ORIGINAL RESEARCH

Changes in contrast sensitivity functions after photorefractive keratectomy and laser *in situ* keratomileusis

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Acknowledgment
This study was supported by the Natural Science Grant of Guangdong Province, China.
The authors have no propriety interests in any materials or methods described within the article.

Abstract

Aim: To evaluate the visual function in terms of changes in contrast sensitivity following photorefractive keratectomy (PRK) and laser *in situ* keratomileusis (LASIK).

Materials and Methods: Distant and near contrast sensitivity functions were tested in 36 eyes that had undergone PRK and 31 eyes that had undergone LASIK respectively. Only those eyes that retained pre-operative best corrected visual acuity were included in the study. The pre-operative refractive errors ranged from -1.75 to -7.75 diopters.

Results: Post-operatively, all patients had best corrected visual acuity of 1.0 or better. Contrast sensitivity was reduced in the first few months following the operations. The greatest reduction in contrast sensitivity occurred at the intermediate spatial frequencies. Contrast sensitivity returned to the pre-operative baseline level at 12 months and 6 months following PRK and LASIK respectively.

Conclusion: There is a transient reduction in contrast sensitivity, especially at the intermediate spatial frequencies, after PRK and LASIK. The restoration of contrast sensitivity is faster in those underwent LASIK than PRK.

Introduction

More and more studies report that photorefractive keratectomy (PRK) and laser in-situ keratomileusis (LASIK) have achieved satisfactory refractive results. In most papers, however, the uncorrected and best corrected Snellen visual acuities were the only parameters for the evaluation of visual performance.[1-4] Clinically, some patients who have visual acuity of 1.0 or better may still complain of "blurred vision". These patients may suffer from loss of contrast sensitivity after the surgery.[5] The purpose of the current study was to evaluate the changes in contrast sensitivity functions after PRK and LASIK.

Materials and methods

Thirty-six eyes that had undergone PRK and 31 eyes that had undergone LASIK were examined in this study. The mean pre-operative refractive errors ranged was -4.56 $\pm$1.75 diopters (range: -1.75 to -7.00 diopters) in the PRK group and -5.12 $\pm$1.63 diopters (range:-2.00 to -7.75 diopters) in the LASIK group (P>0.05). Before operation, the uncorrected visual acuity (UCVA) was 1.0 or better in all eyes.

The Keracor 116 excimer laser (Chiron Technolas, Irvine, CA, USA) and the Automated Corneal Shaper (Chiron Vision, Irvine, CA, USA) were used. The PRK procedure included mechanical removal of the corneal epithelium and multizone ablation. The maximum diameter of the ablation was 7.0 mm. After PRK, FML (Allergan, CA, USA) was given for 4 months. In LASIK, we used the 160-micron plate. The average diameter of the corneal cap was 8.0 mm. For myopia lower than -4 diopters, a single ablation zone of 6 mm was used. For higher myopia, we used 3-zone ablation. The diameters were 5, 6, and 6.8 mm respectively. FML was given for 4 weeks after LASIK.

Distant contrast sensitivity function was tested with the CS-2000 Nicolet television test system (U.S.A). The screen mean luminance was 100 cd/m^2. The spatial frequencies were 0.5, 1, 3, 6, 11.4 and 22.8 c/deg. The size of the stimulation field corresponded to an angle of vision of 4 at 3 meters using a sinusoidal pattern. The threshold was determined by increasing the contrast at a given spatial frequency until the patient was able to recognize the grid pattern. Contrast sensitivity was tested for 4 times for each spatial frequency with the mean calculated.

For near contrast sensitivity testing, we used the F.A.C.TÔ near chart (Stereo Optical Co., Inc., U.S.A). The patterns on rows A to E corresponded to spatial frequencies of 1.5, 3, 6, 12 and 18 c/deg. The chart was held at 46 cm under adequate illumination as instructed. The patients were asked to look at the chart from left to right (the highest to the lowest contrast) and stated the last pattern he or she could recognize. The last correct response was recorded for each frequency and a contrast sensitivity curve was plotted.

Results

All PRK and LASIK procedures were uneventful. The uncorrected visual acuity was 1.0 or better in 84% (30/36) of eyes that had undergone PRK and 87% (27/31) of eyes that had undergone LASIK. One eye in the PRK group had the best corrected visual acuity deteriorated by 2 lines because of severe corneal haze and was excluded from this study. Best corrected visual acuity was not reduced in the all other tested eyes.

