Evaluation of visual outcomes and patient satisfaction after implantation of a diffractive trifocal intraocular lens

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PURPOSE: To evaluate clinical outcomes after the implantation of a diffractive trifocal intraocular lens (IOL).

SETTING: Nine European ophthalmology centers.

DESIGN: Prospective noncomparative interventional multicenter study.

METHODS: The trifocal diffractive AT LISA tri 839MP IOL was implanted in eyes with bilateral cataract. Monocular and binocular visual performance was assessed as was the level of perceived photic phenomena, patient satisfaction, and spectacle dependence 1 month and 3 months postoperatively.

RESULTS: The IOL was implanted in 208 eyes of 104 patients. The mean binocular uncorrected distance visual acuity improved from 0.44 logMAR ± 0.30 (SD) to 0.02 ± 0.10 logMAR and 0.03 ± 0.09 logMAR at 1 month and 3 months, respectively ($P < .01$). The mean binocular uncorrected intermediate visual acuity (80 cm) improved from 0.51 ± 0.30 logMAR to 0.09 ± 0.13 logMAR and 0.10 ± 0.15 logMAR at 1 month and 3 months, respectively ($P < .01$). The mean binocular uncorrected near visual acuity improved from 0.67 ± 0.31 logMAR to 0.16 ± 0.14 logMAR and 0.15 ± 0.14 logMAR, respectively ($P < .01$). Among the more frequently perceived photic phenomena were halos; however, approximately 75% of patients were not bothered by them. More than 90% of patients were satisfied with the outcome. Spectacle independence at all distances was higher than 90%.

CONCLUSION: This IOL provided excellent visual outcomes and high refractive predictability at all distances, including intermediate, leading to high levels of patient satisfaction and spectacle independence.

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Multifocal intraocular lenses (IOLs) are designed to reduce spectacle dependence after cataract surgery and improve some aspects related to quality of life. A variety of clinical studies have confirmed the significant improvement in uncorrected near visual acuity (UNVA) after the implantation of multifocal IOLs compared with after implantation of monofocal IOLs, and they did so without decreasing the levels of uncorrected distance visual acuity (UDVA) and providing an acceptable visual performance.[1] Multifocal IOLs based on a diffractive platform send light to the retina with a predefined light distribution to different foci.[2] In the past, designs were bifocal, which allowed the patient to obtain a postoperative functional distance and near visual function.[3,4] Currently, extended computer use and the possibility of changing the size of letters or the contrast of the stimuli in near or intermediate distance devices have changed the preference of spectacle independence from near to intermediate distances. Recently, trifocal diffractive technology was developed; this new IOL is concept based on 100% diffractive

technology and provides 3 useful focal distances (far, intermediate, and near).[5–7]

This study assessed the performance of the AT LISA tri 839MP trifocal diffractive IOL (Carl Zeiss Meditec AG) in terms of visual acuity, refraction, predictability, and patient satisfaction. The main endpoint was uncorrected intermediate visual acuity (UIVA) at 80 cm. Other objectives of the study, such as changes in distance and near visual acuities and refraction, level of patient satisfaction, spectacle independence, and rate of visual disturbances, were analyzed postoperatively.

PATIENTS AND METHODS

This prospective noncomparative interventional and multicenter (9 study sites) clinical study included eyes of patients older than 50 years having cataract surgery with bilateral implantation of the AT LISA tri 839MP diffractive trifocal IOL.

The inclusion criterion for the study was significant bilateral cataract. Exclusion criteria included patient inability to meet the limitations of the protocol or unlikely to cooperate during the trial as well as 1-eyed patients. Specific exclusion criteria were previous ocular surgery including corneal or refractive surgery, chronic or recurrent uveitis, acute ocular disease or external/internal infection, diabetes with retinal changes, glaucoma or intraocular pressure of 24 mm Hg or higher, pseudoexfoliation syndrome, pathological miosis, keratoconus, and corneal endothelial dystrophy. All patients were informed about the study and provided informed consent to have clinical examinations in accordance with the tenets of the Declaration of Helsinki. The study received the approval of the local ethics committees.

