Time Course of Changes in Ocular Higher-Order Aberrations and Contrast Sensitivity after Overnight Orthokeratology

Takahiro Hiraoka,1 Chikako Okamoto,1 Yuko Ishii,1 Tetsubiko Kakita,2 Fumiki Okamoto,1 and Tetsuro Oshika1

PURPOSE. To investigate prospectively the time course of changes in ocular higher-order aberration and contrast sensitivity after overnight orthokeratology.

METHODS. Data from 34 eyes of 17 patients who completed 1-year follow-up examinations were analyzed. The manifest refraction was $-2.17 \pm 0.86$ D at baseline. Ocular higher-order aberrations for a 4-mm pupil were measured, and the root-mean-square (RMS) of the third- and fourth-order aberrations were determined. Contrast sensitivity was assessed at four spatial frequencies, and the area under the log contrast sensitivity function (AULCSF) was calculated. These examinations were performed before and 1, 2, 3, 6, and 12 months after commencement of the procedure.

RESULTS. The treatment significantly increased third-, fourth-, and total higher-order RMS (all $P < 0.0001$, paired t-test). Log contrast sensitivity significantly decreased at all four spatial frequencies, and AULCSF was also significantly reduced after the treatment ($P < 0.0001$). To assess the time course of changes in these parameters, posttreatment data were analyzed by using repeated-measures analysis of variance. There were no significant fluctuations in manifest refraction; uncorrected visual acuity; third-, fourth-, and total higher-order RMS; and AULCSF (all $P > 0.05$). In addition, there was no significant variance in log contrast sensitivity at each spatial frequency during the 1-year follow-up period (all $P > 0.05$).

CONCLUSIONS. The initial reduction in optical quality of the eye and quality of vision after the procedure is stable during the treatment period of at least 1 year, and the reduction does not worsen further after 1 month. Orthokeratology candidates should be fully informed of these changes.

Orthokeratology, also known as corneal reshaping or corneal refractive therapy, is a method of temporarily changing refraction in myopic patients by the programmed application of specially designed rigid contact lenses, called reverse-geometry lenses. This procedure generates epithelial thinning of the central cornea and thickening of the midperipheral cornea, leading to a reduction in myopia and improvement in unaided vision.1,2 Overnight orthokeratology, in which patients wear the lenses only during sleep, provides practical vision during waking hours, and decreases patients’ dependence on daytime optical correction. The efficacy has been well demonstrated,3–6 and the procedure has gained some acceptance as one of the new alternative options to wearing contact lenses or eyeglasses, especially for low to moderate myopia.2

Several studies have recently shown that overnight orthokeratology increases higher-order wavefront aberrations of the cornea and the eye7–11 and reduces contrast sensitivity function.10,11 The long-term course of these changes, however, has not been studied. Given the growing interest and the number of patients undergoing overnight orthokeratology,7 it is critical to investigate how these deteriorations may change with time after the procedure. We conducted the current prospective study to assess the time course of changes in ocular higher-order aberration and contrast sensitivity after overnight orthokeratology.

PATIENTS AND METHODS

Inclusion criteria for this study were as follow: age between 20 and 37 years, myopic spherical equivalent (manifest refraction) between $-4.00$ and $-1.00$ D with regular forms of astigmatism ($<1.00$ D), best spectacle-corrected visual acuity of 20/20 or better, mean keratometry reading between 40.00 and 46.25 D, no ocular and systemic diseases, and no previous experience with overnight orthokeratology. The research protocol had institutional review board approval, and written informed consent was obtained from each patient. The study adhered to the tenets of the Declaration of Helsinki.

