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Bifocals Fail to Improve Stereopsis Outcomes in High AC/A Accommodative Esotropia

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Purpose: To assess whether stereopsis outcomes of patients with accommodative esotropia with high accommodative convergence/accommodation relationship (AC/A) were improved after treatment with bifocal glasses compared with single-vision lenses.

Design: Retrospective cohort study.

Participants: Patients with high AC/A accommodative esotropia; evidence of stereopsis, binocularity (on Worth 4-dot testing), or improvement in near angle with +3.00 D lenses; and at least 4 years of records available for review, who were seen in the Department of Ophthalmology at Boston Children's Hospital between 2006 and 2014.

Methods: Use of bifocal or single-vision glasses. Charts were reviewed retrospectively. Stereopsis was log transformed for statistical analysis. Linear (for stereopsis) or logistic (for surgery) regression was used to control for confounders.

Main Outcome Measures: Stereopsis at final follow-up, difference in stereopsis between final and initial visits, and progression to strabismus surgery. Secondary outcomes included final near and distance deviations.

Results: Of the 180 patients who met inclusion criteria, 77 used bifocals and 103 used single-vision lenses. Bifocals did not improve stereopsis outcomes compared with single-vision lenses. In both groups, stereopsis was similar at the initial and final visits, with similar improvement in both groups. Children in the bifocal group had a 3.6-fold higher rate of strabismus surgery than children in the single-lens group ($P = 0.04$.) Additionally, children in the bifocal group had near deviations 4 PD larger than those with single lenses at final follow-up, even after controlling for age and initial deviation ($P = 0.02$). These results did not change if surgical patients were eliminated or in the subgroup with initial distance deviation of 0 PD in full hyperopic correction.

Conclusions: Despite their widespread use, there is no evidence that bifocals improve outcomes in children with accommodative esotropia with high AC/A. In our retrospective review, children with bifocals had higher surgical rates and a smaller improvement in near deviation over time. Although our results suggest that eliminating bifocals could reduce the cost and complexity of care while potentially improving quality, prospective, randomized controlled trials are needed to determine whether a change in practice is warranted. *Ophthalmology 2016;123:690-696 © 2016 by the American Academy of Ophthalmology.*

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In patients with accommodative esotropia and high accommodative convergence/accommodation relationship (AC/A), the full hyperopic correction often controls alignment at distance, but a deviation at near persists. A near addition lens (bifocal) often reduces or eliminates this residual near angle, motivating many clinicians to recommend bifocals to improve near alignment, with the logical goal of improving sensory outcomes. Although the only 2 comparative trials that have evaluated sensory outcomes of bifocal treatment have failed to show benefit,[1,2] the use of bifocals for patients with accommodative esotropia and high AC/A remains common. In this article, we present evidence that sensory outcomes were not significantly different between patients treated with single-vision lenses and patients treated with bifocals, and that patients in the bifocal group were more likely to need strabismus surgery.

Methods

We conducted a retrospective chart review of patients with accommodative esotropia with high AC/A cared for at Boston Children's Hospital for at least 4 years. Patients were treated with either bifocals or single-vision lenses based on practitioner preference. Inclusion criteria (at the qualifying visit) included esodeviation (measured with distance correction, based on full cycloplegic refraction) of less than 10 PD at distance and more than 10 PD at near, with at least a 10 PD difference between distance and near measurements. Included patients were required to display either fusion (on Worth 4-dot testing), stereopsis (on Titmus or Randot testing [Stereo Optical Inc., Chicago, IL]), or improvement in near angle to less than 10 PD with +3.00 D lenses. Exclusion criteria included prior strabismus surgery, Down syndrome, a developmental disorder that precluded stereopsis testing, aphakia, pseudophakia, and myopia.

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For each patient, a qualifying visit was identified when the following criteria were met: cycloplegic refraction known, patient being treated with single-vision spectacles, and inclusion criteria met. Results from the qualifying visit are the initial values reported. Follow-up commenced with the qualifying visit, and the reported follow-up time is the time between the qualifying visit and the final study visit. Although all patients had a minimum of 4 years of visits for inclusion in the study (and thus had a 4-year interval of observation), not all had 4 full years between the qualifying visit and the final study visit. This was because some patients had several visits before the qualifying visit (usually because the patient did not initially demonstrate stereopsis or fusion), whereas others required surgery before completing the full 4 years of follow-up, with the last preoperative appointment serving as the final study visit.