Clinical Protocol

Before surgery, all patients had a comprehensive preoperative ophthalmologic examination that included measurement of monocular and binocular UDVA, UIVA (80 cm), and UNVA (40 cm) measured with Early Treatment Diabetic Retinopathy Study charts; monocular and binocular corrected distance visual acuity (CDVA); distance-corrected intermediate visual acuity (DCIVA); and distance-corrected near visual acuity (DCNVA). Also performed were optical biometry by partial coherence interferometry (PCI) (IOLMaster, Carl Zeiss Meditec AG), manifest refraction, biomicroscopy, Goldmann applanation tonometry, and dilated fundoscopy. Intraocular lens power and predicted postoperative refraction were based on biometry data measured with the PCI device and calculated using the Haigis[8] or SRK/T[9] formula. The IOL power was selected to provide a postoperative refraction closest to emmetropia.

Patients were evaluated 1 month and 3 months after surgery. The UDVA, UIVA, UNVA, CDVA, DCIVA, DCNVA, and subjective refraction were assessed at each visit. In addition, patients were asked at each visit about perception of photic phenomena or visual disturbances, such as glare or halos, and about the need to use spectacles for reading or intermediate distance. A validated questionnaire[10] was used to evaluate the level of patient satisfaction and the rate of visual disturbances after IOL implantation. The questionnaire consisted of 10 items that scored the perception of glare, halos, starburst, hazy vision, blurred vision, distortion, multiple images, fluctuation, focusing difficulties, and depth. Each item was scored from 0 (minimum) to 3 (maximum) for frequency and level of disturbance.[10] An additional question asked about the patient's overall satisfaction and was subdivided in 4 subitems to evaluate total satisfaction; choice of same multifocal IOL again; the use of spectacles at far, near, and intermediate distances; and the frequency of spectacle use at each distance. General safety parameters regarding the position of the IOL or the presence of adverse events were recorded and compared between the 2 postoperative visits.

Intraocular Lens

The AT LISA tri 839MP IOL is designed for aphakia correction after crystalline lens removal in eyes with senile cataract and other forms of cataract. The IOL is also indicated for presbyopia correction in patients with or without cataract (presbyopic lens exchange or refractive lens exchange). The IOL is designed to be placed in the intact capsular bag. It is a microincision IOL, and no enlargement of the incision (1.8 mm) is necessary for implantation with the Bluemixs injector (Carl Zeiss Meditec AG). The IOL material is a biocompatible hydrophilic copolymer with an ultraviolet filter. According to the prevailing conditions in the human eye, the IOL material has a water content of 25% at 35°C. The aspheric diffractive trifocal IOL model is aberration correcting to reduce or compensate for corneal spherical aberrations. Table 1 shows the IOL characteristics.

Surgical Technique

All surgeries were performed by 1 of 9 experienced surgeons using a standard technique of sutureless phacoemulsification. In all cases, topical anesthesia was administered and pharmacologic mydriasis was induced using a combination of tropicamide and phenylephrine 10.0%. A mean clear corneal microincision of 2.3 ± 0.4 mm was made with a diamond knife. A paracentesis was made 60 to 90 degrees clockwise from the main incision, and the anterior chamber was filled with an ophthalmic viscosurgical device (OVD) after phacoemulsification and removal of the cataract. The IOL was subsequently implanted through the main incision using the injector. The OVD was then removed. Postoperative pharmacologic treatment consisted of a combination of antibiotic and steroidal antiinflammatory drops. Nonsteroidal

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Table 1. Characteristics of the diffractive trifocal IOL.

Parameter	Description
General	Foldable, single-piece, trifocal, MICS design for implantation in capsular bag
Total length (mm)	11.0
Optic diameter (mm)	6.0
Optic design	Diffractive, biconvex, aspheric
Haptic angulation (°)	0
Incision size (mm)	1.8
Material	Foldable hydrophilic acrylate, 25% water content, with UV absorber
Available diopters	0.0 to +32.0 in 0.5 increments
Intermediate addition (D)	1.66
Near addition (D)	3.3

MICS = microincision cataract surgery; UV = ultraviolet

antiinflammatory drops were also prescribed to prevent macular edema.

Statistical Analysis

Data analysis was performed using SAS software (version 9.2, SAS Institute Inc.). Normality of the data samples was evaluated using the Kolmogorov-Smirnov test. When parametric analysis was possible, the Student *t* test for paired data was used for comparisons between the preoperative and postoperative data, whereas the Wilcoxon rank-sum test was applied to assess the significance of such differences when parametric analysis was not possible. For all statistical tests, a *P* value less than 0.05 was considered statistically significant.