The changes in distant contrast sensitivity functions after PRK and LASIK are shown in figures 1 and 2. The contrast sensitivity, especially the at the mid-spatial frequency levels, was reduced post-operatively. It returned to the pre-operative level at about 12 months after PRK and at 6 months after LASIK. Figures 3 and 4 show the changes in near contrast sensitivity functions. Reduction in contrast sensitivity was also noticed. Similar to the changes in distant contrast sensitivity, the most obvious decline in near contrast sensitivity occurred at 6 and 12 c/deg spatial frequencies. Again the contrast sensitivity returned to baseline 12 months after PRK and 6 months after LASIK.

Discussion

To evaluate vision after refractive surgery, Snellen visual

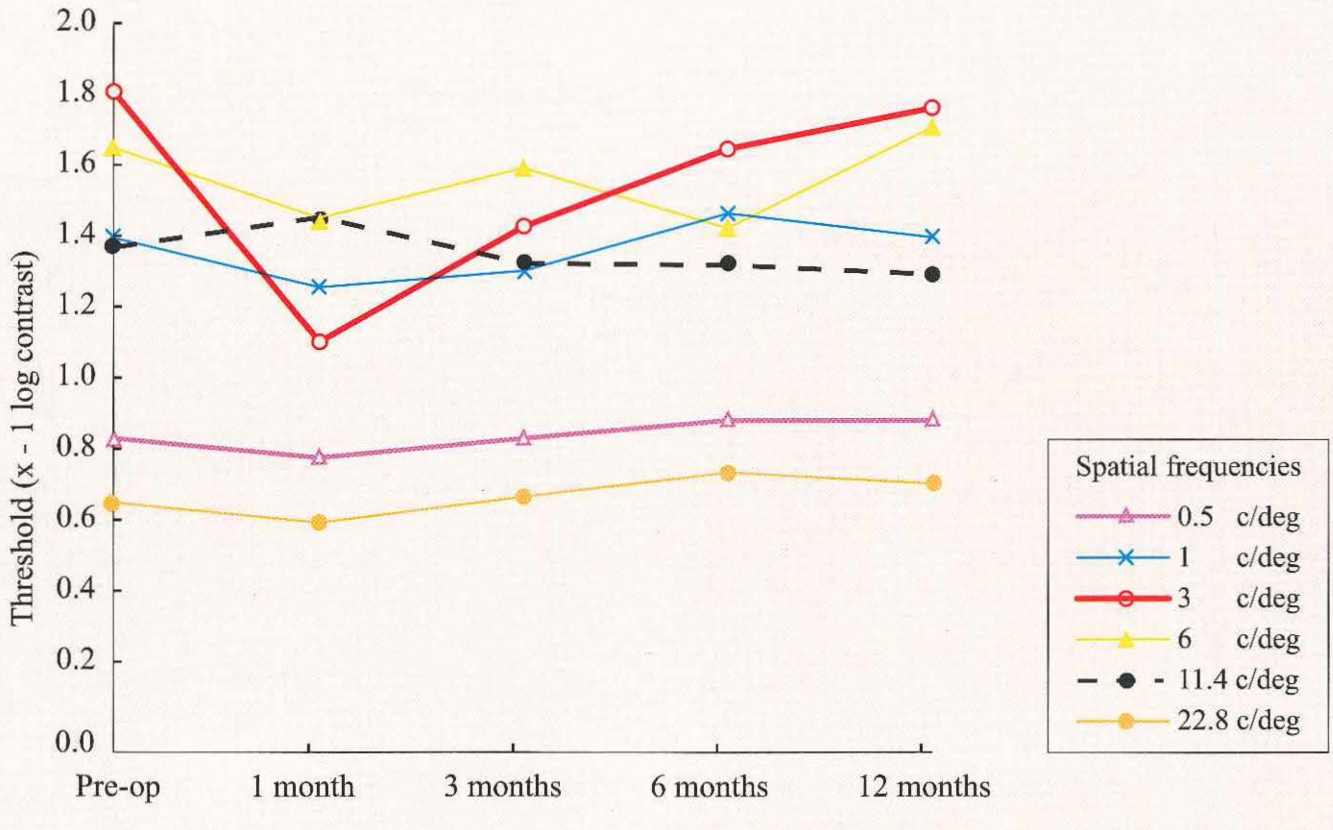


Figure 1. Distant contrast sensitivity functions before and after PRK.

acuity chart was the only parameter used in many studies. Snellen visual acuity only measures the ability to distinguish small details at high contrast. However, the ability to perceive objects without sharp outlines is equally important. Contrast sensitivity can be affected by refractive surgeries.[6] Patients with reduced contrast sensitivity may complain of poor visual performance although they can see 1.0 or better. Contrast sensitivity function, therefore, is no less important than uncorrected visual acuity and best corrected visual acuity in the evaluation of visual performance.