Forty-six eyes of 23 patients were enrolled in the study. Before baseline examination, the participants were instructed to cease any contact lens wear for at least 3 weeks, permitting a washout period during which any corneal irregularity induced by contact lenses could resolve. Each patient underwent a comprehensive baseline examination including manifest refraction, logMAR uncorrected visual acuity (UCVA), logMAR best-corrected visual acuity (BCVA), keratometry, slit-lamp evaluation, dilated fundus evaluation, corneal topography, wavefront aberrometry, and contrast sensitivity testing. All these examinations but dilated funduscopy were performed at 1, 2, 3, 6, and 12 months after commencement of overnight orthokeratology. To minimize the influence of diurnal variation, all measurements were conducted between 9 and 11 AM, and patients were requested to attend the examinations from 2 to 4 hours after lens removal.

Orthokeratology lenses used in this study were four-zone, reverse-geometry lenses (Boston XO material; Polymer Technology Corp., Wilmington, MA) with a nominal Dk of $100 \times 10^{-11}$ (cm$^2$/s)/(mL·O$_2$/mL·mm Hg). The nominal central thickness of the lenses is 0.22 mm. As previously described,11 the patients were fitted with the lenses according to the manufacturer’s fitting protocol. After the lenses were dispensed, the patients were advised to wear their contact lenses every night for at least 7 consecutive hours.

1Department of Ophthalmology, Institute of Clinical Medicine, University of Tsukuba, Ibaraki, Japan; and 2Kakita Eye Clinic, Chiba, Japan.

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Corresponding author: Takahiro Hiraoka, Department of Ophthalmology, Institute of Clinical Medicine, University of Tsukuba, 1-1-1 Tennoudai, Tsukuba, Ibaraki, 305-8575 Japan; thiraoka@md.tsukuba.ac.jp.

From the 1Department of Ophthalmology, Institute of Clinical Medicine, University of Tsukuba, Ibaraki, Japan; and 2Kakita Eye Clinic, Chiba, Japan.

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TABLE 1. Patients’ Clinical Data at Baseline and 1 Month after Overnight Orthokeratology

<table>
<thead>
<tr>
<th></th>
<th>Baseline Mean ± SD (Range)</th>
<th>1 Month after Treatment Mean ± SD (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manifest refraction (D)</td>
<td>−2.17 ± 0.86 (−4.00 to −1.00)</td>
<td>−0.20 ± 0.35 (−1.25 to 0.00)*</td>
</tr>
<tr>
<td>UCVA (logMAR)</td>
<td>0.71 ± 0.29 (0.22 to 1.30)</td>
<td>−0.04 ± 0.11 (−0.18 to 0.22)*</td>
</tr>
<tr>
<td>BCVA (logMAR)</td>
<td>−0.10 ± 0.06 (−0.18 to 0.00)</td>
<td>−0.09 ± 0.06 (−0.18 to 0.15)</td>
</tr>
<tr>
<td>Third-order RMS (μm)</td>
<td>0.074 ± 0.029 (0.022 to 0.135)</td>
<td>0.251 ± 0.130 (0.099 to 0.665)*</td>
</tr>
<tr>
<td>Fourth-order RMS (μm)</td>
<td>0.038 ± 0.019 (0.010 to 0.101)</td>
<td>0.132 ± 0.049 (0.053 to 0.274)*</td>
</tr>
<tr>
<td>Total higher-order RMS (μm)</td>
<td>0.084 ± 0.035 (0.035 to 0.161)</td>
<td>0.289 ± 0.126 (0.122 to 0.692)*</td>
</tr>
<tr>
<td>AULCSF</td>
<td>1.447 ± 0.120 (1.177 to 1.615)</td>
<td>1.277 ± 0.195 (0.722 to 1.512)*</td>
</tr>
<tr>
<td>Log contrast sensitivity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 cyc/deg</td>
<td>1.82 ± 0.13 (1.63 to 2.08)</td>
<td>1.66 ± 0.32 (0.40 to 2.08)*†</td>
</tr>
<tr>
<td>6 cyc/deg</td>
<td>2.09 ± 0.16 (1.70 to 2.29)</td>
<td>1.81 ± 0.22 (1.38 to 2.14)*‡</td>
</tr>
<tr>
<td>12 cyc/deg</td>
<td>1.80 ± 0.21 (1.25 to 1.99)</td>
<td>1.58 ± 0.35 (0.31 to 1.99)*†</td>
</tr>
<tr>
<td>18 cyc/deg</td>
<td>1.29 ± 0.23 (0.81 to 1.55)</td>
<td>1.17 ± 0.25 (0.64 to 1.55)*‡</td>
</tr>
</tbody>
</table>

Significant differences are between baseline and posttreatment values (paired t-test).