RESULTS

The study included 208 eyes of 104 patients. The number of patients per study site ranged from 6 to 20. There were 41 men (39.4%) and 63 women (60.6%). The IOL calculations were performed with the Haigis formula in 114 cases (54.8%) and with the SRK/T formula in 94 cases (45.2%). The mean IOL power implanted was 21.9 diopters (D) ± 1.9 (SD) (range 17.0 to 27.0 D). Table 2 shows the patients' preoperative refractive and biometric characteristics.

Visual Acuity

Differences between preoperative and postoperative monocular and binocular visual acuities at far, intermediate, and near distances were statistically significant ($P < .01$), (Table 3). Before surgery, the monocular UDVA was 0.3 logMAR or better in 151 eyes (72.6%). One month and 3 months after surgery, 193 eyes (93.7%) and 195 eyes (94.7%), respectively, achieved this level of visual acuity. Likewise, the preoperative monocular CDVA was 0.3 logMAR or better

Table 2. Patients' preoperative refractive and biometric characteristics.

Parameter	Mean ± SD	Range
Sphere (D)	1.08 ± 1.96	−7.00, 5.00
Cylinder (D)	−0.57 ± 0.35	−2.00, 0.00
SE (D)	0.81 ± 1.95	−7.50, 4.50
Axis (°)	78.21 ± 46.62	0.00, 175
K (mm)		
Radius 1	7.80 ± 0.25	7.29, 8.46
Radius 2	7.70 ± 0.25	7.19, 8.34
ACD (mm)	3.10 ± 0.30	2.31, 3.95
AL (mm)	23.25 ± 0.80	21.51, 25.42

ACD = anterior chamber depth; AL = axial length; K = keratometry; SE = spherical equivalent

in 50 eyes (24.0%). At 1 month and 3 months, 203 eyes (98.5%) and 202 eyes (98.1%), respectively, reached this level of visual acuity. Regarding binocular UDVA, only 1 patient (1.0%) did not reach at least 0.3 logMAR at 1 month and 3 months (Table 4).

Before surgery, the monocular UIVA was 0.3 logMAR or better in 155 eyes (76.0%). One month and 3 months after surgery, 176 eyes (86.3%) and 180 eyes (87.4%), respectively, achieved this level of visual acuity. The preoperative monocular DCIVA was 0.3 logMAR or better in 106 eyes (51.0%). At 1 month and 3 months, 150 eyes (89.8%) and 163 eyes (94.8%), respectively, reached this level of DCIVA. Regarding binocular UIVA, only 2 patients (2.0%) did not achieve at least 0.3 logMAR at 1 month and 3 months (Table 4).

Before surgery, the monocular UNVA was 0.3 logMAR or better in 183 eyes (88.0%). One month and 3 months after surgery, 37 eyes (18.1%) and 30 eyes (14.6%), respectively, did not achieve this level of visual acuity. The preoperative monocular CNVA was 0.3 logMAR or better in 78 eyes (37.5%). At 1 month and 3 months, 155 eyes (92.8%) and 160 eyes (92.5%), respectively, reached this level of visual acuity. Regarding binocular UNVA, 96 patients (94.1%) and 95 patients (92.2%) at 1 month and 3 months, respectively, reached at least 0.3 logMAR (Table 5).

Regarding the stability of the visual outcome, there were no statistically significant differences in the intermediate, distance, and near visual acuity results between the 1-month postoperative visit and the 3-month visit except for monocular CDVA ($P = .030$).

Predictability

Regarding spherical equivalent (SE), the postoperative refraction was within ±0.50 D in 177 cases (85.9%) and 171 cases (83.0%) 1 month and 3 months after

Table 3. Achieved levels of UDVA and CDVA during the preoperative examination and at follow-up visits.

	Baseline (Safety Population)		Postoperative			
			1 Month		3 Months	
Parameter	Monocular	Binocular	Monocular	Binocular	Monocular	Binocular
UDVA (logMAR)						
Number	208	104	206	103	206	103
≤0.0 (%)	0	2.9	49.5	72.8	49.0	71.8
0.0 to 0.1 (%)	2.9	10.6	25.2	16.5	27.7	19.4
0.1 to 0.3 (%)	24.5	29.8	18.9	8.7	18.0	7.8
>0.3 (%)	72.6	56.7	6.3	1.9	5.3	1.0
CDVA (logMAR)						
Number	208	104	206	103	206	103
≤0.0 (%)	17.3	25.0	68.9	84.5	73.8	87.4
0.0 to 0.1 (%)	17.8	23.1	24.3	10.7	19.4	9.7
0.1 to 0.3 (%)	40.9	36.5	5.3	3.9	4.9	1.9
>0.3 (%)	24.0	15.4	1.5	1.0	1.9	1.0

