

Long-term Outcomes of Photorefractive Keratectomy for Anisometropic Amblyopia in Children

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Purpose: To evaluate the long-term visual acuity (VA) and refractive error responses to excimer laser photorefractive keratectomy (PRK) for treatment of anisometropic amblyopia in children.

Design: Prospective interventional case-control study.

Participants: Eleven children, 2 to 11 years old, with anisometropic amblyopia who were noncompliant with conventional therapy with glasses or contact lenses and occlusion therapy were treated with PRK. A cohort derived retrospectively of 13 compliant and 10 noncompliant children with refractive errors similar to those of the PRK group who were treated with traditional anisometropic amblyopia therapy served as control groups.

Intervention: Photorefractive keratectomy for the eye with the higher refractive error.

Main Outcome Measures: (1) Refractive error reduction and stability in the treated eye, (2) cycloplegic refraction, (3) VA, (4) stereoacuity, and (5) corneal haze up to 3 years after PRK. Compliant and noncompliant children with anisometropic amblyopia were analyzed as controls for refractive error and VA.

Results: Preoperative refractive errors were -13.70 diopters (D) (± 3.77) for the myopic group and $+4.75$ D (± 0.50) for the hyperopic group. Mean postoperative refractive errors at last follow-up (mean, 31 months) were -3.55 D (± 2.25) and $+1.41$ D (± 1.07) for the myopic and hyperopic groups, respectively. At last follow-up, cycloplegic refractions in 4 (50%) of 8 myopes and all hyperopes (100%) were within 3 D of that of the fellow eye. Five (63%) of 8 myopic children achieved a refraction within 2 D of the target refraction. Two (67%) of 3 hyperopic patients maintained their refractions within 2 D of the target. Refractive regressions (from 1 year after surgery to last follow-up) were 0.50 ± 1.41 D (myopes) and 0.60 ± 0.57 D (hyperopes). Seven children (77%) were able to perform psychophysical VA testing preoperatively and postoperatively. Five (71%) of the 7 children had uncorrected VA improvement of at least 2 lines, and 4 (57%) of 7 had best spectacle-corrected VA improvement of at least 2 lines, with 1 improving 7 lines. Five (55%) of 9 children had improvement of their stereoacuity at last follow-up. Subepithelial corneal haze remained negligible. The mean final VA of the PRK group was significantly better than that of the noncompliant control group ($P = 0.003$). The mean final refractive error for both myopic and hyperopic groups was also significantly better than that of the control groups ($P = 0.007$ and $P < 0.0001$, respectively).

Conclusions: Photorefractive keratectomy for severe anisometropic amblyopia in children resulted in long-term stable reduction in refractive error and improvement in VA and stereopsis, with negligible persistent corneal haze. *Ophthalmology* 2006;113:169-176 © 2006 by the American Academy of Ophthalmology.

Traditional treatment options for anisometropic amblyopia include refractive correction with spectacles or contact lenses and occlusion or penalization of the sound eye.

Children with this condition, however, are commonly noncompliant with these therapies. Children are often intolerant to spectacle correction if the anisometropia is severe because of resultant aniseikonia and diplopia caused by refractive correction. A human can tolerate only about 5% to 6% aniseikonia, which occurs with 2 to 3 diopters (D) of anisometropia, after which the image disparity is intolerable.¹ Furthermore, anisometropic children usually have one eye with an acceptable refractive error from which they see well. For this reason, the children perceive no benefit from spectacles and often reject them on this basis. Contact lenses are often difficult to use and maintain in children and can be costly. Excimer laser refractive surgery could be a viable treatment option for severe anisometropia, if found to be safe and effective in the long term.

Long-term concerns with photorefractive keratectomy

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Table 1. Patient Demographics and Refractive Results of the Children Who Underwent Photorefractive Keratectomy for Anisometropia

Characteristic	Myopic Group	Hyperopic Group
No. of patients	8	3
Mean age (yrs) (range)	4 (2–8)	9 (8–11)
Mean preoperative keratometry readings \pm SD (D)	44.80 \pm 1.54	42.30 \pm 1.06
Mean preoperative corneal thickness \pm SD (μ m)	521 \pm 43.4	536 \pm 42.4
Mean preoperative SE RE \pm SD (D)	-13.70 \pm 3.77	+4.75 \pm 0.50
Mean interocular SE RE difference \pm SD (D)	11.07 \pm 4.02	4.38 \pm 0.45
Maximum refractive SE RE dose (D)	-11.50	+5.25
Mean target SE RE \pm SD (D)	-3.50 \pm 3.70	Plano
Mean target SE RE reduction \pm SD (D)	10.10 \pm 1.39	4.75 \pm 0.5
Mean 12-mo SE RE reduction \pm SD (D)	10.56 \pm 3.0	4.08 \pm 0.80
Mean 36-mo SE RE reduction \pm SD (D)	9.81 \pm 2.94	2.88 \pm 1.05
Mean 12-mo postoperative SE RE \pm SD (D)	-3.20 \pm 2.50	+0.67 \pm 0.50
Mean 36-mo postoperative SE RE \pm SD (D)	-3.53 \pm 2.25	+1.41 \pm 1.07
Mean SE RE 12-mo regression \pm SD (D)	2.50 \pm 2.23	1.10 \pm 1.60*
Mean SE RE 12- to 36-mo regression \pm SD (D)	0.50 \pm 1.41	0.60 \pm 0.57
No. of patients within 1 D of target at last follow-up	2/8	1/2
No. of patients within 2 D of target at last follow-up	5/8	2/3
% reduction in RE at last follow-up	74%	70%

