Visual Outcomes of Two Aspheric PCIOLs: Tecnis Z9000 versus Akreos AO

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Purpose: To compare spherical aberration and contrast sensitivity with two different types of aspheric posterior chamber intraocular lenses (PCIOLs): Tecnis Z9000 versus Akreos AO.

Methods: Thirty-four eyes of 34 patients undergoing phacoemulsification for senile cataracts were randomly assigned to implantation of Tecnis Z9000 or Akreos AO PCIOLs. Outcome measures included best-corrected visual acuity (BCVA), spherical aberration (SA) with 4 and 6 mm pupil diameters and contrast sensitivity under photopic and mesopic conditions at spatial frequencies of 1, 2, 5, 10 and 20 cycles per degree (cpd) three months postoperatively.

Results: Mean BCVA was 0.08±0.08 logMAR in the Tecnis Z9000 group and 0.11±0.09 logMAR in the Akreos AO group (P=0.33). SA was less with Tecnis than Akreos AO with 4 and 6 mm pupil diameter (0.14±0.10 μm vs 0.28±0.09 μm, P< 0.001 and 0.30±0.18 μm vs 0.33±0.08 μm, P=0.4, respectively). Contrast sensitivity was significantly higher in the Tecnis Z9000 group at 1, 2, 5 and 10 cpd under photopic and at 1, 2 and 10 cpd under mesopic conditions.

Conclusion: Tecnis Z9000 IOL seems to entail better visual outcomes in terms of spherical aberration and contrast sensitivity as compared to Akreos AO.

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INTRODUCTION

Cataract surgery and posterior chamber intraocular lens (PCIOL) implantation is one of the most common surgical procedures worldwide. In the past, research was focused on issues such as safer and more rapid surgical techniques, PCIOL structure and material, and prevention of posterior capsule opacification (PCO). Nowadays, with the advent of flexible lenses of various compositions, safe and rapid cataract surgery has become possible; therefore interest has been shifted to improving the quality of vision.

Naturally, the cornea has positive spherical aberration which does not significantly change with age. The spherical aberration of the crystalline lens increases with age, which when added to the corneal spherical aberration, will deteriorate retinal image quality.[1-5] Implantation of current spherical PCIOLs increases the positive spherical aberration of the eye, reduces contrast sensitivity thereby decreasing the quality of vision. PCIOLs with negative spherical aberration may compensate for the positive spherical aberration of the normal cornea and consequently improve contrast sensitivity and quality of vision.[6,7]

Advances in the function and structure of PCIOLs have led to the development of aspheric PCIOLs. In these types of lenses, negative spherical aberration (e.g. Tecnis Z9000) or no spherical aberrations (e.g. Akreos AO) has been incorporated.[8-11] In the Tecnis lens, increased thickness of the anterior edge of the lens and a modified prolate anterior surface result in negative spherical aberration (-0.27 μm).[8,12] By focusing peripheral light beams on the retina, these lenses improve retinal image quality.[8] In Akreos AO, an equal increase in lens thickness in the center and periphery induces null spherical aberration.[13] The aim of this study was to compare the visual outcomes of two aspheric PCIOLs, namely Tecnis Z9000 and Akreos AO.

METHODS

Patients with senile cataract scheduled for phacoemulsification cataract surgery at Labbafinejad Medical Center were randomly assigned to implantation of Tecnis Z9000 or Akreos AO PCIOLs. Inclusion criteria consisted of age from 50 to 75 years, predicted postoperative visual acuity of 20/30 or better, preoperative corneal astigmatism less than 1.5 D and the absence of any ocular condition other than cataract. Exclusion criteria included intra- or postoperative complications such as vitreous loss, PCO, significant macular edema, uveitis, infection, PCIOL decentration, pigment deposits on the PCIOL and incomplete follow-up.