CDVA = corrected distance visual acuity; UDVA = uncorrected distance visual acuity

surgery, respectively. At 1 month and 3 months, 196 eyes (95.1%) and 201 eyes (97.6%), respectively, were within ±1.00 D (Figure 1). The differences in sphere, cylinder, and SE were statistically significant between preoperatively and postoperatively at 1 month and 3 months. The differences in sphere, cylinder, and SE between the 1-month postoperative visit and the 3-month visit were not statistically significant ($P > .05$).

Although in all cases emmetropia was the targeted postoperative refraction, small myopic and hyperopic deviations were found after surgery. The mean absolute error (MAE) was calculated and defined as the

Table 4. Achieved levels of UIVA and CIVA (80 cm) during the preoperative examination and UIVA and DCIVA during the follow-up visits.

	Baseline (Safety Population)		Postoperative			
			1 Month		3 Months	
Parameter	Monocular	Binocular	Monocular	Binocular	Monocular	Binocular
UIVA (logMAR)						
Number	204	102	204	102	206	103
≤0.0 (%)	12.7	8.8	17.6	37.3	20.4	38.8
0.0 to 0.1 (%)	1.5	3.9	25.0	30.4	24.3	25.2
0.1 to 0.3 (%)	9.8	10.8	43.6	30.4	42.7	34.0
>0.3 (%)	76.0	76.5	13.7	2.0	12.6	1.9
CIVA (logMAR)						
Number	208	104	—	—	—	—
≤0.0 (%)	10.6	15.4	—	—	—	—
0.0 to 0.1 (%)	10.1	16.3	—	—	—	—
0.1 to 0.3 (%)	28.4	36.5	—	—	—	—
>0.3 (%)	51.0	31.7	—	—	—	—
DCIVA (logMAR)						
Number	—	—	167	85	172	88
≤0.0 (%)	—	—	26.3	42.4	27.3	43.2
0.0 to 0.1 (%)	—	—	18.0	24.7	19.8	21.6
0.1 to 0.3 (%)	—	—	45.5	31.8	47.7	33.0
>0.3 (%)	—	—	10.2	1.2	5.2	2.3

CIVA = corrected intermediate visual acuity; DCIVA = distance-corrected intermediate visual acuity; UIVA = uncorrected intermediate visual acuity

Table 5. Achieved levels of UNVA and CNVA during the preoperative examination and of UNVA and DCNVA during the follow-up visits.

	Baseline (Safety Population)		Postoperative			
			1 Month		3 Months	
Parameter	Monocular	Binocular	Monocular	Binocular	Monocular	Binocular
UNVA (logMAR)						
Number	208	103	204	102	206	103
≤0.0 (%)	1.0	1.9	8.3	20.6	12.6	26.2
0.0 to 0.1 (%)	3.4	2.9	27.5	31.4	26.7	30.1
0.1 to 0.3 (%)	7.7	11.7	46.1	42.2	46.1	35.9
>0.3 (%)	88.0	83.5	18.1	5.9	14.6	7.8
CNVA (logMAR)						
Number	208	104	—	—	—	—
≤0.0 (%)	21.6	28.8	—	—	—	—
0.0 to 0.1 (%)	15.7	21.2	—	—	—	—
0.1 to 0.3 (%)	25.5	27.9	—	—	—	—
>0.3 (%)	37.5	22.1	—	—	—	—
DCNVA (logMAR)						
Number	—	—	167	85	173	88
≤0.0 (%)	—	—	38.3	57.6	31.2	47.7
0.0 to 0.1 (%)	—	—	24.6	27.1	31.8	27.3
0.1 to 0.3 (%)	—	—	29.9	10.6	29.5	21.6
>0.3 (%)	—	—	7.2	4.7	7.5	3.4

CNVA = corrected near visual acuity; DCNVA = distance-corrected near visual acuity; UNVA = uncorrected near visual acuity

absolute value of the difference between the target refraction and achieved refraction. The MAE of the SE was 0.299 ± 0.255 D 1 month postoperatively and increased to 0.350 ± 0.280 D at 3 months. These differences were statistically significant compared with the target refraction at both postoperative visits ($P < .001$).

