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CLINICAL INVESTIGATION

Comparative analysis of the visual and refractive outcomes of a refractive segmented multifocal intraocular lens with and without toricity: 1-year results

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Abstract
Purpose To compare the visual and refractive outcomes up to 1 year postoperatively following implantation of a refractive segmented or a refractive segmented toric multifocal intraocular lens (IOL).
Methods This retrospective study included 108 eyes of 64 patients who underwent cataract surgery with implantation of a refractive segmented multifocal IOL (Lentis Mplus LS-313 MF30 IOL) (LM group) and 81 eyes of 49 patients with implantation of a refractive segmented toric multifocal IOL (Lentis Mplus LU-313 MF30T IOL) (LMT group). The visual and refractive postoperative outcomes and the rate of additional refractive procedures were evaluated up to 1 year postoperatively.
Results The uncorrected distance visual acuity (VA) and uncorrected near VA exceeded 1.0 and 0.60 in decimal VA, respectively, and both were stable postoperative groups. The postoperative subjective refractive astigmatism was also stable and the postoperative refraction was near emmetropia in both groups. No significant differences were found in the need for additional surgical refractive procedures.
Conclusion The outcomes with a refractive segmented toric multifocal IOL were comparable to those with a non-toric model despite higher preoperative corneal astigmatism.

Keywords Multifocal intraocular lens · Astigmatism · Refractive outcome

Introduction

Several multifocal intraocular lenses (IOLs) have been developed recently to provide complete restoration of near and distance vision after cataract surgery or refractive lens exchange [1–4]. Among them, several studies confirm the efficacy of a new generation of IOLs with refractive rotational asymmetry optics [5–7].

The Lentis Mplus platform (Oculentis GmbH, Berlin, Germany) has an aspheric surface with a posterior sector-shaped, near-vision segment. IOLs based on this multifocal technology provide a theoretical addition of 3.0 diopters (D) at the IOL plane.

Many studies report excellent short term clinical outcomes with this IOL either with or without toricity, mostly within 3 months [5, 8, 9]. However, to date, the long-term clinical outcomes and whether the combination of the refractive segmented platform with a toric optical surface results in similar outcomes compared with the same platform without toricity have not been reported. The aim of the current study was to analyze and compare the distance, intermediate, and near visual acuities (VAs); refractive outcomes; and the incidence of additional surgical procedures including refractive surgery and neodymium: yttrium–aluminum-garnet (Nd:YAG) laser capsulotomy at 1 year postoperatively.

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Methods

Patients

This comparative case series included patients who underwent cataract surgery with implantation of a Lentis Mplus LS-313 MF30 multifocal IOL (LM group) or a Lentis Mplus LU-313 MF30T multifocal toric IOL (LMT group). Patients were implanted either monocularly or binocularly, but for the latter the same IOL was always implanted in both eyes. All patients were informed about the details of this study and provided written informed consent. The study adhered to the tenets of the Declaration of Helsinki and the Institutional Review Board for Human Studies of the Minamiaoyama Eye Clinic approved the study protocol.

The inclusion criteria were a postoperative corrected distance visual acuity (VA) exceeding 0.1 logarithm of the minimum angle of resolution (logMAR) and age over 20 years. The exclusion criteria were an ocular pathology other than cataract (e.g., dry eye syndrome or macular disease), diabetes with or without retinopathy, any disease affecting visual function, intraoperative and postoperative ocular complications except for posterior capsular opacification, including postoperative abnormal inflammation in the anterior chamber of the eye, secondary glaucoma, IOL decentration or tilt, and a rotational error of toric IOL alignment over 5°.

IOLs

The Lentis Mplus LS-313 MF30 is a one-piece multifocal IOL with a plate-haptic design made of a hydrophilic acrylic material with a hydrophobic surface. The IOL has an aspheric surface with a posterior sector-shaped, near-vision segment, providing 3.0 D of near addition (add) at the IOL plane. The optic diameter is 6.0 mm and the overall length is 11.0 mm.

The Lentis Mplus toric LU-313 MF30T has the same platform as the Lentis Mplus LS-313 MF30 except with a toric surface. The IOL is custom-made with available spherical corrections between 0.00 and +36.00 D in 0.01-D increments. Cylindrical corrections are available between +0.25 and +12.00 D in 0.01-D increments.