We found that contrast sensitivity was decreased in the first few months after both PRK and LASIK. The greatest reduction occurred at the intermediate frequencies. However, the contrast sensitivity at high spatial frequency was not affected. This finding can also be reflected by the fact that all the patients in this study had corrected Snellen acuity of 1.0 or better. The small "E"s on line 1.0 of the Snellen Chart corresponded to high contrast at high spatial frequency.

The deterioration of contrast sensitivity after PRK can be attributed to many factors including decrease in corneal transparency, corneal haze, irregular astigmatism, and the refractive aberrations caused by irregular epithelial healing. It is unclear whether the absence of the Bowman's layer might plays any role. The reduction in contrast sensitivity after LASIK can be caused by the corneal edema at the early stage, light scattering at the interface, and irregular astigmatism.

It is found that the contrast sensitivity gradually improved over time in both groups. This is consistent with the findings of other studies. Ambrosio *et al*[7] reported that the corneal sensitivity is reduced for as long as 6 months after PRK and then slowly recovers. Pallikaris *et al*[8] reported that contrast sensitivity is reduced at 1 month following the surgery but recovers to the pre-operative values by 3 months. We found that contrast sensitivity was abnormal until 12 months after PRK. The recovery after LASIK was faster. Contrast sensitivity was very close to the pre-operative values at 6-month follow up. The presence of corneal haze after PRK may be responsible for the prolonged recovery.

