CLINICAL PRACTICE

Emmetropization in Accommodative Esotropia: An Update and Review

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Abstract. Many children with accommodative esotropia are able to successfully discontinue spectacle wear, while others require spectacle correction into adulthood. Parents often ask about the likelihood of glasses being required on a long-term basis and whether use of spectacles will cause dependency. Most infants are hyperopic and gradually become emmetropic. The extent to which accommodation and spectacle use affect this process is still debated. However, certain characteristics, such as degree of hyperopia, can help predict long-term spectacle requirement. **(Comp Ophthalmol Update 7: 145-9, 2006)**

Key words. accommodation • accommodative esotropia • emmetropization • esotropia • strabismus

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Introduction

Accommodative esotropia is the most common form of childhood esotropia. Treatment should be prompt in order to preserve good visual acuity and binocularity and to avoid amblyopia. One problem in treating accommodative esotropia is maintaining good acuity, stereopsis, and orthotropia, while also allowing emmetropization. Whether glasses or contacts lenses are used to treat accommodative esotropia, the concern exists that correcting the patient's hyperopia optically may impede the development of emmetropia.

Normal Emmetropization of the Human Eye

Most human infants are hyperopic, and emmetropia usually develops by early adolescence. Fabian is credited with first describing the process of the spherical equivalent refractive error becoming reduced with increasing age.[1] The mean refractive error of infants during the first year of life is 1.00 to 1.25 diopters (D) of hyperopia.[2,3] Approximately 5% of infants between 6 months and 9 months of age have greater than 3 D of hyperopia.[4] Astigmatism is also common with a 15–30% prevalence of greater than 1.0 D of astigmatism

in the first year of life.[2,3] Both hyperopia and astigmatism decrease with age.[5,6] If the hyperopia present at 1 year of age is greater than 2.50 D, approximately half of those patients will continue to have an increase in hyperopia.[2] After 3 years of age, the incidence of astigmatism greater than or equal to 1 D is less than 8%.[3]

The process of emmetropization and sphericalization is poorly understood. Many factors appear to play a role. Animal studies demonstrate that inducing a hyperopic or myopic refractive error with external lenses can change axial elongation.[7,8] An eye will elongate more if a hyperopic refractive error is induced and less if a myopic refractive error is induced.[7,8] Studies in humans have provided seemingly disparate results. One study by Ingram et al showed that more infants remained hyperopic if their hyperopia was corrected with spectacles and they were compliant with their use,[9] while another, by Atkinson et al showed that a partial spherical correction had no effect on emmetropization.[10] Both studies were prospective, with reasonable sample sizes (144 and 62 treated children, respectively), and perhaps the difference arose because one cohort was treated with their full cycloplegic correction, whereas the other wore only a partial correction (1.00 D less than their full cycloplegic correction). Alternatively, the difference may have arisen due to differing degrees of compliance with spectacle prescription, as only those deemed most likely to have been compliant with spectacle use were noted to have impaired emmetropization in the Ingram et al study. Furthermore, substantial variability exists in the emmetropization of hyperopic infants, with some having marked reductions in hyperopia and others having little change.[11]

A study by Ong et al of 43 myopes over 3 years showed no change in the progression of myopia between lens wearers and non-lens wearers, which strengthens the position that myopia is not significantly altered by lens wear.[12] Other studies have shown that correcting an infant's refractive error substantially reduces the incidence of accommodative esotropia and amblyopia but does not interfere with emmetropization.[13] Nevertheless, the statement that spectacle wear does not affect emmetropization has not been proven conclusively. Larger prospective studies would be required to settle this debate. Possibly, the emmetropization of the human eye is at least somewhat genetically predetermined, although it is partially affected by the environment and cannot necessarily be predicted in a given individual. Regardless, in most cases, the benefit of treating accommodative esotropia outweighs the potential risk of disrupting emmetropization.