Intraocular Lens Position

One significantly decentered IOL (0.5%) was observed and was caused by a rupture of the capsule during the phacoemulsification procedure. This adverse event did not require explantation of the IOL and did not affect the visual outcomes in the affected eye (UDVA 0.10 logMAR).

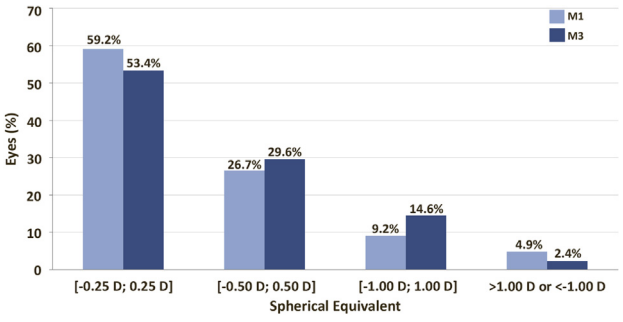

Figure 1. Postoperative SE in diopters during the postoperative period in the current series (M1 = 1 month; M3 = 3 months).

Refractive Surprises

One eye (0.5%) with postoperative unexplained and moderate hyperopia was detected. Further investigation showed that inaccurate biometry was the reason. This patient required IOL explantation and substitution with another the IOL using an addition power of +1.0 D. The patient recovered completely.

Visual Disturbances and Patient Satisfaction

Figure 2 shows the results of the questionnaire evaluating the frequency of visual disturbances perceived by the patient. Figure 3 shows the rates of general satisfaction at 5 levels (from very good to very bad) for far, intermediate, and near distances evaluated at both postoperative visits. The most frequently perceived photic phenomena were halos and glare and the least were distortion, multiple images, and problems in depth perception. Although 82 patients (~80.0%) perceived some level of halos after 1 month and 3 months (Figure 2), 77 patients (75.0%) said they were not bothersome. Regarding all type of visual disturbances, 77 patients (75.0%) were not at all bothered or only slightly bothered. After 1 month, 101 patients (98.0%) would have chosen the same IOL again and

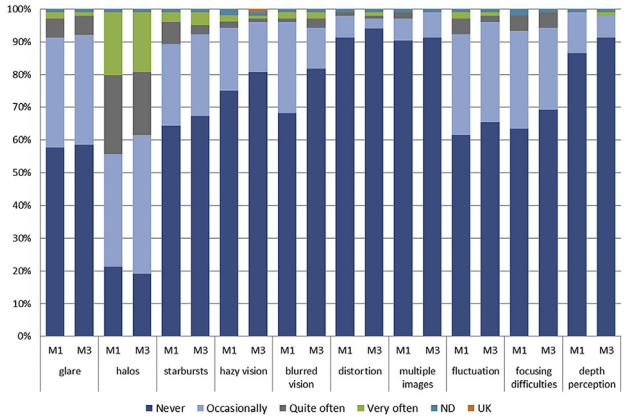

Figure 2. Frequency of visual disturbances after the implantation of the diffractive trifocal IOL (M1 = 1 month; M3 = 3 months; ND = not done; UK = unknown).

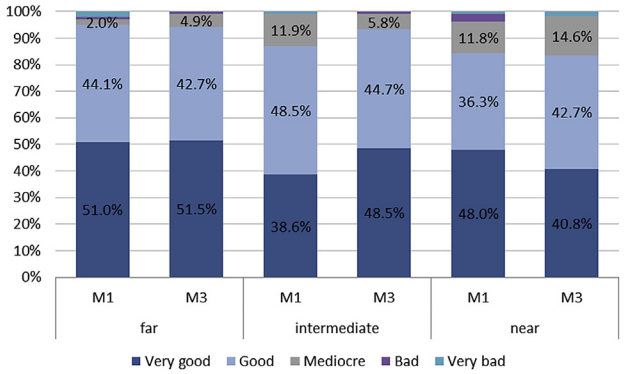

Figure 3. Patient satisfaction with uncorrected visual outcome achieved at different distances including intermediate distance (80 cm) after the implantation of the diffractive trifocal IOL (M1 = 1 month; M3 = 3 months).

after 3 months, 99 patients (96.1%). Patient satisfaction was high or very high in 93 cases (approximately 90.0%) for distance vision at both postoperative visits and for intermediate vision 3 months after surgery. More than 82 cases (>80.0%) reported high or very high satisfaction with intermediate vision at the first postoperative visit and with near vision at 1 month and 3 months. Of the patients, 92 (almost 90.0%) said they did not need spectacles for any distance (Figure 4).