* P < 0.0001.
† P < 0.01.
‡ P < 0.05.

The details of wavefront aberrometry and contrast sensitivity testing have been explained.12 In brief, ocular higher-order aberrations for a 4-mm pupil were measured with a Hartmann-Shack wavefront analyzer (KR-9000 PW; Topcon Co., Tokyo, Japan) through a natural pupil without the use of dilating drugs. The root mean square (RMS) of the third-order Zernike coefficients was used to represent a comalike aberration, and the RMS of the fourth-order coefficients was used to denote spherical-like aberration. Total higher-order aberrations were calculated as the RMS of the third and fourth-order coefficients.13,14 Contrast sensitivity was evaluated monocularly at four spatial frequencies: 5, 6, 12, and 18 cyc/deg with a chart (CSV-1000E; Vector Vision Co., Greenville, OH), and the contrast level of the last correct response was recorded as the contrast threshold in logarithmic values for each frequency. From these data, the area under the log contrast sensitivity function (AULCSF) was calculated according to the method of Appleget et al.15 This represented the contrast sensitivity data as a single quantity used to characterize the overall contrast sensitivity function.

Pretreatment and 1-month posttreatment data were compared by using the paired t-test for visual acuity, refraction, ocular higher-order aberrations, and contrast sensitivity. To assess the time course of changes in these parameters, posttreatment data up to 12 months were assessed by using repeated-measures analysis of variance (ANOVA). P < 0.05 was regarded as statistically significant.

RESULTS

Among the 23 patients who were enrolled initially, 17 (9 men, 8 women) successfully completed 1-year follow-up examinations. Their ages ranged from 21 to 35 years (23.9 ± 3.5, mean ± SD). Manifest refraction at baseline was between −4.00 and −1.00 D (−2.17 ± 0.86 D), with refractive astigmatism between −0.75 and 0.00 D (−0.13 ± 0.22 D). UCVA ranged from 0.22 to 1.30 (0.71 ± 0.29), and BCVA was from −0.18 to 0.00 (−0.10 ± 0.06) before treatment. Six patients withdrew from the study. The reasons for discontinuation included poor improvement in UCVA (n = 2), incidence of monocular diplopia (n = 2), lens discomfort (n = 1), and inability to keep follow-up appointments (n = 1).

Intrastream corneal topography significantly reduced manifest refraction from −2.17 ± 0.86 at baseline to −0.20 ± 0.35 D at 1 month after commencement of the procedure (P < 0.0001, paired t-test), and significantly improved UCVA from 0.71 ± 0.29 to −0.04 ± 0.11 (P < 0.0001). BCVA did not change significantly, with −0.10 ± 0.06 before and −0.09 ± 0.06 at 1-month after the treatment (P = 0.68). There were significant increases in third-order RMS from 0.074 ± 0.029 at baseline to 0.251 ± 0.130 μm at 1-month after the procedure (P < 0.0001), fourth-order RMS from 0.038 ± 0.019 to 0.132 ± 0.049 μm (P < 0.0001), and total higher-order RMS from 0.084 ± 0.033 to 0.289 ± 0.126 μm (P < 0.0001). Overnight orthokeratology significantly reduced log contrast sensitivity from 1.82 ± 0.13 at baseline to 1.66 ± 0.32 at 1 month after the procedure at 3 cyc/deg (P = 0.0066), from 2.09 ± 0.16 to 1.81 ± 0.22 at 6 cyc/deg (P < 0.0001), from 1.80 ± 0.21 to 1.58 ± 0.35 at 12 cyc/deg (P = 0.0053), and from 1.29 ± 0.23 to 1.17 ± 0.25 at 18 cyc/deg (P = 0.0216). AULCSF also decreased significantly from 1.447 ± 0.120 at baseline to 1.277 ± 0.195 at 1 month after the treatment (P < 0.0001; Table 1).