D = diopters; RE = refractive error; SD = standard deviation; SE = spherical equivalent.
*Published previously.

(PRK) are refractive treatment stability, uncorrected visual acuity (UCVA), best spectacle-corrected visual acuity (BSCVA), and corneal status. There have been several studies published on refractive surgery in children.^{2–11} Most had short follow-ups and did not include a control group. Only one study has prospectively evaluated the long-term results of pediatric PRK for myopic anisometropia.¹⁰ We report the first prospective pilot study with long-term follow-up of children treated with PRK for both anisometropic myopia and hyperopia and compare the visual outcomes with those of a noncompliant and a compliant control group.

Materials and Methods

This prospective interventional case study of PRK in children with anisometropic amblyopia was approved by the institutional review board of Baylor College of Medicine. Written parental informed consent and verbal assent from children old enough to understand were obtained for all participants. Eleven children between 2 and 11 years old were treated with PRK for severe anisometropia with amblyopia. Inclusion criteria were (1) anisomyopia of at least 6 D or anisohyperopia of at least 4 D, (2) poor compliance with spectacles and/or contact lenses and occlusion therapy based on parental report, and (3) amblyopia of the eye with the highest refractive error, defined as a best-corrected visual acuity (BCVA) in the amblyopic eye that was at least 3 logarithm of the minimum angle of resolution (logMAR) lines lower than that of the sound eye or a strong fixation preference for the fellow eye in preverbal children. Children with an abnormality of the cornea, lens, or fovea were excluded.

Each child underwent a comprehensive ophthalmologic examination that included UCVA, BSCVA, stereoacuity testing (Titmus stereo fly test, Stereo Optical Co., Chicago, IL), pupillary examination, ocular motility, intraocular pressure measurement as tolerated, biomicroscopy, funduscopy, and cycloplegic refraction. Visual acuity (VA) testing was done with the most sophisticated standard VA test the child could comprehend and perform. Visual

behavior was tested in younger children using the fixation-and-following response and the vertical prism test for determination of fixation preference. Psychophysical VA testing was done as soon as patient comprehension permitted. The Titmus stereo fly test was used to test stereoacuity because of its ease of use and reproducibility in young children. Ultrasound pachymetry and keratometry were performed preoperatively.

The refractive goal for each child was emmetropia or to reduce the anisometropia to \leq 3 D, up to a maximum myopic treatment of 11.50 D and a maximum hyperopic treatment of 5.25 D. The details of the refractive surgical procedure and postoperative medications are reported elsewhere.^{12,13} Briefly, 9 children required general anesthesia. Centration was achieved manually. The surgeon centered the treatment on the entrance pupil. Two observers positioned themselves so that their eyes were at the level of the iris plane of the eye to be treated. Before and during the treatment, the observers ensured that the iris plane was maintained perpendicular to the laser beam. Postoperatively, the children were examined every day until the corneal epithelium healed. They were then examined 1 month after the procedure and every 3 months for 12 months and again at 24 months and 36 months after the surgery. Data analyzed from each comprehensive follow-up examination included UCVA, BSCVA, stereoacuity, ocular motility, degree of corneal haze, and cycloplegic refraction. Postoperative subepithelial corneal haze was graded on a scale of 0 to 4+.¹³

The BSCVAs for the PRK study group at the last follow-up examination were compared with those of 2 control groups: (1) anisometropic children who were either diagnosed after age 6 years or noncompliant with amblyopia therapy (noncompliant control group) and (2) anisometropic amblyopic children who were diagnosed at age 6 or before and were compliant with therapy (compliant control group). The BCVA at the last visit in each control group was used for comparison. Control group patients were identified retrospectively by medical records review, as it would have been unethical to randomize children prospectively to a no-treatment group. All control patients were identified using a computer search for *anisometropia* over a 3-year period. All controls had at least 4 D of anisometropia and 1 year of follow-up.

