Case Report

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Visual outcomes after bilateral implantation of a new generation diffractive trifocal intraocular lens

Abstract

Cataract surgery today has become more of a refractive surgery with high patient expectations and demand of independence from glasses. Modern cataract surgery is characterized by obtaining precise postoperative target refraction with the premium intraocular lenses (IOLs) available today. The multifocal IOLs are designed to reduce the spectacle dependence after cataract surgery. Previously a variety of studies were performed that confirmed a significant improvement in uncorrected visual acuity after implantation of multifocal IOLs as compared to monofocal IOLs.[1–5] Initially multifocal IOLs that were designed were having a bifocal design which allowed the patient to have a good distance and near visual acuity post operatively, but near vision came at the expense of reduced contrast sensitivity.[6–8] Nowadays, due to increased use of computers the preference of spectacles has changed from near to intermediate distance. In this sense achieving an intermediate vision with an IOL is a good option. The IOL technologies in the latest times help in rehabilitating the distance and near visual acuities and also by incorporating a component of intermediate vision (ie, trifocal IOLs) to ensure spectacle independence.[9–11] The present study aims at assessing the performance of AT LISA tri 839MP trifocal diffractive IOL in terms of visual acuity and independence from spectacles. The other objectives are to assess changes in the distance, near and intermediate visual acuities, contrast sensitivity postoperatively and plotting the defocus curves.

Keywords cataract surgery, IOLs, visual acuity testing, refractive surgery, corneal astigmatism

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Introduction

The IOL design

The AT Lisa tri 839MP is a single piece preloaded diffractive multifocal IOL which has a length of 11.0 mm and a 6.0 mm biconvex optic. It has a foldable hydrophilic acrylic structure with a water content of 25% and hydrophobic surface properties. The surface is divided into main zones and phase zones. Its diffractive structure has a soft transition of the phase zones between the main zones. The entire optic diameter is covered by the diffractive zones (Figure 1). The optic of the IOL consists of a central 4.34 mm trifocal zone and a peripheral bifocal zone from 4.34 to 6.00 mm. The aspheric optic corrects spherical aberrations of the typical cornea and the asphericity of the IOL is -0.18 mm. The IOL has a trifocal anterior surface and provides an addition of 3.33 D for near and of 1.66 D for intermediate distance. The design of the IOL allocates 50.0% of light to distance, 20.0% to intermediate and 30.0% to near with overall efficiency of global light transmittance is 85.7%. The IOL is not dependent on pupil diameters up to 4.5 mm and provides adequate visual performance under all lighting conditions. It has a 4-haptic design with an angulation of 0º and a 360º square edge to prevent posterior capsule opacification formation.

Study design

The study was conducted between June 2019 and December 2019

Inclusion criteria

Patients with bilateral age-related cataract above the age of 40, presenting to the outpatient department of a tertiary eye care hospital in south India were included in the study who gave consent for the same.

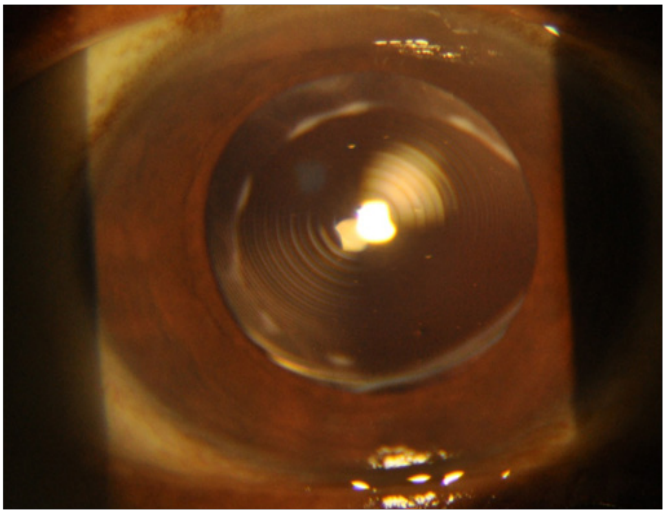

Figure 1 Implanted Trifocal intraocular lens.