Data (axial length, anterior chamber depth, and keratometry) obtained from the partial coherence interferometry device (IOLMaster Software Version 5.4, Carl Zeiss Meditec AG, Jena, Germany) were used for the IOL power calculations. The IOL power and alignment were calculated using the manufacturer's web-based program (Oculentis, Toric Lens Calculator, available at: http://www.lentistoric.com/GB/Intro.aspx. Accessed January 31, 2013) using the Haigis formula. All eyes were targeted for emmetropia. The toric model was chosen only when the estimated postoperative refractive astigmatism exceeded 1.0 D. A half diopter of the surgical induced corneal astigmatism was used for calculation of the postoperative refractive astigmatism. If the cylindrical power of the IOL was less than this value, the model without toricity was used as first option considering that in such cases the efficacy of the astigmatic correction with a toric IOL is low [10, 11].

Surgical technique

Surgery was performed under topical anesthesia after instillation of two drops of lidocaine hydrochloride 4% and oxybuprocaine 0.4% three times every 5 min before surgery.

Lens extraction was performed using a standard phacoemulsification technique through a 2.3-mm incision created at the 3- or 9-O'clock position. For implantation of the study IOL, the incision was widened to 2.4 mm at the time of IOL injection using a Viscoject 2.2 injector (Oculentis GmbH). Slight rotation of the toric IOL was necessary to align the axis marks on the IOL with the SMI Surgical Guidance system (Alcon Laboratories, Inc., Ft. Worth, TX, USA).

Topical antibiotics and corticosteroids were instilled. All eyes were treated with topical ofloxacin, dexamethasone 0.1%, and diclofenac sodium 0.1% eye drops for 1 month postoperatively. The same surgeon (HA) performed all surgery.

Preoperative and postoperative examinations

All patients underwent assessment of the refraction status including measurement of the uncorrected distance visual acuity (UDVA), corrected distance VA (CDVA), and binocular uncorrected distance VA (BUDVA), distance Landolt VAs, binocular uncorrected intermediate Landolt VA (BUIVA), and uncorrected near VA (UNVA), corrected near VA (CNVA), and binocular corrected near VA preoperatively, 1 week, 1 month, and 3, 6, and 12 months postoperatively. The preoperative and postoperative corneal astigmatism, refractive astigmatism, and spherical equivalent (SE) of the subjective refraction also were recorded.

The patients who had additional refractive procedures within 1 year after cataract surgery were excluded from the data analysis. Instead, the same assessments were performed only before and 3 months after the additional refractive procedure.

Distance, intermediate, and near VA

The UDVA, CDVA, and BUDVA were measured using standard Landolt charts displayed 5 m from the patients. The BUIVA was measured using standard Landolt charts displayed 1 m from the patients. The UNVA, CNVA, and BUNVA were measured with Landolt optotype near charts at 40 cm (SC-1600, Nidek, Aichi, Japan). The mean VAs were calculated after conversion to logMAR units.

Additional surgical procedures

The incidence of additional surgical procedures including refractive surgery and Nd:YAG laser capsulotomy were compared between the groups. Nd:YAG laser capsulotomy was indicated when the presence of posterior capsule opacification (PCO) was confirmed using a slit-lamp examination with subjective deterioration of visual function, and/or decreased CDVA, and/or decreased contrast of the fundus photograph obtained under mydriasis.

All patients requiring additional refractive procedure underwent laser in situ keratomileusis (LASIK).

Statistical analyses

Statistical analysis was performed using SPSS for Windows software (version 22.0, SPSS, Inc.). The data samples were evaluated using the Wilcoxon signed-rank test and one-way analysis of variance (ANOVA). All results with a P value less than 0.05 were considered statistically significant.

The uncorrected distance and near VAs at 1 year according to the preoperative corneal astigmatism in all eyes were compared using ANOVA, otherwise the data samples were evaluated using the Wilcoxon signed-rank test and ANOVA.

Results

The LM group included 108 eyes of 64 patients and the LMT group included 81 eyes of 49 patients. Table 1 shows the patients' preoperative demographic data. The preoperative profiles of the groups were well matched except for the SE, corneal and refractive astigmatism, and UDVA. The LMT group was significantly ($P < 0.001$, $P < 0.001$, $P = 0.015$, respectively) more myopic and had more corneal and refractive astigmatism than the LM group.