Accommodative Esotropia Characteristics

Accommodative esotropia may be refractive or nonrefractive.[14] In refractive accommodative esotropia, the patient has moderate-to-high hyperopia and a normal accommodative convergence/accommodation (AC/A) ratio. In nonrefractive accommodative esotropia, the patient may have a low amount of hyperopia, or even myopia, and a high AC/A ratio. Most commonly, accommodative esotropia develops around the age of 3 years, but it may develop as late as 6 years or 7 years of age.[14]

Frequently, accommodative esotropia begins as an intermittent strabismus that occurs following an illness and may worsen or become more noticeable with fatigue. Over the next several weeks to months, the esotropia will usually become constant.[14] A strong hereditary component exists, and Birch and coworkers have reported that more than 75% of patients with accommodative esotropia have a first- or second-degree relative with accommodative esotropia.[15] In a series from Ziakas and coworkers, 26% of patients with hypermetropic accommodative esotropia had a first-degree relative with the disease, and a stronger hereditary tendency existed with accommodative esotropia than with infantile esotropia, anisometropic esotropia, or exotropia.[16] This has also been supported by the high concordance rates of accommodative esotropia in monozygotic twins.[17]

Abnormalities in pregnancy and delivery are more likely to cause infantile esotropia than other types of strabismus, such as accommodative esotropia.[18] Seeley et al reported that nonfamilial and familial accommodative esotropes are very similar, and the average degree of hyperopia in these two groups differed by less than half a diopter.[19]

Focus Point #1

Accommodative esotropia is the most common form of childhood esotropia.

Treatment

The four goals of treatment for accommodative esotropia include maintenance of normal visual acuity

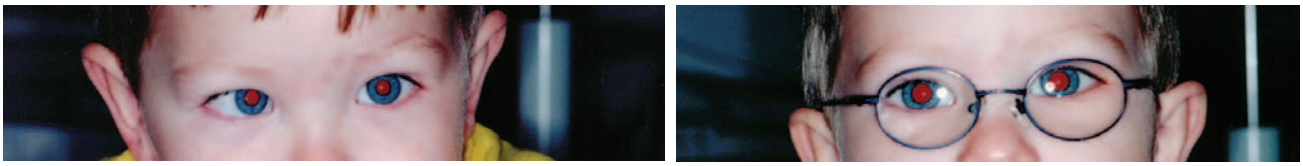

Fig. 1. *A:* A 2-year-old child with an acquired esotropia. *B:* With spectacle correction (+4.50+2.00 x 90 D OU), his esotropia resolved.

in each eye, restoration of ocular alignment, maintenance of excellent binocularity, and weaning the patient from spectacle use (or attempted facilitation of emmetropization).[14]

Amblyopia may be treated with patching and/or atropine penalization, and amblyopia treatment in accommodative esotropia is usually successful.

Restoring ocular alignment can often be accomplished with spectacles alone, although a nonaccommodative esotropia may become superimposed, possibly due to a delay in treatment and the development of amblyopia (Figures 1A and 1B).

Maintaining stereopsis can be quite difficult, particularly in situations where delay in treatment occurs. Prompt attention to ocular alignment can facilitate the maintenance of stereopsis. Stereopsis can degrade fairly quickly, even over several weeks.[14] Spectacle correction is usually the treatment of choice, particularly because of the typical patient's age, but contact lenses may be considered in older patients if the refractive error is high (greater than 6 D of hyperopia and/or 3 D of astigmatism) or if compliance is expected to be better with contact lenses. Autorefraction at least 30 minutes after the instillation of cyclopentolate 1%, with attention to mydriasis (as patients with darker irides often require more than one set of drops), is now preferred by many pediatric ophthalmologists to retinoscopy alone due to the ability of autorefraction to better detect and quantify astigmatism in children. Refractive laser surgery has met with some success in treating accommodative esotropia, although long-term data are sparse. Although good results can be achieved if hyperopia can be completely eliminated by refractive surgery, alignment is unpredictable in patients with residual hyperopia. Thus, the eligibility of patients is limited by their degree of hyperopia. Attempts to treat children with refractive surgery can be quite difficult due to the need for general anesthesia. Furthermore, the safety of refractive surgery in children has not been ascertained.[20,21]

