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SMALL-ANGLE STRABISMUS IN CHILDREN: CURRENT APPROACHES TO SURGICAL DOSAGE AND CONSERVATIVE MANAGEMENT — A LITERATURE REVIEW

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ABSTRACT

Small-angle strabismus in children remains a complex clinical problem despite relatively minimal ocular deviation. Functional disorders associated with impaired binocular vision, suppression scotoma, microamblyopia, and instability of fusional mechanisms may significantly affect visual rehabilitation outcomes. The present literature review summarizes current data regarding epidemiology, clinical features, conservative treatment, and principles of surgical dosage in children with small-angle strabismus. Special attention is paid to minimally invasive surgical approaches, individualized surgical planning, and preservation of binocular functions. The analysis demonstrates that optimization of surgical dosage and combined sensory rehabilitation remain key factors for achieving stable functional outcomes.

Keywords: small-angle strabismus, exotropia, esotropia, pediatric ophthalmology, surgical dosage, binocular vision, amblyopia, orthoptic treatment.

INTRODUCTION

Strabismus remains one of the most common ocular disorders in childhood and represents not only a cosmetic defect but also a significant functional impairment associated with disruption of binocular and stereoscopic vision [13,17,22]. Persistent ocular deviation leads to the development of sensory adaptations, including suppression scotoma, amblyopia, and impaired spatial perception [13,24]. According to epidemiological studies, the prevalence of strabismus in children ranges from 2% to 5%, depending on the population studied and diagnostic criteria used [17,22]. Among all forms of strabismus, comitant deviations are the most common, particularly esotropia [13,23].

Special attention should be paid to small-angle strabismus, which, despite relatively minor ocular deviation, may result in substantial sensory dysfunction and often presents significant diagnostic and therapeutic challenges [1,7,13]. In such patients, partial preservation of binocular interaction and fusional mechanisms may create a misleading impression of functional compensation, resulting in delayed diagnosis and treatment [12,24]. Unlike large-angle deviations, small-angle strabismus is frequently characterized by preserved visual acuity, unstable binocular status, variable fusional reserves, and subtle cosmetic manifestations [7,13]. These features complicate treatment planning and increase the risk of both undercorrection and overcorrection during surgical intervention [11,13,20].

Therefore, optimization of surgical dosage and individualized selection of conservative and surgical treatment strategies remain highly relevant issues in pediatric ophthalmology [11,15,20].

Definition and Clinical Features of Small-Angle Strabismus. The angle of ocular deviation is considered one of the principal criteria for the classification of strabismus [13,18]. Traditionally, microtropia, small-, moderate-, and large-angle deviations are distinguished [13]. Small-angle strabismus usually corresponds to a deviation ranging from 10 to 24 prism diopters (PD), which approximately equals 5–12 degrees [1,7,13].

Unlike large-angle strabismus, this condition is characterized by several important clinical features. Patients often retain partial fusional ability and certain binocular interactions, while persistent diplopia may be absent [12,24]. In many cases, the cosmetic defect is minimal, which may lead to underestimation of disease severity [7,13].

At the same time, small-angle deviations are frequently associated with the formation of a central suppression scotoma and microamblyopia [13,24]. Such sensory adaptations contribute to impaired stereopsis and unstable binocular vision despite relatively preserved visual acuity [12,24].

The clinical significance of small-angle strabismus is determined by disturbances of fine binocular mechanisms, particularly fusional reserves and stereoscopic vision [12,24]. Therefore, patients with small-angle deviations require a differentiated diagnostic and therapeutic approach [13,20].

EPIDEMIOLOGY AND CLINICAL SIGNIFICANCE

Comitant strabismus represents one of the most common forms of childhood ocular deviation, and a considerable proportion of these patients present with small-angle deviations [13,17,22]. Recent advances in diagnostic techniques have improved the detection rate of these conditions [7,13]. The practical importance of small-angle strabismus is associated with several factors. First, standard diagnostic methods may demonstrate lower sensitivity in patients with minimal ocular deviation [7]. Second, treatment outcomes are often less predictable compared to large-angle strabismus [13,15].

