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Case Report

# Enhancing Intermediate Vision in Different Working Distances with a Novel Enhanced Depth of Focus Intraocular Lens (EDOF)

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## Abstract

We present a case of a 77 year old male patient complaining of decreased visual acuity, difficulty night driving and issues reading the TV at a distance due to binocular subcapsular posterior cataract. To target the different intermediate distances the patient requested an enhanced depth of focus intraocular lens (AT LARA, Carl Zeiss Meditec, Germany) to be implanted binocularly during uneventful cataract surgery. Corrected distance visual acuity [logMAR] increased on OD and OS from 0.4 and 0.3 to 0.0 and 0.1. Three months postoperative binocular UDVA, DCIVA in 90 cm, 80 cm and 60 cm were 0.0, -0.2, 0.2 and 0.2 respectively. In the patient questionnaire, and the halo and glare simulator, the patient did not report any photic phenomena and was very satisfied.

**Purpose:** To assess visual outcomes following implantation of an enhanced depth of focus intraocular lens (IOL) and to analyze the correlation with patient satisfaction and their ease of performing daily tasks.

***Keywords:*** *IOL; Cataract; Emmetropia; Presbyopia; EDOF*

## Introduction

Several clinical studies showed that visual loss is considered to have a strong impact on the quality of life during the aging process.

Loss of accommodative power, known as presbyopia, occurs when the lens loses the functional ability to flex, which results is diminished ability to focus up close. This steady loss of accommodation happens during the age of 40 to 60 years and is coupled with difficulty in restoring focus from far to near [1]. Presbyopia can be corrected by spectacles, contact lenses, multifocal intraocular lenses and corneal refractive surgery. Based on a cycle of spectacle replacement every 2 - 5 years, between 134 and 335 million spectacles would be required each year to meet this need [2].

Cataract surgery is the most common surgical procedure performed. As modern technology advances and patient expectations increase, cataract surgery has also become more and more a refractive procedure in which ophthalmologists now have the ability to target emmetropia for spectacle independence in distance [3-5]. Currently, there are different approaches in IOL optic design to compensate for the loss of accommodation [6]. One approach is to provide the visual system with two simultaneous images, either monocularly using multifocal IOLs or binocularly through monovision [5]. In monovision, one eye is optimized for distance vision and the other eye for near vision.

Multifocal IOLs use a refractive or diffractive technology that attempts to give patients a full range of vision (near, distance and intermediate) and to increase their independence from spectacles after surgery. Excellent clinical outcomes have been reported with different IOLs [6-11]. Patient selection is very crucial in order to avoid patient dissatisfaction and secondary procedures for IOL exchange. Until recently, most multifocal IOLs could provide satisfactory vision for far and either near or intermediate distance [6-11]. They were actually bifocal lenses. The most recent multifocal IOLs with improved optics have three distinct focal points and have enhanced intermediate distance, giving the patient a full range of vision [12-19]. A new development for presbyopia correction are Extended Depth of Focus (EDOF) IOLs. By creating a focus tube rather than distinct focal points, they are designed to create less visual side effects by restoring visual function from distance to near [6,20-22].

## Case Report

A 77 year old male patient presented in our outpatient department due to an overall decrease in vision over the past year, difficulty driving at night, and difficulty reading the TV screen and iPad at a normal distance. His main focus was on intermediate distances ranging from 60 cm till far with the acceptance to wear spectacles for close by reading.

During the examination a posterior subcapsular cataract on both eyes could be found without any other pathologies to decrease visual acuity. Functional Results showed a corrected distance visual acuity (CDVA) for OD and OS of 0.4 [logMAR] and 0.3 respectively.

The patient underwent preoperative examination and counseling for cataract surgery. As a preoperative assessment, when the decision to operate was taken, the patient underwent a complete examination, including manifest refraction, corneal tomography (Pentacam HD, Oculus, Germany), IOP, slit lamp examination, biometry (IOLMaster 700, Carl Zeiss Meditec, Germany) and fundoscopy. Target refraction was closest to emmetropia.

