Original Article

Visual Outcomes and Patient Satisfaction after Unilateral Implantation of a Diffractive Trifocal Intraocular Lens to Treat Cataract

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Abstract

Purpose: To assess clinical outcomes and patient satisfaction after unilateral implantation of a diffractive trifocal intraocular lens (IOL) following phacoemulsification in unilateral cataract.

Patients and Methods: This retrospective case series study included six males and five females. Patients underwent phacoemulsification and unilateral implantation of a trifocal IOL (AT LISA tri 839 MP, Carl Zeiss Meditec, Jena, Germany). Visual acuity was evaluated at 1 month, 3 months, 1 year, and 2 years postoperatively. Monocular and binocular contrast sensitivity and patient satisfaction were evaluated at 2 years of follow-up using 25 item National Eye Institute visual functioning questionnaire (NEI VFQ-25).

Results: At 2 years, the mean uncorrected distance visual acuity was from 0.549 ± 0.32 to 0.021 ± 0.037 LogMAR, uncorrected intermediate visual acuity was from 0.544 ± 0.31 to 0.018 ± 0.045 LogMAR, and uncorrected near visual acuity was from 0.52 ± 0.30 to 0.022 ± 0.045 LogMAR showing a significant improvement in the operated eye. The VFQ-25 evaluation indicated that patients were satisfied with their outcomes. Also, Binocular contrast sensitivity measured by CSV1000 was similar to monocular contrast sensitivity.

Conclusion: Unilateral implantation of trifocal intraocular lens can be considered as a safe and viable option in presbyopic patients with unilateral cataract.

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Introduction

Multifocal diffractive intraocular lenses (IOLs) are designed to correct both near and distance vision and to reduce the spectacle dependency after cataract surgery [1,2].

Earlier studies have revealed that diffractive trifocal IOLs including AT LISA 839 MP, TECNIS Symfony, AcrySof IQ PanOptix and PhysIOL FineVision provide good distant, intermediate and near visual acuity with good contrast sensitivity and visual performance [3-7]. However, prior studies have emphasized mainly on bilateral trifocal presbyopia correction for better neuro-adaptation and stereopsis. There are some concerns that unilateral implantation of multifocal IOLs may lead to neuro-adaptation failure. The present study aimed to evaluate visual performance and patients' satisfaction following unilateral implantation of trifocal IOLs in individuals with presbyopic unilateral cataract. To our knowledge the present study is one of very few studies examining the use of trifocal IOLs unilaterally.

Patients and Methods

This case series study followed the tenets of the declaration of Helsinki and was approved by the Ethics committee of the Basir Eye Health Research Center. Written informed consent was obtained from each participant after explanation of the purpose, nature, procedures and potential risks of the study. Individuals with unilateral cataract who were seeking spectacle independence were enrolled in the present study from September 2014 to September 2016.

Patients with a history of previous ocular surgery in either eye, ocular inflammation, trauma, and any ocular pathology other than cataract were excluded. Patients with significant cataract in the fellow eye were also excluded.

Preoperative Examination

All individuals underwent a full preoperative ocular examination including manifest and subjective refraction, monocular uncorrected and corrected distance visual acuity test, intermediate and near visual acuity test, applanation tonometry, slit lamp biomicroscopy, funduscopy, corneal topography using orbscan (Bausch and Lomb, Rochester, NY, USA) and biometry using IOL master 500 (Carl Zeiss Meditec AG, Jena, Germany).

IOL

The AT Lisa tri 839 MP is a single-piece aspheric trifocal IOL. This IOL is made from 25 % hydrophilic acrylic material and has a hydrophobic surface. The overall diameter is 11.0 mm and the biconvex optic is 6.0 mm in diameter. The power ranges from 0.00 to 32.00 D with 0.50 D increments. The add powers are C 1.66 D for intermediate vision and C 3.33 D for near vision.

Cataract Surgery Technique

A single surgeon A.A performed cataract surgeries using a standard 2.2 mm temporal clear corneal incision and the Alcon Infiniti phacoemulsification system, with the patient under general anesthesia. A unilateral trifocal IOL (AT LISA tri 839 MP, Carl Zeiss Meditec AG, Jena, Germany) was implanted.

Postoperative Follow-up

Patients were examined at 1 day, 1 month, 3 months, 1 year, and 2 years after the surgery. Monocular and binocular uncorrected far visual acuity at 6 m (UDVA), intermediate visual acuity at 80 cm (UIVA) and near visual acuity at 40 cm (UNVA) were evaluated using a Snellen chart.

At 1 year followup, the patients were assessed for monocular and binocular visual acuity in far, intermediate and near distances and monocular and binocular contrast sensitivity

using CSV1000 (VectorVision, Dayton, Ohio, USA) at 2.5 meters in photopic condition for 4 frequencies (3,6,12,18) in cycles per degree (CPD).

