15 Multifocal Intraocular Lenses: AT LISA 809 Diffractive Bifocal Intraocular Lens

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15.1 Introduction

A patient's visual performance after cataract surgery is highly dependent on the type of intraocular lens (IOL) implanted. Several IOL designs are based on diffractive and refractive optical principles [1–3] with the goal of improving postoperative near vision and reducing spectacle dependence after crystalline lens or cataract removal [4]. Diffractive IOLs are one specific type of multifocal lenses, which are based on the Huygens Fresnel's principle. Specifically, diffractive IOLs present concentric rings that form two or three primary focal points [5]. This optical behaviour of the lens allows an effective far intermediate and near visual restoration. A kind of this type of diffractive bifocal IOL is the AT LISA 809 [6, 7].

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15.2 The AT LISA 809 IOL

The AT LISA 809 [6–10] (Carl Zeiss Meditec AG) is an aspheric bifocal biconvex diffractive IOL. This lens is a single-piece IOL with an optic diameter of 6.0 mm and an overall diameter of 11.0 mm. The surface is divided into main zones and phase zones; the phase zones assume the function of the steps of diffractive power of the main zones. The IOL power responsible for distance vision is refractive and diffractive at the same time. The two focal points are created by phase zones on the anterior surface of the IOL. The incident light is distributed with 65% to distance focus and 35% to near focus. The near vision add of this lens is +3.75 D over the distance power [6, 7].

15.3 Surgery

All surgeries are performed using a sutureless standard 2.2 mm mini-incision technique or biaxial microincision (MICS) phacoemulsification. All patients receive topical anaesthesia before and adequate dilation is obtained with intracameral mydriasis. The incision to implant the lens is placed on the axis of the positive corneal meridian. The AT LISA 809 IOL is implanted using a specific hydraulic injector (BLUEMIXS® 180, Zeiss). Postoperative, topical therapy includes a combination of topical antibiotic and steroid agents prescribed to be applied.

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15.4 Clinical Experience

15.4.1 Methods

We have studied the outcomes of the lens in 48 eyes of 24 bilateral cataract patients with age ranging between 47 and 77 years who were implanted with AT LISA 809 IOL [11–13]. All patients received topical anaesthesia before and adequate dilation was obtained with intracameral mydriasis.

All patients had a full ophthalmological examination preoperatively, including the evaluation of the refractive status, distance and near visual acuities, slit-lamp examination, tonometry and funduscopy. Distance visual acuity was measured with the Snellen charts and the near visual acuity was measured with Radner Reading Charts [14, 15] (Spanish validated version). Other specific examinations were also performed: corneal topography (CSO, Costruzione Research Institute), ocular aberrometry (COAS, Wavefront Sciences, Inc.), biometry (IOL Master, Zeiss) and contrast sensitivity (CST 1800, Vision Science Research).

Postoperatively, patients were evaluated during 6 months. The postoperative examination protocol at 1, 3 and 6 months was identical to the preoperative protocol, with the additional measurement of the defocus curve and the ocular optical performance with the OQAS system (Optical Quality Analysis System, Visiometrics SL).

15.4.2 Results

15.4.2.1 Visual Outcomes and Refractive Analysis

Table 15.1 summarizes visual outcomes obtained with AT LISA 809 IOL. At 6 months after surgery, a statistical significant improvement was observed in the uncorrected distance visual acuity (UDVA), uncorrected near visual acuity (UNVA) and distance corrected near visual acuity (DCNVA) ($p < 0.01$). These results confirm the efficacy of the IOL to obtain a good visual acuity at near and far distances. No significant changes were found in the corrected distance visual acuity (CDVA) ($p = 0.72$). The improvements in uncorrected distance and near visual acuities confirm the efficacy of the IOL for visual rehabilitation after cataract surgery. This was consistent with various reports using AT LISA 809 IOL [7, 9, 10, 12, 16–20]. These outcomes were similar to other diffractive IOLs [19, 20].

The spherical refraction was reduced significantly after surgery ($p < 0.001$). The cylinder was not modified significantly with surgery ($p = 0.348$) (Table 15.1).

