

Strabismus

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Primary Disciplinary Field(s): Ophthalmology, Optometry, Pediatric Medicine, Neurology

1. Core Definition

Strabismus, commonly referred to as crossed eyes or squint, is a binocular vision condition defined by the misalignment of the visual axes. This ocular pathology prevents the eyes from looking at the same object simultaneously, resulting in diplopia (double vision) or suppression (the brain ignoring input from the misaligned eye). When an individual has strabismus, one eye may fixate straight ahead while the other deviates inward (esotropia), outward (exotropia), upward (hypertropia), or downward (hypotropia). This deviation stems fundamentally from issues related to poor or imbalanced control of the extraocular muscles, which are responsible for coordinating eye movement, though the underlying cause often involves complex neurological or refractive elements.

The coordination required for normal binocular vision involves intricate neurological pathways that ensure the fovea of both eyes are directed toward the same target, allowing the brain to fuse the two slightly disparate images into a single three-dimensional percept. In the context of **strabismus**, this fusion mechanism fails. The magnitude and direction of the deviation can be constant or intermittent, and it can affect one eye consistently (monocular strabismus) or alternate between the two eyes (alternating strabismus). The presence of strabismus during critical developmental periods, particularly in early childhood, poses a significant threat to the development of normal stereopsis and depth perception, often leading to secondary vision loss known as amblyopia, or "lazy eye," in the misaligned eye.

Clinically, strabismus is classified not only by the direction of the deviation but also by its constancy, size, and underlying etiology. It is crucial to distinguish between phorias and tropias; a phoria is a latent misalignment only visible when fusion is broken (e.g., covering one eye), whereas a tropia is a manifest, constant misalignment visible under normal viewing conditions. Furthermore, strabismus is often categorized as comitant, where the degree of misalignment is consistent regardless of the direction of gaze, or incomitant (or paralytic), where the misalignment changes depending on the direction of gaze, typically indicating a specific neurological or muscular injury affecting one or more extraocular muscles.

2. Etymology and Historical Development

The term **strabismus** derives from the Greek word *strabismos*, meaning "a squinting," which itself comes from *strabizein*, "to squint." Historical recognition of this condition dates back to antiquity. Ancient Egyptian and Greek physicians observed and documented the misalignment, though early attempts at correction were often rudimentary. Hippocrates, for instance, noted the condition and

suggested exercises, although effective understanding of the musculature was centuries away. Throughout the medieval period, strabismus was primarily viewed cosmetically or attributed to supernatural causes, hindering true therapeutic advancement.

Significant steps were taken in the 18th and 19th centuries. The early systematic attempts at surgical correction emerged in the 1830s. Dr. Johann Friedrich Dieffenbach performed one of the earliest documented modern strabismus surgeries in 1839, involving the partial severance of an extraocular muscle to adjust eye tension. While these early surgeries often resulted in overcorrection or recession due to lack of precision, they paved the way for modern ophthalmic surgery. Furthermore, the development of reliable refractive correction methods, such as eyeglasses, in the 19th century provided a non-surgical means of managing specific types of accommodative strabismus, marking the integration of optometry into the treatment paradigm.

The 20th century brought neurological and physiological understanding, particularly recognizing the critical link between strabismus, amblyopia, and the plasticity of the visual cortex in infants. Pioneers like Alfred Bielschowsky advanced the diagnostic understanding of parietic strabismus through sophisticated testing methods. Today, strabismus management is highly specialized, integrating pediatric ophthalmology, advanced surgical techniques (including adjustable sutures), and sophisticated orthoptic training to maximize functional binocular vision rather than focusing solely on cosmetic alignment.

3. Key Characteristics: Classification by Deviation and Aetiology

The primary classification of strabismus is based on the direction of the deviation, which dictates the clinical presentation and often influences treatment strategies. These directional deviations are crucial for diagnosis and surgical planning.

Esotropia: Inward turning of one or both eyes (cross-eyed). This is the most common form of strabismus in infants and is often associated with hyperopia (farsightedness) in its accommodative variant.

