·Clinical Research·

Higher order aberration comparison between two aspherical intraocular lenses: MC6125AS and Akreos advanced optics

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Abstract

• **AIM: To compare higher order aberrations in two aspherical intraocular lenses (IOLs): Akreos advanced optics (AO) and Dr. Schmidt Microcrystalline 6125 aspheric anterior surface (MC6125AS) with each other.**

• **METHODS: Forty eyes of 39 patients underwent phacoemulsification and Akreos AO and MC6125AS were implanted in their eyes in a random manner. Three months post-operatively, higher order aberrations including spherical aberration, coma aberration, and total aberrations were measured and compared.**

• **RESULTS: The total aberration was 0.24±0.17 in eyes with Dr. Schmidt and 0.20±0.01 in eyes with Akreos AO (P=0.361). The mean of coma aberration was 0.17±0.21 and 0.09 ±0.86 in Dr. Schmidt and Akreos lenses, respectively (P=0.825). Total spherical aberration was almost the same in both groups (mean: 0.05, P=0.933). Best corrected visual acuity in Akreos AO (0.10±0.68) and Dr. Schmidt (0.09±0.67) did not differ significantly (P= 0.700).**

• **CONCLUSION: There is no statistically significant difference in the higher order aberrations between these two aspherical lenses.**

• **KEYWORDS:** aspherical lenses; higher order aberrations; cataract; intraocular lens

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INTRODUCTION

Cataract is responsible for near 50% of unilateral and bilateral visual impairment and accounted for about 21% of unilateral and bilateral incident of blindness [1]. The only available treatment right now is surgery. Following the advances in surgical techniques that resulted in less post-operative complications like posterior capsule opacification, decentration and consequence astigmatism, designation of intraocular lenses have attracted lots of attention and evolved significantly.

Aspheric intraocular lenses were first commercially available in the early 21st century. With one or two aspheric surfaces, they were expected theoretically to reduce the positive aberration of the cornea and compensate for the total positive aberration of an aged eye. Studies demonstrate that aspherical lenses in comparison with conventional spherical lenses increase contrast sensitivity and reduce higher order, and total aberration of the eyes; a benefit that can be reduced or even reversed if a tilt or misalignment occurs [2-4]. Some researchers reported though no statistically significant difference in the best corrected visual acuity (BCVA), even contrast sensitivity and above all patients satisfaction[2,5-9].

A wide range of aspherical intraocular lenses is now commercially available. They differ from each other through constructing material, centralization diameter and detailed refractory properties.

There are limited papers to compare the existing aspherical lenses with each other to help the clinicians to select the best option for each patient and studies, which compared different kinds of aspheric lenses, revealed statistically significant differences in spherochromatic and higher order aberrations along with depth of focus and overall patient satisfaction[5,10-12].

This study is thus designed to compare Dr. Schmidt Microcrystalline 6125 aspheric anterior surface (MC6125AS) and Akreos Adapt Advanced objectively based on higher order aberrations; spherical aberration, coma aberration, and internal aberration which (as far as we know) have not yet been compared with each other.

SUBJECTS AND METHODS

Subjects In this prospective double blind study, all patients

between 30 and 50y, who referred to our eye clinic with cataract in one eye in 2012 (from January till December), were recruited. Before the entrance, each single step of the study was fully explained and all patients signed an informed consent. This study was approved by the ethics committee of the Farabi Eye Hospital and conducted in accordance with the tenets of the Declaration of Helsinki.

The inclusion criteria were predicted visual acuity (VA) of 20/30 or better, preoperative and postoperative astigmatism less than 1.5 diopters (D), no ocular lesion but cataract and power of intraocular lens between +18 to +20 D.

All patients who suffered from post-surgical complications like macular edema, uveitis, infection, intraocular lens decentration, posterior capsule opacification, and vitreous loss or had systemic disease, affecting the ocular system were excluded from the study.

The sample size was calculated using the formula adopted for comparing two means. Thirty-nine patients entered the study and were randomly allocated into two groups.

Materials MC6125AS is a single piece, foldable lens with posterior hydrophilic property, which is made from acryl, superficially aspheric and aberration free with ultraviolet filtering and index of refraction: 1.436. This lens is manufactured in Germany by Dr. Schmidt Intraocularlinsen GmbH.