Table 2 shows the postoperative refractive and visual outcomes of the LM and LMT groups. There were no significant differences in the refractive and visual outcomes except for the corneal astigmatism, which was significantly ($P < 0.001$) higher in the LMT group than the LM group. The rate of Nd:YAG laser treatment for PCO was very low in both groups. Nd:YAG laser capsulotomy was performed in one eye only in the LMT group, which had an atopic cataract.

Table 3 shows the uncorrected distance and near VAs at 1 year according to the preoperative corneal astigmatism in all eyes. There were no significant differences in the uncorrected distance and near VAs, according to the preoperative corneal astigmatism in both groups.

Table 4 shows the clinical data from the eyes that required LASIK to correct the residual refractive errors in both groups. The mean patient ages (years), the times after cataract surgery (months), and the incidence rates of additional LASIK were 62.4 ± 4.6 years, 11.9 ± 8.9 months, and 4.6% (5/108) in the LM group and 64.8 ± 6.0 years, 8.5 ± 3.7 months, and 7.4% (6/81) in the LMT group, respectively. There were no significant differences between the groups, except for the corneal astigmatism, before and 3 months after LASIK ($P = 0.008$, $P = 0.013$, respectively).

Table 5 shows the comparison of the clinical outcomes after cataract surgery between patients with and without enhancement in both groups. There were no significant differences in the refractive and VA data after cataract surgery between the patients who underwent LASIK and those who did not.

Table 6 shows the changes over time in the SE and refractive astigmatism of the subjective refraction. Postoperatively, the subjective SE and the refractive astigmatism were very stable during the 12 months of follow-up. There were no significant differences in the subjective SE and the refractive astigmatism between the groups at any postoperative time point.

Table 7 shows the changes over time in the UDVA and UNVA. The UDVA and the UNVA were excellent and very stable postoperatively in both groups. The UNVA was significantly ($P < 0.05$) better in the LMT group from 1 week to 6 months postoperatively, although the difference was not significant at 12 months postoperatively.

Discussion

To the best of our knowledge, this is the first study to compare the outcomes obtained with a refractive segmented IOL and a refractive segmented toric multifocal IOL up to 1 year postoperatively.

Several reports have been published on the refractive and visual outcomes of a refractive segmented multifocal IOL [3, 4, 7, 8, 12–14]. Venter et al. [8] report that the mean postoperative cylinder and the SE 3 months after

Table 1 Between-group comparison of preoperative patient demographic data

	LM group (mean ± SD)	LMT group (mean ± SD)	*P* Value
Eyes (patients)	108 (64)	81 (49)	
Age (years)	60.2 ± 8.8	58.3 ± 8.9	0.135
SE (D)	−2.11 ± 5.03	−4.24 ± 4.30	<0.001*
Corneal astigmatism (D)	0.71 ± 0.38	1.68 ± 0.84	<0.001*
Subjective refractive astigmatism (D)	0.87 ± 0.64	1.11 ± 0.72	0.015*
UDVA (logMAR)	0.69 ± 0.53	0.98 ± 0.43	<0.001*
CDVA (logMAR)	0.05 ± 0.27	0.07 ± 0.23	0.68
UNVA (logMAR)	0.84 ± 0.38	0.75 ± 0.36	0.31
CNVA (logMAR)	0.16 ± 0.31	0.14 ± 0.19	0.81
Axial length (mm)	24.69 ± 2.15	25.03 ± 1.79	0.05
Spherical power of the implanted IOL (D)	16.81 ± 5.83	13.3 ± 5.52	<0.001*
Cylindrical power of the implanted IOL (D)	–	3.01 ± 2.19	–

LM Lentis Mplus LS-313 MF30 IOL, *LMT* Lentis Mplus LS-313 MF30 toric IOL, *SE* spherical equivalent, *UDVA* uncorrected distance visual acuity, *CDVA* corrected distance visual acuity, *UNVA* uncorrected near visual acuity, *CNVA* corrected near visual acuity, *D* diopters, *logMAR* logarithm of the minimum angle of resolution

* Statistically significant difference (P > 0.05)