The last goal of weaning children from glasses while attempting to maintain ocular alignment, excellent acuity, and high-grade stereopsis is particularly challenging.[14] Diminishing the hyperopic correction in a gradual fashion can be successful. Prescribing the full cycloplegic refraction initially will provide the best opportunity for restoring ocular alignment and maintaining good visual acuity and stereopsis. Once normal ocular alignment has been restored for an extended period of time, however, the hyperopic power can be gradually reduced in many children. Success rates for weaning accommodative esotropes from spectacles have been reported to be as low as 15%.[14] Also, as previously stated, the question remains whether spectacle correction of hypermetropia significantly disrupts emmetropization. Strabismus surgery should be reserved for patients in whom refractive treatments fail to restore ocular alignment.

Predicting Ability to Wean Spectacles

Most children with accommodative esotropia will require spectacles into adulthood.[22] Many children who wear spectacles for accommodative esotropia as children require glasses in adulthood for best corrected vision for myopia, astigmatism, or residual hyperopia. Lambert et al concluded that grade-school children, ages 7–9, could be weaned out of glasses in most cases if their initial, full cycloplegic, hyperopic correction was less than 3 D.[22,23] However, only about 20% of children with a hyperopic correction of 3–5 D could be successfully weaned out of glasses.[22,23]

Focus Point #2

Most human infants are hyperopic, and emmetropia usually develops by early adolescence.

Focus Point #3

The four goals of treatment for accommodative esotropia include maintenance of normal visual acuity in each eye, restoration of ocular alignment, maintenance of excellent binocularity, and weaning the patient from spectacle use (or attempted facilitation of emmetropization).[14]

Children in this study were gradually weaned out of their hyperopic correction in 0.50-D increments every 6 months until glasses were discontinued or until they developed esotropia, asthenopia, or decreased vision. The mean time to successful termination of glasses wear was 17.3 months. For the patients who were unable to discontinue glasses wear, the mean time of follow-up was 2.7 years. High-grade stereopsis was not a prerequisite to successful spectacle weaning. The biggest limitation of the study was that only 20 patients were included and followed. Certainly, over a longer period of time, some of those children might have been able to discontinue glasses wear. The timing of the initial prescription is also important, as the first prescription could be given well before the full degree of hyperopia is reached, resulting in a large underestimation of the ultimate degree of hyperopia.

Conclusion

Accommodative esotropia is a common disorder of childhood and the most common form of strabismus. Successful treatment requires patience, diligence, and timely intervention. Although the effect of spectacle treatment on emmetropization is still incompletely understood due to a paucity of long-term, prospective studies and disagreement among existing studies, fostering emmetropization or weaning spectacles is a goal worthy of pursuit. Emmetropization in patients treated with partial correction of hyperopia appears to correlate with emmetropization in the general population. Some evidence exists for delay or prevention of emmetropization in patients treated with their full cycloplegic refraction; thus, attempts to gradually wean hyperopic correction, while maintaining acuity, alignment, and stereopsis are considered reasonable and are attempted in our practice. Statistically, most children with accommodative esotropia, with greater than 3 D of initial hyperopia at the time of diagnosis will require glasses into adulthood, but caution should be employed when attempting to predict the future spectacle requirement for any given individual.

Focus Point #4

Many children who wear spectacles for accommodative esotropia as children require glasses in adulthood for best corrected vision for myopia, astigmatism, or residual hyperopia.