This issue is especially relevant in surgical management, where even minimal inaccuracies in surgical dosage may result in undercorrection or overcorrection [11,13,15]. Preservation of partial binocular interaction further complicates the choice of surgical strategy [12,20].

SURGICAL DOSAGE IN SMALL-ANGLE STRABISMUS

The primary goal of strabismus surgery is restoration of muscular balance and creation of favorable conditions for binocular vision development [11,13,20]. Classical surgical dosage tables are based on the relationship between muscle displacement and the expected correction of ocular deviation [11,18].

On average, displacement of a rectus muscle by 1 mm provides correction of approximately 2–3 prism diopters [11,20]. However, in small-angle strabismus, application of standard dosage schemes may lead to excessive surgical effect, postoperative overcorrection, or disturbance of binocular balance [1,13,15].

For this reason, several authors have proposed modified surgical approaches involving reduced recession or resection values and preference for less traumatic procedures [13,15,16].

Surgical Dosage for Esotropia

Medial rectus recession remains the most commonly used procedure for small-angle esotropia [11,13].

Angle of deviation	Medial rectus recession
8–10 PD	3.0 mm
10–12 PD	3.5 mm
12–15 PD	4.0 mm
15–18 PD	4.5 mm

In patients with stable symmetrical esotropia, bilateral recession may be performed [11,20].

Angle of deviation	Bilateral MR recession
12–15 PD	3.0 mm
15–18 PD	3.5 mm
18–20 PD	4.0 mm

Such an approach decreases the risk of postoperative esophoria and preserves fusional reserves [12,13].

Surgical Dosage for Exotropia

In small-angle exotropia, lateral rectus recession is usually preferred [15,19].

Angle of deviation	Lateral rectus recession
8–10 PD	3 mm
10–12 PD	4 mm
12–15 PD	5 mm
15–18 PD	6 mm

In unstable deviations, combined surgery may be indicated [20].

Angle of deviation	LR recession	MR resection
12–15 PD	4 mm	2–2.5 mm
15–18 PD	5 mm	2.5–3 mm

Principles of Surgical Planning

Several characteristic principles can be distinguished in the surgical management of small-angle strabismus [13,20]:

- preference for unilateral surgery;
- reduction of standard surgical dosage by 0.5–1 mm;
- limitation of combined muscle procedures;
- mandatory consideration of sensory status and fusional reserves.

Thus, surgical correction of small-angle strabismus should not be regarded as a routine mechanical procedure but rather as a precise functional adjustment of ocular motor balance [12,13,20].

CONSERVATIVE TREATMENT

Management of strabismus is usually performed in stages and begins with conservative therapy aimed at restoration of sensory function and preparation for surgical correction [20,25]. The first step includes complete optical correction of refractive errors. In some

patients, adequate optical correction may significantly reduce or even eliminate ocular deviation [13,20].

Pleoptic treatment is directed toward amblyopia management and stimulation of the deviating eye using occlusion therapy, using occlusion therapy, device-based methods, and computer-assisted visual training [1,20]. Orthoptic treatment is aimed at restoration of binocular interaction and improvement of fusional reserves [12,20,24]. After achieving simultaneous vision, diploptic therapy may be used to develop stable stereoscopic vision [12,24].

In selected patients, prism correction or botulinum toxin injections may be applied to temporarily reduce ocular deviation and facilitate sensory adaptation [20].

CONCLUSION

Small-angle strabismus represents a distinct clinical form of ocular deviation in which functional impairment may be more significant than the cosmetic defect itself. Partial preservation of binocular vision and variability of ocular motor balance complicate the selection of optimal treatment strategies. Conventional surgical dosage tables do not always provide predictable outcomes in such patients, emphasizing the need for individualized and minimally traumatic approaches. At the same time, conservative treatment remains an essential component of management because restoration of sensory mechanisms significantly influences postoperative functional outcomes. Further improvement of diagnostic methods and refinement of surgical dosage principles remain important directions for increasing the effectiveness of treatment in children with small-angle strabismus.

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