Table 2 Between-group comparison of 1-year postoperative outcomes

	LM group (mean ± SD)	LMT group (mean ± SD)	*P* value
SE (D)	0.26 ± 0.42	0.12 ± 0.43	0.12
Corneal astigmatism (D)	0.63 ± 0.32	1.58 ± 0.59	<0.001*
Subjective refractive astigmatism (D)	0.27 ± 0.37	0.38 ± 0.48	0.28
UDVA (logMAR)	−0.05 ± 0.12	−0.03 ± 0.13	0.59
CDVA (logMAR)	−0.11 ± 0.10	−0.10 ± 0.09	0.48
UNVA (logMAR)	0.25 ± 0.22	0.18 ± 0.17	0.14
CNVA (logMAR)	0.04 ± 0.10	0.03 ± 0.08	0.95
BUDVA (logMAR)	−0.11 ± 0.08	−0.12 ± 0.09	0.96
BUIVA (logMAR)	0.10 ± 0.12	0.13 ± 0.14	0.56
BUNVA (logMAR)	0.14 ± 0.13	0.12 ± 0.12	0.44
Nd:YAG rate (%)	0 (0/108)	0.01 (1/81)	–

LM Lentis Mplus LS-313 MF30 IOL, *LMT* Lentis Mplus LS-313 MF30 toric IOL, *SE* spherical equivalent, *UDVA* uncorrected distance visual acuity, *CDVA* corrected distance visual acuity, *UNVA* uncorrected near visual acuity, *CNVA* corrected near visual acuity, *BUDVA* binocular uncorrected distance visual acuity, *BUIVA* binocular uncorrected intermediate visual acuity, *BUNVA* binocular uncorrected distance visual acuity, *D* diopter, *logMAR* logarithm of the minimum angle of resolution, *Nd:YAG* neodymium: yttrium–aluminum-garnet

* Statistically significant difference (P > 0.05)

implantation of the Mplus IOL in 9366 eyes of 4683 consecutive patients were −0.35 ± 0.38 and 0.03 ± 0.37 D, respectively. They also report that the mean UDVA and UNVA were −0.04 ± 0.06 and 0.13 ± 0.14, respectively [8]. Rosa et al. [12] report that the mean postoperative cylinder, mean UDVA, and mean UNVA 3 months after implantation of the Mplus IOL (LS-312) in 56 eyes were −0.14 ± 0.17, 0.07 ± 0.02, and 0.15 ± 0.02, respectively. Van der Linden et al. [13] report that the visual and refractive outcomes in 90 eyes with a segmented multifocal IOL (LS-312) were a mean UDVA and UNVA of 0.04 ± 0.15 SD and 0.16 ± 0.21, respectively, at 3 months postoperatively.

Regarding the toric IOL model, Venter and Pelouskova [4] report the refractive outcomes of the refractive segmented multifocal toric IOL (LU-313 MFT) in 89 eyes and showed that the mean monocular postoperative UDVA and UNVA were 0.03 ± 0.11 and 0.17 ± 0.14 logMAR,

Table 3 Uncorrected distance and near VAs at 1 year according to the preoperative corneal astigmatism in all eyes

Preoperative corneal astigmatism (D)	UDVA (logMAR) (mean ± SD)	n	UNVA (logMAR) (mean ± SD)	n
0	0.05	1	0.40	1
0< and 0.25≥	0.00 ± 0.12	10	0.35 ± 0.23	13
0.25< and 0.5≥	−0.05 ± 0.10	18	0.22 ± 0.20	20
0.5< and 0.75≥	−0.07 ± 0.13	22	0.22 ± 0.21	23
0.75< and 1.0≥	−0.03 ± 0.11	9	0.21 ± 0.23	11
1.0< and 1.25≥	−0.06 ± 0.08	8	0.20 ± 0.15	8
1.25< and 1.5≥	−0.04 ± 0.17	9	0.15 ± 0.17	9
1.5< and 1.75≥	−0.04 ± 0.12	4	0.18 ± 0.15	4
1.75< and 2.0≥	0.06 ± 0.06	4	0.23 ± 0.05	4
2.0< and 2.25≥	−0.15 ± 0.10	3	0.05 ± 0.04	3
2.25 < and 2.5≤	0.10 ± 0	1	0.22 ± 0	1
P value	0.50	–	0.52	–

