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Spectacle correction of heterophoria in hyperopic amblyopic children

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Abstract: Objective: To test the effects of corrective spectacles in hyperopic amblyopic children with heterophoria. Methods: Visual acuity, refraction and the amount of heterophoria on near (33 cm) fixation were measured before and after 3 weeks of spectacle-wearing in 30 hyperopic amblyopic children with heterophoria. The control group consisted of 20 emmetropic children age-matched to the patients. Results: Uncorrected eyes displayed hyperopic amblyopia accompanied by heterophoria. Corrective spectacles not only attenuated the hyperopia and amblyopia, but also changed the heterophoria to orthophoria. The amount of heterophoria before wearing spectacles was significantly different from that in emmetropic children; but after correction with spectacles, it was the same as that in the emmetropic controls. Conclusion: Correction with spectacles is effective for the treatment of heterophoria in hyperopic children with amblyopia.

Key words: Heterophoria, Hyperopia, Amblyopia, Spectacles
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INTRODUCTION

Amblyopia is a common ophthalmic disorder that affects the vision of young children. One of the commonest causes of amblyopia is strabismus. Strabismic amblyopia results from suppression of vision mediated by the deviating eye, in order to avoid diplopia. Suppression is the mechanism by which the immature visual system deals with diplopia. In a young child, amblyopia is evident when the eye that has been suppressed for a long period of time begins to lose visual acuity. Although amblyopia is much more likely to occur in esotropia (Mittelman, 2003), the occurrence of amblyopia in heterophoria also has been reported (Sheedy and Saladin, 1978). Furthermore, strabismic amblyopia in humans has also been found to be associated with hyperopic refractive errors. Several retrospective studies of strabismic children have shown that the amblyopic eye tends to be more hyperopic than the fixating eye (Lepard, 1975; Nastri *et al*., 1984; Ingram, 1977). Therefore, the relationship between heterophoria and amblyopia, as well as between heterophoria and hyperopic refractive error, is an intriguing topic; and has not been well studied. The present study aimed to investigate heterophoria in hyperopic amblyopic children to determine the ability of spectacles to correct the heterophoria.

MATERIALS AND METHODS

Patients

We studied 30 hyperopic amblyopic children who presented initial complaint of amblyopia in our ophthalmic clinic. The average age was 6.9 years, range of 6~8 years. The subject recruitment criteria were set as (1) corrected visual acuity of ≥0.5; (2) cycloplegic refraction with topic 1% atropine +1.00~+6.00 diopters sphere (DS), and astigmatism ≤0.75 diopters cylinder (DC); (3) monocular vision in

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both eyes, with no heterotropia; and (4) no abnormalities revealed by external examination of the ocular adnexa and fundus examination. The control group was 20 emmetropic children of the same age as the amblyopic children (average 6.8 years), with uncorrected vision acuity ≥1.0 and cycloplegic refraction −0.25~+0.75 DS. Subjects were able to terminate their participation at any time and for any reason. The parents of all subjects gave informed consent.

Methods

1. Assessment of cycloplegic refraction

Atropine eye drops (1%, w/v) were used in all subjects, twice daily for 5 d, and the cycloplegic refraction was checked by retinoscopy. Afterwards, corrective spectacles were prescribed, and the corrected visual acuity was recorded. The subjects wore these spectacles every waking moment until bedtime. Three weeks after the subjects started to wear the spectacles, their cycloplegic refraction and visual acuity were re-examined.

2. Measurement of the amount of heterophoria

The amount of heterophoria was measured with a Vision Tester VT-10 (TOPCON, Japan). A 6 prism diopters (Δ) prism with base upward was put in front of the right eye, while a rotating prism was placed in front of the left eye. A near target consisting of a row of letters was held 33 cm in front of eyes. The subjects were then asked to observe the target without wearing spectacles. This caused various perceptual abnormalities, e.g. two rows of letters in the target. Then the rotating prism was adjusted until the subjects saw one clear row of letters in the target. The scale that the rotating prism indicated at this point was the amount of heterophoria (Δ) of the uncorrected eyes for each subject. Afterwards, the amount of heterophoria was assessed again with corrective spectacles.

3. Statistical analysis

The data were expressed as mean±*SD*. The differences in the amounts of heterophoria between amblyopic patients and emmetropic subjects without the spectacles, as well as between the patients with spectacles and emmetropic subjects without spectacles, were compared using a Mann-Whitney U-test. The difference of the amounts of heterophoria with and without spectacles in individual amblyopic patients was compared using a two-tailed paired-comparison *t*-test. The significance was set at $P<0.05$.

