การศึกษาเปรียบเทียบผลของการใช้เลนส์ (แก้วตา) เทียมสองชนิดในการผ่าตัดสลายต้อกระจกต่อความคมชัดการเบี่ยงเบนของแสงประสิทธิภาพการมองเห็นและคุณภาพชีวิตของผู้ป่วย

Comparison of Contrast Sensitivity, Higher-Order Aberration and Subjective Visual Function after Different Aspheric Intraocular Lens Implantation in Phacoemulsification Patients

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บทคัดย่อ

วัตถุประสงค์　เพื่อศึกษาเปรียบเทียบผลของการใส่เลนส์เทียมชนิดความโค้งที่ไม่ใช่ทรงกลม (aspheric)　2 ชนิดที่มีต่อประสิทธิภาพความคมชัดในการมองเห็น　และการเบี่ยงเบนของแสง รวมทั้งคุณภาพการมองเห็นและคุณภาพชีวิตของผู้ป่วย

วัสดุและวิธีการ　การศึกษาในผู้ป่วยต้อกระจกจำนวน 45 ราย ทั้งหมด 45 ตา ผู้ป่วยที่จะได้รับการสลายต้อกระจกด้วยคลื่นเสียงความถี่สูง ร่วมกับการใส่เลนส์เทียมชนิดความโค้งที่ไม่ใช่ทรงกลม โดยสุ่มตัวอย่างเป็นสองกลุ่ม กลุ่มแรกใช้เลนส์เทียม Tecnis ZA9003 จำนวน 23 ตา กลุ่มที่สองใช้เลนส์เทียม AcrysofIQ จำนวน 22 ตา ก่อนผ่าตัด และหลังผ่าตัดเป็นเวลาอย่างน้อย 3 เดือน ผู้ป่วยจะได้รับการตรวจค่าความคมชัดของการมองเห็น วัดการเบี่ยงเบนของแสงโดยใช้เครื่อง Aberrometer สัมภาษณ์โดยใช้แบบสอบถามคุณภาพการมองเห็นและคุณภาพชีวิต

ผลการศึกษา　หลังการผ่าตัด 3 เดือน ผู้ป่วยทุกรายมีระดับสายตา (LogMar UCVA) มีค่า 0.30 (20/40) หรือดีกว่า และระดับสายตา LogMar BCVA มีค่า 0.18 (20/30) หรือดีกว่า โดยไม่แตกต่างกันระหว่างผู้ป่วยสองกลุ่ม เลนส์เทียมทั้งสองชนิดให้ผลเพิ่มระดับความคมชัดของการมองเห็นทั้งในที่สว่างและที่มืด ผลการวัดการเบี่ยงเบนของแสงพบว่าเลนส์ทั้งสองชนิดสามารถลดค่าการเบี่ยงเบนของแสงชนิด spherical aberration และhigher-order aberration การเปรียบเทียบระดับคุณภาพการมองเห็นและคุณภาพชีวิตได้ไม่แตกต่างกันทางสถิติ

สรุป　เลนส์เทียมทั้งสองชนิดสามารถทำให้ประสิทธิภาพความคมชัดในการมองเห็น การเบี่ยงเบนของแสง รวมทั้งคุณภาพการมองเห็นและคุณภาพชีวิตของผู้ป่วยดีขึ้นได้ไม่แตกต่างกันอย่างมีนัยสำคัญทางสถิติ

คำสำคัญ: เลนส์ (แก้วตา) เทียมชนิดความโค้งที่ไม่ใช่ทรงกลม ประสิทธิภาพความคมชัดในการมองเห็น การเบี่ยงเบนของแสง การวิเคราะห์คลื่นของแสง การเบี่ยงเบนแบบทรงกลม

Abstract

Objective: To compare contrast sensitivity, higher-order aberrations (HOAs), and patient satisfaction after two aspheric intraocular lenses (IOLs) implantation after phacoemulsification (PE) of cataract patients.

Material and Methods: This randomized prospective study included 45 eyes of 45 cataract patients who underwent PE and aspheric IOLs. implantation. Patients were randomized to receive one of two aspheric IOL types: Tecnis ZA9003　(n=23) or Acrysof IQ SN60WF (n=22). Preoperative and 3-monthpostoperative　evaluations included uncorrected and best-corrected distance visual　acuity (LogMar UCVA and BCVA), photopic and mesopic contrast sensitivity testing (Optec®6500), wavefront analysis and Visual Function (VF-14) questionnaire.