Patient satisfaction and spectacle independence

To assess the satisfaction level at the 2 years follow-up visit, patients completed a questionnaire (The National Eye Institute Visual Function Questionnaire 25, 2000, NEI VFQ-25). The questionnaire included the questions pertaining to visual performance and difficulty in near vision for reading newspaper, shopping, computer working as well as symptoms such as glare, halo, ghost images, vision in photopic and mesopic condition and overall contentment with the surgery. To assess spectacle independence, patients were asked regarding the need for spectacle wear in near and distance activities (never, sometimes or always).

Statistical Analysis

Snellen visual acuities were converted to LogMAR. SPSS statistic software version 22 (IBM, Armonk, NY, USA) was used in statistical analysis. Chi-square test and paired t-test were used for analysis. P-values less than 0.05 were considered significant.

Results

In total, 11 eyes of 11 patients were evaluated. The mean age of six male and five female patients entering the study was 50.54 ± 11.42 years (range 34-70 years). No major intraoperative or postoperative complication occurred. Five patients were office workers, two were bank tellers, two were housewives, one was a farmer and one was a poet. Four eyes had senile cataract, two eyes had congenital cataract without amblyopia, and five eyes had posterior subcapsular cataract.

Table 1 shows near, intermediate and distant visual acuities pre and postoperatively. Preoperative and post operative mean corrected distance visual acuities (CDVA) were 0.387 ± 0.33 LogMAR and 0.013 ± 0.029 LogMAR, respectively. The mean uncorrected near visual acuity (UNVA) was 0.022 ± 0.045 LogMAR postoperatively. Target refraction was Plano. Preoperative and two-year postoperative mean spherical refraction were -0.34 ± 1.17 (range + 1.5 to - 2.5) and 0.09 ± 0.28 (range -0.25 to + 0.25) diopters, respectively. Mean cylinder was - 0.52 ± 0.43 (range 0 to - 1) preoperatively, and - 0.20 ± 0.20 (range 0 to - 0.5) diopters postoperatively. Mean uncorrected distance visual acuity (UDVA) was 0.119 ± 0.1 LogMAR and mean CDVA was 0.04 ± 0.06 LogMAR in the fellow eye of the patients. None of the patients had posterior capsular opacity (PCO) during this period.

Table 2 shows the postoperative results of photopic contrast sensitivity using CSV1000 for four measured different spatial frequencies. Contrast sensitivity was improved in the operated eye and binocular contrast sensitivity was similar to monocular contrast sensitivity. The mean total NEI VFQ-25 score was 90 out of 100 postoperatively at two years follow-up, where 0 indicated complete dissatisfaction and 100 indicated complete satisfaction. All patients became spectacle independent for near and distant activities.

Discussion

Our findings indicated that in a significant percentage of cataract patients, unilateral implantation of a trifocal IOL resulted in spectacle independence and satisfactory visual outcomes. Notably, none of the subjects asked

Table 1: Near, intermediate and distant visual acuities pre and post operatively

	Visual Acuity (LogMAR)		
	Pre operation (mean ± SD)	Post operation (mean ± SD)	P value*
UDVA	0.549 ± 0.32	0.021 ± 0.037	< 0.001
CDVA	0.387 ± 0.33	0.013 ± 0.029	0.004
UIVA	0.544 ± 0.31	0.018 ± 0.045	< 0.001
CIVA	0.423 ± 0.36	0.018 ± 0.045	0.004
UNVA	0.52 ± 0.30	0.022 ± 0.045	< 0.001
CNVA	0.395 ± 0.33	0.013 ± 0.029	0.004

* T-Test

UDVA: Uncorrected Distance Visual Acuity, CDVA: Corrected Distance Visual Acuity, UIVA: Uncorrected Intermediate Visual Acuity, CIVA: Corrected Intermediate Visual Acuity, UNVA: Uncorrected Near Visual Acuity, CNVA: Corrected Near Visual Acuity

Table 2: Comparison of pre and post operative contrasts sensitivity for frequencies of 3,6,12 and 18

	Pre operation (mean ± SD)	Post operation (mean ± SD)	P-value*
Monocular CPD_3	1.02 ± 0.20	1.51 ± 0.008	< 0.001
Monocular CPD_6	1.142 ± 0.21	1.81 ± 0.009	< 0.001
Monocular CPD_12	0.85 ± 0.21	1.419 ± 0.017	< 0.001
Monocular CPD_18	0.471 ± 0.16	0.872 ± 0.15	< 0.001
Binocular CPD_6	1.435 ± 0.088	1.51 ± .032	0.024
Binocular CPD_12	1.74 ± 0.11	1.81 ± 0.009	0.074
Binocular CPD_18	1.37 ± 0.093	1.42 ± 0.016	0.054
Binocular CPD_6	0.853 ± 0.091	0.877 ± 0.15	0.683

* T-Test

CPD: Cycles Per Degree

for IOL removal or were bothered by optical side effects after two years.

In terms of visual acuity, all major components of visual function improved postoperatively. The NEI VFQ-25 survey exhibited enhanced postoperative quality of vision.