DISCUSSION

New multifocal IOL designs such as the AT LISA tri 839MP were developed to overcome clinically relevant limitations of traditional multifocal IOLs, such as the generation of photic phenomena (especially under dim lighting conditions) and the poor level of intermediate vision. Several studies of the clinical experience with trifocal diffractive IOLs[11–16] confirmed the ability of trifocal IOLs to restore the visual function completely after cataract surgery. Our distance visual outcomes are consistent with those reported in most previous clinical research work on trifocal IOLs. In a sample of 90 eyes with the Finevision IOL (Physiol S.A.) by Cochener et al.,[13] the 3-month postoperative monocular and binocular logMAR UDVA were 0.08 ± 0.11 and 0.02 ± 0.09, respectively; the IOL in their study combines 2 bifocal diffractive patterns. In a study by Sheppard et al.[11] of 30 eyes with the same trifocal IOL, the mean monocular 2-month postoperative logMAR UDVA was 0.19 ± 0.09, similar to the result reported by Alió et al.[12] in a sample of 40 eyes. Likewise, Mojzis et al.[15] found excellent monocular and binocular UDVA outcomes with the AT LISA tri 839MP IOL, with a mean value of −0.03 logMAR 6 months after implantation. Van Horenbeeck[A] performed a prospective comparative clinical study of 118 eyes operated on by the same surgeon. Of the eyes, 58 had implantation of the Finevision IOL and 60 of the AT LISA tri 839MP IOL. The 2 groups were comparable in age and preoperative refraction. The mean postoperative monocular decimal UDVA was not significantly different between the 2 IOL groups (1.0 ± 0.20 versus 0.97 ± 0.12). Regarding postoperative residual refraction, both IOL models provided outcomes close to emmetropia and thus showed a high level of predictability.[A]

Regarding UNVA, different authors have reported relatively similar outcomes with the AT LISA tri 839MP and Finevision IOLs, with mean logMAR UNVA values of approximately 0.2 logMAR (Jaeger 2) with both types of trifocal IOLs.[11–16] Alió et al.[12] found worse UNVA with the Finevision IOL than what was reported in other studies. Independent of the relatively small differences found between trifocal IOLs in different studies, both trifocal diffractive technologies have been shown to provide

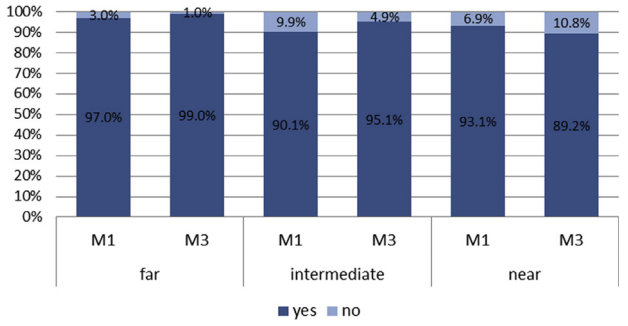

Figure 4. Rate of spectacle independence at different distances after implantation of the diffractive trifocal IOL (M1 = 1 month; M3 = 3 months).

functional near vision after cataract surgery without a detrimental effect on the distance focal point.