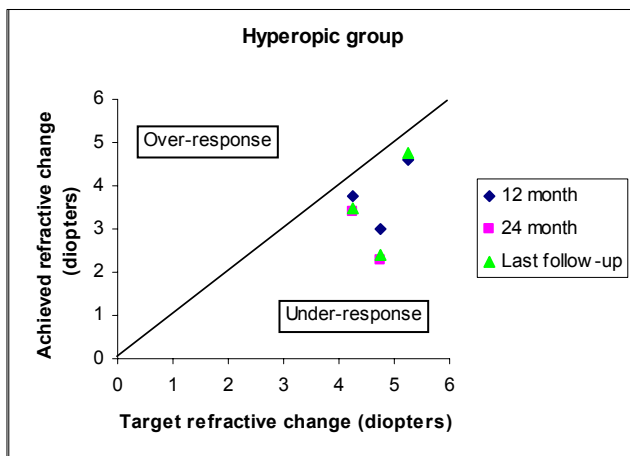
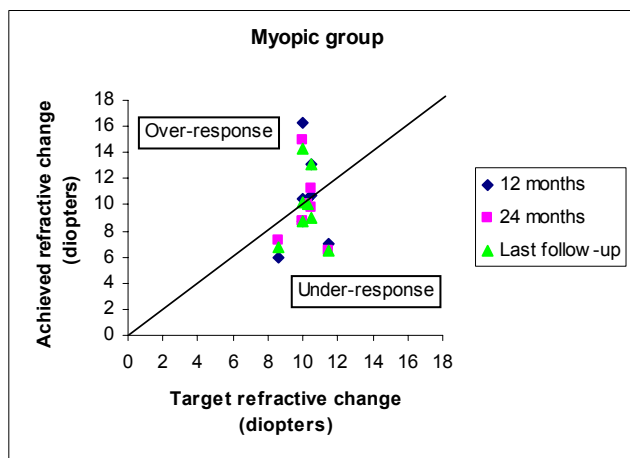


Figure 1. Target refractive treatment change compared with the 12-month, 24-month, and last follow-up results in the myopic and hyperopic groups treated with photorefractive keratectomy. Note that the points above the line represent overresponse from target and those below the line represent underresponse from target.

Strabismus was the only other eye abnormality the control patients were allowed to have.

Visual acuities in the PRK group and the control groups were converted to logMAR acuities for analyses because of linearity. They were then converted back to the more familiar Snellen values to facilitate review of the data. Statistical calculations were performed using Intercooled Stata, version 7.0 (Stata Corp., College Station, TX). Continuous data were compared between PRK cases and control groups using the Student's *t* test. Ordinal data were analyzed using logistic regression. Refractive and corneal haze results were analyzed throughout. Visual acuity outcomes were analyzed at the 12-month, 24-month, and last follow-up visits.

Safety of PRK in children with anisometropic amblyopia was assessed using a previously published refractive surgery safety index (postoperative BCVA ÷ preoperative BCVA).³ Efficacy was assessed using a previously published refractive surgery efficacy index (postoperative UCVA ÷ preoperative BCVA).³

Compliance was defined as follows: excellent compliance was a parental report of ≥76% of the recommended time actually completed, good compliance was a parental report of 51% to 75% of the recommended time completed, fair compliance was a parental report of 25% to 50% of the recommended time completed,

and poor compliance was a report of <25% of the recommended time completed.

Results

The mean age of the 11 treated children was 6.1 years (range, 2–11). Nine (82%) children were male, and 10 (91%) of the treated eyes were right eyes. Eight children were treated for anisomyopia and 3 for anisohyperopia. Eight (73%) children were Caucasian, 1 (10%) was Hispanic, and 2 (18%) were African American. Mean follow-up time was 31±9.9 months (Table 1).

Myopia Group

Table 1 demonstrates demographics and complete refractive results. Table 2 shows the preoperative and postoperative results at last follow-up of the individual patients. Figure 1 demonstrates the target versus achieved refractive error change over the follow-up period.

At the last follow-up visit, the cycloplegic refractive error of the treated eye was within 3 D of that of the fellow eye in 4 (50%) of 8 eyes. At this same visit, 2 (25%) of 8 myopes were within 1 D of target refractive spherical equivalent (SE), and 5 (63%) of 8 were within 2 D (Table 1, Fig 1). No patient had an overresponse producing hyperopia. Mean postoperative anisometropia at last follow-up was 2.86 D (±1.53).