Exotropia: Outward turning of one or both eyes (wall-eyed). Exotropia frequently presents as intermittent deviation, often becoming more pronounced when the individual is tired, ill, or focused on distant objects.

Hypertropia: Upward turning of the eye. This type often suggests a paresis (weakness) or paralysis of specific vertical muscles, such as the superior or inferior oblique or rectus muscles.

Hypotropia: Downward turning of the eye. Similar to hypertropia, hypotropia frequently indicates underlying muscle dysfunction or structural orbit abnormalities.

A secondary but equally important classification distinguishes between **comitant** and **incomitant** strabismus. Comitant strabismus, which is typical in childhood onset, means the angle of deviation remains the same in all directions of gaze. This suggests a problem in the central control of eye

alignment or a symmetrical muscle imbalance. Conversely, incomitant strabismus, often acquired later in life due to trauma, vascular events, or neurological disease, demonstrates a deviation that varies with the direction of gaze. Incomitant strabismus often points toward a specific palsy of a cranial nerve (III, IV, or VI) or direct damage to an extraocular muscle.

Further subcategories exist based on the underlying cause, such as **accommodative esotropia**, which is corrected fully by glasses compensating for hyperopia, and **non-accommodative esotropia**, which requires other interventions like surgery. Understanding these nuanced classifications is paramount because misdiagnosis of the type of strabismus can lead to ineffective treatment and potentially irreversible visual impairment, particularly in children where the visual system is still developing its capacity for fusion and stereopsis.

4. Etiology and Underlying Pathophysiology

The etiology of **strabismus** is complex and often multifactorial, involving an interplay between genetic predisposition, neurological development, and refractive status. The most immediate mechanical cause involves inadequate control of the six **extraocular muscles** (four recti and two oblique muscles) that surround and control the movement of each eyeball. If these muscles are excessively tight, weak, or improperly innervated, the eyes will fail to maintain parallel alignment. This lack of proper eye muscle control, as noted in the source content, is a key physiological manifestation of the underlying disorder.

A significant contributing factor, particularly in pediatric strabismus, is uncorrected high refractive error. For example, high levels of **hyperopia** (farsightedness) require excessive accommodation (focusing effort) to see clearly. Because the nervous system links accommodation with convergence (the turning inward of the eyes), the constant effort to accommodate leads to an over-convergence, manifesting as **accommodative esotropia**. Furthermore, anisometropia (a significant difference in refractive error between the two eyes) can result in the brain suppressing the image from the blurrier eye, thereby breaking fusion and potentially leading to strabismus and profound amblyopia.

Neurological factors represent another major category of causation. Strabismus can arise from defects in the motor fusion centers of the brainstem or cerebral cortex, which are responsible for maintaining alignment. Acquired strabismus, especially the incomitant type, frequently results from paresis or paralysis of the cranial nerves responsible for eye movement, specifically the third (oculomotor), fourth (trochlear), or sixth (abducens) nerves, often due to trauma, stroke, or systemic diseases like diabetes. Moreover, certain genetic syndromes (e.g., Down syndrome, cerebral palsy) and prenatal exposures significantly increase the risk profile for developing ocular misalignment.

5. Diagnosis and Clinical Assessment

Accurate diagnosis of strabismus requires a comprehensive ophthalmic examination, which extends beyond simple visual acuity measurements. The primary objective is to determine the presence and magnitude of the deviation, classify its type (comitant or incomitant), and assess the resulting impact on binocular function and visual development. Key diagnostic procedures include thorough history taking, assessment of visual acuity in both eyes, and a detailed examination of ocular motility.