Akreos Adapt Advanced is a single piece, foldable, biconvex, aspheric (both anteriorly and posteriorly) lens, constructed from acrylic material (26%), with index of refraction of 1.458 when hydrated, aberration free and ultraviolet filtering. This intraocular lens is designed and produced by Bausch & Lomb, Germany.

Methods All patients underwent phacoemulsification by one expert surgeon under topical anesthesia. After irrigation and aspiration, the intra ocular lens was implanted in the capsular bag through a 3 to 3.2 mm corneal incision. No suture was used for incision closure. After the surgery, topical steroids and antibiotics were applied for two weeks. All patients were followed up one and three months after the surgery.

Data collection Before the surgery, all patients' eyes were examined by slit lamp and direct ophthalmoscopy, when possible. Post-surgical measured values in this study included: refraction, refraction was measured objectively by autorefractometer (Nidek 7000®, Japan).

VA was measured using logMAR acuity charts under photopic conditions in standard 6 m of distance and luminance in the range from 30 to 50 CDL/m^2. Testing was conducted unilaterally and the non-study eye was occluded.

Biometry Before the cataract surgery, the axial length was measured with the A-scan UD-6000 (Tomey Corporation, Nagoya, Japan).

Aberration Wavefront aberration analysis was performed with the Topcon iTrace combo visual analyzer version 4.1 aberrometer under mesopic condition without pupillary dilation (presumed pupil diameter: 4 mm). If rejected points more than 8, aberrometry was repeated. All steps for topography and abberometry were done automatically. Refraction, higher order aberrations: total aberration, coma aberration and corneal spherical aberration were collected. Spherical intraocular lens aberration was also calculated through subtraction of corneal spherical aberration from total aberration.

Statistical Analysis Consequence data entered IBM SPSS 19, IBM Corporation, underwent descriptive analysis and means and standard deviations were calculated. In normal variables, *t*-test was used to compare the means between two groups and the non-parametric Mann-Whitney model was applied, when the variables were not normally distributed. Differences were considered statistically significant, only if the *P* value was less than 0.05.

RESULTS

Thirty-nine patients (40 eyes) included in the study, 17 (43.6%) men and 22 (56.4%) women that were followed up for 3mo. No operative or postoperative complications occurred in any patient. Nineteen and 21 eyes were implanted with Dr. Schmidt and Akreos advanced optics (AO), respectively.

The logMAR BCVA 3mo after operation was 0.10±0.68 in Dr Schmidt's group and 0.09±0.67 in the Akreos AO group (Table 1). The difference in logMAR BCVA between the two groups was not statistically significant (P=0.700).

Total spherical aberration in Dr. Schmidt's group (0.05± 0.02) was not significantly different from Akroes group (0.05± 0.02, P=0.933).

In comparison to Akreos AO, coma aberration in the Dr. Schmidt's group was not significantly higher (P=0.825). Total aberration in the Dr Schmidt's group (0.24±0.17) was higher than Akreos group (0.20 ±0.01) that was not statistically significant (P=0.361). Total intraocular lens aberration in both groups did not differ significantly (P=0.509), (-0.11±0.08) in Dr Schmidt's and -0.10±0.06 in Akroes AO group.

Limitation Contrast sensitivity is a valuable index to estimate the post-surgical ophthalmic function; nevertheless we were unable to measure contrast sensitivity under photobic and mesopic condition because of non-adjustable luminance of the examination room.

DISCUSSION

Cataract surgery and intraocular lens implantation are the most successful procedure in new medicine worldwide. Although the achievement of uncorrected 20/20 VA is satisfactory, patients occasionally experience some degree of glare, haze or night vision disturbances. These symptoms may result from posterior capsule opacification (PCO), postoperative mydriasis or IOL-related factors[13,14]. Moreover,

Table1 Clinical and aberration findings of Dr. Schmidt and Akreos AO groups

Parameters	Dr. Schmidt *n*=19 eyes	Akreos AO *n*=21 eyes	*P*
BCVA (logMAR)	0.10±0.68	0.09±0.67	0.700
Total aberration	0.24±0.17	0.20±0.01	0.361
Coma aberration	0.17±0.21	0.09±0.86	0.825
Spherical aberration	0.05±0.02	0.05±0.02	0.933
Intraocular lens aberration	-0.11±0.08	-0.10±0.06	0.509

AO: Advanced optics; BCVA: Best corrected visual acuity.

the recent introduction of wavefront technology indicates that the increasing higher-order aberrations induced by IOLs are related to these symptoms [15]. In the young patients, the average positive spherical aberration of the cornea is partly compensated by a negative spherical aberration of the crystalline lens. While the cornea is a relatively stable optical system throughout a lifetime, aberration of the lens increases with age, becoming positive around the age of 40y [16]. The aging lens loses the compensation function and leads to the loss of visual quality. Similarly, it helps to understand the symptoms after the conventional spherical IOL implantation. Since a spherical IOL like the older lens has an inherent positive spherical aberration, again there is no correction of the positive spherical aberration of the cornea[15].