Refractive error stability over the 36-month follow-up period is illustrated in Figure 2. Our myopic group had moderate refractive regression over the first 12-month follow-up period, with a mean

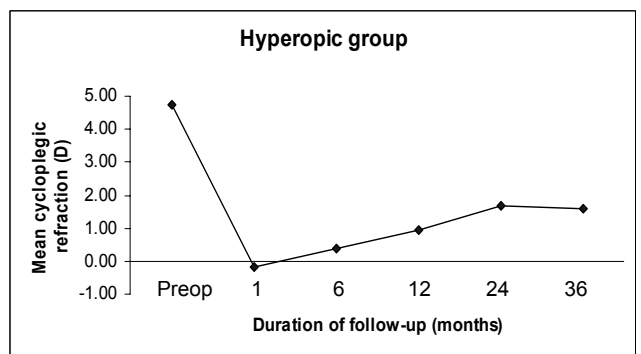
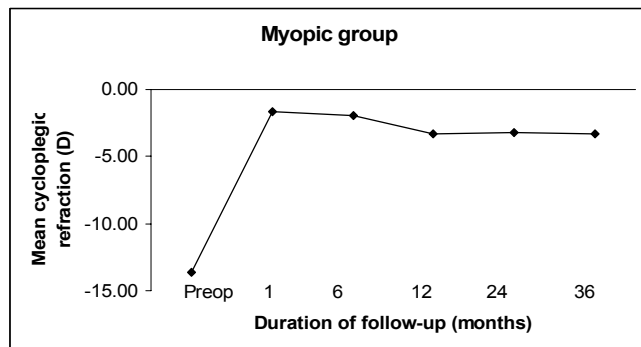


Figure 2. Refractive error stability over time in the myopic and hyperopic subgroups of children treated with photorefractive keratectomy. The mean refraction is the spherical equivalent refraction. D = diopters; preop = preoperative.

Table 2. Preoperative and Postoperative Results of

Patient No.	Preoperative Data						Stereopsis (Seconds of Arc)	Ocular Alignment (PD)	PRK Dose (D)
	Age (yrs)	SE (D)	Interocular SE Difference (D)	UCVA	BSCVA				
1	3	-15.75	12.87	F&F	F&F	Too young to test	Orthotropic	-10.5	
2	8	-10.00	8.13	20/300	20/200	Nil	Orthotropic	-10	
3	2	-13.75	11.62	F&F	F&F	Too young to test	Orthotropic	-10.5	
4	6	-15.75	14.00	3/400	20/200	Nil	Orthotropic	-10	
5	10	+4.25	3.88	20/60	20/40	800	Orthotropic	+4.25	
6	4	-11.50	11.25	20/200	20/200	Nil	Orthotropic	-11.5	
7	7	-21.00	18.35	3/200	10/300	Nil	Esotropia 25	-10	
8	4	-9.75	9.25	20/250	20/200	Nil	Esotropia 20	-8.63	
9	4	-11.75	10.25	5/400	5/400	Nil	Orthotropic	-10.5	
10	13	+5.25	4.75	20/300	20/40	400	Orthotropic	+5.25	
11	8	+4.75	4.50	20/200	20/60	400	Orthotropic	+4.75	

BSCVA = best spectacle-corrected visual acuity; D = diopters; F&F = fix and follow; PD = prism diopters; SE = spherical equivalent; UCVA =

SE regression of 2.50 ± 2.23 D, which stabilized over the next 12 months, with minimal further regression of 0.50 ± 1.41 D over the next 2 years.

Hyperopia Group

Table 1 demonstrates complete refractive results. Table 2 shows the preoperative and postoperative results at last follow-up of the individual patients. Figure 1 demonstrates the target versus achieved refractive error change over the follow-up period.

At the last follow-up visit, the cycloplegic refractive error of the treated eye was within 3 D of the fellow eye in all children. Two were within 1 D of the target SE. The other, who had developed peripheral anterior corneal stromal haze, was 2.32 D from target (Fig 1). Mean postoperative anisometropia was 1.91 D (± 2.25).

Refractive error stability over the 36-month follow-up period is demonstrated in Figure 2. Over the first 12-month follow-up interval, our hyperopic group showed mild refractive regression, with a mean SE regression of 1.10 ± 1.6 D. Between 12 and 36 months' follow-up, further regression of 0.60 ± 0.57 D occurred.

Corneal Haze and Topography

The mean treatment decentration on the cornea of the 9 patients cooperative enough to undergo corneal topography was 0.68 ± 0.43 mm (Table 2, Fig 3). At the 36-month visit, the mean corneal haze measurement was 0.3+ (nil to 0.5+). The child with the largest decentration was 7 years old at the time of the procedure and had a preoperative SE refractive error of -21.00 D and a VA of 5/200 preoperatively and postoperatively, with eccentric fixation in this eye. The other outlier, with 1.05 mm of decentration, was 8 years old at the time of the procedure and had undergone hyperopic PRK under general anesthesia. Her UCVA and BSCVA went from 20/200 and 20/60 preoperatively to 20/60 and 20/50 postoperatively.