Results: Three-month postoperative LogMar UCVA and BCVA in all eyes were 0.30 (20/40)　or　better and 0.18 (20/30) or better, respectively; with no statistically significant difference between the groups (p > 0.05). Both aspheric IOLs yielded similarly better contrast sensitivity at all spatial frequencies under photopic and mesopic conditions (p>0.05). Comparisons of spherical aberrations for a 4-mm pupil, HOA and subjective visual function (VF-14-scores) showed no statistically significant difference

Conclusion: Both aspheric acrylic IOLs improved contrast sensitivity, subjective visual function, and provided significant reduction in spherical aberration and higher-order aberration similarly.

Keywords: Aspheric intraocular lens, Contrast sensitivity, Higher-order aberration, Wavefront analysis, Spherical aberration

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1. Introduction

The evolution of PE technology and new-generation IOLs has lead cataract surgery in the current era not only to restore the patients' visual acuity, but also to obtain the most favorable quality of vision. Aspheric IOLs have been shown to improve functional vision in a number of previous studies (Packer, 2004; Bellucci, 2005; Sandoval, 2008; Tzelikis, 2008; Rocha, 2006; Munoz, 2006). The IOLs have originally been designed to decrease or neutralize positive ocular spherical aberration in aging eyes, thus providing enhanced contrast sensitivity and better image quality in pseudophakic patients compared with those implanted with conventional spherical IOLs. The gaining popularity of aspheric IOL use is rapid and widespread among cataract surgeons. The authors aimed to compare the contrast sensitivity, higher-order aberrations and patients' satisfaction of the two aspheric IOLs currently available in Thailand.

2. Objective

To compare contrast sensitivity, higher-order aberrations (HOAs), and patient satisfaction after two aspheric IOLs implantation after PE of cataract patients.

3. Material and Method

This prospective randomized study was conducted at the Department of Ophthalmology, Priest Hospital, Bangkok and the RSU Eye Medical Center, Faculty of Optometry, Rangsit University, Pathumthani, Thailand from June 2009 to May 2010. Two currently available aspheric IOLs of different designs, Tecnis ZA9003 and AcrysofIQ SN60WF were investigated. Patients with bilateral cataract undergoing PE with IOL implantation were included. The exclusion criteria were

1) eyes with extreme refractive errors i.e. corneal astigmatism of 1.5 diopters and over, high myopia or hyperopia of 6 diopters and over

2) eyes with pathology that can affect the vision, the acquisition of wavefront analysis and contrast sensitivity tests

3) eyes with previous intraocular surgery.

Patients were randomized to receive Tecnis ZA9003 (AMO) or AcrysofIQ SN60WF (Alcon). The postoperative target refraction was plano. Uneventful PE and aspheric IOL implantation were performed by experienced surgeons in the same manner. Each patient provided informed consent.

Questionnaires and ocular exams were done preoperatively, and 3 months postoperatively. Ocular examinations included UCVA, and BCVA, manifest and subjective refraction, Goldmann applanation tonometry, slit lamp biomicroscopy, and dilated fundus exam. Contrast sensitivity function test was performed at photopic ($85cd/m^2$) and mesopic ($5cd/m^2$) conditions using Optec® 6500 (Stereo Optical Co, Inc, Chicago, Illinois, USA). Wavefront analysis was done at 4 mm pupil diameter with LADARWave aberrometer (Alcon Laboratories, Fort Worth, Texas, USA). The Visual function (VF-14) questionnaire which was originally developed to measure functional impairment caused by cataract was used to evaluate subjective visual function (Steinberg, 1994) and modified to Thai patients in rural areas (Sornpaisarn, 2002) The questionnaire contained questions about a variety of vision-dependent activities performed in everyday life.. Statistical analysis was done using mean, percentage, and standard deviation for descriptive data. The Student's t-test was used for comparison of quantitative variables. A P value < 0.05 was considered statistically significant.

4. Results

Forty-five eyes of 45 cataract patients were included in the study. Preoperative demographic and clinical data are provided in Table 1. All patients

were men with the mean age of 66.6 years. (SD 5.7, range 51-81 years). Overall mean preoperative LogMar UCVA and BCVA were 0.81 (SD 0.23) (equivalent to 20/126) and 0.49 (SD 0.19) (equivalent to 20/61), respectively. Overall mean preoperative spherical equivalence (SE) was -1.82 (SD 2.28). There were no statistically significant differences between the 2 different IOL groups in age, preoperative BCVA and preoperative SE. Preoperative contrast sensitivity testing and wavefront analysis also showed similar photopic and mesopic contrast sensitivity and wavefront maps between the two groups (Table 1).