For ocular biometry, the IOLMaster700 was used and the IOL powers were calculated using the Haigis formula (Table 1). For implantation the EDOF IOL AT LARA 829MP (Carl Zeiss Meditec, Germany) was chosen (Table 2).

| [logMAR] | Pre-Op | | | Post-Op | | |
|---|---|---|---|---|---|---|
| | OD | OS | OU | OD | OS | OU |
| CDVA | 0.4 | 0.3 | 0.3 | 0.0 | 0.1 | 0.0 |
| UDVA | | | | 0.0 | 0.20 | 0.0 |
| DCIVA (90 cm) | | | | 0.3 | 0.3 | -0.2 |
| DCIVA (80 cm) | | | | 0.2 | 0.20 | 0.2 |
| DCIVA (60 cm) | | | | 0.2 | 0.20 | 0.2 |
| DCNVA (40 cm) | | | | 0.6 | 0.5 | 0.5 |
| UNVA (40 cm) | | | | 0.5 | 0.5 | 0.5 |

***Table 1:*** *Pre- and postoperative functional Results (CDVA: corrected distance visual acuity, UDVA: Uncorrected Distance Visual Acuity; DCIVA: Distance Corrected Intermediate Visual Acuity; DCNVA: Distance Corrected Near Visual Acuity; UNVA: Uncorrected Visual Acuity [logMAR]*

| | | Refractive Results | | | | IOL Master 700 | | | | | IOL Calculation | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | sph [D] | cyl [D] | A [°] | SE [D] | K1 [mm] | Axis | K2 [mm] | Axis | AL [mm] | IOL SE [D] | Target refraction [D] | △ Target Refraction [D] |
| pre-Op | OD | 1.75 | -1.75 | 179 | 0.875 | 7.59 | 117 | 7.55 | 27 | 23.13 | 21 | -0.21 | |
| | OS | 4 | -4 | 37 | 2 | 7.55 | 35 | 7.49 | 125 | 23.13 | 20.5 | -0.02 | |
| post-Op | OD | 0 | -0.25 | 115 | -0.125 | 7.61 | 127 | 7.58 | 60 | 23.01 | | | -0.085 |
| | OS | 0.25 | -0.75 | 64 | -0.125 | 7.51 | 37 | 7.45 | 150 | 22.91 | | | 0.105 |

***Table 2:*** *Functional Results, Biometry Data and Target Refraction.*

Surgery was performed with topical anaesthesia with two days between each eye. The main incision was performed with a 2.00 mm trapezoid blade at the 12o' clock position and both sideports with a 1.0 mm MVR-blade 90° from the main incision. After filling the anterior chamber with cohesive OVD (Healon, Johnson and Johnson, USA) capsulorhexis was performed with a 23G micro-forceps. After hydrodissection and hydrodelineation phacoemulsification was performed in a stop and chop technique and followed by bimanual cortex removal and polishing of the capsule. The IOL was implanted with the Bluemixs injector (Carl Zeiss Meditec, Germany) with the irrigation port and continuous BSS flow through the side port. The IOL unfolded and centered itself without complications. Afterwards the wounds were hydrated with BSS solution and the anterior chamber was washed with cefuroxime. Postoperative dexamethasone and gentamicin eyedrops were administered 5 times daily for one week.

Three months postoperative we evaluated visual acuity monocular and binocular (UDVA, CDVA, DCIVA (90 cm), DCIVA (80 cm), DCIVA (60 cm), DCNVA (40 cm) and UNVA (40 cm) (Table 1), functional results (Table 2) Defocus curve (Figure 1) patient satisfaction (McAlinden), Halo and Glare Simulation (Halo and Glare Simulator Software, Carl Zeiss Meditec, Germany) (Figure 2) and HD Analyzer (Visiometrics, USA) measurements.

The binocular defocus curve analysis showed a visual acuity of 0.3 logMAR or better in a range of -2.5 D to +1.5 D and of 0.1 logMAR or better in a range of -1.5 D to +0.5 D (Figure 1). Those results and absence of visual side effects, especially for different intermediate distances ranging from 60 to 90 cm were the main reason for the patient's high satisfaction.