Exclusion criteria

Eyes with previous ocular trauma, coexistent ocular pathologies such as diabetic retinopathy, age-related macular degeneration, glaucoma, pseudoexfoliation, corneal guttae, corneal astigmatism of more than 1.50D were excluded from the study.

Preoperative evaluation

A comprehensive ophthalmic evaluation was performed in consenting patients before cataract surgery which included uncorrected (DUCVA) and best-corrected (DBCVA) distance visual acuity using the Snellens Visual acuity chart which was converted to logarithm of the minimum angle of resolution (DUCVA logMAR and DBCVA logMAR), intermediate visual acuity (IUCVA) logMAR at 66 cm by Goodlite Visual Acuity chart and near visual acuity uncorrected near visual acuity (NUCVA) and best corrected near visual acuity (NBCVA) at 33 cm using the Snellen near visual acuity charts monocularly. A slit lamp evaluation was performed after dilatation to grade the cataract using the LOCS III cataract grading system, Goldmann applanation tonometry was used to calculate the intraocular pressure, optical biometry was performed using the NIDEK optical biometry system, and IOL power calculation was done using the SRK-T formula.

Surgical technique

A single surgeon performed all cataract surgeries via a 2.8-mm clear corneal incision (temporal/superior) using the phacoemulsification system. After the incision, an approximately 5mm capsulorrhexis was made and the nucleus was fragmented using chopping techniques and emulsified, followed by cortical clearance and the IOL of appropriate power was implanted in the bag. A thorough anterior chamber wash was done at the end of surgery to avoid any residual viscoelastics. Postoperatively, patients were treated with tapering dose of topical steroids for 1 month and antibiotics for 1 week.

Postoperative examination

At 1-month and 3-month follow-up period, patients underwent visual acuity testing as mentioned before. Additionally contrast sensitivity was recorded. At the third-month follow-up, near, intermediate and distance vision was tested and spectacle dependence for daily activities was asked. The defocus curve was plotted using Snellens Visual acuity chart at a distance of 6 meters. Lenses from +1.5 D to -3.50 D in 0.50 D steps were placed in each eye and the value of visual acuity was recorded. This information was represented in a graphical form using spherical blur in 'x' axis and visual acuity in 'y' axis.

Statistical analysis

Statistical analysis of the data was performed using SPSS for Windows software (version 19.0, SPSS, Inc.). All continuous variables were presented as means with standard deviation or median. The data that was not normally distributed the non-parametric test Wilcoxon sign rank test is used to see the mean change between the preoperative and post-operative variables.

Results

The study included 32 eyes of 16 patients. There were 9 men (57%) and 7 women (43%). The IOL power was calculated using SRK-T formula. The mean IOL power implanted was 20.44 diopters±3.40 (SD) ranging between 11 and 26. Tables 1&2 shows patients' baseline demographic, refractive and biometric characteristics.

Visual acuity

Differences between preoperative and postoperative distance, intermediate and near visual acuities was statistically significant ($p < 0.01$). The median rank logMAR DUCVA improved from 0.69±0.55 to 0.03±0.067 and logMAR DBCVA improved from 0.19±0.36 to 0.01±0.05 with a statistically significant difference ($p < 0.001$) by Wilcoxon sign rank test. Similarly the logMAR IUCVA and NUCVA median ranks showed a statistically significant difference between the preoperative and post operative values by Wilcoxon sign rank test with p-value <0.001. The defocus curve plotted for each patient showed a consistent visual acuity from 0 to -1.5 D showing a continuous and acceptable visual acuity at all distances. The contrast sensitivity 3 months post operatively was found to have a mean 1.59±0.17 log units at a medium to high spatial frequency. Spectacle independency was assessed by asking the use of spectacles for the daily activities like watching television, computer screens and reading books and newspaper. Only 2 patients (12.5%) had given the history of using spectacles for distance. For intermediate and near visual activities 100% spectacle independency was noted.