Seventeen eyes of 17 patients received the Tecnis Z9000 and 17 eyes of 17 other patients received Akreos AO. All operations were performed under local (retrobulbar) anesthesia. A 3.2 mm clear corneal incision was made on the steep axis in eyes with pre-existing astigmatism and temporally in the absence of astigmatism. Continuous curvilinear capsulorrhexis 4.5-5.5 mm in diameter was performed. Phacoemulsification was performed using the Sovereign machine (AMO Co, USA). PCIOLs were implanted in the capsular bag in all cases and sutures were not used to close the incision in any patient. Postoperatively, 0.5% chloramphenicol drops every 6 hours and 0.1% betametha-

sone drops every 4 hours were prescribed. Chloramphenicol was discontinued after one week and betamethasone was gradually tapered over one month.

Patients underwent slitlamp biomicroscopy, tonometry and funduscopy 1, 3, 7 and 21 days, and 2 and 3 months postoperatively. The outcome measures of the study were evaluated 3 months postoperatively and consisted of best-corrected visual acuity (BCVA), contrast sensitivity in photopic (85 cd/m^2) and mesopic (5 cd/m^2) conditions at spatial frequencies of 1, 2, 5, 10 and 20 cycles per degree (cpd) using the Mono ELC Metrovision CS. France), and spherical aberration with 4 and 6 mm pupil diameter using an aberrometer/topographer machine (Zywave, Bausch and Lomb, USA). Mean values were compared using *t*-test and frequency values were compared using Chi-square test with significance set at 0.05.

RESULTS

Overall, 34 subjects including 18 male (52.9%) and 16 female (47.1%) patients underwent surgery, equal number of eyes (17 in each study group) underwent Tecnis Z9000 and Akreos AO PCIOL implantation. The only borderline difference in baseline characteristics between the study groups was in mean age which was 58.0±6.1 years in the Tecnis versus 64.0±5.8 years in the Akreos AO groups (P= 0.06).

Three months postoperatively, mean uncorrected visual acuity (UCVA), BCVA and spherical aberration were better in the Tecnis Z9000 group as compared to the Akreos AO group; however this advantage was only statistically significant for spherical aberration with 4 mm pupil size (table 1). BCVA was better than 20/30 in all eyes in the Tecnis Z9000 group and in 94.1% of eyes in the Akreos AO group (P= 0.33); 47.1% of patients in the Tecnis group and 29.4% of individuals in the Akreos AO group achieved BCVA of 20/20 (P= 0.1, Fig. 1). Contrast sensitivity was better in the Tecnis Z9000 group in photopic condition at all frequencies except for 20 cpd and in mesopic condition at 1, 2 and 10 cpd (table 2).

Table 1 Visual acuity and spherical aberration three months after surgery.

	Mean ± Standard Deviation		*P Value
	Tecnis Z9000	Akresos AO	
UCVA (logMAR)	0.178±0.104	0.254±0.135	0.083
BCVA (logMAR)	0.076±0.080	0.115±0.090	0.33
Spherical aberration (µm)			
4 mm pupil	0.140±0.097	0.285±0.087	<0.001
6 mm pupil	0.303±0.183	0.329±0.083	0.40

UCVA, uncorrected visual acuity; BCVA, best-corrected visual acuity
*t-test

Table 2 Contrast sensitivity (Mean ± Standard Deviation) three months after surgery.

Spatial Frequency	Photopic			Mesopic		
(cpd)	Tecnis Z9000	Akreos AO	*P value	Tecnis Z9000	Akreos AO	*P value
1	19.58±1.46	16.94±1.19	<0.001	14.29±0.77	11.23±1.30	<0.001
2	22.29±1.25	20.17±1.70	<0.001	15.94±0.96	13.52±2.18	<0.001
5	24.82±1.81	22.88±1.96	0.05	18.52±2.15	19.00±2.26	<0.2
10	19.52±1.80	17.70±1.57	<0.001	14.05±1.67	11.76±2.19	<0.001
20	13.94±2.24	13.41±1.58	0.55	9.94±1.56	9.52±1.23	1