Visual Acuity

There were 9 patients able to perform psychophysical acuity tests preoperatively and postoperatively. At last follow-up, the UCVA had improved by ≥ 2 Snellen lines from the preoperative acuity in 7 of 9 (78%) eyes, with the maximum improvement of 7 lines (Fig 4A). In this same group, BSCVA improved at last follow-up by ≥ 2 logMAR lines in 3 (33%) of 9 and remained within 1 line of

the preoperative VA in 5 eyes (Fig 4B). Three children experienced an improvement to the point that the amblyopic eye was no longer considered legally blind.

Case-Control Refractive and Visual Acuity Comparison

Table 3 shows data comparing our PRK cases with the control groups of compliant children (compliant group [n = 13]) and noncompliant/late diagnosis children (noncompliant group [n = 10]). Mean SE interocular differences in the myopic PRK and control groups were 11.1 ± 4.0 D and 12.1 ± 3.2 D, respectively ($P = 0.58$). Mean SE interocular differences in the hyperopic PRK and control groups were 4.4 ± 0.4 D and 5.5 ± 1.2 D, respectively ($P = 0.15$).

For the myopic subgroup, comparing our PRK patients (cases) with controls, the final SE refractive error ($P = 0.007$) and difference between initial and final SE refractive error ($P = 0.0001$) in the PRK group were significantly better than those of the control group. For the hyperopic subgroup, comparing our PRK cases with controls, initial BSCVA ($P = 0.02$), final SE refractive error ($P < 0.0001$), and final difference between SE refractive error ($P = 0.001$) in the PRK group were significantly better than those of the control group.

The mean posttreatment BSCVA of the compliant control group (both myopes and hyperopes) was 20/40, whereas that of the noncompliant control group was significantly worse, at 20/270 ($P = 0.002$). Six (67%) of 9 PRK children experienced improved BSCVA by ≥ 2 logMAR acuity lines, with a maximum improvement of 7 lines. In contrast, none of the 10 noncompliant control patients achieved ≥ 2 logMAR lines of acuity improvement ($P = 0.003$) (Fig 5). As expected, the compliant control group achieved an improvement in BCVA in 12 (91%) of 13 subjects.

The PRK safety index was 1.24 (> 1 means the BCVA improved postoperatively and vice versa), and the PRK efficacy index was 1.12 (> 1 means the postoperative UCVA was better than the preoperative BCVA and vice versa).

Stereoacuity, Ocular Alignment, and Amblyopia Therapy Compliance

Stereopsis was testable preoperatively and postoperatively in 9 orthotropic children. Four (ages 4, 4, 7, and 8 years at treatment) had no measurable stereoacuity before or after the treatment. Five patients reported an improvement in stereopsis. These children

Individual Patients with Photorefractive Keratectomy

Last Postoperative Visit (Mean = 31±9.9 mos)						
SE (D)	Interocular SE Difference (D)	UCVA	BSCVA	Stereopsis (Seconds of arc)	Ocular Alignment (PD)	Corneal haze (0-4+)
-5.90	3.00	F&F	F&F	Too young to test	Orthotropic	1+
+0.75	2.75	20/200	20/100	Nil	Orthotropic	0
-0.82	0.08	20/60	20/50	100	Orthotropic	0
-7.00	5.50	20/100	20/100	140	Orthotropic	0.5+
0.82	0.32	20/30	20/30	50	Orthotropic	0
-5.00	4.38	20/300	20/300	Nil	Orthotropic	1+
-6.75	2.50	3/200	10/300	Nil	Esotropia 10	0.5+
-3.00	3.50	20/100	20/100	800	Intermittent exotropia 10	0
-2.75	2.75	6/300	6/300	400	Flick ET	0
0.25	0.50	20/40	20/40	100	Orthotropic	0.5+
2.32	3.57	20/60	20/50	3000	Orthotropic	0.5+

uncorrected visual acuity.

were 4, 6, 8, 10, and 11 years old at the time of the PRK procedure. The best response was in a child 10 years old at the time of PRK who improved from no measurable stereopsis to 60 seconds of arc.

Ocular alignment did not change postoperatively in most subjects. One patient had a small decrease in his esotropia. Another changed from a small esotropia to a small exotropia (Table 2). Compliance with amblyopia occlusion therapy did not improve postoperatively in any patient.

Discussion

Very little is known about the long-term pediatric response to refractive surgery—namely, the refractive response, long-term corneal status, VA, and stereopsis. We have 3-year follow-up data for a pilot group of 11 children with anisometric amblyopia noncompliant with standard therapy who were treated with PRK to normalize their refractive error. We have also compared the changes in visual function of these PRK patients with those of a compliant and a noncompliant control group.