The cornerstone of strabismus diagnosis involves various ocular alignment tests, notably the **Cover-Uncover Test** and the **Alternate Cover Test**. The Cover-Uncover Test differentiates between a phoria (latent deviation) and a tropia (manifest deviation) by observing the movement of the eye when the other is covered and then uncovered. The Alternate Cover Test measures the total magnitude of the deviation (tropia plus phoria) by rapidly alternating the cover between the two eyes, forcing the eye under the cover to assume its full resting position. Measurements are often taken using prisms to quantify the deviation in prism diopters across various directions of gaze, especially crucial for diagnosing incomitant strabismus.

Furthermore, a critical step, especially in children, is the cycloplegic refraction. By temporarily paralyzing the focusing muscles, this test accurately reveals the total refractive error, allowing the clinician to identify and treat accommodative components of the strabismus using eyeglasses. Assessment of binocular function, including the presence of stereopsis (depth perception) and the degree of suppression, provides crucial information regarding the prognosis for achieving functional vision post-treatment and guides the decision between optical, orthoptic, or surgical management pathways.

6. Management and Treatment Modalities

The management of **strabismus** is highly individualized and aims to achieve three primary goals in order of priority: preservation or restoration of visual acuity (treating amblyopia), achievement of functional binocular alignment, and aesthetic alignment. Treatment typically involves a stepwise approach, beginning with non-surgical interventions. As suggested by the source content, wearing **eyeglasses** is often the first line of defense, particularly for accommodative esotropia, as they neutralize the underlying refractive error and eliminate the need for excessive convergence effort.

Addressing secondary conditions, such as **amblyopia**, is crucial before attempting surgical correction, especially in pediatric cases. Treatment for amblyopia often involves forcing the brain to use the weaker eye through methods like using eye patches over the stronger eye for prescribed periods, or using atropine eye drops in the stronger eye to blur vision (penalization). These techniques compel the visual cortex to process input from the deviated eye, thereby strengthening its neural pathways. Orthoptic therapy, involving visual exercises aimed at improving fusion, depth

perception, and eye coordination, is often utilized for certain intermittent phorias and small tropias, particularly exotropia.

When optical correction and amblyopia therapy fail to achieve adequate alignment and binocular function, **eye muscle surgery** becomes the necessary intervention. Strabismus surgery involves carefully repositioning or adjusting the tension of the extraocular muscles. Procedures may include recession (weakening the pull of a muscle by moving its attachment point further back on the globe) or resection (strengthening the muscle by shortening it). The goal is precise alignment to facilitate fusion. In adults or cases of residual misalignment, prism lenses may be incorporated into spectacles to shift the image entering the eye, allowing the patient to achieve fusion without requiring perfect muscular alignment.

7. Significance and Potential Complications

The significance of timely diagnosis and aggressive treatment of **strabismus**, particularly when it presents in early childhood, cannot be overstated. Untreated childhood strabismus is the primary cause of functional blindness (amblyopia) in developed nations. If the brain consistently ignores the input from the misaligned eye (suppression) to avoid diplopia, the neural pathways corresponding to that eye fail to develop correctly. This leads to profound and often irreversible loss of fine visual acuity and, critically, the inability to achieve **stereopsis** (true three-dimensional depth perception), severely impacting activities requiring fine motor skill and spatial judgment.

Beyond functional visual deficits, strabismus carries considerable psycho-social implications. Misaligned eyes can attract unwanted attention, leading to self-consciousness, decreased self-esteem, and social isolation, particularly during school-age years. Cosmetic correction, even if full functional vision is not recoverable, is therefore an important secondary goal of treatment, contributing significantly to the patient's quality of life and confidence.

While modern strabismus surgery is generally safe and highly effective, potential complications exist, including infection, hemorrhage, and risks associated with general anesthesia. Post-operative outcomes may require further intervention, as the eyes may overcorrect or undercorrect, necessitating further surgery or the use of prisms. Regular, life-long follow-up care is essential to manage recurrent deviations and maintain visual health, ensuring that the benefits achieved through initial treatment persist over time.

Further Reading

[Wikipedia: Strabismus](#)

[Wikipedia: Eyeglasses](#)

[Wikipedia: Eye Patch](#)

Wikipedia: Eye Drops

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