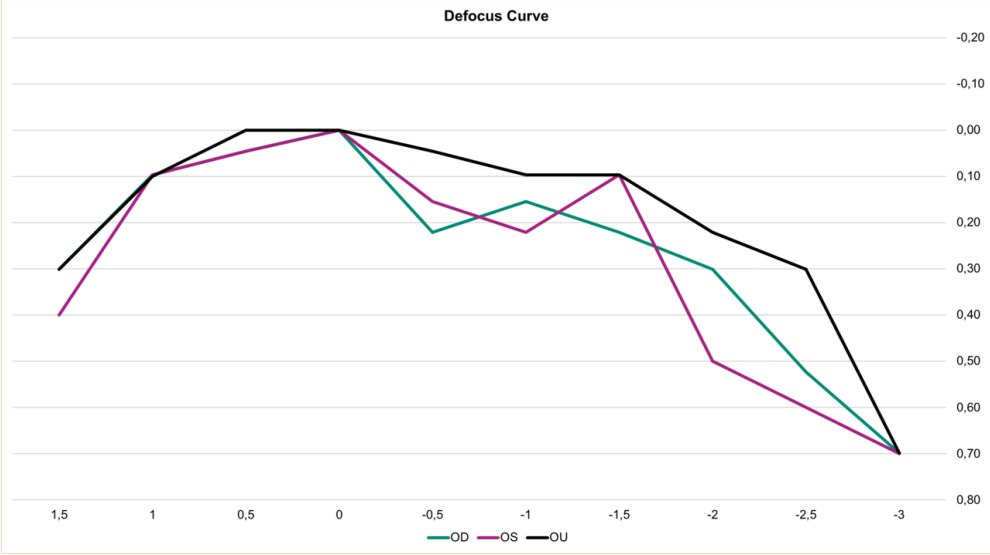


***Figure 1:*** *Defocus curve analysis.*

Postoperative and in order to evaluate the patient's satisfaction after surgery, a McAlinden questionnaire inquiring about the quality of vision for far, intermediate and near distance, the existence and severity of halos and glare were evaluated. All questions on side effects were negated and the patient reported absolute spectacle independence. The corresponding Halo and Glare simulator settings also showed no values for photic phenomena (Figure 2).


***Figure 2:*** *Halo and Glare Simulator.*

## Discussion

The AT LARA 829MP is one of the few enhanced depth of focus (EDOF) IOLs based on a diffractive optical pattern [20-22].

This new approach for presbyopia treatment rather provides a range of vision from distance to intermediate with still functional near visual acuity compared to a monovision approach or typically used multifocal IOL approaches.

With the number of potential methods to correct for presbyopia, and an increase in patient expectations, the specific goals of the patient need to be taken into account to find the optimum solution. Optical design for individual patient care and careful patient selection is an essential component of surgical success and determining the patient's degree of satisfaction.

It is estimated that with the use of this EDOF IOL, overall patient satisfaction would be achieved, due to spectacle independence in distance to intermediate vision and good night vision being achieved.

Several previous studies evaluated clinical outcomes with implantation of trifocal intraocular lens (IOL), specifically to evaluate visual and refractive outcomes, contrast sensitivity, and quality of vision after cataract surgery [12-18].

Regarding the results, we will compare the AT LARA 829MP with trifocal intraocular lenses (IOLs) such as; the AT LISAtri 9-839MP IOL, the trifocal Fine Vision IOL,

Law., *et al*. [23] evaluated the AT LISA tri 839 and found mean values of 0.05 ± 0.07 and -0.02 ± 0.05 logMAR for monocular UDVA and CDVA, respectively. Mean values of 0.16 ± 0.07, 0.12 ± 0.07, and 0.16 ± 0.07 logRAD were obtained for binocular UNVA, CNVA, and DCIVA, respectively. Almost all patients were satisfied with their distance, intermediate, and near vision [23].

Alio., *et al*. [24] evaluated the trifocal diffractive Fine Vision IOL and showed monocular visual outcomes (logMAR) at 6 months post-operatively of UDVA 0.18 ± 0.13, UNVA 0.26 ± 0.15, and UIVA 0.20 ± 0.11. With the best distance correction, the visual outcomes were 0.05 ± 0.06 for CDVA, 0.16 ± 0.13 for DCNVA, and 0.17 ± 0.09 for DCIVA [24].

Compared to the TECNIS Symfony IOL (Johnson and Johnson, USA), which is also based on a diffractive pattern, a similar result was achieved in this one case.

## Conclusion

In conclusion, this case demonstrates the feasibility and numerous advantages using the new AT LARA 829MP IOL which provides:

1. An additional option for individualized patient care.
2. Enhancement of intermediate visual acuity.
3. Reduced photic phenomena and increased optical performance of vision related daily activities for both distance and intermediate range.

However, studies with a greater number of patients and longer follow-up periods are needed to establish the long-term outcomes and to address most of the limitations of this case report.

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