

# Technical Note: Pre-surgical anisometropia influences post-LASIK binocular mesopic contrast sensitivity function

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## Abstract

**Purpose:** To investigate if pre-surgical anisometropia influences the post-LASIK binocular mesopic contrast sensitivity function (CSF).

**Methods:** Pre- and post-surgical binocular CSF was measured for 54 patients under mesopic conditions. Data on visual acuity and corneal topography were also obtained.

**Results:** The binocular contrast sensitivity declined significantly ( $r = 0.86$ ;  $p < 0.001$ ) with increasing pre-surgical anisometropia. Post-surgical interocular differences in corneal asphericity were also associated with increasing pre-surgical anisometropia.

**Conclusions:** Pre-surgical anisometropia may be indicative of a possible significant deterioration of post-surgical mesopic binocular CSF, and therefore should be taken into account before surgery in analysing the possible disadvantages and limitations of refractive surgery.

**Keywords:** anisometropia, binocular vision, contrast sensitivity function, corneal refractive surgery, mesopic conditions

## Introduction

Although the habitual vision of an observer is binocular, very few studies have analysed binocular vision in patients who have undergone refractive surgery (Boxer Wachler, 2003; Lombardo *et al.*, 2006). Recently, some authors have shown (Jiménez *et al.*, 2005, 2006) that the interocular differences in corneal and total aberrations and corneal asphericity correlate with a greater deterioration of binocular vision after refractive surgery under mesopic conditions. Although it is known that the mesopic contrast sensitivity function (CSF) can deteriorate monocularly after surgery, this deterioration is even greater in the binocular case when large interocular differences arise in corneal and total eye aberrations.

The average deterioration of the binocular CSF was found to be 28%, exceeding 40% in any cases (Jiménez *et al.*, 2006). This result is important because, as indicated above, the natural viewing state is binocular, and the effects of the parameters that influence the deterioration of vision after surgery have been investigated monocularly.

Easy pre-surgical identification of the parameters that can diminish visual performance after surgery, would be of importance in recommending or advising against the operation, or at least presenting the patient or clinician with information on possible variables that may limit vision after surgery. Concerning the above-mentioned results, although it is important to quantify the interocular differences in corneal and total eye aberrations, in daily clinical and optometric practice the corneal topographer is used routinely but an aberrometer may not always be available, and, therefore, criteria based on aberrometry are limited in their application.

In this note, we seek to identify a simple binocular parameter that would also provide potential information on post-surgical visual quality. A detailed study on the binocular data shows that high initial anisometropia

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could indicate greater deterioration of binocular vision after surgery and therefore it is a factor to take into account in evaluating the advisability or not of the operation (Sharma *et al.*, 2005).

## Methods

In our analysis, we used data from 54 patients who, before participating in the study, gave their informed consent in accordance with the Helsinki Declaration. They were operated on with LASIK using a non-customised procedure in a clinic specialising in refractive surgery employing the VISX Star S-2 (VISX Inc., Santa Clara, CA, USA). The age of the patients ranged from 22 to 42 years. Their mean preoperative spherical refractive error was  $-4.4 \pm 2.2$  D (standard deviation), ranging from  $-1$  to  $-7$  D. Astigmatism in all eyes was lower than 0.5 D. The optical zone was 6 mm. All the patients fulfilled the following conditions: after 3 months, they were satisfied with the outcome of the surgery, no longer used any form of optical correction, and their mean postoperative spherical refractive error did not exceed 0.5 D. Data on corneal topography were obtained with a calibrated Orbscan® II (Bausch & Lomb, Rochester, NY, USA) topographer. Their Snellen visual acuity comparison was within one line (higher or lower) of the best-corrected preoperative state. Average pre-surgical best-corrected visual acuity was  $1.16 \pm 0.18$ , being  $1.13 \pm 0.17$  after surgery. No patient had pre-existing abnormal conditions that might affect contrast sensitivity (glaucoma, corneal or neuro-ophthalmological diseases, amblyopia, cataracts, etc.). Given the objective of the work, we sought patients with different degrees of pre-surgical anisometropia who fulfilled the above-mentioned conditions. Anisometropia was computed as the difference between the spherical equivalent of each eye. The average pre-surgical anisometropia was  $0.9 \pm 0.1$  D and the range of the anisometropia found was from 0 to 2.5 D (22 patients had an initial anisometropia  $\leq 0.5$  D and 12 patients  $\geq 1.5$  D).