Table 1 Mean preoperative patient demographics

	Total (n = 45 eyes)	Tecnis ZA9003 (n = 23 eyes)	Acrysof IQ (n= 22 eyes)	p-value
Age - years (SD)	66.6 (5.7)	65.3 (5.6)	68.0 (5.6)	0.11
Range	51-81			
Gender: male n (%)	45	23 (100%)	21 (100%)	
UCVA –LogMar (SD)	0.81 (0.23)	0.85 (0.23)	0.77 (0.23)	0.22
BCVA – LogMar (SD)	0.49 (0.19)	0.51 (0.18)	0.47 (0.20)	0.58
Spherical equivalence Diopters (SD)	-1.82 (2.28)	-1.94 (2.44)	-1.69 (2.15)	0.71

At 3 month postoperative, all eyes in both groups had mean UCVA of 0.30 (equivalence to 20/40) or better, and mean BCVA of 0.18 (equivalence to 20/30) or better. There was no statistical difference in postoperative BCVA between groups. (P=0.46).

Postoperative contrast sensitivity testing showed no significant difference between the groups under photopic and mesopic conditions. Figures 1, 2, and 3 demonstrate postoperative contrast sensitivity in log units at all spatial frequencies under photopic, mesopic and mesopic with glare conditions. There was no statistically significant difference in the mean contrast sensitivity between the Tecnis and AcrysofIQ groups.
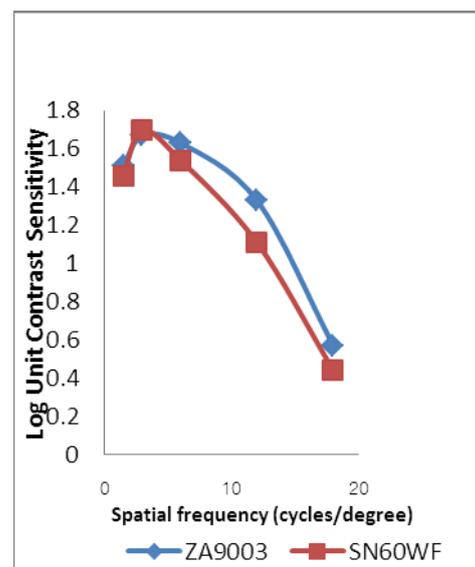

Figure 1 Postoperative contrast sensitivity under photopic condition without glare for 2 intraocular lens groups
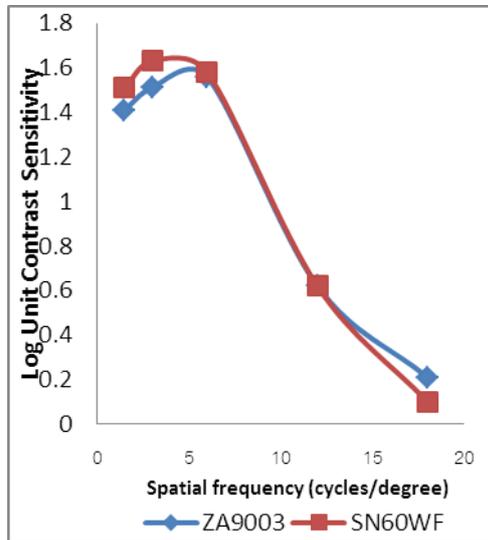
Figure 2 Postoperative contrast sensitivity under mesopic condition without glare for 2 intraocular lens groups
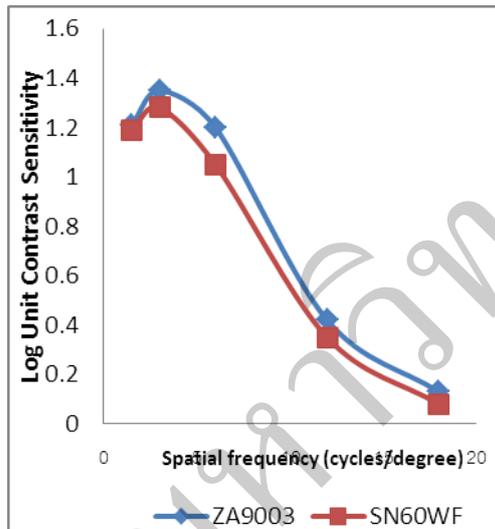

Figure 3 Postoperative contrast sensitivity under mesopic condition with glare for 2 intraocular lens group

Comparisons of ocular aberrations for a 4-mm pupil diameter revealed no statistically significant different mean postoperative spherical aberration between the two groups (p=0.12); 0.03 μm (SD 0.03) in the Tecnis group and 0.04 μm (SD 0.04)

in the AcrysofIQ group. Mean postoperative higher-order aberrations (HOA) were also similar between two groups; 0.24 μm (SD 0.15) for the Tecnis group and 0.34 μm (SD 0.17) for the AcrysofIQ (p=0.15) group; (Table 2).