Based on these findings, the logical approach to compensate for the increasing spherical aberration in older eyes is to develop an IOL designed to balance the positive spherical aberration of the cornea. Such an IOL, the Akreos AO and MC6125AS IOL have been developed. With a modified prolate anterior and posterior surface, these IOLs are intended to restore the balance of spherical aberration in the typical young eye and consequently improve visual performance.

In the present study, we compared higher order aberrations in two aspherical IOLs: Dr. Schmidt and Akreos AO. Based on our findings, there is no statistically significant difference between these two lenses, which means whether there is not any significant difference between them or their difference is beyond the sensitivity of our applied wavefront measurement system.

Since the appearance of aspherical lenses, cumulating studies have compared them with spherical lenses. Packer *et al*[17] first reported better contrast sensitivity with aspherical lenses than spherical ones.

In a study by Santhiago *et al* [4] contrast sensitivity was significantly better in eyes implanted with aspherical IOL. They also reported a lower level of higher order aberrations in these lenses compared with conventional spherical lenses. They found though no better uncorrected or best corrected distance VA[4].

Other researchers reported better contrast sensitivity, reading speed, driving safety and even VA[2,18-20] in aspherical lenses in comparison with spherical lenses.

Nonetheless, the results are not the same and a number of studies demonstrated that aspherical lenses do not increase the best VA and some studies show that aspherical lenses decrease the depth of focus [5-8,21,22] and overall patient satisfaction. In a study by Marcos *et al* [22] it was revealed that the tolerance of defocus is less in the eyes with aspherical lenses.

After all, the universal trend is towards the application of aspherical lenses instead of spherical lenses and to bestow the best visual performance, asphericity should be regarded individually based on each patient's corneal aberration[23].

Further studies were designed to compare aspherical lenses with each other. In a study by Johansson and coworkers [12], two lenses: Tecnis Z900 and Akreos were compared and no significant differences were reported in the BCVA and contrast sensitivity. But higher order aberrations (HOA) were less in Tecnis Z900 and depth of focus was more in Akreos AO. The overall subjective ophthalmic function was better in Akreos AO. This finding shows that the HOA are not the only indices that affect the subjective quality of vision.

Baghi *et al* [11] also found that Akreos AO in comparison with Tecnis Z900 causes more spherical aberration in pupil diameter 4 and 6 mm.

A study of 250 eyes, which compared three aspherical lenses, no difference was found in contrast sensitivity and BCVA. Finding that parallels with other studies. In this study, spherical aberration was reported less in Tecnis Z 9000[5].

Lee *et al* [24] also compared three aspherical lenses; there was no significant difference in subsequent BCVA, refractory error, and total aberration among those three groups. Although spherical aberration was less in Tecnis Z900, the overall patients' satisfaction was the same in three groups. Less spherical aberration observed for some aspherical lenses in these studies could be attributed to refractive index and optic material[25].

In our study, wavefront analysis was done with iTrace TM combo visual analyzer version 4.1. The coma aberration and total aberrations were lower in Akreos AO but the differences were not statistically significant. Measured spherical aberration though theoretically zeroes and was -0.11 and -0.1 in Dr. Schmidt and Akreos AO, respectively.

Woon *et al*[26] found that the measured values by two different aberrometer: automatic retinoscope aberrometer (OPD scan, Nidek) and iTrace differ significantly with each other. A concept that should be noticed when pulling and comparing the results from studies applying different measuring systems.

Finally from observations of the present study, it can be concluded that although it is mentioned that the aspherical IOLs can provide better satisfaction by enhancing contrast sensitivity and improving functional vision, and can reduce

aberration and improve contrast sensitivity as compared with the spherical IOLs, however, a comparison between two types of aspherical IOLs; Dr. Schmidt and Akreos AO showed that their differences are not significant.

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