The importance of intermediate vision was neglected for many years, probably because bifocal IOLs were not able to restore it. However, intermediate vision is important for daily routine activities, such as shopping, reading the instruments on a car dashboard, and working with computers. Typically, a distance between 40 cm and 100 cm from an object is regarded as intermediate vision; however, there is no clear definition. Mojzis et al.[15] found a mean UIVA of 0.08 logMAR 6 months after implantation of the AT LISA tri 839MP IOL, whereas Alió et al.[12] found a mean value of 0.18 logMAR 3 months after implantation of the Finevision IOL. As expected, our results are consistent with those reported by Mojzis et al.[15] and confirm the ability of the evaluated trifocal diffractive IOL to provide functional intermediate vision that is at least as good as that provided by the Finevision trifocal IOL.[13,14] Intermediate visual results with trifocal diffractive technology are significantly better than those reported with diffractive bifocal IOLs (mean binocular UIVA of 0.3 to 0.4 logMAR or worse).[16] Recently, Mojzis et al.[17] performed a comparative analysis of the visual outcomes achieved with the AT LISA bifocal and trifocal IOLs. They found that the trifocal IOL provided significantly better intermediate vision over the bifocal IOL model (postoperative UIVA at 66 cm: trifocal 0.06 $\pm$ 0.07 logMAR versus bifocal 0.29 $\pm$ 0.18 logMAR), with equivalent postoperative levels of optical quality. The outcomes in the current study confirm that the trifocal IOL we evaluated is a useful option to restore intermediate visual function in patients having lensectomy. In addition to the improvement in UDVA, UNVA, and UIVA, significant improvements were also observed in CDVA, DCNVA, and DCIVA. This was expected because most of our patients had cataract and therefore significant deterioration in visual function. The high levels of postoperative CDVA, DCNVA, and DCIVA with the AT LISA tri 839MP IOL confirm that the multifocality generated by this model does not induce deterioration in visual quality in terms of corrected visual acuity, as has been reported with refractive multifocal IOLs.[18]

The perception of visual disturbances is a common issue after the implantation of diffractive multifocal IOLs compared with monofocal IOLs.[19] De Vries et al.[20] studied patients who were dissatisfied after multifocal IOL implantation. In addition to blurred vision, a major complaint by 38.2% of the dissatisfied patients was the perception of photic phenomena.[20]

In our opinion, it depends on how the incidence of photic phenomena is assessed. Indirect questions such as, "Do you have any problems with your vision?" will yield a much lower incidence than direct questions, such as "Do you sometimes see rings around light sources?" In our study, we asked direct questions; therefore, the incidence of photic phenomena seems rather high. However, the percentage of severe symptoms was low (6.25%). A recent study by Vryghem and Heireman[21] evaluated the rate of halos after implantation of the Finevision IOL and concluded that 68% of the patients did not perceive them as significant or disabling. Also, Law et al.[22] found a high level of satisfaction after the implantation of the AT LISA tri 839MP IOL and a progressive decrease in symptoms associated with photic phenomena. This could be partially explained by the specific design of the trifocal IOL. The use of an aspheric optic that minimized the effect of spherical aberration is another important factor to consider. We did not evaluate the contrast sensitivity function in our study, which can be considered a limitation and therefore should be assessed in future studies.

In our series, the level of disturbance for 10 visual phenomena was rated; the disturbance was rated as "not at all" or "only a little" disturbing by approximately 75% of patients, which confirms the results of Vryghem and Heireman.[21] Also, in our study the perception of photic phenomena was less frequent at 3 months compared with the 1-month postoperative visit. The combination of good visual outcomes at all distances, high spectacle independence (~90%), and a low incidence of disabling photic phenomena is the main reason for the high level of satisfaction (~90%) reported by patients in our sample. The high level of spectacle independence is consistent with the results of Law et al.,[22] who used a self-developed questionnaire to evaluate the level of difficulty in performing some vision-related tasks after cataract surgery with implantation of the AT LISA tri 839MP IOL. None of their patients reported difficulties watching television or driving, with only some saying they had difficulty performing near and intermediate visual tasks, such as reading a newspaper or working at the computer.

In summary, the AT Lisa tri 839MP IOL, designed to restore the visual function after extraction of the crystalline lens, provided excellent efficacy outcomes regarding uncorrected and corrected visual acuity at far, intermediate, and near distances. The predictability of the postoperative refraction was good. The diffractive component of the IOL implies some level of photic phenomena; however, most patients did not find them to be disturbing and the phenomena decreased with time, probably because of neuroadaptation. The combination of the good visual outcomes, spectacle independence, and a low incidence of disabling photic phenomena led to high levels of patient satisfaction.

WHAT WAS KNOWN

- Bifocal diffractive IOLs provide good far and near vision.
- Bifocal diffractive IOLs do not provide useful intermediate vision.
- Diffractive designs are typically related to photic phenomena.

WHAT THIS PAPER ADDS

- The diffractive trifocal IOL provided excellent efficacy outcomes for uncorrected and corrected visual acuity at all distances embedded in the IOL profile, including at intermediate distance (80 cm).
- The incidence of severe disabling phenomena (6.25%) was low.
- The diffractive trifocal IOL yielded high spectacle independence.

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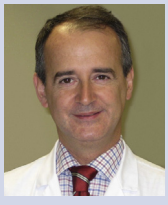

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