We previously reported that over the first 12 months there was a moderate amount of regression of treatment effect noted in both the myopic group and the hyperopic group.¹³ The refractive error from 12 months to last follow-up (mean, 31 months) seems to have stabilized for

the most part thereafter. This small amount of continued regression could be attributed to continued eye growth in this pediatric population¹⁴⁻¹⁶ or to corneal stromal reorganization after PRK. At the last follow-up visit, 25% of myopes and 63% of hyperopes were within 1 D of target. At this visit, 63% of myopes and all hyperopes were within 2 D of target. These results, though not nearly as good as those reported for PRK for mild myopia, are in agreement with previously published reports on adult and pediatric eyes with similar levels of extremely high refractive error.^{4-7,10,17,18}

Corneal haze in our cohort was never clinically significant in any patient. During the early postoperative period, it was minimal and not visually important, even in one child who was noncompliant with the postoperative topical steroid regimen. No child had clinically significant corneal haze at the 3-year follow-up.

Most children treated with PRK in our study enjoyed mild to moderate improvement in UCVA and BSCVA over the follow-up period after PRK, despite many having moderate to severe amblyopia at presentation. When compared with the noncompliant control group, our PRK group experienced a statistically significant improvement in BCVA. Stereoacuity also improved in 5 of 9 children, an encouraging and unexpected finding.

Table 3. Summary Comparisons of Photorefractive Keratectomy Cases versus Controls, Baseline and Final Refractive and Visual Outcomes

Characteristic	Myopic Group		P Value	Hyperopic Group		P Value
	Cases (n = 8)	Controls (n = 9)		Cases (n = 3)	Controls (n = 15)	
Age (yrs)	4.8±2.1	5.1±1.9	0.74	9.7±1.5	5.6±2.6	0.01
Mean follow-up ± SD (mos)	31±9.9	19±5.6	<0.05	20±6.9	15±11.9	0.22
Interocular SE RE difference ± SD (D)	11.1±4.0	12.1±3.2	0.58	4.4±0.4	5.5±1.2	0.15
Final SE RE ± SD (D)	-3.53±25	-11.3±4.3	0.0007	1.41±1.07	6.5±1.4	<0.00001
Difference between initial and final SE RE ± SD (D)	-9.81±2.94	+0.2±0.8	<0.00001	2.88±1.05	0.6±1.2	0.001
Initial BSCVA (Snellen)	20/400	20/350	0.87	20/40	20/200	0.02

BSCVA = best spectacle-corrected visual acuity; D = diopters; RE = refractive error; SD = standard deviation; SE = spherical equivalent; UCVA = uncorrected visual acuity.

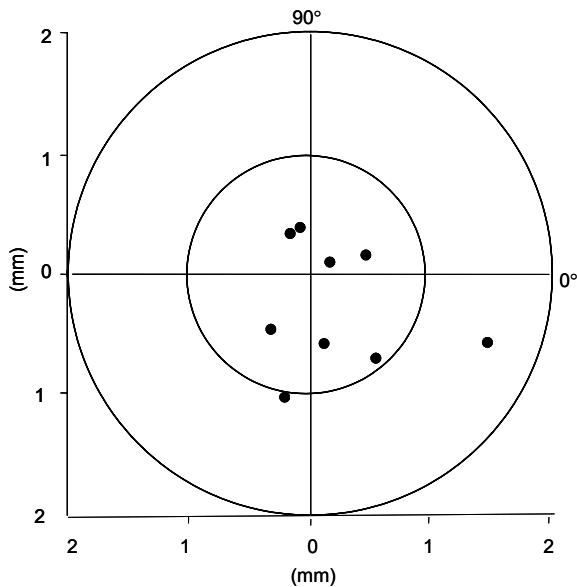


Figure 3. Decentration measurements of the children treated with photorefractive keratectomy (PRK) who were cooperative enough for corneal topography. Mean decentration was 0.68 ± 0.43 mm. The one extreme outlier had a preoperative spherical equivalent refractive error of -21.00 D and visual acuity of 5/200 preoperatively and postoperatively with eccentric fixation in this eye. The other outlier with decentration of >1 mm had had hyperopic PRK.

It is possible that if refractive surgery were performed at an earlier age, before severe amblyopia developed, the long-term visual prognosis might be better. As an example, the youngest child in this study, who preoperatively at 2 years of age could be assessed only by comparing fixation behavior, had a postoperative UCVA of 20/60 and a BSCVA of 20/50 at the 36-month visit, despite his continued postoperative lack of compliance with spectacle use and amblyopia therapy. His visual results were markedly better than what we might have anticipated had he not undergone the PRK and continued to be noncompliant. For example, there were 2 noncompliant control patients with similar SE refractive errors. These patients' BCVA's were 20/200 and 20/300.

