Contrast Sensitivity Comparison between Two Thin Lenses, Thinoptx® versus Acrismart®, after Micro Incision Cataract Surgery

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Abstract

Purpose: Contrast sensitivity (CS) evaluation by SV–1000E chart in all spatial frequencies after micro incision cataract surgery (MICS) and its comparison between two thin lenses after optical correction in natural and glare conditions

Methods: In this cross sectional study, 100 eyes having MICS with Dodick ARC phacolaser system were evaluated. 50 Thinoptx lenses and 50 Acrismart lenses were randomly implanted in the eyes. Uncorrected visual acuity (UCVA), best spectacle corrected visual acuity (BSCVA), refractive error and CS, in all spatial frequencies were measured three months after surgery. CSV-1000E chart with or without glare test was used for CS evaluation. Normalized measures of CS were compared between two thin lenses with Student's T-test.

Results: CS profile was within the normal range in 52% of eyes and 48% of eyes had CS in lower than the normal range. The differences of CS in lower spatial frequencies [3 and 6 cycle/degree (c/d)] and higher spatial frequencies (12 and 18 c/d) between two lenses were not significant (P<0.449 and P<0.835, respectively).

Conclusion: After implantation of two lenses by MICS, the CS in all spatial frequencies was similar.

Keywords: Contrast Sensitivity, Spatial Frequencies, Micro Incision Cataract Surgery, Thin Lens

Introduction

Modern cataract surgery has resulted in good visual rehabilitation. Exact calculation of intraocular lens (IOL) power, good centration of IOL, using methods to reduce postoperative astigmatism, design, and material of IOL all have improved postoperative refractive status of the eye.

Nowadays, improvement of visual acuity (VA) after optical correction is an index of surgical success and effectiveness. However, there is little information about quality of vision after cataract surgery. Contrast sensitivity (CS) measurement, exactly shows visual function after cataract surgery. CS is reversely correlated to contrast threshold, which is the lowest contrast required to see a target.
A person who requires more contrast to see a target has lower CS.

CS measurement shows light scattering, optical aberrations and image defocus after refractive surgery. Standard clinical tests such as Snellen chart with high contrast are not proper indexes to express the quality of vision. As a result, CS would be a better feature to measure. CS is evaluated in multiple spatial frequencies, thus visual quality is determined in five spatial frequencies. A number of charts such as vistech, vector vision CSV-1000 E, and steric optical FACT are used for CS measurement. Image defocus reduces retinal image contrast in the middle and higher spatial frequencies, without any effect on lower spatial frequencies. As a result, CS measurement was done with best corrected visual acuity (BCVA).

Smaller incisions (1.75 mm) are used in micro incision cataract surgery (MICS). Therefore, induced corneal astigmatism rarely happens, and visual rehabilitation occurs earlier. Special thin lenses such as Thinoptx and Acrismart are used in MICS. Purpose of this study is to compare CS in all spatial frequencies in CSV-1000 E chart after MICS between two thin lenses following optical correction in general condition and after glare test.

Methods

In this cross sectional study, 100 eyes underwent MICS by one surgeon and incisions were made by 1.75 mm knife. 56% of patients were female and 46% male.

After continuous curvilinear capsulorhexis (CCC), nucleus was divided with chop technique and removed with phaco laser (Dodick ARC) system. Aspiration of cortical material was made with Simco Aspiration irrigation cannula. In preoperative examination, nuclear density was 3+ to 4+ using (LOCSIII) classification. Thinoptx was implanted in 50 patients, and in other 50 patients Acrismart lenses were applied. Randomly postoperative examinations were performed from minimum 1 month to maximum 6 months following surgery for the parameters of uncorrected visual acuity (UCVA), BCVA and refractive error. Furthermore, CS was evaluated using vector vision CSV-1000 E chart. Statistical analysis was performed with and analyzed by SPSS software using Student’s T-test method.

Contrast sensitivity measurement

CS test was performed with CSV-1000E (Vectorvision Inc, Dayton, Ohio). CSV-1000E is a projection chart with four double rows, which consists of eight circles with vertical columns of reducing contrast from left to right. Each line has spatial frequencies of 3, 6, 12, 18 cycle/degree (c/d). In each double ring, patient says that columns are seen or not. The last correct answer is taken from patient. Results are transferred to three curves based on patient age (20-59, 60-69, 70-80), and CS line drawn. This test permits to determine the functional VA in the end of each curve (Figure 1).

In CSV-1000E test, there is no need for excessive illumination. In different mediums, light intensity of chart changes in different lighting conditions sensed by light detector and as a result, level of instrument light is regulated in 85 cd/mm. Ideal distance for test is 2.4 m (2.1-2.7 m). Maximum time for testing of each eye is 30-40 seconds done with best spectacle corrected visual acuity (BSCVA).

In our study, CS was calculated in 3, 6, 12 and 18 c/d frequencies and was transformed to logarithmic and normalized values as shown in table 1. Moreover, CS was compared in 6 and 12 frequencies with Glare test. Glare test was performed with switching on the bulbs of lateral port of chart (Table 1).
Two lenses were used in this study:

**Thinoptx®**

Thinoptx is an acrylic hydrophilic posterior chamber IOL (PCIOL) with optic thickness of 350 \( \mu \)m and haptic thickness of less than 50 \( \mu \)m. Thinoptx has a smooth posterior surface, but in anterior surface, there are concentric rings with 50 \( \mu \)m height. Each ring has special curvature that focuses image on the same point, thus eliminates spherical aberration. All rings focus the image on a single point.6 Optic diameter is 5.5 mm with a constant of 118.9.