For visual performance, we determined the binocular CSF. This test was conducted on a calibrated computer-controlled monitor with the software package Vision Works by Vision Research Graphics (Durham, NH, USA). The frequencies tested were: 1.5, 3.1, 6.1, 9.8, 14.2 and 18 cycles per degree. The average luminance level of the CSF test was  $8 \text{ cd m}^{-2}$ , a value within the mesopic range. For each patient, the CSF was computed as the reciprocal of the contrast threshold; this being determined using the method of limits. For each spatial frequency, the post-surgical visual deterioration was computed by dividing the post-surgical binocular CSF by the pre-surgical best-corrected binocular CSF [post-LASIK-CSF/pre-LASIK-(best-corrected) CSF]. Although

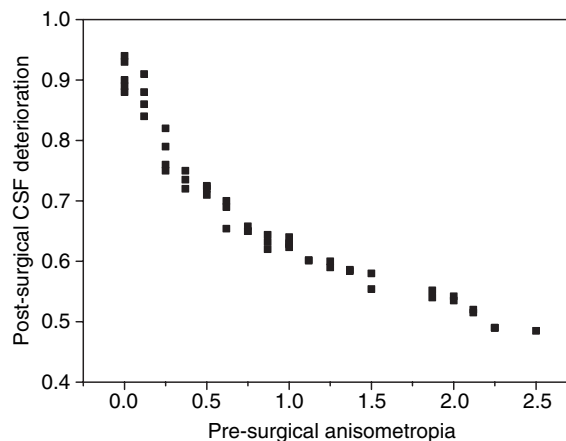
this computation was made for each of the frequencies tested, these data were used to average the results for all the frequencies for each observer.

## Results and discussion

Figure 1 shows the binocular deterioration as a function of the initial anisometropia for each patient. The results show a significant deterioration with increasing anisometropia ( $p < 0.0001$ ,  $r = 0.86$ ). The larger the initial anisometropia the greater the binocular deterioration. Although the deterioration depended on the spatial frequency, the analysis for each spatial frequency led to the same conclusion: a significant deterioration with increasing anisometropia ( $p < 0.01$  for all frequencies).

On computing the deterioration according to the degree of pre-surgical anisometropia, we found the average deterioration to be 0.77 for anisometropia  $< 1.0$  D, increasing to an average of 0.54 for anisometropia  $\geq 1.0$ .

These results are also correlated with the corneal-asphericity (Q) changes that arise after surgery (Anera *et al.*, 2003; Jiménez *et al.*, 2004). Post-surgical asphericity depends on the initial degree of myopia, and variations in this factor could trigger significant variations in asphericity (Jiménez *et al.*, 2004). Therefore, interocular asphericity differences can arise when there is an initial anisometropia. In addition, it has been demonstrated that interocular differences in asphericity diminish the binocular contrast sensitivity for emmetropic subjects (Jiménez *et al.*, 2003) and patients undergoing refractive surgery (Jiménez *et al.*, 2005, 2006). These results were confirmed with the patients in this study. From the corneal asphericity data taken with the topographer, we found a high correlation ( $p < 0.001$ ;  $r = 0.82$ ) between post-surgical interocular



**Figure 1.** Post-surgical binocular deterioration [post-LASIK-CSF/pre-LASIK-(best-corrected)-CSF] as a function of the pre-surgical degree of anisometropia.

differences in corneal asphericity and the initial degree of anisometropia.

We must indicate that this study has been limited to binocular conditions, the habitual viewing condition, and that a comparison of binocular and monocular post-surgical visual performance had been extensively reported elsewhere (Jiménez *et al.*, 2005, 2006). It is also important to indicate that although this study has also been limited to mesopic conditions, the greater post-surgical deterioration (for example, decrease of CSF, appearance of halos) appears under this (mesopic) lighting condition.

Our results show that initial anisometropia is a variable that can influence visual performance in those who have undergone refractive surgery. A high initial anisometropia may be an indicator of greater deterioration in visual performance after surgery and should be taken into account (together with other variables that influence post-surgical visual quality) when recommending the operation or advising patients as to the possible limitations of refractive surgery.

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