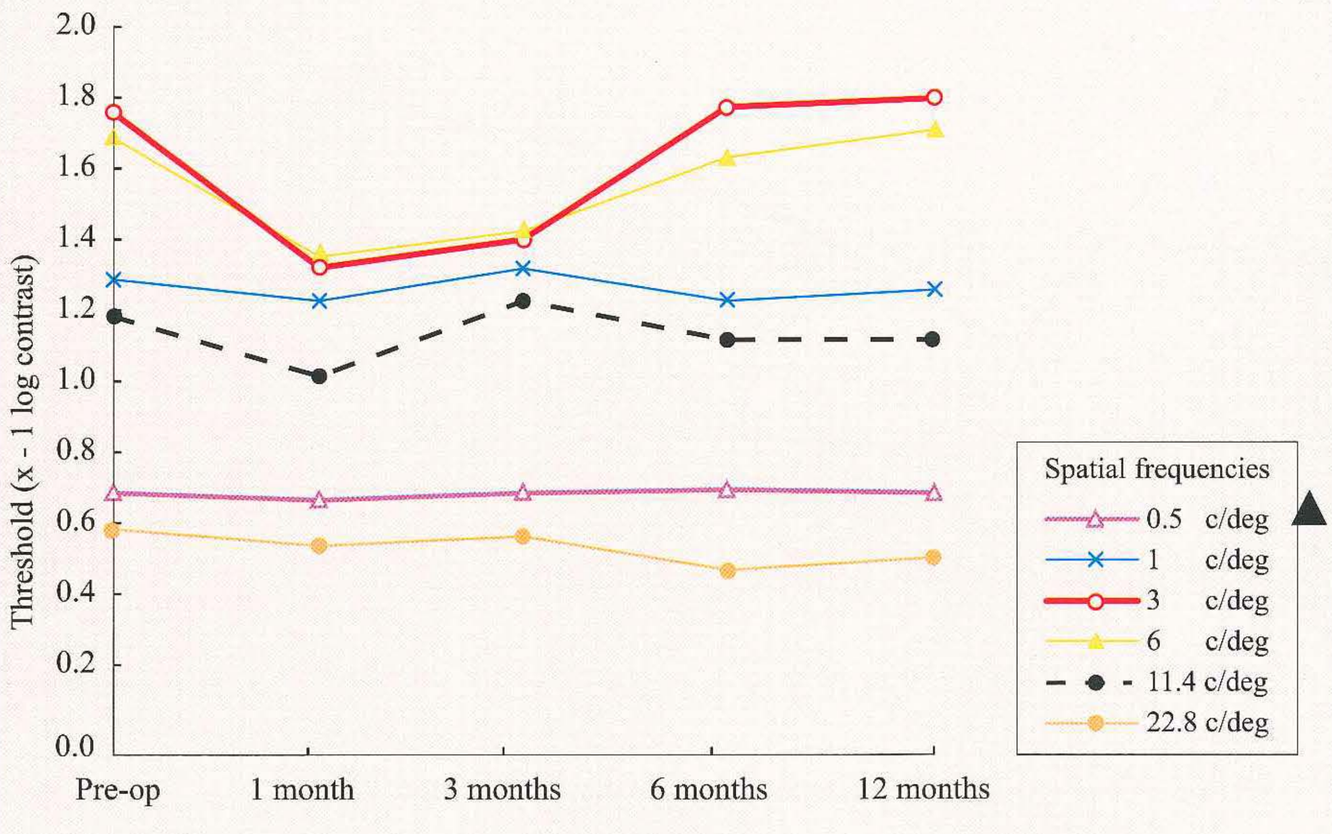
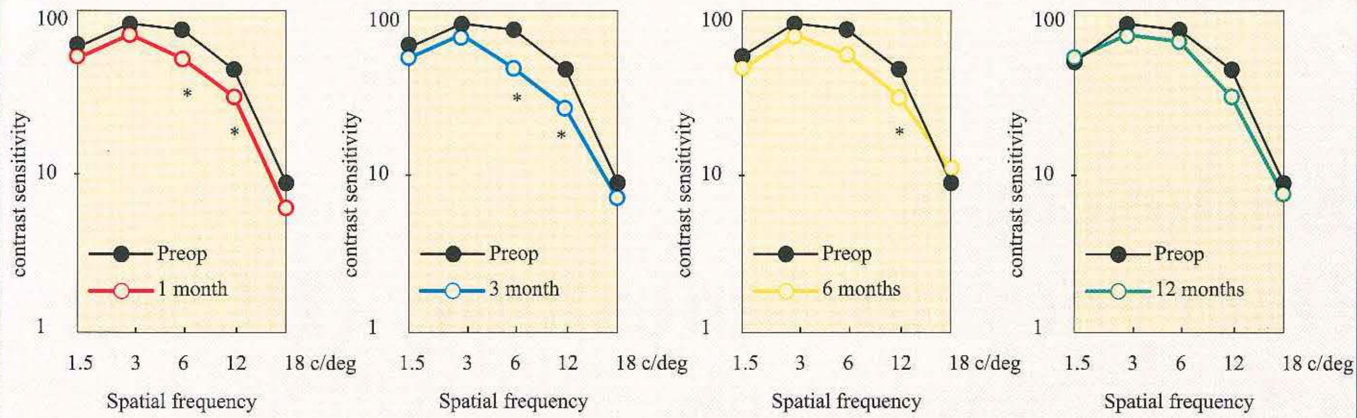
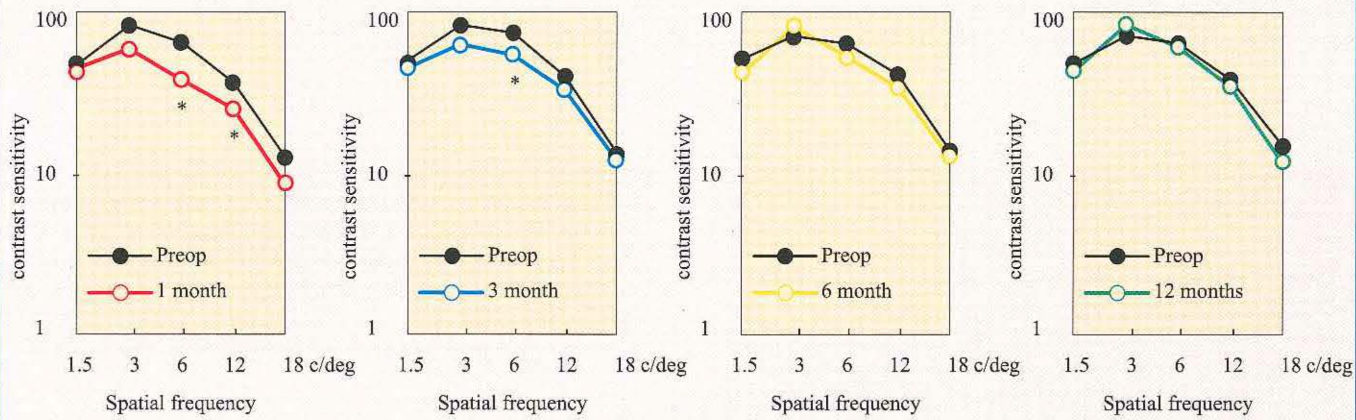


Figure 2. Distant contrast sensitivity functions before and after LASIK.



* *Statistically significant*

Figure 3. Near contrast sensitivity function after PRK.



* *Statistically significant*

Figure 4. Near contrast sensitivity function after LASIK.

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