To assess the time course of changes in these parameters, posttreatment data (at 1, 2, 3, 6, and 12 months) were analyzed by repeated-measures ANOVA. During the 1-year follow-up period, posttreatment data showed no significant fluctuations in manifest refraction; UCVA; BCVA; third, fourth-, and total higher-order RMS; AULCSF; and log contrast sensitivity at all spatial frequencies (Figs.1–6).

FIGURE 1. Time course of changes in manifest spherical equivalent refraction after overnight orthokeratology. Manifest refraction significantly decreased at 1 month after orthokeratology (P < 0.0001, paired t-test) and thereafter remained at the decreased level. There was no significant variance in posttreatment data from 1 to 12 months (P = 0.3093, repeated-measures ANOVA). Data are expressed as the mean ± SD.
In overnight orthokeratology practice, patients occasionally report visual disturbances, even though their visual acuity is excellent on the high-contrast visual acuity testing. They report that their vision is not the same as when they were wearing glasses or contact lenses, indicating the possibility that quality of vision has deteriorated. Standard high-contrast visual acuity, which relies on the patient’s recognition of Landolt rings or familiar letters with 90% contrast level, is useful but is an incomplete description of visual function. On the other hand, contrast sensitivity, which is defined as the ability to detect differences in luminance between adjacent areas, is now considered to provide much more information about vision than the high-contrast visual acuity, reflecting quality of vision. The importance and usefulness of such evaluation is widely recognized in patients after refractive surgery procedures, and numerous studies have demonstrated that contrast sensitivity function declines after radial keratotomy (RK), photorefractive keratectomy (PRK), and laser in situ keratomileusis (LASIK). In addition, several studies have shown that increases in higher-order aberrations contribute to decreased contrast sensitivity, thereby reducing the quality of vision after RK, PRK, and LASIK. These procedures are designed to correct defocus by surgical modification of the corneal curvature, and consequently produce a nonphysiological, more oblate cornea. Similarly, a more oblate cornea is induced by overnight orthokeratology, and studies have shown that overnight orthokeratology also increases corneal and ocular higher-order aberrations and decreases contrast sensitivity.

In corneal refractive surgery, there have been long-term follow-up studies on changes in optical aberrations and contrast sensitivity function. It must be emphasized that contrast sensitivity decreases initially after refractive surgery, but these effects are temporary and generally recover to the
preoperative levels within 3 to 12 months after surgery. In overnight orthokeratology, however, the posttreatment course of contrast sensitivity has not been studied. It is also unknown how optical aberrations change with time after overnight orthokeratology. Therefore, in the current study, we examined the time course of changes in clinical parameters including contrast sensitivity and ocular higher-order aberrations over 1 year.

As shown in the results, myopic refractive error significantly decreased and UCVA significantly improved at 1 month after overnight orthokeratology, and these changes were persistent for 1 year. BCVA was maintained at the baseline level over the follow-up period. Ocular higher-order aberrations significantly increased at 1 month after the procedure and remained stable thereafter. There was an initial loss of contrast sensitivity after overnight orthokeratology, and the loss persisted during the 1-year follow-up. As a whole, all these parameters were stable throughout the posttreatment period from 1 month to 12 months. That is, posttreatment clinical parameters including refraction, visual acuity, optical aberrations, and contrast sensitivity were stable in the eyes that underwent overnight orthokeratology.