VA visual acuity, *UDVA* uncorrected distance visual acuity, *UNVA* uncorrected near visual acuity, *D* diopter, *logMAR* logarithm of the minimum angle of resolution

* Statistically significant difference (P > 0.05)

Table 4 Between-group comparison of clinical data before and after enhancement

	Before LASIK			3 months after LASIK		
	LM group n = 5 (mean ± SD)	LMT group n = 6 (mean ± SD)	*P* value	LM group n = 5 (mean ± SD)	LMT group n = 6 (mean ± SD)	*P* value
SE (D)	0.65 ± 0.70	0.29 ± 0.65	0.78	0.13 ± 0.58	−0.27 ± 0.56	0.36
Corneal astigmatism (D)	0.45 ± 0.40	1.63 ± 0.43	0.008	0.90 ± 0.49	2.42 ± 0.69	0.013*
Subjective refractive astigmatism (D)	0.95 ± 0.75	1.33 ± 0.31	0.23	0.25 ± 0.32	0.38 ± 0.35	0.56
UDVA (logMAR)	0.18 ± 0.29	0.16 ± 0.14	0.85	0.16 ± 0.34	0.02 ± 0.14	0.71
CDVA (logMAR)	−0.08 ± 0.15	−0.14 ± 0.05	0.67	−0.15 ± 0.13	−0.05 ± 0.07	0.16
UNVA (logMAR)	0.57 ± 0.33	0.27 ± 0.15	0.13	0.36 ± 0.14	0.22 ± 0.19	0.19
CNVA (logMAR)	0.23 ± 0.08	0.17 ± 0.18	0.59	0.18 ± 0.15	0.00 ± 0.00	0.08
BUDVA (logMAR)	−0.13 ± 0.05	−0.04 ± 0.04	0.06	−0.08 ± 0.00	−0.04 ± 0.04	0.13
BUNVA (logMAR)	0.19 ± 0.03	0.23 ± 0.07	0.53	0.25 ± 0.15	0.05 ± 0.05	0.06

LM Lentis Mplus LS-313 MF30 IOL, *LMT* Lentis Mplus LS-313 MF30 toric IOL, *LASIK* laser in situ keratomileusis, *SE* spherical equivalent, *UDVA* uncorrected distance visual acuity, *CDVA* corrected distance visual acuity, *UNVA* uncorrected near visual acuity, *CNVA* corrected near visual acuity, *BUDVA* binocular uncorrected distance visual acuity, *BUNVA* binocular uncorrected distance visual acuity, *D* diopter, *logMAR* logarithm of the minimum angle of resolution

* Statistically significant difference (P > 0.05)

respectively, and the mean refractive cylinder decreased significantly ($P < 0.001$) from 2.90 ± 1.31 D preoperatively to 0.50 ± 0.39 D postoperatively.

The current results were comparable to those results and show that the Mplus and Mplus toric IOLs successfully restored distance and near visual function.

Only one previous report described the stability of the refractive and visual outcomes. Van der Linden et al. [13] report the refractive and visual outcomes at 3, 6, and 12 months postoperatively and show that good UDVA was maintained throughout the first 12 months. The current study shows that good UDVA and good UNVA in eyes with Mplus with and without toricity were maintained throughout 12 months postoperatively. In addition, the UNVA with the toric model was significantly better than that with the non-toric model from 1 week to 6 months postoperatively despite the lack of a significant difference in the postoperative refractive outcomes. It is not clear why the UNVA was better in eyes with a toric model; however, the astigmatic correction in eyes with higher corneal

Table 5 Comparison of the clinical outcomes between patients with and without enhancement

