·Clinical Research·

Improving quality of vision with an anterior surface modified prolate intraocular lens: A prospective clinical trial

V Subrayan[1], E Mavrikakis[2], J A Bell[2]

[1]Department of Ophthalmology, University of Malaya, Kuala Lumpur, Malaysia

[2]The Laser Eye Clinic, Royal Tunbridge Wells, Kent, United Kingdom

Correspondence to: Visvaraja Subrayan. Department of Ophthalmology, Faculty of Medicine, University of Malaya, 50603 Kuala Lumpur, Malaysia. dvisva@hotmail.com

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Abstract

• AIM: To compare the optical performance of the anterior surface modified prolate Tecnis Z9000 IOL with the standard 911A IOL in terms of contrast sensitivity outcomes.

• METHODS: The Tecnis Z9000 silicone IOL shares the same basic characteristics with the 911A IOL including a 12.0mm overall diameter, 3-piece equiconvex 6.0mm optic and angulated cap C polyvinylidene fluoride haptics. This is a randomized prospective study that involved ten consecutive patients (20 eyes) with bilateral cataracts. Each patient underwent phacoemulsification and received randomly the Tecnis Z9000 IOL in one eye and the control (911A IOL) in the fellow eye within 6 weeks period of one another. Contrast sensitivity was measured after six postoperative weeks. The collected data were analyzed through using Mann Whitney U test.

• RESULTS: The mean pre-operative best spectacle corrected Snellen visual acuity in the eyes that were randomly selected to receive the Tecnis IOL was 6/8.5 (0.70) and in the eye selected to receive the 911A IOL was 6/9.4 (0.64). Postoperatively all 20 eyes achieved best corrected Snellen visual acuity of 6/6 (1.0). Postoperative contrast sensitivity testing showed statistically significant differences (P<0.05) between the two IOLs at 12 and 18 cpd under photopic, at 1.5 and 3 cpd under mesopic, and at 1.5 and 3 cpd under mesopic with glare conditions.

• CONCLUSION: The Tecnis Z9000 IOL proved to have statistically significant superior contrast sensitivity to the 911A IOL at high spatial frequencies under photopic conditions and at low spatial frequencies under mesopic and mesopic with glare conditions.

• KEYWORDS: Tecnis Z9000; 911A IOL; contrast sensitivity; phacoemulsification

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INTRODUCTION

In the past decade cataract patients have benefited from dramatic improvements in surgical technique as well as important innovations in intraocular lens design. The benefits include shorter surgery time, less morbidity and more predictable visual outcomes. The goal of cataract surgery now is to restore functional vision. Functional vision is an index of patient's ability to perform daily activities such as driving and shopping. Snellen visual acuity measures only a small portion of functional vision, while contrast sensitivity has been found to provide a higher degree of correlation between functional vision and visual performance[1,2].

Contrast sensitivity declines with age even in the absence of ocular pathology such as glaucoma or macular degeneration[3]. The pathogenesis of this decline is most likely due to changes in the spherical aberration of the crystalline lens[4].

In the young eye the positive spherical aberration found in the cornea is essentially neutralised by the negative spherical aberration found in the crystalline lens[5,6]. With age however the crystalline lens adds lens fibers at the equator, and it thickens. This results in an increase of the index refraction of the peripheral lens, which induces positive spherical aberration. The positive spherical aberration in the older lens and the normal positive spherical aberration in the cornea combine to give a decrease in the quality of vision with age[7].

The Tecnis Z9000 is the only intraocular lens (IOL) designed with a modified prolate anterior surface so as to

have the same negative spherical aberration as the crystalline lens of the young eye. Thus, postoperative patients with this intraocular lens are more likely to possess the same refractive qualities of the youthful eye.

MATERIALS AND METHODS

Patients This is a randomized prospective study that includes ten consecutive patients (20 eyes) presenting with bilateral cataracts at the Eye Unit, Pembury Hospital, Royal Tunbridge Wells, United Kingdom. Each patient underwent phacoemulsification and received randomly the Tecnis Z9000 IOL in one eye and the control (911A IOL) in the fellow eye within 6 weeks period of one another. Each patient was allowed at least six weeks postoperative recovery prior to visual analysis.

Of the 10 patients that have been studied, 4 were males and 6 were females. The age range varied between 50 and 85 years with a mean age of 73.1 years.

Inclusion criteria were patients with visually significant cataract, estimated potential Snellen visual acuity of 6/9 or better postoperatively, mesopic pupil size of 4mm or greater, measured with a hand held pupil gauge and informed consent. In addition, all patients must have had uncomplicated cataract surgery with secure in-the-bag IOL fixation.

Patients with ocular pathology other than cataract, neurologic or other disease known to affect contrast sensitivity or using medications known to influence contrast sensitivity as well as patients with high hyperopia or high myopia were excluded from the study.

Methods The surgical technique for cataract extraction included a 3.2mm clear corneal superior incision, followed by a 5.0mm continuous curvilinear capsulorhexis, hydrodiss-ection and endocapsular phacoemulsification, performed by the same surgeon (JAB). The intraocular lens was implanted in the bag in all eyes. Postoperatively, all patients were treated with maxitrol on a tapering schedule.

All patients underwent detailed ocular examination before surgery, on the day of surgery and 2 and 6 weeks postoperatively. The intraocular lens was inspected for optic decentration and tilt at the slit-lamp.