Regarding optical aberrations, there have been some reports evaluating the time course of changes after refractive surgery. Oshika et al. showed that both standard PRK and LASIK significantly increased total higher-order wavefront aberrations of the cornea, and those changes did not recover to the preoperative level throughout the 12-month follow-up period. Hjortdal et al. reported that spherical and coma-like aberrations of the cornea significantly increased immediately after both PRK and LASIK, and thereafter spherical aberrations decreased with time but did not return to the baseline level in PRK eyes, whereas the aberrations did not decrease in LASIK eyes, and that coma-like aberrations did not change significantly in both groups during the 12-month follow-up period. The authors indicated that epithelial rethickening and smoothing after PRK may explain the reduction in spherical aberrations during this period. Judging from these findings, corneal refractive surgery increases higher-order aberration and thus decreases optical quality of the eye; however, these changes do not return to preoperative status, even though some regression was observed. In our overnight orthokeratology study, ocular higher-order aberrations including third-, fourth-, and total higher-order RMS significantly increased in the early phase of the study period, and these increases did not regress at all throughout the 12-month follow-up period. Unlike corneal refractive surgery, in overnight orthokeratology, there is no need for the corneal wound-healing that results from cutting or removing corneal tissue, because it is a nonsurgical procedure. This explanation is a possible reason that there is no regression of increased higher-order aberrations after overnight orthokeratology.

As for contrast sensitivity, it has been reported that corneal refractive surgery causes temporary reduction in contrast sensitivity with gradual normalization by 6 to 12 months in PRK eyes and 3 to 6 months in LASIK eyes. In the current overnight orthokeratology study, however, no apparent recovery of posttreatment declines in contrast sensitivity was encountered throughout the 1-year study period, in disagreement with previous studies after refractive surgery. So far, both light-scattering structures, such as haze and scars, and optical aberrations have been thought to account for the reduction in contrast sensitivity function after refractive surgery. Corneal haze is usually seen during the early postoperative months after PRK, and the incidence and severity generally diminishes with time. Therefore, corneal haze is considered to be one of the factors that can account for the time course of changes in contrast sensitivity. Wang et al. compared the postoperative course of contrast sensitivity in PRK and LASIK eyes with low to moderate myopia and found that contrast sensitivity, which decreased in both groups at the early postoperative stage, recovered more quickly after LASIK (~3 months) than after PRK (6–12 months). They suggested that subepithelial wound-healing and epithelial hyperplasia may be responsible for the later recovery in PRK eyes, because corneal haze and central islands were more frequent in PRK eyes. In contrast, Tanabe et al. described that there was no correlation between the degree of corneal haze and low-contrast visual acuity after PRK, although low-contrast visual acuity significantly correlated with ocular higher-order aberrations. They concluded that deterioration of contrast sensitivity function is mainly attributable to increases in wavefront aberrations and not to corneal haze. Likewise, several studies have demonstrated significant correlations between contrast sensitivity function and higher-order aberrations in eyes undergoing corneal refractive surgery. Seiler et al. showed a highly significant correlation between losses of low-contrast visual acuity and increases in ocular higher-order aberrations after PRK. Marcos found that contrast sensitivity was significantly reduced after conventional LASIK as corneal aberrations increased. Yamane et al. reported that standard LASIK increased ocular higher-order aberrations, and these contributed to the loss of contrast sensitivity. Based on these studies, higher-order aberrations seriously affect contrast sensitivity function after refractive surgery. Also in overnight orthokeratology, a significant relationship between increases in ocular higher-order aberrations and declines of contrast sensitivity function has been confirmed. This finding seems quite reasonable, because corneal haze and wound-healing do not occur in overnight orthokeratology. Although, as discussed earlier, there is no doubt about the relationship between contrast sensitivity and higher-order aberrations. It is noteworthy that contrast sensitivity returns to the preoperative level with time, despite the fact that higher-order aberrations do not recover completely after refractive surgery. At present, the reason for this discrepancy is unknown, but recently, Artal et al. conducted a interesting study, in which they examined neural adaptation to optical aberrations using adaptive optics techniques to control an eye’s aberrations. They found that the stimulus seen with the
subject’s own aberrations was always sharper than that seen through the unfamiliar rotated version in all tested subjects and suggested that neural visual system is adapted to an eye’s aberrations, thereby removing somehow the effects of blur generated by the sensory apparatus from visual experience. This adaptation may explain why contrast sensitivity normalize with time, even though higher-order aberrations remain at an increased level after refractive surgery. Turning now to overnight orthokeratology, the quantity and quality of higher-order aberrations after the treatment fluctuate every day according to contact lens fitting, and thus it would be difficult for neural visual system to adapt the variable aberrations. Hence, the declines in contrast sensitivity may last in overnight orthokeratology.