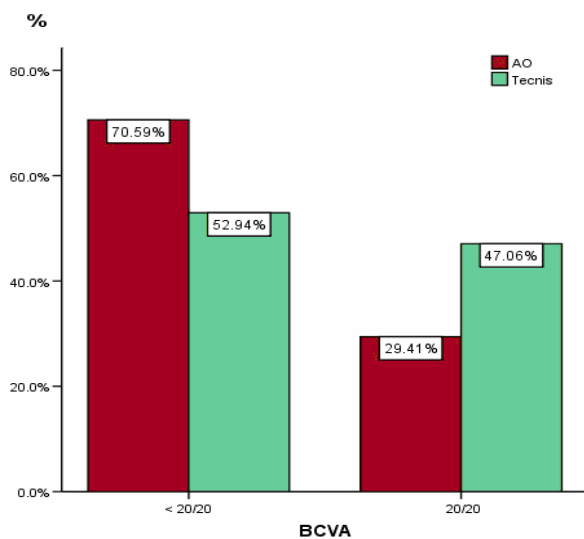cpd, cycle per degree
*t-test

Figure 1 Mean best-corrected visual acuity (BCVA) three months postoperatively

DISCUSSION

Wavefront technology has made it possible to measure optical aberrations of the eye and has facilitated the design of aspheric IOLs. Aspheric IOLs may compensate for the positive spherical aberration of the cornea or at least not add to the pre-existing amount of aberrations. The negative spherical aberration of the Tecnis Z9000 IOLs and the nil spherical aberration of the Akreos AO theoretically reduce optical aberrations of the eye as compared to spherical IOLs.[1] Various studies have reported improved retinal image quality with aspheric IOLs.[1,6-8]

Apart from visual acuity, we evaluated two other significant indicators of visual function namely contrast sensitivity and spherical aberration.[1] Since age influences spherical aberration and contrast sensitivity, in the current study only patients 50 to 70 years of age were selected. Pupil size also has significant impact on spherical aberration,[6] we therefore evaluated aberration with pupil sizes of 4 and 6 mm in order to better evaluate postoperative changes.

Although not statistically significant, both UCVA and BCVA were better in the Tecnis Z9000 group as compared to the Akreos AO group. Our findings demonstrated that spherical aberration was less in the Tecnis group with both 4 and 6 mm pupil diameters, however this

was only statistically significant for pupil size of 4 mm. The negative spherical aberration of Tecnis Z9000 decreases the total spherical aberration of the eye and some studies have reported a greater decrease in spherical aberration by this type of PCIOL as compared to others.[14,15] Macros et al[16] performed a study on aspheric IOLs and concluded that spherical aberration is lower with Tecnis as compared to Acrysof IQ. Johansson et al[13] compared Akreos AO and Tecnis and concluded that these two types of aspheric IOLs are comparable in terms of visual acuity in mesopic and photopic conditions but reported lower spherical aberration for Tecnis IOLs. In a study performed by Caprossi et al[7] comparing the same types of IOLs, the Tecnis PCIOL was associated with greater decrease in spherical aberration with a 5 mm pupil, although this was not statistically significant. These finding suggest that with implantation of an appropriate aspheric PCIOL, total optical aberrations of the eye may be reduced thereby improving quality of vision.[17]

In our study, contrast sensitivity in both photopic and mesopic conditions at spatial frequencies of 1, 2, 5, 10 and 20 cpd was better in the Tecnis group as compared to the Akreos AO group; however this was not significant in photopic conditions at 20 cpd and in mesopic conditions at 5 and 20 cpd. These results are in line with previously reported studies. Belluci et al[8] reported higher contrast sensitivity with Tecnis IOLs as compared to Acrysof in both photopic and mesopic conditions. Denoyer et al[14] also reported that Tecnis is associated with higher contrast sensitivity in both photopic and mesopic conditions in comparison with Cee-On-Edge lenses. However, in the study performed by Kasper et al,[15] even though contrast sensitivity was better with Tecnis as compared to Sensar, the difference was not statistically significant. Also according to Caprossi et al[7] there was no statistically significant difference between Tecnis and Akreos AO in term of contrast sensitivity in photopic condition and this difference was statistically significant only in mesopic condition at 6 cpd. The present study is consistent with the above-mentioned

studies in that Tecnis yields higher contrast sensitivity when compared to Akreos AO which can be explained by the more negative spherical aberration of the former.