Enhancement	LM group (mean ± SD)			LMT group (mean ± SD)		
	−	+	*P* value	−	+	*P* value
n	108	5		81	6	
Observational point	1 year postop	Just before LASIK		1 year postop	Just before LASIK	
SE (D)	0.26 ± 0.42	0.65 ± 0.70	0.16	0.12 ± 0.43	0.29 ± 0.65	0.10
Corneal astigmatism (D)	0.63 ± 0.32	0.45 ± 0.40	0.66	1.58 ± 0.59	1.63 ± 0.43	0.41
Subjective refractive astigmatism (D)	0.27 ± 0.37	0.95 ± 0.75	0.18	0.38 ± 0.48	1.33 ± 0.31	0.10
UDVA (logMAR)	−0.05 ± 0.12	0.18 ± 0.29	0.32	−0.03 ± 0.13	0.16 ± 0.14	0.18
CDVA (logMAR)	−0.11 ± 0.10	−0.08 ± 0.15	1.00	−0.10 ± 0.09	−0.14 ± 0.05	1.00
UNVA (logMAR)	0.25 ± 0.22	0.57 ± 0.33	0.18	0.18 ± 0.17	0.27 ± 0.15	0.18
CNVA (logMAR)	0.04 ± 0.10	0.23 ± 0.08	1.00	0.03 ± 0.08	0.17 ± 0.18	1.00
BUDVA (logMAR)	−0.11 ± 0.08	−0.13 ± 0.05	1.00	−0.12 ± 0.09	−0.04 ± 0.04	1.00
BUNVA (logMAR)	0.14 ± 0.13	0.19 ± 0.03	0.16	0.12 ± 0.12	0.23 ± 0.07	0.16

LM Lentis Mplus LS-313 MF30 IOL, *LMT* Lentis Mplus LS-313 MF30 toric IOL, *Postop* postoperatively, *LASIK* laser in situ keratomileusis, *SE* spherical equivalent, *UDVA* uncorrected distance visual acuity, *CDVA* corrected distance visual acuity, *UNVA* uncorrected near visual acuity, *CNVA* corrected near visual acuity, *BUDVA* binocular uncorrected distance visual acuity, *BUNVA* binocular uncorrected distance visual acuity, *D* diopter, *logMAR* logarithm of the minimum angle of resolution

* Statistically significant difference (P > 0.05)

Table 6 Changes over time in refractions before and after surgery

	LM group (mean ± SD)	LMT group (mean ± SD)	*P* value
Subjective spherical equivalent (D)			
Pre	−2.11 ± 5.03	−4.24 ± 4.30	<0.001*
1 W	0.13 ± 0.49	0.19 ± 0.48	0.42
1 M	0.18 ± 0.48	0.20 ± 0.47	0.76
3 M	0.23 ± 0.44	0.21 ± 0.50	0.91
6 M	0.67 ± 1.09	0.49 ± 1.10	0.73
12 M	0.29 ± 0.42	0.12 ± 0.43	0.12
Subjective refractive astigmatism (D)			
Pre	0.87 ± 0.64	1.11 ± 0.72	0.015*
1 W	0.32 ± 0.38	0.39 ± 0.43	0.24
1 M	0.34 ± 0.49	0.39 ± 0.53	0.58
3 M	0.34 ± 0.44	0.38 ± 0.42	0.43
6 M	0.25 ± 0.33	0.29 ± 0.35	0.46
12 M	0.26 ± 0.37	0.38 ± 0.49	0.28

LM Lentis Mplus LS-313 MF30 IOL, *LMT* Lentis Mplus LS-313 MF30 toric IOL, *SD* standard deviation, *Pre* preoperatively, *1 W* 1 week postoperatively, *1 M* 1 month postoperatively, *3 M* 3 months postoperatively, *6 M* 6 months postoperatively, *12 M* 12 months postoperatively, *D* diopters

* Statistically significant difference (P > 0.05)

astigmatism preoperatively may affect the postoperative visual function more effectively than in eyes without preoperative corneal astigmatism.

The significant etiologies resulting in suboptimal visual outcomes and patient dissatisfaction were residual refractive errors and PCO [15–17].

Residual ametropia and astigmatism may result from measurement errors in the preoperative biometry, inadequate selection of the IOL power due to limitations in the calculation formulas, surgical induced astigmatism, and lack of precision in the manufacturing of the IOLs. In addition, preexisting corneal astigmatism is a major factor that limits the optimal uncorrected VA. LASIK is the most accurate, viable, and noninvasive procedure to correct residual refractive errors after cataract surgery [18].