RESULTS

The amount of heterophoria in the uncorrected eyes of hyperopic amblyopic patients (without the corrective spectacles) was (4.5±5.7) Δ, whereas the amount of heterophoria with the corrective spectacles in these patients was (−4.4±5.68) Δ. The heterophoria magnitude of the control emmetropic subjects was (−5.1±4.76) Δ. The difference between magnitude of heterophoria in the hyperopic amblyopic patients without corrective spectacles, and that with spectacles, was statistically significant. The heterophoria magnitude in the uncorrected eyes of hyperopic amblyopic patients was also significantly different from that in the emmetropic controls without spectacles. However, the difference between magnitude of heterophoria in the hyperopic amblyopic patients with corrective spectacles, and in emmetropic subjects without the spectacles, was not statistically different (Table 1).

Table 1 Magnitude of heterophoria before and after spectacle correction in hyperopic amblyopic patients

	N	Magnitude of heterophoria (mean±*SD*, Δ)
Emmetropic controls	20	−5.1±4.76
Patients before correction	30	4.5±5.7 [a]
Patients after correction	30	−4.4±5.68 [b,c]

[a] $P<0.05$ compared to emmetropic controls; [b] $P<0.01$ compared to patients before correction; [c] $P>0.05$ compared to emmetropic controls

DISCUSSION

The present study found that heterophoria existed in hyperopic amblyopic children and that corrective spectacles were of benefit for attenuating it. Heterophoria is defined as a deviation from orthoposition that occurs when binocular fusion is made impossible, e.g., by covering one eye. One type of heterophoria, esophoria, is a common condition in which the visual axes tend to deviate inwards; it may be due to a convergence excess, and it occurs most often in hyperopia. In our study, before correction with spectacles the patients displayed both hyperopia and esophoria, as expected. However, they also showed amblyopia, indicated by the loss of normal visual acuity. In the present study, we used corrective spectacles in hyperopic amblyopic patients with heterophoria, which adjusted the amount of heterophoria

from (4.5±5.7) Δ to (−4.4±5.68) Δ; this was similar to the heterophoria magnitude, (−5.1±4.76) Δ, in the control emmetropic subjects. This result demonstrated that spectacle-wearing could correct the heterophoria in hyperopic amblyopic patients.

The normal heterophoric magnitude in near vision (33 cm) is from +2 Δ to −7 Δ (Duke-Elder and Wybar, 1973). Our data indicated that the heterophoria magnitude in hyperopic amblyopic children was 4.5 Δ according to a near-vision measurement. This heterophoria magnitude was over the normal scale, implying that esophoria might also be present. After correction with spectacles, the heterophoria magnitude was changed to −4.4 Δ. However, even though the corrected heterophoria was −4.4 Δ, it was still within the normal range, and therefore did not mean that exophoria was present.

It has been reported that increasing hyperopic refractive error is related to the development of amblyopia and frequently associated with development of strabismus (Ingram *et al*., 1986). It is known that an increased activation of convergence, coupled to increased accommodation due to a hypermetropic refractive error, is the most common factor in the etiology of heterophoria. Schor (1999) as well as Hasebe *et al*.(2005) reported that a high accommodative convergence/accommodation (AC/A) ratio in hyperopia and esophoria. Therefore, a full correction of refractive error is the first necessity in the treatment of heterophoria. Detecting children with high hyperopia and treating them at an early time has been shown to improve final visual acuity and thereby decrease the incidence of amblyopia and strabismus (Ingram *et al*., 1990). On the other hand, in binocular vision, a fixated target is imaged onto the centre of the fovea in each eye, so that the principal visual directions of both eyes intersect at the fixation point. In this state of bicentral fixation, visual acuity is higher than in monocular vision (Campbell and Green, 1965; Heravian *et al*., 1990). This improvement in acuity due to binocularity can be lost in cases of heterophoria, in which the visual axes deviate slightly from the centre of the fovea. In the present study, spectacle-wearing not only corrected the patients' hyperopia and converted their heterophoria to orthophoria, but also attenuated their amblyopia. We speculate that the results could be due to the correction of the hyperopic refractive error by the spectacles, this restoring the balance of binocular accommodative convergence led to the orthophoria and recovery of the visual acuity. Taken together, these findings suggest that spectacle correction is a suitable treatment for hyperopic amblyopia in children with heterophoria, especially esophoria.

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