism lenses:** Fresnel or ground-in prisms can be used to alleviate double vision (diplopia) by realigning the images seen by both eyes.
3. **Orthoptic exercises:** Special eye exercises can help strengthen extraocular muscles and retrain binocular coordination. This may include activities like patching the strong eye to force the weaker one to work harder.
4. **Strabismus surgery:** Realigning eye muscles via surgery can directly tackle muscle imbalances causing eye misalignment. This involves tightening or repositioning extraocular muscles to enable straight positioning.
5. **Botulinum toxin injections:** Injections of small amounts of botulinum toxin can relax or weaken overactive muscles pulling the eyes out of alignment. The effect is temporary helping retrain the system.