It is noteworthy that the higher contrast sensitivity and lower spherical aberration of Tecnis can only be achieved when the lens is well centered in the capsular bag; decentration may result in increased spherical aberration and decreased contrast sensitivity. Therefore, in cases where adequate centration of the PCIOL is doubtful, implantation of these lenses should be avoided. In such cases, lenses with neutral spherical aberration such as Akreos AO may yield better visual results.[13] One should keep in mind that the material of the optic of IOL and its refractive index also contribute to optical aberrations;[6] the present study only considered the surface design of two types of PCIOLs while other factors influencing the optical performance of these lenses were not evaluated.

REFERENCES

1. Munoz G, Albarran-Diego C, Montes-Mico R, Rodriguez-Galietero A, Alio J. Spherical aberration and contrast sensitivity after cataract surgery with Tecnis IOL. *J Cataract Refract Surg* 2006;32:1320-1327.
2. Artal P, Ferro M, Miranda I, Navarro R. Effect of aging in retinal image quality. *J Opt Soc Am A Opt Image Sci Vis* 1993;10:1656-1662.
3. Guirao A, Gonzalez C, Redondo M, Artal P. Average optical performance of the human eye as a function of age in a normal population. *Invest Ophthalmol Vis Sci* 1999;40:203-213.
4. Guirao A, Redondo M, Artal P. Optical aberration of the human cornea as a function of age. *J Opt Soc Am A Opt Image Sci Vis* 2000;17:1697-1702.
5. Artal P, Berrio E, Guirao A, Piers P. Contribution of the cornea and internal surfaces to the change of ocular aberrations with age. *J Opt Soc Am A Opt Image Sci Vis* 2002;19:137-143.
6. Kasper T, Buhren J, Kohnen T. Visual performance of aspherical and spherical IOL: intra-individual comparison of visual acuity, contrast sensitivity, and higher order aberration. *J Cataract Refract Surg* 2006;32:2022-2029.
7. Caporossi A, Marton G, Casprini F, Rapisarda L. Prospective randomized study of clinical performance of 3 Aspheric and 2 spheric IOL in 250 eye. *J Refract Surg* 2007;23:639-648.
8. Bellucci R, Scialdone A, Buratto L, Morselli S,

Chierego C, Criscuoli A, et al. Visual acuity and contrast sensitivity comparison between Tecnis and Acrysof SA60 AT IOL. *J Cataract Refract Surg* 2005;31:712-717.

9. Owstey C, Sekuler R, Siemsen D. Contrast sensitivity throughout adulthood. *Vision Res* 1983;23:689-699.

10. Smith G, Cox MJ, Calver R, Garner LF. The spherical aberration of the crystalline lenses of the human eye. *Vision Res* 2001;41:235-243.

11. Atchison DA. Design of aspheric IOL. *Ophthalmic Physiol Opt* 1991;11:137-146.

12. Holladay JT, Piers PA, Koranyi G. A new intraocular lens design to reduce spherical aberration of psudophakic eyes. *J Cataract Refract Surg* 2002;18:603-669.

13. Johansson B, Sundelin S, Wikberg-Matsson A, Unsbo P, Behndig A. Visual and optical performance of the Akreos Adapt Advanced optical and Tecnis intraocular lenses: Swedish multicenter study. *J Cataract Refract Surg* 2007;33:1565-1572.

14. Denoyer A, Le Laz ML, Majzoub S, Pisella P. Quality of vision after cataract surgery after Tecnis Z9000 intraocular lens implantation. *J Cataract Refract Surgery* 2007;33:210-216.

15. Kasper T, Buhren J, Kohnen T. Intra-individual comparison of higher order aberration after implantion of aspherical and spherical intraocular lenses as a function of pupil diameter. *J Cataract Refracts Surg* 2006;32:78-84.

16. Marcos S, Rosales P, Llorente L, Jimenez-Alfaro I. Change in corneal aberration after cataract surgery with 2 types of aspherical intraocular lenses. *J Cataract Refract Surg* 2007;33:217-226.

17. Morsellis BR. Comparison of wave front aberration and optical quality of eyes implanted with five different intraocular lenses. *J Refract Surg* 2004;20:297-304.