When considering subjective visual function, the patients reported comparable high postoperative VF-14 scores with the mean scores of 94.4± 6 and 96.2 ± 4.4 in the Tecnis and AcrysofIQ groups, respectively (p=0.27). However the mean increase in VF scores was significantly higher in the Tecnis group than in the AcrysofIQ group (p=0.005).

Table 2. Preoperative and postoperative spherical aberration and higher order aberration for both intraocular lens groups *4 mm pupil diameter analyzed

Aberrations – mean (μm ± SD)		All	Tecnis ZA 9003	Acrys ofIQ SN60 WF	p-value
Spherical aberration	Pre-op	0.16 ± 0.09	0.15 ± 0.09	0.16 ± 0.09	0.81
	Post-op	0.04 ± 0.03	0.03 ± 0.02	0.04 ± 0.04	0.12
Higher-order aberration	Post-op	0.29 ± 0.16	0.24 ± 0.15	0.34 ± 0.17	0.15
	Pre-op	0.52 ± 0.19	0.46 ± 0.23	0.60 ± 0.16	0.14
Coma	Pre-op	0.29 ± 0.18	0.26 ± 0.18	0.33 ± 0.18	0.22
	Post-op	0.17 ± 0.10	0.15 ± 0.98	0.19 ± 0.11	0.29
Total aberration	Pre-op	2.62 ± 1.56	2.26 ± 1.39	3.02. ± 1.68	0.16

5. Discussion

Based on the knowledge of wavefront analysis of the optical system, ocular aberrations other than astigmatism and defocus have a critical impact on visual function. Aspheric IOLs; in attempt to correct spherical aberration, have demonstrated improvement in contrast sensitivity and visual performance when compared to spherical lens which theoretically introduce more positive spherical aberration as the lens power increases. This has been confirmed in several prior studies comparing conventional spherical lens vs aspheric lens results (Bellucci, 2005; Sandoval, 2008; Tzelikis, 2008; Rocha, 2006; Kasper, 2006). Our investigations found significant enhancement of contrast sensitivity at all spatial frequencies under photopic and mesopic conditions in pseudophakic patients implanted with two different aspheric IOLs.

Two aspheric IOL designs studied were Tecnis ZA9003 (AMO) and AcrysofIQ SN60WF (Alcon). The Tecnis ZA9003 is a hydrophobic acrylic three-piece lens with an anterior aspheric surface. The AcrysofIQ is a single-piece lens made of hydrophobic acrylic with a posterior aspheric design. It also incorporates blue light-filtering chromophores believed to prevent retinal pigment epithelial cell damage and age-related macular degeneration (Sparrow, 2004). The discussion on blue light-filtering IOLs has been conflicting. Previous studies have suggested no effects of yellow (blue light-filtering) IOLs on contrast sensitivity (Mester, 2008; Eberhard, 2009). Nevertheless, recent report found decreased contrast sensitivity especially at scotopic conditions (Bhattacharjee, 2006; Wirtitsch, 2009). In the present study, the difference in contrast sensitivity improvement between UV-

absorbing IOL and additional blue-light absorbing IOL could not be confirmed.

Considering correcting spherical aberration, if one aims to reach the target total root-mean-square (RMS) of 0 μm or optimal spherical aberration, an aspheric IOL can be customized in each individual eye according to neutralize preoperative corneal spherical aberration. Although the present study designed to randomly select the IOLs without customization to corneal wavefront maps, the results showed postoperative spherical aberration clustered between 0 to 0.1 μm and patients reported relatively high visual function scores in both IOL groups. Despite the benefit of asphericity on visual function, using aspheric IOL universally is not recommended. Limited advantages of aspheric IOLs with smaller pupils have been reported (Kasper, 2006). Moreover, an earlier report has proposed that decentration and tilting of IOL with negative spherical aberration can decrease IOL performance and even induce higher-order aberrations i.e coma (Dietze, 2005). This is of concern in patients with uncertain capsular stability such as cataract with exfoliation syndrome. In the present study, the authors detected a decline in coma, spherical aberration, and higher-order aberration which may indicate the good centration of IOLs

6. Conclusion

The two different designs of aspheric acrylic IOLs performed equally well in improving contrast sensitivity and subjective visual function, and providing significant reduction in spherical aberration and higher-order berration

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