**Acrismart 48S**

Acrismart is a one-piece acrylic hydrophobic PCIOL with optic thickness of 1-1.2 mm. Optic diameter is 5.5 mm with 11 mm length. A constant of this lens is 118.7.

**Results**

MICS was performed in 100 eyes with phaco laser method. Thinoptx lens was implanted in 50 eyes and Acrismart 48S in the other 50 eyes. 52% of operations were done in right eye and 48% in left eye. 56% of patients were female and 44% male with the mean age of 51 years. Minimum-maximum age in thinoptx and Acrismart 48s groups were 18-73, and 28-76, with the mean age of 46±13 and 56±10 respectively.

Mean of BSCVA in all eyes was 20/22. Mean of BSCVA was 22/25 in Acrismart group and 20/22 in thinoptx group. Mean of UCVA in all eyes was 20/30.

Spherical equivalent (SE) of postoperative refractive error was zero in 36% of eyes, ±0.5 diopter (D) in 84% and ±1.00 D in 92% of eyes.

Mean of CS in 52% of eyes was in normal range, but 48% of eyes had lower CS. In middle spatial frequencies (6, 12 c/d), 68% of eyes had functional VA of 20/40 or better, and 88% of eyes had functional VA of 20/50 or better.

With regard to normalized numbers, CS in different frequencies was presented for Thinoptx and Acrismart lenses in Table 2.

### Table 1. Normalized values of contrast sensitivity in vector vision

<table>
<thead>
<tr>
<th>Lens</th>
<th>1 (0.6)</th>
<th>2 (0.7)</th>
<th>3 (0.8)</th>
<th>4 (0.9)</th>
<th>5 (1.0)</th>
<th>6 (1.1)</th>
<th>7 (1.15)</th>
<th>8 (1.25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>D</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

**CS** in 52% of eyes was in normal range, but 48% of eyes had lower CS. In middle spatial frequencies (6, 12 c/d), 68% of eyes had functional VA of 20/40 or better, and 88% of eyes had functional VA of 20/50 or better.

With regard to normalized numbers, CS in different frequencies was presented for Thinoptx and Acrismart lenses in Table 2.

### Table 2. Mean of contrast sensitivity in spatial frequencies with two thin lenses

<table>
<thead>
<tr>
<th>Lens</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Thinoptx®</td>
<td>0.956</td>
</tr>
<tr>
<td>Acrismart®</td>
<td>0.928</td>
</tr>
</tbody>
</table>

Mean of CS in 6 and 12 frequencies (middle spatial frequencies) with Glare test was 0.852 in Thinoptx and 0.818 in Acrismart lenses. Mean of normalized CS in Thinoptx lens was 0.861 in 6 c/d and 0.843 in 12 c/d. For Acrismart lenses, the figures were 0.820 in 6 c/d and 0.817 in 12 c/d. Mean of normalized CS in middle frequencies with Glare test was compared using T-test, demonstrating no statistical difference between two lenses (P=0.387).

In lower frequencies (3, 6 c/d), mean of normalized CS in Thinoptx and Acrismart lenses were 0.927 and 0.904 that was not statistically significant (P=0.449).

In higher frequencies (12, 18 c/d) mean of normalized CS in Thinoptx and Acrismart
lenses were 0.820 and 0.805 with no statistically significance (P=0.835).

**Discussion**

CS and Glare disability are highly related to VA and age. Distance VA was determined in both groups. Mean of BSCVA was not statistically different in two groups, also 80% of Thinoptx group had VA of 20/25 or better, but 68% of Acrismart group had this VA. Amount of normalized CS in higher frequencies (18 c/d) -that requires better VA and retinal clarity- was similar in both groups (P=0.835). Decreased CS has many causes. Defocusing and other optical aberrations would cause reduced CS in middle and upper frequencies, but media opacity reduce CS in all frequencies. In this study, regardless of time in which CS test was performed, all spatial frequencies were tested. 52% of eyes in CS diagram were in normal range at all spatial frequencies. In 48% of eyes, reduction of CS was present in middle and higher frequencies. There is no statistically significant difference between two lenses regarding to lowering CS. It has been shown in many articles that, CS is reduced in multifocal diffractive lenses, specially in middle parts of CS curve.10 Some articles refer to special frequencies in which CS is lower, and these are selected frequencies for CS evaluation. In some other studies, selected spatial frequencies for CS evaluation after refractive surgery are 6 and 12 c/d, but in our study, the test was performed in all spatial frequencies.

For evaluation of CS in lighting condition (luminosity test), two lenses are compared in 6 and 12 c/d frequencies. Mean amount of normalized CS in special range of age for two lenses are in lower normal limits, but there was not statistically significant difference.

**Conclusion**

Following MICS (Phaco laser) with two mentioned lenses, there is no reduction in CS due to optical aberrations if residual refractive error was corrected. CS in all spatial frequencies is similar between two lenses, although it is in lower normal limits. For exact conclusion, evaluation of optical aberrations with objective instruments such as aberrometers is recommended.

**References**

7. Acritec User manual; Acrismart 46S information leaflet.