Visual acuity, ocular deviation at near and distance, fusion, refraction, amblyopia, and stereopsis were recorded. Visual acuity was measured with age-appropriate methods: Snellen letters when possible, HOTV or LEA symbols for younger children, and preferential looking testing for children unable to cooperate with other methods. Deviations were measured using alternate prism and cover testing, with patients wearing their full cycloplegic refraction, at both distance (6 m) and near (1/3 m). Stereopsis was measured using the Titmus fly and Randot animals and circles. All initial measurements were performed through the patient's distance correction. For patients wearing bifocals, final measurements of stereopsis were conducted through the bifocal segment. For patients wearing single-vision lenses, final measurements of stereopsis were conducted through the distance correction. Fusion was measured using the Worth 4-dot test at distance and near. Cycloplegic refraction was determined by retinoscopy for all patients. Amblyopia was defined as at least a 2-line difference in visual acuity measurement between the 2 eyes.

To facilitate statistical analyses and calculation of means and differences, we used logarithmic transformation of stereopsis, with natural logs. Stereopsis values and corresponding log transformations are shown in Table 1. No measurable stereopsis was assigned a value of 10 000 arcsec for purposes of logarithmic transformation (in contrast with Weakley,[3] who assigned a value of 3000 arcsec to those with nil stereopsis). Analyses were repeated with 6000 and 100 000 arcsec as assigned values for no stereopsis, with no change in the conclusions. Mean differences were compared between patients treated with bifocals and those treated with single-vision lenses.

Table 1. Transformation of Stereopsis to lnArcsec

Seconds of Arc	Ln Seconds of Arc
Nil	9.21*
3000	8.01
800	6.68
400	5.99
200	5.30
140	4.94
100	4.61
80	4.38
70	4.25
60	4.09
50	3.91
40	3.69
30	3.40
25	3.22
20	3.00

Ln = natural log.
*To transform 0 stereopsis to a real number, a stereopsis value of 10 000 seconds of arc was selected.

Linear regression was used to control for confounding variables including initial stereopsis, amblyopia, age, initial cycloplegic refraction, and initial deviations at distance and near. For patients in whom initial stereopsis could not be tested because of age or inability to cooperate, including 10 with single-vision lenses and 6 with bifocals, initial stereopsis was treated as 0. All calculations were repeated with those values as missing values, with similar results.

Patients were coded as progressing to surgery if they underwent strabismus surgery during the care interval. (All of the patients who progressed to surgery did so because of decompensation of their distance alignment.) For surgical patients, the final presurgical visit was used as the final study visit. The binary outcome of "surgery" vs. "no surgery" was compared with the exposure to bifocals and analyzed using the Fisher exact test. Logistic regression was used to control for confounding variables. All statistical analyses were conducted in SAS version 9.3 (SAS Inc, Cary, NC).

The study complied with the Health Insurance Portability and Accountability Act. Institutional review board approval was obtained through Boston Children's Hospital, and all research adhered to the tenets of the Declaration of Helsinki.

Results

A total of 180 patients met the inclusion criteria, of whom 77 were treated with bifocals and 103 with single-vision lenses. The average care interval was 4.3 years. Patients were cared for by a total of 9 different faculty pediatric ophthalmologists. Baseline characteristics are shown in Table 2. The groups had similar distributions of age, gender, initial visual acuity, and amblyopia. They did differ on initial cycloplegic refraction (single-vision patients were, on average, more hyperopic) and initial deviation at near, with bifocal patients being more esotropic at near than patients treated with single-vision lenses. All but 2 patients in the bifocal group received an add of at least +2.50 D.

Improvement in Stereopsis was Similar in Both Groups

Stereopsis was similar in the single-vision and bifocal groups initially and at final follow-up (Fig 1A). Patients in the bifocal group had an average improvement in stereopsis of −0.95 lnArcsec over the 4-year care interval, and single-vision patients had an average improvement of −1.18 lnArcsec (adjusted $P = 0.76$; Fig 1B). (Using the lnArcsec scale, improvement in stereopsis is represented by a negative change, which indicates a smaller number.) Final mean stereopsis (measured through bifocals in the bifocal group and through distance correction in the single-vision group) was 5.94±2.3 lnArcsec in the bifocal group versus 5.59±2.1 lnArcsec in the single-vision group (equivalent to 379 arcsec for the bifocal group and 268 arcsec for the single-vision group). Predictors that were associated with significantly improved stereopsis in either group were better initial stereopsis ($P < 0.001$), lower initial deviation at distance ($P = 0.02$), and lack of amblyopia ($P = 0.004$). In addition, the association of lower initial deviation at near with greater improvement in stereopsis was of borderline significance ($P = 0.052$).