Jacobi et al.[8], evaluated the outcomes of a zonal-progressive optic three-piece multifocal IOL (AMO Array, SSM-26NB; Allergan, Irvine, CA) implantation in pre-presbyopic individuals with unilateral cataract. Multifocal IOL implants resulted in superior UNVA, lower spectacle dependency and better stereopsis compared with monofocal IOLs. Bilbao-Calabuig et. al.,[9] compared the benefits of bilateral implantation of two trifocal IOLs, FineVision MicroF and AT Lisa tri 839 MP. They reported spectacle independence was similar between the two IOLs and near, intermediate, and distance visual outcomes were satisfactory, although the AT Lisa tri 839 MP demonstrated slightly better refractive outcomes.

We evaluated the visual outcomes of unilateral implantation of AT LISA 839 MP trifocal IOL

with respect to various visual and refractive outcomes as well as spectacle independence. Target refraction was Plano and all postoperative spheres were within ± 0.25 diopter. IOL calculation with SRK T formula was appropriate, similar to another study that found 86.67 % of postoperative SE to be within ± 0.5 Diopter with the same trifocal IOL [10].

The restoration of distance, intermediate and near visual function found in our study was accompanied with a good photopic contrast sensitivity comparable to other studies [10–12]

Conventional multifocal IOLs are bifocal and depend on two focal points that represent the two working distances (far and near), at which they produce a sharp image on the retina. The intermediate working distance, such as that used for computer work, falls between the near and far points that results in poor intermediate visual acuity [3,5,6,10,13].

Recently, trifocal IOLs are widely utilized for patients undergoing cataract or lens exchange surgery. Multifocal IOLs provide spectacle independence to patients who have high functional visual expectations and requirements. Some studies report better visual outcomes from diffractive trifocal IOLs compared with monofocal IOLs. The distance visual outcomes reported in our series were consistent with those reported by others (LogMAR UDVA and CDVA of approximately 0.0) with identical trifocal IOL models [3,7]. Meanwhile, some reports suggest that the UDVA values in two models of trifocal IOLs (fully trifocal and combination of two bifocal patterns) are rather worse than those obtained with the trifocal IOLs [3,6].

Several factors impact reported optical effectiveness of the trifocal IOL and differences in distance visual outcomes including age, sample size, non-optimized selection of the IOL constants, or differences in the clinical protocols in measuring the visual acuity. In our study, the predictability of visual acuity correction was excellent, with a mean postoperative uncorrected distance, intermediate and near visual acuity of approximately 0.04. This confirms the refractive precision of the correction achieved with the evaluated IOL, suggesting that an appropriate constant was defined for the power calculations of IOL.

In a study by Alio et al., [14] mean postoperative monocular UDVA of 0.18 ± 0.13 LogMAR was reported with a trifocal IOL based on the combination of two bifocal diffractive patterns (FineVision, physIOL, Liege, Belgium). Better outcomes compared to Alio et al., study was reported in another study by Cochener et al., [12] who used the same trifocal IOL.

Kretz et al., [11] examined implantation of trifocal IOL AT LISA 839 MP and found 0.00 LogMAR in binocular uncorrected intermediate and near visual acuity in 76 eyes 3 months after surgery with high levels of patients satisfaction.

Regarding near and intermediate visual outcomes, our results (LogMAR UNVA and UDVA of approximately 0.04) were consistent or better than those reported in previous studies evaluating the same model of trifocal IOL[3,7] and other trifocal IOL models [1,4,5,10]. In a study by Cionni et al.[15], comparing the visual outcome of unilateral versus bilateral implantation of multifocal IOLs after 6 months of follow up, 75 % of patients in unilateral group were satisfied with their vision and 56 % achieved spectacle independence, showing no statistically significant difference with the bilateral group. Limitations of Cionni et al. [15], study were usage of a traditional type of multifocal IOL and short followup period. Another study on multifocal IOLs by Jacobi et al., [8] compared 54 patients receiving multifocal

IOL (Array SA40-N, Allergan, Irvine, CA) with 41 patients receiving monofocal IOLs after unilateral phacoemulsification and reported significant difference in spectacle dependency between the two groups (51 % of the monofocal group requiring an additional plus add for near tasks compared with 9 % in the multifocal group), where stereopsis was superior in the multifocal group. Moreover, Hayashi et al., [16] compared binocular visual function between two groups of patients with unilateral cataract (30 patients with unilateral multifocal IOL implantation (Restore SN6AD1, Alcon) and 30 patients with monofocal IOL implantation. They reported better binocular near and intermediate visual acuity and spectacle independence in the multifocal group.

The present study was limited by its small sample size and lack of a control group. Despite our limitations, all of participants showed a UDVA of 20/30 or better and 63.6 % (7 patients from 11) had a UDVA of 20/20 or better. Furthermore, all the subjects had UNVA J2 or better and 72.72 % (8 patients from 11) had UNVA J1 with good contrast sensitivity and 72.72 % (8 patients from 11) recommended this IOL to others.

Conclusion

Unilateral implantation of trifocal intraocular lens might be considered as a safe and viable option in presbyopic patients with unilateral cataract. Future studies are required to further assess the outcomes of unilateral implantation of these IOLs for patients with unilateral cataract at presbyopic age.

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Footnotes and Financial Disclosures

Conflict of Interest:

The authors declare no conflict of interest with the subject matter of the present manuscript.