Table 7 Change over time in uncorrected visual acuity before and after surgery

	LM group (mean ± SD)	LMT group (mean ± SD)	*P* value
UDVA (logMAR)			
Pre	0.69 ± 0.53	0.98 ± 0.43	<0.001*
1 W	−0.05 ± 0.14	−0.02 ± 0.14	0.27
1 M	−0.02 ± 0.17	−0.03 ± 0.13	0.64
3 M	−0.03 ± 0.13	−0.04 ± 0.15	0.40
6 M	−0.04 ± 0.13	−0.04 ± 0.12	0.75
12 M	−0.05 ± 0.12	−0.03 ± 0.13	0.59
UNVA (logMAR)			
Pre	0.84 ± 0.38	0.75 ± 0.36	0.31
1 W	0.23 ± 0.22	0.15 ± 0.17	0.021*
1 M	0.20 ± 0.27	0.15 ± 0.16	0.045*
3 M	0.24 ± 0.21	0.16 ± 0.16	0.033*
6 M	0.25 ± 0.20	0.16 ± 0.16	0.010*
12 M	0.25 ± 0.22	0.18 ± 0.17	0.14

LM Lentis Mplus LS-313 MF30 IOL, *LMT* Lentis Mplus LS-313 MF30 toric IOL, *SD* standard deviation, *Pre* preoperatively, *1 W* 1 week postoperatively, *1 M* 1 month postoperatively, *3 M* 3 months postoperatively, *6 M* 6 months postoperatively, *12 M* 12 months postoperatively, *UNVA* uncorrected near visual acuity, *UDVA* uncorrected distance visual acuity, *logMAR* logarithm of the minimum angle of resolution

* Statistically significant difference (P > 0.05)

Gunvant et al. report that 6 weeks after the implantation of a multifocal AcrySof IQ ReSTOR IOL (Alcon Laboratories, Inc., interviews regarding visual outcome satisfaction were conducted with each patient, the result of which was that 21 (20%) of 104 eyes underwent LASIK enhancement after cataract surgery) [19]. Among the current cases, few patients required a LASIK enhancement after multifocal IOL implantation. The better contrast sensitivity comparable to that obtained with monofocal IOLs and the customization of the spherical and cylindrical corrections with the Mplus toric model probably contributed to the reduced need for additional procedures to correct postoperative residual refractive error compared with non-customized diffractive multifocal IOLs including the AcrySof IQ ReSTOR IOL [20]. In addition, the fact that there were no significant differences in the refractive and VA data between those who requested enhancement and those who did not suggests that individual patients' insistence of improved visual function despite satisfactory vision might be driving the indications for enhancement procedures rather than the actual visual and refractive results.

Regarding PCO, Yoshino et al. [21] report that Nd:YAG capsulotomy was performed in six (14.3%) eyes during the 5-year follow-up period, and the mean time to YAG capsulotomy was 3.72 ± 0.76 years (range, 2 years 8 months to 4 years 7 months) after implantation of the AcrySof ReSTOR apodized diffractive multifocal IOL (SN60D3, Alcon Laboratories, Inc.) among 42 study eyes. Gauthier et al. [22] reported that 24 months after implantation of Acri.LISA hydrophilic acrylic multifocal IOLs (Carl Zeiss Meditec) 37.2% of eyes required Nd:YAG laser capsulotomy among 152 study eyes.

The current results show that the rate of Nd:YAG capsulotomy after implantation of Mplus was low both with and without the toric component over 1 year (0.01 and 0%, respectively). Long- term follow-up of PCO is, however, necessary.

The limitation of the current study was that this case series partially included both eyes for one case. Another limitation is the lack of data for intermediate vision except for at 1 year postoperatively. This warrants further investigation, although good intermediate vision at 3 months postoperatively with these IOLs has been reported previously [3, 12, 14].

In conclusion, to the best of our knowledge the current study is the first to compare the outcomes of refractive segmented or refractive segmented toric multifocal IOLs up to 1 year in a single setting. These IOLs were equally able to successfully restore excellent and stable distance and near visual function. The outcomes with the toric IOL model were excellent and comparable to those obtained with the non-toric model despite the preoperative higher corneal astigmatism. These IOLs are good surgical options to correct presbyopia after cataract surgery.

Conflicts of interest R Shodai, None; K. Negishi, None; H. Arai, None; I. Toda, None; H. Torii, None; K. Tsubota, None.

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