In addition to daily fluctuation, diurnal (morning to evening) variation in optical aberrations may delay the recovery of decreased contrast sensitivity, because optical aberrations including higher-order aberrations significantly change during the day in eyes undergoing overnight orthokeratology. As for diurnal variation, it has been well documented that refraction and visual acuity significantly fluctuate from morning to evening in eyes after RK. Although we are unaware of previous studies that investigated diurnal fluctuation in higher-order aberrations or contrast sensitivity after RK, it is known that, similar to PRK and LASIK, RK significantly reduces contrast sensitivity immediately after surgery, but the reduced contrast sensitivity returns to the baseline level with time, despite the persistence of increased wavefront aberrations. The recovery period of contrast sensitivity has been reported approximately 1 to 2 years after RK, which is longer than that after PRK and LASIK. The recovery period of contrast sensitivity is possibly due to the diurnal fluctuation in optical aberrations after RK, but this is only a speculation. Further clinical research is needed to clarify the exact influence of diurnal variation of optical aberrations on recovery of contrast sensitivity in both RK and orthokeratology.

We found a statistically significant reduction in AULCSF after overnight orthokeratology, and the mean reduction from baseline to 1 month after the procedure was 0.17 ± 0.23 (SD). Also in refractive surgery, some investigators have evaluated AULCSF with the same instrument as we used. Sakata et al. reported that conventional myopic PRK significantly reduced AULCSF and the mean reduction from the preoperative value was 0.14 ± 0.27 at 1 month after surgery. Yamane et al. reported that conventional myopic LASIK significantly reduced AULCSF by 0.08 ± 0.14 at 1 month after surgery. Compared with these studies, our reduction seems to be larger than that of the LASIK study, but roughly consistent with that of the PRK study. Although the clinical significance of these declines has not been investigated in detail in orthokeratology, the National Eye Institute Refractive Error Quality of Life Instrument (NEI RQ-42) has been used recently to evaluate refractive error-specific quality of life. The questionnaire consists of 42 items used to develop 13 subscales, including “clarity of vision,” “glare,” and “satisfaction with correction.” Berntsen et al. reported that a statistically significant reduction was found in the glare subscale after orthokeratology, whereas there were no significant differences in the clarity of vision and satisfaction with correction subscales between pre- and posttreatment assessment. The authors suggested that the decrease in the glare subscale results from increased higher-order aberrations after orthokeratology. Lipson et al. showed that the glare subscale score was significantly lower in an overnight orthokeratology group than in a daily-wear soft contact lens group, whereas no significant differences were found in the clarity of vision and satisfaction with correction subscales between the two groups. According to a study by Ritchey et al., there were no significant differences in the glare, clarity of vision, and satisfaction with correction subscales between orthokeratology and soft contact lens groups. Judging from these results, the reduction in contrast sensitivity after orthokeratology may not significantly affect quality of life, although induced glare after the treatment is likely to affect it. However, the influence on quality of life of the long-lasting reduction in contrast sensitivity, such as that found in the present study, is unknown. Further studies are needed to clarify this point.