References

1. Fabian G: [Ophthalmological investigation of 1200 1-year-old children]. Acta Ophthalmol (Copenh) 44: 473-9, 1966
2. Ingram RM, Traynar MJ, Walker C, et al: Screening for refractive errors at age 1 year: a pilot study. Br J Ophthalmol 63: 243-50, 1979
3. Fulton AB, Dobson V, Salem D, et al: Cycloplegic refractions in infants and young children. Am J Ophthalmol 90: 239-47, 1980
4. Atkinson J, Braddick OJ, Durden K, et al: Screening for refractive errors in 6-9 month old infants by photorefraction. Br J Ophthalmol 68: 105-12, 1984
5. Abrahamsson M, Fabian G, Sjöstrand J: Changes in astigmatism between the ages of 1 and 4 years: a longitudinal study. Br J Ophthalmol 72: 145-9, 1988
6. Mäntyjärvi MI: Changes of refraction in schoolchildren. Arch Ophthalmol 103: 790-2, 1985
7. Troilo D, Wallman J: The regulation of eye growth and refractive state: an experimental study of emmetropization. Vision Res 31: 1237-50, 1991
8. Hung LF, Crawford ML, Smith EL: Spectacle lenses alter eye growth and the refractive status of young monkeys. Nat Med 1: 761-5, 1995
9. Ingram RM, Arnold PE, Dally S, et al: Emmetropisation, squint, and reduced visual acuity after treatment. Br J Ophthalmol 75: 414-6, 1991
10. Atkinson J, Anker S, Bobier W, et al: Normal emmetropization in infants with spectacle correction for hyperopia. Invest Ophthalmol Vis Sci 41: 3726-31, 2000
11. Ludwig IH, Parks MM, Getson PR, et al: Rate of deterioration in accommodative esotropia correlated to the AC/A relationship. J Pediatr Ophthalmol Strabismus 25: 8-12, 1988
12. Ong E, Grice K, Held R, et al: Effects of spectacle intervention on the progression of myopia in children. Optom Vis Sci 76: 363-9, 1999
13. Simons K: Amblyopia characterization, treatment, and prophylaxis. Surv Ophthalmol 50: 123-66, 2005
14. Lambert SR: Accommodative esotropia. Ophthalmol Clin North Am 14: 425-32, 2001
15. Birch EE, Fawcett SL, Marale SE, et al: Risk factors for accommodative esotropia among hypermetropic children. Invest Ophthalmol Vis Sci 46: 526-9, 2005
16. Ziakas NG, Woodruff G, Smith LK, et al: A study of heredity as a risk factor in strabismus. Eye 16: 519-21, 2002
17. Matsuo T, Hayashi M, Fujiwara H, et al: Concordance of strabismic phenotypes in monozygotic versus multizygotic twins and other multiple births. Jpn J Ophthalmol 46: 59-64, 2002
18. Matsuo T, Yamane T, Ohtsuki H: Heredity versus abnormalities in pregnancy and delivery as risk factors for different types of comitant strabismus. J Pediatr Ophthalmol Strabismus 38: 78-82, 2001
19. Seeley MZ, Paul TO, Crowe S, et al: Comparison of clinical characteristics of familial and sporadic acquired accommodative esotropia. J AAPOS 5: 18-20, 2001
20. Nucci P, Serafino M, Hutchinson AK: Photorefractive keratectomy followed by strabismus surgery for the treatment of partly accommodative esotropia. J AAPOS 8: 555-9, 2004
21. Phillips CB, Prager TC, McClellan G,

et al: Laser in situ keratomileusis for high hyperopia in awake, autofixating pediatric and adolescent patients with fully or partially accommodative esotropia. J Cataract Refract Surg 30: 2124-9, 2004

22. Lambert SR, Lynn M, Sramek J, et al: Clinical features predictive of successfully weaning from spectacles those children with accommodative esotropia. J AAPOS 7: 7-13, 2003
23. Hutcheson KA, Ellish NJ, Lambert SR: Weaning children with accommodative esotropia out of spectacles: a pilot study. Br J Ophthalmol 87: 4-7, 2003

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