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Contrast Sensitivity following Amblyopia Treatment in Children

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To the editor

Prior studies have found a reduction in contrast sensitivity in eyes with amblyopia using sinusoidal gratings,¹⁻³ whereas minimal loss has been reported with Pelli-Robson charts.^{3, 4} Most studies have evaluated contrast sensitivity at the time of diagnosis of amblyopia or after short-term treatment. A follow-up study of an earlier randomized trial provided us the opportunity to evaluate contrast sensitivity using Pelli-Robson low contrast letter charts at age 10 years, several years after treatment of amblyopia.⁵

Methods

Contrast sensitivity was measured using Pelli-Robson charts⁵ (Richmond Products, Albuquerque, New Mexico 87108) in 86 subjects (mean age 10.3 years) who at 3 to 6 years of age had previously participated in a randomized treatment trial comparing atropine versus patching for moderate amblyopia. Institutional Review Boards approved the study and written consent was obtained from parents. Details of the randomized trial and the age 10 years exams have been reported.⁶ The low contrast letter identification score for each eye was the lowest contrast triplet for which the child correctly identified at least two of three letters on the first attempt, reading from highest to lowest contrast. Monocular visual acuity was measured with the Electronic Early Treatment of Diabetic Retinopathy Study visual acuity testing protocol.⁷

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*A list of the members of the Pediatric Eye Disease Investigator Group participating in the study has been published.

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Results

Mean visual acuity in the amblyopic and fellow eyes at the time of the exam were 0.17 logMAR (approximately 20/32) and -0.04 logMAR (approximately 20/20), respectively. Mean log low contrast letter identification score was slightly worse in the amblyopic eye than in the fellow eye (1.75 versus 1.78, $P=0.04$ with a Paired Samples T-Test, Table). There was a weak correlation between the interocular contrast sensitivity difference and the interocular visual acuity difference (Spearman correlation = 0.27, 95% CI 0.08 to 0.47). Contrast sensitivity scores in the amblyopic and fellow eyes did not differ with respect to original treatment group assignment (atropine versus patching, $P=0.77$ for amblyopic eye and $P=0.95$ for fellow eye, respectively with an Independent Samples T-Test). There was a suggestion that younger age at the time of entry into the randomized trial was associated with better amblyopic eye contrast sensitivity (Spearman correlation = -0.21, 95% CI -0.42 to -0.01).

Comment

Our results confirm the finding of other studies that the loss of contrast sensitivity after treatment of strabismic and anisometropic amblyopia is slight in the intermediate spatial frequencies tested with the low contrast letters of the Pelli-Robson charts.^{3, 4} The distribution of contrast sensitivity in the amblyopic eye nevertheless was similar to that reported for monocular testing of normal 10-year olds.⁸

The suggestion that younger patients at enrollment into the randomized trial (3 to < 5 years compared with those 5 to < 7 years) were more likely to have slightly better contrast sensitivity in the amblyopic eye at 10 years of age is consistent with what we have reported for visual acuity.⁶ This effect, if substantiated, could be due to a number of factors. Possibilities include a younger age at treatment allowing more complete cortical development, and a shorter duration of the vision deficit. Each of these circumstances might allow a more complete treatment effect or alternatively a shorter and thus less profound insult to the developing visual sensory system.

There are limitations to the Pelli-Robson chart in that it is a measure of low contrast letter identification that correlates with contrast sensitivity in the medium spatial frequency range.⁵ Losses at high spatial frequency have been reported for all types of amblyopia.⁹ Thus, although we found a slight reduction in Pelli-Robson scores, there could be greater contrast sensitivity loss at other spatial frequencies or prior to treatment. Nevertheless, it seems likely that mild residual amblyopia, which was present in the majority of cases, is associated with only a mild reduction in contrast sensitivity after treatment of moderate amblyopia from strabismus, anisometropia or both combined.

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References

1. Hess RF, Howell ER. The threshold contrast sensitivity function in strabismic amblyopia: evidence for a two type classification. *Vision Res* 1977;17:1049–55. [PubMed: 595414]
2. Howell ER, Mitchell DE, Keith CG. Contrast thresholds for sine gratings of children with amblyopia. *Invest Ophthalmol Vis Sci* 1983;24:782–7. [PubMed: 6853106]
3. McKee SP, Levi DM, Movshon JA. The pattern of visual deficits in amblyopia. *J Vis* 2003;3:380–405. [PubMed: 12875634]
4. Moseley MJ, Stewart CE, Fielder AR, Stephens DA. Intermediate spatial frequency letter contrast sensitivity: its relation to visual resolution before and during amblyopia treatment. *Ophthalmic Physiol Opt* 2006;26:1–4. [PubMed: 16390475]

5. Pelli DG, Robson JG, Wilkins AJ. The design of a new letter chart for measuring contrast sensitivity. *Clin Vision Sci* 1988;2:187–99.
6. Pediatric Eye Disease Investigator Group. A randomized trial of atropine vs patching for treatment of moderate amblyopia: follow-up at age 10 years. *Arch Ophthalmol* 2008;126:1039–44. [PubMed: 18695096]
7. Beck RW, Moke PS, Turpin AH, et al. A computerized method of visual acuity testing: adaptation of the early treatment of diabetic retinopathy study testing protocol. *Am J Ophthalmol* 2003;135:194–205. [PubMed: 12566024]
8. Myers VS, Gidlewski N, Quinn GE, et al. Distance and near visual acuity, contrast sensitivity, and visual fields of 10-year-old children. *Arch Ophthalmol* 1999;117:94–9. [PubMed: 9930166]
9. Ciuffreda, KJ.; Levi, DM.; Selenow, A. In *Amblyopia: Basic and Clinical Aspects*. Butterworth-Heinemann; Boston: 1991. Sensory Processing in Strabismic and Anisometropic Amblyopia; p. 81-5.

Table: Contrast Sensitivity at the Age 10 Years Visit

	Amblyopic Eye* N=86	Fellow Eye* N=86
Contrast Sensitivity Score (log units)	n (%)	n (%)
2.25	0	0
2.10	1 (1%)	0
1.95	20 (23%)	27 (31%)
1.80	21 (24%)	23 (27%)
1.65	40 (47%)	34 (40%)
1.50	3 (3%)	2 (2%)
1.35	0	0
1.20	1 (1%)	0
≤1.05	0	0
Mean (SD)	1.75 (0.15)	1.78 (0.13)
Median (quartiles)	1.65 (1.65,1.80)	1.80 (1.65,1.95)
[Range]	[1.20 to 2.10]	[1.50 to 1.95]
Interocular Difference in Contrast Sensitivity	n (%)	
2 triplets better in the amblyopic eye	2 (2%)	
1 triplet better in the amblyopic eye	12 (14%)	
Tested the same	47 (55%)	
1 triplet better in the fellow eye	18 (21%)	
2 triplets better in the fellow eye	6 (7%)	
3 triplets better in the fellow eye	1 (1%)	

* `Amblyopic' eye and `Fellow' eye refers to the study eye at the time of randomization