Contrast sensitivity (CS) measurements were obtained by using the Contrast Sensitivity 1800 Digital viewer (Ginsburg box) which in addition allows glare testing and the second-generation Functional Acuity Contrast Test (FACT) chart. This chart employs sine wave grating to measure contrast sensitivity at five standard spatial frequencies, 1.5, 3.0, 6.0, 12.0, 18.0 cycles per degree (cpd).

All measurements were obtained with best spectacle correction under photopic (85cd/m^2), mesopic (3cd/m^2) and mesopic with glare (35 Lux) conditions. The last patch on

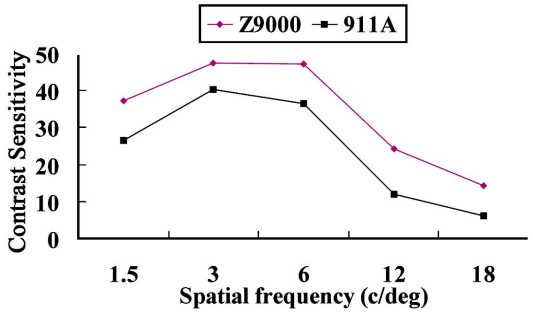

Figure 1 Mean postoperative photopic contrast sensitivity

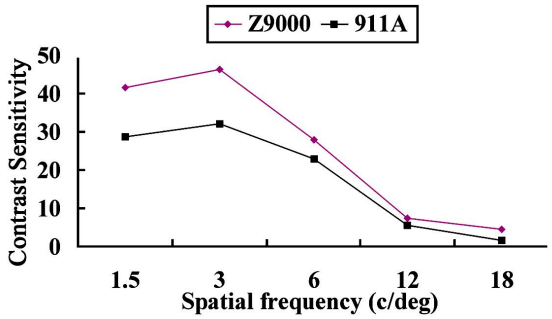

Figure 2 Mean postoperative mesopic contrast sensitivity

the FACT chart that each patient could read for each spatial frequency was assigned contrast sensitivity value using software provided by Vision Sciences Research Corporation. The mean and standard deviation of the contrast sensitivities values found in the two-study populations were compared using the non-parametric Mann Whitney U test. A statistically significant difference was considered when $P<0.05$. A functionally significant difference in vision was considered to correspond to a 0.15 log unit or greater difference between tests[8,9].

RESULTS

Results include a total of 20 eyes in 10 patients. Each patient received the Tecnis Z9000 IOL in one eye and the 911A IOL in the fellow eye. The mean pre-operative best spectacle corrected Snellen visual acuity in the eyes that were randomly selected to receive the Tecnis IOL was 6/8.5 (0.70) and in the eye selected to receive the 911A IOL was 6/9.4 (0.64). Postoperatively all 20 eyes achieved best spectacle corrected Snellen visual acuity of 6/6 (1.0).

Slit-lamp evaluation of the IOL showed no cases of decentration or tilt in any eye.

Postoperative contrast sensitivity testing showed statistically significant differences ($P<0.05$) between the two IOL at 12 and 18 cpd under photopic (Figures 1), at 1.5 and 3 cpd under mesopic (Figure 2), and at 1.5 and 3 cpd under mesopic with glare conditions (Figure 3).

The differences represented functional significant improvement in vision (0.15 log unit or greater difference between tests) at all spatial frequencies except 3 cpd under

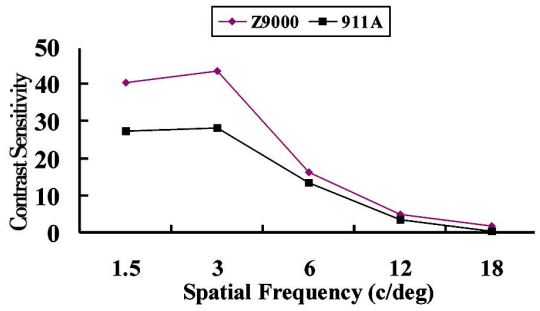

Figure 3 Mean postoperative mesopic with glare contrast sensitivity

photopic, 6cpd under mesopic and 6 cpd under mesopic with glare conditions.

DISCUSSION

The Tecnis Z9000 IOL proved to have statistically significant superior contrast sensitivity to the 911A IOL at high spatial frequencies under photopic conditions and at low spatial frequencies under mesopic and mesopic with glare conditions. The control IOL used in this study, the 911A, is produced by the same company (Pfizer) as the Tecnis IOL and they are sharing the same basic design characteristics. After an extensive review of the literature, we believe we are the first to report comparison of similarly designed lenses, therefore representing a pure control for the prolate modified IOL. In addition, to our knowledge, this is the only study where the Tecnis and the 911A IOL have been implanted in the eyes of the same patient allowing for intra-individual comparisons by means of the patient being the control as well as the study group.

One of the limitations of the study is the absence of wave-front aberrometry, which can be used to evaluate the spherical aberrations in eyes with the implanted IOLs. However, in a recent study [10] wave-front measurements revealed no significant spherical aberrations in eyes with a Tecnis Z9000 IOL.

To minimize possible bias in this study the following measures were taken: (1) intra-individual comparative study design; (2) strong inclusion and exclusion criteria; (3) bilateral surgery was performed by the same surgeon using identical surgical technique. Yet, we are aware that due to wide range of aberration of the cornea and crystalline lens, not all patients will benefit from the Tecnis IOL, as it is not individually customised.

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