Our high-myopia children had poorer initial and final VA than our high-hyperopia children. It is known that unilateral high myopes tend to do more poorly with all treatments for anisometropic amblyopia than hyperopic or astigmatic anisometropes, even when they are compliant.^{19,20} Many feel there is an inherent anatomic abnormality in the retina or optic nerve to account for this.²⁰⁻²³ We understand that optic nerve or retinal abnormalities do sometimes coexist in these patients and that this could limit the extent of visual recovery from refractive correction and amblyopia therapy, but we also feel that if a child with unilateral high myopia has ipsilateral mild optic nerve hypoplasia or a subtle foveal abnormality, this fact should not necessarily preclude this eye from achieving meaningful improvements in vision from PRK or some other treatment for the high refractive error.

It is interesting and unfortunate to note that compli-

ance with occlusion therapy did not improve after PRK in the study group. Several factors are known to predict poor response to traditional therapy for anisometropic amblyopia, including initial VA of less than 20/200, age ≥ 6 years at initiation of treatment, and astigmatism of ≥ 1.5 D.²⁴ Many of the children in this study had one or more of these risk factors. These factors may further predict risk for poor compliance. Perhaps if children are treated with PRK at a younger age, before they develop profound amblyopia, they may be more compliant with therapy after PRK.

Before commencing this study, we were concerned first about the safety and second about the efficacy of PRK in children with anisometropic amblyopia. The safety index (1.24) found in our study demonstrated that PRK in noncompliant children with anisometropic amblyopia seems to be safe through 36 months' follow-up, though this safety index evaluates only VA as the indicator for safety. The efficacy index (1.12) in our study was also positive, even in this group of children with marked anisometropia and profound amblyopia who had already failed traditional amblyopia therapy. We must take this information with some reservations, as the study population was very small. We postulate, however, that performing PRK on younger children who are identified

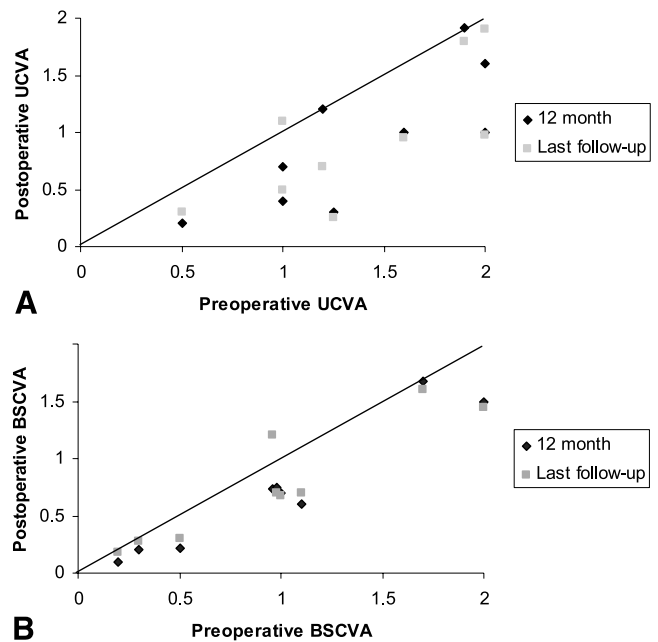


Figure 4. A, Comparison of preoperative, 12-month, and 36-month postoperative uncorrected logarithm of the minimum angle of resolution visual acuities (UCVAs). Seven (78%) of 9 children able to perform psychophysical visual acuity (VA) testing preoperatively and postoperatively had at least 2 lines of improved UCVA. Points below the line represent improved postoperative VA, and points above the line represent reduced postoperative acuity. B, Comparison of preoperative, 12-month, and 36-month postoperative best spectacle-corrected VAs (BSCVAs). Three (33%) of 9 children able to perform psychophysical VA testing preoperatively and postoperatively had at least 2 lines of improved BSCVA. Points below the line represent improved postoperative VA, and points above the line represent reduced postoperative acuity.