Table 15.1 Preoperative and postoperative visual outcomes

Mean ± SD	Preoperative	3 Months	6 Months	*P* value pre-op – 6 months
LogMAR UDVA	0.61 ± 0.39	0.09 ± 0.11	0.12 ± 0.16	<0.01
SPHERE (D)	2.61 ± 2.42	0.16 ± 0.56	0.32 ± 0.38	<0.01
CYLINDER (D)	−0.73 ± 0.62	−0.55 ± 0.38	−0.55 ± 0.36	0.35
LogMAR CDVA	0.03 ± 0.09	0.01 ± 0.03	0.03 ± 0.09	0.75
LogMAR UNVA	0.82 ± 0.33	0.09 ± 0.11	0.16 ± 0.13	<0.01
LogMAR DCNVA	0.59 ± 0.21	0.11 ± 0.10	0.14 ± 0.13	<0.01
LogMAR CNVA	0.17 ± 0.30	0.08 ± 0.08	0.13 ± 0.13	0.72

Abbreviations: *SD* standard deviation, *D* dioptres, *UDVA* uncorrected distance visual acuity, *CDVA* corrected distance visual acuity, *UNVA* uncorrected near visual acuity, *DCNVA* distance corrected near visual acuity, *CNVA* corrected near visual acuity

15.4.2.2 Contrast Sensitivity

Figure 15.1 shows an improvement in contrast sensitivity with the surgery ($p \leq 0.01$). This seems logical because the cataractous crystalline lens was removed and replaced by a new transparent lens. During the rest of follow-up, significant changes were only found in photopic contrast sensitivity for the spatial frequencies of 3 and 6 cycles/degree in the postoperative period going from 3 to 6 months ($p \leq 0.038$), and in the scotopic contrast sensitivity for 3 cycles/degree in the same period ($p = 0.038$). When the contrast sensitivity obtained with this IOL was compared with other multifocal IOLs and with the trifocal model of the same platform no differences were reported [20, 21].

15.4.2.3 Defocus Curve

Figure 15.2 shows the mean defocus curve for eyes implanted with AT LISA 809. The profile of the curve shows 2 peaks of maximum vision for defocus levels of 0.00 D and −2.50 D, with a visual acuity decrease for defocus levels corresponding to intermediate vision, similar to other investigations with diffractive bifocal IOLs [7, 9, 13, 22, 23].

15.4.2.4 Optical Quality Analysis

The analysis of the ocular PSF and MTF showed a significant reduction of the Strehl ratio between 1 month (0.16 ± 0.04) and 6 months (0.13 ± 0.04) after surgery ($p < 0.01$). Accordingly, the cut-off spatial frequency for the MTF also decreased

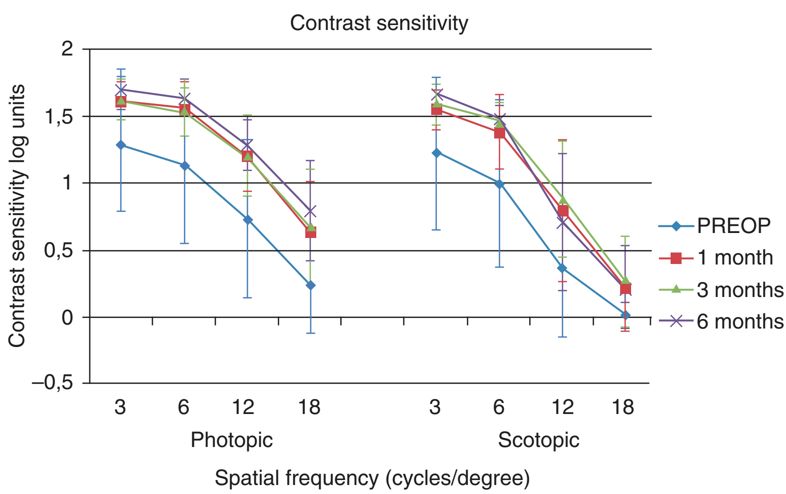

Fig. 15.1 Evolution contrast sensitivity (preoperative, 1 month, 3 months and 6 months) in photopic and scotopic conditions for all frequencies (3, 6, 12 and 18 cycles/degree)