In this study, we found significant decreases in contrast sensitivity at all spatial frequencies from 3 to 18 cyc/deg after overnight orthokeratology. Moreover, these decreases were statistically significant at all posttreatment time points compared with baseline, though they showed some fluctuation. Unfortunately, we are unaware of detailed studies on spatial frequencies of contrast sensitivity after overnight orthokeratology. In corneal refractive surgery, there are conflicting reports concerning spatial frequencies that are affected by the procedure. Wang et al. reported that contrast sensitivity decreased after PRK and LASIK, especially at medium spatial frequencies such as 6 and 12 cyc/deg. Montés-Mico and Charman suggested that the reduction in contrast sensitivity after PRK and LASIK was greater at higher spatial frequencies (6, 12, and 18 cyc/deg). Mutyal et al. described depressed contrast sensitivity at the spatial frequency of 6, 12, and 18 cyc/deg in low to moderate myopia groups after LASIK. Wang et al. found that daytime contrast sensitivity reduction after LASIK was larger at 12 and 18 cyc/deg. On the other hand, Perez-Santonja et al. found that contrast sensitivity decreased only at the low and intermediate spatial frequencies of 3 and 6 cyc/deg 1 month after LASIK. Chan et al. reported that low-contrast regions (1.5 and 3.4 cyc/deg) were more affected than high-contrast regions after LASIK, though there was a general depression. As mentioned, at present, there is very little agreement on this matter. The exact influence of overnight orthokeratology on spatial frequencies of contrast sensitivity should be studied further.

As described earlier, overnight orthokeratology causes a statistically significant reduction in optical quality of the eye and quality of vision, but the procedure has been reported to be reversible in light of refraction, visual acuity, corneal curvature, and corneal thickness. Thus, the decreased optical quality of the eye and quality of vision after overnight orthokeratology are considered to return to the pretreatment values once the treatment is discontinued. However, the recovery of these parameters after discontinuation of the procedure has not been investigated. Further studies are needed to elucidate this matter.

It should be noted that the current data of optical aberrations and contrast sensitivity had large standard deviations, indicating significant individual variability. We previously reported that orthokeratology significantly increases ocular higher-order aberrations and compromises contrast sensitivity function, depending on the amount of myopic correction. Thus, higher-order aberrations and contrast sensitivity after overnight orthokeratology are greatly affected by baseline myopic error. This effect may explain the large SD of the data of higher-order aberrations and contrast sensitivity in our study.

There are some limitations to our study. First, the follow-up period was only 1 year. Although there was no statistical significance, AULCSF showed a slight trend of recovery at 12 months. It is very interesting to know how contrast sensitivity function changed thereafter. In the field of corneal refractive surgery, studies with long-term follow-up, such as 2,31,32 and 5,34 years, have been conducted. Also in overnight orthokeratology, longer-term studies should be performed to elucidate this point. Another limitation of this study is that we did not evaluate the time course of changes in mesopic visual function.
Mesopic or night vision disturbances have been widely reported as one of the declines in quality of vision after refractive surgery.\(^{42-44}\) It is also known that mesopic visual function is compromised after overnight orthokeratology.\(^{45}\) No follow-up studies on this problem have been conducted in overnight orthokeratology, and thus it will be the theme of future work. In conclusion, the present study revealed that overnight orthokeratology significantly improved UCVA through reducing myopic refractive errors, and the improvement was maintained throughout the 1-year follow-up period. High-contrast BCVA did not change after the procedure, compared with the baseline value. Ocular higher-order aberrations significantly increased after overnight orthokeratology, and the increases persisted for 1 year. Contrast sensitivity showed significant posttreatment reduction, and the reduction did not worsen after 1 month. Posttreatment reduction of contrast sensitivity appears to be stable for a longer period in overnight orthokeratology than in laser refractive surgery such as PRK and LASIK. It is thus important to apprise patients of this consequence during informed consent before overnight orthokeratology. In addition, more refinements of overnight orthokeratology procedure are required to minimize the increases in ocular higher-order aberrations and provide a better quality of vision after the treatment.

References