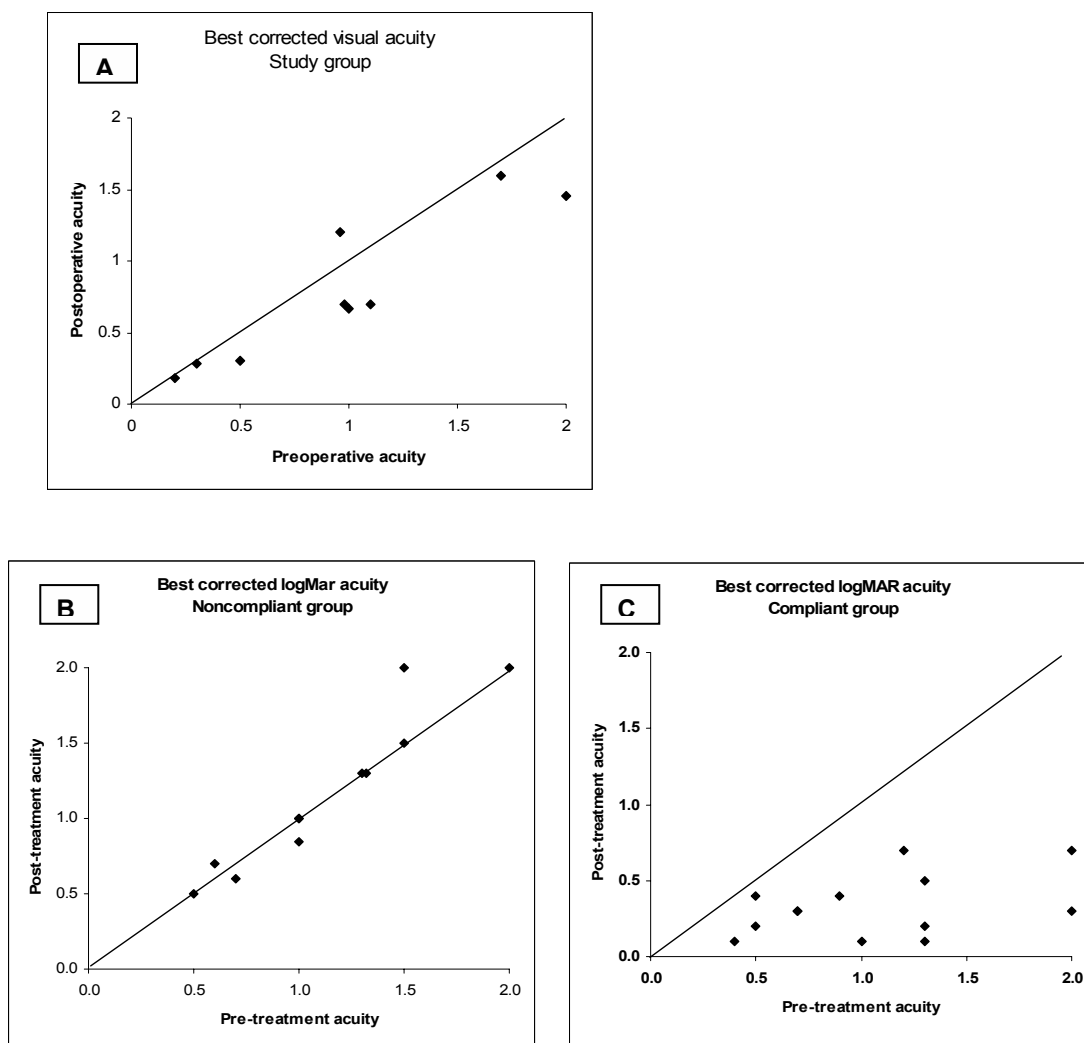


Figure 5. Comparison of best spectacle-corrected logarithm of the minimum angle of resolution (logMAR) visual acuities (VAs) in our photorefractive keratectomy study group (A) compared with a group of noncompliant or late-diagnosis anisometric amblyopic children ($P = 0.003$, Fisher exact test) (B) and a group of compliant anisometric amblyopic children ($P = 0.26$) (C). Improved VA after treatment is demonstrated as a point below the line.

as having a high risk for traditional amblyopia treatment failure would result in significantly better visual outcomes.

This study, although important, has some limitations. First and foremost, our case-comparison study is limited by a small sample size. This small sample size, however, was intentional. Because pediatric refractive surgery is a new area of research, with little previously published information, we elected to treat only a small group of noncompliant severely affected children and observe them for a long time in an effort to detect adverse long-term complications *before* subjecting other children to this procedure. When performing the statistical analysis, we also assumed that the control groups were representative of severe anisometric amblyopes in the population at large. Selection bias is a potential weakness of all studies; however, we controlled for this bias as much as possible by including all patients who met the

inclusion criteria in our practice and in the amblyopia database over a set period.

In conclusion, our long-term follow-up of children with anisometric amblyopia treated with PRK demonstrated improvements in UCVA and BSCVA and stereopsis in most children. Also, refractive errors were stable after the first 12 months, with minimal refractive regression thereafter. Photorefractive keratectomy, indeed, seems to have potential as a treatment option for anisometric amblyopia in children. This study demonstrated only mild improvements in VA, probably because the amblyopia was longstanding, deeply ingrained, and severe. If the anisometropia is treated at a younger age, amblyopia will likely be milder or may never even develop. A randomized clinical trial is warranted of PRK versus standard therapy for severe anisometropia in children probably younger than 6 to 8 years. Based on our findings, with approximately 70% of the PRK children

demonstrating at least 2 lines of VA improvement, compared with a combined response in our control group of approximately 50% for this same improvement, an α of 0.05, and a power of 0.80, 206 children (103 in the PRK group and 103 in the standard therapy group) would need to be enrolled. From such a randomized clinical trial, we would be able to determine which treatment is superior for this potentially blinding condition.

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