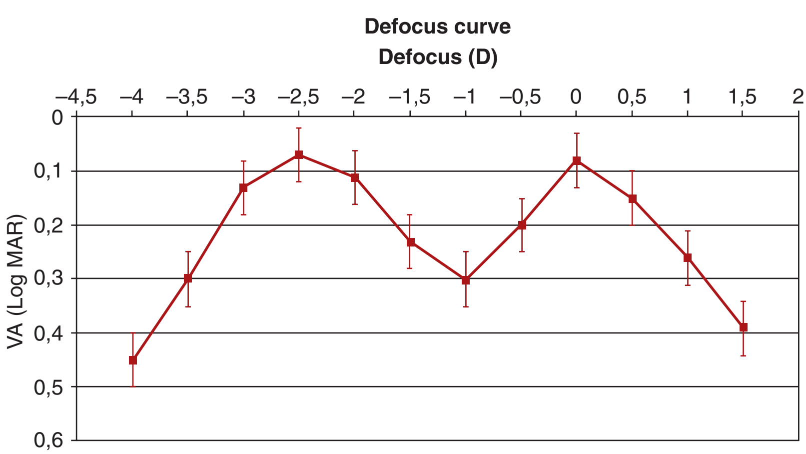

Fig. 15.2 Mean defocus curve obtained with the AT LISA 809 IOL

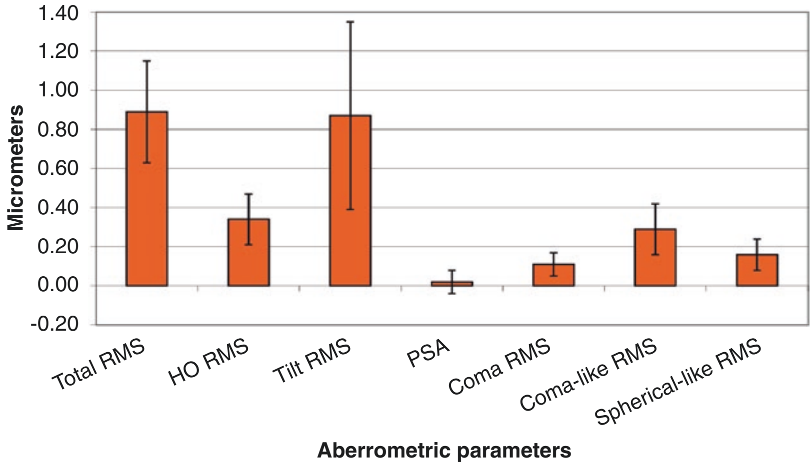

Fig. 15.3 Mean postoperative intraocular aberrations calculated by means of the VOL-CT software of the AT LISA 809 IOL

significantly from 1 month (24.91 ± 7.19 cycles/degree) to 6 months (18.38 ± 6.43 cycles/degree) after surgery ($p < 0.01$). These outcomes were better than other monofocal IOLs [24] and lower than another study with this IOL model [25].

Besides the postoperative intraocular optical quality, Fig. 15.3 shows the analysis of the intraocular postoperative aberrations; as shown no significant amounts of these parameters were detected. In a previous study [13] it was observed that a monofocal IOL had higher spherical-like RMS and primary spherical aberrations than the AT LISA 809, and in this same study, no differences were detected in the intraocular aberrometric parameters between the AT LISA 809 and the ReSTOR SN6AD3.

Also, the intraocular Strehl ratio obtained with the VOL-CT software was 0.30 ± 0.05; this parameter was compared with a monofocal and with the ReSTOR SN6AD3 IOLs, and no differences among groups were found [13]. Therefore, the AT LISA 809 provides a similar optical quality behaviour of monofocal IOLs.

15.4.2.5 Quality of Vision and Patient Satisfaction

A previous study [19] evaluated the quality of vision with this IOL using the Quality of Vision Questionnaire (QoV) [26]. In this study it was found that halos are the most prominent visual symptom. When the Rasch-adjusted QoV scores were compared with other bifocal diffractive IOL, no differences were detected [19]. In this same study, a spectacle independence of 82.1% was reported.

Other investigation [20] studied the perception of glare and halo with the Halo & Glare Simulator, Eyeland-Design and patient satisfaction and spectacle independence with an in-house questionnaire obtained with the AT LISA 809, and other bifocal diffractive IOL and one trifocal IOL. In this study of halos and glare, no differences were found among IOLs. And no differences were reported among IOLs regarding the spectacle independence for far intermediate or near distances [20]. Regarding patient satisfaction, a high rate was detected with the AT LISA 809 IOL, and no significant differences between IOLs studied were reported in this investigation [20].

15.5 Conclusion

The AT LISA 809 IOL multifocal IOL provides a good visual rehabilitation after cataract surgery. This IOL provides a good clear vision at far and near focus allow to the patient an optimal vision and high spectacle independence. The quality of vision and the visual dysphotopsia reported with this IOL is similar to other bifocal diffractive and trifocal IOLs.

What is the best of this multifocal lens?

- Restore the distance and near visual function after cataract surgery.
- Contrast sensitivity is good and similar to other bifocal and trifocal IOLs.
- Patients have a high ratio of spectacle independence.

What is less good of this lens?

- The AT LISA 809 IOL is less effective for intermediate vision.
- The Halos perception is the most common visual symptom detected.

Compliance with Ethical Requirements Jorge L. Alió and Ana B. Plaza-Puche declare that they have no conflict of interest. All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all patients for being included in the study. No animal studies were carried out by the authors for this article.

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