Table 1 Patient's baseline demographic preoperative refractive and biometric characteristics

Parameter	Mean± SD	Range
Age	58.38±8.8	39.68
SE	2.04± 2.01	1.1.75
K1	44.66± 1.56	42.48
K2	44.52± 1.50	42.47
AL(mm)	23.31± 1.2	22.26
ACD	3.13± 0.36	2.4
IOL	20.44± 3.40	11.26
DUCVA(logMAR)	0.69± 0.55	0.2
DBCVA(logMAR)	0.19± 0.36	0.2
IUCVA (logMAR)	0.80±0.15	0.1
NUCVA (Median)	N24	

Table 2 Post operative changes

Parameter	Mean± SD	Range
DUCVA(logMAR)	0.03± 0.07	0.0
DBCVA(logMAR)	0.01± 0.05	0.2
IUCVA (logMAR)	0.00±0	0
NUCVA (Median)	N6	
SE	-0.32± 0.075	0.0
CS	1.59± 0.17	1.2

Discussion

Multifocal IOLs were basically designed for improving vision at different distances by increasing the depth of field in the eye[12]. There are different approaches to achieve this depending on the particular IOL model. The principal goal of using these IOLs is to provide the best levels of spectacle independence.[5] The most frequently used designs up to now have been refractive, diffractive, or a combination of both. Although multifocal IOLs have greatly improved in recent years, but one of their weakest points is the inability to provide good intermediate vision. This lead to the introduction of trifocal models which could help improves intermediate vision. In the present study, there was a significant improvement in the logMAR DUCVA (0.03±0.07)and logMAR DBCVA(0.01±0.05). This is consistent with previous studies on trifocal lenses. Cochener et al.[13] studied 90 eyes

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implanted with Finevision IOL(Physiol S.A.) which showed binocular logMAR UDVA 0.02±0.09. Similarly Sheppard et al.[14] and Alio et al.[15] found significant improvement in the post operative UDVA. Mojzis et al.[16] found excellent outcomes in UDVA after 6 months of implantation of AT LISA tri 839MP IOL with a mean logMAR UDVA -0.03. Mendicute et al.[17] reported an improvement from 0.44 logMAR±0.30 to 0.02 logMAR ±0.10. Gundersen et al[18] did a comparative study of two types of trifocal lenses The Fine Vision IOL(PhysIOL, Liege, Belgium)and AcrySof Panoptix IOL (Alcon,TX,USA) which showed a postoperative uncorrected VA at 4 meters -0.04logMAR±0.07 and 0.05logMAR±0.07 respectively. Miyajima et al.[19] found a logMAR VA to be -0.104±0.10. The NUCVA in our study improved from a median value to N24 to N6 with statistically significant change (p <0.001). It is consistent with the previous studies done on the trifocal IOLs.[13–17,19]

Intermediate visual acuity is important in today's world where there is increased usage of computers and tabs. It is also important for other daily routine activities like shopping and reading the dashboard of the car. In our study we have found a significant improvement in the logMAR IUCVA at 66 cm from 0.80 ±0.15 to 0.00 ±0 (p<0.001). Similar to this, Mojzis et al.[16] found a mean logMAR UIVA of 0.08 after 6 months of implantation of trifocal IOL. Alio et al.[15] and Mendicute et al.[17] found similar improvements in the logMAR UIVA 0.18 and 0.09 respectively.

The defocus curve showed a continuous and consistent visual acuity for 0 to -1.50D corresponding to distances 6 meters and 1 meter. This is consistent to previous study by Mojzis et al.[16] The main limitation of the study is the lack of objective measurement of the higher order aberrations induced by the IOL. Previous studies have shown that most multifocal IOL induced some amount of higher order aberrations such as coma and trefoil and these are pupil-dependent. Another limitation is that there are some standard questionnaires to record glare and halos which could have been used for the study; unfortunately, we have not used it. To summarize, the AT Lisa tri 839MP IOL which was designed to restore the visual function after cataract surgery provided excellent results in regards to uncorrected distance, intermediate and near visual acuities. This leads to spectacle independence and there is a high level of patient satisfaction.[20]

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Conflicts of interest

Author declares that there is no conflict of interest.

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